USGS
science for a changing world

Providing New Soil Survey Products to the GIS Modeling Community:

"National Atlas of Ecosystem Services Project"

2010 Southern Regional Cooperative Soil Survey Conference
July 12, 2010 **College Station, Texas**

Presented by:
Norman B. Bliss
Contractor to USGS EROS
Contract 08HQCN0007

U.S. Department of the Interior
U.S. Geological Survey

Coauthors

- Norman Bliss, Principal Scientist,
  ASRC at U.S. Geological Survey, EROS, Sioux Falls, SD
- Anne Neale, Research Ecologist,
  Landscape Ecology Branch, USEPA,
  Research Triangle Park, NC
- Sharon Waltman, Soil Scientist,
  National Soil Survey Center –
  Geospatial Research Unit, USDA-NRCS,
  Morgantown, WV

USGS

Outline

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

USGS

Objectives

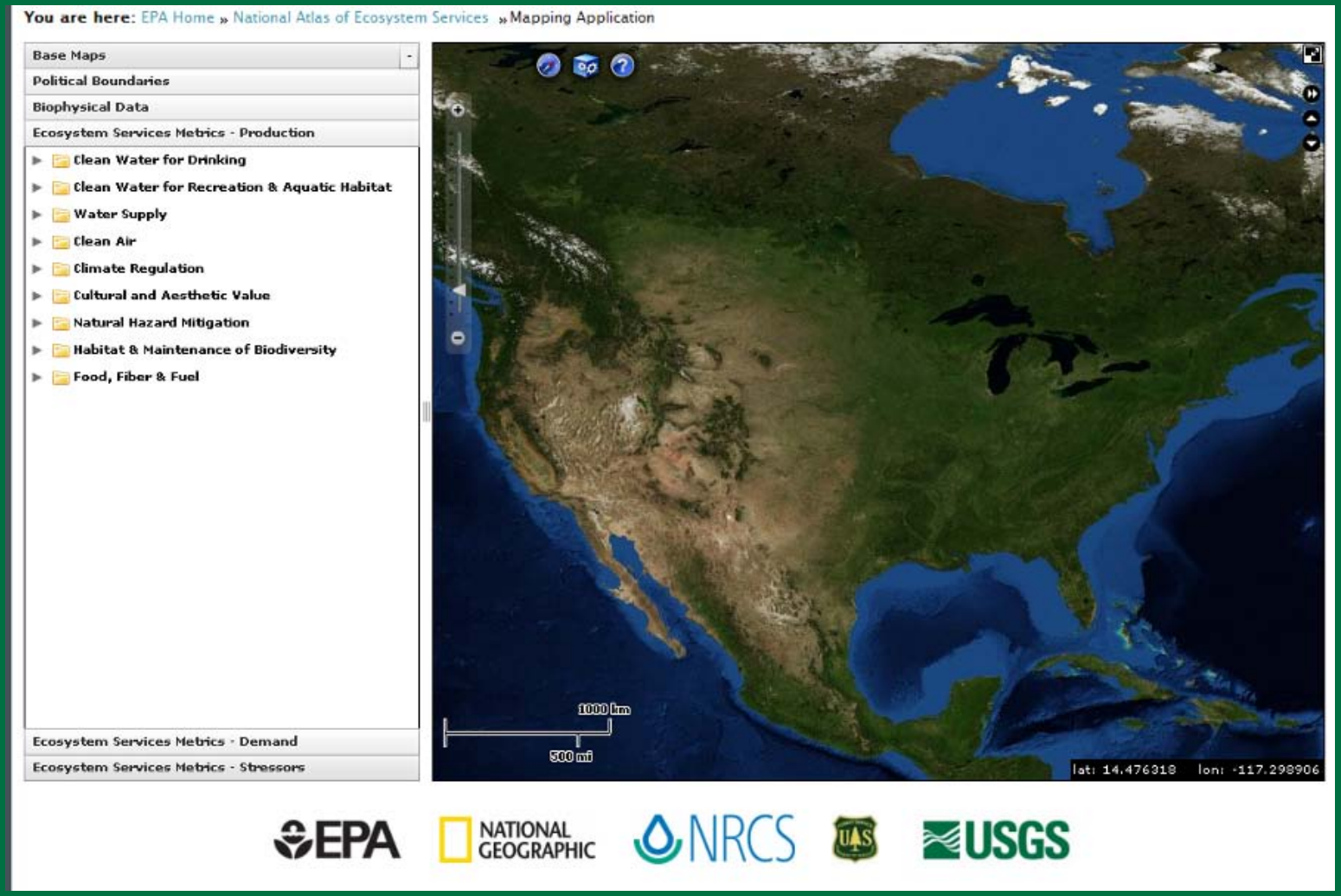
- To make detailed soil survey data available to modelers in “easy to use” formats.
- To use soil survey information to address pressing national issues such as climate change, biodiversity, and ecosystem services.

