Warmer climates don't necessarily mean more fertile soils, study says

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(Phys.org)—Warmer climates won't necessarily speed the return of nitrogen to soils as scientists once thought, according to a Purdue University study.

Increased temperatures from climate change have been expected to speed decomposition of plant materials and the return of nitrogen to soils, making the soil more fertile for plants. But Jeff Dukes, an associate professor of forestry and natural resources at Purdue, found that the microbes responsible for returning nitrogen to soils react differently to a range of climate scenarios.

"More nitrogen being available is not something we can count on in all ecosystems," said Dukes, whose findings were published in the journal Global Change Biology.

The findings suggest that while warming has been expected to accelerate nitrogen cycling, it may actually have little to no effect on the process in some ecosystems. This means that climate models that assume increased soil fertility in warmer conditions may overestimate the amount of plant productivity in those ecosystems.

Dukes runs the Boston-Area Climate Experiment, which measures ecosystem responses to climate change. His research group uses heaters, plastic roofs and sprinklers to change the climate over small plots of land and then tests plant and soil responses to increases in temperature and increases or decreases in precipitation.

In this experiment, Dukes tested 36 plots under 12 different climate scenarios - four levels of warming and three different levels of precipitation - over two years.

Although Dukes and his team expected to find that warming would speed the return of nitrogen to the soil, they instead found that warming and changes in precipitation rarely influenced this rate. Instead, warming and drought caused the processes involved in nitrogen cycling to become less sensitive to temperature.

"It seems that some ecosystems are less responsive than we expected," Dukes said. "It may be that as you warm up, the soil microbes in those ecosystems adjust and the rate of nitrogen cycling winds up being the same."

Novem Auyeung, a doctoral student who was involved in the study, added, "Soil microbes operate on very short time scales, and many adjustments could have happened in the microbial community over the course of our two-year experiment."

Dukes said it would take further study to understand just how soil microbes are affected by climate changes.

"These responses would have to be based on the abundance or composition of microbes or the activity of these microbes," Dukes said. "We need to learn which it is."

Dukes said he would like to test whether the results are similar in other soil types so that climate models can accurately simulate these processes.

"Soil fertility can affect carbon storage, and ultimately the rate of climate change," Dukes said. "I want to see how general this result is so that we can better predict how ecosystems will function in the future. If lots of ecosystems work this way, then nature may not be as good at slowing climate change as we had thought."

More information: Warming and Drought Reduce Temperature Sensitivity of Nitrogen Transformations, *Global Change Biology*.

Abstract
Shifts in nitrogen (N) mineralization and nitrification rates due to global changes can influence nutrient availability, which can affect terrestrial productivity and climate change feedbacks. While many single-factor studies have examined the effects of environmental changes on N mineralization and nitrification, few have examined these effects in a multi-factor context or recorded how these effects vary seasonally. In an old-field ecosystem in Massachusetts, USA, we investigated the combined effects of four levels of warming (up to 4°C) and three levels of precipitation (drought, ambient and wet) on net N mineralization, net nitrification and potential nitrification. We also examined the treatment effects on the temperature sensitivity of net N mineralization and net nitrification and the ratio of C mineralization to net N mineralization. During winter, freeze-thaw events, snow depth and soil freezing depth explained little of the variation in net nitrification and N mineralization rates among treatments. During two years of treatments, warming and altered precipitation rarely influenced the rates of N cycling, and there was no evidence of a seasonal pattern in the responses. In contrast, warming and drought dramatically decreased the apparent Q10 of net N mineralization and net nitrification, and the warming-induced decrease in apparent Q10 was more pronounced in ambient and wet treatments than the drought treatment. The ratio of C mineralization to net N mineralization varied over time and was sensitive to the interactive effects of warming and altered precipitation. Although many studies have found that warming tends accelerate N cycling, our results suggest that warming can have little to no effect on N cycling in some

ecosystems. Thus, ecosystem models that assume that warming will consistently increase N mineralization rates and inputs of plant-available N may overestimate the increase in terrestrial productivity and the magnitude of an important negative feedback to climate change.

Provided by Purdue University

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