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Topographic Controls on Soil Carbon Distribution in Iowa Croplands, USA

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Topography is a key factor affecting soil organic carbon (SOC) redistribution (erosion or deposition) because it influences several hydrological indices including soil moisture dynamics, runoff velocity and acceleration, and flow divergence and convergence. In this study, we examined the relationship between 15 topographic metrics derived from Light Detection and Ranging (Lidar) data and SOC redistribution in agricultural fields. We adopted the fallout 137Cesium (137Cs) technique to estimate SOC redistribution rates across 560 sampling plots in Iowa. Then, using stepwise ordinarily least square regression (SOLSR) and stepwise principle component analysis (SPCA), topography-based SOC models were developed to simulate spatial patterns of SOC content and redistribution. Results suggested that erosion and deposition of topsoil SOC were regulated by topography with SOC gain in lowland areas and SOC loss in sloping areas. Topographic wetness index (TWI) and slope were the most influential variables controlling SOC content and redistribution. The topography-based models exhibited good performances in simulating SOC content and redistribution across two crop sites with intensive samplings. SPCA models had slightly lower coefficients of determination and Nash-Sutcliffe efficiency values compared to SOLSR models at the field scale. However, significantly SPCA outperformed SOLAR in predicting SOC redistribution patterns at the watershed scale. Results of this study suggest that the topography-based SPCA model was more robust for scaling up models to the watershed scale because SPCA models may better represent the landscapes and are less subject to over fitting. This work suggests an improved method to sample and characterize landscapes for better prediction of soil property distribution.