Clean air policies unintentionally drive up wetland methane emissions, study finds

February 5 2025

Credit: Unsplash/CC0 Public Domain

Reducing sulfur in the air may inadvertently increase natural emissions of methane from wetlands such as peatlands and swamps, a new study has found.

The findings published in the journal *Science Advances* suggest that the decline of global sulfur emissions as the result of clean air policies, coupled with the warming and fertilization effects of carbon dioxide emissions, lifts a lid on wetland methane production, resulting in increased emissions.

The resulting additional future release of 20–34 million metric tons of methane each year from natural wetlands would mean targets to reduce human-caused emissions need to be more stringent than currently set out in the Global Methane Pledge.

Methane, which is one of the most potent greenhouse gases in trapping heat in the atmosphere, is produced in wetlands around the world. Sulfur (in the form of sulfate) has a very specific effect on natural wetlands that reduces methane emissions, while CO_2 increases methane production by increasing growth in plants that make the food for methane-producing microbes.

Professor Vincent Gauci from the University of Birmingham and a senior author of the study said, "Well-meaning policies aimed at reducing atmospheric sulfur appear to be having the unintended consequence of lifting this sulfur 'lid' on wetland methane production. This coupled with increased CO_2 means we have a double whammy effect that pushes emissions much higher.

"How has this happened? Put simply, sulfur provides the conditions for one set of bacteria to outmuscle another set of microbes that produce methane when they compete over the limited food available in wetlands. Under the conditions of acid rain sulfur pollution during the past century, this was enough to reduce wetland methane emissions by up to 8%.

"Now that clean air policies have been introduced, the unfortunate

consequence of reducing sulfur deposition, which does have important and welcome effects for the world's ecosystems, is that we will need to work much harder than we thought to stay within the safe climate limits set out in the Paris agreement."

More than 150 nations signed up to the Global Methane Pledge at COP26 in Glasgow, which seeks to reduce human-caused emissions of methane by 30% on a 2020 baseline, by 2030.

The study is the latest to implicate reductions in atmospheric sulfur in driving warming at a faster rate than anticipated. In 2020, shipping pollution controls were introduced to reduce emissions of sulfur dioxide and fine particles that are harmful to human health. This reduction in atmospheric sulfur over the oceans has been implicated in larger warming than expected in what has come to be known as 'termination shock.'

Lead author of the paper Lu Shen of Peking University said, "Our study points to the complexity of the climate system. Representation of these complex biogeochemical interactions has not previously been well integrated into estimates of future methane emissions.

"We show that it is essential to consider these feedbacks to get a true understanding of the likely future of this important greenhouse gas."

More information: Lu Shen, The large role of declining atmospheric sulfate deposition and rising CO_2 concentrations in stimulating future wetland CH_4 emissions, *Science Advances* (2025). DOI: 10.1126/sciadv.adn1056. www.science.org/doi/10.1126/sciadv.adn1056

Provided by University of Birmingham