Study finds warming peat may boost greenhouse gases

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SPRUCE study site for studying effects of warming temperatures on peatland. Credit: Oak Ridge National Laboratory

Warming temperatures in cold-climate peatlands may over time trigger decomposition of old, deeply buried peat and increase emissions of climate-harming methane and carbon dioxide into the air, according to a study led by a former University of Oregon doctoral student.

Most troubling is the potential release of methane, a potent greenhouse gas that absorbs sunlight and warms the atmosphere, said study co-author Scott Bridgham, a biologist in the Department of Biology and member of the UO's Environmental Studies Program and Institute of Ecology and Evolution.

The study, led by Anya Hopple and conducted by a nine-member team at an experimental Minnesota forest, appeared last month in *Nature Communications*. Peatlands, which consist of decaying organic matter that can be many meters deep, contain half of the world's soil carbon but occupy only 3 percent of land area. How warming will affect gas emissions and global warming is a growing concern.

"Most of this peat carbon has accumulated over thousands of years due to prolonged cold and waterlogged conditions, so a central question is how inert this carbon is in the face of climate change," Bridgham said. "In the world's only whole-ecosystem warming and elevated atmospheric carbon dioxide experiment in a peatland, our team showed that after a lag period of about a year, the entire peat profile began to produce more carbon dioxide and methane."

In the U.S. Department of Energy-funded study, researchers warmed the soil to 3 meters deep, or about 10 feet, with electric resistors at five different temperatures related to projected warming. Deeper soils tend to mirror annual average temperatures while surface soils reflect seasonal variation, Bridgham said.

Results presented in the study were drawn from four years of data collected in 2015-18 as part of long-term research being done by multiple institutions at the Spruce and Peatland Responses Under Changing Environments experimental site, known as SPRUCE.

During that time, exponential increases were seen in surface methane emissions, with much greater methane production occurring at greater depths, in response to increasing temperatures throughout the soil profile. Radiocarbon analyses showed that older and deeper carbon sources were playing a significant role in the changes.

"The microbes that decompose soil organic matter under waterlogged conditions respire carbon dioxide and/or methane," Bridgham said. "The ratio of these gases matters in microbial respiration because methane is a 45-times-stronger greenhouse gas than is carbon dioxide over a 100-year time frame."

The researchers looked for but found little evidence for increases in the level of atmospheric carbon dioxide, which is important in photosynthesis. Effects have been seen in plant physiology, Bridgham said, but that has not yet permeated down to other ecosystem functions.

In earlier published work that looked at just 14 months of warming temperatures deep in the peat, a team that also included Hopple, who is now a researcher at the Pacific Northwest National Laboratory, and Bridgham found no effects on methane and carbon dioxide production in deeper peat.

"Our current results suggest that ecosystem responses remain largely driven by surface peat, but that following a relatively short lag, the vast (carbon) bank at depth in peatlands is responsive to warming," the team noted.

The authors noted that their results came from one northern peatland location and may apply most directly to traditionally cold-climate peatlands experiencing warming temperatures. The highest elevated temperature used in the study was at the high end of a range expected in a worst-case scenario for arctic locations.

Provided by University of Oregon