



Providing New Soil Survey Products to the GIS Modeling Community: “National Atlas of Ecosystem Services Project”

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Presented by:

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Outline

- **National Atlas of Ecosystem Services Project**
- **Needs of Modelers**
- **Gridded SSURGO**

Objectives

- To make detailed soil survey data available to modelers in “easy to use” formats.
- To use soil survey information to address pressing national issues such as climate change, biodiversity, and ecosystem services.

Examples of Ecosystem Services

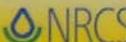
Wetlands Reserve Program

Restoring Pennsylvania's Wetlands

Wetland Benefits Include:

- Sediments, Nutrients & Flood Water Control
- Critical Wildlife Habitat
- Plant Diversity
- Education/Recreation Opportunities



United States Department of Agriculture
 **NRCS** Natural Resources Conservation Service

For more information please contact:
"www.pa.nrcs.usda.gov" or 717-237-2100

National Atlas of Ecosystem Services

You are here: [EPA Home](#) » [National Atlas of Ecosystem Services](#) » Mapping Application

Base Maps

Political Boundaries

Biophysical Data

Ecosystem Services Metrics - Production

- ▶ Clean Water for Drinking
- ▶ Clean Water for Recreation & Aquatic Habitat
- ▶ Water Supply
- ▶ Clean Air
- ▶ Climate Regulation
- ▶ Cultural and Aesthetic Value
- ▶ Natural Hazard Mitigation
- ▶ Habitat & Maintenance of Biodiversity
- ▶ Food, Fiber & Fuel

Ecosystem Services Metrics - Demand

Ecosystem Services Metrics - Stressors



1000 km
500 mi
lat: 14.476318 lon: -117.298906

Vision for the Atlas

- Allow “stacking” of multiple services
- Contain series of clickable background maps
- Multiple metrics for each category
- Includes change and future scenarios
- Allow user to place their “area” in context of others

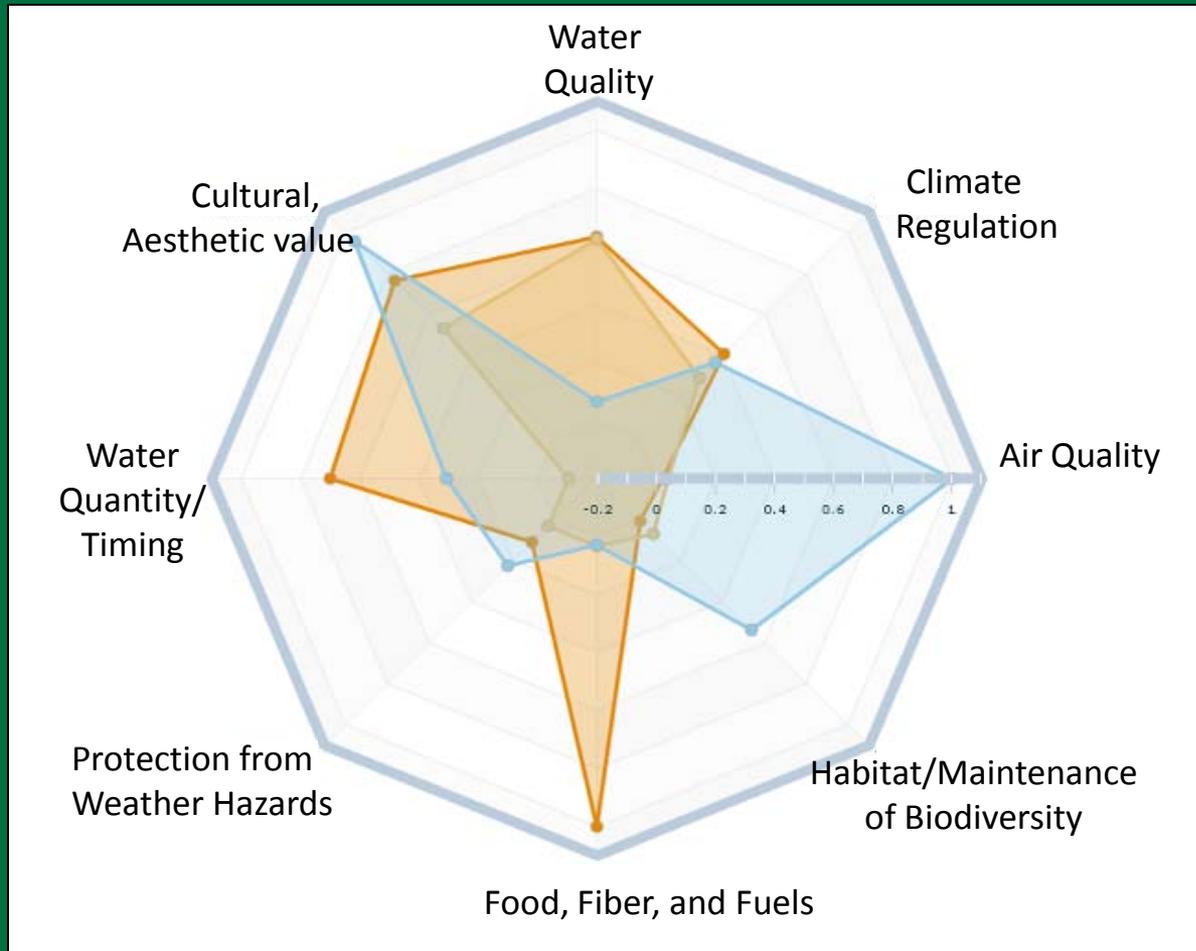
Categories for the Atlas

- **Base Maps**
 - Street Maps
 - Satellite Imagery
 - Shaded Relief
 - Topographic Maps
- **Political Boundaries**
 - States
 - Counties
 - Congressional Districts
 - EPA Regions

