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Layer- and land use-specific analysis of soil organic carbon patterns in a small catchment in the semi-arid and tropical south of India

Peter Fiener (1), Tom Gottfried (2), Michael Sommer (3,4), and Kristin Steger (5)

(1) University Augsburg, Department of Geography, Augsburg, Germany (peter.fiener@geo.uni-augsburg.de), (2) Indo-German Centre for Sustainability, Indian Institute of Technology Madras, Chennai, India, (3) Leibniz-Centre for Agricultural Landscape Research (ZALF) e.V., Institute of Soil Landscape Research, Müncheberg, Germany, (4) University of Potsdam, Institute of Earth and Environmental Sciences, Potsdam, Germany, (5) Institute for Modelling Hydraulic and Environmental Systems; Hydraulic Engineering & Water Resources Management, Stuttgart, Germany

Soil organic carbon (SOC) is the largest terrestrial organic carbon pool; thus, there is a growing interest in its spatial distribution and potential for carbon sequestration. However, our knowledge about spatial distribution in different soil layers and under different land uses is still limited in many regions of the world. The aim of this study was to analyse the soil layer and land use specific SOC stocks in a small catchment (6.46 km^2) located in the semi-arid, tropical south of India and to determine potential auxiliary variables suitable to derive high resolution maps. In a first step, a soil survey was carried out in 2011 taking 183 soil cores representing three soil layers each (0-0.2 m, 0.2-0.5 m and 0.5-0.9 m, respectively). In a second step, a number of spatially distributed auxiliary variables (slope; curvature; elevation above the next potential irrigation source; water erosion; wetness index; mean NDVI) were determined and the interrelationship between SOC stocks and these variables and their principal components were analysed with a combination of an ANCOVA, an iterative linear regression and a multivariate non-linear regression procedure. The mean SOC contents and stocks (upper 0.9 m) of 0.34% and 4.33 kg/m^2, respectively, are consistent with large scale data. The more detailed analysis of land use specific differences in SOC stocks showed that the sampling points of irrigated arable land had the highest stocks (5.07 kg/m^2), followed by plantations (4.36 kg/m^2), forests/shrubland (4.23 kg/m^2) and grassland (2.45 kg/m^2). Within the different land use categories (i) SOC under arable land declines with increasing elevation above the next potential irrigation source, (ii) SOC under grassland is positively correlated with mean NDVI, (iii) SOC under forest/shrubland is best described through variables indirectly related to the accessibility of forest areas (positive correlation to slope and elevation above the next potential irrigation source; negative correlation to wetness index). Interestingly, no significant correlation between SOC under forest and erosion could be found indicating that this effect can only be assessed by sampling deeper soil layers. Overall, the data analysis allowed deriving a reasonable SOC stock map of the upper 0.9 m of the catchment, which is a valuable basis for future research in this area. The mapping approach using the identified, easy to derive auxiliary variables is also a solid base for further SOC mapping efforts in the region.