Digital Raster Grid Property Maps Versioning for North America

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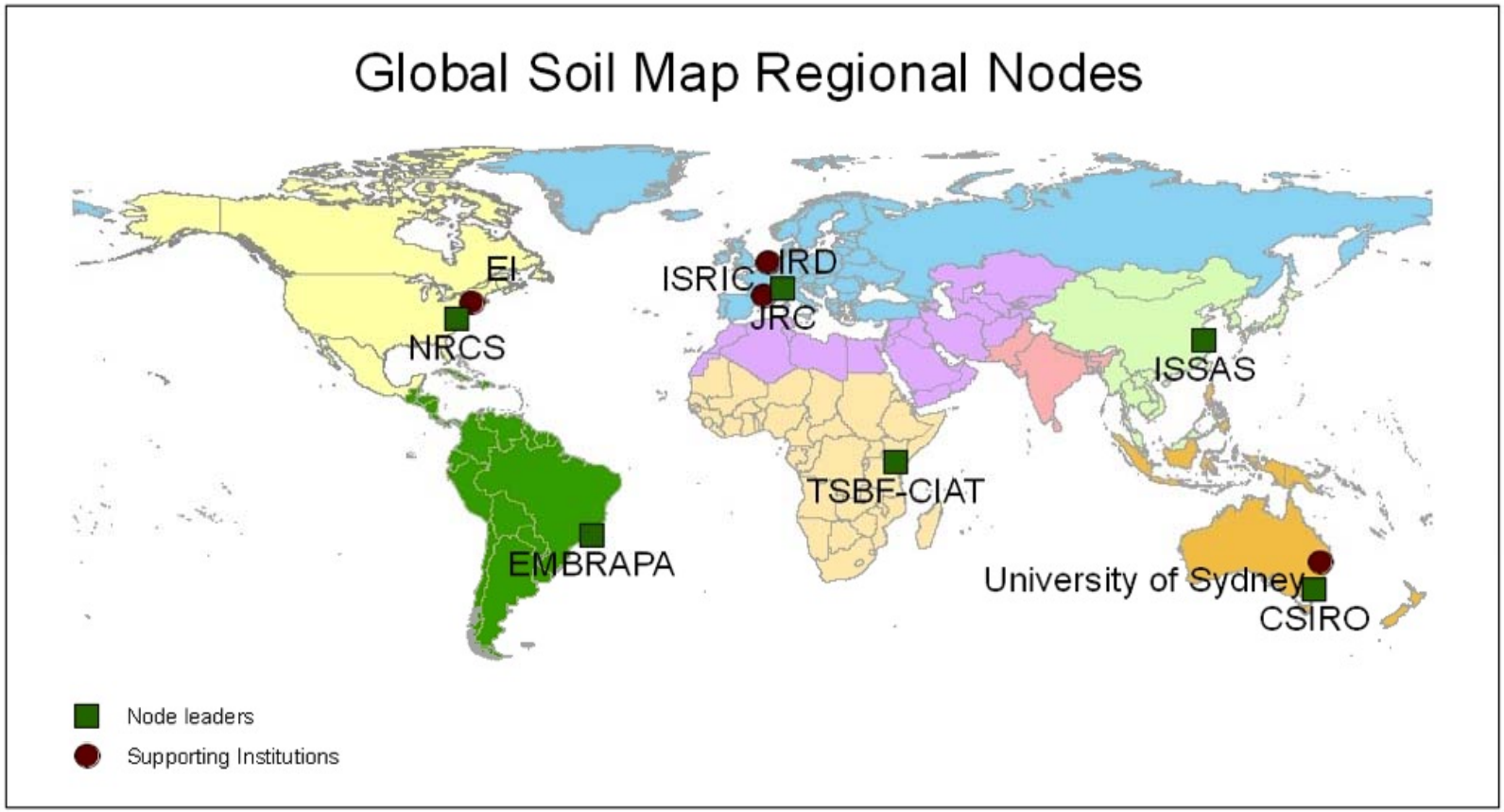


Africa South of the Sahara
East Asia
Eurasia
Latin America and the Caribbean
Middle East/ North Africa
North America
Oceania
South Asia

(Middle East/North Africa and South Asia nodes pending)
Source for land area data: http://sedac.ciesin.columbia.edu/place/datasets.jsp

Land Area Per Region (sq. km)	
East Asia	13,634,162
Eurasia	23,762,066
Latin America/Caribbean	18,393,410
Middle East/North Africa	15,359,662
North America	20,613,157
Oceania	10,663,346
South Asia	4,372,529
Sub-Saharan Africa	23,911,997

Source: http://www.globalsoilmap.net/

North America Node

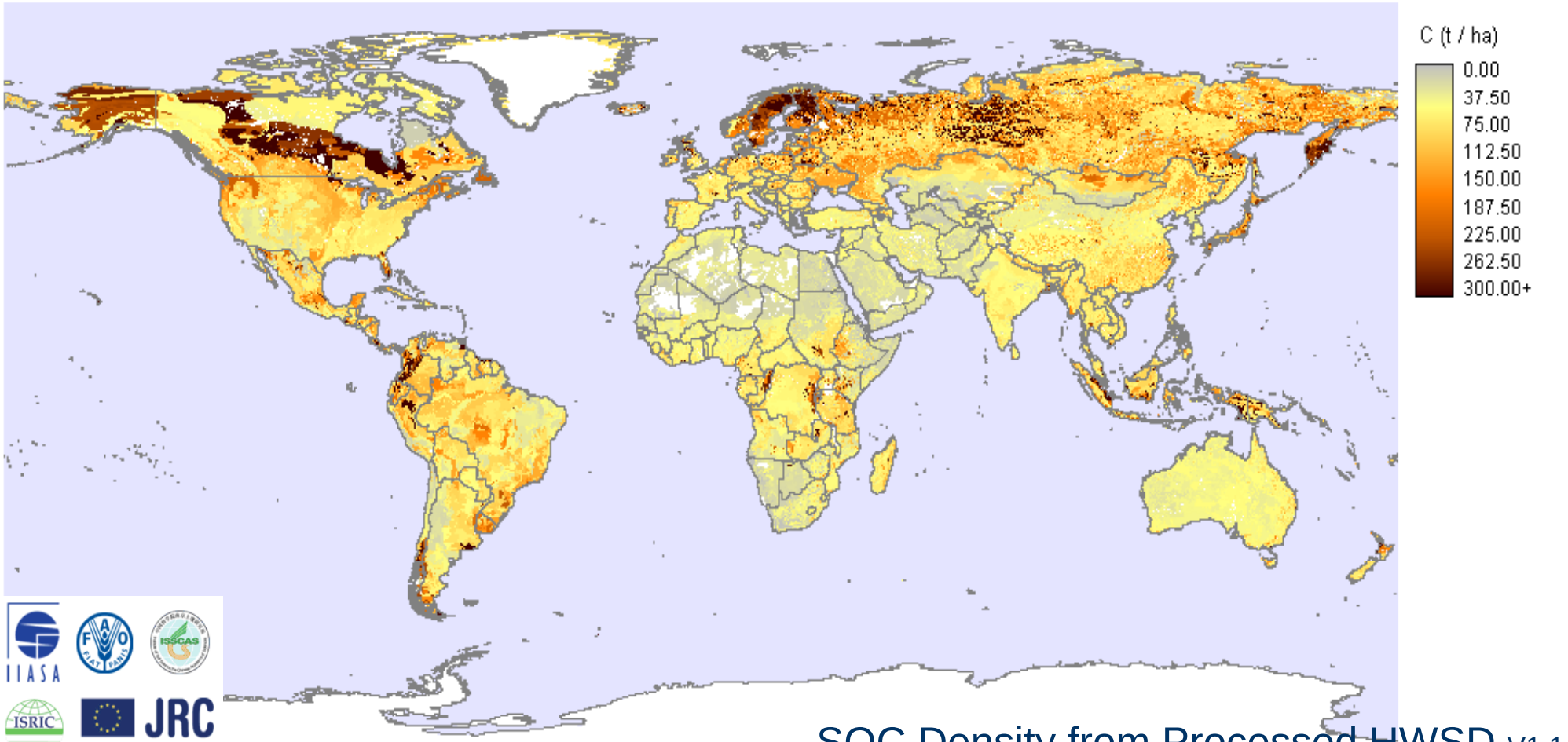
USA

CANADA

MEXICO

North America Node - Team USA (From left to right):
Sabine Grunwald - Professor (University of Florida, Gainesville)
James Thompson - Scientific Coordinator (WVU-GRU, Morgantown)
Nathan Odgers - Post-Doctoral (WVU-GRU)
Zamir Libohova – USDA-NRCS, Lincoln
Phillip R. Owens - Associate Professor (Purdue University, West Lafayette)
Jonathan W. Hempel - Node Leader (USDA-NRCS, Lincoln)
Janis Boettinger - Professor (Utah State University, Logan)