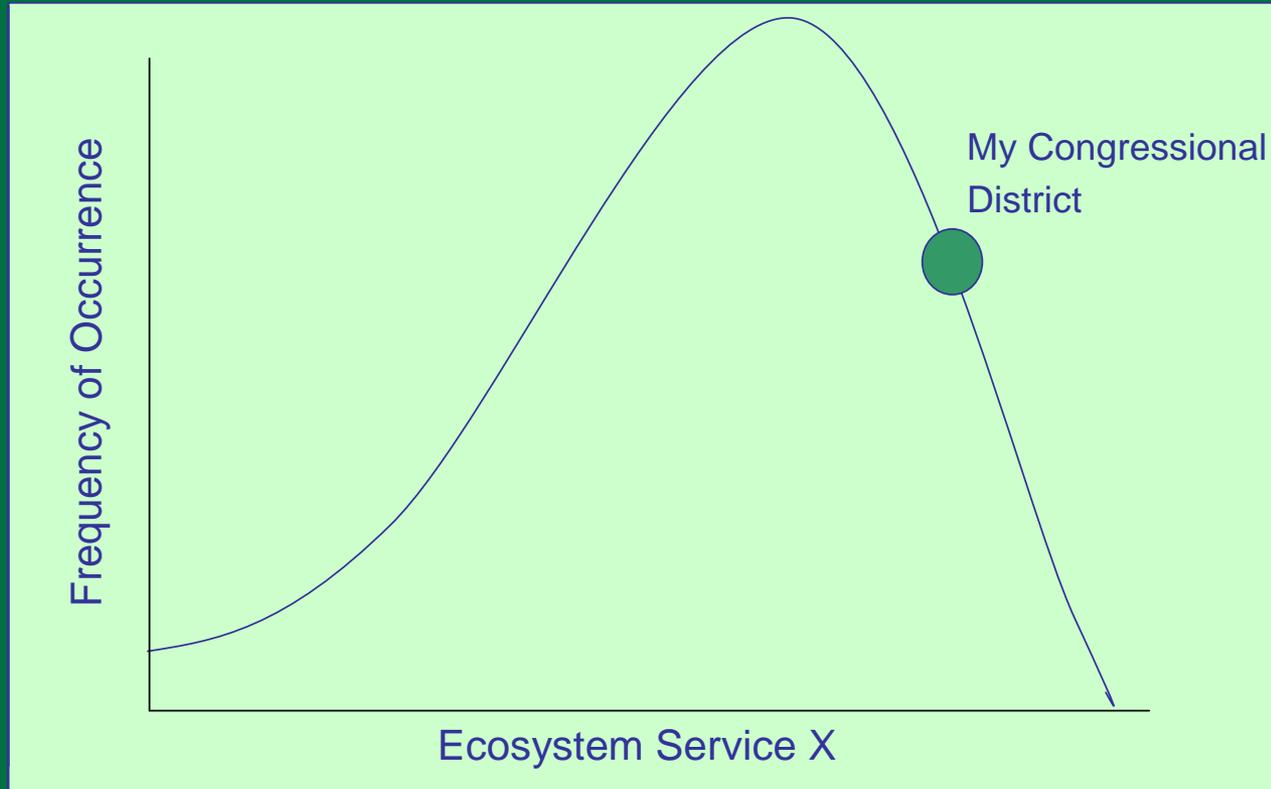
Categories for the Atlas (continued)

- **Biophysical Data**
 - Ecoregions
 - Land Cover
 - Impervious Cover
 - Hydrography
 - Protected Areas
 - Parks
 - Hubs and Corridors
 - *Soil Properties*
- **Demographics**
 - Daytime Population
 - Population Density
 - Vulnerable Populations

Representing multiple ecosystem services



Aggregate information by spatial area



Value-added interpretations from soil data

National Commodity Crop Productivity Index (NCCPI)

Credits



Overview

This section should include a short descriptive overview of the data layer

How is this important to ecosystem services?

This section should include both positive impacts as well as negative impacts. Should include exactly which ecosystem services are impacted and how. Include ecological mechanisms.

What are the overall societal benefits associated with this metric?

How could I use this information?

How was the data layer compiled?

Should include links to source data

What are the limitations of the data layer?

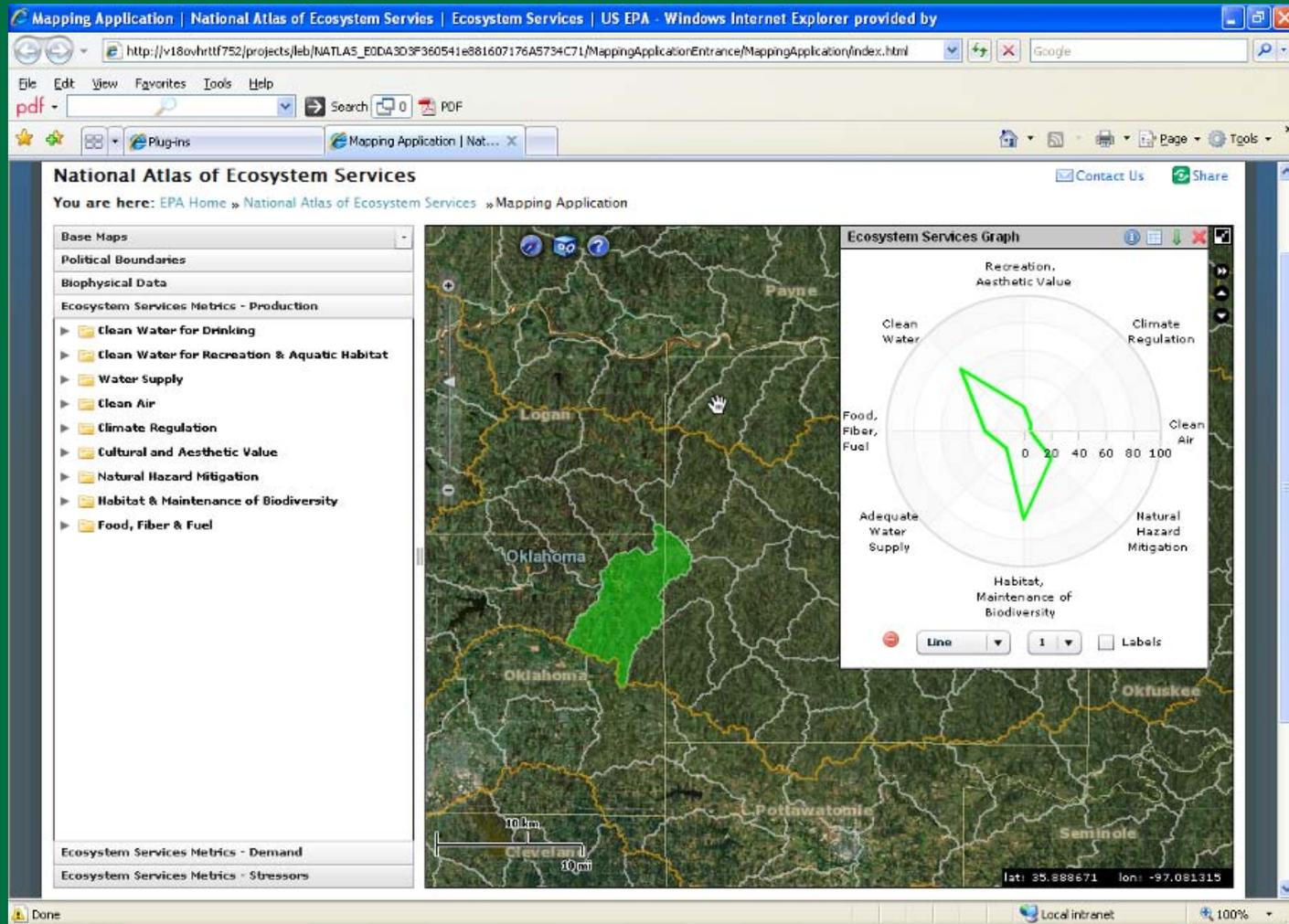
How can I get the data layer?

