EGU2020-791, updated on 27 Jun 2022
https://doi.org/10.5194/egusphere-egu2020-791
EGU General Assembly 2020

Volumetric soil quality modelling with machine learning in a diverse agricultural landscape in Andalusia, Spain

Tobias Rentschler[1,2], Martin Bartelheim[1,3], Marta Díaz-Zorita Bonilla[1,3], Philipp Gries[1,2], Thomas Scholten[1,2], and Karsten Schmidt[2,4]

[1]SFB 1070 ResourceCultures, University of Tübingen, D-72074 Tübingen, Germany
[2]Department of Geosciences, Chair of Soil Science and Geomorphology, University of Tübingen, D-72070 Tübingen, Germany
[3]Institute of Prehistory, Early History and Medieval Archaeology, University of Tübingen, D-72070 Tübingen, Germany
[4]eScience-Center, University of Tübingen, D-72074 Tübingen, Germany

Soils and soil functions are recognized as a key resource for human well-being throughout time. In an agricultural and forestry perspective, soil functions contribute to food and timber production. Other soil functions are related to freshwater security and energy provisioning. In general, the capacity of a soil to function within specific boundaries is summarised as soil quality. Knowledge about the spatial distribution of soil quality is crucial for sustainable land use and the protection of soils and their functions. This spatial knowledge can be obtained with accurate and efficient machine-learning-based soil mapping approaches, which allow the estimation of the soil quality at distinct locations. However, the vertical distribution of soil properties is usually neglected when assessing soil quality at distinct locations. To overcome such limitations, the depth function of soil properties needs to be incorporated in the modelling. This is not only important to get a better estimation of the overall soil quality throughout the rooting zone, but also to identify factors that limit plant growth, such as strong acidity or alkalinity, and the water holding capacity. Thus, the objective of this study was to model and map the soil quality indicators pH, soil organic carbon, sand, silt and clay content as a volumetric entity. The study area is located in southern Spain in the Province of Seville at the Guadalquivir river. It covers 1,000 km^2 of farmland, citrus and olive plantations, pastures and wood pasture (Dehesa) in the Sierra Morena mountain range, at the Guadalquivir flood plain and tertiary terraces. Soil samples were taken at 130 soil profiles in five depths (or less at shallow soils). The profiles were randomly stratified depending on slope position and land cover. We used a subset of 99 samples from representative soil profiles to assess the overall 513 samples with FT-IR spectroscopy and machine learning methods to model equal-area spline, polynomial and exponential depth functions for each soil quality indicator at each of the 130 profiles. These depth functions were modelled and predicted spatially with a comprehensive set of environmental covariates from remote sensing data, multi-scale terrain analysis and geological maps. By solving the spatially predicted depth functions with a vertical resolution of 5 cm, we obtained a volumetric, i.e. three-dimensional, map of pH, soil organic carbon content and soil texture. Preliminary results are promising for volumetric soil mapping and the estimation of soil quality and limiting factors in three-dimensional space.