Soil Survey Objectives and Pilot Projects for Measuring Soil Change

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Arlene J. Tugel, Soil Scientist, NRCS
Liaison to ARS

Conventions for soil change

Simple conceptual models

Taxonomic classes	Phase distinctions	Model change
Drastically altered ▪Transported (Minesols) ▪ Horizons destroyed ▪ Horizons mixed	**Relatively unaltered control section** ▪ Eroded ▪ Drained ▪ etc.	**Dynamic management effects on soil** ▪Dynamic soil properties

Outline

- New soil survey objectives for soil change and dynamic soil properties
- Status report on pilot studies and Sampling Guide
- Challenge to NCSS cooperators

NRCS Soil Change Leadership Team

- Karl Hipple, Nat. Leader, Interpretations, NRCS
- Arlene Tugel, Soil Sci., Liaison to ARS, NRCS
- Chris Smith, Nat. Leader Technical Soil Services, NRCS
- Susan Andrews, Soil Quality Team Leader, NRCS

New soil survey objectives (NRCS)

1. Provide information about how soils change over the human time scale.
2. Refine existing soil survey data to improve accuracy.
3. Develop interpretations of management effects on soil function
4. Quantify landscape scale soil processes.

Objective 1. Account for soil change over the human time scale

= Centuries, decades and less

- Decades to centuries - the *recovery* time scale
- Decades - the *management* time scale