Where can I go for more information?

Contact the Atlas Team through the Feedback Form or refer to references below.

References:

Interactive viewing by study area



EPA: National Atlas of Ecosystem Services

- **Many data sources**
 - Landcover (NLCD), NASS crop, Landfire, FORE-SCE
- **National and regional**
 - Midwest (biofuels), Tampa, Willamette, Desert SW
- **Framework for future EPA work**
 - Nonpoint sources of pollution: cumulative picture
 - “Free” services essential to human well-being
 - “Third wave” of conservation efforts (NGOs)
- **Soils: delivery this year; foundation for other work**
- **Modeling, decision support at multiple scales**

SSURGO

- **Soil Survey Geographic Database**
 - **Developed by the Natural Resources Conservation Service (NRCS)**
 - **Based on National Cooperative Soil Survey**
 - **More than 3,000 soil surveys (e.g., counties)**
 - **Compiled at 1:12,000 or 1:24,000 map scales**
 - **86% complete for the Conterminous United States**
 - **7% complete for Alaska**

Soil Contribution to the Atlas: Gridded SSURGO

A key concept is using a nation-wide detailed soil survey geographic database (SSURGO) layer in a “value added” gridded format.

Deep root zone soils (left) provide greater available water capacity (AWC) than shallow root zone soils (right) Hagerstown soils, Centre Co, PA.



National vector SSURGO layer

- Over 35,000,000 polygons
- 150+ Gbyte size
- Powerful computing environments for access
- Several hours to draw on the screen
- National views and analyses out of reach for NCSS soil scientists and their customers

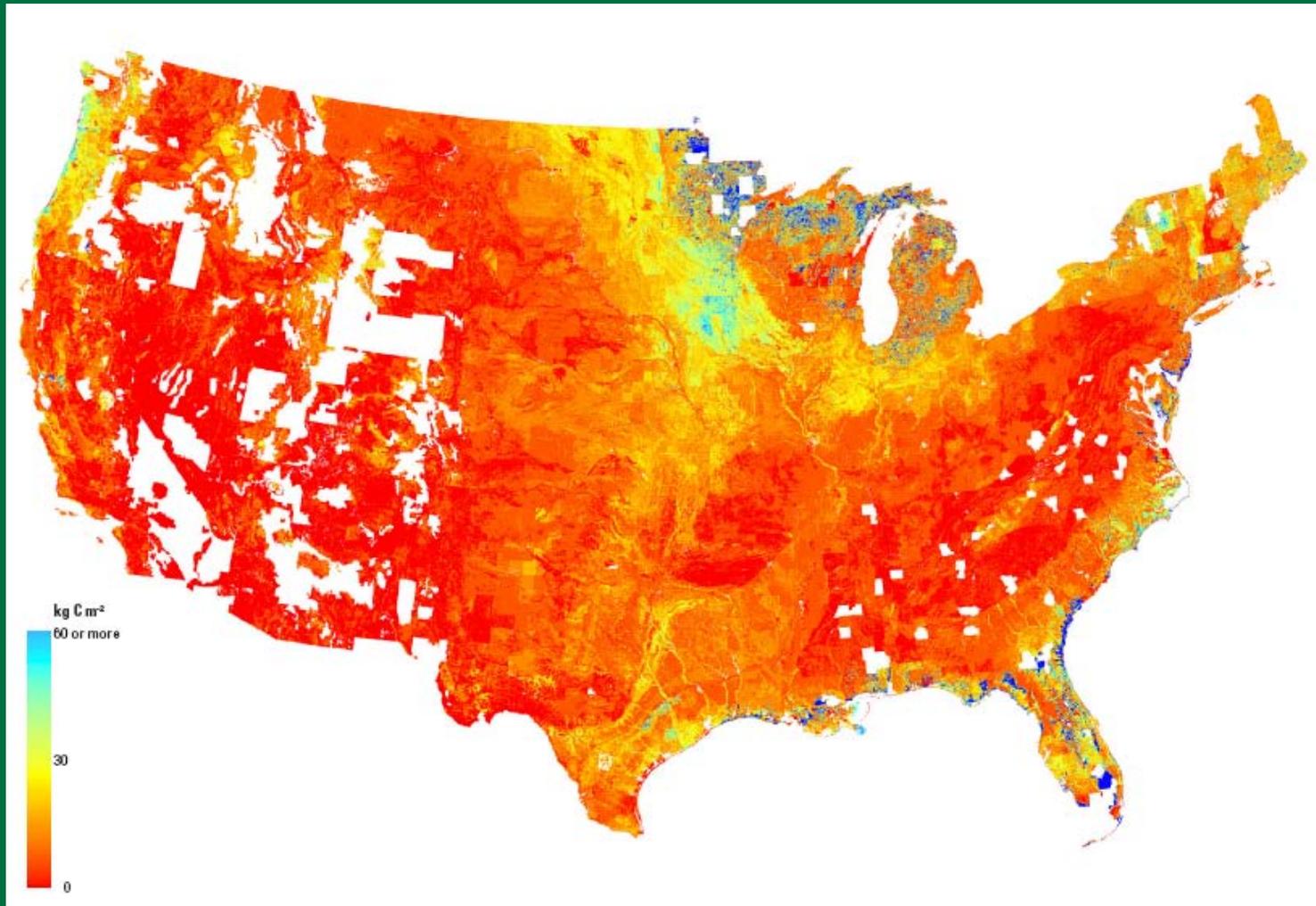
Gridded SSURGO

- GIS technique makes “grids” from the SSURGO polygon using the mukey (as an integer)
- Map projection suitable for conterminous U.S.
- Multiple resolutions: 10, 30, 90, or 100 m
 - 100 meters creates a 1 hectare cell size
- Annual or semi-annual Soil Data Mart snapshot

