

PRESS RELEASE

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INTEGRATED CARBON OBSERVATION SYSTEM, ICOS

Drought in Europe decreases carbon uptake and crop yields

ICOS, the Integrated Carbon Observation System, has enabled a set of studies showing how nature and crops in Europe respond to extremely dry conditions, such as occurred in the last three summers, 2018-2020. The results published today in *Philosophical Transactions B* show, for example, that in 2018 the vegetation's carbon sink function decreased by 18 percent, and crops produced the lowest yields in decades. The results are significant since such extreme droughts will likely happen much more frequently in the future.

Extremely hot and dry summers are expected to be much more frequent in the future due to climate change. This is visible even now, the past summer being the third extremely hot summer in row. The areas of crops affected by droughts will also probably increase considerably, when carbon dioxide (CO₂) levels continue to rise.

The 2018 summer had the largest ever area in Europe under extreme drought. Temperature records were broken in many regions of Central Europe and the UK, fires broke out in the Nordic countries, and several countries were affected by crop failures.

The 17 study results published today in a [special issue of *Philosophical Transactions B*](#) show how vegetation in Europe responds to drought, i.e. how the exchange of carbon between the vegetation and atmosphere is affected. The studies cover areas from Spain to Sweden and Finland, and from the Czech Republic through Germany, France and Belgium to the Netherlands and the UK. The drought studies provide crucial knowledge when trying to minimise the negative effects of the climate change.

Forest carbon sinks decreased, crops were lost, and grasslands browned down

According to the results presented, the plants first profited from warm and sunny conditions in spring 2018, but then had not enough water available to their roots when the summer heat wave hit. Grasslands "browned-down" during the drought, causing to shortages of hay for cattle, and many crops produced the lowest yields in decades, causing financial losses for many industrial sectors. "Several studies show that the dryness of the soil affected the plants even more than e.g. the high temperature and the humidity of the air," explains **Ana Bastos**, a scientist at Max Planck Institute, Germany, and one of the lead authors of the theme issue.

Many of the studies found that on the European scale, the forests protected themselves by reducing their evaporation and growth, leading to decreased uptake of carbon dioxide. Carbon sinks decreased in general by 18% according to a study covering 56 sites.

The dry conditions even turned some ecosystems from sinks into sources. However, rewetted peatlands seemed to survive better e.g. due to new plant growth. This is good news since rewetting peatlands is one of the means widely used to mitigate the consequences of the climate change.

Further, these studies show that the response of the vegetation to an extremely dry summer is strongly dependent on the conditions of the previous spring and even winter. In some parts of the Europe, the winter 2018 was wet, leaving a lot of soil moisture in the ground, while spring was sunny and came early - this caused the vegetation to grow more than average in spring, taking up more carbon from the atmosphere than usual. In some places, this early spring growth was enough to offset the reduction of carbon uptake later in summer. "If the scientific community could predict such droughts and their impacts several months prior to the drought, it would help in adapting to changing climate conditions," ponders Professor **Wouter Peters** from the University of Wageningen, the Netherlands. Peters is one of the lead authors of the theme issue.

Joint research effort of over 200 top scientists

The 17 studies represent the work of over 200 scientists within the ICOS research infrastructure, representing all European top universities and research institutes. The scientists participating in the research effort cooperated extremely well, gathering a vast amount of data, points out **Alex Vermeulen**, co-organiser of the study and Director of the ICOS Carbon Portal: "We had open data exchange during process, [resulting in the unique data sets openly available through ICOS Carbon Portal](#)". The first data sets were available already within 6 months since starting the initiative.

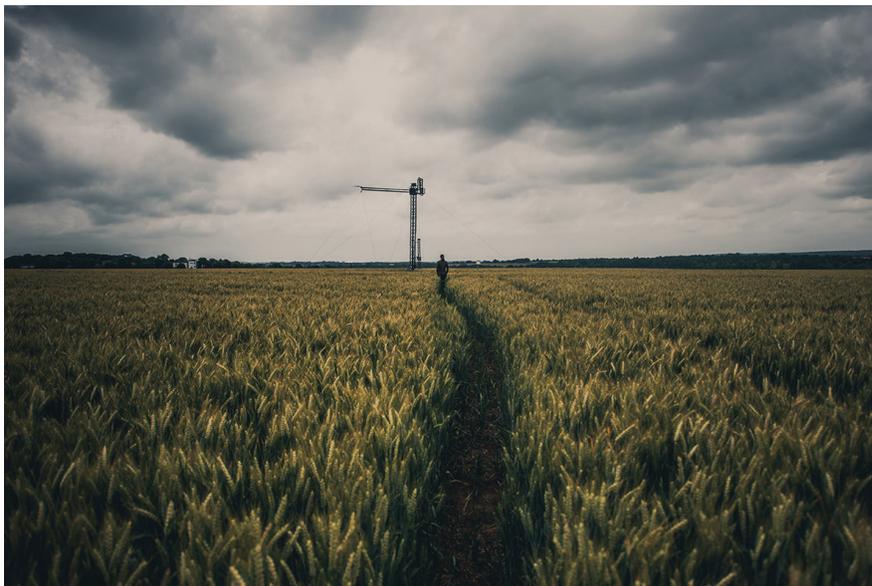
This all was possible thanks to the existing infrastructure and data of ICOS, the Integrated Carbon Observation System, which continuously measures important climate variables over 140 stations across Europe. The long-term high-quality data provided allows for reaching scientific results faster than in traditionally conducted studies.