Harmonized World Soil Database HWSD



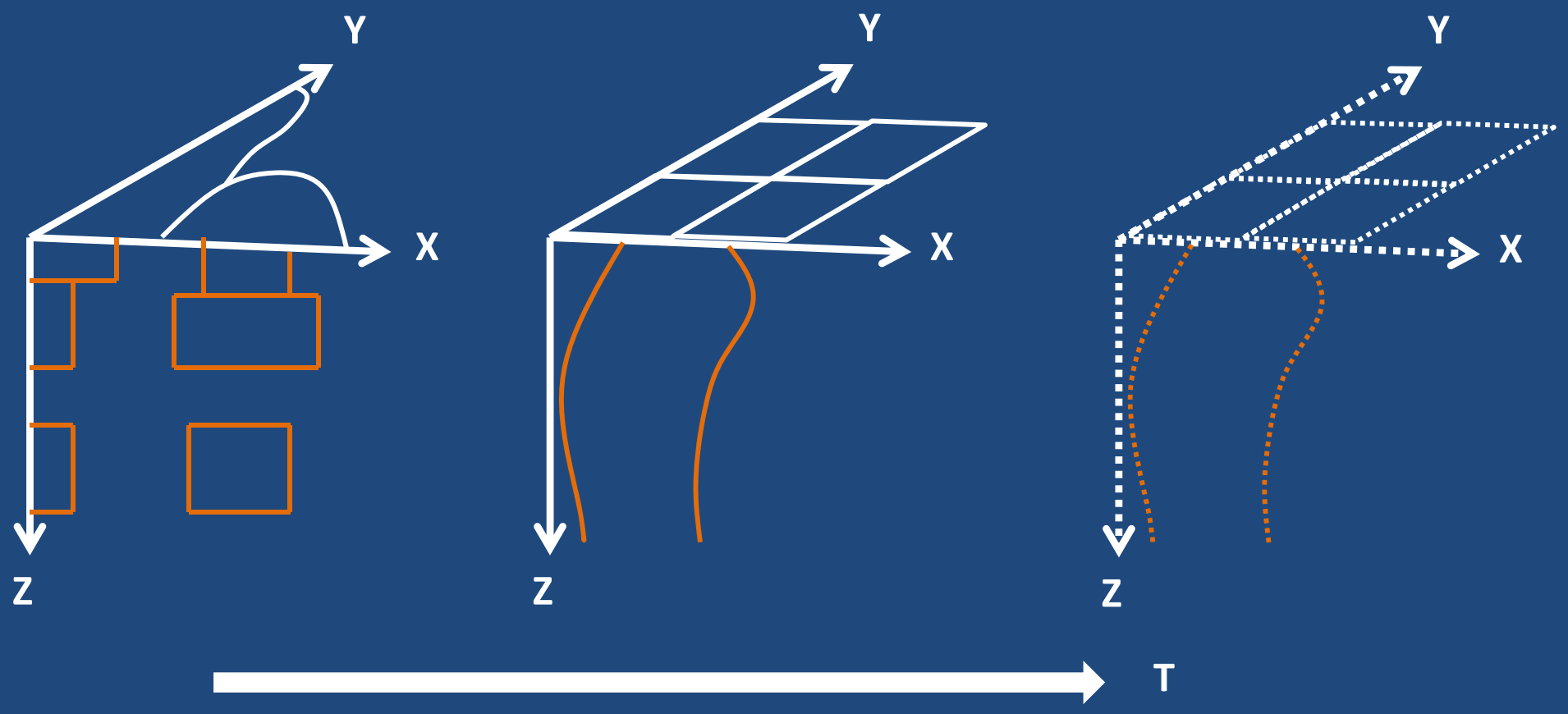
SOC Density from Processed HWSD V1.1

Source: http://www.iiasa.ac.at/Research/LUC/luc07/External-World-soil-database/HTML/index.html

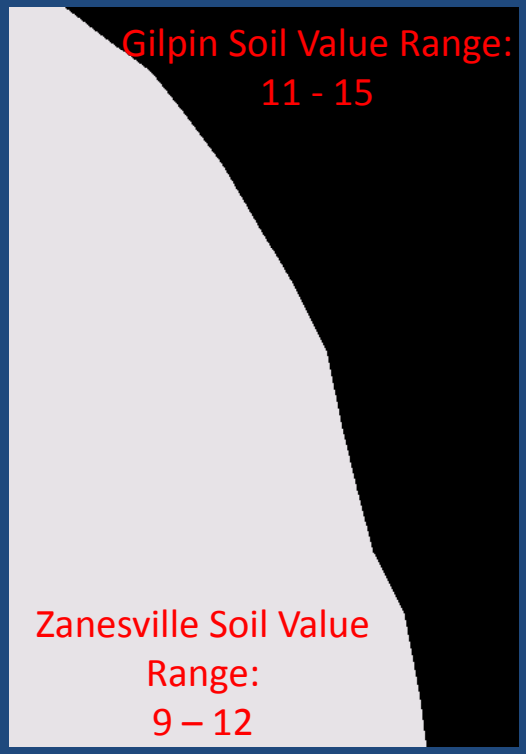
Goals and Objectives

- Create raster predictive soil property maps for the entire world at 90 m resolution (Sanchez *et al*., 2009).
- Soil Properties:
  - Primary
    - Organic Carbon (g kg^{-1})
    - pH (1:5 soil/ 0.01 mol L^{-1} $CaCl_2$ solution)
    - Particle Size (Clay, Silt, Sand, Coarse Fragments) (g kg^{-1})
  - Derived
    - Bulk Density (Mg m^{-3})
    - Available Water Capacity (mm – total over the depth range)
  - Optional, secondary
    - ECEC ($cmol_c$ kg^{-1})
    - Electric Conductivity (dS m^{-1})
  - Standard depth increments (0-5, 5-15, 15-30, 30-60, 60-100, 100-200 cm)
- Nodes (<u>North America</u>, South America, Oceania, Africa, Asia, Europe)

Continuous 4D



Polygon vs. Raster



11.88	11.28	11.33	12.45	13.49	14.06	14.34
11.48	10.78	11.18	12.48	13.42	14.18	14.72
11.22	10.38	10.86	12.06	13.13	13.88	14.53
11.20	10.54	10.65	11.60	12.70	13.58	14.21
10.70	10.49	10.57	11.19	12.15	13.01	13.80
9.90	9.82	10.13	10.74	11.44	12.20	13.13
9.51	9.33	9.58	10.14	10.69	11.49	12.67
9.91	9.60	9.45	9.68	10.17	11.21	12.38
10.52	10.11	9.64	9.59	10.02	11.01	12.21
11.11	10.62	10.06	9.73	9.86	10.77	11.99

