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Climate and root proximity as dominant drivers of enzyme activity and C and N isotopic signature in soil

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The Chilean ecosystems provide a unique study area to investigate biotic controls on soil organic matter (SOM) decomposition and mineral weathering depending on climate (from hyper arid to temperate humid). Microorganisms play a crucial role in the SOM decomposition, nutrient release and cycling. By means of extracellular enzymes microorganisms break down organic compounds and provide nutrients for plants. Soil moisture (abiotic factor) and root carbon (biotic factor providing easily available energy source for microorganisms), are important factors for microbial decomposition of SOM and show strong gradients along the investigated climatic gradient. A high input of root carbon increases microbial activity and enzyme production, and facilitates SOM breakdown and nutrient release

The aim of this study was to determine the potential enzymatic SOM decomposition and nutrient release depending on root proximity and precipitation. C and N contents, δ^{13}C and δ^{15}N values, and kinetics (Vmax, Km) of six extracellular enzymes, responsible for C, N, and P cycles, were quantified in vertical (soil depth) and horizontal (from roots to bulk soil) gradients in two climatic regions: within a humid temperate forest and a semiarid open forest.

The greater productivity of the temperate forest was reflected by higher C and N contents compared to the semiarid forest. Regression lines between δ^{13}C and -[ln(%C)] showed a stronger isotopic fractionation from top- to subsoil at the semiarid open forest, indicating a faster SOM turnover compared to the humid temperate forest. This is the result of more favorable soil conditions (esp. temperature and smaller C/N ratios) in the semiarid forest. Depth trends of δ^{15}N values indicated N limitation in both soils, though the limitation at the temperate site was stronger. The activity of enzymes degrading cellulose and hemicellulose increased with C content. Activity of enzymes involved in C, N and P cycles decreased from top- to subsoil and with distance to roots. Chitinase and acid phosphatase activities increased with increasing C contents and indicated a faster substrate turnover in soil under the temperate forest compared to the semiarid forest. In contrast, Tyrosin-aminopeptidase activities indicated a faster substrate turnover under semiarid forest than the temperate forest, and strongly increased with increasing N content.

We conclude that the N availability and SOM turnover under semiarid open forest is higher than under humid temperate forest. The enzyme activities are depending on depth only indirectly and are driven mainly by soil C content, which is directly affected by root carbon input.