Gridded SSURGO (continued)

- R&D SSURGO grids prepared by NSSC (Lincoln and Morgantown)
 - Rapid Assessment of Carbon
 - Deepwater Oil Spill
- Used by USGS EROS and EPA to prepare “value added” SSURGO layers
 - Can use standardized depth zones

Preview: Soil Organic Carbon



Choices for modelers

- **Even simple queries require choices**
- **Modelers wanting water relations should use attributes that can be properly aggregated**
 - **AWC is good**
 - can sum across horizons and components
 - **Texture is bad**
 - Cannot properly compute averages
 - Some models use texture in a look-up-table to get AWC
- **Use other variables for spatial precision**
 - Topography with percentage hydric area
 - No/Yes by pixel for hydric soils (0 or 100%)

Choices (cont.)

- **Option to fill SSURGO gaps with GSM**
 - For each query chosen
 - Advantages: More complete (better totals)
 - Disadvantages: More anomalous boundaries
 - Need to use metadata layer giving the source
- **Metadata questions**
 - How do soil properties of a series vary between survey areas?
 - Approach the “county line anomaly” problem

Disciplines of modelers

- **Hydrologists**
 - Soil water: content, movement
- **Pollution**
 - Erosion and sedimentation
 - Solute transport, pesticides
- **Vegetation scientists**
 - Plant growth
 - Crop yield
 - Forest, range productivity
 - Phenology
- **Climate Change**
 - GHG emission or sequestration, carbon flux
 - Albedo, energy balance, water balance

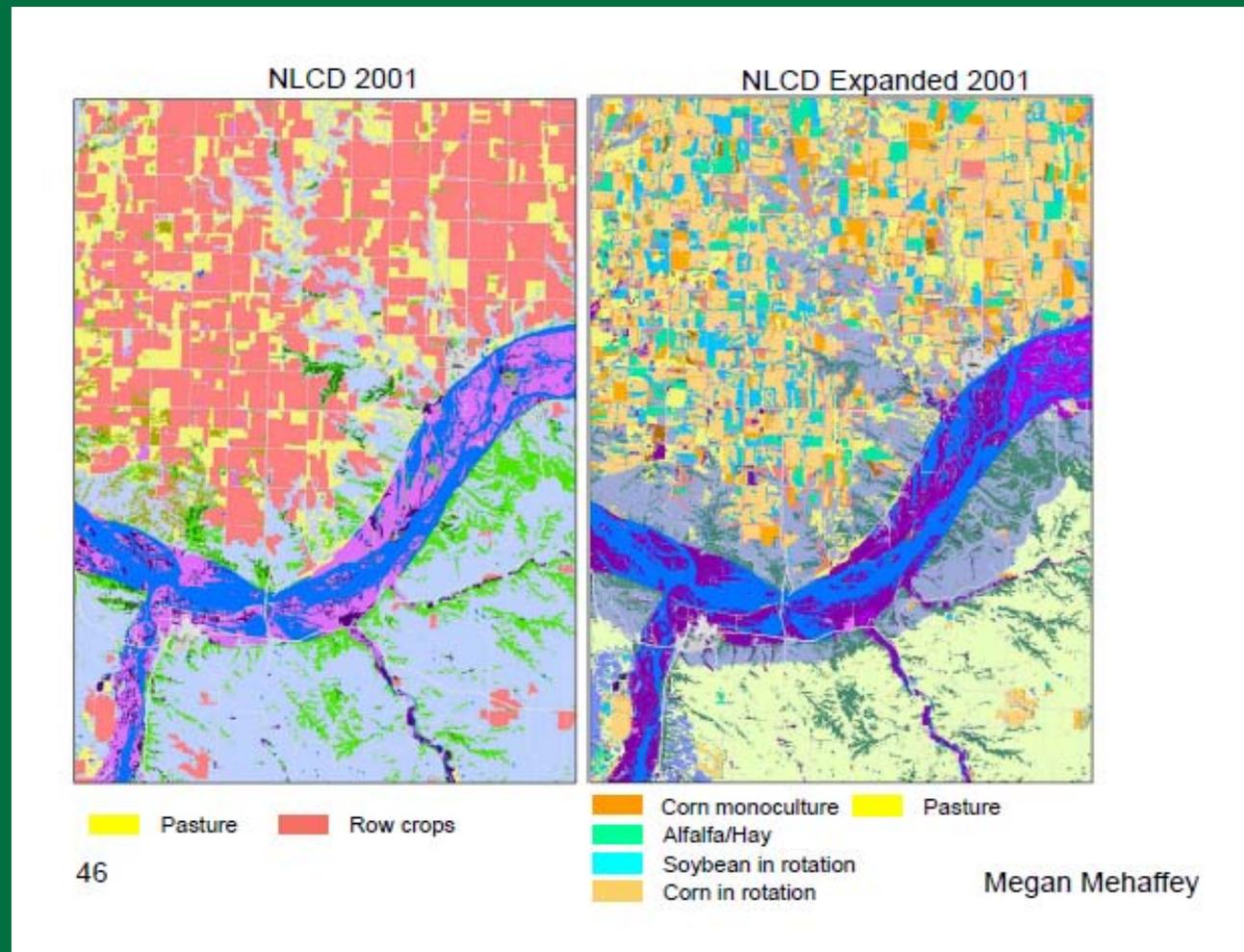
Attributes of interest to EROS modelers

- **Sand, Silt, Clay**
 - **Texture**
- **Rock content; volume of soil fines**
- **Depth to Bedrock; depth of soil**
- **Soil carbon**
- **Available Water Capacity**
 - **Root Zone AWC**
- **Permeability (hydrologic conductivity)**
- **Percentage hydric soils**
- **Erosion model factors**
- **Range productivity and ecological site index**

