Geophysical Research Abstracts
Vol. 15, EGU2013-8677, 2013
EGU General Assembly 2013

Biotic versus geomorphic control of landscape soil carbon accumulation

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Soil organic matter (SOM) is the largest terrestrial pool of carbon. In order to assess the impact of increasing human-induced land use changes and future climate on this huge reservoir, it is important to understand the complex process of carbon cycling at different temporal and spatial scales. A key challenge in this effort is the correct representation in global assessments and models of those processes that vary strongly over small scales and are strongly affected by the spatial distribution of carbon stocks (both horizontally and vertically) within the landscape. Many studies have shown that spatial variation of SOC storage at the landscape scale is related to topography as a result of either the redistribution of soil or spatial variation in biological C fluxes (input and decomposition). The objective of this study, is to assess the relative importance of biotic versus geomorphic controls in determining SOC patterns and their potential interactions. Therefore the relationships between topography on the one hand and SOC and carbon isotopes on the other hand, were quantified along an erosional gradient. For this purpose, a grassland area and two agricultural fields with a different management regime (conventional tillage, reduced tillage) were selected. All field sites have a similar topography but are characterized by different rates of soil redistribution, related to management regime. Our results show clearly that for temperate climate regions without moisture/nutrient deficit, soil redistribution is the main driver for spatial variations in SOC, dwarfing any biological effects. From the results, the impact of soil redistribution on carbon dynamics by the continued maintenance of a disequilibrium between carbon in-and output at different landscape positions is reconstructed and we discuss the implications for C sequestration processes.