

Modeling Dynamic Soil Properties in APEX for U.S. Soil Survey



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Photo credit: Skye Wills

What is U.S. Soil Survey?



Soil Survey is an inventory of soil which contains the distribution and extent of soils in an area

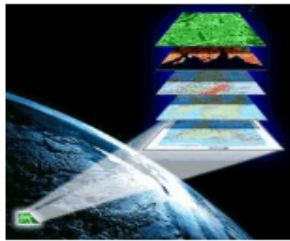
- Provides an interpretation concerning the use and management of each soil for uses such as farming, recreation, buildings, forestry, etc.

What are the Soil Survey Products?



Web Soil Survey

The Web Soil Survey (WSS) is an interactive website where current soil survey information can be viewed, explored and printed without having to download the database to your computer. Use the WSS to access soil information on areas less than or equal to 10,000 acres.



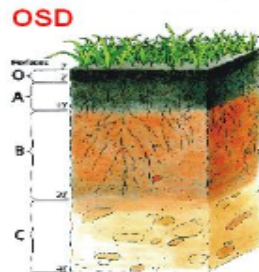
Geospatial Data Gateway

The Geospatial Data Gateway provides one stop shopping for natural resources or environmental data at anytime, from anywhere, to anyone. The data gateway allows you to choose your area of interest, browse and select data from our catalog, customize the format, and have it downloaded or shipped on CD or DVD. You can also request multiple soil survey datasets.



Soil Data Viewer

Soil Data Viewer is a free downloadable tool built as an extension to ArcMap that allows a user to create soil-based thematic maps. The application can also be run independent of ArcMap, but output is then limited to a tabular report.



Official Series Descriptions (OSD)

This site gives you access to the official description approved by the Natural Resources Conservation Service that defines a specific soil series in the United States. These official soil series descriptions are descriptions of the taxa in the series category of the national system of classification. They mainly serve as specifications for identifying and classifying soils.

Who Uses Soil Survey Products?

- Researchers
- Engineers (i.e. roads)
- City Planners
- Insurance Companies
- Modelers



EPIC/APEX for U.S. Soil Survey

Soil survey products do not reflect the effects of management



- Historically, soil survey products described inherent soil properties for an entire soil profile under common land use.

Soil Survey Mission:

“Keeping soil survey relevant to ever-changing needs and providing technical assistance.”



EPIC/APEX for U.S. Soil Survey



- The National Cooperative Soil Survey (NCSS) has recognized the need to provide enhanced information about soil change in response to land use, management and climate change.
- Soil survey studies have been initiated to collect and aggregate dynamic soil properties (DSPs) focusing on surface layers that respond most rapidly to changes in management or land use.

Dynamic Soil Properties



Properties that can change over the course of months and years in response to land use or management practice changes, natural disturbances, or climate change.