USGS

Examples of Ecosystem Services

USGS

National Atlas of Ecosystem Services



USGS

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

USGS

Categories for the Atlas

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

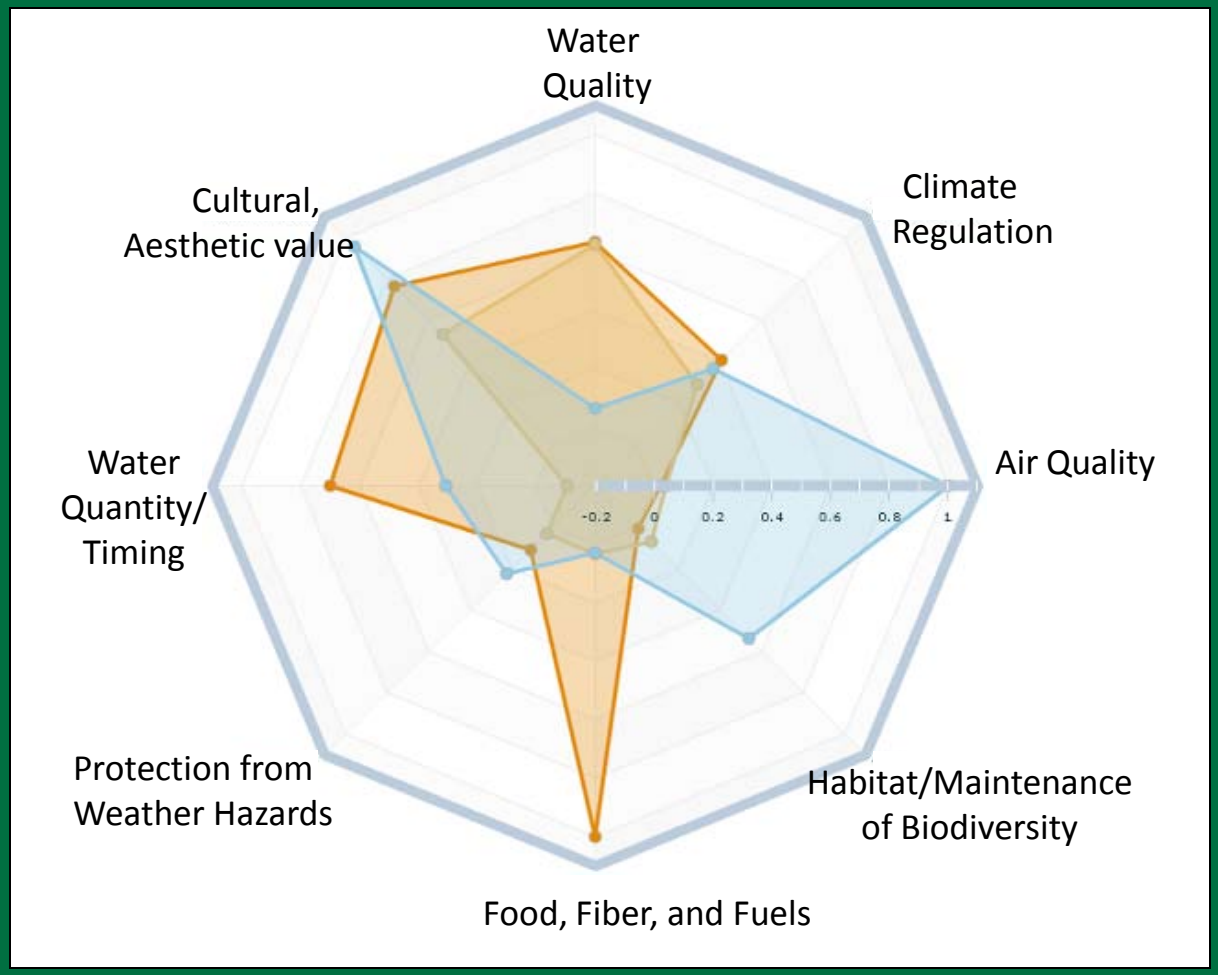
USGS

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

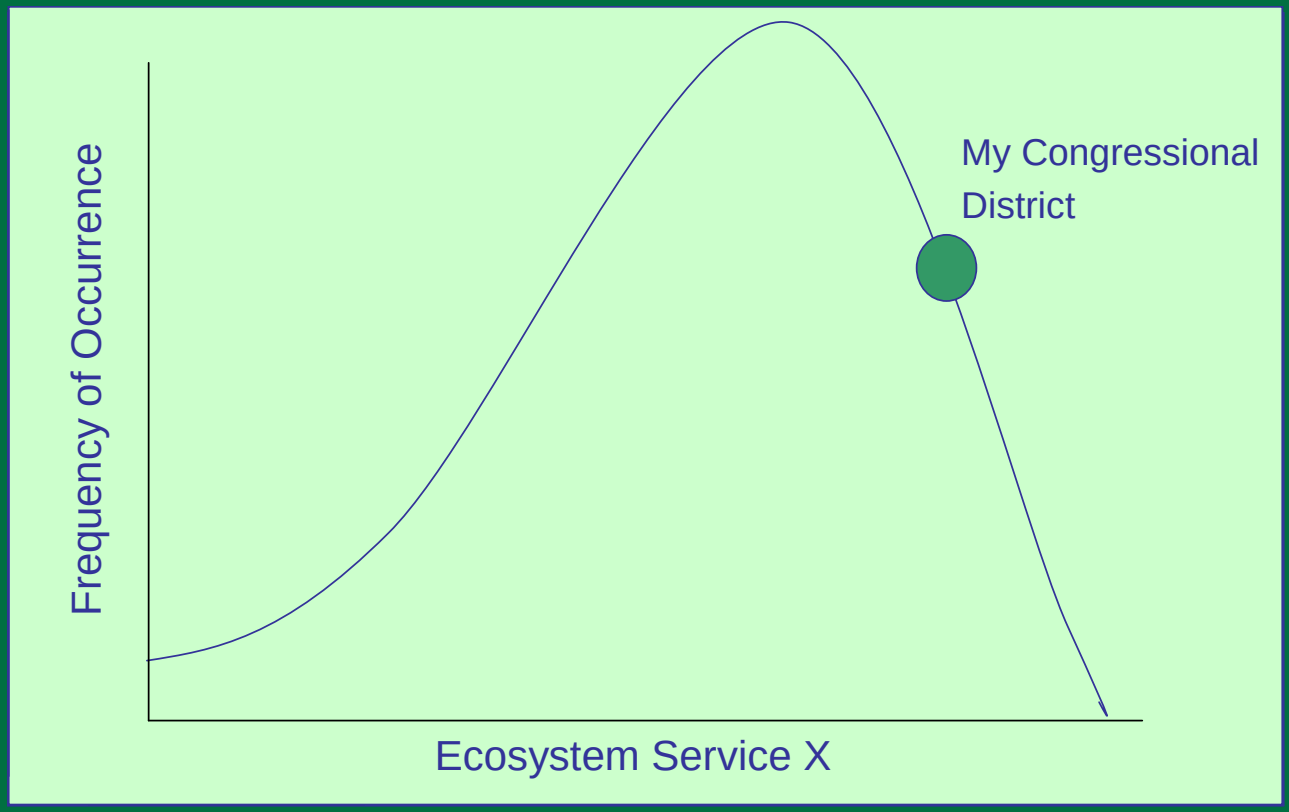
USGS

Representing multiple ecosystem services



USGS

Aggregate information by spatial area



USGS

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?

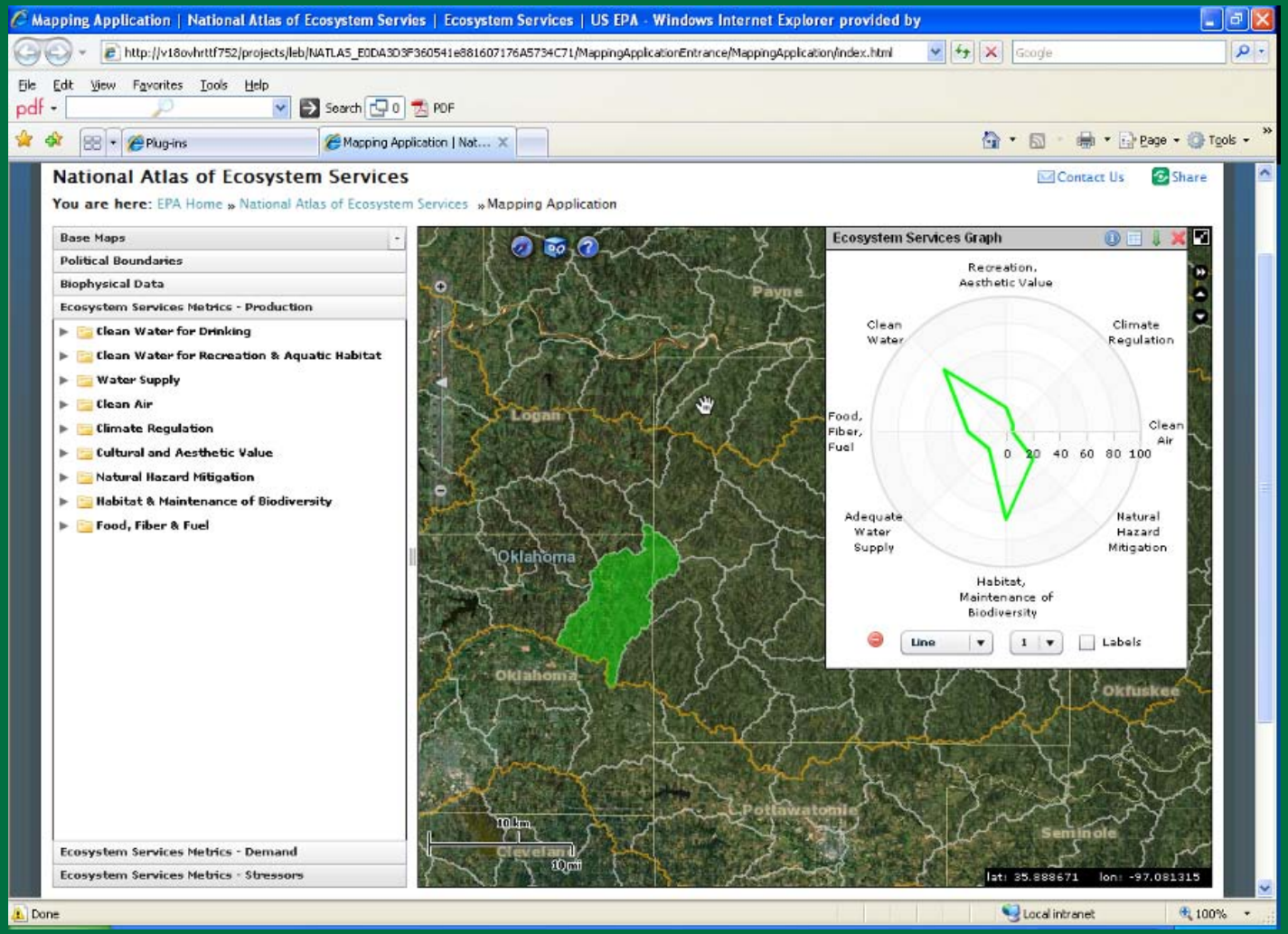
How can I get the data layer?

