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Leibniz Centre for Agricultural Landscape Research (ZALF)

Study in cooperation with ZALF fills the gap between regional and global data

CO_2 emissions from dry inland waters globally underestimated

Inland waters such as rivers, lakes and reservoirs play an important role in the global carbon cycle. Calculations that scale up the carbon dioxide emissions from land and water surface areas do not take account of inland waters that dry out intermittently. This means that the actual emissions from inland waters have been significantly underestimated – as shown by the results of a recent international research project led by scientists at the Helmholtz Centre for Environmental Research (UFZ) in Magdeburg and the Catalan Institute for Water Research (ICRA) and in cooperation with the Leibniz Centre for Agricultural Landscape Research (ZALF) in Muencheberg. The study was published in *Nature Communications*.

“It all began in 2013, during a measurement campaign in Catalonia in Spain”, says Dr Matthias Koschorreck, a biologist in the Department of Lake Research at UFZ. Together with a Spanish team, he was studying the release of greenhouse gases in the catchment of a small river. "It was summer and parts of the riverbed were dry. On a whim, we decided to take some measurements in those areas too," Koschorreck explains. "The results surprised us – these dry, gravelly areas of the riverbed released unexpectedly high levels of carbon dioxide." Koschorreck and his colleague Dr. Rafael Marcé from ICRA in Girona (Spain), decided to investigate that further. Results from various locations in Spain and Germany all produced the same finding: dry inland waters released readily measurable and sometimes considerable levels of carbon dioxide.

“We wondered whether this might be the case in other regions of the world, and whether greenhouse gas emissions from inland waters might be fundamentally underestimated," says Koschorreck. "In studies that scale up emissions of greenhouse gases from land and water surface areas, inland waters that dry out intermittently haven't previously been taken into account."

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To investigate these questions, in 2016 Koschorreck and Marcé together with a core team of six German and Spanish scientists launched the dryflux research project, with the aim of measuring greenhouse gas emissions from dry inland waters. As part of a workshop held at the UFZ's Magdeburg site, they developed a measurement and sampling concept for their study. They then engaged the help of their international networks. "Every participant at the workshop got in touch with research teams all over the world to see whether they would be interested in taking part in measurement campaigns on freshwater systems in their area," explains Koschorreck. "The response was amazing. Twenty four research teams from all over the world took part, which meant that we were able to collect data from 196 different sites on every continent except Antarctica." Among them was the ZALF research team integrated by Florian Reverey and Dr. Gabriela Onandia, who contributed to the project with measurements performed in ten kettle holes in the AgroScapeLab Quillow, in the Uckermark region, Northeast Germany.

Each team carried out three closed-chamber measurements in dry areas of at least three freshwater systems in their region – a river, lake, reservoir or pond. This involves placing a special measuring container with its open end downwards on the ground, separating the air inside the container from the ambient air. An analytical device is then used to measure the change in the amount of carbon dioxide inside the container. At the same location, the project partners also took samples of the dry sediment and measured its moisture, organic matter and salt content, temperature, and pH.

The large, complex dataset was evaluated by Philipp Keller, a doctoral researcher in the Department of Lake Research at the UFZ and first author of the study, who came to some interesting conclusions. "We found significant carbon dioxide emissions from dry areas of inland waters across all climate zones", says Keller.

"So this really is a global phenomenon." The researchers also discovered that these emissions are in fact often higher than typical emissions from water surfaces of the same size. "We were able to show that dry areas of inland waters actually account for a significant proportion of total carbon dioxide emissions from these freshwater systems", says Koschorreck. "If you take account of this in global calculations for inland waters, the carbon dioxide emissions increase by six percent." But what mechanisms are responsible for the release of carbon dioxide from dry inland water sediments? "Respiration processes of microorganisms", says Philipp Keller. "The more substrate available – the more organic matter in the soil – and the more favorable the conditions like temperature and sediment moisture, the more active they are and the more carbon dioxide is released."

From the results of the study, the researchers concluded that the factors responsible for carbon dioxide release are essentially the same all over the globe. "The interaction of local conditions like temperature, moisture and the organic matter content of the sediments is crucial, and it has a bigger influence than regional climate conditions", Keller explains.

So what do the results of the study mean for the future assessment of carbon dioxide emissions from inland waters? "Our study shows that carbon dioxide emissions from inland waters have been significantly underestimated up until now", says Koschorreck. "We hope that our work will help ensure that dry areas of freshwater systems are included in future calculations. With the progression of climate change, more surface waters are probably drying out and thus, CO2 emissions will likely increase."

More information:

Project Dryflux: https://www.ufz.de/dryflux/

Publication („Global CO2 emissions from dry inland waters share common drivers across ecosystems") in Nature Communications: https://doi.org/10.1038/s41467-020-15929-y

River Elbe (Germany) in June 2018 | Source: © Matthias Koschorreck | Picture in color and print quality: http://www.zalf.de/de/aktuelles

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About the Leibniz Centre for Agricultural Landscape Research (ZALF) in Muencheberg, one of the institutes of the Leibniz Association:

Mission of ZALF is to deliver solutions for an economically, environmentally and socially sustainable agriculture –together with society.

As a contribution to overcoming global challenges such as climate change, food security, biodiversity conservation and resource scarcity, we develop and design crop systems, integrated in their landscape contexts that combine food security with sustainability. Therefore we process complex landscape data with a unique set of experimental methods, new technologies and models as well as socio-economic approaches.

ZALF research is integrated systems research: starting from processes in soils and plants to causal relationships on the field and landscape level up to global impacts and complex interactions between landscapes, society and economy. www.zalf.de