Geophysical Research Abstracts
Vol. 15, EGU2013-11288, 2013
EGU General Assembly 2013

Changes in SOC stocks and fractions after natural afforestation of alpine grasslands

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Land use changes are considered one of the major driving forces of global carbon fluxes and can induce significant alterations of soil organic carbon stocks. In the European Alps, the dominant form of land use change is represented by the abandonment of marginal mountain grasslands and their invasion by tree species, i.e. a transition from grassland to forest. While an increase in live and dead aboveground biomass is commonly reported, the impact on soil organic carbon (SOC) is still unclear. The main objective of the current study was to quantify the effect of abandonment and forest regrowth of mountain grassland on SOC, considering both SOC stocks and its physically separated fractions.

The study area is located in a pre-alpine area of the Trentino region (Italy), with an elevation of about 1150 m. We compared four land uses representing a transition from grassland to forest: I) managed grassland; II) grassland abandoned 10 years ago; III) natural afforested grassland abandoned after 1973; IV) reference forest, already present in 1861. The afforested area and the reference forest are both dominated by Norway spruce (Picea abies) and beech (Fagus sylvatica). For each land use intensity three sampling areas were selected. In each area we collected eight soil cores to a depth of 30 cm, dividing the soil core in 4 depth increments. To assess changes in SOC stocks, we measured bulk density, stoniness, root biomass and organic carbon content. Mineral SOC stocks were calculated using both an equivalent depth and an equivalent mass approach. Changes in SOC fractions were assessed using aggregate size fractionation (Cambardella and Elliott, 1993) and size-density fractionation procedures.

Preliminary results show higher soil C concentrations in forest sites compared to grassland. This can be attributed to higher C inputs and lower mineralization rates due to a higher degree of soil aggregation and protection of soil organic matter, but also to the higher stoniness registered in forest sites which can lead to a concentration of C inputs in a smaller volume of soil. If C stocks are computed using an equivalent soil depth approach, mineral SOC stocks are lower in forest land uses compared to grassland while no significant difference emerges if an equivalent soil mass approach is used. The aggregate size fractionation highlighted an increase in C stored in large macroaggregates following afforestation and a decrease in silt and clay size fraction (<53 μm). The strongest change shown through the size-density fractionation procedure is a three-fold increase in C stored in free organic matter (POM) from grassland to forest. Intriguingly, we found a decreasing trend in the microaggregate (53-250 μm) fraction as well as for the mineral-associated heavy fraction following afforestation, suggesting a decrease in the more stable SOC fraction, while the labile fractions increased.