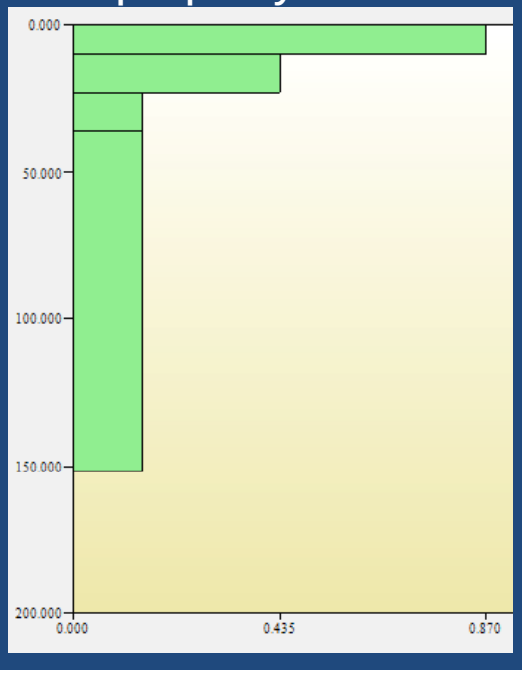
- **Polygons**
- Discreet boundaries
- Broken interconnectedness
- Vague predictions (value ranges)
- Incompatibility with raster-based models
- Simplicity of representation, complexity of interpretation

- **Rasters**
- Fuzzy boundaries
- High degree of interconnectedness
- Specific predictions at specific geographic intervals
- High compatibility with raster models
- Complexity of representation, simplicity of interpretation

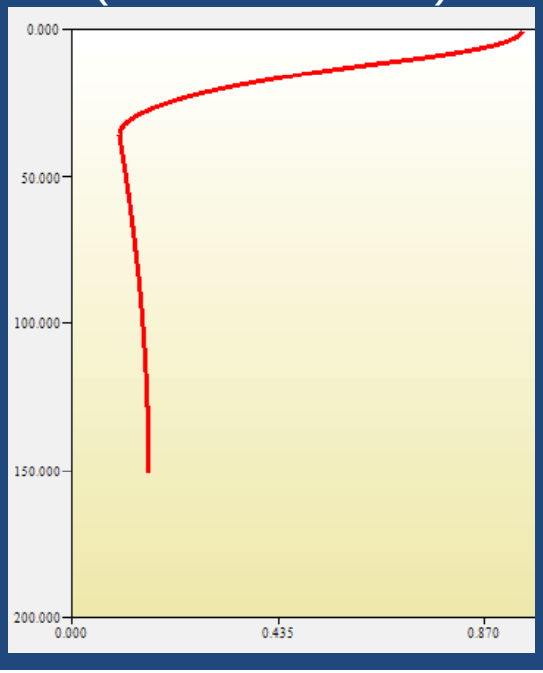
Fitting splines

- Splines (ver. 0.1–0.9):
  - Fit equal-area splines to SSURGO/STATSGO components (*viz*. Malone *et al*. 2009, Bishop *et al*. 1999)
  - Derive property values at GSM standard depth increments (0-5, 5-15, 15-30, 30-60, 60-100, 100-200 cm)
  - Generate weighted-means maps for GSM soil properties
  - See Spatial Predictions In Soils, Crops and Agro/Forest/Urban/Wetland Ecosystems: II, Title: Application of the Equal-Area Spline Function to Legacy Soil Data.

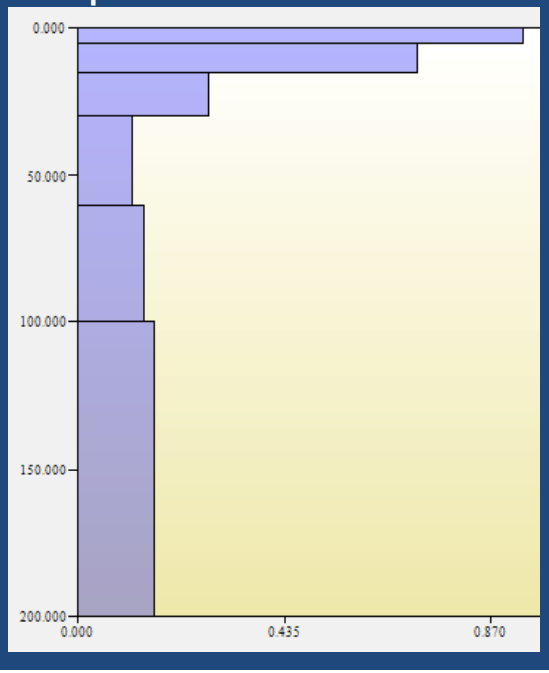
Soil profile with property data



Continuous spline (1 cm resolution)



Property estimates at specific increments



North America Node

- Approach:
  - Versions “0.1”–“0.4” Gridded current soil maps
    - USA - State Soil Geographic Data Base (STATSGO - 1:250,000)
    - CANADA - Soil Landscapes of Canada (SLC – 1:1,000,000)
  - Versions “0.5”–“0.9”
    - USA – STATSGO + Soil Survey Geographic Database (SSURGO – 1:12,00- to 1:65,000).
    - CANADA – SLC + Canada Land inventory (CLI) – (Detailed Soil Surveys – 1:10,000-1:250,000)
  - Versions 1+
    - Version 1 - Pilot Projects
    - Version 1.1 + Continuous raster grids of soil properties up scaled to continental scale.

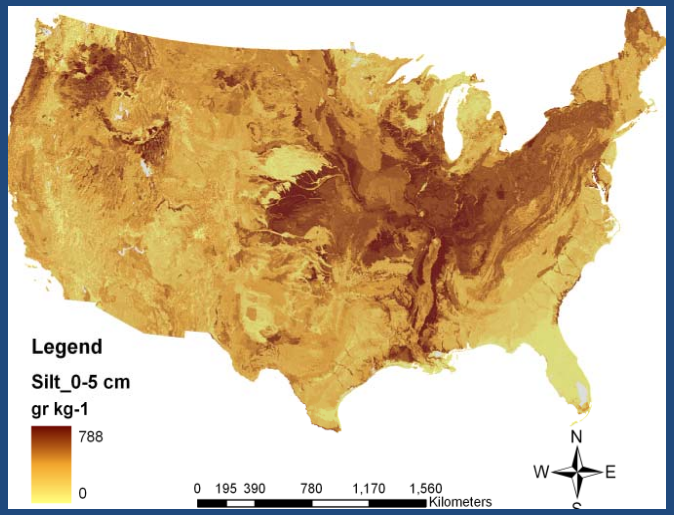
North America Node

- Versions “0.1”–“0.4” Gridded current soil maps;
- STATSGO has been the base polygon map;
- Properties:
  - Organic C (g kg^{-1});
  - Particle Size (Clay, Silt, Sand, Coarse Fragments) (g kg^{-1});
  - Soil Depth (cm);
  - Available Water Capacity (mm).
  - pH – A study has been conducted by the National Soil Survey Center to develop relationships between pH determined at 1:1 H_20 and 1:2 soil/ 0.01 mol L^{-1} $CaCl_2$ solution versus 1:5 soil/ 0.01 mol L_{-1} $CaCl_2$ solution.