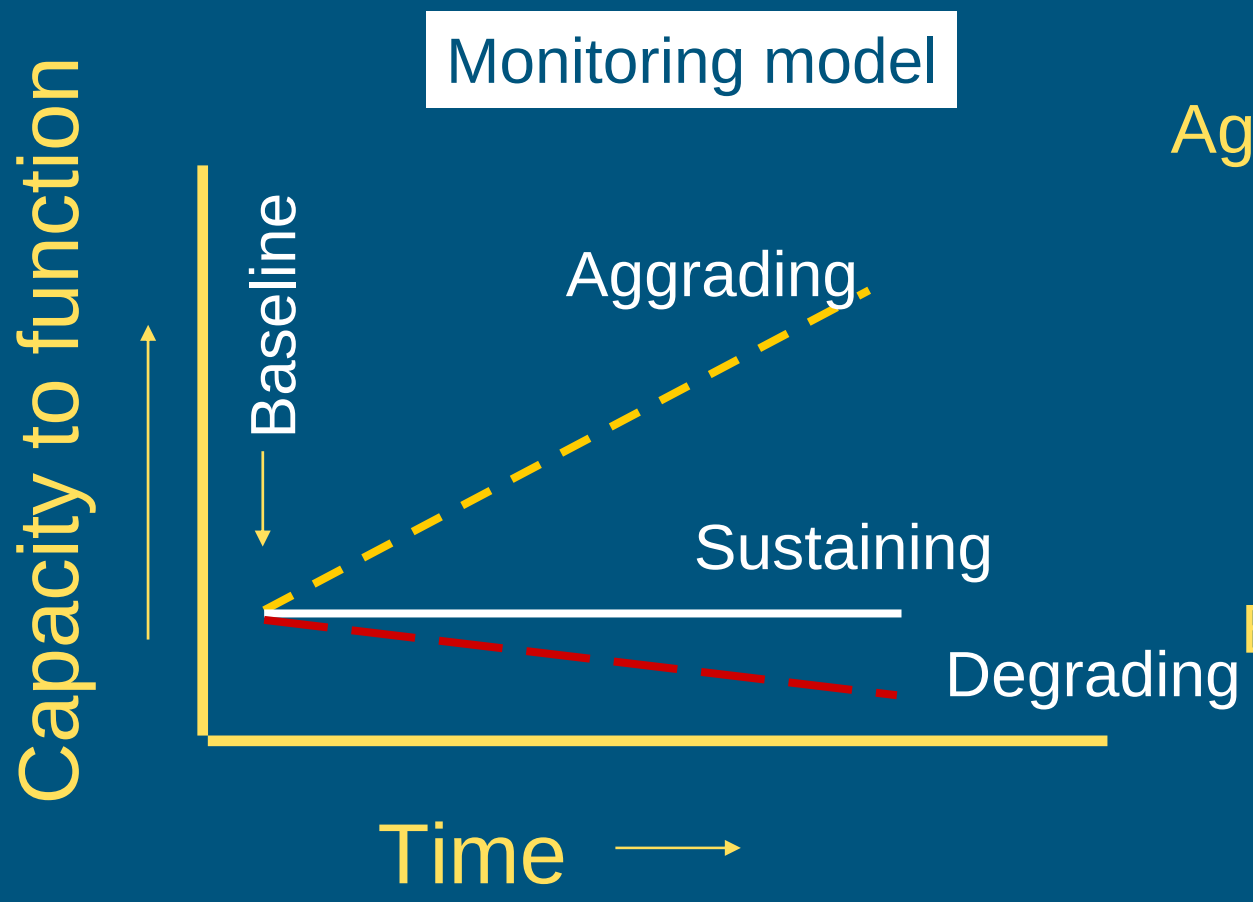
Tugel et al., 2005

Richter and Markowitz, 2001

Understanding Soil Change

Dynamic soil properties =

Soil properties that change over the human time scale.

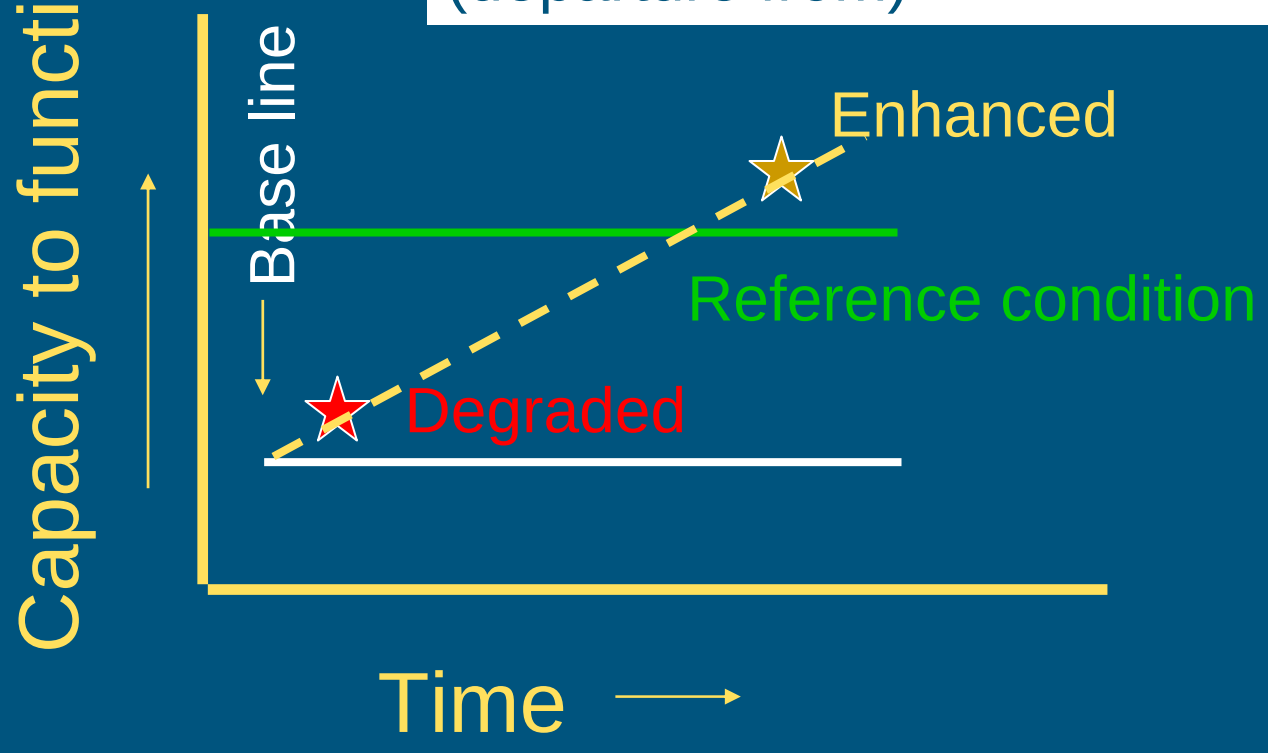


Organic matter
Aggregate stability
Salinity
Infiltration
Ksat
Topsoil depth
Biological crusts
etc.

Dynamic soil properties =

Soil properties that change over the human time scale.

Reference condition model for soil survey (departure from)



Objective 2. Improve accuracy of databases.

Soil organic matter content for two soil soils under different land uses.

