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MURASOC, a parametric model to test climate change effects on soil organic carbon. Application to Southern Spain (Mediterranean áreas)

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ABSTRACT

Soil organic carbon (SOC) is formed through the decomposition processes of plant, animal and microbial residues, root exudates, living and dead microorganism and soil biota; and is the main energy source for soil microorganism. Consequently, a strong feedback is stablished among a large number of components in the complex biota-abiota network. Likewise, SOC influences in physical, chemical and biological soil properties such as temperature, cationic exchange capacity and plant growth (Parras-Alcántara et al., 2015). Therefore, to improve our knowledge about what soil variables are more responsible of SOC content would be extremely useful in soils characterization. In many studies, independent variables were related to SOC, however, the possible combined effects of different independent variables and their ability to model SOC have not been considered. On the other hand, over the last few decades interest in soil organic carbon (SOC) has increased due to its role in C sequestration in terrestrial ecosystems, which could contribute to decreasing atmospheric CO_2 levels (Lozano-García et al., 2016; Fernández-Romero et al., 2016; Parras-Alcántara and Lozano-García 2014). Then, attempts to model SOC content have multiplied over this time.

In this study, 612 soil profiles obtained from the Natura 2000 network of protected areas in the Sierra Morena mountains, (Spain) were used with the following objectives: i) To quantify SOC content according to different variables (analytical, morphological, genetic and climatic) in order to define the variables that are most closely related to SOC content; ii) To model the Current SOC content for a geographic area (Sierra Morena – Spain); iii) To model SOC suitability-habitat under a climate change scenario; iv) To extrapolate the SOC content and distribution model to the wider Andalusia region, showing the areas that have a high probability to experience an increase in their SOC content in coming years; and v) To propose effective management in Andalusia's soils according to land use and land cover in protected areas of Sierra Morena and the entire Andalusia region.

To this aim, 24 independent variables were obtained and, using a correlation and a multiple linear regression analysis (MURASOC), the effects of these variables on the correlation with SOC content were considered. Indeed, predictor analysis was carried out with the best parameters determined with the regression analysis to be used in a climatic change scenario as predictor variables. The main conclusions of this work could be summarize as: i) Direct relationships between environmental variables and SOC content are similar to described by other authors; ii) In a multiple regression analysis, a poor relationship was observed between the analyzed variables and the SOC content; iii) When SOC content is under study, soil organic fraction (and activity) must be taken into consideration; iv) Similar to described by other authors in living entities under a climatic change scenario, a tend to migration of SOC >2% could be observed in latitude and altitude (it tend to disappear in lower altitudes and southern-oriented slopes; and v) The SOC content will decrease in Sierra Morena under a climatic change scenario, but it would increase in Andalusia under ideal conditions. The information generated in this study might support new strategies in decision-making to complete analyses started long ago, and extend it with new biological and biochemical strategies, as for example, identification of microorganism and relationships among them, with the terrestrial ecosystem and with the SOC synthesis and content. Once that is done, it will provide important information for soil management and climate adaptation strategies.

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