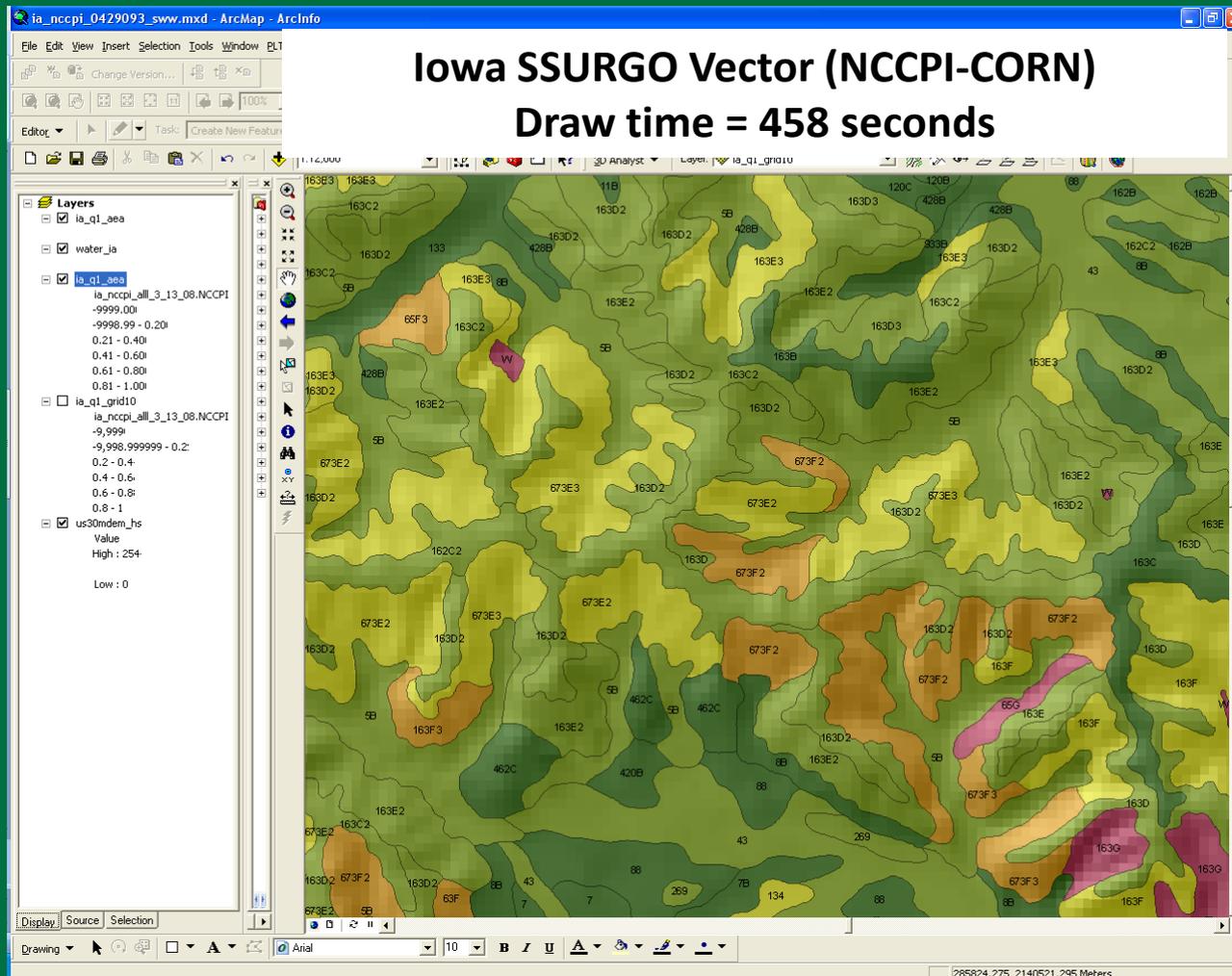
Gridded SSURGO

- **Preferred by GIS Modeling community**
 - Draws rapidly for easy visualization
 - Combined with other data
 - National Land Cover Database (NLCD)
 - NASS Crop Data Layer (CDL)
 - National Elevation Database (NED), DEM
- **Geospatial decision support systems**
 - Provide geography
 - Interpretations would otherwise be “fuzzy”
 - Add spatial rules
 - Proximity to water bodies or streams

