# Digital Soil Mapping

Tom D'Avello
Soil Scientist/GIS Specialist
NSSC - Geospatial Research Unit
Morgantown, WV

# Definitions

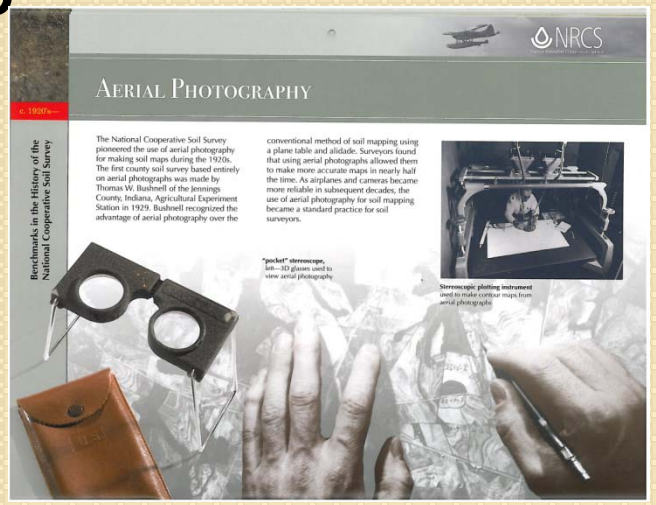
"the creation and the population of a geographically referenced soil databases generated at a given resolution by using field and laboratory observation methods coupled with environmental data through quantitative relationships." - The international WORKING GROUP ON DIGITAL SOIL MAPPING (WG-DSM)

Production of soil class and property maps using GIS and/or Remote Sensing software – anonymous

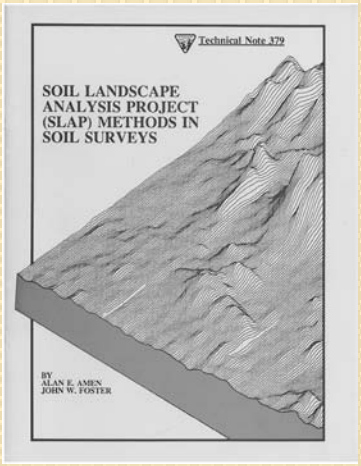
Everything starts with Jenny's model (or similar variations)
s = f(cl, o, r, p, t)

