Modeling soil organic carbon stock after 10 years of cover crops in Mediterranean vineyards: improving ANN prediction by digital terrain analysis.

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Estimate changes in soil organic carbon (SOC) stock after Agro Environment Measures adoption are strategically for national and regional scale. Uncertainty in estimates also represents a very important parameter in terms of evaluation of the exact costs and agro environment payments to farmers. In this study we modeled the variation of SOC stock after 10-year cover crop adoption in a vine growing area of South-Eastern Sicily.

A paired-site approach was chosen to study the difference in SOC stocks. A total 100 paired sites (i.e. two adjacent plots) were chosen and three soil samples (Ap soil horizons, circa 0-30 cm depth) were collected in each plot to obtain a mean value of organic carbon concentration for each plot. The variation of soil organic carbon (SOCv) for each plot was calculated by differences between concentrations of the plot subjected to cover crops (SOC10) and the relative plot subjected to traditional agronomic practices (SOC0). The feasibility of using artificial neural networks as a method to predict soil organic carbon stock variation and the contribution of digital terrain analysis to improve the prediction were tested. We randomly subdivided the experimental values of SOC-stock difference in 80 learning samples and 20 test samples for model validation. SOCv was strongly correlated to the SOC0 concentration. Model validation using only SOCv as unique covariate showed a training and test perfection of 0.724 and 0.871 respectively.

We hypothesized that terrain-driven hydrological flow patterns, mass-movement and local micro-climatic factors could be responsible processes contributing for SOC redistributions, thus affecting soil carbon stock in time. Terrain attributes were derived by digital terrain analysis from the 10 m DEM of the study area. A total of 37 terrain attributes were calculated and submitted to statistical feature selection. The Chi-square ranking indicated only 4 significant covariates among the terrain attributes (slope height, valley depth, protection index, surface area). Model validation using SOCv and the selected terrain attributes as predictors showed a training and test perfection of 0.889 and 0.921 respectively. Results confirmed that after 10 years of cover crop practices the SOC concentrations generally increased in the topsoil horizon and this increment is affected by the initial SOC concentration and terrain-driven factors.