Soil	Database estimate	Grassland-measured	Cultivated-measured
Askarben	2-4 %	6.0	3.0
Monona	2-4 %	3.6	2.9

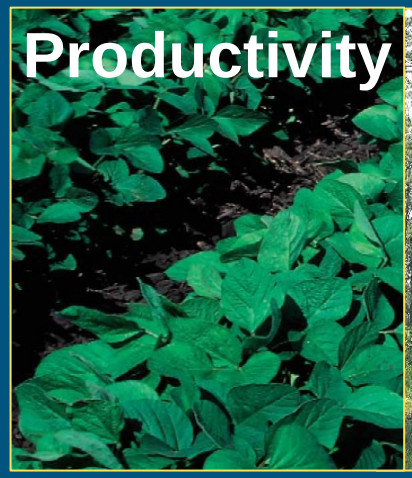
(Grossman, unpublished)

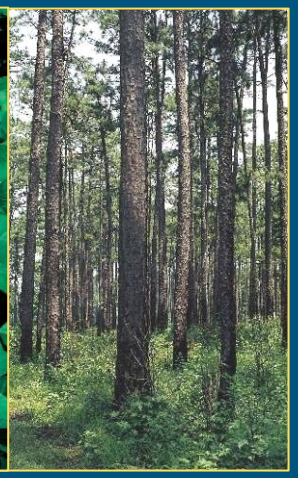
- Important for
  C-sequestration, pesticide applications, nutrient applications

Objective 3. Develop interpretations of management effects on soil function.

- The importance of soil change is its affect on function.
  - Stable medium for plant growth
  - Hydrologic function
  - Nutrient cycles
- The consequences of change depend on its reversibility.

(Arnold et al.,1990)





Function-based questions for new interpretations

- **What is the condition of my soil (level of function; soil quality)?**
- **What can be used to detect soil degradation before it occurs?**
- **What will it take to restore or improve it? *(and how much $$$***
- **How will soil changes affect future management options?**

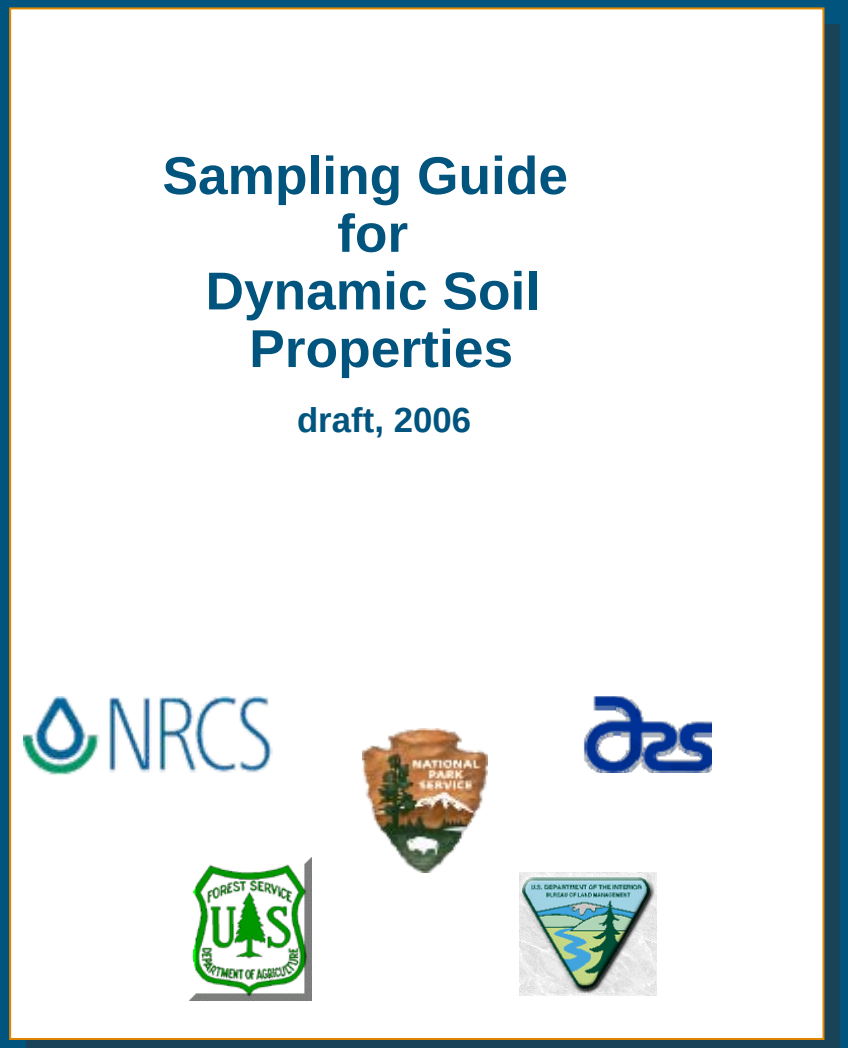
SS Product

- **Reference condition**
- **Early warning indicators**
- **Resistance and resilience ratings**
- **Resilience**