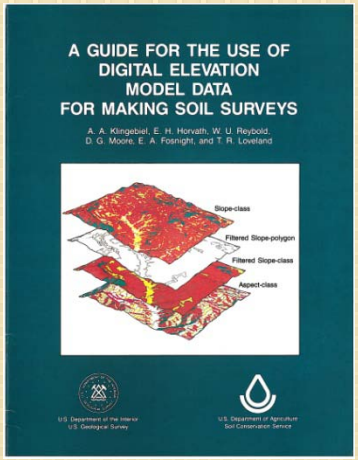
# Timeline of soil mapping tools


1890s-1930s



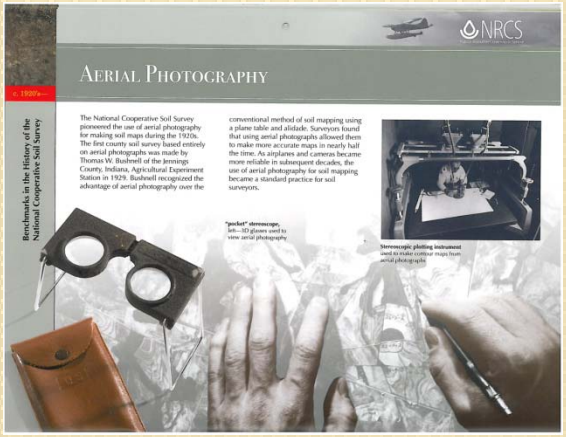

1930s-present



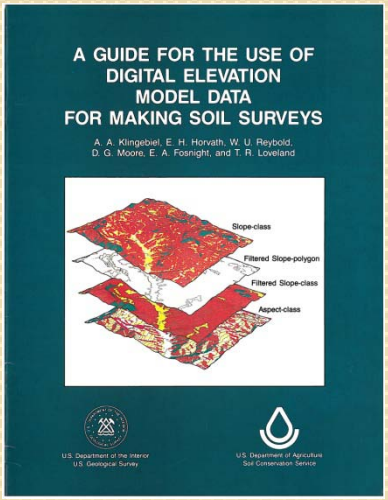




1972 – present, the start of digital age

# Constraints of tools



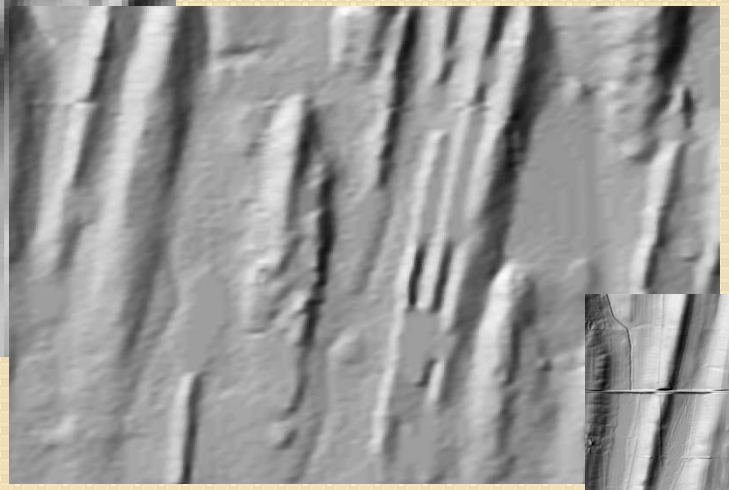

Cartographic limits, stereo vision, human variability, and polygon model



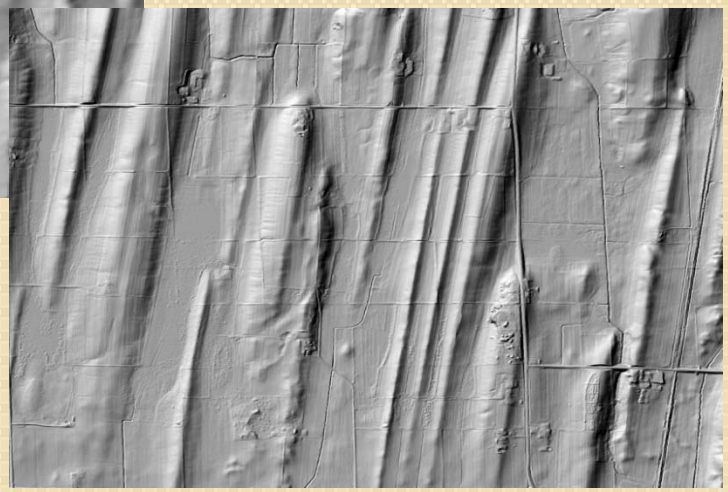

Low resolution data until recently, computing resources, software resources

# Improvement of tools – better data

30m DEM - inadequate for 1:12k – 1:24k mapping



10m DEM - Better resolution - still inadequate

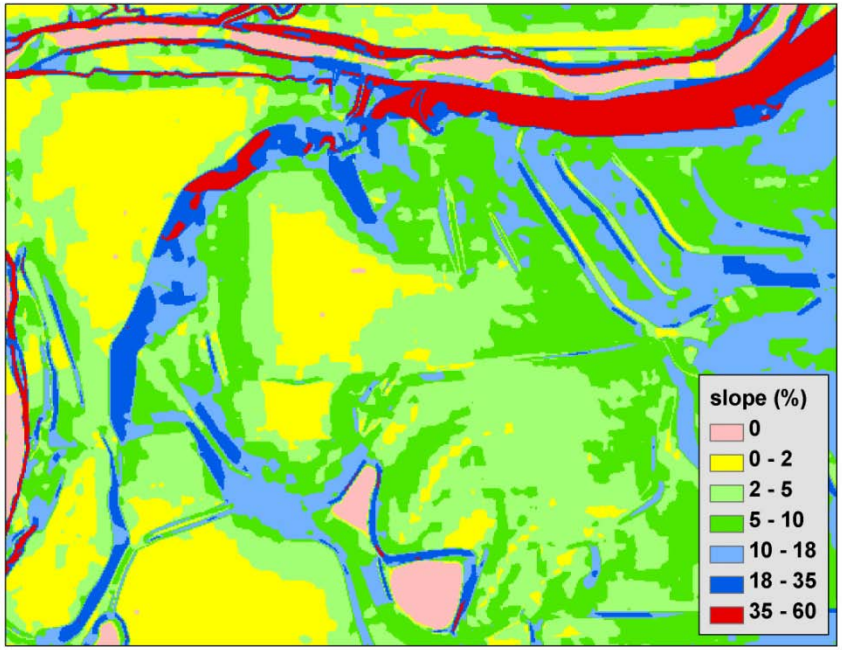


3m DEM – appropriate for 1:12k – 1:24k mapping

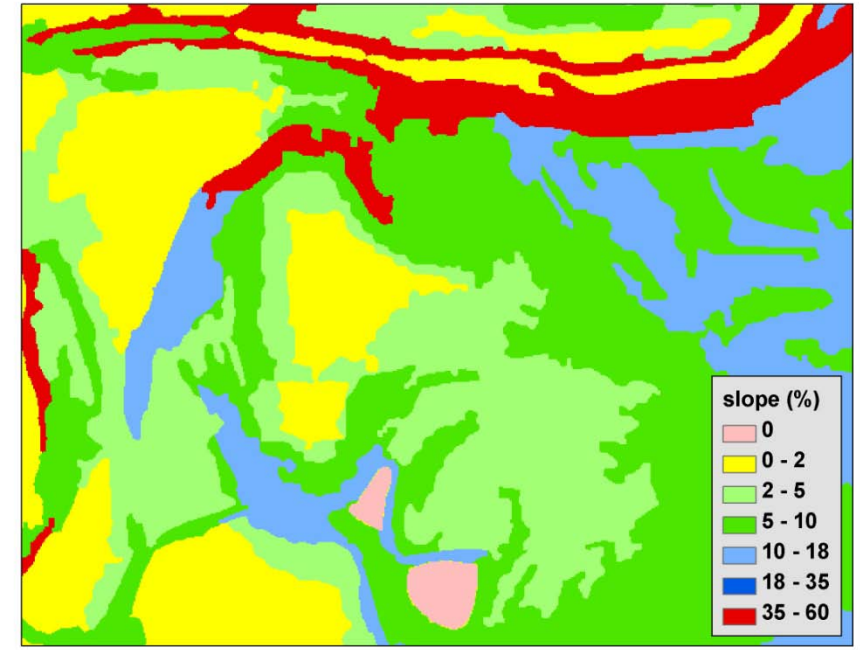
# Improvement of tools – better engine

- Widespread availability of GIS software
- Widespread availability of GPS
- Availability of  specialty software like ArcSIE
- Better computers
- GIS & RS education and training is common for employees

# Improvement of tools – better processes




Slope map from high resolution DEM
**too** much noise for direct practical use




Slope map processed with LESS model
to a **directly usable** product

LESS = **L**iDAR **E**nhanced **S**oil **S**urvey
Developed by Springfield IL, MLRA SSO

# Methods

- Mathematical – eg predicting surface horizon thickness using linear regression - confined to numeric data, linearity affects chosen model, sample intensive, typically specific spatial extent

- Crisp – predicting soil taxonomic classes - confined to categoric data, eg RASP model

- Fuzzy – predicting classes or properties, eg SoLIM/SIE/ArcSIE

Crisp and Fuzzy methods rely on Jenny model (or similar variations)
s = f(cl, o, r, p, t)

# Sample of DSM projects

- ❖RASP (remote area soil proxy) – Washington NRCS
- ❖SoLIM/SIE/ArcSIE - VT, TX, WI, MI, AL, MO, IL, Purdue
- ❖PURC (pedogenic understanding raster classification) – Utah State/UT
- ❖SoilMap – Oregon State/OR
- ❖Mojave – California NRCS
- ❖Organ Pipe National Monument – U A
- •TEUI – ID, CO, WY …
- •Ad hoc – many other states