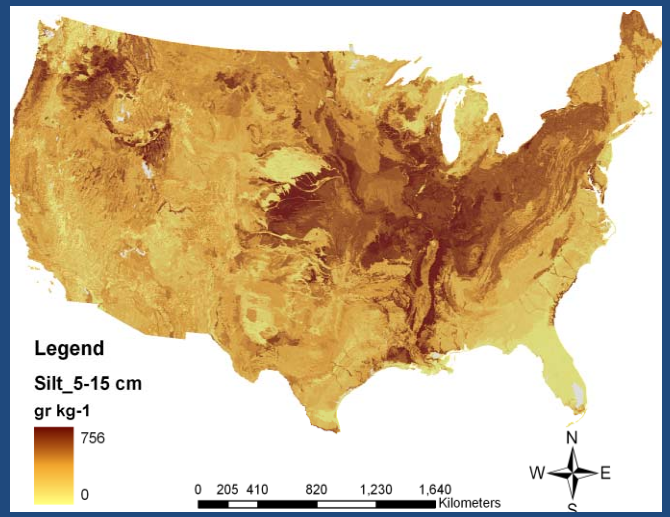
    (See Session: General Pedology II; Poster Board Number: 210; Title: Soil Reaction Conversions Between ISO and US Soil Survey Methods for GlobalSoilmap.Net Specifications.)

Silt Content

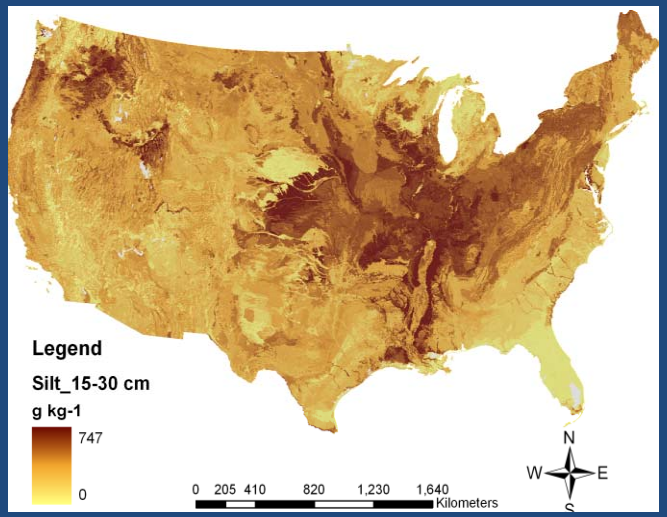
0-5 cm



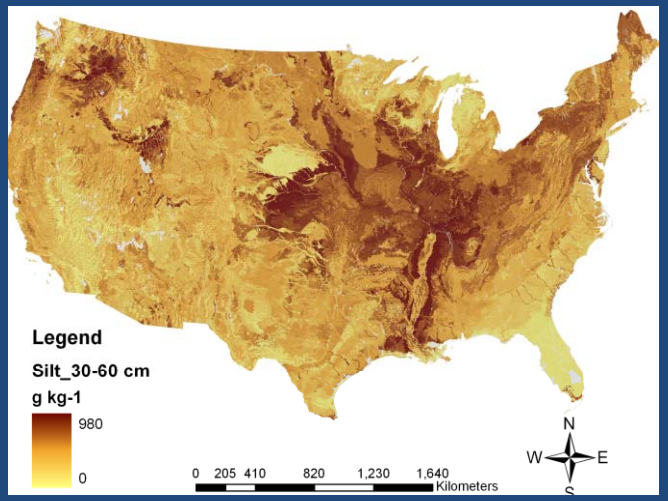
5-15 cm



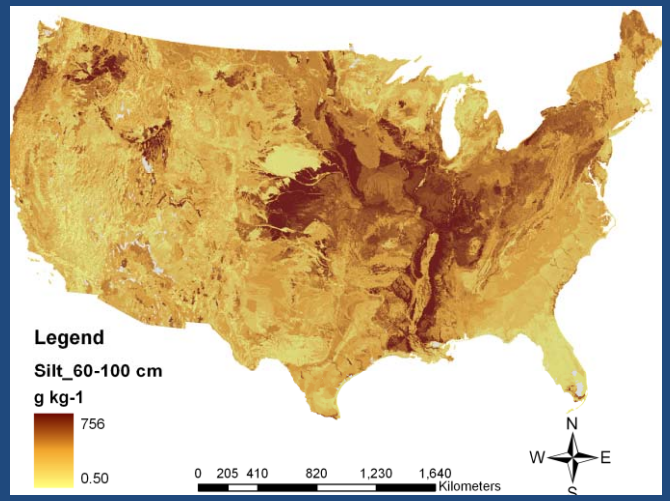
15-30 cm



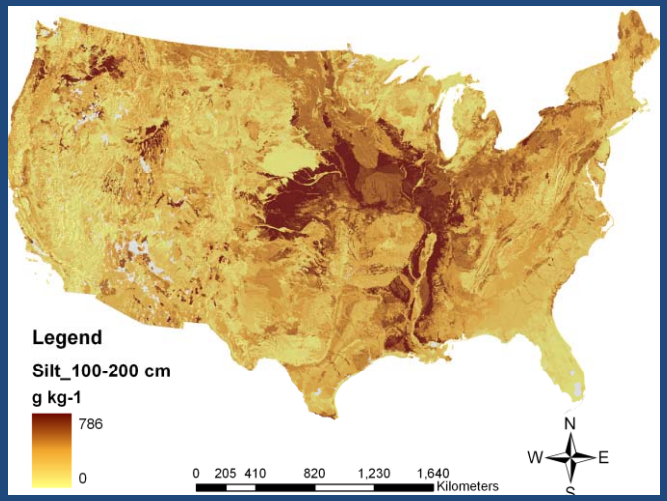
30-60 cm



60-100 cm



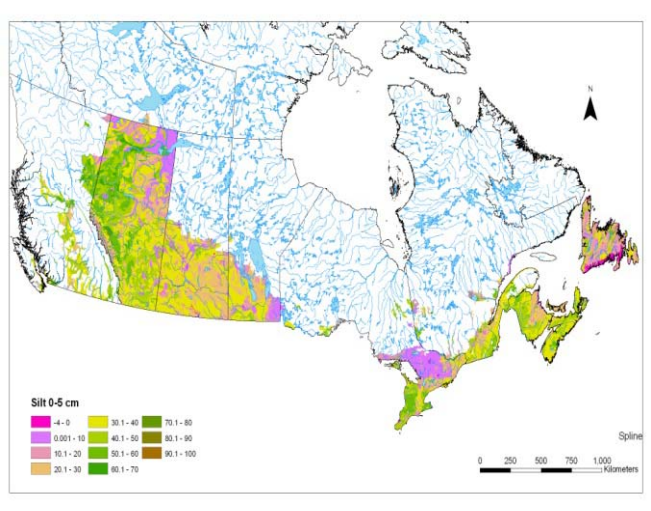
100-200 cm



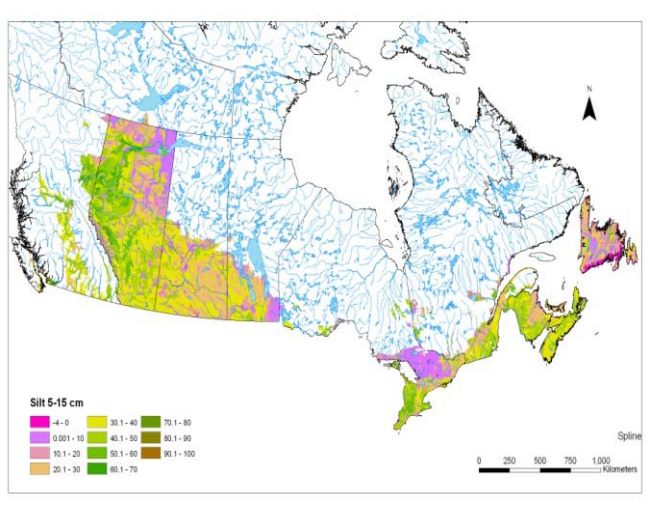
0	30.1 - 40	70.1 - 80
0.001 - 10	40.1 - 50	80.1 - 90
10.1 - 20	50.1 - 60	90.1 - 100
20.1 - 30	60.1 - 70	

