Climate change enhances carbon dioxide flux from lakes

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Boreal lakes play a significant role in global carbon cycling. Small and shallow lakes are abundant in northern areas, and they are often biologically active because of the loading of organic matter from the catchments. As microbes degrade organic matter that has been accumulated in the water column and in the bottom sediments, the water column carbon dioxide concentration exceeds the saturation level in many lakes, and some of the carbon dioxide is released to the atmosphere.

In his thesis at the University of Jyväskylä, M.Sc. Petri Kiuru studied carbon cycling in lakes using a process-based model that describes the temporal evolution of temperature distribution and water quality in a lake. The study was especially focused on carbon dioxide exchange between the lake water column and the atmosphere. Another aim of the study was to assess the impact of climate change on carbon dynamics in boreal lakes.

Because of climate change-induced increases in air temperature and annual precipitation, boreal lakes are warming and the amount of external loading of organic matter to the lakes may increase. The study results indicated that these factors may also increase the lake carbon dioxide concentrations and enhance the release of carbon dioxide to the atmosphere. These increases should also be considered in the estimation of future changes in global carbon cycling.

In the study, Kiuru also used model simulations to assess the effects of improved estimates of air-water carbon dioxide exchange on the determination of the carbon budgets of boreal lakes. Continuous carbon dioxide flux measurements that have been performed with new, advanced methods have shown that the exchange of carbon dioxide between the lake water column and the atmosphere occurs faster than previously estimated. Hence, also the extent of carbon dioxide production in lakes and the amount of external carbon loading, including loading through groundwater, should be assessed more closely.

Process-based models are important tools in illustrating and studying the complex dynamic processes in a lake. They enable researchers to build a comprehensive description of a lake and to study the interplay between different components of the lake system, such as ice cover; hydrodynamics; thermal, chemical, and biological conditions; and catchment loading. The vertical lake model that was developed and applied in the study can be further utilized in freshwater ecosystem

research. The modeling tool can be applied to describe carbon cycling in different lakes both under present and future conditions, especially together with models that simulate hydrological and biochemical processes in lake catchments and substance loading from the catchments.

More information: Kiuru, Petri. Modeling CO2 emissions from boreal lakes in present and future. JYU dissertations. urn.fi/URN:ISBN:978-951-39-7777-1

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