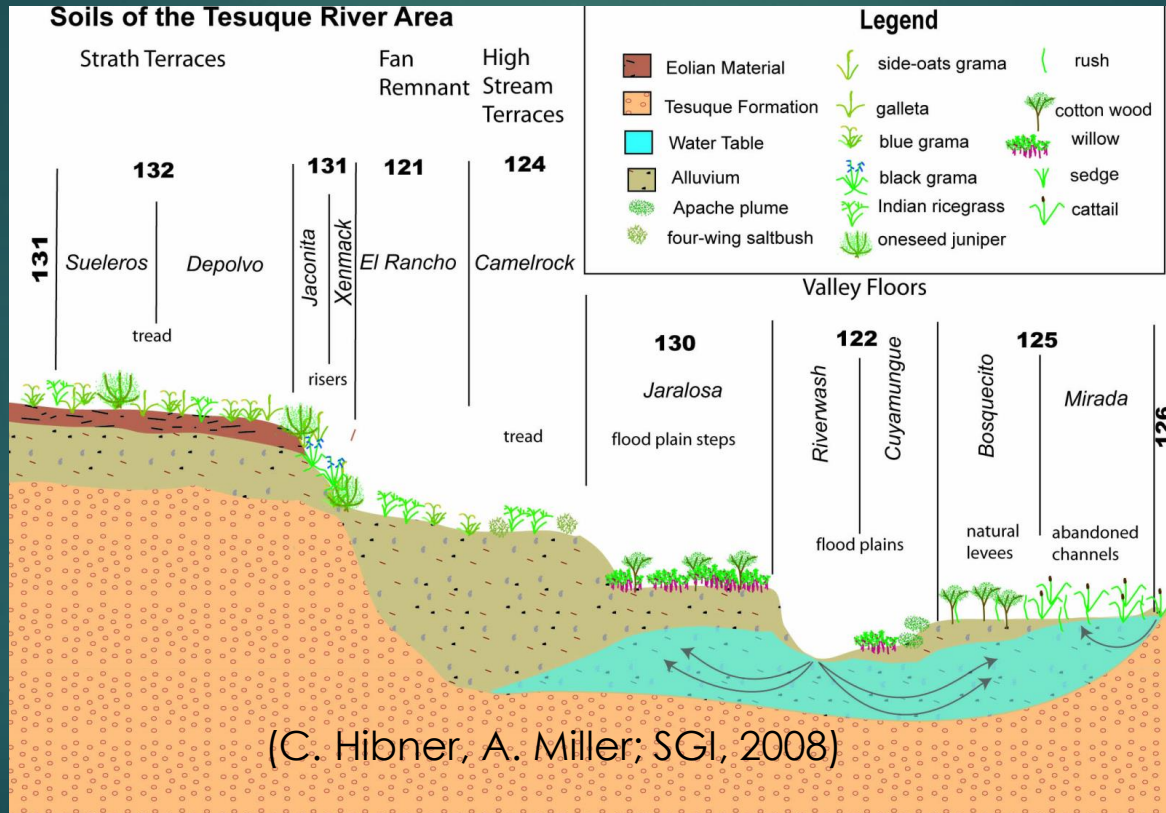
Changes in dynamic properties depend both on land management practices and the inherent properties of the soil.

EPIC/APEX for U.S. Soil Survey

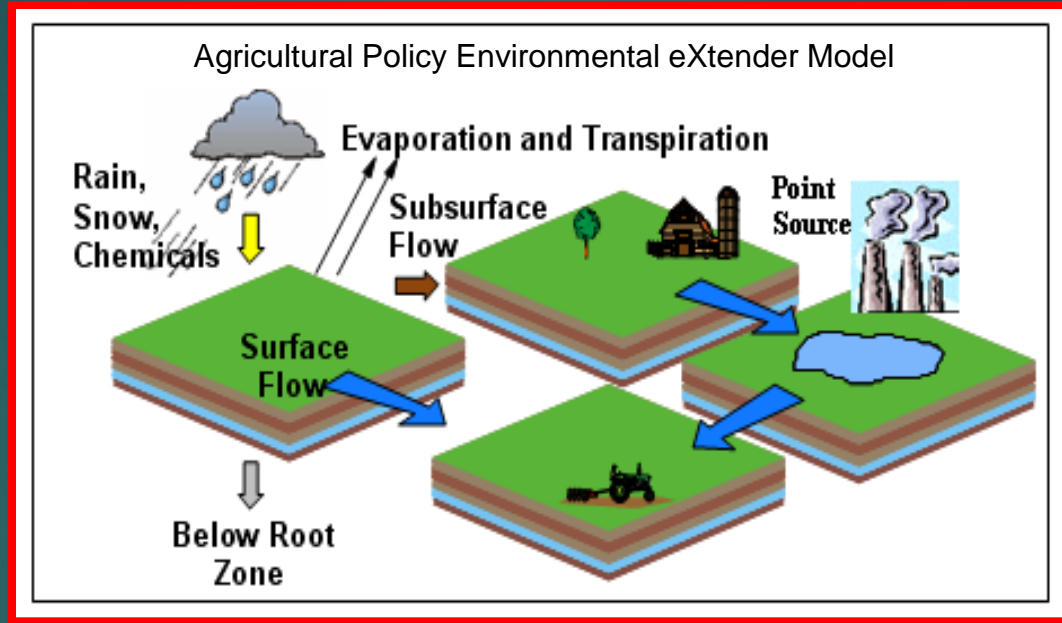


- While changes in DSPs have been traditionally measured over time through long-term studies and monitoring, potential changes in DSPs can be estimated using soil survey methods by careful space-for-time substitution comparing land use or management conditions (i.e. vegetation, tillage, climate) on the same soil.
- To provide comprehensive information about a range of soil and management conditions, soil survey projects must be supplemented using predictive models (i.e. APEX).
- A combination of data collection and modeling will allow Soil Survey to quickly populate a DSPs database and inform conservation tools.

