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Spatial patterns of topsoil organic carbon in semi-arid areas – examples from SE Spain and Israel

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A key uncertainty in our understanding of the global carbon cycle is the lateral redistribution of carbon through the terrestrial system driven by erosion and transport. This relocation generates spatial patterns of soil organic carbon (SOC) depletion and accumulation. As soils are the major storage of carbon in terrestrial ecosystems, reliable estimates of spatial patterns of SOC are needed for greenhouse gas inventories and carbon mitigation projects.

Various techniques of data gathering, analysis and modelling are available to obtain reliable results on SOC distribution. Here we present a combination of techniques that include remote sensing, terrain analysis and geostatistics. Their application is exemplified with studies carried out in southern Spain and Israel.

The aim of the study carried out in Spain is to characterize spatial patterns of SOC in a Mediterranean, semi-arid area at different spatial scales and to assess the relationship between these patterns and terrain. We adopt a remote sensing based approach for the estimation of SOC in the topsoil. A statistical modeling approach is used to obtain quantitative, spatial estimates of SOC concentrations based on visible and near-infrared spectral properties of soils. Spatially distributed estimates (resolution 6 m) of SOC are obtained from the transfer of the statistical model to airborne hyperspectral data (HyMAP). Geostatistical techniques and digital elevation model analysis are used to characterize spatial patterns of SOC. A similar approach was adopted in the Negev, Israel, to derive spatial information on SOC distribution. Here, we focused on small scale variability of SOC and their relation to vegetation patterns and terrain.

The results indicate that the semi-arid hydrological and geomorphological process domain in both study areas exerts strong control on the lateral distribution of SOC generating high, small scale variability but also spatially contiguous patterns at larger scales. We conclude that hyperspectral remote sensing can be successfully applied to quantify the spatial distribution of SOC and provide a methodological framework for the analysis of the data.