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Soil Carbon Storage Estimation in a Forested Watershed using Quantitative Soil-Landscape Modeling

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Abstract

Carbon storage in soils is important to forest ecosystems. Moreover, forest soils may serve as important C sinks for ameliorating excess atmospheric CO_2 Spatial estimates of soil organic C (SOC) storage have traditionally relied upon soil survey maps and laboratory characterization data. This approach does not account for inherent variability within map units, and often relies on incomplete, unrepresentative, or biased data. Our objective was to develop soil-landscape models that quantify relationships between SOC and topographic variables derived from digital elevation models. Within a 1500-ha watershed in eastern Kentucky, the amount of SOC stored in the soil to a depth of 0.3 m was estimated using triplicate cores at each node of a 380-m grid. We stratified the data into four aspect classes and used robust linear regression to generate empirical models. Despite low coefficients of correlation between measured SOC and individual terrain attributes, we developed and validated models that explain up to 71% of SOC variability using three to five terrain attributes. Mean SOC content in the upper 30 cm, as predicted from our models, is 5.3 kg m^{-2}, compared with an estimate of 2.9 kg m^{-2} from soil survey data. Total SOC storage in the upper 30 cm within the entire watershed is 82.0 Gg, compared with an estimate of 44.8 Gg from soil survey data. A soil-landscape modeling approach may prove useful for future SOC spatial modeling because it incorporates the continuous variability of SOC across landscapes and may be transportable to similar landscapes.

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Soil organic carbon was predicted using eight predictor variables derived from the advanced space borne thermal emission and reflection radiometer satellite images and digital elevation model. The soil organic carbon was determined in 248 soil samples collected randomly within a 300 m2 grid overlaid on the study area. Soil carbon storage estimation in a forested watershed using quantitative soil-landscape modeling. Soil Science Society of America Journal, 69, 1086–1093. https://doi.org/10.2136/sssaj2004.0322.CrossRefGoogle Scholar. Triantafilis, J., Odeh, I. O. A., & McBratney, A. B. (2001). The use of soil-landscape models to predict soil attributes is theoretically better than interpolation techniques, because the former uses topography and satellite data as a background to guide prediction, while interpolation relies solely on the spatial relationships between adjacent observations without considering the variations in factors that drive soil differentiation. The watershed subdivisions were considered as a base unit in the prediction model analyses. The approach indicated that soil-landscape modeling could be used with a low number of observations to produce accurate predictions of soil attributes with an acceptable representation of the spatial distribution of soil attributes over the landscape.