Global nitrogen availability consistent for past 500 years, linked to carbon levels

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Credit:Satoru Kikuchi via photopincc

(Phys.org) —A Kansas State University research team has found that despite humans increasing nitrogen production through industrialization, nitrogen availability in many ecosystems has remained steady for the past 500 years. Their work appears in the journal *Nature*.

"People have been really interested in nitrogen in current times because

it's a major pollutant," said Kendra McLauchlan, assistant professor of geography and director of the university's Paleoenvironmental Laboratory. "Humans are producing a lot more nitrogen than in the past for use as crop fertilizer, and there is concern because excess levels can cause damage. The mystery, though, is whether the biosphere is able to soak up this extra nitrogen and what that means for the future."

Nitrogen is a key component of the ecosystem and the largest regulator of plant growth. It determines how much food, fuel and fiber the land can produce. It also determines how much carbon dioxide plants remove from the atmosphere, and it interacts with several components of the climate system. Excessive amounts of nitrogen in ecosystems contribute to global warming and impairment of downstream ecosystems.

McLauchlan worked with Joseph Craine, research assistant professor in biology; Joseph Williams, postdoctoral research associate; and Elizabeth Jeffers, postdoctoral research associate at the University of Oxford. The team published their findings, "Changes in global nitrogen cycling during the Holocene epoch," in the current issue of *Nature*.

In the study the team also looked at how nitrogen availability changed thousands of years ago.

Roughly 15,000 years ago, the Earth began to warm, melting many glaciers and ice sheets that covered the landscape. Researchers found that Earth experienced an 8,000-year long decline in nitrogen availability as temperatures rose and carbon and nitrogen became locked up in soils. According to researchers, how the nitrogen cycle responded to these ancient global changes in carbon dioxide could be a glimpse into the future.

"What happened in the past might be a dry run for Earth's future," Craine said. "By looking at what happened millennia ago, we can see

what controlled and prevented changes in nitrogen availability. This helps us understand and predict how things will change in the future."

The team collected and analyzed data from the sediment records of 86 lakes scattered across six continents. The lakes were distributed between tropical and temperate zones. With the data, the team was able to compare past and present cycling in various regions.

Researchers found that once most of the glaciers and ice sheets had melted around 11,000 years ago, the Earth continued to experience a global decline in nitrogen that lasted another 4,000 years.

"That was one of the really surprising findings," Craine said. "As the world was getting warmer and experiencing higher carbon dioxide levels than it had in the past, just like we are currently experiencing, the ecosystems were starting to lock carbon in the soils and in plants, also like we are seeing today. That created a long decline in nitrogen availability, and it scrubbed nitrogen out of the atmosphere."

McLauchlan said the most surprising finding, however, was that although humans have nearly doubled the amount of nitrogen to the ecosystems, globally nitrogen levels have remained stable at most sites for the past 500 years.

One reason may be that plants are using more nitrogen than they previously have, keeping nitrogen levels consistent with those thousands of years ago even though humans continue to add carbon dioxide and nitrogen to the atmosphere, McLauchlan said.

"Our best idea is that the nitrogen and carbon cycles were linked tightly back then and they are linked tightly today," McLauchlan said. "Humans are now manipulating both nitrogen and carbon at the same time, which means that there is no net effect on the biosphere."

The balance may be only temporary, McLauchlan said.

"Based on what we learned from the past, if the response of plants to elevated carbon dioxide slows, nitrogen availability is likely to increase and ecosystems will begin to change profoundly," McLauchlan said. "Now more than ever, it's important to begin monitoring our grasslands and forests for early warning signs."

More information: www.nature.com/nature/journal/ … ull/nature11916.html

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