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



USGS

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

USGS

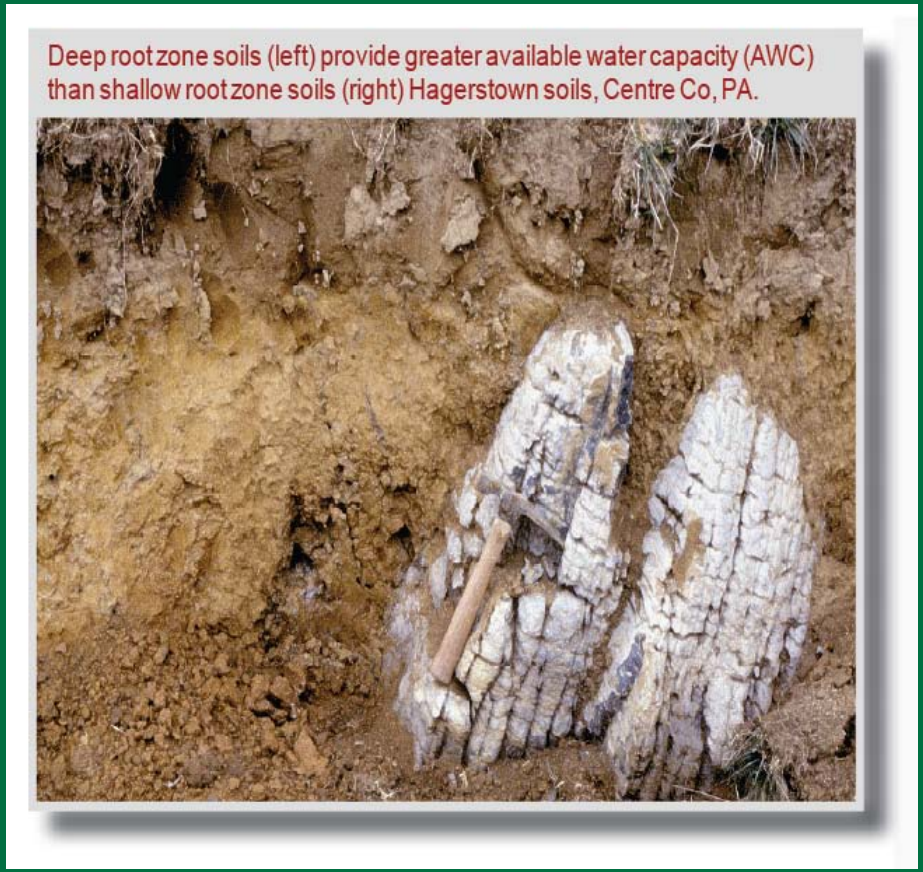
SSURGO

- 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

USGS

Soil Contributon 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.



USGS

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

USGS

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

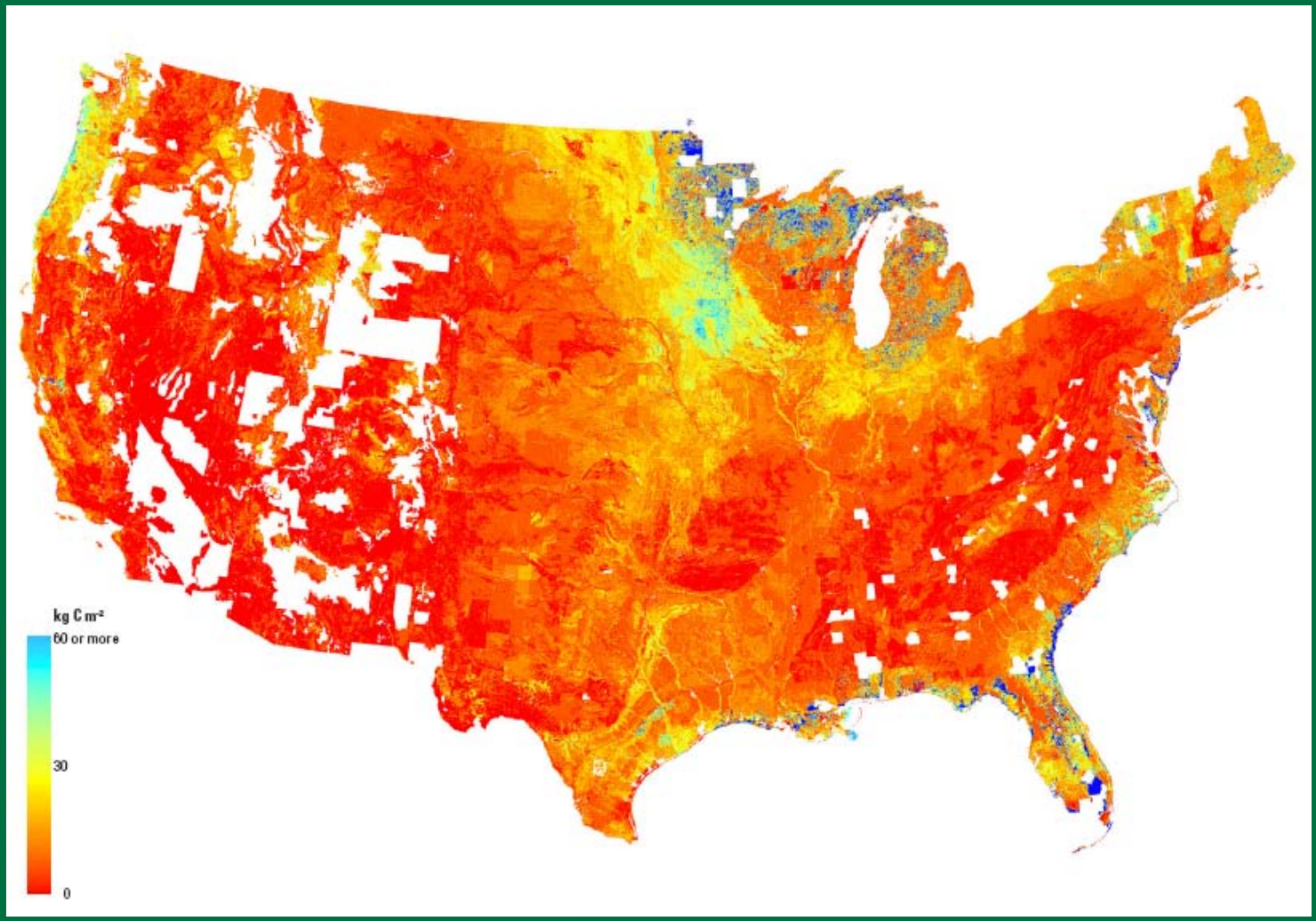
USGS

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

USGS

Preview: Soil Organic Carbon



USGS

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%)