❖ **funded by Geospatial Research Unit**

# Current and future efforts

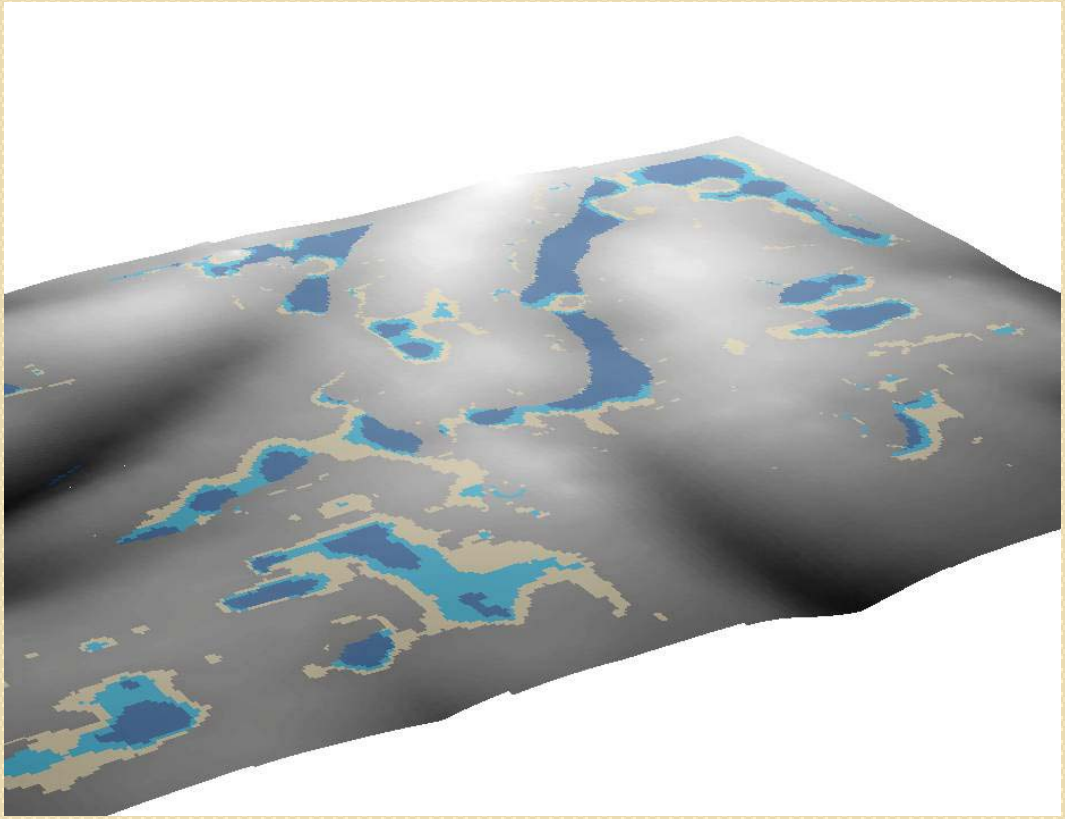
- High resolution DEMs will be common
- Many options for imagery
- Raster output offers potential such as:

✓ Direct input as "predictor"
✓ Fuzzy membership map by series
✓ Entropy map
✓ Exaggeration map
✓ Soil property maps
✓ Combined with traditional polygon as reference

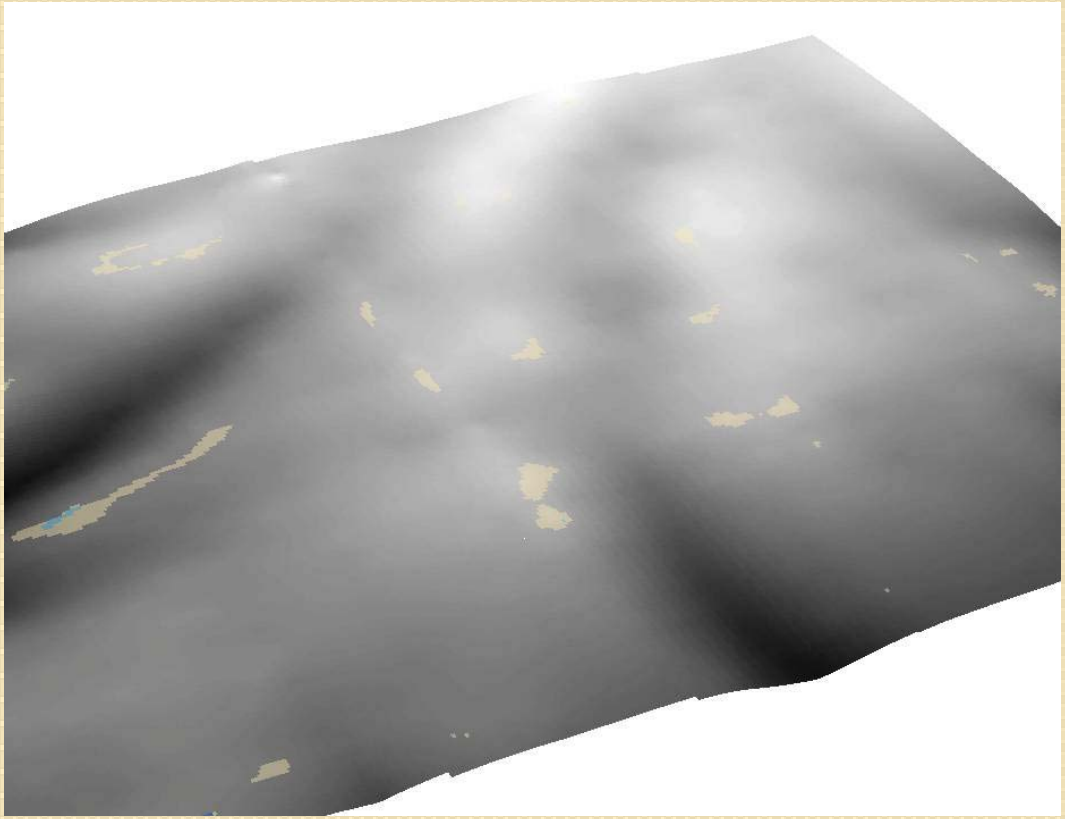
It started with raster, ~~got diverted~~, now raster is back

