Vision, Strategies, and Benefits for Soil Change Data Collection in Soil Survey: Implications for Soil Research

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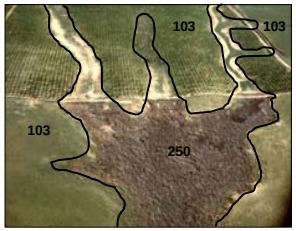
Introduction

Today's questions about sustainable land management and threats to the environment demand new kinds of soil information. Policy makers, producers, federal land managers, conservationists, and other soil survey customers need information about management effects on soil and their reversibility over the human time scale (centuries, decades, and less).

This paper describes the new National Cooperative Soil Survey emphasis on soil change, dynamic soil properties, and management effects on soil.



Vision

Enhancing the new soil survey with information about how soils change.

Mission statement

The National Cooperative Soil Survey of the future will inventory and predict soil change over the human time scale, determine the mechanisms, and interpret the consequences of those changes.

Soil survey conventions for change

- Soil change reflecting management effects has been traditionally addressed through classification (I) and phase distinctions (II).
- A new convention uses conceptual models of change (III) and comparison studies. (See poster 1524)
- The central tendency and range of variability in near-surface dynamic soil properties will be determined for specific plant communities or management systems within soil map unit component phases.

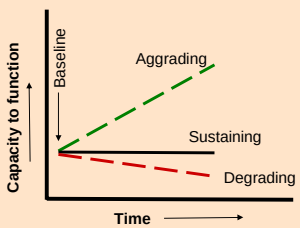
I Taxonomic classes	II Phase distinctions	III Models of change	IV Short-interval monitoring
Drastically altered •Transported (Minesoils) • Horizons destroyed • Horizons mixed	**Relatively unaltered control section** • Eroded • Drained • etc.	**Dynamic management effects on soil** •Dynamic soil properties	**Regular, periodic and cyclic fluctuations** •Soil moisture •Temperature •Water tables

High Change in function *Low – high*

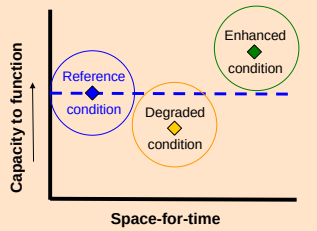
Reference condition and dynamic soil properties

Comparison studies (Pickett, 1989; Richter and Markewitz, 2001; Tugel et al., 2005) rather than long-term monitoring will be used to quantify values for the reference condition (inherent functional status). Dynamic soil property data reflecting departure from the reference condition indicates how soils change.

Long-term monitoring model (No reference condition)



Soil survey model (Departure from reference condition)



Realizing the Vision

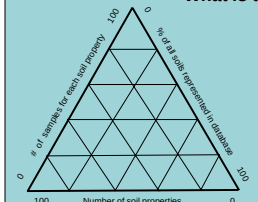
Four initial objectives for program implementation and collection of dynamic soil property data have been identified.

1. **Soil change information.** Account for soil change over the human time scale.
2. **Data quality.** Refine existing soil survey data (aggregated data) to improve accuracy.
3. **Interpretations.** Develop interpretations of land use and management effects on soil function.
4. **Landscape scale processes.** Describe soil processes related to soil function at the landscape scale.

Implementation Strategy

- Initial data collection will focus on representative or benchmark soils that are major in importance or extent or soils where long-term study data are already available. Projects will be part of, though not limited to soil survey updates.
- Methods will be sanctioned by the National Cooperative Soil Survey. Specialist or research scientist staff will be provided to assist with data analysis.
- Initial funding priorities include technology development for methods and interpretations, database design, and training.
- Hard data will be stored in a point data base that is linked to other systems such as the Laboratory Information System and the Ecological Site Inventory System.
- Methods will be developed to extrapolate measured results to other soil map units in order to populate aggregate databases (soil map unit databases).
- New products and progress reporting measures can be developed, such as: point data, interpretations that account for land use and management effects, function-based interpretations, benchmark soil reports, and acres benefited by a dynamic soil properties project.

What is the optimum allocation of effort?



Because of costs, data collection will involve tradeoffs between:
1. Number of soil properties (bottom of triangle),
2. Number of samples to be analyzed for each property for a particular soil or group of soils (left), and
3. Number of soils (right).

The left axis reflects the proportion of the spatial variability that would be captured (and the precision of these estimates): more samples = more precise estimate of range of values.

Technology Gaps and Research

Research needed to fill gaps should be identified. Important requirements and examples are described below.

Soil properties and data analysis

Dynamic soil properties selected for sampling must be functionally important, cost-effective to measure, and simple to evaluate.

- Relationships between property and function as well as simple field methods for measuring the properties.
- Methods to estimate highly variable properties such as infiltration from less costly measures.
- Methods to compare results for samples with unlike horizon sequences and to evaluate vertical redistributions in the profile.

What will we measure?

Spatial and temporal variability

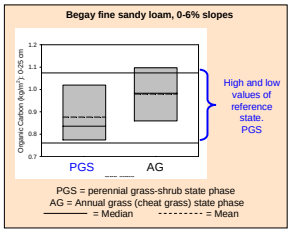
Scientifically credible sampling procedures depend on knowledge of the spatial and temporal variability of near surface dynamic soil properties.

- Approved definitions for soil change, including state variables, fluctuation and trend changes, characteristic response time, thresholds, and pathways of change.
- Soil property spatial variability at multiple scales and sampling requirements for soil-landscape-management units. (skyew@nmsu.edu or atugel@lin.usda.gov or jherrick@nmsu.edu)

Interpretations

Soil change data must be simplified and presented in new soil survey products and interpretations to meet customer needs.

- Interpretations to assist the management of human impacts on soil functions (e.g., hydrologic functions, nutrient cycling, and providing a stable medium for plant growth and structures). In particular, threshold values, resistance, resilience and rates of change.
- Procedures to identify suitable indicators for resource monitoring and assessment.



For example, federal agencies manage large areas of rangeland, woodland, and forest ecosystems. (Bureau of Land Management, 262 million ac.; Forest Service, 193 million ac.; National Park Service, 85 million ac.) The ability of these ecosystems to function and sustain natural resource values and productivity are determined through land health, soil resource, and watershed condition assessments. Reference values for near surface dynamic soil properties (e.g., OC, aggregate stability, and biological soil crusts) are needed to improve these assessments.

Landscape scale

Providing information about how soils function at the landscape scale is important for many resource issues.

- Scaling procedures to apply point data to coarser scales.
- Remote sensing technologies to characterize dynamic soil properties as spatially continuous variables.

Uses and Benefits

With an emphasis on concurrent data collection for soil properties, management, and vegetation, new information will be available for integrated planning, management, and conservation programs.

Point data and new interpretations will:
- Add value to soil survey updates.
- Expand the ability of soil survey to address sustainability, soil quality, and ecosystem services.
- Improve practice designs and information on practice effects.

A soil change program will strengthen agency and academic programs and the NCSS partnership.
- Field soil scientists retain old and gain new skills.
- The program attracts students and employees interested in socially important environmental issues. Higher enrollments strengthen university soil science departments and continue the supply of agency employees.
- Collaboration among NCSS cooperators and the broader research community 1) enhances soil change research and 2) results in interdisciplinary proposals for research that are more competitive in many granting programs.