

Public Abstract

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Traditional soil mapping concepts do not sufficiently address the spatial resolution of some soil management problems. Continuous models of soil profiles and landscapes are needed to move beyond the categorical paradigm of horizons and soil map units. This work proposes a strategy combining sensors and empirical functions of profile properties to develop high resolution 3-D models of soil landscapes. The strategy proceeds in three steps as follows: 1) estimate soil profile properties at high resolution with the combined use of a visible-to-near-infrared diffuse-reflectance spectroscopy (VNIR-DRS) sensor and several soil electrical conductivity (EC) sensors, 2) model measured or sensor predicted soil profile properties with nonlinear peak functions, and 3) map the parameters of peak functions across the landscape to produce a continuous numerical soil-landscape model. Coherent depth translation (CDT) was introduced as a method to transform and combine sparse soil profile data into a single dataset for improved modeling. These methods were tested in the upland landscapes of northern Missouri. Sensor calibrations were successfully developed to estimate profile clay and organic carbon, however calibrations for pH and one:one (soil:water) suspension EC were not successful. Combination of profile and proximal EC measurements with VNIR-DRS measurements did not improve calibrations for soil properties over those with VNIR-DRS measurements alone. The Pearson IV and the asymmetric logistic peak functions were successfully used to model profile clay content. They were flexible enough to fit depth profiles of clay in a range of soil series with varying shapes in the clay peak. Coherent depth translation enabled the hierarchical modeling of pedogenic trends in peak function parameters. First, by allowing the pooling of sparse soil series data, CDT made it possible to use peak functions for profile modeling. Second, by fitting multiple soil series on a common depth scale, the parameters of the peak functions from each series could be modeled as linear or quadratic functions. Prototype numerical soil-landscape models were developed by the hierarchical method for a lithosequence and a toposequence of common soil series in northern Missouri. The results of this research address a primary limitation for solving soil management problems – the availability of high-resolution soil property data. Critical problems in water quality, soil productivity, and soil hydrology need the data this research can provide in order to advance their solutions to the scale at which the problems occur in the real world.