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Moderate effects of reforestation with Norway spruce (Picea abies) on carbon storage and turnover in a Swiss sub-alpine pasture

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In alpine regions the forested area is strongly increasing through woody plant encroachment on abandoned pastures or by man-made afforestations. These natural or artificial reforestations, in fact, have several implications on the nutrient cycling between plants and soils and thus, are likely to affect carbon turnover. Although afforestations are to be accounted as a sink according to the Kyoto protocol, there are still uncertainties about their effects on the soil carbon storage.

In the present study, we assessed soils under pasture, an adjacent chronosequence of spruce afforestations (25-45 years) and a mature spruce forest (older than 120 years) on a homogenous slope in a Swiss sub-alpine ecosystem. While the soil bulk densities were not affected by the land use change, carbon concentrations in the mineral soil decreased 25-45 years after tree establishment. However, no differences between pasture and the mature forest were apparent, indicating that the C-loss after land use conversion was only transient. Up to 2.5kg m^{-2} C was additionally stored in the organic layer of the oldest stands, resulting in a net C gain in the old forest soils. C:N-ratios of the soil organic matter (SOM) considerably increased with stand age in the uppermost soil layer, displaying the distinct chemical composition of the plant input. In accordance, a shift of the δ^{13}C natural abundance of the SOM in the uppermost mineral layer towards a less negative signal was observed with tree development.

The abundance of soil microorganisms, as identified by their phospholipid fatty acids (PLFA), was only moderately affected by vegetation type in the mineral soils. In contrast, a strong alteration of the microbial community composition with a decreasing proportion of fungi from the organic layers to the uppermost mineral layer was observable.

Our results show that afforestation with spruce trees on an extensively used sub-alpine pasture only led to a transient loss of C in the mineral soils. In contrast, the accumulation of additional C in the organic layer resulted in higher C-stocks in the old forest as compared to the pasture. Therefore, afforestation with coniferous trees is likely to increase the total amount of C stored, particularly if also the plant biomass is taken into account.