Combined nutrients and warming massively increase methane emissions from lakes

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Shallow lakes may be a serious source for methane release to the atmosphere. Credit: Ben Goldsmith

Shallow lakes in agricultural landscapes will emit significantly greater amounts of methane, mostly in the form of bubbles (ebullition) in a warmer world, which is a potential positive feedback mechanism to climate warming.

Submerged plants are key predictors of methane ebullition. The combination of warming with the loss of plants appears to transform shallow lakes into methane bubbling machines.

These are the main findings of a study published today in *Nature Climate Change* led by senior researcher Thomas A. Davidson, from the Department of Bioscience and Arctic Research Centre, Aarhus University, Denmark.

Methane is a potent greenhouse gas with 25 times greater warming potential than carbon dioxide. Shallow lakes are increasingly recognised as playing an important role in global greenhouse gas cycling. Given the number of shallow lakes globally, they potentially have a large influence on atmospheric methane concentrations, which continue to rise.

Methane is released from lakes in a number of ways, both by diffusion of dissolved gas and by bubbles released from the sediments, also called ebullition. Ebullition is not constant, but happens in episodes of bubble release, so is hard to measure accurately. As a result, it is not clear how much methane is released as bubbles from lakes, nor are we sure how it will respond to the combination of climate change and nutrient enrichment.

Abundant submerged plants may reduce the methane flux to the atmosphere. Credit: Ben Goldsmith

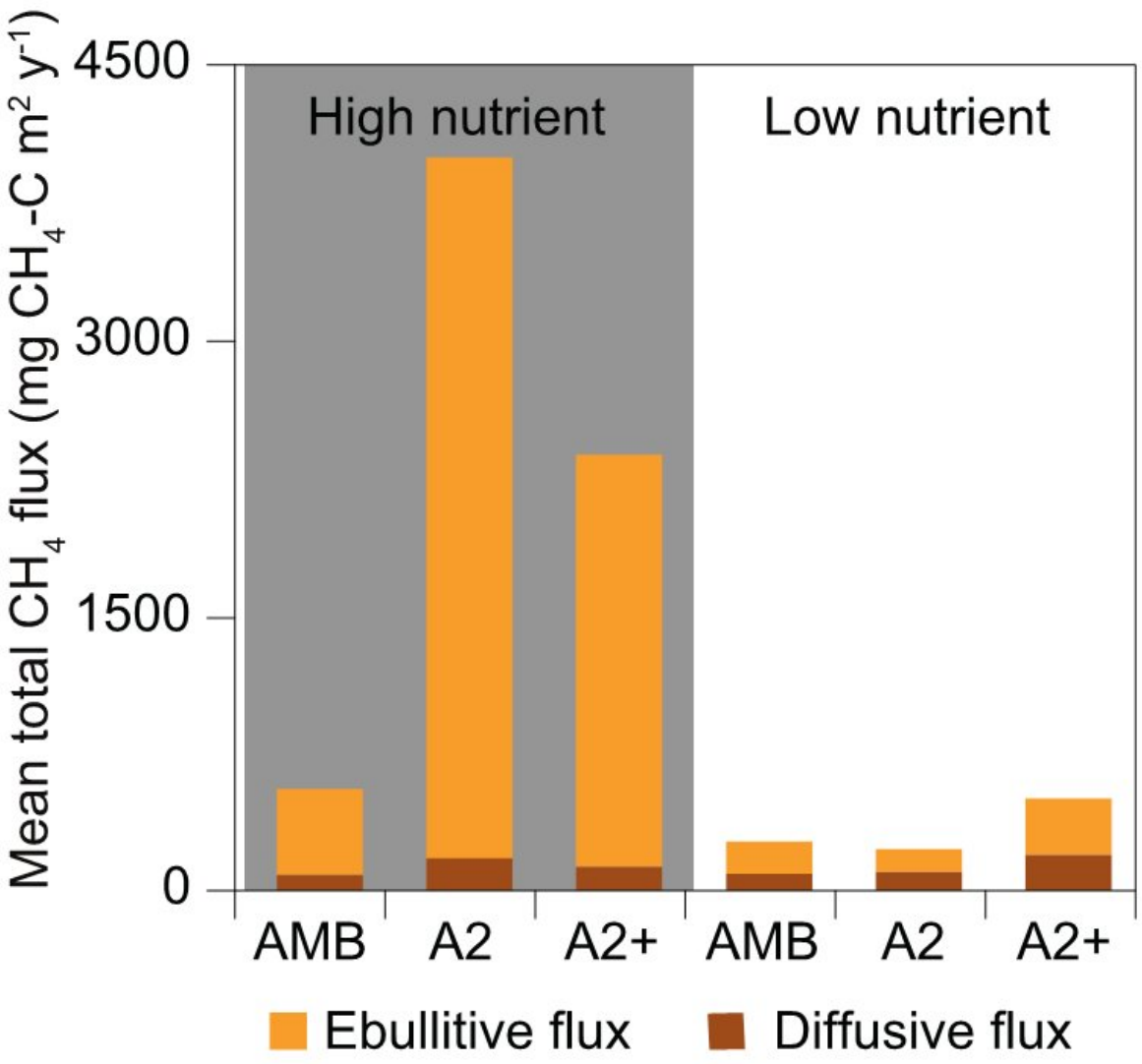
The present study used the longest-running freshwater mesocosm climate change experiment in the world to investigate how warming and eutrophication might interact to change methane ebullition in the future.

The results here were striking as they showed that the combination of increased nutrient loading and warming had a synergistic effect on the ebullition of methane. In the absence of nutrient enrichment, warming alone increased annual methane ebullition by around 50 percent and its relative contribution to total methane emission rose from about 50 percent to 75 percent.

In stark contrast, when nutrient levels were high, warming increased total methane emission by at least six-fold, and in some cases, 17-fold, and the proportion of ebullition increased to 95 percent of total annual methane flux.

Submerged plants reduce methane ebullition

Nutrient enrichment, or eutrophication, is the most common human impact on fresh waters, with all lakes in agricultural landscapes likely to be impacted.



The annual mean methane emission (divided into diffusion and ebullition) from different experimental treatments within the mesocosm. High and low nutrient levels and then three temperature levels - AMB is ambient temperature, A2 is +2-3 degrees C and A2+ is +4-5 degrees C. Credit: Thomas A. Davidson

A feature of eutrophication in shallow lakes is the loss of biodiversity and the replacement of submerged plants by phytoplankton as the

dominant primary producer.

The current study identified the abundance of submerged plants as a key predictor of methane ebullition. However, where plants were abundant, methane ebullition was reduced compared to when plants were absent, even at higher temperatures.

This suggests that through careful management of agricultural landscapes and fresh waters ensuring the proliferation of submerged plants, ebullition of methane can be minimised and in addition ecological condition and fresh water biodiversity will benefit.

More information: Thomas A. Davidson et al, Synergy between nutrients and warming enhances methane ebullition from experimental lakes, *Nature Climate Change* (2018). DOI: 10.1038/s41558-017-0063-z

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