Soil Systems : Characteristic Landscapes within an MLRA



Why use APEX to populate DSPs for Soil Survey?



APEX's unique feature to Soil Survey is the ability to subdivide farms or fields by soil type, landscape position, surface hydrology or management configuration to represent crop diversity and landscape characteristics within a field or farm.

Why use APEX to populate DSPs for Soil Survey?

Minnesota
MLRA 103
DSP Study

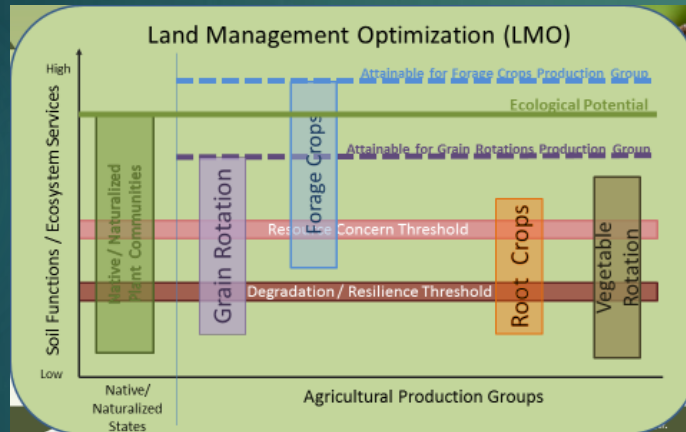


MUSYM	1369A		1371BA		1382		1205		1802		L163A	
MUNAME	Crooksford 1-3%		Crooksford- Swankle 3-6%		Louis 1-3%		Leen-Okobojo 0-2%		Calcousta- Okobojo 0-1%		Okobojo 0-1%	
Till												
LANDFORM	Flats		Flats/Rims		Rims		Depressions /Flats		Depressions		Lake Plains	
PARENT MATERIAL	Lacustrine over Till		Fine Loamy Till		Lacustrine over Till		Lacustrine over Till/Silty Alluvium		Lacustrine over Till		Lacustrine over Till	
DRAINAGE	MWD		MWD/W		SPD		PD/VPD		VPD		VPD	
Taxonomic Classification	Hapludoll		Hapludolls /Calcudoll		Calcudolls		Calciaquolls/ Vertic Endoaquolls		Endoaquolls		Vertic Endoaquolls	

Use of APEX for Soil Survey

To Assess soil condition

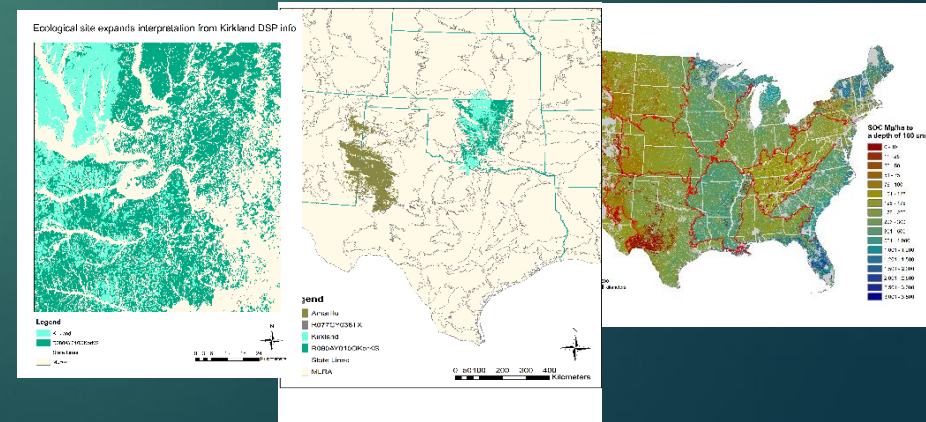
- ▶ Compare measured/observed values to those expected for similar or alternative management systems



- ▶ Modelers can build and improve models using point data for specific soils and specific management systems.

