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Influence of altered precipitation pattern on greenhouse gas emissions and soil enzyme activities in Pannonian soils

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Precipitation patterns are likely to be altered due to climate change. Recent models predict a reduction of mean precipitation during summer accompanied by a change in short-term precipitation variability for central Europe. Correspondingly, the risk for summer drought is likely to increase. This may especially be valid for regions which already have the potential for rare, but strong precipitation events like eastern Austria.

Given that these projections hold true, soils in this area will receive water irregularly in few, heavy rainfall events and be subjected to long-lasting dry periods in between. This pattern of drying/rewetting can alter soil greenhouse gas fluxes, creating a potential feedback mechanism for climate change.

Microorganisms are the key players in most soil carbon (C) and nitrogen (N) transformation processes including greenhouse gas exchange. A conceptual model proposed by Schimel and colleagues (2007) links microbial stress-response physiology to ecosystem-scale biogeochemical processes: In order to cope with decreasing soil water potential, microbes modify resource allocation patterns from growth to survival. However, it remains unclear how microbial resource acquisition via extracellular enzymes and microbial-controlled greenhouse gas fluxes respond to water stress induced by soil drying/rewetting.

We designed a laboratory experiment to test for effects of multiple drying/rewetting cycles on soil greenhouse gas fluxes (CO_2, CH4, N2O, NO), microbial biomass and extracellular enzyme activity. Three soils representing the main soil types of eastern Austria were collected in June 2012 at the Lysimeter Research Station of the Austrian Agency for Health and Food Safety (AGES) in Vienna. Soils were sieved to 2mm, filled in steel cylinders and equilibrated for one week at 50% water holding capacity (WHC) for each soil. Then soils were separated into two groups: One group received water several times per week (C=control), the other group received water only once in two weeks (D=dry). Both groups received same water totals for each soil. At the end of each two week drying period, greenhouse gas fluxes were measured via an open-chamber-system (CO_2, NO) and a closed-chamber-approach (CH4, N2O, CO_2). Additional cylinders were harvested destructively to quantify inorganic N forms, microbial biomass C, N and extracellular enzyme activity (Cellulase, Xylanase, Protease, Phenoloxidase, Peroxidase).

We hypothesize that after rewetting (1) rates of greenhouse gas fluxes will generally increase, as well as (2) extracellular enzyme activity indicating enhanced microbial activity. However, response may be different for gases and enzymes involved in the C and N cycle, respectively, as drying/rewetting stress may uncouple microbial mediated biogeochemical cycles.

Results will be presented at the EGU General Assembly.

Reference: Schimel, J., Balser, T.C., and Wallenstein, M. (2007). Microbial stress-response physiology and its implications for ecosystem function. Ecology 88, 1386–1394.