- Raster output as product to be investigated – Fuzzy membership map of Aquic Argiudoll

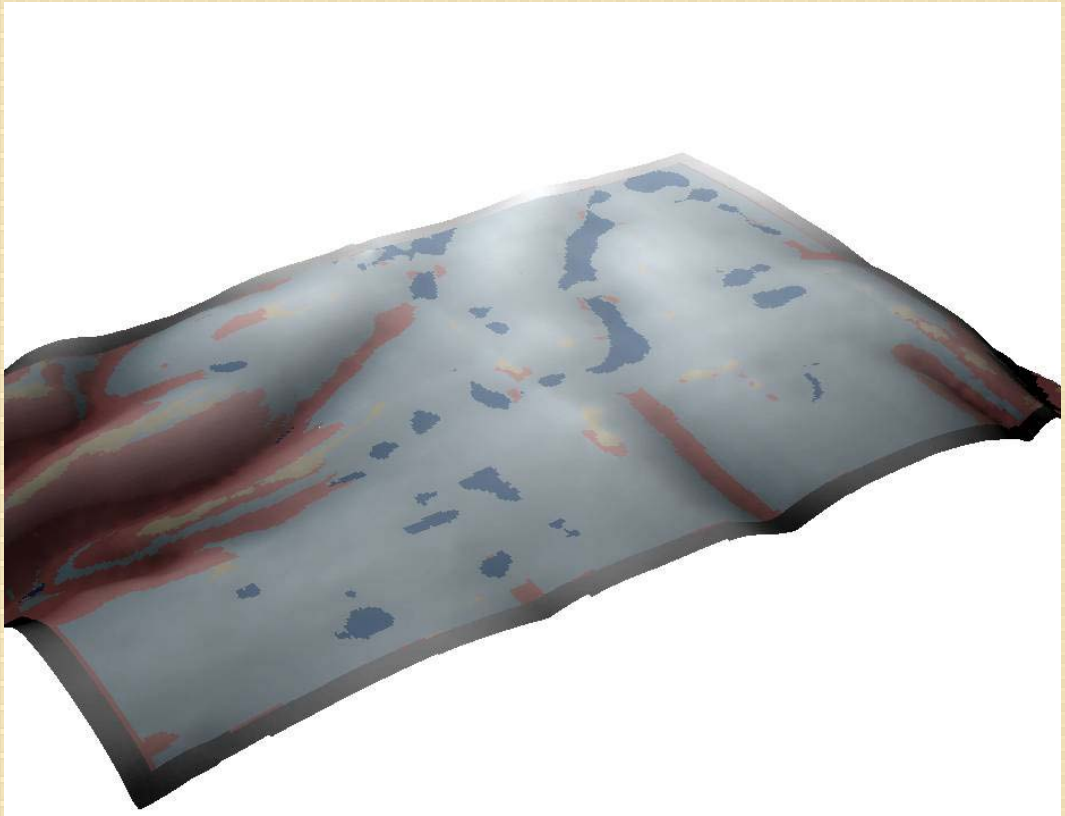
- Raster output as product to be investigated – Fuzzy membership map of Typic Endoaquoll