Silt Content

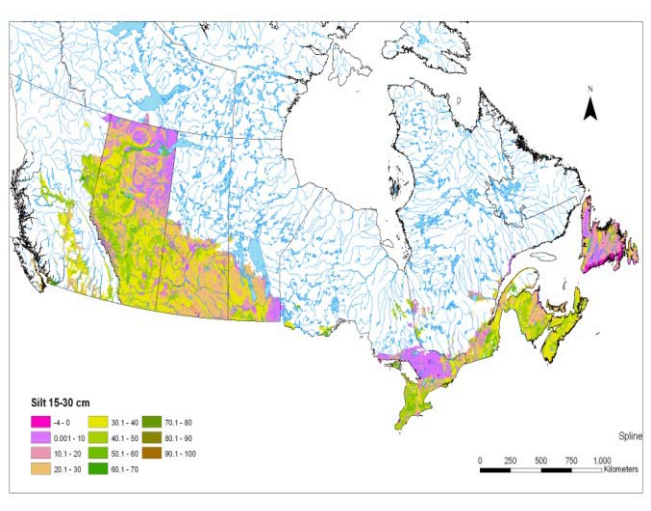
0-5 cm



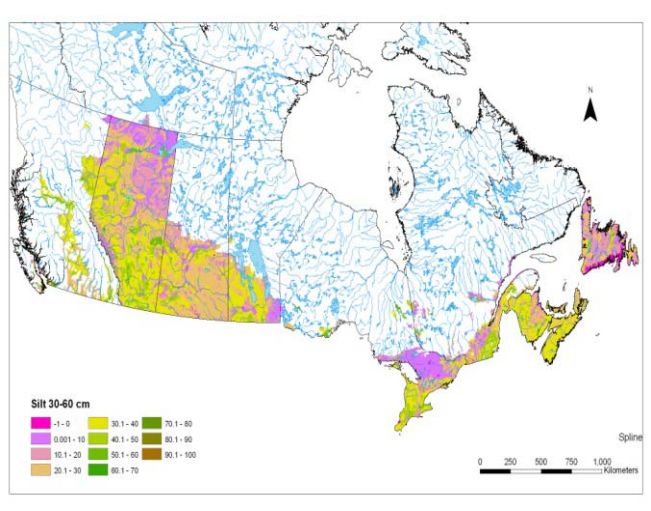
5-15 cm



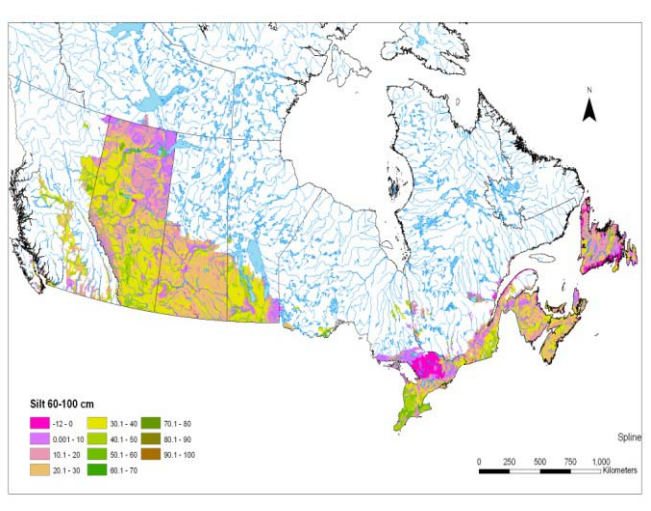
15-30 cm



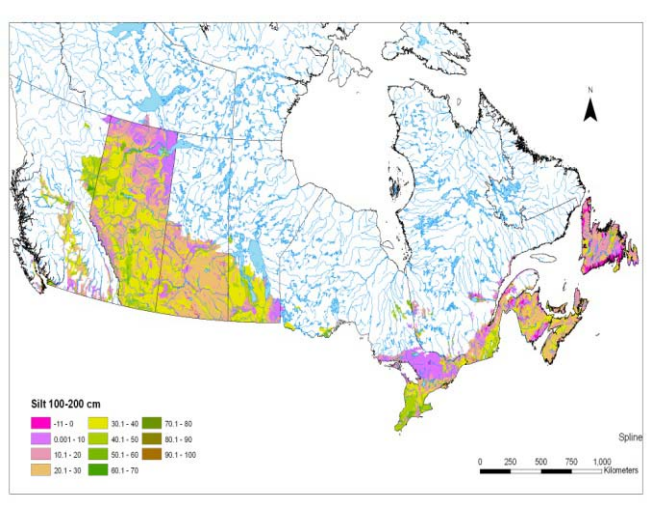
30-60 cm



60-100 cm



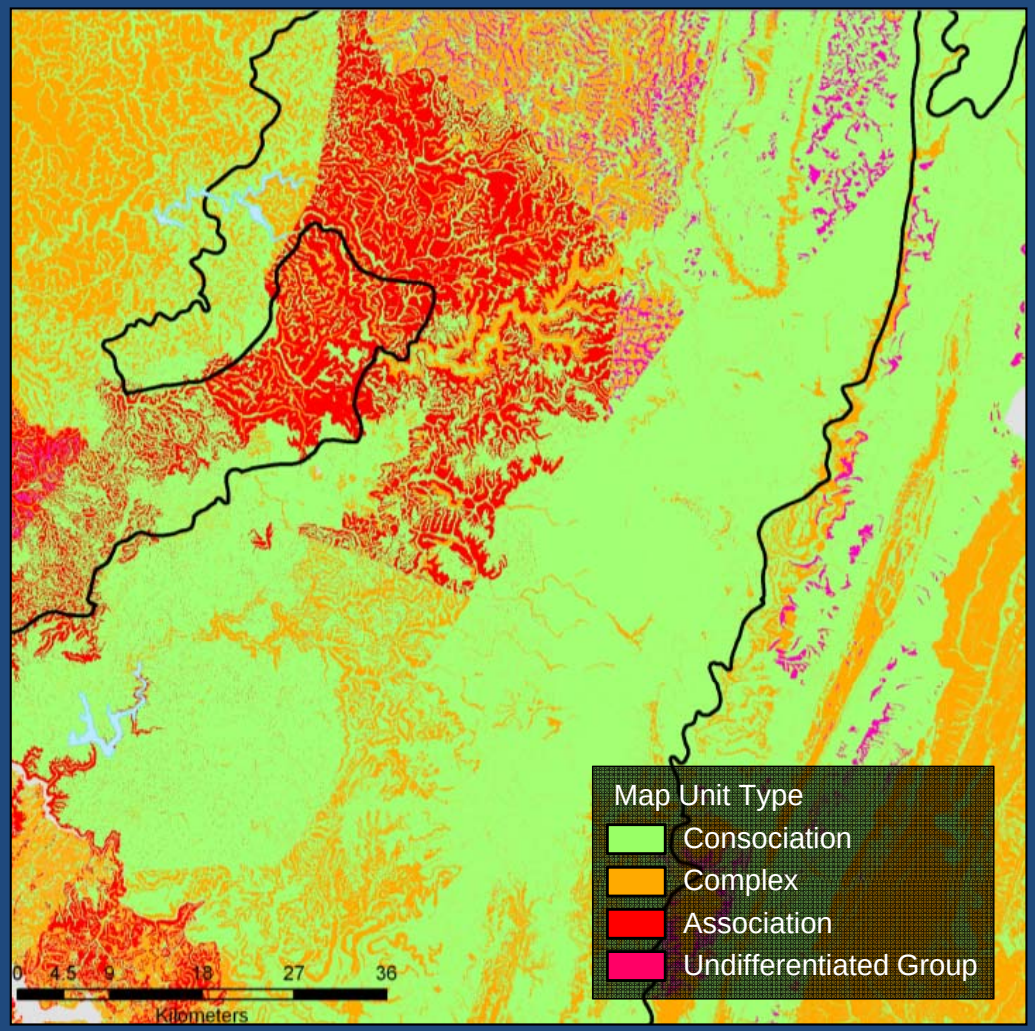
100-200 cm



Disaggregation and Harmonization

- SSURGO databases are produced and maintain independently.
- Many factors necessitate disaggregation/harmonization:
  - Different purposes,
  - Different scales,
  - Different mapping concepts,
  - Different soil components,
  - Different tabular data,
  - Different Surveyors.

