Dynamic Soil Property

Inventory and Assessment

Long-Term Plan

2014-2016

A 3-Year Plan for Full Implementation of
Dynamic Soil Property Inventory and Assessment Program
in the National Cooperative Soil Survey

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Vision

Deliver scientifically-defensible soil change information to support conservation management for healthy soils and sustainable ecosystems

Mission

To enhance National Cooperative Soil Survey data and products regarding soil change in response to management and climate to inform conservation planning, in the following fourfold fashion:

1) Lead the National Cooperative Soil Survey in the inventory, prediction, and interpretation of soil change at the human time scale, as measured by dynamic soil properties;
2) Coordinate research efforts, seek out new data sources and develop methods for interpretation of soil dynamic properties to efficiently and effectively develop the inventory;
3) Assist NCSS soil scientists with training, project development, and review; and
4) Design and develop products from the data for use by conservation planners, policy makers and landowners.

Background

Alignment: USDA, NRCS and Soil Science Division Program Long Term Plans, 2005-2015

In 2005, the inventory of dynamic soil properties was added to the NRCS Soil Survey Program Strategic Plan for 2005-2015. The relevant initiative in the Plan is included under Objective 3 of Mission Function 2 – Keep soil survey relevant to meet emerging and ever-changing needs. The Initiative is "*Develop interdisciplinary technologies that relate soils to the overall ecosystem and predict changes to both the soil and the overall ecosystem under a variety of management scenarios. Assess existing activities, define needs and develop procedures for collecting reference data for dynamic soil properties used in the development of soil change interpretations and soil landscape processes over time for users who assess and monitor soil condition and for other purposes".*

What are dynamic soil properties?

We define dynamic soil properties as those measurable aspects of soil that change at the human time scale as the result of disturbance. Disturbance can be naturally occurring, such as flood or drought, human-induced, such as tillage or pesticide application, or their combined impacts. Dynamic soil properties are the measures that estimate soil quality or health, which is the capacity of the soil to function.

Soil change, the broader term, is temporal variation in soil properties at a specific location. Temporal variation can span time scales of seconds to centuries or longer. Pedogenesis, as applied traditionally in soil survey, accounts for change over the millennial time scale and is also a type of soil change. Soil change over the human time scale, as measured by dynamic soil properties, occurs over periods of decades to centuries and less.

Two primary kinds of change are trend and fluctuation. Trend changes, such as a decrease in soil organic matter, are important considerations for long-term soil resource management. Fluctuations, such as seasonal variation in soil water table depths, are important for short-term management decisions. Soil survey can provide information for both kinds of change in quality or health by coupling model predictions with field sampling.

A number of terms related to soil change are used in this document. Definitions are provided as a reference (Table 1).

Table 1. Dynamic Soil Property-related Terms and Definitions

Term	Definition
Soil change	Temporal variation in soil properties at a specific location over time.
Dynamic soil properties	Soil properties that change at the human time scale.
Human time scale	Periods of centuries, decades or less.
Soil quality/soil health	The capacity of the soil to function and perform ecosystem services
Soil function	A service, role, or task performed by soil (e.g., providing a stable medium for plant growth and structures, regulating water and nutrient cycles, buffering contaminants)
Resistance	The capacity of a soil to continue to function through a disturbance.
Resilience	The capacity of a soil to recover the functional integrity lost after a disturbance or prolonged stress. Resilience has both temporal and amplitude aspects, i.e. how fast and how much does function recover
Pedotransfer function	Mathematical expressions that predict soil properties and processes derived from other measured properties

Objectives

The following, broadly defined objectives pertain to the National Cooperative Soil Survey as well as natural resources management, conservation, and planning over the long term. They are based on our current understanding of soil change information needs and may be supplemented as the understanding increases.

The primary objective is the prediction and collection of dynamic soil property data and information. This includes the inventory, modeling and interpretation of information on soil change due to human management, climate change and natural disturbance at the human time scale for the purpose of conservation planning and natural resource management.

Objectives secondary to the primary objective include:

1. **Enhance Soil Survey data.** Add value to existing soil survey information to improve its accuracy with measured and modeled dynamic soil property data stratified by soil component, climate, DEMs, land use/land cover, and management system information. Methods will include:
   a. Rapidly populate a dynamic soil properties database by using modeled data, e.g. APEX;
   b. Use data mining and meta-analysis techniques to develop model subroutines and pedotransfer functions (PTFs) to estimate DSPs;
   c. Field sample DSPs to validate PTFs and model subroutines, using a less intensive design than needed for comparison studies;
   d. Account for spatial variation of DSPs in field sampling design; and
   e. Model soil groups based on inherent soil properties and taxonomy, and sample benchmark soils within soil groups, to target initiative areas and assist in extrapolation of data for maximum inventory coverage.
   f. Enhance conservation effects assessment model(s) and PTF accuracy using analyzed sample information.
   g. Used science-based methods to enhance soil survey, to include but not to be limited to: extrapolation, uncertainty estimates, taxonomic distance calculation, digital mapping, and model subroutine development, calibration and validation.

