Geophysical Research Abstracts
Vol. 17, EGU2015-4775, 2015
EGU General Assembly 2015

Quantification of functional soil organic carbon pools in a chronosequence of land abandonment in southern Spain.

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Land abandonment is the dominant land use change in the Mediterranean, and determines the soil organic carbon (SOC) as the vegetation recovers during secondary succession. The rate of SOC recovery is influenced by environmental factors such as precipitation, soil properties or other local factors. Using aerial photographs taken in 1956, 1977, 1984, 1998, 2001 and 2009, a chronosequence of crop land abandonment was designed and topsoil samples were taken at each stage of recovery in a region North of Málaga. As SOC is a mixture of functional pools, it is important to isolate organic carbon with distinct functional properties to better understand the overall dynamic over decades. Using fractionation scheme introduced by Zimmermann et al. (2007), five fractions were isolated based on particle size, density and resistance: particulate organic matter (POM), dissolved organic carbon (DOC), SOC linked to silt and clay (s & c), SOC attached to sand particles or occluded in aggregates (S+A) and a chemically resistant fraction obtained by NaOCl oxidation (rSOC). Although there were no significant changes in particle-size distribution between the recovery stages (except for the croplands), there was a significant increase of S+A fraction over time (16 to 38%) at the expense of the s & c fraction (84 to 58%), indicating aggregation processes. Carbon concentrations within fractions S+A or rSOC did not change over time. Rather, carbon associated with silt and clay particles (s &c) was significantly affected after a few decades of abandonment. It increased from 5.7 gC.kg-1 in croplands to 10.3 gC.kg-1 in semi-natural plots. The chronosequence showed that carbon can be stored in more stable fractions. Taking into account active carbon (DOC + POM) and intermediate carbon (s & c, S+A) as indicators for carbon dynamics, we showed that the proportion of active carbon increased from 11% to 34% within the chronosequence. On the other hand, the proportion of slow cycling carbon decreased from 79% to 59%. However at the same time the amount of slow cycling carbon increased from 7.1 to 14.1 gC.kg-1. These results indicate that the proportion of labile carbon is increasing along the secondary succession but, at the same time, organic carbon is sequestered in more stable fractions.