Mercury concentrations in Yukon river fish could surpass EPA criterion by 2050

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Kevin Schaefer standing above melting ground ice in front of the Alaska pipeline on the North Slope. Credit: Roger Michaelides

The concentration of mercury in the fish in Alaska's Yukon River may exceed the EPA's human health criterion by 2050 if greenhouse gas

emissions that cause global warming are not constrained, according to scientific research funded in part by NASA. This first of its kind research estimates potential releases of mercury from thawing permafrost under high and low carbon emissions scenarios. The researchers predict that by 2200, the mercury emitted into both the atmosphere and water annually by thawing permafrost will compare with current global anthropogenic mercury emissions. That's because higher carbon emissions lead to faster and more atmosphere and water, where it can accumulate in wildlife like fish. The team's results were published Sept. 16 in *Nature Communications*.

"If we can hit the Paris Accord target, we expect minimal impacts to mercury concentrations in fish and water. If we continue with unconstrained greenhouse gas emissions, however, it is likely that we will see large increases in mercury concentrations," said Kevin Schaefer, a scientist at the National Snow and Ice Data Center (NSIDC) and lead researcher on the project. Mercury emissions of these magnitudes could have a global impact. "What happens in the Arctic does not stay in the Arctic," said Schaefer, "The mercury emissions from thawing permafrost could persist for centuries, impacting the environment both locally and globally."

In 2018, Schaefer and several of his colleagues found that permafrost soils store nearly twice as much mercury as all other soils, the ocean and the atmosphere combined. That work was funded by NASA as part of the Arctic-Boreal Vulnerability Experiment (ABoVE), a major effort to improve understanding of how climate change is affecting Arctic ecosystems, and how those changes ultimately affect people and places in the Arctic and beyond. Now, the researchers have created a model—which relies in part on data from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument aboard NASA's Terra satellite—to predict how mercury emissions from thawing Arctic permafrost will change under different global emissions scenarios.

The new paper characterizes the release of mercury from thawing permafrost for high and low carbon emissions scenarios based on two of the four Representative Concentration Pathways (RCPs) from the Intergovernmental Panel on Climate Change's Fifth Assessment Report (AR5). The high carbon emissions scenario (RCP 8.5) assumes unconstrained "business as usual" emissions, while the low carbon emissions scenario (RCP 4.5) assumes carbon emissions consistent with the Paris Agreement global target of less than 2 degrees Celsius of warming above pre-industrial levels.

The results indicate minimal impacts to mercury concentrations in water and fish for the low carbon emissions scenario and large increases for the high carbon emissions scenario. At the global level, the high carbon emissions scenario would significantly increase the amount of mercury released into the atmosphere, where it would persist in the environment for centuries. At a local level, this would result in large increases to mercury concentrations in fish and water in the Yukon River. For the high emissions scenario, mercury concentrations could double in the Yukon River by 2100. The low carbon emissions scenario shows minimal mercury releases to the atmosphere and small changes to mercury concentrations in fish and water. For the low emissions scenario, mercury concentrations would likely increase by only about 14 percent and would not exceed EPA criterion by 2300.

"The thaw of permafrost due to climate change may release mercury as well as greenhouse gases like methane. We need to comply with the Paris Accord target of 2 degrees C. Otherwise, under a high emission scenario, a significant portion of mercury will be released to the environment, and it will continue for hundreds of years," said Yasin Elshorbany, a co-author on the study from the University of South Florida St. Petersburg campus.

The Yukon River is the fifth largest drainage basin in North America

and home to one of the world's longest salmon runs. It serves as an important commercial and subsistence fishery.

More information: Kevin Schaefer et al, Potential impacts of mercury released from thawing permafrost, *Nature Communications* (2020). DOI: 10.1038/s41467-020-18398-5

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