USGS

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

USGS

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

USGS

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

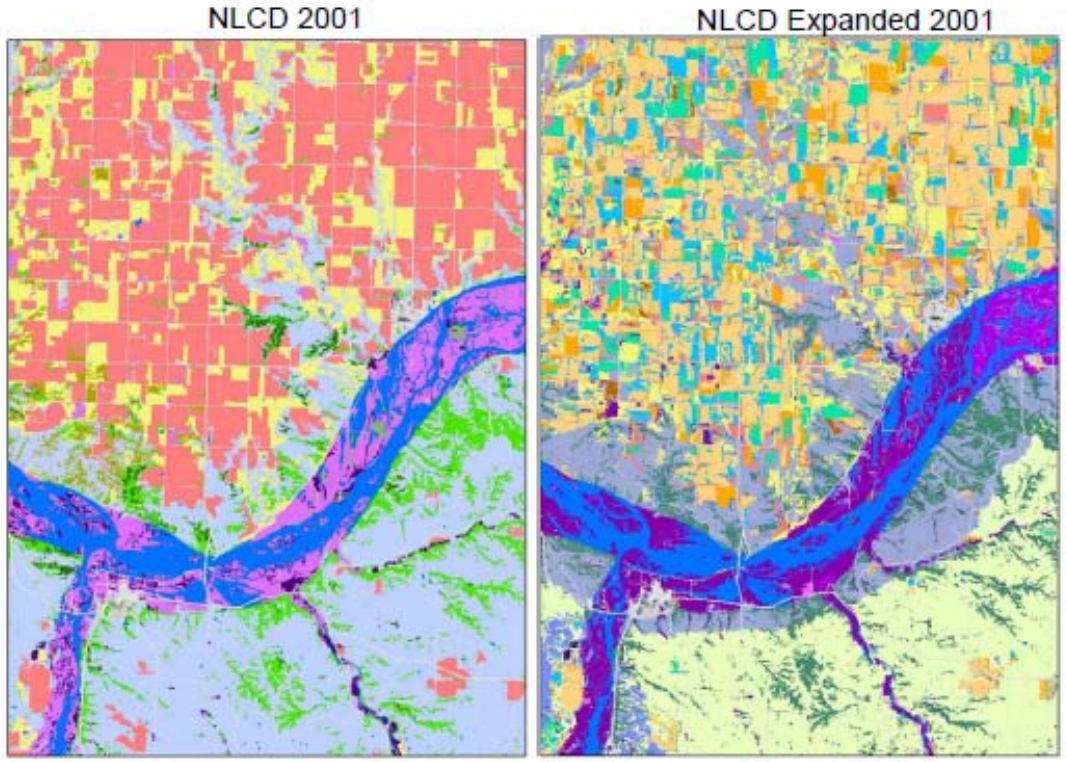
USGS