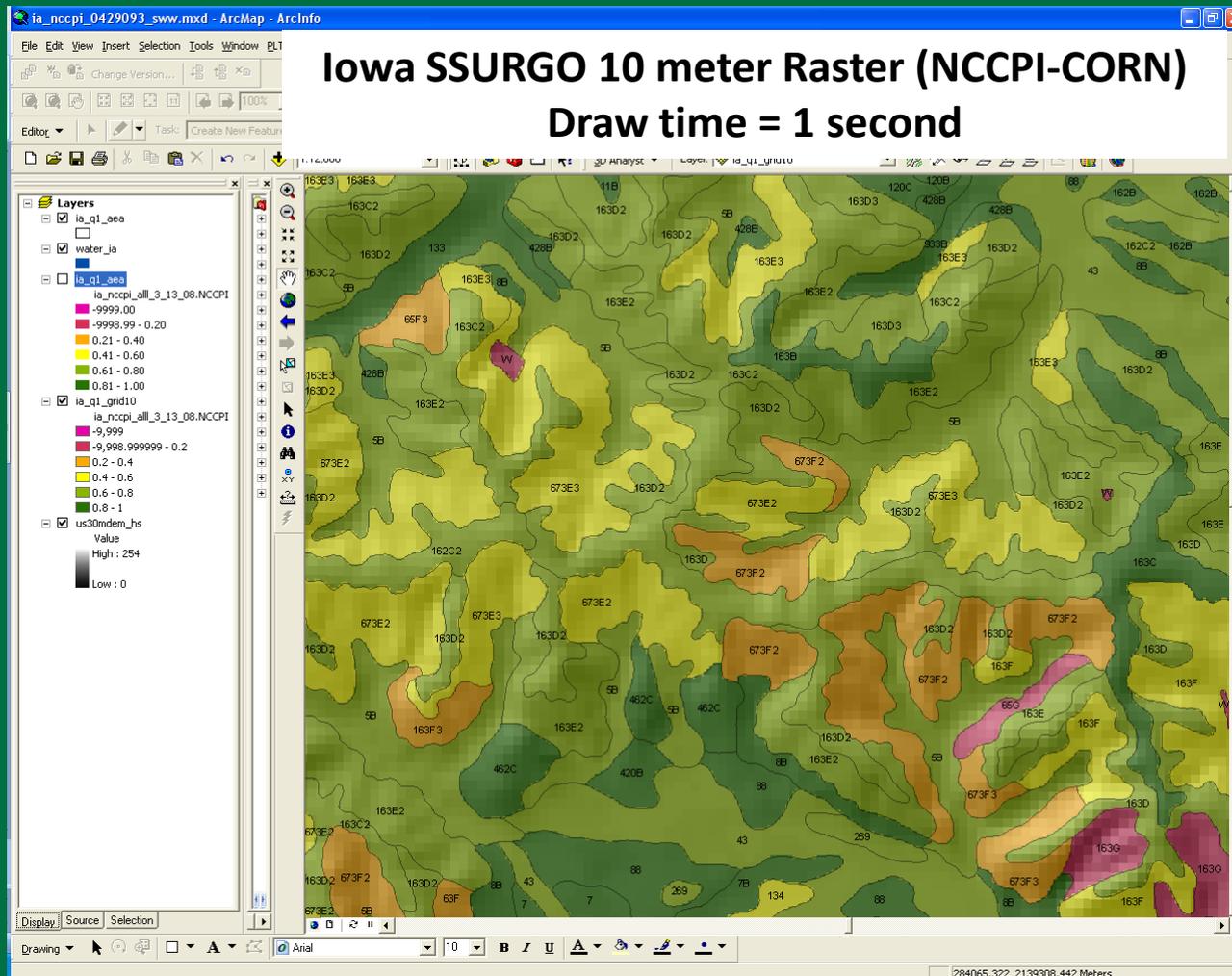
NLCD and NASS CDL



SSURGO as Vectors



SSURGO Gridded



Application: Soil Carbon




Detailed Mapping of Soil Organic Carbon Stocks in the United States Using SSURGO

B51F-0367

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Introduction

The quantity of soil organic carbon (SOC) stocks forms a foundation for understanding potential sequestration or release of carbon in the future in response to changes in land management and climate. We have made new maps and databases of SOC stocks for the conterminous United States from the Soil Survey Geographic (SSURGO) database, developed by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS). These data have much greater spatial detail than the previous maps formed from the State Soil Geographic (STATSGO) data developed by NRCS in 2003. The SSURGO data are now 85% complete for the conterminous United States (CONUS). We show relationships between the SOC stocks and other spatial data such as Federal Land ownership status. The new data are expected to improve spatially explicit modeling of regional carbon dynamics, and reduce the uncertainty of estimation for scenarios of future soil carbon storage. We calculate 73.43 Petagrams of soil organic carbon as the carbon stock for the soils of the conterminous United States.

Methods

The SOC for each mapunit was calculated following the methods of Bliss (2003) and Bliss et al. (1998). The results shown on the maps are for the total soil profile (all horizons present in the database). The primary data source was the SSURGO database (NRCS Soil Survey Staff, 2010). The SSURGO database has a relational database structure, so estimates of SOC were calculated by horizon, component, and mapunit, as shown in figure 1. The estimate for each mapunit (g C m⁻²) was multiplied by the area of each mapunit (m²) to get estimates of the total amount of carbon. We used a gridded version of SSURGO with a 300 meter cell size. We also used an overlay with the Federal Lands data to compute carbon on lands controlled by Federal agencies. Where SSURGO data were not available, the results were substituted from a similar analysis using the General Soil Map (GSM) of the United States as a source for the SSURGO database.

The basic SSURGO data structure is given in figure 1. The analysis of soil organic carbon starts on the component horizon (horizon) table, aggregates the carbon over the appropriate layers for a given analysis, and stores the result at the level of the component table (component). A weighted average of the component values is computed using the representative component percentage (average) as the area weighting factor, and the results are stored at the level of the mapunit (mapunit) table. These results are then copied to the spatial datasets where they are used to plot maps.



Figure 2. Soil organic carbon (g C m⁻²) from SSURGO data. The total SOC represented on the map is 61 Pg. The land area with carbon data is 3,243,000 km²; the area with no data is 102,000 km², and the total area is 3,345,000 km² which is 85.5% of the 3,920,000 km² shown in Figure 4.



Figure 3. Soil organic carbon (g C m⁻²) from the General Soil Map data. The total SOC represented on the map is 61 Pg. The land area with carbon data is 3,345,000 km²; the area with no data is 102,000 km², and the total area is 3,447,000 km².

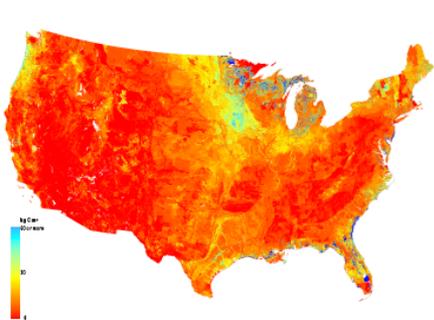


Figure 4. Soil organic carbon (g C m⁻²) from SSURGO, with gaps filled from the GSM. The total SOC represented on the map is 73.43 Pg. The land area with carbon data is 3,243,000 km²; the area with no data is 102,000 km², and the total area is 3,345,000 km².

Conclusions

We calculate the stock of soil organic carbon in the conterminous United States as 73.43 petagrams (Pg). This is greater than the estimate of 61 Pg made from the State Soil Geographic (STATSGO) database in 2003, although the differences represent improvements to the database rather than changes in the carbon on the ground.

There are many sources of uncertainty in these estimates, but we consider it likely that the true value would be within a few percent of the reported estimate. Efforts are ongoing to update both the map and attribute data for the SSURGO database. Inconsistencies observed in national views (as shown here) can lead to improvements in the databases.

