Does a Raster-based Soil Survey for an Updated Product Make Sense for the Future of Soil Survey?

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ABSTRACT

The USDA Natural Resources Conservation Service Interpretations, Standards and Soil Business Branches' staffs met through teleconference and in person with MLRA office 12-STJ (Essex County, VT) field crew, Region 12 and Region 6 GIS staff and State Soil Scientists to explore the ideas of rasterized interpretations and raster based soil survey's future with the National Cooperative Soil Survey (NCSS) at a Rasterized Interpretation Workshop Amherst MA March 17-18, 2015. Topics that were covered were: **Limitations of Existing Systems; Acceptance of the Raster data model; Capital Investments; Data Requirements; Software Needs; Validation and Quality Control; and Integrating and using raster data with SSURGO.** The team saw a lot of work for the future but also a lot of promise for new products and perhaps a new focus for the NCSS. Here are some of the concerns and proposals for future work for the NCSS:

1) Analyze the pros/cons of generating Standard NASIS Interpretations of SSURGO when coupled with external raster data like slope, aspect, climatic, etc.
2) If raster products are pursued, delivery systems like Web Soil Survey, Soil Data Viewer, CDSI etc. would need the ability to handle raster data as smoothly as they handle vector data
3) Need an Interpretation generator outside of NASIS---No provisions for raster data in NASIS database
4) Development of a Standards Document – to start in CY2016
5) Work on Definitions as part of Standards
6) Justification to NRCS Leadership for Raster Data and interpretations
7) NSSC testing of interpretations from raster products
8) Develop minimum data needs for national and data acquisition priorities

There is a plan to continue and repeat these Workshops in 2015 and 2016 regionally in the North Central, West and South to better conceptualize the threats and opportunities for this paradigm shift and potential new direction in Soil Survey.

Limitations of Existing Systems

1) The polygon data model and our mapping conventions do not allow detailed mapping of soil components, even when qualitatively described and characterized for consociations and associations
2) The construct of the map unit is treated as a constant. Using slope as an example, individual soil polygons of a given map unit will have different slope distributions resulting in varying interpretations when interpreted by polygon rather than map unit
3) Geographic attributes are populated for map units in a relational database that is unable to represent the reality accurately (e.g. slope, aspect, climactic variables etc.)
4) Inability to handle raster data mechanically. All current tools like Web Soil Survey and Soil Data Viewer are built to handle vector data
5) A completely raster based system at the factor level (soil physical & chemical properties, terrain, climatic, land use etc.) will require a separate, unique system from NASIS for creating interpretations

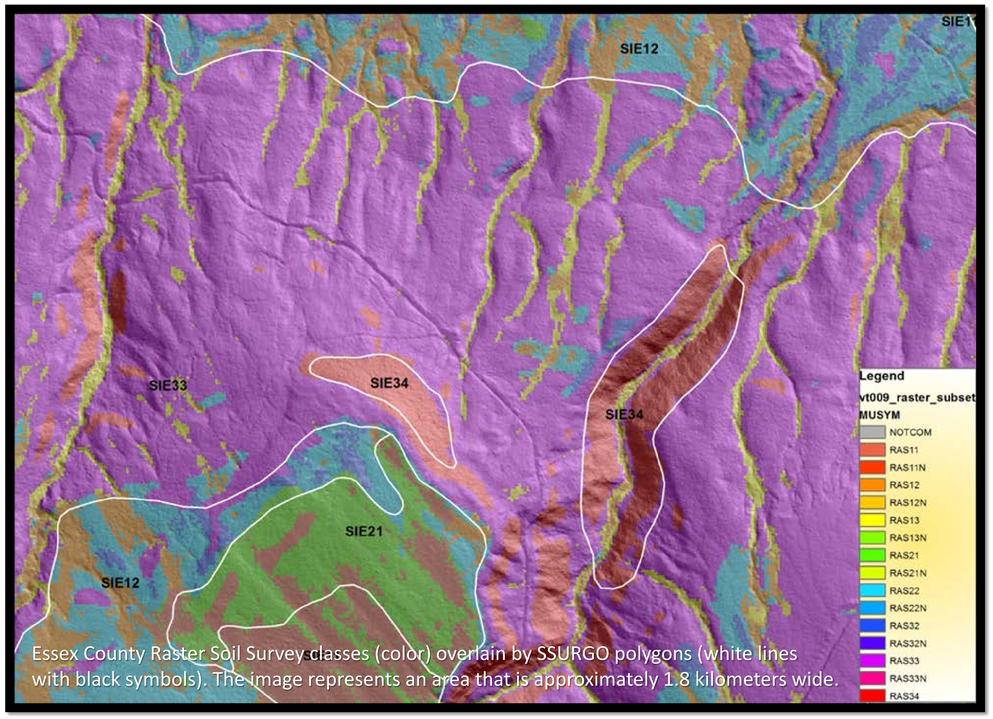
Integrating and using raster data with SSURGO

1) How will a raster update for an MLRA Project be managed with existing data
2) Which is the authoritative dataset?
3) How will we prioritize workload and staff years?

