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Achievements and challenges of the modelling of soil organic carbon in a highly variable Mediterranean area

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Mediterranean areas are vulnerable and at high risk of desertification, although harboring high fractions of the global biodiversity. Resilience of these (agro)ecosystem strongly relies on soil preservation, and thus the reduction of both the sediment and soil organic carbon (SOC) losses. However, SOC dynamic is understudied in the Mediterranean areas, especially in the arid and semiarid regions **[1]**.

Here we are summarizing the known and unknown of the SOC modelling in a highly variable Mediterranean area, namely Sicily (southern Italy). In addition, we highlight main research needs to increase the reliability of the estimation of the SOC change in time.

A total of 6674 soil samples were taken in various sampling campaigns from the 1993 to the 2008 from various depths (of which only 20% with soil bulk density [SBD] information) from both agricultural and forest lands on a 25,711-km^2 area **[2]**. Such database was used for SOC modelling through various procedures including classification and regression trees (CARTs) and Least Absolute Shrinkage and Selection Operator (LASSO) **[3-5]**.

Modelling SOC stock estimated with an already developed pedotransfer (R^2 = 0,3) function for SBD consisted in a high uncertainty, with a ratio between the model mean absolute error and the modelled 90th percentile higher than 26.9%, suggesting that SBD information or its reliable prediction is a prerequisite for SOC stock modelling in these areas, especially in agricultural land. In addition, taking into account the sampling campaign almost doubled the r squared of the CART models, which on average outcompeted the kriging and LASSO methods for the prediction certainty.

When modelling the time-variation of the SOC concentration through the use of non-paired samples **[5]**, the closer of which was few km apart, a mean SOC variation was highlighted, and the model yielded high pseudo-R^2 (0.63–0.69) and low uncertainty (s.d. < 0.76 g C kg^{-1}). However, these s.d. can be used only to highlight strong variations at a relatively low resolution (i.e. 1-km), especially if data are not collected with the same sampling scheme. The variation found in the aforementioned work **[5]** likely depended on a change of both the sampling scheme and land use rather than an accumulation or loss of SOC in a given land use.

Thus, measuring SOC concentration and SBD in time-paired sites appears as a prerequisite to detect a SOC change in a given land use, especially if taking into account that the most important SOC predictors throughout the experiments were rainfall and temperatures and climate change is likely to differentially affect each site. To overcome such a lack, a time paired-sampling was performed in 2017 in 30 sites in the arable land, providing evidence that the increases estimated from the 1993 to 2008 were not evident when resampling the 10% of the 1993's sites in field with continuous arable land use.

Reference: **[1]** Schillaci et al. DOI: 10.3301/ROL.2018.68; **[2]** Schillaci et al. DOI: 10.1016/j.catena.2018.12.015; **[3]** Veronesi and Schillaci DOI: 10.1016/j.ecolind.2019.02.026; **[4]** Lombardo et al. DOI: 10.1016/j.geoderma.2017.12.011; **[5]** Schillaci et al. DOI: 10.1016/j.scitotenv.2017.05.239