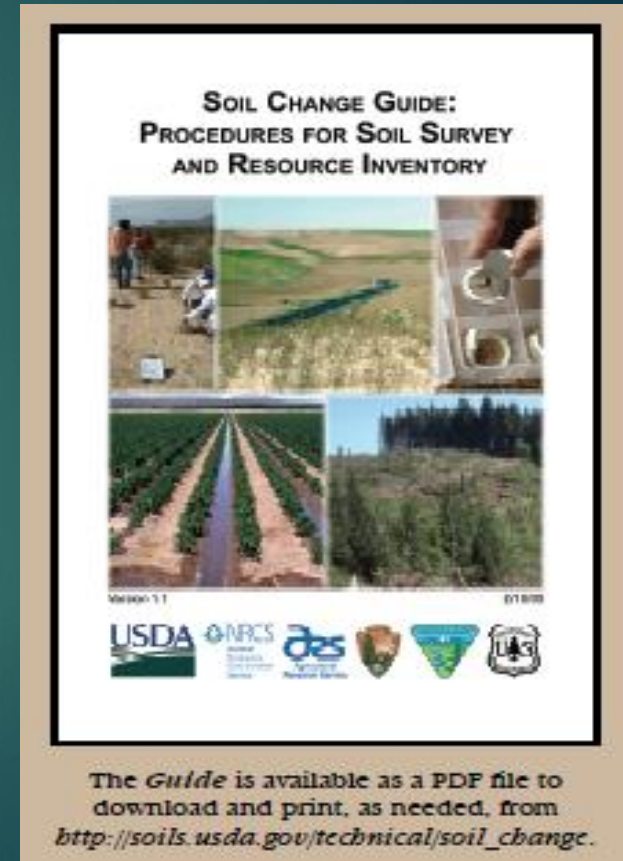
To predict and scale soil condition

- ▶ Aggregate observations and link to layers with relevant soil and management information
- ▶ Knowledge of alternative states/systems and predictive models can be used to predict change under different conditions



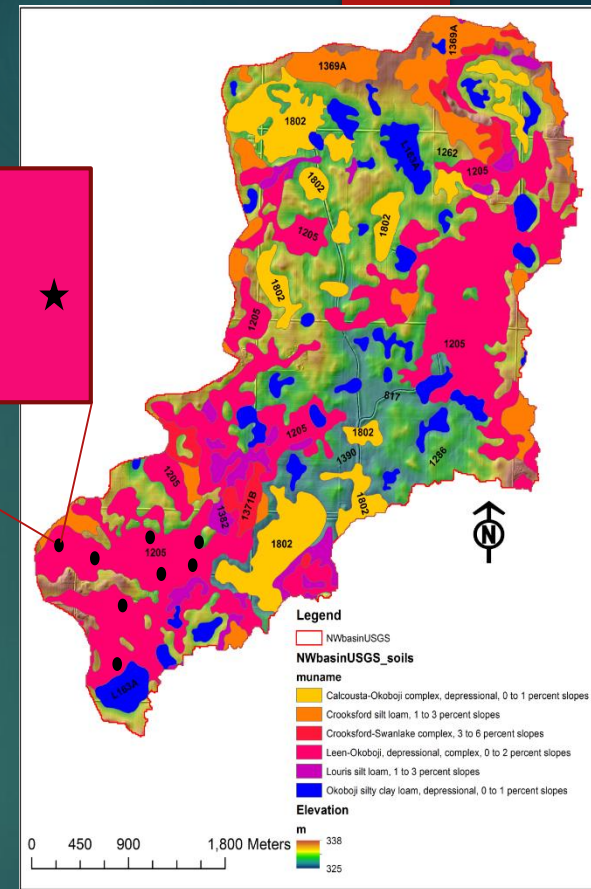
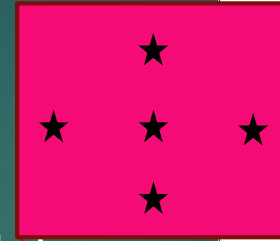
Soil Survey Procedures

- Soil Survey has chosen the comparison study approach to document the effects of land management over time.
- A study is conducted for an important or extensive soil (i.e. benchmark soil) within an important crop management zone.
- Data (management history and soil properties) collected from study sites is then used to initialize a predictive model.



