Team reassesses greenhouse gas emissions from African lakes

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The emissions of carbon dioxide (CO_2) and methane (CH_4)—the most potent greenhouse gases—into the atmosphere from African lakes are reassessed in a study undertaken by the Laboratory of Chemical Oceanography (FOCUS research unit / Faculty of Science). While it was previously assumed that these lakes were significant CO_2 sources, it has

since been discovered that they really emit very little CO_2 but a lot of methane, adding to the emissions burden. The study is published in *Science Advances*.

One of the keys to predict climate change is to predict how greenhouse gas (GHG) emissions from our planet's natural ecosystems might change. But to do this, it is important to be able to estimate them as accurately as possible and to understand the underlying mechanisms. There are about 1.5 million lakes on Earth. Unlike the oceans, they play an important role in the emission of greenhouse gases. Recognition of the important role of continental waters as emitters of carbon dioxide (CO_2) and methane (CH_4)—the two main GHGs—came rather late. It was not until in the mid-1990s that they began to be studied and are therefore relatively undersampled.

"This is problematic," explains Alberto Borges, FNRS researcher at the Laboratory of Chemical Oceanography at ULiège, "because spatial heterogeneity is very important, both within a single lake or river and between different systems. If the heterogeneity is very high, very large amounts of data are required to obtain a robust estimate of GHG emissions. There are almost two million lakes on Earth."

Until now, researchers have only had data on North American and Scandinavian (boreal) lakes and very little on tropical lakes and none on African lakes. These values were extrapolated to all lakes worldwide, including tropical lakes. However, these lakes do not "behave" in the same way in terms of GHG sequestration and emissions. A study conducted over ten years by researchers from the ULiège Chemical Oceanography Laboratory has shown that the data collected for North American and Scandinavian lakes does not apply to African lakes.

"The microalgae that make up the phytoplankton are very fond of the warm and luminous conditions of the tropical 'endless summer,'" says

Alberto Borges, "which means that some of the African lakes that we have studied are extremely productive. However, through photosynthesis , phytoplankton removes CO_2 from the water and these lakes, therefore, sequester CO_2 in the form of organic matter buried at the bottom of the lakes in the sediments. They therefore act as carbon sinks, whereas until now it had always been assumed that lakes emitted CO_2 in very large quantities into the atmosphere, as do boreal lakes." Indeed, due to the colder and less luminous conditions, boreal lakes have very little phytoplankton and are limited to "composting" plant waste from the surrounding forest, which is transported to the lakes by runoff, and therefore cannot play the role of sink as African lakes do.

But the warm tropical conditions all year round have a downside. The heat is very favorable to the development of archaea, micro-organisms that produce methane (CH_4). This means that methane concentrations in tropical lakes are very high compared to boreal lakes, especially as the phytoplankton that sediment at the bottom of tropical lakes provides a very interesting substrate from a 'nutrient' point of view for methane-producing archaea. What was thought to be 'gained' in tropical lakes in terms of CO_2 sequestration, is in fact 'lost' through increased CH_4 production.

"Thanks to an understanding of the mechanisms underlying the production of CO_2 and CH_4 by lakes (depth and surrounding vegetation cover), we can now have a more informed and rigorous approach to the situation rather than a blind extrapolation based on a simple average of all the data, as has been done until now in the literature," concluded Alberto Borges.

The study carried out by the ULiège researchers allowed for the extrapolation of CO_2 and CH_4 emissions to 72,500 tropical lakes around the world by integrating several spatial databases. This study synthesizes measurements obtained over more than 10 years in 24 African lakes,

including the largest of the African Rift (Victoria, Tanganyika, Albert, Kivu, Edouard), during 17 field missions, in the framework of 2 BELSPO projects (EAGLES, HIPE) and 5 FNRS projects (TRANS-CONGO, LAVIGAS, TANGAGAS, KYBALGAS, MAITURIK).

More information: Alberto V. Borges et al, Greenhouse gas emissions from African lakes are no longer a blind spot, *Science Advances* (2022). DOI: 10.1126/sciadv.abi8716