(See Session: S05 Pedology ; Spatial Predictions In Soils, Crops and Agro/Forest/Urban/Wetland Ecosystems: II , Title: Disaggregation of Polygon Soil Class Maps to Produce Raster Soil Property Maps Using Digital Soil Mapping Techniques).

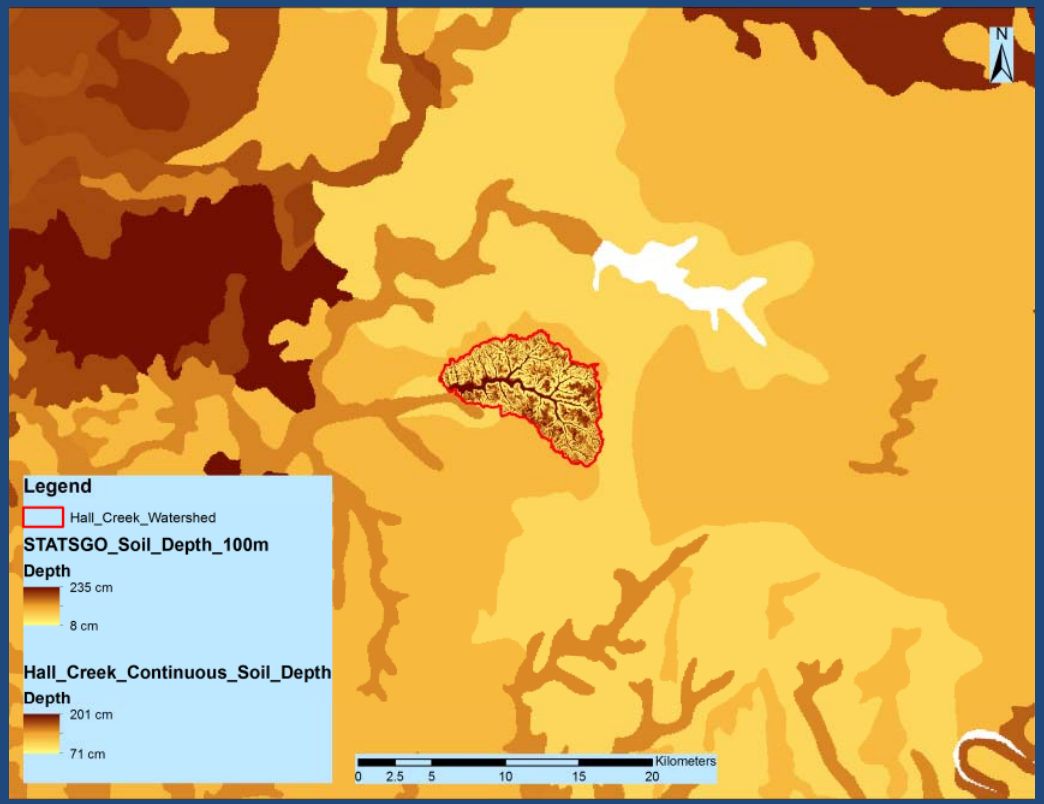


Source: Thompson et al., 2005. Regional Approach to Soil Property Mapping using Legacy Data and Spatial Disaggregation Techniques. Proceedings from the World Conference of Soil Science, Philadelphia, PA.