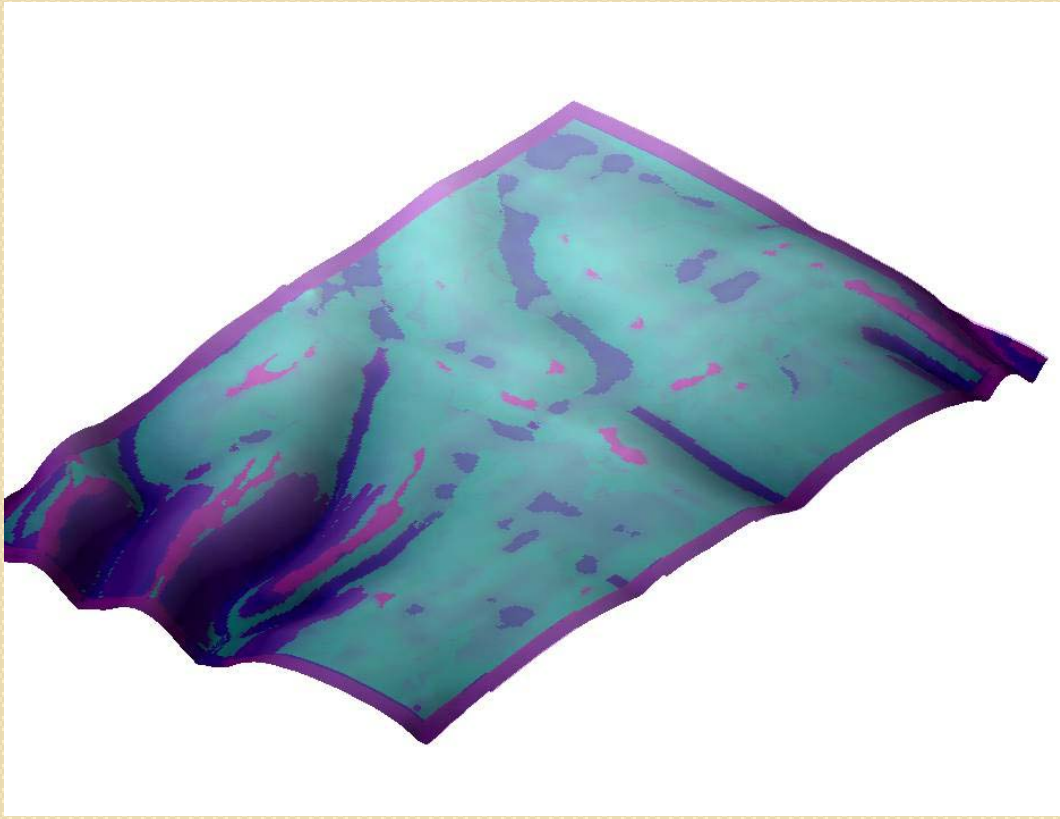
- Raster output as product to be investigated – Fuzzy membership map of Oxyaquic Argiudoll