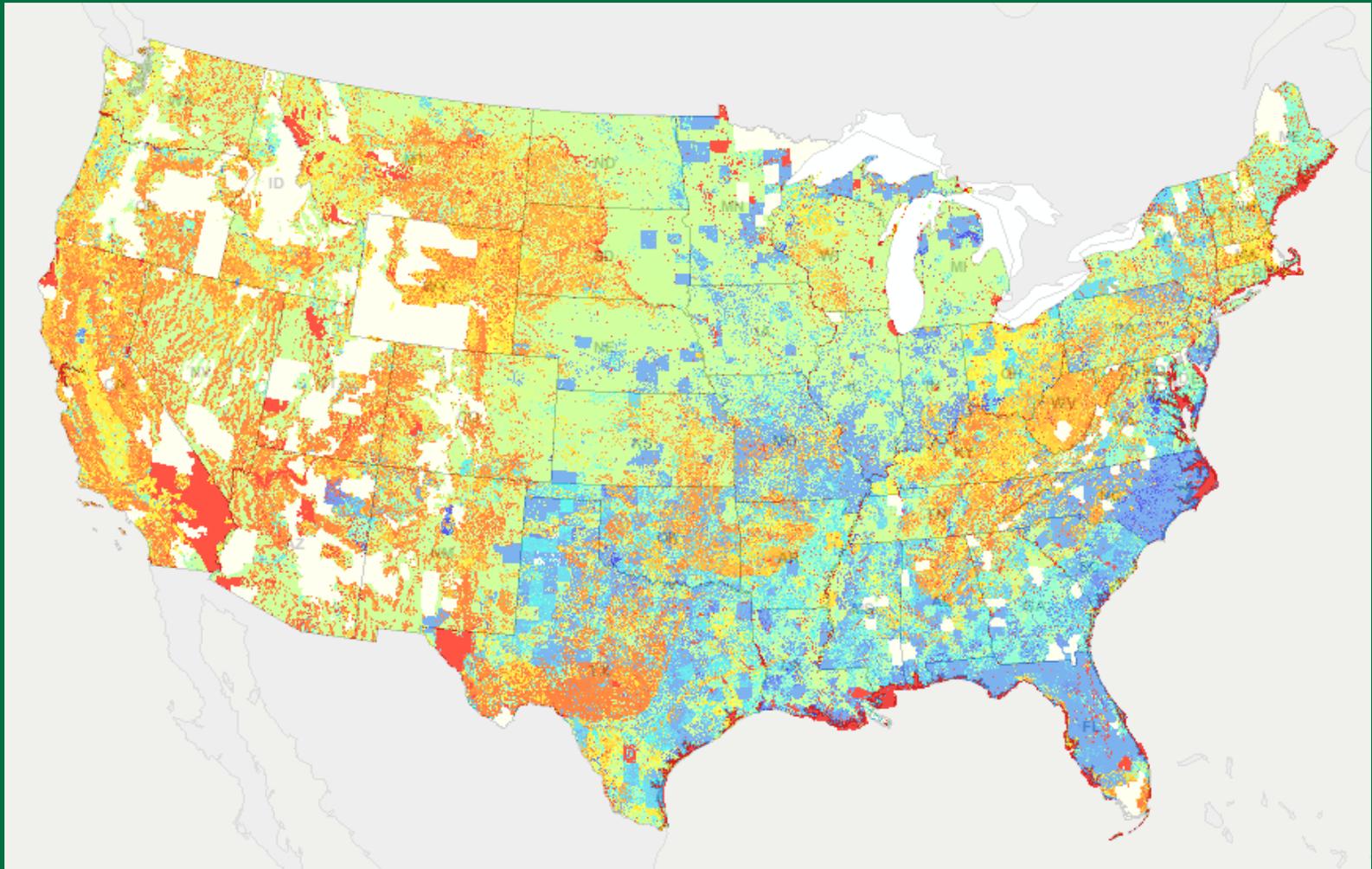
We consider the results from SSURGO (compiled at 300,000 and 1,200,000 map scales) to be much more reliable than those from the GSM (compiled at 1,200,000 map scale). The NRCS and cooperating agencies have invested considerable resources in upgrading the quality of the soil databases in recent years and these efforts are reflected in the SSURGO data.

The SSURGO database has over 800 attributes, of which perhaps 300 will be useful for biogeochemical modeling. Future work includes distribution of national soil databases formats that will enable nationwide data to be easily available for modeling.

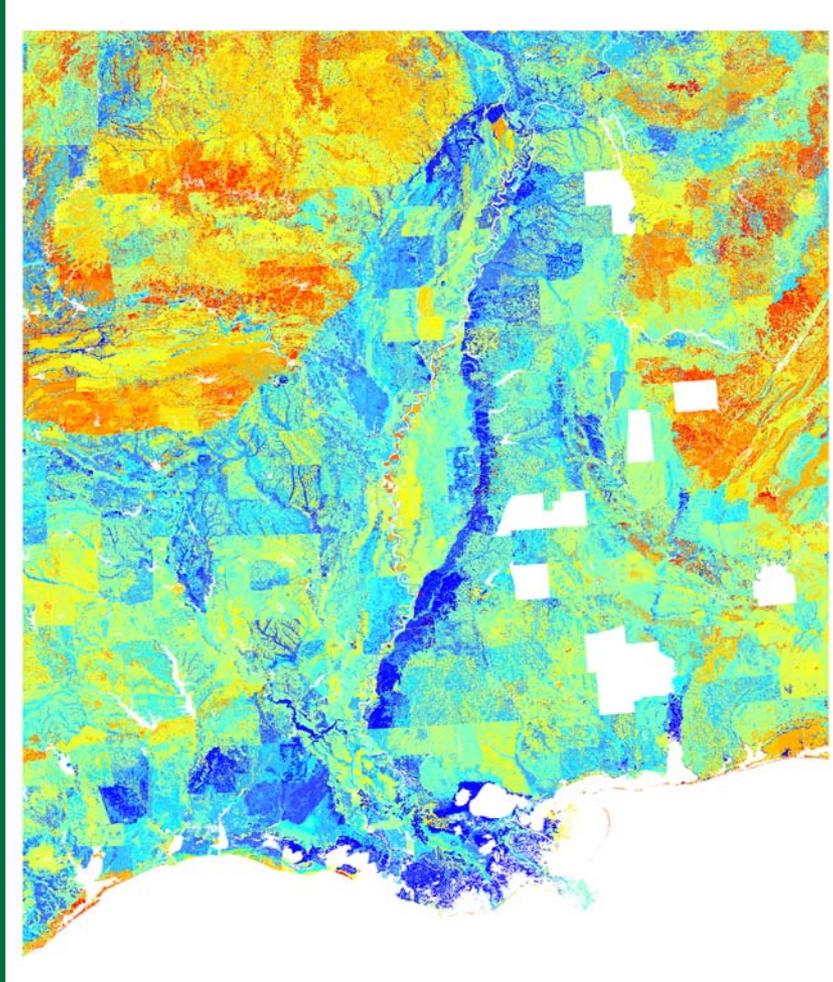
References

Bliss, N.B., 2003. Soil organic carbon on lands of the conterminous United States. *Soil Science Society of America Journal*, 67, 103-112.

