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Impact of land use change on soil organic matter dynamics in subalpine grassland

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Information regarding the response of soil organic matter (SOM) in soils to past and expected future land use changes in the European Alps is scarce. Understanding this response requires knowledge of size and residence times of SOM fractions with distinct stabilities. In order to quantify differences between types of land use in the amount, distribution and turnover rates of soil organic carbon (SOC) in subalpine grassland soils, we used soil aggregate and SOM density fractionation in combination with ^{14}C dating. Samples were taken along gradients of different types of land use from meadow (M) to pasture (P) and to abandoned grassland (A) in the Stubai Valley and in the Matsch Valley. Sampling sites in both areas were located at equal altitude (1880 m and 1820 m, respectively) with the same parent material and soil type, but the Matsch Valley receives 400-500 mm less annual rainfall. SOC stocks in the top 10 cm were 2.47 $\pm$ 0.32 (M), 2.75 $\pm$ 0.32 (P), and 2.50 $\pm$ 0.31 kg C/m^2 (A) in the Stubai Valley and 2.25 $\pm$ 0.14 (M), 3.45 $\pm$ 0.22 (P), 3.16 $\pm$ 0.27 kg C/m^2(A) in the Matsch Valley. Three aggregate size classes were separated by wet sieving: $<$0.25, 0.25-2, $>$2 mm. The light floating fraction (wPOM, ρ $>$1 g/cm^3) was included in the analysis. Free (f-) and occluded particulate organic matter (oPOM) were isolated from each aggregate size class (ρ $>$1.6 g/cm^3). At both locations, more than 80% of SOC was stored in small (0.25-2 mm) and large ($>$2 mm) macroaggregates, but no trend in relation to the different types of land use could be detected. The fraction of C in fPOM and in oPOM in all aggregate size classes was highest for soil from abandoned grasslands. The bulk soil of the abandoned site in the Stubai Valley showed a significantly higher share of fPOM-C and oPOM-C and a higher amount of wPOM-C as compared to the soil from managed grassland, whereas in the Matsch Valley pasture soil had a significantly higher wPOM-C content. At both sites, ^{13}C natural abundance analyses revealed a gradient in ^{13}C between density fractions. wPOM was particularly useful to reveal differences between sampling sites. Radiocarbon values emphasized the importance of this fraction for the calculation of the turnover of bulk soil C. wPOM turned out to be the most active fraction turning over in 2-4 years. Bulk SOC turnover time was approximately 46 years for pasture soil and 78 years for meadow soil. In conclusion, density fractionation produced homogenous fractions allowing detection of differences between different land use types. However, C distribution among aggregates did not systematically differ.