Influence of soil sampling approaches in the evaluation of soil organic carbon stocks under different land uses in a Mediterranean area

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BACKGROUND

Different approaches of soil sampling can provide significantly different estimates of Soil Organic Carbon stocks (SOCs) (Parras-Alcántara et al., 2015a). Many studies have focused on SOC distribution only in the biologically active layers of topsoil, the IPCC carbon accounting method estimates the change in SOC storage for the top 30 cm of a soil profile, and indeed limited data are available for SOCs below this depth. Anyhow, the open question is whether soil should be sampled following the pedogenetic horizons with soil entire soil approach (ESP), or along fixed depth increments using the soil control section method (SCS) (Parras-Alcántara et al., 2015b).

In addition, SOCs are often not adjusted for the soil volume occupied by coarse fragments as recommended by the IPCC Good Practice Guidance for LULUCF (IPCC, 2003) accordingly to the equation:

$$SOCs = SOC\ (g\ kg^{-1}) \times bulk\ density\ (Mg\ m^{-3}) \times depth\ (m) \times (1 - coarse\ fragment) \times 10$$

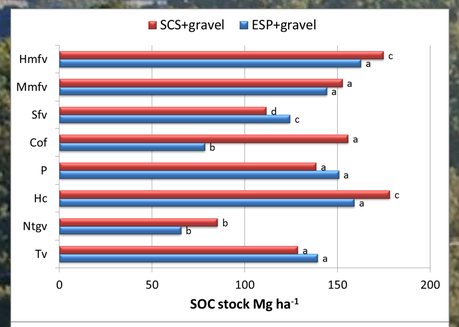
Moreover, SOC estimates are more uncertain in areas with heterogeneous land uses and pedoclimatic conditions such as Mediterranean environments, which are more prone to land degradation due to SOC degradation and depletion and erosive processes (Muñoz-Rojas et al., 2015).

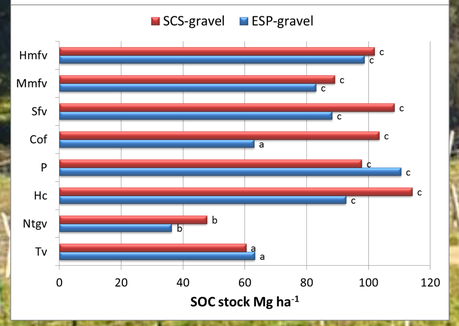
THE CASE STUDY

The work deals with the comparison of SOCs using the ESP and SCS approach, applied to a study area of northeastern Sardinia (Italy) under typical agro-silvo-pastoral systems (Francaviglia et al., 2014). The area lies within a hilly basin where elevation is in the range 275-340 m a.s.l., and slope ranges from 2-6% to 16-30%. The local climate is warm temperate with dry and hot summers, mean annual rainfall is 623 mm and mean annual temperature is 15.0°C.

The area has the same soil type (Haplic Endoleptic Cambisols, Dystric) according to IUSS Working Group WRB (2006), and the following land uses with different levels of cropping intensification were compared: Tilled vineyards (Tv), No-tilled grassed vineyards (Ntgv), Hay crop (Hc), Pasture (P), Cork oak forest (Cof), former vineyards revegetated by Scrublands (Sfv), Mediterranean Maquis (Mmfv), and Helichrysum meadows (Hmfv). Each sampling point was analyzed as ESP (by horizons) and as SCS with 25 cm depth increments.

Comparison of total SOCs (topsoil + subsoil): without (upper) and with gravel adjustment (lower)





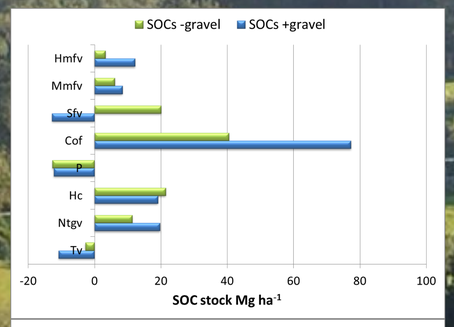
128.0

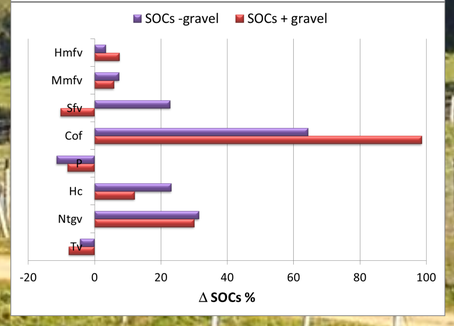
140.6

79.4

90.4

Total SOCs (topsoil + subsoil) as difference between soil control sections and entire soil profiles (SCS minus ESP)





+12.6

+10.9

+16.0

+17.0

CONCLUSIONS

Average total SOCs were 128.0 (65.6-162.6) and 140.6 (85.3-178.2) Mg ha^{-1} with the ESP and SCS approaches respectively if the coarse fraction is not included in the IPCC equation, 79.4 (36.3-110.5) and 90.4 (47.7-114.1) Mg ha^{-1} when the coarse fraction is included.

This indicates the importance to consider the coarse fraction when estimating SOC stocks to avoid their overestimation.

Lastly, the average overestimation of SOCs when SCS sampling approach is adopted is equal to 10.9-12.6 Mg ha^{-1}, i.e. 16-17%.

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