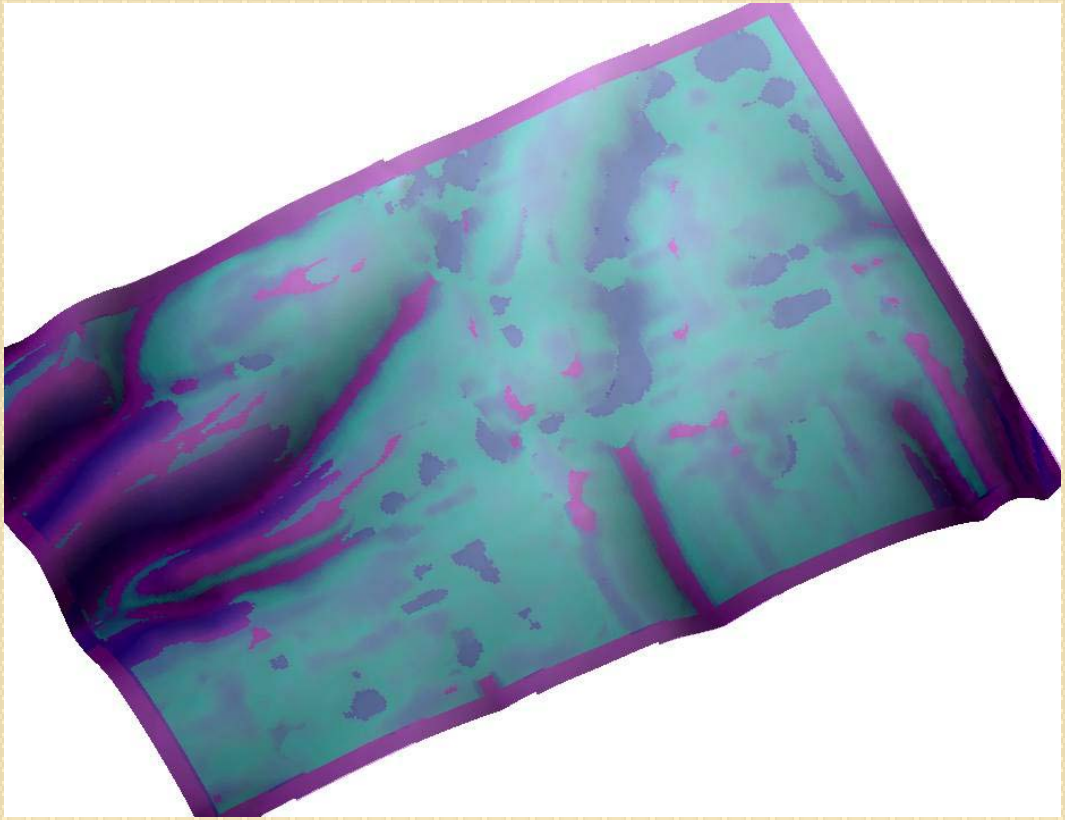
- Raster output as crisp/hardened map



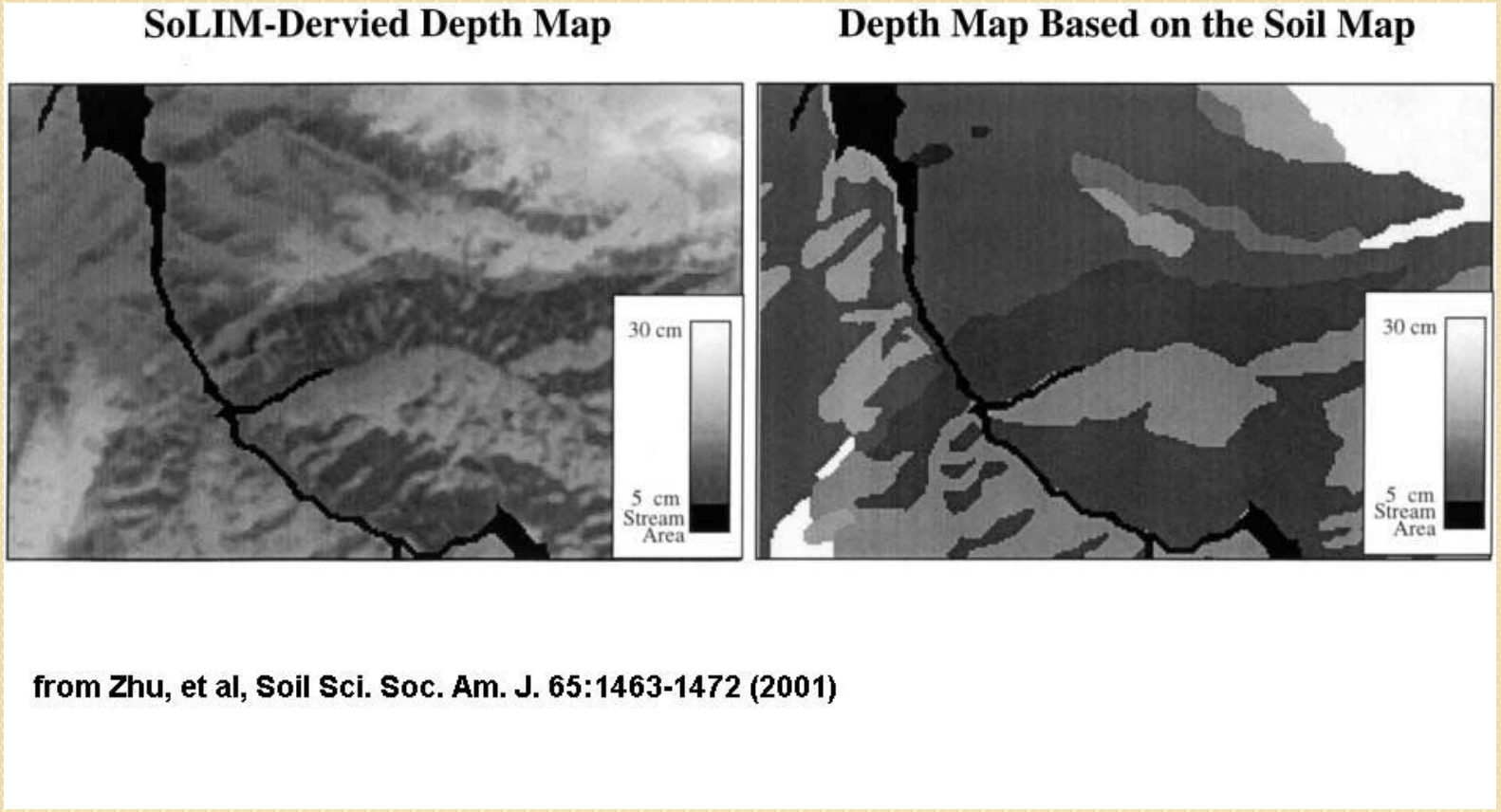
- Raster output - entropy map - "shows degree of "competition" for geographic space among soils"