2. **Allow many sources of information.** Develop a minimum data set of supporting information, including management, soil, and climate information. Any DSP would be acceptable, if sampled at an appropriate density to account for spatial variation in the property.

3. **Delivery of information.** Develop and test interpretations important for conservation planning and soil management. Include interpretations of land use, climate change effects and management impacts on soil function and ecosystem services. Query target end-users as to the most effective types and formats of information.

Projected Outcomes

Emphasizing the objectives identified above will provide information needed to maintain high quality soils, a productive landscape, and a healthy environment. Dynamic soil property data and interpretations will help meet the following customer needs:

1. Soil products to educate the public, planning and policy makers about how soils change in response to human activity and climate change.
2. Soil information for USDA programs and planners to identify, target, and recommend site-specific conservation practices and systems.
3. Information to assist in quantifying the benefits of conservation practices and systems.
4. Information to assist in eligibility ranking for farm bill conservation programs by identifying lands those most feasible for successful and economical restoration.
5. Information for use by decision makers to identify and protect lands at risk of irreversible change (e.g. due to erosion, salinization, contamination, sulfurization, climate change).
6. Soil survey data and information to support sustainable land management, including maintenance or improvement of soil quality, soil function, or ecosystem services.

Team Roles

Technical Team: The technical team is responsible for performing the tasks assigned by the leadership team to develop the DSP Inventory and Assessment program. As technical experts, they may provide feedback to the leadership team on task assignments, when other options to meet objectives are available. They will operate largely as sub-teams, with tasks assigned in their areas of expertise. Some team members may serve as liaisons and technical resources to field staff.

Leadership Team: The leadership team is responsible for developing all policy regarding the DSP Inventory and Assessment program. The team develops the action plans and long-range plans. The team provides action items, reviews products and provides feedback to the technical team. The leadership team provides all products to the advisory team for their review and recommendation. Leadership team members may be asked to participate in technical team meetings and provide members with specialized training or advice in their areas of expertise.

Advisory Team: The advisory team is responsible for providing review and recommendations for all aspects of DSP Inventory development. Team members may participate in any leadership team meetings of interest and technical team meetings, when invited. They will be asked to review all products and may do so as their time and expertise dictates. Members may be asked to provide specialized assistance in their area of expertise, when technical issues arise.

Five-year Plan:

Milestones and Action Items

1. **DSP Information Needs:**
    a. **Customers**
        i. Identify potential users of DSP Information – FY14
        ii. Form DSP product team, as a sub-group from technical teams (and others) to identify products – FY14
        iii. Gather feedback on previous DSP pilot data and information – FY14
    b. **Products**
        i. Document the DSP soil survey products needed to address conservation planning challenges, including the impact of management systems of soil functions – FY14
        ii. Identify DSP needs for farm bill conservation programs – FY14

2. **Potential DSP products**
    a. **Point data**
        i. Examine and/or develop predictive models to estimate DSP under various soil, management and climate scenarios in collaboration with RAD and RID – FY14-16
        ii. Make point data publicly accessible for use by researchers, modelers, land managers and others – FY 16-18
    b. **Project data**
        i. Use feedback from potential user groups to develop potential products from on-going and previous pilot studies - FY13-14
        ii. Consider different products from various sources of information (field data, models, etc.) – FY14-15
    c. **Aggregated information**
        i. Develop vision for delivering DSP information with standard soil survey products
        ii. Develop and test extrapolation techniques (algorithms, pedotransfer functions and model subroutines) to populate soil databases with DSP information – FY 14-16

3. **Data Needed to Feed DSP products**
    a. **Use all relevant data**
        i. Develop 'metadata' requirements: additional information (management history etc.) necessary for data to be relevant for DSP work – FY 14
        ii. Identify methods to focus data collection for DSP product development including: benchmark or representative soils, long-term study areas and landscape initiative areas – FY14
    b. **Existing data**

i. Determine what existing corporate data is available and appropriate for use, e.g. Rapid Carbon Assessment, LTERs, LTARs – FY14
ii. Explore uses of data mining techniques – FY14 -15
iii. Consider needs for meta-analysis – FY14-15
iv. Collaborate with industry, universities and other cooperators to utilize other datasets for DSP work – FY14-16

c. New data

i. Develop protocols for data collection – FY14-15
    1. Maintain and update Soil Change Guide, as needed
    2. Develop less intensive protocols for data collection through:
        a. Targeted sampling – for model validation, hypotheses testing or extrapolation improvement
        b. Value-added sampling – gather additional DSP information from ongoing soil survey work.
ii. Explore possibilities for complementary data collection with: ecological site (ESD) work, National Resource Inventory (NRI), NCSS, etc. – FY 14-15