DSP Study Design

- Choose a study area (Benchmark)
- Choose a set of soils (soil map units)
- Choose 2 or more management conditions within that map unit
- Choose 3 or more sites per management condition
- At each site
 - A central pedon is fully characterized (2 m depth)
 - 4 to 8 additional satellites pedons (0-5 cm, 5-10 cm, 10 cm-bottom of A horizon)



Minimum Data Set (Soil Change Guide)

- Properties should be sensitive to disturbances or management
- Relationships between properties and processes they reflect should be clear
- Relatively insensitive to daily or seasonal fluctuations
- Organic C
- pH
- Electrical Conductivity
- Bulk density
- Soil porosity
- Aggregate stability
- Total N

Additional Properties Collected for Interpretation

- Soil horizon thickness
- Particle size distribution
- Field moisture content
- Infiltration (highly variable)
- CEC
- Extractable bases
- Rock fragments
- Clay mineralogy (as needed)
- Saturated hydraulic conductivity (K_{sat})

Verifying and Validating APEX

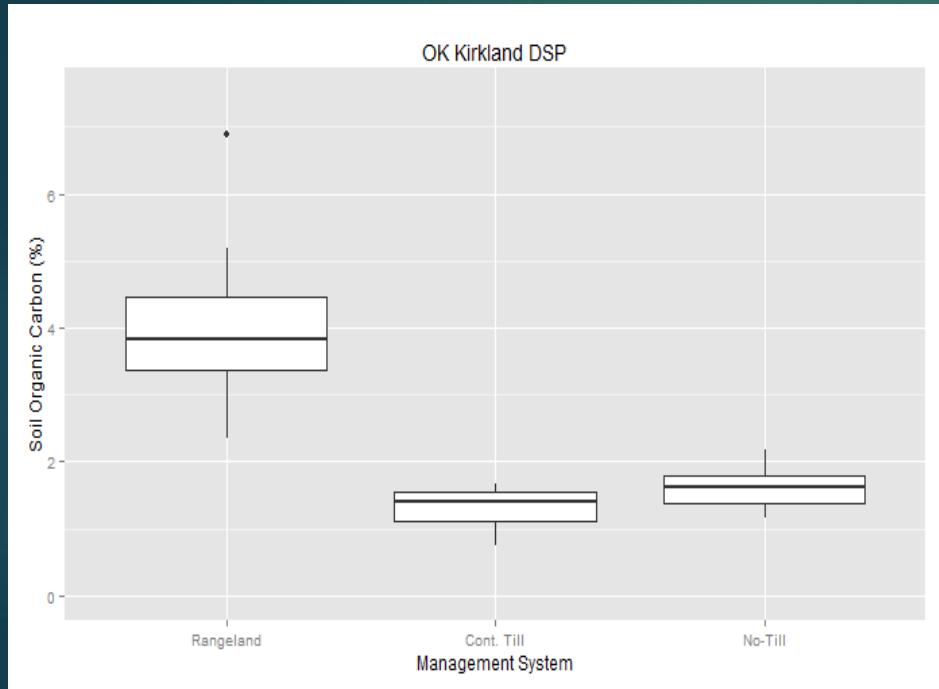
- ▶ Soil Survey study sites are located on land with a history of management (10-15 years).
- ▶ Crop yields
 - Soil fertility reports (C and N)
 - Soil survey reports

For each management scenario:

- ▶ Evaluate the sensitivity of APEX input parameters and adjust to closely match measured data (i.e. crop yield, C, N).
- ▶ Validate to test the accuracy of an APEX simulation with independent measured data.



