Sophisticated soil analysis for improved land use

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Soil variation occurs across multiple geographic scales ranging from vast climatic regions of the Earth to a 50 acre farm field to the molecular world of soil nano-particles in a pinch of soil.

For example, in a forest or an agricultural field, soil properties vary from the summit of a hill down to the base. Within a single soil aggregate that may be less than a quarter inch in diameter, there is a variable distribution of open spaces (soil pores), solids (soil particles), and water and gas molecules, and within each of the elements themselves there is variation, such as different pore shapes and different elemental solids.

Many approaches have been used to examine soil variation at these diverse scales, but there is a common difficulty among methods in separating out random variations from systematic variations. Some of the variation observed in, say, a desert community or a handful of soil is random, but other variation is predictable (systematic) based on variables such as landscape position, climate, or time of the year.

New methodological developments better enable us to separate out these different sources of variation by examining soil variability over a range of scales, which is important for linking soil properties with soil processes. These linkages have important predictive capacities, such as forecasting corn yields based on soil characteristics, or understanding where microorganisms live in soil and how human alteration to certain soil properties affects their livelihood.

Scientists from USDA-ARS-NSTL in Iowa, The University of Tennessee, and E.T.S. Ingenieros Agrónomos in Spain have assembled a collection of 12 papers covering a range of original approaches for assessing soil variability across multiple scales. The papers are published in a special section of the May 2008 issue of Vadose Zone Journal.

A variety of multi-scale methods are described and some authors compared the performance of different approaches. The methodologies employed include a variety of sophisticated mathematical approaches including geostatistics (variance of a property depends upon its position in space) and fractals and multi-fractals (similar patterns at different scales), to name a few. The authors then applied these different multi-scale methods to diverse data sets including soil pore shapes, soil aggregates, water content, rate of water movement, gas fluxes, corn yields, geochemical data, and remote sensing data.

"Understanding the interrelationships between physical, chemical, and biological factors at different scales is essential for research in agriculture, engineering, hydrology, and the environment," says researcher Dr. Sally Logsdon of the USDA-ARS, National Soil Tilth Laboratory, Ames, IA. "Future research should examine how to better mesh together soil data and predictions across landscape position and time scales."

Source: Soil Science Society of America

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