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

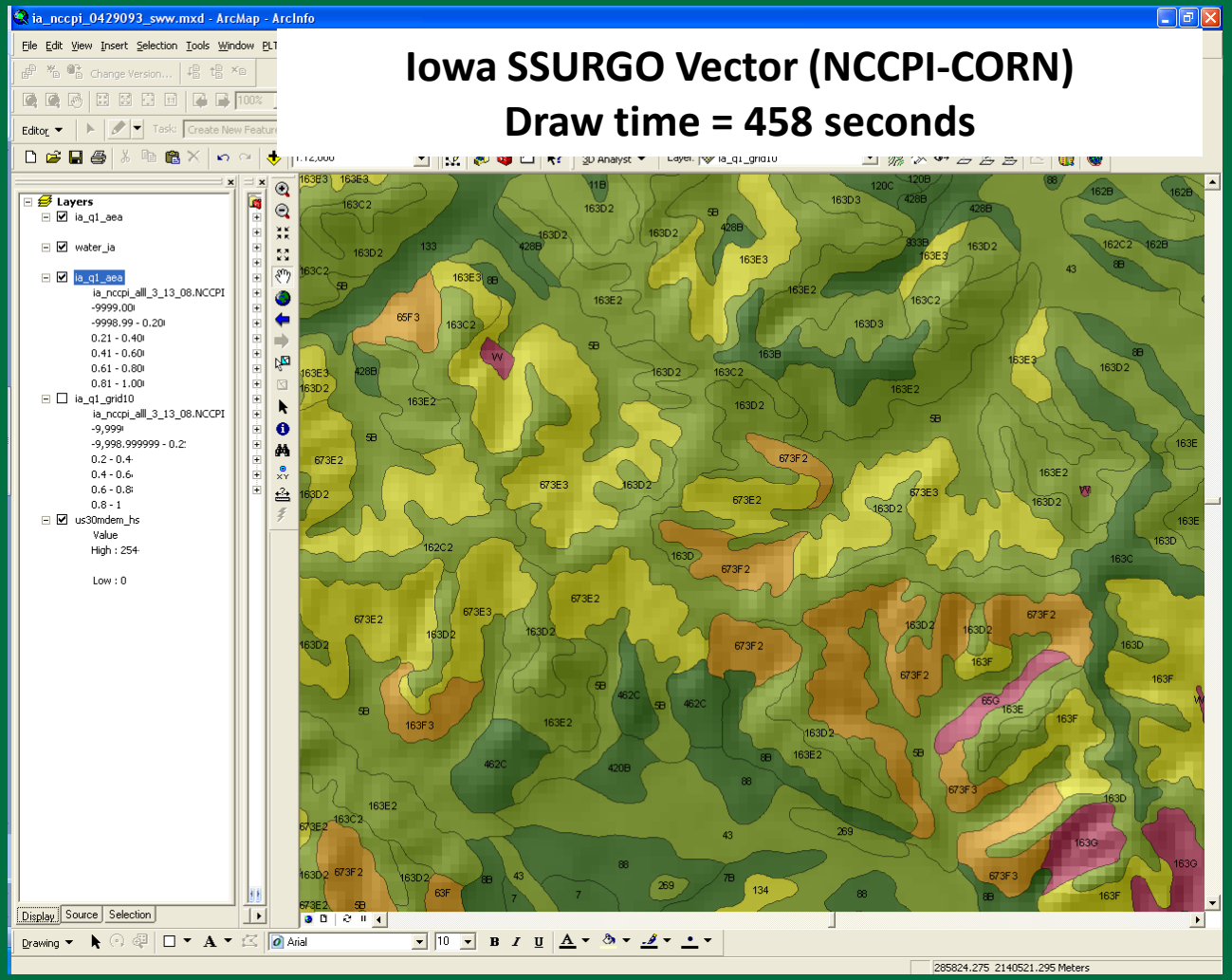
USGS

NLCD and NASS CDL



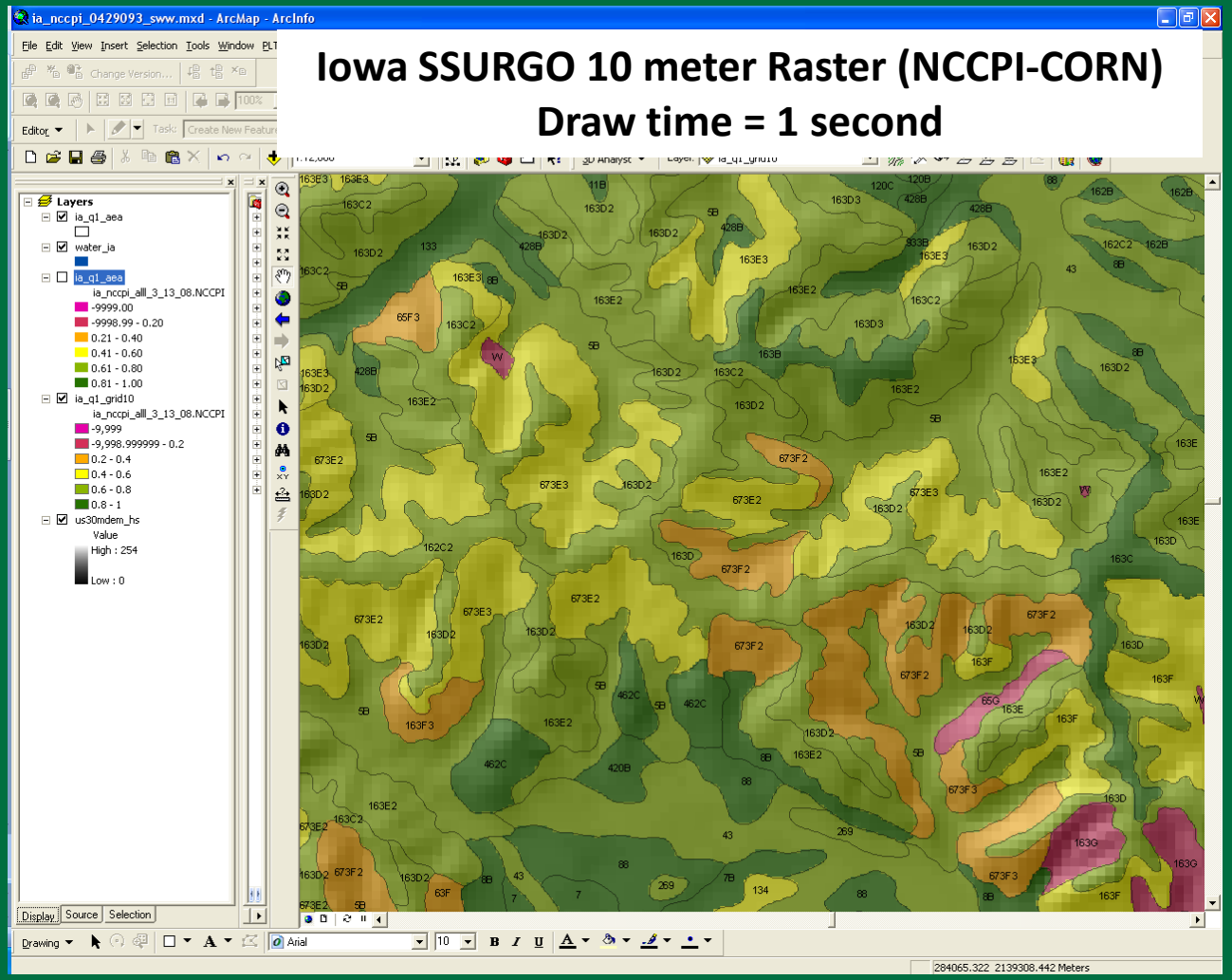
USGS

SSURGO as Vectors



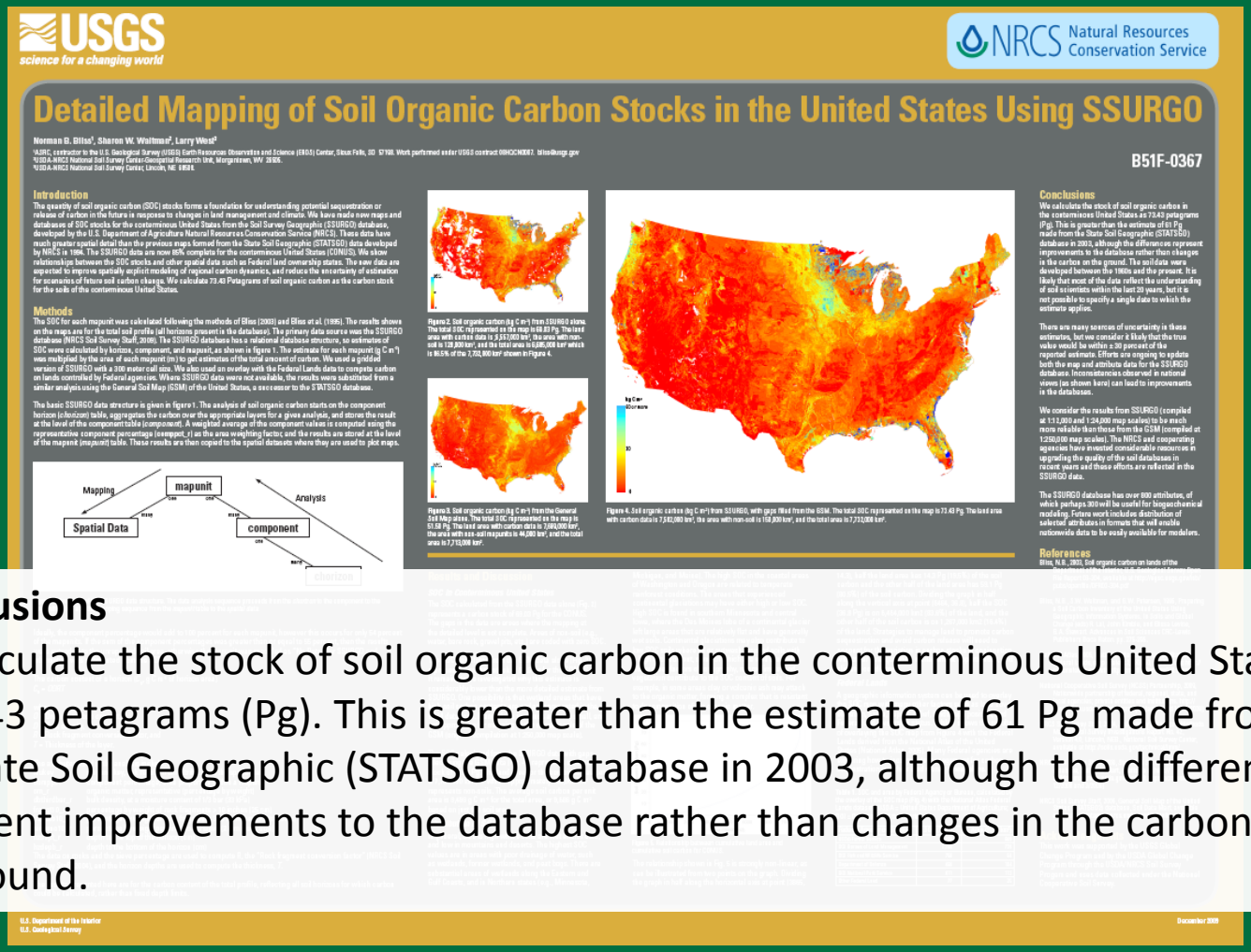
USGS

SSURGO Gridded



USGS

Application: Soil Carbon