"Being able to produce unique data sets and results in such a short time shows that research infrastructures such as ICOS are powerful tools enabling high-quality research. To adapt to the changing climate, we cannot rely on tens-of-years-old-knowledge: We must have timely information about the state of the Earth," states **Philippe Ciais**, Research Director at the Laboratoire des Sciences du Climat et de l'Environnement (LSCE), France, and one of the organisers and editors of the theme issue.

"These drought studies demonstrate that the ICOS community is able to collaborate across disciplines, integrate various data streams and bring forth new knowledge to solve the challenges climate change sets all of us," says **Werner Kutsch**, Director General of ICOS.

ICOS Science Conference presents the results of the studies in 15-17 September

ICOS organises its Science Conference online on 15-17 September 2020. Many of the results are being presented by the authors in the Session 2 of the conference, on Tuesday at 14-15.30. The ICOS conference program is available on the ICOS website, and [registration is free of charge](#). Oral sessions are recorded for the participants.



Caption for the photo: In 2018, many crops produced the lowest yields in decades. The ICOS Grignon greenhouse gas measurement station in France (prior to severe droughts). Photo by Konsta Punkka.



Caption for the photo: Spruce trees at the ICOS Hyltemossa station in Sweden cannot sustain their needles amidst the severe heat and drought. Photo by Tobias Biermann.

Further information:

About Integrated Carbon Observation System, ICOS, a European-wide greenhouse gas research infrastructure: ICOS produces standardised data on greenhouse gas concentrations in the atmosphere, as well as on carbon fluxes between the atmosphere, the ecosystems and oceans. This information is essential for predicting and mitigating climate change. The standardised ICOS data is based on the measurements from over 140 stations across 12 European countries. The inter-governmental organization is financed by its member countries.

Webpage: www.icos-ri.eu Twitter: https://twitter.com/icos_ri Drought and other main data sets in ICOS Carbon Portal: <https://www.icos-cp.eu/data-products>

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The theme issue, *Philosophical Transaction B*, published by Royal Society:

The Philosophical Transactions B: 'Impacts of the 2018 severe drought and heatwave in Europe: from site to continental scale' <https://royalsocietypublishing.org/toc/rstb/375/1810>.

Articles and the lead authors, with direct links to the scientific articles:

Wouter Peters, Ana Bastos, Philippe Ciais and Alex Vermeulen, **Introduction: A historical, geographical and ecological perspective on the 2018 European summer drought.**

<https://doi.org/10.1098/rstb.2019.0505>

Ana Bastos et al., **Impacts of extreme summers on European ecosystems: a comparative analysis of 2003, 2010 and 2018.** <https://doi.org/10.1098/rstb.2019.0507>

Michael Ramonet et al., **The fingerprint of the summer 2018 drought in Europe on ground-based atmospheric CO₂ measurements.** <https://doi.org/10.1098/rstb.2019.0513>

Naomi E Smith et al., **Spring enhancement and summer reduction in carbon uptake during the 2018 drought in northwestern Europe.** <https://doi.org/10.1098/rstb.2019.0509>

Christian Rödenbeck, Sönke Zaehle, Ralph Keeling and Martin Heimann, **The European carbon cycle response to heat and drought as seen from atmospheric CO₂ data for 1999–2018.**

<https://doi.org/10.1098/rstb.2019.0506>

Rona L Thompson et al., **Changes in net ecosystem exchange over Europe during the 2018 drought based on atmospheric observations.** <https://doi.org/10.1098/rstb.2019.0512>

Damien Beillouin et al., **Impact of extreme weather conditions on European crop production in 2018.** <https://doi.org/10.1098/rstb.2019.0510>

Alexander Graf et al., **Altered energy partitioning across terrestrial ecosystems in the European drought year 2018.** <https://doi.org/10.1098/rstb.2019.0524>

Zheng Fu et al., **Sensitivity of gross primary productivity to climatic drivers during the summer drought of 2018 in Europe.** <https://doi.org/10.1098/rstb.2019.0747>

Tarek S El-Madany et al., **Drought and heatwave impacts on semi-arid ecosystems' carbon fluxes along a precipitation gradient.** <https://doi.org/10.1098/rstb.2019.0519>

Anders Lindroth et al., **Effects of drought and meteorological forcing on carbon and water fluxes in Nordic forests during the dry summer of 2018.**
<https://doi.org/10.1098/rstb.2019.0516>

Janne Rinne et al., **Effect of the 2018 European drought on methane and carbon dioxide exchange of northern mire ecosystems.** <https://doi.org/10.1098/rstb.2019.0517>

Mana Gharun et al., **Physiological response of Swiss ecosystems to 2018 drought across plant types and elevation.** <https://doi.org/10.1098/rstb.2019.0521>

Natalia Kowalska et al., **Analysis of floodplain forest sensitivity to drought.**
<https://doi.org/10.1098/rstb.2019.0518>

Franziska Koebsch et al., **The impact of occasional drought periods on vegetation spread and greenhouse gas exchange in rewetted fens.** <https://doi.org/10.1098/rstb.2019.0685>

Louis Gourlez de la Motte et al., **Non-stomatal processes reduce gross primary productivity in temperate forest ecosystems during severe edaphic drought.**
<https://doi.org/10.1098/rstb.2019.0527>