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Litter decomposition and soil respiration in response to increased rainfall variability, winter warming and altered cutting frequency in a temperate grassland

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Climate change is likely to alter decomposition rates through direct effects on soil biotic activity and indirect effects on litter quality with possible impacts on the global carbon budget and nutrient cycling. Currently, there is an urgent need to study combined effects of various climatic drivers and of agricultural practise on decomposition. In an in-situ litter bag experiment, we studied effects of rainfall variability (including drought plus heavy rain pulses and regular irrigation) interacting with winter warming and increased winter precipitation and with changes in cutting frequency, on decomposition in a temperate grassland. Litter bags contained mixed and species-specific litter out of all different climate and land-use manipulations and were placed within the plots of litter origin. Moreover, we aimed to disentangle causes for altered decomposition by following two further approaches: To study effects of changed leaf chemicals due to the manipulations we placed litter out of the experiment that has been pre-exposed to the manipulations before on an untreated standard plot outside the experiment. To assess effects of changed soil faunal activity, we investigated decomposition of standard material under differing rainfall variability. We further compare the observed decomposition results with soil respiration data.

Decomposition was reduced when litter bags were exposed to drought for six weeks within an 11 months period. Neither additional winter rain nor winter warming had an effect on decomposition, probably because winter warming reduced snow cover and increased variability of surface temperatures. Climate manipulations did not change litter quality. Further, decomposition on the untreated standard plot was not affected by the climate manipulations that the litter previously was exposed to. Thus, reduced decomposition under extreme rainfall variability and drought may be mainly caused by a decrease in soil biotic activity, as indicated by reduced decomposition of standard material during drought.

More frequent cutting strongly stimulated decomposition, however, this stimulating effect was absent under extreme rainfall variability including drought. The stimulation of decomposition under more frequent cutting was attributed to changes in litter quality, namely a decrease in C/N ratio. Accordingly, litter from more frequently cut communities decomposed faster on the untreated control plot outside the experiment.

Projected increases in drought frequency and increased rainfall variability under climate change may inhibit decomposition and alter nutrient and carbon cycling along with soil quality. Especially decomposition in frequently cut grassland appears vulnerable towards drought.