Pilot studies and Sampling Guide

Pilot studies

- TX (2002-2004)
  - Rangeland, Big Bend National Park
- UT (2005-2006)
  - Invasive plants, Arches National Park
- MO (2006-2007)
  - Deciduous woodland and pasture, Springfield Plateau
- ID (2006-2007)
  - Mature forest and second growth on ~40 year old clearcut, Northern Idaho
- (initiate FY 07)
  - cropland pilot



- Peer reviewed Jan. 2007
- Revisions underway
- Release in early FY 08

Instructions for

- Properties to sample (soil, vegetation)
- Sample designs
- Data summaries and reports

Comparison studies…….
……NOT Monitoring

1. Use a conceptual model to describe hypothesized causes and effects of change and to select sample sites.
2. Sample two or more different and previously defined management systems.
3. Document reference condition (or potential).
4. Substitute space-for-time to analyze change. (Pickett, 1989)

What will we measure?

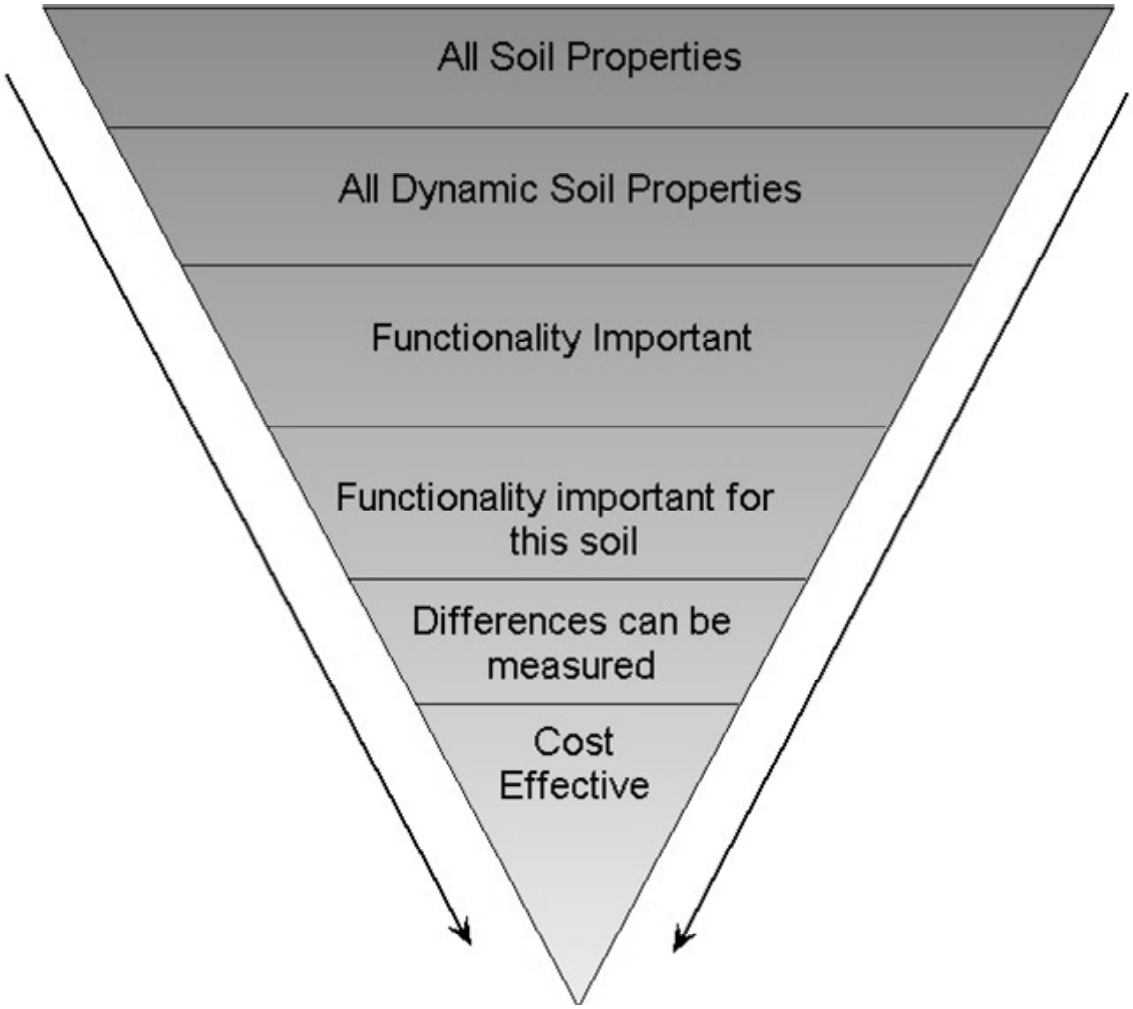


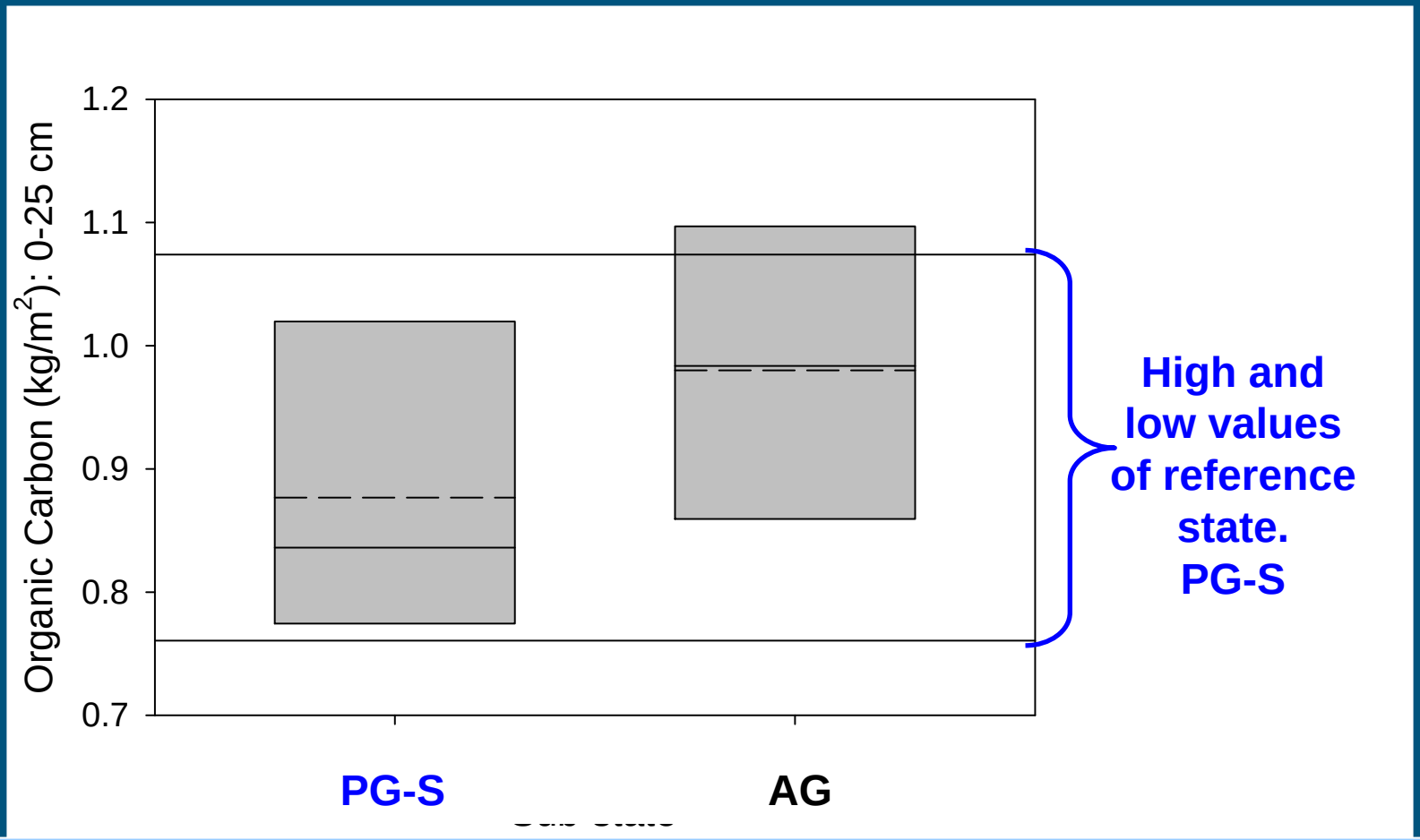
Table 2. Characterization and comparison of the central tendency (mean) and variation (standard deviation) in the intact mixed perennial grass/shrub community (PG-S) and the annual grass (cheatgrass) invaded community (AG). The number of plots per community is 4.

