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Potential consequences of water limitation and drought-induced tree mortality on carbon and nitrogen cycling

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Water limiting conditions for the growth and physiology of trees as well as episodes of tree mortality triggered by drought have recently been documented in several bioregions across the world. In parallel to these major vegetation alterations, the impact of water scarcity also has prominent effects on soil processes mediated by the microbiome such as the transformation of organic matter, heterotrophic respiration, microbial uptake as well as nutrient mineralization. Although currently little explored, shifts in the interplay occurring between tree functioning and soil microbial processes may be crucial during tree mortality events and may feed back on ecosystem carbon and nitrogen cycling. We will present a multidisciplinary setup to mechanistically explore how water limitation acts synergistically on the interplay between trees and soil microorganisms, with potential consequences for ecosystem biogeochemical fluxes.

The experimental setup focusses on a key temperate forest species, Scots pine (*Pinus sylvestris* L.), which is currently facing high mortality rates in several inner-Alpine valleys of Europe due to drier climatic conditions during parts of the year. We make use of small scale mesocosms featuring young trees and soil collected from a drought-affected natural forest. The mesocosms are treated with different levels of water availability under controlled conditions. Plant growth and physiological changes related to water limitation are investigated in parallel to various soil properties. State-of-the-art isotopic labelling techniques are used to trace alterations in carbon and nitrogen transfers within the plant-soil-microbe continuum. We will specifically test whether extended periods of drought suppress the flux of carbon from plants to soil and lead plants to invest more in the maintenance of fine root systems. Moreover, we will follow the potential changes in the rates of decomposition, mineralization and incorporation of plant debris into soil organic matter over time and link them to potential alterations of the soil microbiota. These experimental observations will be validated by measurements in drought-affected Scots pine forests in inner-Alpine valleys. We expect the outcomes of this work to advance the fundamental understanding of the alterations occurring in the plant-soil-microbe system related to drought as well as to improve the detection of mechanisms leading to Scots pine mortality.