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Effect of land abandonment on soil organic carbon fractions along a precipitation gradient in Mediterranean conditions

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Land abandonment has been the main land use change in rural European Mediterranean areas over the last decades. The secondary succession process following land abandonment is strongly affected by precipitation, which in consequence determines the parallel change of soil organic carbon (SOC) and other soil properties. SOC is usually assumed to increase due to the intensification of plant residues inputs to soil, above as well below ground. However, SOC is composed of different fractions with contrasting resistance to decomposition that can have different responses to land abandonment. The objectives of this study are: i) to determine the net effect of land abandonment on the different soil organic carbon fractions; ii) to assess the relation between vegetation evolution and SOC fractions; iii) to establish the conditions with the greater potential to store stable SOC along a precipitation gradient. Three field sites with contrasting annual precipitation (GAU: 1080.5 mm yr-1- ALM: 650 mm yr-1- GER: 350 mm yr-1) were selected. On each site Fields abandoned in different periods, as verified on aerial photographs taken in 1956, 1977, 1984, 1998, 2001, 2004 and 2009, were selected using a chronosequence approach. The fractionation protocol implemented was based on the separation of different soil particle sizes, which are associated to SOC pools with different degree of stability. Samples of the first 10 cm of soil were added to a sodium-hexametaphosphate (HMP) solution (40 g L-1) and shaken horizontally for 1h (150 r.p.m.). The soil solution was then sieved consecutively through two meshes of 250 μm and 50 μm, obtaining the following fractions: i) >250 μm (coarse fraction), it contains coarse particles (coarse sand) and plant residues (particulate organic matter, POM), easily decomposable, that constitute the more labile SOC pool; ii) 50 - 250 μm (mid fraction), it contains fine sand, fine POM easily decomposable and stable microaggregates, that contains SOC physically stabilized; and iii) < 50 μm (fine fraction), it contains the silt and clay (s+c) particles, which can chemically stabilize SOC by association. Land abandonment triggered a net SOC stock increment of 0.94 kg m-2, 1.20 kg m-2 and 0.74 kg m-2 in GAU, ALM and GER, but the proportion of labile SOC was 51.1, 26.9 and 43.2% respectively. Thus, the site located in the midpoint of the gradient presented the most favorable conditions for both total and stable SOC accumulation. In the two driest sites the highest values of total and stable SOC were reached at the end of the chronosequence, but in the wet extreme the intermediate grassland state accumulated the maximum value of stable SOC. In this site, the labile SOC accumulation compensated the loss of the stable SOC in the succession from grasslands to forests, resulting in total SOC gain. The stable fraction associated to silt and clay particles was the most affected by changes in precipitation.