		PG-S		AG		Comparison		
Property	**Depth**	**Mean**	**SD**	**Mean**	**SD**	**Difference**	***t***	***p*-value**
Bulk density (Db)								
	A horizon	1.51	0.06	1.42	0.06	0.09	-2.14	0.08
	B horizon*	1.55	0.03	1.51	0.03	0.04	-1.90	0.11
Soil stability								
	Surface	5.1	0.10	4.5	0.80	0.56	-1.38	0.26
	2.5 cm	2.2	0.75	2.4	1.01	-0.20	0.32	0.76
	Top of B	2.1	0.68	2.6	0.71	-0.51	1.03	0.34
Organic C (%)								
	A horizon	0.36	0.03	0.45	0.09	-0.09	1.91	0.14
	B horizon*	0.18	0.04	0.18	0.06	0.00	-0.11	0.92
Organic C (mg/cm3)	*(OC% x Db x10)*							
	A horizon	5.36	0.51	6.40	1.48	-1.04	1.33	0.26
	B horizon*	2.80	0.59	2.67	0.83	0.14	-0.26	0.80
Canopy cover (%)		47.6	9.6	77.0	12.7	-29.38	3.68	0.01
Basal Cover (%)		4.1	5.1	11.5	10.8	-7.38	1.24	0.28
Annual production, not adjusted for seed shattering (lbs/acre)		523	177	666	96	-142.83	1.42	0.22

*B horizon to 25 cm

Control Charts

OC kg/m2 (0-25cm)



PG-S = perennial grass-shrub sub-state; AG = Annual grass (cheat grass) sub-state; n=4 ——— = Median ------- = Mean

NRCS implementation strategy

- Develop procedures for sampling and interpretation of dynamic soil properties.
- Start with benchmark soils; use models to populate aggregated database.
- Store data as point data (adding business requirements).
- Go slow at first.
- Do trial implementation -- 1 or 2 MLRA SSA's.
- Readjust as we learn.

Seeking cooperator involvement

Challenges for NCSS cooperators

Suggested NCSS implementation strategy: Who and How?

- Agencies
  - Identify agency business requirements.
    - Soil quality, federal monitoring programs, sustainable development.
- NCSS: Committee work
  - Needs and availability assessments.
  - Explore existing and encourage new funds for research.
- University cooperators
  - Lead education and research on human impacts on soil.

What?

- Develop a collective vision for soil change in soil survey.
- Develop interpretations to support monitoring, assessment and management of human impacts on soil.—indicators, thresholds
- Summarize existing data on spatial/temporal variability of dynamic soil properties at multiple scales.
- Build employee capacity.
- Collaborate on future versions of the Guide through testing and research.

Summary

- Soil change on the human time scale is an emerging concept for soil survey that requires NCSS collaboration.
- Soil change data and interpretations will help land managers and decision makers balance their goals for production, economics, sustainability, and the environment.
- Documenting soil change in soil survey can be accomplished through comparison sampling based on a conceptual model of how soils change. Modeling is needed to extend data.
- Monitoring for changes in resource condition is an alternative, but it could take decades or centuries.

More information

Tugel, A.J., J.E. Herrick, J.R. Brown, M.J. Mausbach, W. Puckett, and K. Hipple. 2005. Soil change, soil survey, and natural resources decision making: A blueprint for action.
Soil Sci. Soc. Am. J. 69:738-747.

Also available online at http://soil.scijournals.org/content/vol69/issue3/#PEDOLOGY

atugel@nmsu.edu

jherrick@nmsu.edu

How will the data be used?

- Interpret assessments and monitoring
  - Quality criteria, rangeland health, indicator selection
- Support practice designs
  - Derived values
- Quantify amounts
  - Carbon pools
- Predict soil behavior/response
  - Change in capacity to function (STM-ESD's)
- Technical soil services
  - Special user needs