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Modelling spatial distribution of Soil Organic Carbon (SOC) in France using multiple linear regression approach and comparing model selection criteria.

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Soil Organic Carbon (SOC) is a key element of soil quality as it is the main indicator of soil fertility, as it has a major influence on soil aggregate stability and as it diminishes the risk of groundwater pollution because of its capacity to adsorb, immobilize and degrade contaminants such as pesticides and nitrates. Moreover, given the active C-exchange between soil and atmosphere, this reservoir is considered as a dynamic element in the global C-cycle, which underlines its potential to act as a driving factor on climate change feedbacks. Consequently, improved knowledge of the interaction between SOC and environmental factors in a spatio-temporal framework is needed. Moreover, mapping SOC at the regional or national scale becomes an important issue in order to catch the spatial variability of SOC and to help policymakers in planning an appropriate soil management strategy.
Here, we aimed to model the spatial distribution of SOC as a function of land use, soil type, climate and manure practice related variables for metropolitan France by applying a multiple regression approach. Moreover, a comparison between the output obtained by using different model selection criteria, i.e. Akaike information criterion (AIC), the corrected AIC rule (AICc), Hannan - Quinn information criterion (HQC) and Bayesian information criterion (BIC), was made. In this study, data from the RMQS soil survey gathered by the National Institute of Agriculture Research of France (INRA) between 2000 and 2009 (N = 2158) were combined with spatial data on land use, soil type, climate and manure production.
The AIC rule resulted in the most complex model (i.e. 36 parameters), the AICc and HQC rules gave the same model (i.e. 30 parameters) and using the BIC a remarkably simpler model was obtained (i.e. 12 parameters). Consequently, the latter had noticeably lower adjusted determination coefficient (R^2adj), root mean square error (RMSE) and ratio of performance to deviation (RPD) as compared to the two more complex models. But R^2adj, RMSE and RPD were only negligibly better in the AIC model than in the AICc - HQC model. Moreover, in the AIC model not all parameters were significant, while they were all significant in the AICc - HQC model. However, when climate - soil type conditions were characterized by few data, the AICc – HQC model output was different to that of the AIC model and the general trend reported in the international literature.

This study stressed the overall influence of climate and soil texture on SOC regardless of land use. In general, SOC content tended to increase with colder and wetter climates as well as fine textured soils. Moreover, land use specific interactions between soil texture and stone content, between manure and stone content and between manure and climate were detected. SOC content (in the fine earth) tended to increase with increasing stone content whatever the textural class under grassland and forest, while under cropland and vineyard/orchard this was only the case for the silt and clay dominated soils. Under grassland and vineyard/orchard an increase in C input related to slurry and farm yard manure (FYM) production resulted in an increase of SOC only in stony soils and/or under wet climate conditions. This manure related SOC enrichment could not be detected in soils without stones experiencing dry climate conditions and it was low under cropland for all climates and stone content settings.