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In-situ carbon and nitrogen turnover dynamics and the role of soil functional biodiversity therein; a climate warming simulation study in Alpine ecosystems

Ika Djukic (1)

(1) Ika Djukic, Institute of Soil Science, BOKU, Vienna, Austria, (2) Franz Zehetner, Institute of Soil Science, BOKU, Vienna, Austria, (3) Olivier Duboc, Institute of Soil Science, BOKU, Vienna, Austria, (4) Torston Berger, Institute of Forest Ecology, BOKU, Vienna, Austria, (5) Andrea Watzinger, Institute of Soil Science, BOKU, Vienna, Austria, (6) Micha Horacek, Austria Institute of Technology GmbH-AIT, Seibersdorf, Austria, (7) Martin H. Gerzabeck, Institute of Soil Science, BOKU, Vienna, Austria

Climate change affects a variety of soil properties and processes. Alpine soils take an extraordinary position in this context because of the vulnerability of mountain regions to climatic changes. We used altitudinal soil translocation to simulate the combined effects of changing climatic conditions and shifting vegetation zones in order to study short- to medium-term soil changes in the Austrian Limestone Alps. We translocated 160 soil cores from an alpine grassland site (1900 m asl) down to a sub-alpine spruce forest (1300 m asl) and a montane beech forest site (900m asl), including reference soil cores at each site to estimate artifacts arising from the method. 15N-labeled maize straw was added (1 kg/m2) to translocated and control soil cores and sampled over a period of 2 years for the analysis of 13C and 15N in the bulk soil and extracted phospholipid fatty acids (PLFAs). Additionally, 20 litter bags (at each of the three climatic zones) containing Fagus sylvatica or Pinus nigra litter were inserted into the soil, and decomposition was studied over a two-year period.

The basic soil parameters (organic C, total N and pH) were unaffected by translocation within the observation time. Overall, decomposition of Pinus nigra litter was significantly slower compared to Fagus sylvatica, and the decomposition rate of both litter types was inversely related to elevation.

The decomposition of the maize straw carbon was significantly faster in the translocated soil cores (sites at 900 and 1300 m asl) than at the original site (1900 m asl). The labelled nitrogen contents in the translocated soil cores showed just marginal differences to the soil cores at the original site. The maize straw application promptly increased the amount of bacterial and fungal PLFAs at all studied sites. Downslope translocated soil cores showed an increase in total microbial biomass and sum of bacteria. The fungal PLFA biomarker 18:26,9 was slightly lower at the new (host) sites compared to the original site. The bacterial to fungal ratio of the translocated soil cores showed a rapid acclimatization to the new (host) soil conditions.

Our study demonstrates that rising temperatures in Alpine ecosystems will accelerate decomposition of fresh C pools but also lead to rapid adaptation of the microbial community to the new conditions.