Soil ecosystem functioning under climate change: shifts in plant community composition matter!

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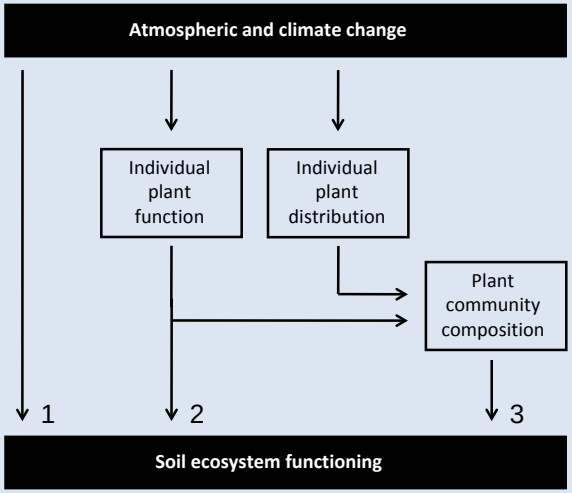
Funding: DOE Office of Science
Biological and Environmental Research



- In mixed old-field communities, we used extracellular enzyme activities and soil nematodes as indicators for multifactor climate change effects on soil ecosystem functioning (e.g., rates of carbon and nutrient cycling).
- Altered precipitation regime had a larger impact on plant community composition and on soil ecosystem functioning than elevated [CO_2] and/or warming.
- As a novel result, we showed that climate change effects on soil ecosystem functioning depended on the plant species beneath the soil samples were collected.
- Accurate assessment of long-term climate change impacts on soil ecosystem functioning requires incorporation of concurrent changes in plant function, distribution, and community composition; hence, a better integration of ecosystem ecology and plant biogeography.

U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
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Abstract:

Feedbacks of terrestrial ecosystems to atmospheric and climate change depend on soil ecosystem dynamics. Soil ecosystems can directly and indirectly respond to climate change. For example, warming directly alters microbial communities by increasing their activity. Climate change may also alter plant community composition, thus indirectly altering the soil communities that depend on their inputs. To better understand how climate change may directly and indirectly alter soil ecosystem functioning, we investigated old-field plant community and soil ecosystem responses to single and combined effects of elevated [CO_2], warming, and precipitation. Specifically, we collected soils at the plot level (plant community soils), and beneath dominant plant species (plant-specific soils). We used microbial enzyme activities and soil nematodes as indicators for soil ecosystem functioning.

Our study resulted in two main findings: 1) Overall, while there were some interactions, water, relative to increases in [CO_2] and warming, had the largest impact on plant community composition, soil enzyme activity, and soil nematodes. Multiple climate change factors can interact to shape ecosystems, but in our study, those interactions were largely driven by changes in water. 2) Indirect effects of climate change, via changes in plant communities, had a significant impact on soil ecosystem functioning and this impact was not obvious when looking at plant community soils. Climate change effects on enzyme activities and soil nematode abundance and community structure strongly differed between plant community soils and plant-specific soils, but also within plant-specific soils.

These results indicate that accurate assessments of climate change impacts on soil ecosystem functioning require incorporating the concurrent changes in plant function and plant community composition. Climate change-induced shifts in plant community composition will likely modify or counteract the direct impact of atmospheric and climate change on soil ecosystem functioning, and hence, these indirect effects should be taken into account when predicting how global change will alter ecosystem functioning.

Citation:

Kardol P, Cregger MA, Campany CE, Classen AT (2010) Soil ecosystem functioning under climate change: plant species and community effects. *Ecology* 91:767-781.