

Moisture the key to soils' ability to sequester carbon, Oregon State research shows

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Soil is the Earth's second-biggest carbon storage locker after the ocean, and a research collaboration has shown that it's moisture, not temperature or mineral content, that's the key to how well the soil carbon warehouse works.

The findings are important for understanding how the global carbon cycle might change as the climate grows more warm and dry, said Oregon State University's Jeff Hatten, co-author of the study published in the Proceedings of the National Academy of Sciences.

"Carbon in soil has many functions," said Hatten, a researcher in the OSU College of Forestry. "It's a major component of soil organic matter that is important to water and nutrient accessibility for plants, and it's an energy supply to diverse populations of soil organisms. Climate change may impact soil carbon and threaten these important ecosystem services, as well as soils' ability to keep carbon out of the atmosphere and mitigate climate change."

Carbon stored in soil has been estimated to total 2,500 gigatons – roughly three times as much as is in the atmosphere and quadruple the amount in every living thing on Earth combined.

Hatten said earlier research had suggested that soil carbon in wet ecosystems was most vulnerable to shifts in temperature and that changes in moisture represented the larger threat only to soil carbon in dry ecosystems.

“The big takeaway from the new study is that most of the things we thought we knew about soil carbon were wrong,” said Kate Heckman of the U.S. Forest Service, who led the research. “Our initial hypothesis centered on the importance of certain kinds of soil minerals that we assumed were important in carbon persistence, or how long carbon stays in soil. We also thought that temperature patterns across the sites would be a strong regulator of carbon age, but we didn’t see the signals we expected to see associated with either temperature or soil mineralogy.”

Hatten, Heckman and collaborators from Virginia Tech, Michigan Tech, the University of Colorado and the Pacific Northwest National Laboratory looked at 400 soil core samples from 34 sites. The samples were collected by the National Science Foundation’s National Ecological Observatory Network, or NEON, whose goal is to gather long-term data from across North America to aid understanding of how ecosystems are changing.

The cores provide pictures of thousands of unique soil “horizons,” Hatten said – layers of soil showing different characteristics based on age and composition.

“Opening the cores was like seeing different parts of the country through an 8-by-200-millimeter soil snapshot,” said Adrian Gallo, who performed many of the initial core analyses as a doctoral student under Hatten. “It was not uncommon to open up the cores and think, ‘What on Earth is happening here with the colors and rocks and roots?’ And then I’d have to look at aerial imagery, topography maps and soil descriptors from nearby locations to help me understand the landscape history.”

“Our results show that when predicting the response of soil carbon to climate change, particularly at a site in a dry ecosystem, we need to consider the history of climate and soil on that site,” Hatten added.

Researchers performed radiocarbon and molecular composition analyses on the core samples to shed light on the relationship between the abundance and persistence of carbon in soil and the availability of moisture. Ultimately, the scientists divided the core sample sites into being from systems that could be broadly described as having either a humid or arid climate. The division correlated with differences in organic carbon decomposition rates from site to site.

“Soil organic carbon is being considered as one of the more promising carbon capture and sequestration approaches we have, and understanding the role moisture plays in that process is critical to helping us realize that potential,” Heckman said. “My hope is that this study encourages a lot of our science community to examine the role of moisture in the terrestrial carbon cycle.”

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