High-Resolution Mapping of Soil Organic Carbon Under Different Land-Use Types Using NEON Remote Sensing Data.

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Abstract

Soil organic carbon (SOC) represents the largest terrestrial carbon pool. Effectively monitoring SOC at high spatial resolution is crucial for estimating carbon budgets at the ecosystem scale and informing climate change mitigation efforts at the regional scale. Traditional soil sampling methods, however, are laborious and expensive. Remote sensing platforms can be used to survey large landscapes to meet the need for rapid and cost-effective approaches for quantifying SOC at landscape to regional scales, if relationships between remotely sensed variables and SOC can be established. We developed a workflow to analyze and predict SOC content based on National Ecological Observatory Network (NEON) Airborne Observation Platform (AOP) remote sensing data. First, we benchmarked related tools and developed reproducible workflows using NEON remote sensing datasets. Hyperspectral data were extracted from the locations where NEON soil data exist. Additional variables from the LiDAR data and key metadata (climate and land cover) were extracted for those locations. Random Forest and Partial Least Squares Regression techniques were then used to create models for fine-scale SOC prediction. Cross-validation was embedded in the model creation step. The most important covariates were selected through recursive feature elimination, stepwise selection, and expert judgment. Preliminary results indicate that machine learning models can re-produce SOC measurements in testing datasets. Key predictors include topographic variables, vegetation indices, and specific wavelength bands in hyperspectral images. We are further validating our algorithms using SOC data from ISCN (International Soil Carbon Network) and SoDaH (SOils DAta Harmonization database) that are co-located with NEON sites. We are creating high-resolution SOC maps for 0-30 cm depth at NEON sites and testing our algorithms for different land use types. Our work paves the way for a broader assessment of SOC stocks using remote sensing observations, and our high-resolution SOC maps will potentially help quantify carbon budgets across heterogeneous landscapes.

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