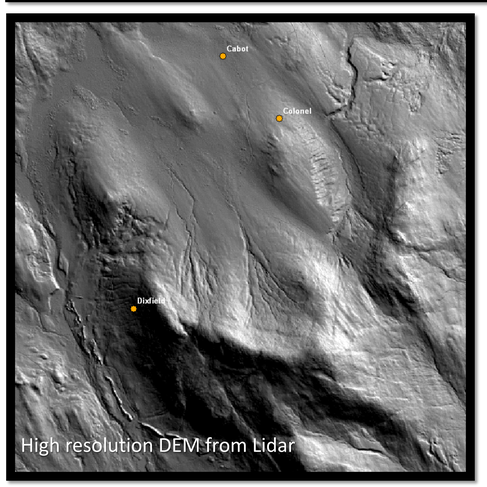
RASTER SOIL SURVEY

A raster soil survey (RSS) provides a unique soil geographic database product that more precisely represents soil concepts in the landscape than the conventional soil survey geographic database called SSURGO or gSSURGO. RSS uses an array of cells rather than points, lines or polygons used in the SSURGO vector map layers. Digital soil mapping techniques and tools that enlist the expert knowledge of soil scientists can be used to develop a RSS by assigning each raster cell to a given legend class.

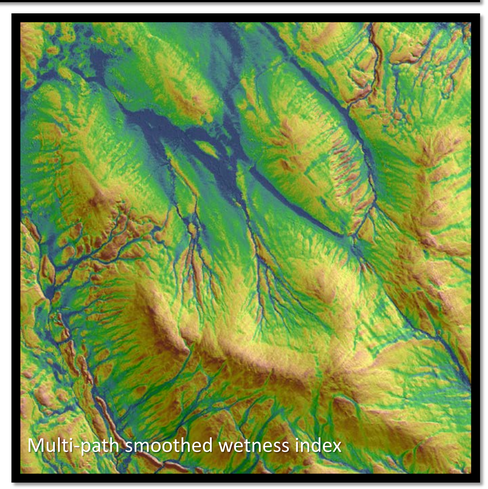
The RSS meets current soil user demand by providing a unique soil geographic data base product that more precisely represents soil concepts in the landscape than the conventional soil survey geographic databases called SSURGO.
For more information, see:
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=stelprdb1254424#raster



Essex County Raster Soil Survey classes (color) overlain by SSURGO polygons (white lines with black symbols). The image represents an area that is approximately 1.8 kilometers wide.



High resolution DEM from Lidar


Multi-path smoothed wetness index

CONCERNS

Does Raster updates as goal make sense? Does continuing updates of polygon vector system make sense as a product?

- Putting time into updating vector polygons takes a huge amount of time and does not assure us of an improved product.
- No GIS database has as much information and is used by as many people.
- We need functionality in data distribution with CDSI to use raster based data.
- Many of the natural base datasets, national and world wide now are raster based and if they are not now, are planned to be in the next 5 years. Examples are LiDAR, SMAP, Satellite imagery, land use/land cover Climate (precip, air temperature, and prevailing winds).

Acceptance of the Raster data model

1) The concept, opportunities and implications need to be presented to NRCS and NCSS users to consider the possibilities of improving decision making with the raster product
2) Standards related to developing and using raster based data will begin during CY2016 as part of the external deliverables from the Boundary Waters Soil Survey
3) Soil scientists need training to implement digital soil mapping (DSM) techniques as provided in existing and proposed DSM courses in the NRCS catalog
4) Data of sufficient resolution to represent the soil/landscape model must be available
5) Training will be required to minimize misuse of higher resolution data

Capital Investments

1) Costs for environmental data (covariates)
2) Cost for training to build critical mass of expertise among agency personnel (soil scientists, ecological site specialists, etc.)
3) Support at the Regional level for training and trouble shooting

Data Requirements

1) Inputs - As determined by local experts or programmatic requirements - would need oversight from regional office
2) Outputs-National minimum requirements as built in NB 430-05-7 in NASIS

Software Needs

1) Analyze the pros/cons of generating Standard NASIS Interpretations of SSURGO when coupled with external raster data like slope, aspect, climatic, etc.
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Validation and Quality Control

1) Accuracy assessment needs to be a required step for all DSM output using accepted standards
2) Adopt an accepted method for relating uncertainty for class (soil series) and property data, e.g. fuzzy membership and entropy for class data, quantiles/percentiles for property data

Actions

1) Development of a Standards Document – to start in CY2016
2) Work on Definitions as part of Standards
3) Justification to NRCS Leadership for Raster Data and interpretations
4) NSSC testing of interpretations from raster products
5) Develop minimum data needs for national and data acquisition priorities

A Brief History of Raster Mapping in NRCS