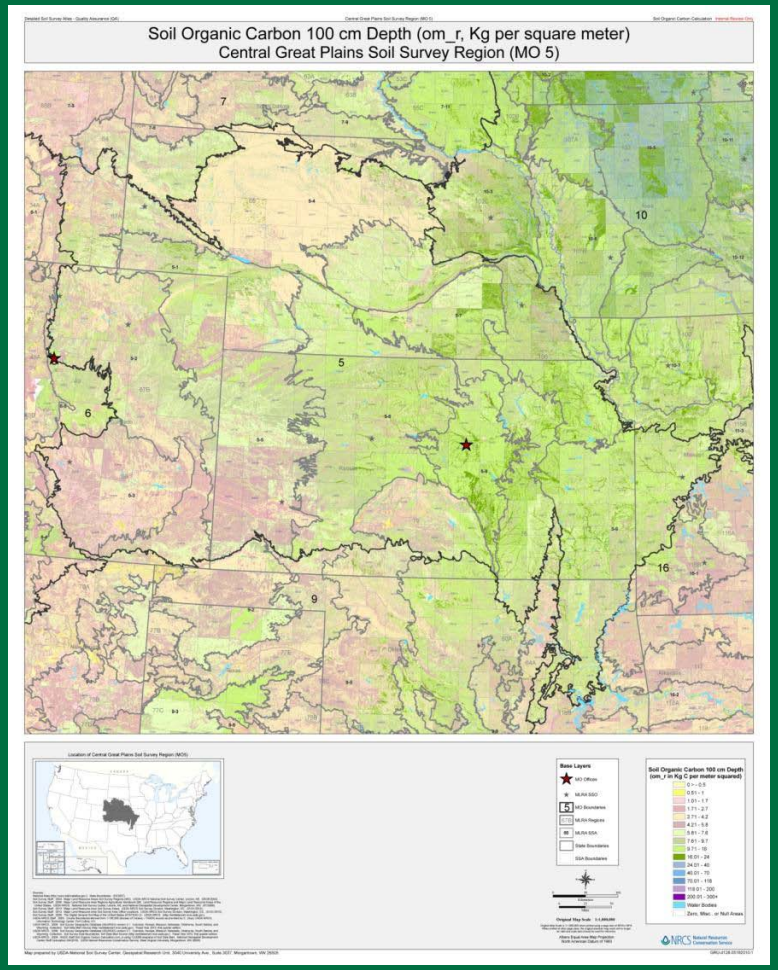
Conclusions

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.

USGS

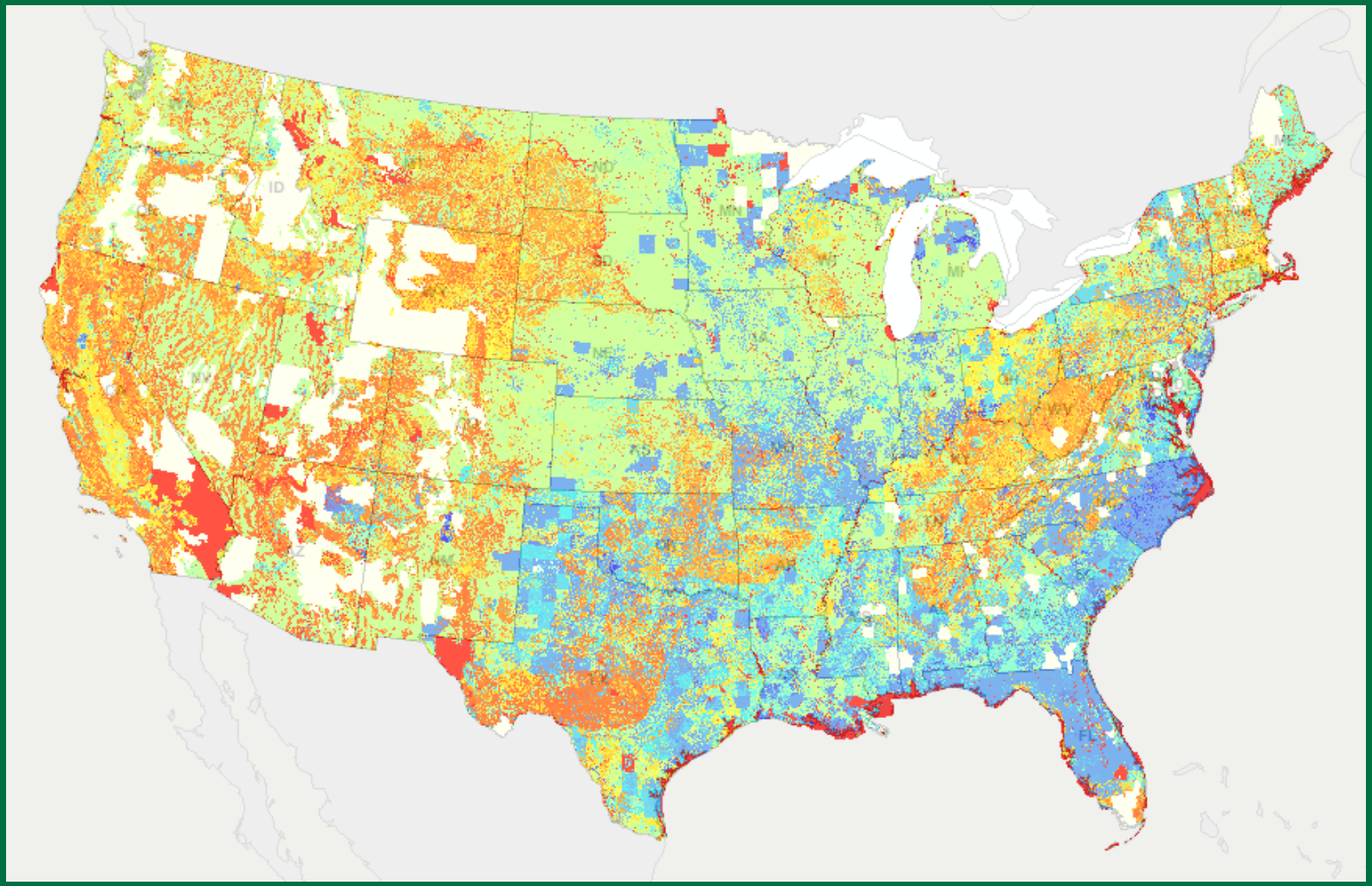
NRCS Rapid Assessment of Carbon Project

To support the Resource Conservation Act (RCA)



