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Mapping the variation of soil organic carbon (SOC) stock in time and space in Sicily, an extremely variable semi-arid Mediterranean region, highlighted that C was lost in area rich in organic C and gained in poor-C areas

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The stock of organic carbon in the soil (SOC) is an indicator of soil ability to support agro-ecosystems productivity and resilience to environmental changes (Schillaci et al. 2016; 2017). In addition, SOC stock change through space and especially time is a valuable indicator of the soil ability to sequester CO_2 from the atmosphere and thus its potential to reduce the greenhouse gas effect. In the present work, we mapped (1-km resolution) the space-time variation of the SOC stock after 15 years (1993 to 2008) in a semi-arid Mediterranean area (25,286 km^2) after modelling SOC concentration (0-0.4 m depth) with boosted regression trees (BRT) and computing the SOC stock after the application of the bulk density maps of ISRIC (soilgrid.com, Hengl et al., 2014). The area under study (Sicily, south of Italy) has a plenty of contrasting environments, with changing ecosystems, soils, and microclimatic regions. The BRT procedure was run with a set of 25 predictors per year, including land use, soil traits, morphometric indicators and remote sensing covariates (derived from Landsat5 data). The BRT output consisted of a high pseudo-R^2(=0.71 for 1993 and 0.63 for 2008) of the SOC concentration, low uncertainty (standard deviation < 0.76 g C kg^{-1}) and root mean square error (4.33 g SOC kg^{-1} in 1993 and 8.39 g SOC kg^{-1} in 2008).

The maps of the SOC stock variation in time were produced as absolute change (t SOC ha^{-1} 15 $years^{-1}$) or percentage variation compared to the initial stock (1993). In the whole area, positive mean and median stock percentage variations were found (+10.9%$\pm$28.2% [mean$\pm$s.d.] and +8.55%, respectively). Strong SOC stock losses (-62.0% to -17.3%, corresponding to the data lower than the mean-s.d.) were found in 15.5% of the area and these pixel were mostly found in mountainous environments with high initial SOC stock and extensively used for forestry. This decrease was likely due to both high erosion rates and a short-term change in the climate, especially temperature. A high and positive percentage variation of the SOC stock (+39.1 % to +180.0%, corresponding to the data higher than the mean+s.d.) was found in 14.3% of the area under study. These environments are dominated by non-irrigated arable lands and characterized by low SOC, low rainfall and high temperature. In these conditions, the increase of the SOC stock found in 15 years likely occurred to the compulsory application of some Good Agricultural and Environmental Conditions, some of which were compulsory during the study period. Despite the mean SOC stock absolute change (and thus its percent variation) in time was positive, and the area under study corresponds to an administrative Italian region, the present results call policy to take into account of the variation of carbon at least at district level. This would allow establishing measures to protect the most vulnerable and higher SOC-stocking areas and increase the soil ability to sequester C in a view of the creation of a CO_2 accounting system, with C credits and debits, at the national and European level. The increase of SOC concentration found irrespective of the land use also suggests that the agronomical measures to be favored to increase SOC should focus on agricultural aspects different from the crop and likely address to the soil and residue management.

Referece:

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