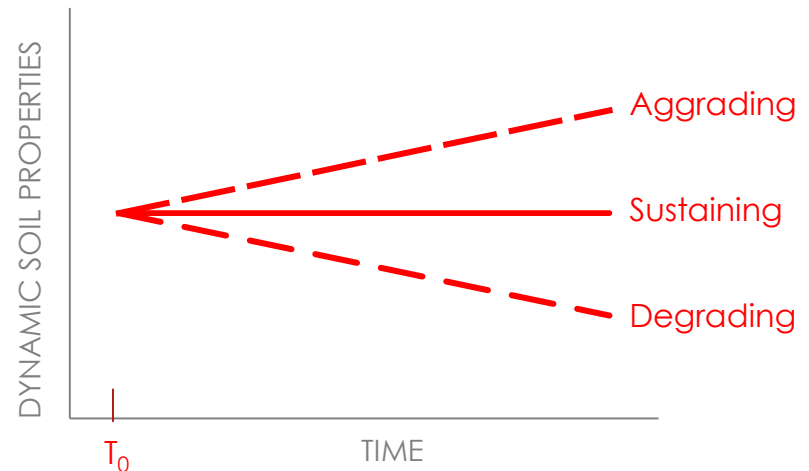
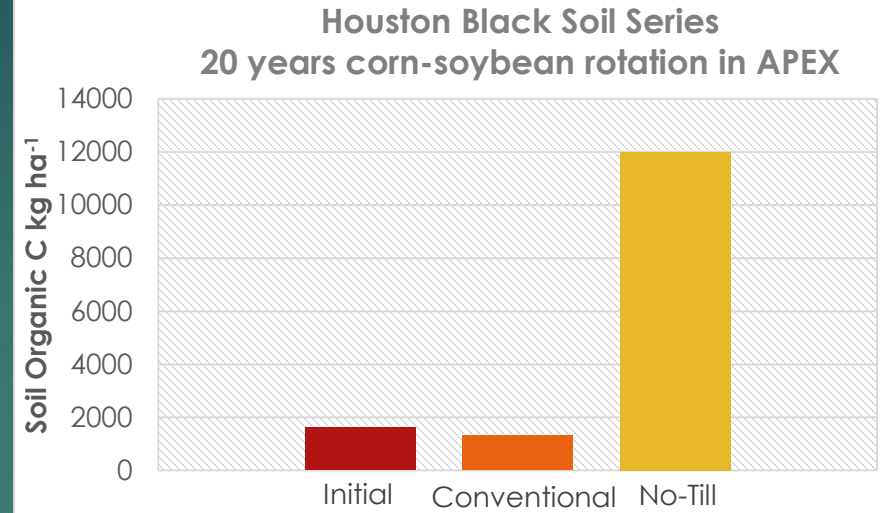
Populating Dynamic Soil Properties using APEX



- ▶ The validated model would then be used to evaluate alternative management scenarios.
- ▶ Document change in organic C, total N, bulk density, soil loss, infiltration, and soil moisture.

Interpretations

- ▶ The use of predictive models to populate DSPs can then be used to ask:
 - ▶ What is the condition of the soil?
 - ▶ If degraded, can it be restored?
 - ▶ How long will it take?
 - ▶ What land uses are at risk of irreversible change?
 - ▶ How will soil changes impact future management options?



Interpretations

Improve accuracy of databases and provide reference values for soil quality indicators.

Soil Organic Matter

Soil	SSURGO Estimate	Grassland-Measured	Cultivated-Measured
Askarben	2-4%	6.0	3.0
Monona	2-4%	3.6	2.9

Grossman, Unpublished

Where we are



- ▶ In 2014, 6 DSP field studies began (Nebraska, Oklahoma, Michigan, Georgia, Kansas and California)
 - ▶ Samples are currently being analyzed at the KSSL
- ▶ We are working with soil survey business operations to include management information in SSURGO (i.e. practice and time in practice).
- ▶ Planning to begin first APEX model runs Winter 2015

Summary



- ▶ Soil change on the human time scale is an emerging concept for soil survey. Field studies are underway.
- ▶ Dynamic soil property data will help meet customer needs for assessing soil quality, soil functions, and ecosystem services.
- ▶ Data from these studies will help planners improve conservation practices, show benefits of these conservation practices, and identify lands at risk of irreversible change.
- ▶ APEX will assist the soil survey in quantifying the impact of management on soil change.

Feedback.....

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