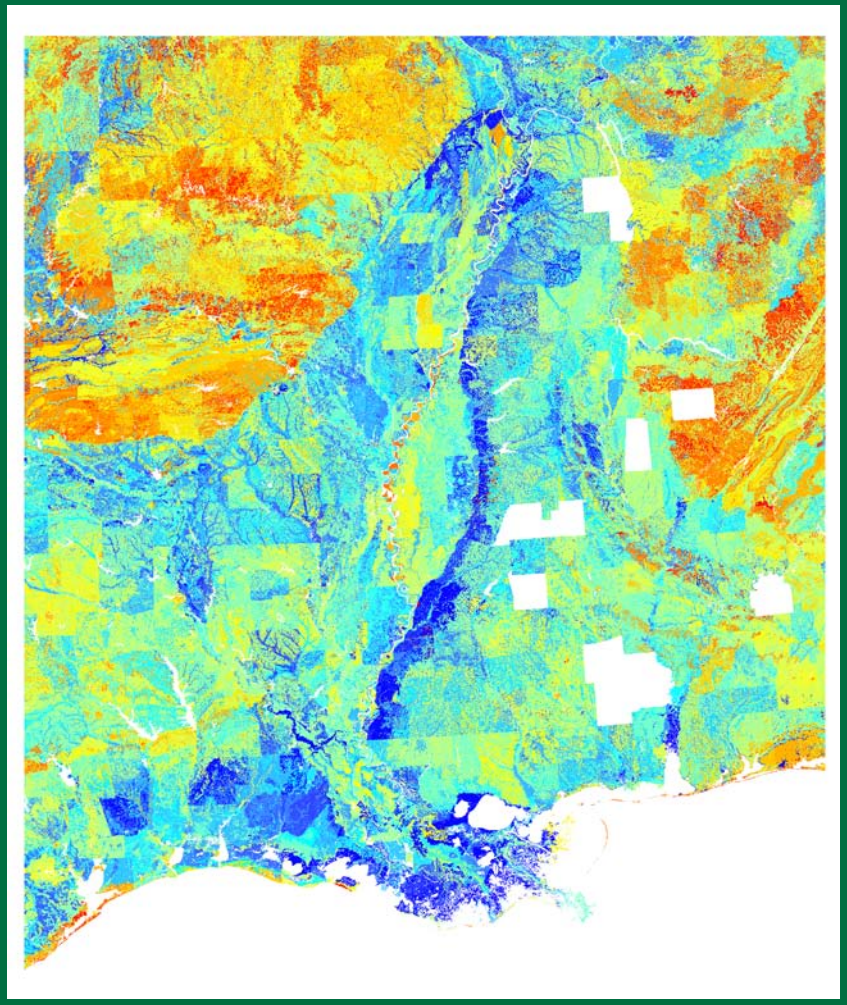
USGS

Soil depth



USGS

Available Water Capacity



250 m resolution

USGS

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

USGS

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)

USGS

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

USGS

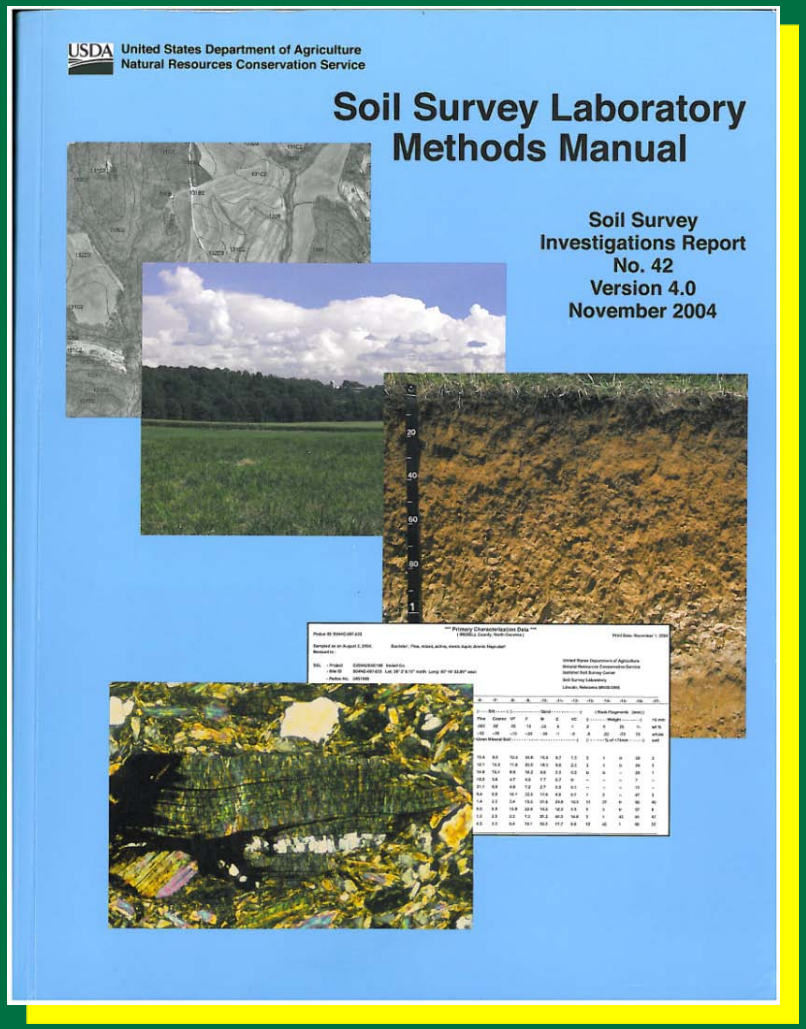
Ecosystem Services: SSURGO Themes

- 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)

