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The impact of soil redistribution on SOC pools in a Mediterranean agroforestry catchment

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Soil redistribution processes play an important role influencing the spatial distribution patterns of soil and associated soil organic carbon (SOC) at landscape scale. Information on drivers of SOC dynamics is key for evaluating both soil degradation and SOC stability that can affect soil quality and sustainability. 137Cs measurements provide a very effective tool to infer spatial patterns of soil redistribution and quantify soil redistribution rates in different landscapes, but to date these data are scarce in mountain Mediterranean agroecosystems.
We evaluate the effect of soil redistribution on SOC and SOC pools in relation to land use in a Mediterranean mountain catchment (246 ha). To this purpose, two hundred and four soil bulk cores were collected on a 100 m grid in the Estaña lakes catchment located in the central sector of the Spanish Pyrenees (31T 4656250N 295152E). The study area is an agroforestry and endorheic catchment characterized by the presence of evaporite dissolution induced dolines, some of which host permanent lakes. The selected landscape is representative of rainfed areas of Mediterranean continental climate with erodible lithology and shallow soils, and characterized by an intense anthropogenic activity through cultivation and water management. The cultivated and uncultivated areas are heterogeneously distributed. SOC and SOC pools (the active and decomposable fraction, ACF and the stable carbon fraction SCF) were measured by the dry combustion method and soil redistribution rates were derived from 137Cs measurements.
The results showed that erosion predominated in the catchment, most of soil samples were identified as eroded sites (n=114) with an average erosion rate of 26.9±51.4 Mg ha-1 y-1 whereas the mean deposition rate was 13.0±24.2 Mg ha-1 y-1. In cultivated soils (n=54) the average of soil erosion rate was significantly higher (78.5±74.4 Mg ha-1 y-1) than in uncultivated soils (6.8±10.4 Mg ha-1 y-1). Similarly, the mean of soil deposition rate in cultivated soils (n=22) was significantly higher (42.6±35.1 Mg ha-1 y-1) than in uncultivated soils (3.4±3.2 Mg ha-1 y-1).
The mean SOC content for all soil samples was 2.5±2.0%. In uncultivated soils, significantly higher (P<0.01) amounts of SOC (3.0±2.6%), ACF (2.1±0.7%) and SCF (0.9±0.4%) were found compared to cultivated soils where the means were 1.1±0.7%, 0.7±0.5% and 0.4±0.3%, respectively. Significant (P<0.05) correlations between SOC, SOC pools and soil redistribution rates indicate that the distribution of SOC pools were significantly affected by soil redistribution in the study area. SOC and SOC pools were significantly higher at depositional (n=90, 2.8±1.8%) than at eroded sampling points (2.2±2.1%). ACF shows greater differences at eroding sites and at depositional sites than SCF reflecting that ACF is more sensitive to soil redistribution processes.
Our findings emphasize the role of soil redistribution and land use in influencing the dynamics of SOC, information that can be also relevant in soil management. Improving the knowledge on the relationships between land use, soil redistribution processes and SOC fractions is of interest, especially in these Mediterranean rapidly changing landscapes.