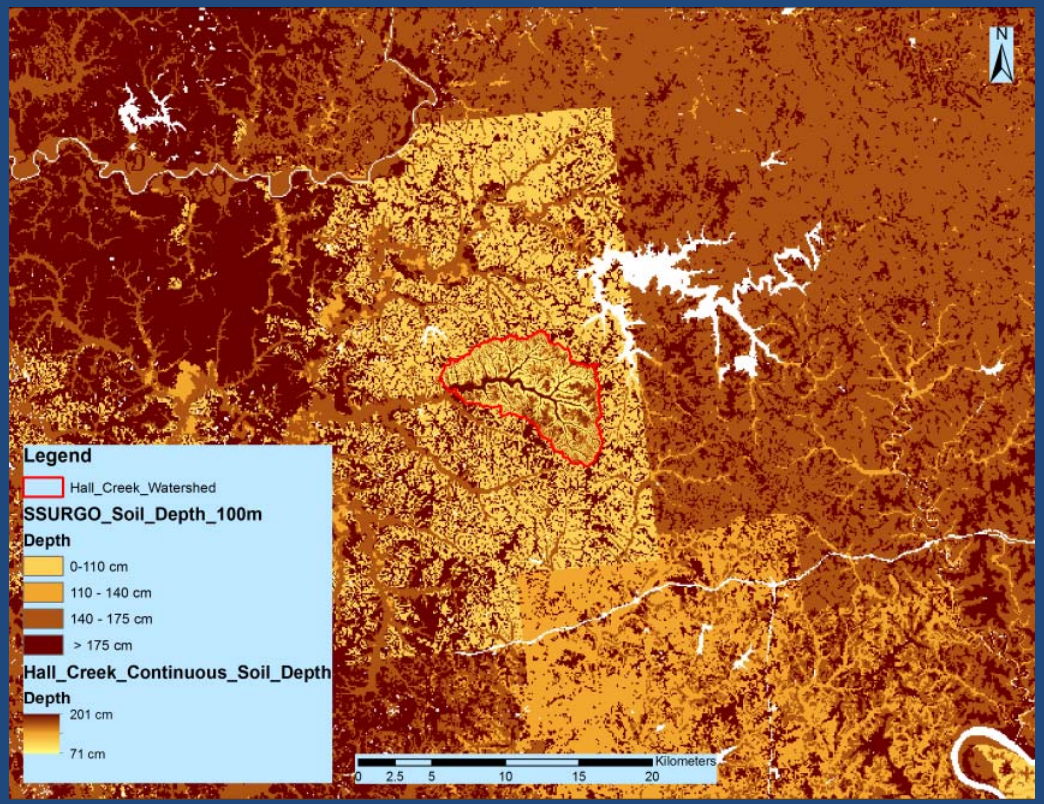
Soil Depth

1:250,000

STATSGO



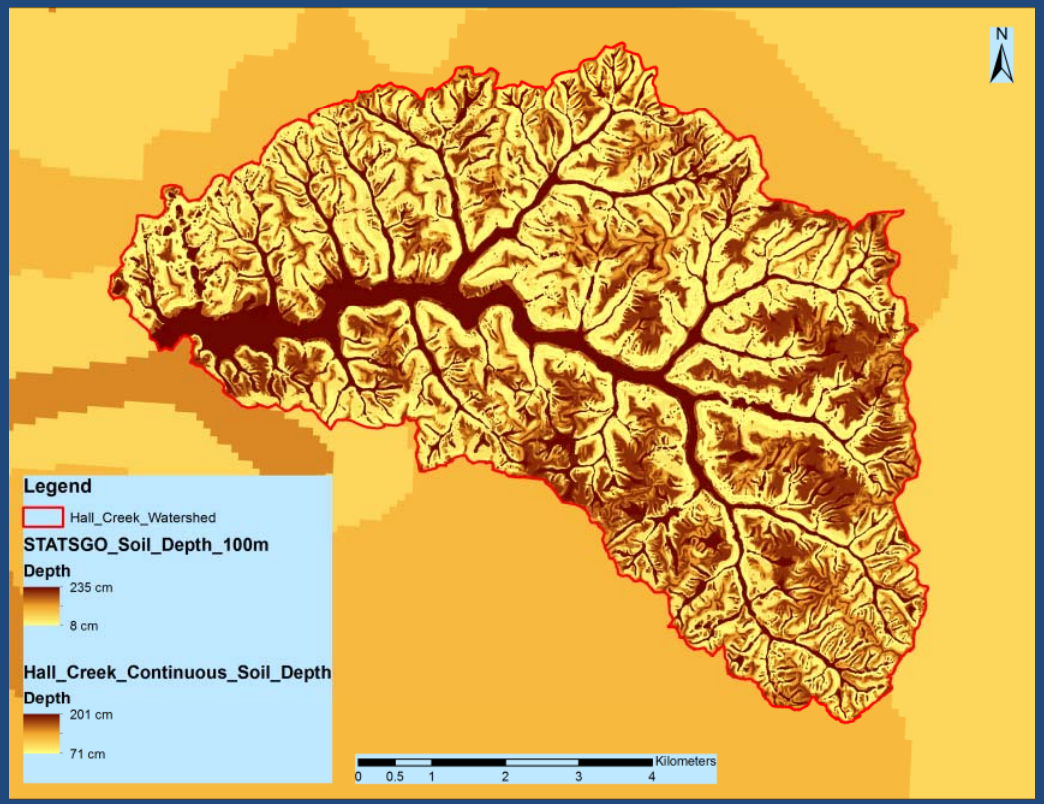
SSURGO



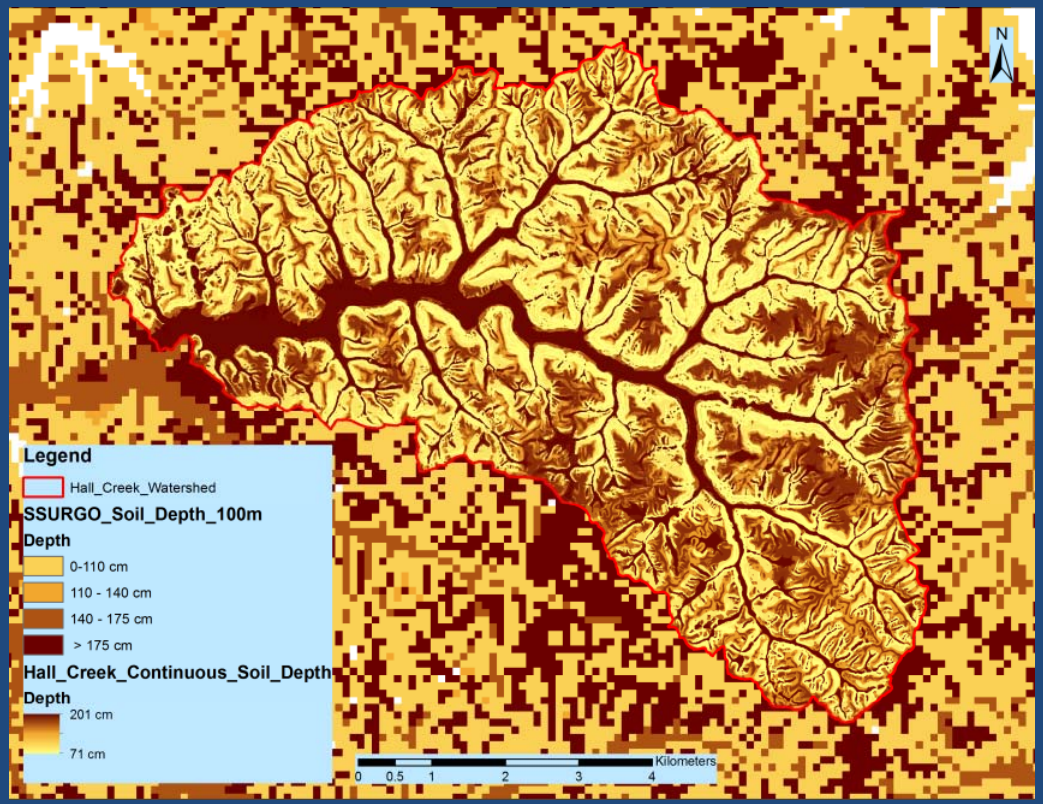
Soil Depth

1:50,000

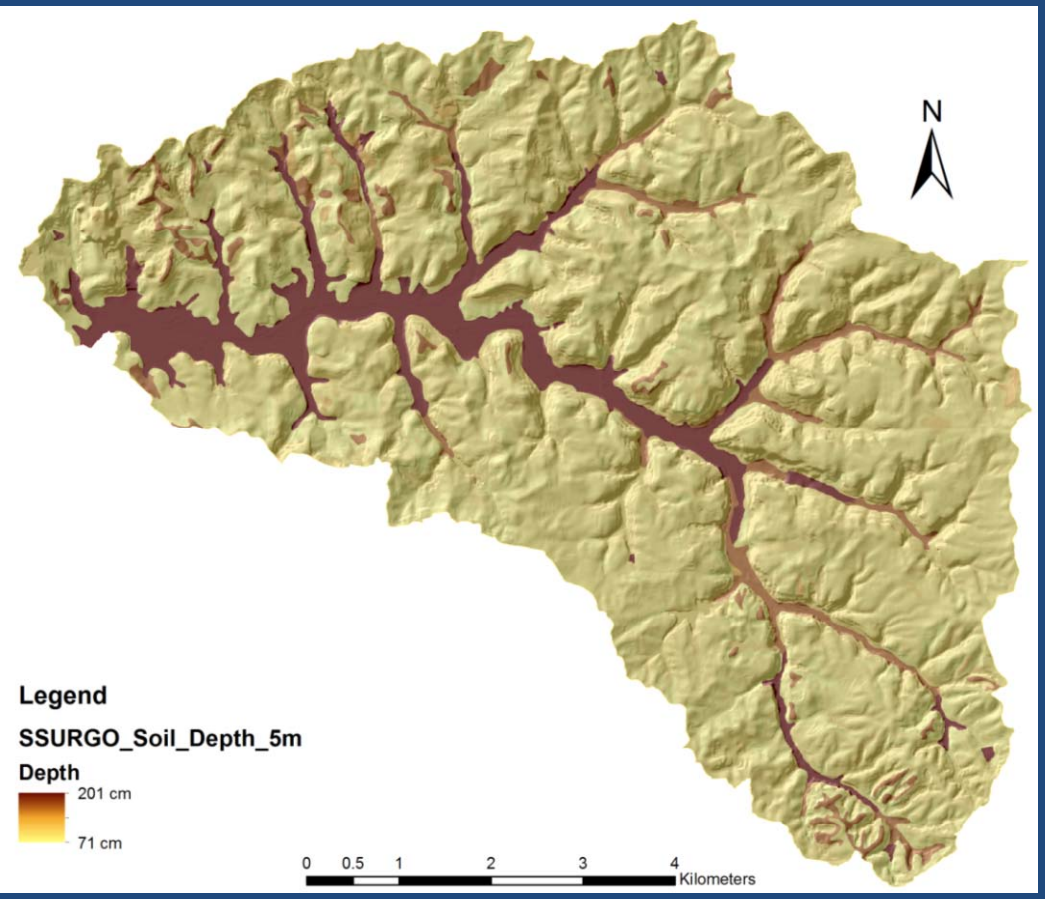
STATSGO

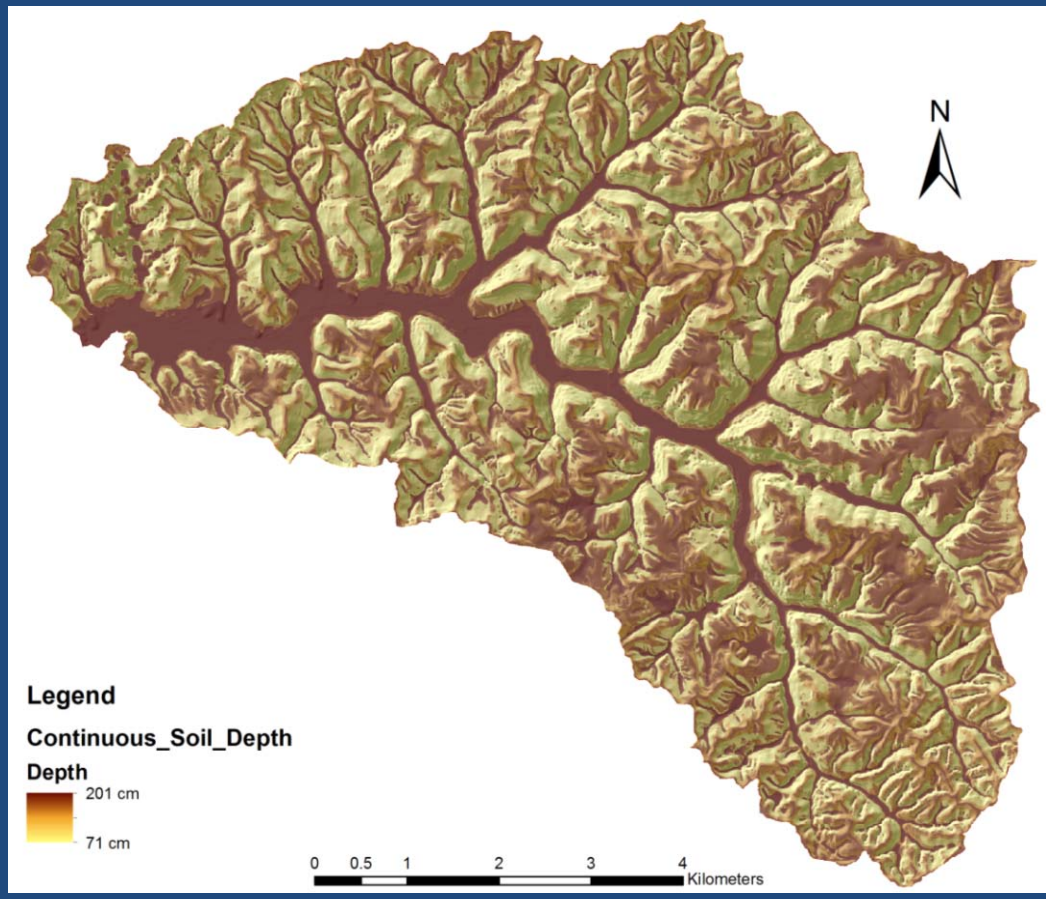


SSURGO



Soil Depth for one of the HUC_12 in MLRA 120B





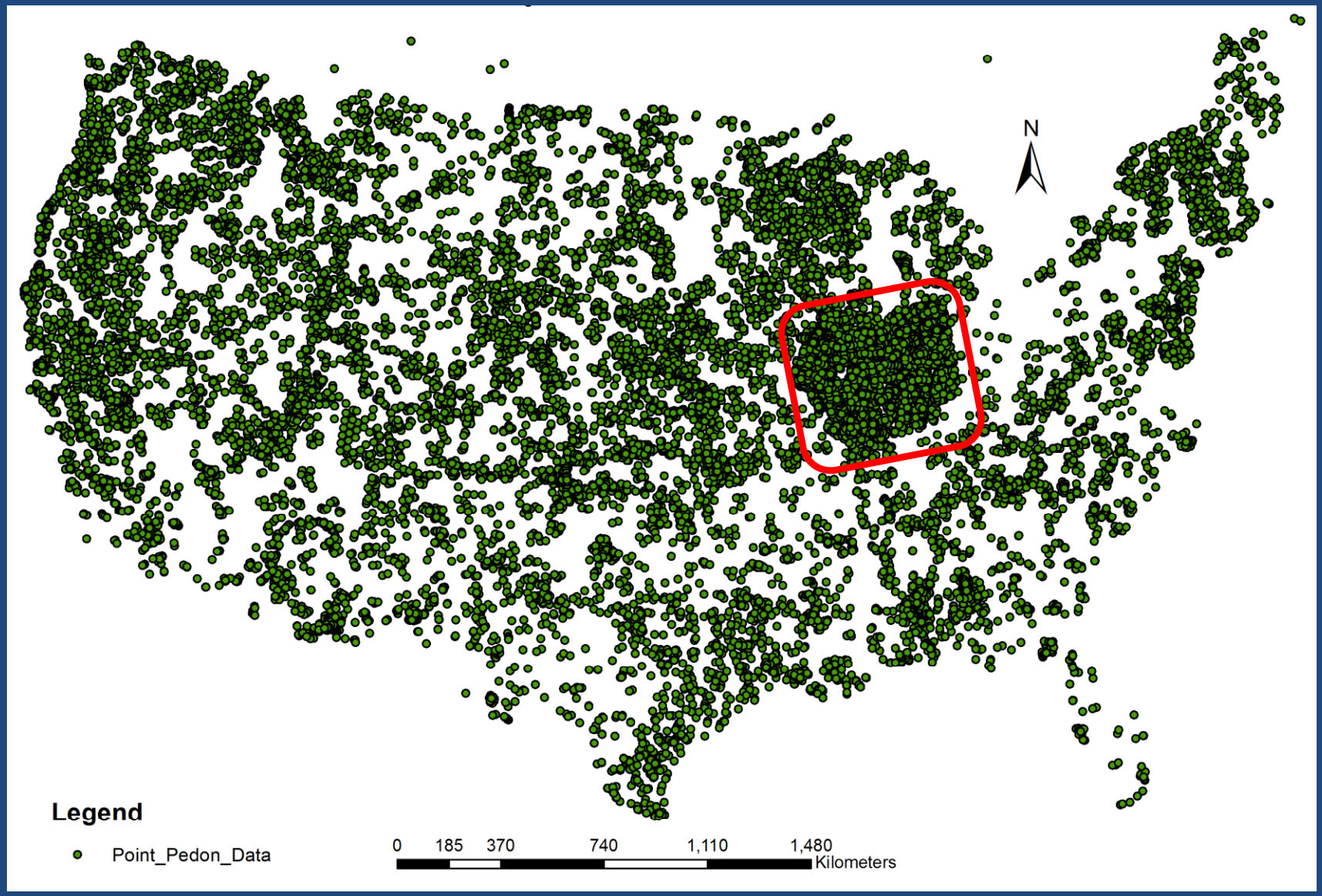
SSURGO-Polygon

Continuous-Raster

Pilot Projects - MLRA Approach

- Create predictive raster soil maps using legacy data:
  - **Step I:** Stratify landscape within each MLRA into rulesheds. Stratification criteria vary among MLRAs depending on nature of terrain/soil cover;
  - **Step II:** Amalgamate soil classes based on taxonomic similarity and/or geomorphic and/or slope position;
  - **Step III:** Establish quantitative soil-landscape relationships based on soil-terrain attribute relationships;
  - **Step IV:** Create predictive raster soil class maps based on fuzzy logic; predictive continuous raster soil property maps;
  - **Step V:** Validation/Error/Uncertainty assessment using Soil Survey Laboratory pedon point data and other independents data sets.

Geo-referenced Pedon Point Data



Where do we go from here?

- In the short-term:
  - Increase the cooperation at the technical level;
  - Continue with soil grouping and generate the continuous soil property maps for the pilot projects;
  - Validate the predicted soil properties maps and provide uncertainties (currently working with University of Sydney, Australia and ISRIC on Indiana pilot study uncertainty assessment);
- In the long-term:
  - Develop tools and methods for up-scaling from the pilot projects to regional and continental scales;
  - Attach $ values associated with soil services and functions for the generated soil property maps (ex, loss of productivity, loss of water filtering capabilities, etc).