Soil depth



Available Water Capacity



250 m resolution

Gridded SSURGO: traditional NCSS customers

- **USDA Economic Research Service (ERS)**
 - grids SSURGO at 30 meters
 - combines with various land cover sources for Farm Bill model runs
- **USDA Farm Service Agency (FSA)**
 - Desires county and state SSURGO map unit acreage values
- **USDA Agricultural Research Service (ARS)**
 - Geospatial modeling of soil organic carbon and biomass production

Gridded SSURGO:

Could be used by relatively new clients

- **USDA-NRCS**
 - Conservation Planning Decision Support Systems
- **USDA-NASS (Crop mapping)**
- **USEPA (ecosystem services)**
- **USGS-Water Resources (water quality)**
- **USGS-Mapping Discipline**
 - GIS data makers/keepers/disseminators
- **University Researchers**
 - Carbon, biomass production/ecosystem services
- **Private sector**
 - e.g. Monsanto, Syngenta (genotype x environment)

Ecosystem Services Gridded SSURGO

- **Proposed summary levels**
 - **Component Horizon or Standard Layer Level**
 - **0-5, 5-20, 20-50, 50-100, 100-150 cm?**
 - **SOC/SIC and calculation parameters**
 - **(SOM, rock fragment conversion factor, bulk density...)**
 - **Percentages of sand, silt, clay (fine earth fraction)**
 - **Rock Fragment Content**
 - **Soil texture class (e.g. silty clay loam)**
 - **Restrictive layer presence/absence**

Ecosystem Services: SSURGO Themes

- **Summary levels**
 - **Soil Map unit/Component Level (series/phase of series)**
 - **Component percentage of map unit**
 - **Soil Organic Carbon (SOC, kg per square meter)**
 - **Soil Inorganic Carbon (SIC, kg per square meter)**
 - **Rooting Depth (crops, trees, range, etc.) (Root Zone, RZ)**
 - **Available Water Capacity (AWC) and RZAWC**
 - **For reported depth**
 - **Bedrock Depth**
 - **Reported Depth and other soil volume measures**
 - **Hydrologic group**
 - **National Commodity Crop Productivity Index (NCCPI)**

NSSC “Best Practices” documented

- Data summary methods

USDA United States Department of Agriculture
Natural Resources Conservation Service

Soil Survey Laboratory Methods Manual

Soil Survey Investigations Report
No. 42
Version 4.0
November 2004

Profile M 20040101 016
Soil Survey Laboratory Methods Manual
Soil Survey Investigations Report
No. 42
Version 4.0
November 2004

Depth (cm)	Moisture (%)	Temperature (°C)	pH	EC (dS/m)	Ca (mg/kg)	Mg (mg/kg)	K (mg/kg)	Na (mg/kg)	Cl (mg/kg)	S (mg/kg)	N (mg/kg)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	B (mg/kg)	I (mg/kg)	Se (mg/kg)	As (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Cr (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Ni (mg/kg)	Mo (mg/kg)	V (mg/kg)	Al (mg/kg)	Si (mg/kg)	Other		
0-5	12.5	15.0	5.5	0.2	100	50	10	5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
5-10	12.5	15.0	5.5	0.2	100	50	10	5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
10-15	12.5	15.0	5.5	0.2	100	50	10	5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
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20-25	12.5	15.0	5.5	0.2	100	50	10	5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
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30-35	12.5	15.0	5.5	0.2	100	50	10	5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
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95-100	12.5	15.0	5.5	0.2	100	50	10	5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

Summarize by 12-digit Hydrologic Units

The screenshot displays the National Atlas of Ecosystem Services Mapping Application. The interface includes a header with the EPA logo and navigation links, a search bar, and a breadcrumb trail. The main content area features a map of Pennsylvania and Lancaster, with hydrologic unit boundaries overlaid. A left-hand sidebar allows users to toggle various data layers, including 12-digit watershed boundaries. The map includes a scale bar and coordinate information. The footer contains logos for EPA, National Geographic, NRCS, and USGS, along with links to news feeds, podcasts, and mobile apps.

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National Atlas of Ecosystem Services
You are here: EPA Home » National Atlas of Ecosystem Services » Mapping Application

Data Hops

Political Boundaries

Biophysical Data

- 1000 Flowline 100K
- 8 Digit Watershed Boundary
- 12 Digit Watershed Boundary

PA 40.125194 Lon -76.623333

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Scalable linkage to Web Soil Survey?

The screenshot displays the Web Soil Survey application in a Mozilla Firefox browser window. The address bar shows the URL: <http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>. The page features a navigation menu with options like "Area of Interest (AOI)", "Soil Map", "Soil Data Explorer", and "Shopping Cart (Free)".

The main content area is titled "View Soil Information By Use: All Uses" and includes a "Printable Version" and "Add to Shopping Cart" button. The interface is divided into several sections:

- Search:** A search bar for finding specific soil data.
- Suitabilities and Limitations for Use:** A list of categories such as "Building Site Development", "Disaster Recovery Planning", and "Land Classifications".
- Map Legend:** A detailed legend for the map, including:
 - Area of Interest (AOI)
 - Soil Survey Areas
 - Soil Map Units
 - Soil Ratings
 - Capability Class - I through VIII
 - Not rated or not available
 - Special Point Features
 - Special Line Features
 - Political Features (States, Counties)
- Map:** A satellite-style map of Lancaster County, Pennsylvania, showing various soil capability classes overlaid on the terrain. The map includes a scale bar (592ft) and a note: "Soil Ratings Map may not be valid at this scale." The legend is currently open over the map.
- Summary Table:** A table titled "Summary by Map Unit — Lancaster County, Pennsylvania" is partially visible at the bottom of the screen.

What do you get when you provide soils data in the gridded SSURGO format that the client desires?

