Fertilization destabilizes global grassland ecosystems, study finds

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This map shows Nutrient Network sites studied. Numbers correspond to chart included with Nature article describing each site. Credit: *Nature*

A new study led by University of Minnesota researchers demonstrates that fertilization of natural grasslands—either intentionally or unintentionally as a side effect of global farming and industry—is having a destabilizing effect on global grassland ecosystems. Using a network of natural grassland research sites around the world called the Nutrient Network, the study represents the first time such a large experiment has been conducted using naturally occurring sites.

Led by Yann Hautier, a Marie Curie Fellow associated with both the Department of Ecology, Evolution, and Behavior at the University of Minnesota and the Institute of Evolutionary Biology and Environmental Studies at the University of Zurich, the research team included U of M

associate professors Eric Seabloom and Elizabeth Borer, and research scientist Eric Lind, along with scientists from institutions around the world including Andy Hector at Oxford University's Department of Plant Sciences. The findings were published on February 16 in the journal *Nature*.

The researchers found that plant diversity in natural ecosystems creates more stable ecosystems over time because of less synchronized growth of plants. "This is sometimes called the portfolio effect," says Seabloom. "If you have money in two investments and they're both stocks, they're going to track each other, but if one is a stock and one is a bond, they're going to respond differently to the overall economy and are more likely to balance each other."

The researchers collected plants from each of the sites, then sorted, dried, and weighed them to monitor the number of species of plants and total amount of plants, or "biomass," grown over time. They used this information to quantify species diversity and ecosystem stability. Says Hautier: "It was really striking to see the relationship between diversity and stability" and the similarities to data collected from artificial grasslands as part of a research effort called BioDepth, indicating that the results from natural grasslands of the Nutrient Network could be predicted from the results of artificial grasslands.

"The results of our study emphasize that we need to consider not just how productive ecosystems are but also how stable they are in the long-term, and how biodiversity is related to both aspects of ecosystem functioning," says Andy Hector.

The researchers also found that grassland diversity and stability are reduced when fertilizer is added. Fertilizers are intentionally used in grassland to increase livestock fodder. Fertilizer addition is also occurring unintentionally in many places around the world because

nitrogen, a common fertilizer, is released into the atmosphere from farming, industry, and burning fossil fuels. Rainfall brings nitrogen out of the atmosphere and on to grasslands, changing the growth and types of plant species. This study placed measured amounts of fertilizer on a portion of their research sites and measured the changes that ensued.

"What we find is that the stabilizing effect [of species diversity] is lost, and we have less stable ecosystems when we have more nutrients coming into that system," says Borer. This, the researchers found, was due to more synchronized growth of plants, eliminating the "portfolio effect."

This study was made possible due to the formation of the Nutrient Network, also known as NutNet. Borer and Seabloom led a small group of scientists who created NutNet to standardize the way that ecology research is conducted. NutNet is a "grassroots campaign" that is supported by scientists who volunteer their time and resources. There are now 75 sites around the world that are run by more than 100 scientists participating in the NutNet experiment. "It's a great project and I'm happy to be a part of it," says Hautier. "The collaboration is fantastic."

NutNet scientists collected data for this study for three years, measuring plant growth in 41 sites on five continents, so the researchers feel confident that their results have global applications. "We can line it up and say - apples to apples - this is what's happening and it allows us to say it's a general effect. We know it's the same because we measured it in the same way in all these different places," says Lind. The group ultimately wants to continue experiments for at least ten years to gather information about long-term trends in plant species diversity and ecosystem stability, extinctions, species invasions, and many other important changes in the world's grasslands.

More information: Eutrophication weakens stabilizing effects of diversity in natural grasslands, DOI: 10.1038/nature13014

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