4. Business needs

a. Data collection

i. Adapt project plan format – FY14-15
ii. Enhance field data entry tools (spreadsheet format) – FY14-15

b. Data analysis and storage

i. Develop business requirements, data model, data dictionary and to store management history – FY15
ii. Develop automated routines to generate extrapolations, interpretations and customized reports- FY16

c. Data and information delivery

i. Develop WSS and/or CDSI interface – FY16
ii. Other potential projects identified by users – FY16

5. Standards

a. Guidance

i. Develop terminology for different kinds of DSP activities – FY14
    1. Comparison studies (using Soil Change Guide)
    2. Targeted sampling (for model validation or extrapolation purposes)
    3. Value-added sampling (collecting DSP data in addition to other soil survey activities)
ii. Update or Develop DSP sections for the NSSH and SSM – FY15-16
    1. Guidance for standard DSP project including minimum criteria for data collection/sampling
    2. Criteria for minimum types and amounts of data needed for non-standard DSP data collection (value-added)

3. Criteria for evaluating outside (not NRCS) DSP data – quality, completeness – for inclusion in soil databases
4. Sampling protocols and management data collection by land uses and regions.
5. Laboratory processing and analysis for DSP samples (including sampling handling for biological analysis)
6. Update Soil Change Guide as protocols change

b. Training

i. Identify training needs in collaboration with other disciplines – FY14
ii. Develop OJT's and other training for DSP sample collection – FY15
iii. Develop advanced DSP data analysis, queries and interpretations training workshop – FY14-15
iv. Finalize specialty workshop on 'Using Comparison studies for Soil Change' – FY15-16
v. Add DSP modules to existing courses as practical – ongoing

6. Progress Reporting

a. **Identify appropriate progress reporting methods** to reflect dynamic soil property data collection and products.

i. Develop national milestones for tracking progress – FY15-16
ii. Set acreage or other goals as appropriate – FY17
iii. Explore use of S&T goals in PRS – FY17

7. Communications

a. Initial outreach to internal and external customers

i. Update SharePoint for Tech Team communications – FY13-14
ii. Develop webpage with information of all aspects of DSPs – FY15
iii. Develop series of white papers using feedback from users and knowledge of importance of effects of disturbance on soil function – FY14-15

1. Write a two-page white paper of the importance of DSP soil survey products for policy – FY14-15
    a. Provide examples of potential DSP products at local and regional scales
    b. Focus on utility and importance of next generation soil survey information for responsible soil management for nation's food security and conservation programs
    c. Send to Legislative Affairs through SSD
2. Provide a general background and guidance on DSP within Soil Science Division with two-page document about the general direction of the DSP effort – FY15
    a. Include new project-type terminology

b. Include examples of products and outcomes
c. Include examples of why DSP effort is important for carbon change, soil health, soil degradation and conservation planning
d. Send to SSD Director and Deputy Chief for consideration as a National Bulletin or other announcement

3. Develop general DSP handout for regional NCSS meetings – FY15
4. Develop detailed roadmap targeted for SSRDs, SSSs, SSO leaders – FY15
    a. Guide planning activities and requests for assistance

iv. **Provide Technical Soil Services related to DSPs** and management effects applied to conservation planning - FY16
v. Deliver soil change information from point and aggregate databases for program delivery, staff and managers – FY17

b. **Engage other NRCS disciplines** in dynamic coil properties initiative
    i. Include Soils, RID, RAD, S&T, Programs and CDSI staff – on-going
    ii. Work with multiple disciplines and end-users to identify a range of specific DSP products – FY14
    iii. Conduct multi-disciplinary netmeetings or video conferencing to integrate DSPs into the planning process – FY14-16

c. Build collaborative support with Partners
    i. Maintain communication with SSSA and IUSS Soil Change Working Groups and encourage groups to collaborate of issues pertinent to DSP effort - ongoing
    ii. Challenge NCSS Soil and Ecosystem Dynamics and Research Needs standing committees to work on outstanding research questions and other action items regarding DSP – on-going
    iii. Consider collaborations with other professional groups, entities and agencies - ongoing