Geophysical Research Abstracts
Vol. 18, EGU2016-14664, 2016
EGU General Assembly 2016

Deep horizons: Soil Carbon sequestration and storage potential in grassland soils

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Soil Organic Carbon (SOC) enhances soil fertility, holding nutrients in a plant-available form. It also improves aeration and water infiltration. Soils are considered a vital pool for C (Carbon) sequestration, as they are the largest pool of C after the oceans, and contain 3.5 more C than the atmosphere. SOC models and inventories tend to focus on the top 30 cm of soils, only analysing total SOC values. Association of C with microaggregates (53-250 μm) and silt and clay (<53 μm) is considered C sequestration as these fractions offer the greatest protection against mineralization. This study assessed the role of aggregation in C sequestration throughout the profile, down to 1 m depth, of 30 grassland sites divided in 6 soil types. One kg sample was collected for each horizon, sieved at 8 mm and dried at 40 °C. Through a wet sieving procedure, four aggregate sizes were isolated: large macroaggregates (>2000 μm); macroaggregates (250-2000 μm); microaggregates and silt & clay. Organic C associated to each aggregate fraction was analysed on a LECO combustion analyser. Sand-free C was calculated for each aggregate size.

For all soil types, 84% of the SOC located in the first 30 cm was contained inside macroaggregates and large macroaggregates. Given that this fraction has a turnover time of 1 to 10 years, sampling at that depth only provides information on the labile fraction in soil, and does not consider the longer term C sequestration potential.

Only when looking at the whole profile, two clear trends could be observed: 1) soils with a clay increase at depth had most of their C located in the silt and clay fractions, which indicate their enhanced C sequestration capacity, 2) free-draining soils had a bigger part of their SOC located in the macroaggregate fractions.

These results indicate that current C inventories and models that focus on the top 30 cm, do not accurately measure soil C sequestration potential in soils, but rather the more labile fraction. However, at depth soil forming processes have been identified as a major factor influencing C sequestration potential in soils. This has a major impact in further quantifying and sustaining C sequestration into the future. Soils with a high sequestration potential at depth need to be managed to enhance the residence time to contribute to future off-setting of greenhouse gas emissions.