USGS

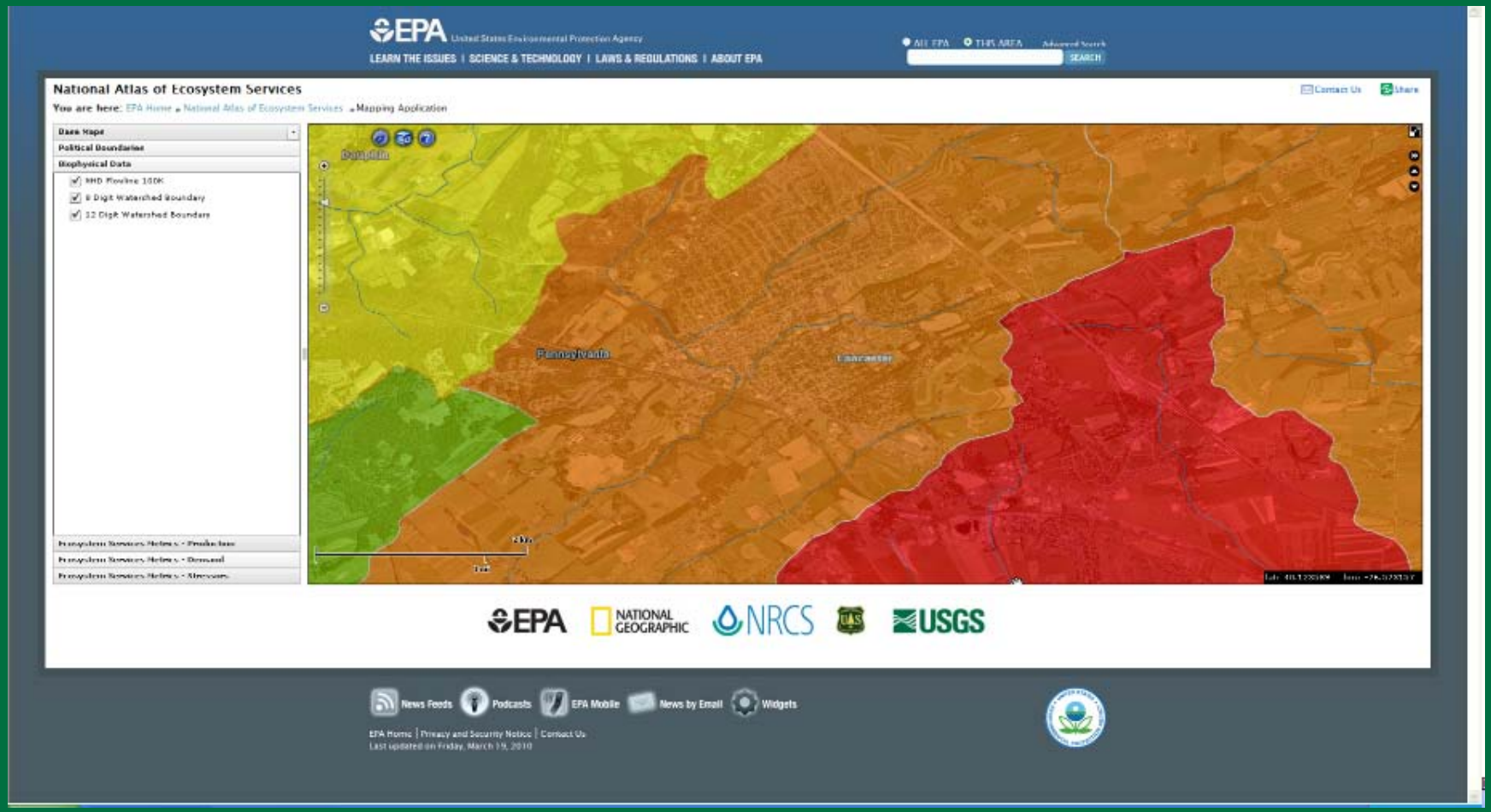
NSSC “Best Practices” documented

- Data summary methods



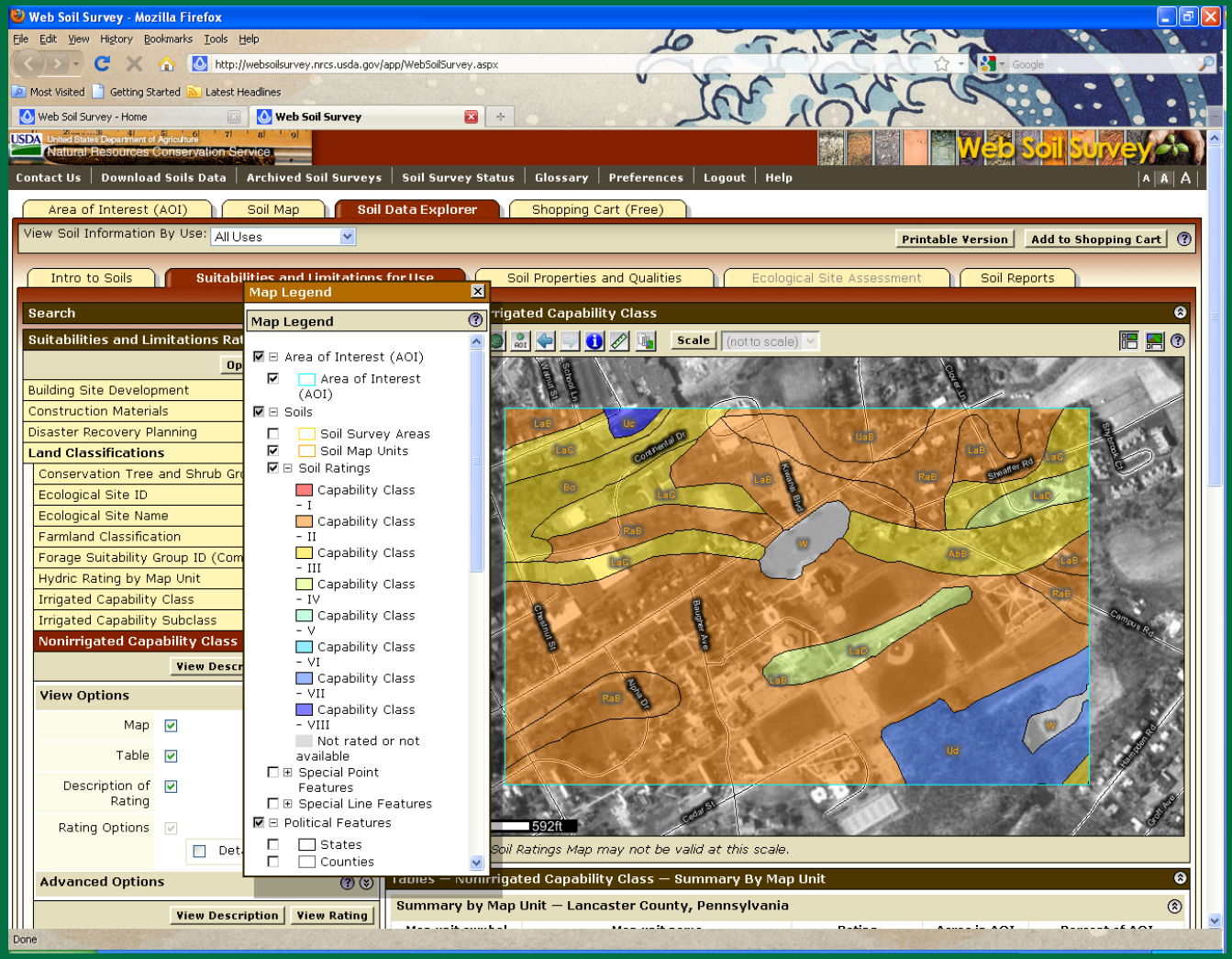
USGS

Summarize by 12-digit Hydrologic Units

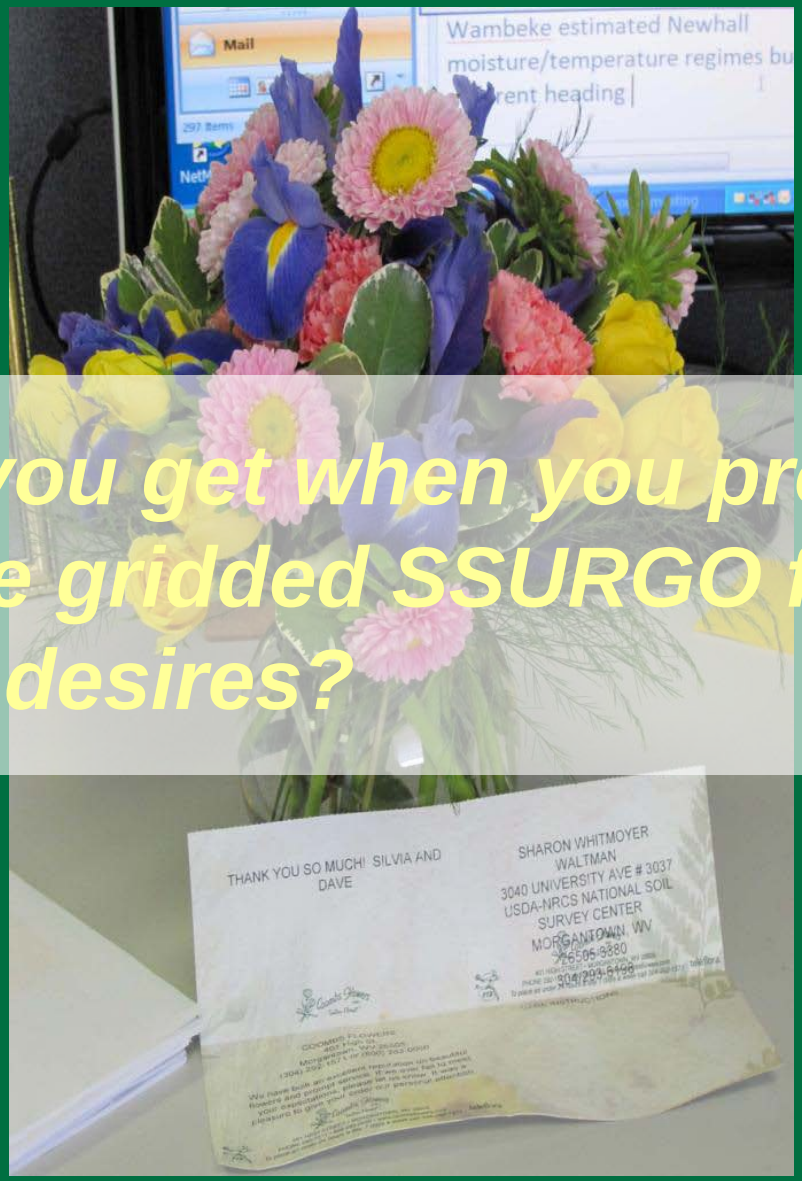


USGS

Scalable linkage to Web Soil Survey?



USGS



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

USGS