# Researchers measure worldwide nitrogen levels in grasslands

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Soil nitrogen in grasslands covering almost a third of Earth's surface is a critical ingredient for producing food and stemming climate change.

Using results from a first ever global-scale experiment, an international research team that includes a University of Guelph ecologist is getting a clearer picture of how nitrogen in grassland soils drives plant growth for food production and ecosystem health.

This global field study provides a more detailed baseline of worldwide nitrogen levels and improves our understanding of natural nitrogen cycles as well as the effects of widespread over-fertilization through farming, said integrative biology professor Andrew MacDougall.

Along with other members of the global Nutrient Network (NutNet), he's one of almost 40 international co-authors worldwide of a new paper published recently in *Nature Communications*.

MacDougall said the team's field measurements conducted over a single growing season on six continents will give researchers more accurate information about nitrogen cycling and its availability to plants than more conventional lab-based estimates.

Although lab soil studies are typically less expensive than fieldwork, he said, "Lab measures may not capture real-world processes. Understanding nitrogen cycles is critical for understanding global plant production, the carbon cycle, the impacts of atmospheric carbon, food production."

Nitrogen is one of the most important plant nutrients. Through a process called mineralization, soil microbes naturally convert organic nitrogen into an inorganic form that plants can use. Farmers worldwide also add nitrogen to crops as a key ingredient in fertilizers.

Working at 30 grassland sites, including MacDougall's field plot on Vancouver Island, the team members isolated soil samples using metal cylinders inserted into the earth. The researchers tracked soil properties

and climate variables such as temperature and moisture in a single growing season.

Those sample cores were dug up and analyzed by lead author Anita Risch, a scientist at the Swiss Federal Institute for Forest, Snow and Landscape Research.

As a percentage of soil volume, nitrogen levels among the 30 sites ranged from trace amounts in New Mexico deserts in the United States to 1.4 percent of total soil volume in Lancaster in the United Kingdom. Nitrogen mineralization rates were as high as 1.4 milligrams of the element per kilogram of soil per day.

By controlling plant growth and productivity of grasslands, nitrogen governs how much grass grows and how many animals—including livestock—can live there.

From Canada's Prairie provinces to the Argentinian pampas to the Crimean Peninsula, MacDougall said, "60 percent of the world's grasslands support livestock grazing." As a growing population consumes more food, he said, human impacts will only increase—from direct grazing by livestock to conversion of grasslands for crops like corn and soy needed to feed those animals.

Nitrogen can also influence how much of the greenhouse gas carbon dioxide is held in grassland soils instead of escaping to the atmosphere. Whether $CO_2$ is sequestered in soil or released depends on activity of soil microbes that make nitrogen available to plants.

That nitrogen mineralization process uses soil carbon. Warmer temperatures and wetter conditions expected under climate change can speed up that process and result in more carbon being release to the atmosphere. "Carbon is stored in soils as long as it's not broken down by

microbes," said MacDougall.

Researchers know that natural grasslands contain much less nitrogen than in areas fertilized by humans. The NutNet team members also conducted fertilization experiments on their grassland plots, although those results are not yet available.

Referring to farming practices, MacDougall said "We tend to oversupply nitrogen. Knowing mineralization rates and how much nitrogen is in the soil already might help us calibrate how much we add."

Calling the study network a "global observatory," he added, "We're trying to determine grassland productivity and how that is shaped by soil and climate and human impacts."

NutNet is an international research collaboration begun in 2007 and based at the University of Minnesota. An inaugural member of the network, MacDougall has worked since 1999 at the Vancouver Island study site owned by the Nature Conservancy of Canada.

**More information:** A. C. Risch et al. Soil net nitrogen mineralisation across global grasslands, *Nature Communications* (2019). DOI: 10.1038/s41467-019-12948-2

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