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Plant diversity induces a shift of DOC concentration over time – results from long term and large scale experiment

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Plant diversity has been demonstrated as a crucial factor for soil organic carbon (SOC) storage. The horizontal SOC formation in turn is strongly impacted by the relative small but consistent flow of dissolved organic carbon (DOC) in soils. In this process, pore water leaches plant material and already stored SOC while simultaneously these leachates are transported downwards. However, there is a big uncertainty about the drivers of DOC flux; in particular about the importance of biological processes.
We investigated the impact of plant diversity and other biotic drivers on DOC concentrations and total DOC fluxes (concentration $\times$ sampled water amount). In addition, we considered abiotic factors such as weather and soil conditions to assess the relative importance of biotic and abiotic drivers and how their importance changes over time. We used a comprehensive data set, gathered in the frame of the long-term biodiversity experiment "The Jena Experiment". Permanent monitoring started directly after establishment of the field site in 2002 and is still running. This enabled us to trace the impact of plant communities with their increasing establishment over the time on DOC concentration.
We found the amount of sampled pore water best explained by rainfall, while it was not related to plant associated variables. Directly after establishing the experimental site, DOC concentrations were highest and then decreasing with time. In the first period of the experiment plant diversity had no or even a slightly negative impact on DOC concentrations. The direction of the plant diversity effect on DOC concentrations changed over time; namely in later phases we observed highest DOC concentrations on plots with high plant diversity. Moreover, DOC concentrations were negatively affected by increased amounts of sampled pore water indicating a dilution effect. Even though this impact was highly significant; its effect size was even less pronounced at later time points.
In summary, inter annual differences of total DOC fluxes reflect patterns of sampled soil water, indicating the major driver of total DOC flux is driven by rainfall. In contrast, intra annually the DOC flux reflects the patterns of the DOC concentrations with a strengthening positive impact of plant diversity among time.
Our results show that variations of the total DOC fluxes are more affected by the pore water flux than by the differences in DOC concentrations as the magnitude of the pore water flux exceeds the magnitude of concentrations by a factor of 20. This indicates that abiotic conditions set the frame in which biotic properties can drive the DOC flux. However, the biotic drivers are getting more important over time and might outperform the dominating role of the abiotic conditions on the longer term.