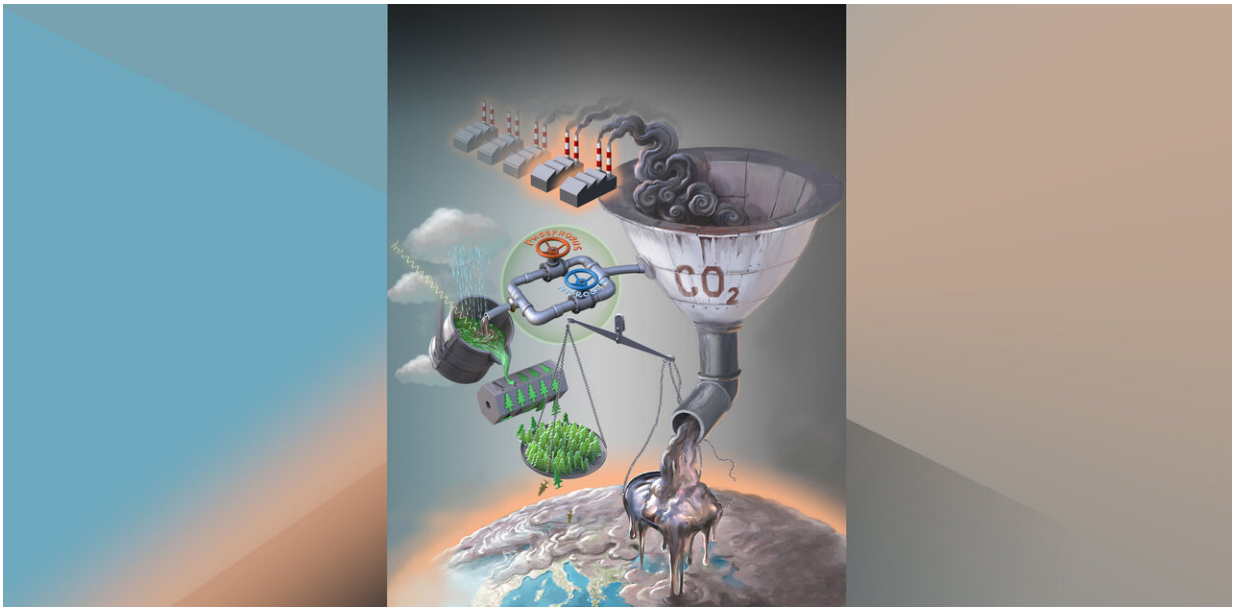
Nutrients limit carbon uptake to slow climate change

February 11 2020, by Anne M Stark



This figure illustrates how the potential for plants to remove CO2 from the atmosphere (and transform it into plant biomass) is strongly regulated by nitrogen and phosphorus. Credit: Victor O. Leshyk.

Nitrogen and phosphorus found in soils are limiting the amount of carbon uptake stored in plants and soils, but maps of where this occurs across the globe are lacking.

A Lawrence Livermore National Laboratory (LLNL) scientist and international collaborators have developed a framework for testing

nutrient limitations and a benchmark of nitrogen (N) and phosphorus (P) limitation for models to be used for predictions of the terrestrial carbon sink. The research is published in the Feb. 10 edition of *Nature Geoscience*.

CO_2 emissions from human activities play a double effect. On one hand, CO_2 causes global warming and on the other, CO_2 can stimulate photosynthesis. The increase in photosynthesis can increase plant growth , creating a feedback that can help absorb some of the CO_2 in the atmosphere and slow global warming.

However, plants also need the right amounts of nutrients for growth, namely nitrogen and phosphorus, not just CO_2. Understanding the limiting role of nutrients in the capacity of plants to help slow climate change is a priority to accurately model and predict climate change.

Elevated atmospheric CO_2 and warming-induced longer growing seasons are likely resulting in greater nutrient limitation of terrestrial ecosystems.

"On a global scale, nitrogen and phosphorus limitations likely constrain current and future ecosystem response to elevated CO_2 concentrations and climate change," said Cesar Terrer, LLNL scientist and co-author of the paper. "Therefore, understanding the spatial heterogeneity in nutrient limitation and its causes remains a high priority."

In a recent *Nature Climate Change* paper, Terrer found that soil nitrogen and phosphorus strongly limit the potential of plants to help draw down CO_2 from the atmosphere. "Now we have quantified and mapped nitrogen and phosphorus limitations globally, which will help better quantify the role of vegetation to slow climate change and make more accurate predictions of global warming," he said.

In the new research, the team found prevailing limited nutrients across

major land-based biomes, confirming the centuries-old hypothesis that tropical forests are primarily limited by phosphorus, and boreal ecosystems by nitrogen. The team mapped the global distribution of nitrogen and phosphorus, quantifying the entire range from nitrogen to phosphorus limitations for all areas on Earth. Historically, scientists have assumed that nitrogen, rather than phosphorus, is the dominant source of plant nutrient limitations worldwide. However, the authors have found that phosphorus dominates as a major source of plant limitations in 43 percent of land, with "only" 18 percent limited by nitrogen. Thirty-nine percent of land is co-limited by nitrogen and phosphorus simultaneously.

To validate the team's predictions of relative nutrient limitations, the researchers compiled a global database of nitrogen and phosphorus limitation based on growth response to experimental nutrient additions in relatively unmanaged ecosystem. An ecosystem was diagnosed to be limited by a certain nutrient if addition of that nutrient significantly stimulated plant growth.

"Our map appears fairly robust because it is based on drivers determined by model selection identified from empirical data, strengthening current understanding for patterns of nitrogen and phosphorus limitations and consistent with results of field experiments," Terrer said.

More information: Enzai Du et al. Global patterns of terrestrial nitrogen and phosphorus limitation, *Nature Geoscience* (2020). DOI: 10.1038/s41561-019-0530-4

César Terrer et al. Nitrogen and phosphorus constrain the CO2 fertilization of global plant biomass, *Nature Climate Change* (2019). DOI: 10.1038/s41558-019-0545-2