- Raster output - exaggeration map - "shows degree of schwag"

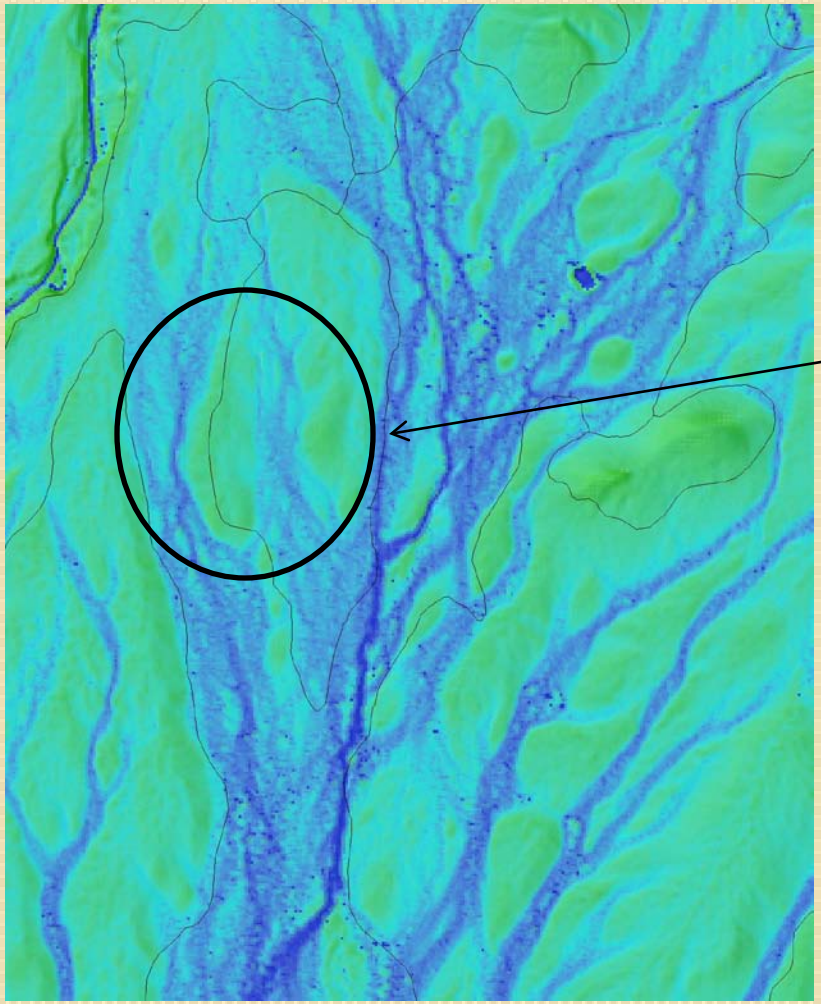


- Raster output – soil property map derived from soil class




from Zhu, et al, Soil Sci. Soc. Am. J. 65:1463-1472 (2001)

# Raster is faster, is vector corrector?



Hillshade from
LiDAR with SSURGO

# Raster is faster, is vector corrector?


Slope class comparison:
LiDAR and SSURGO
47% agreement
53% disagreement

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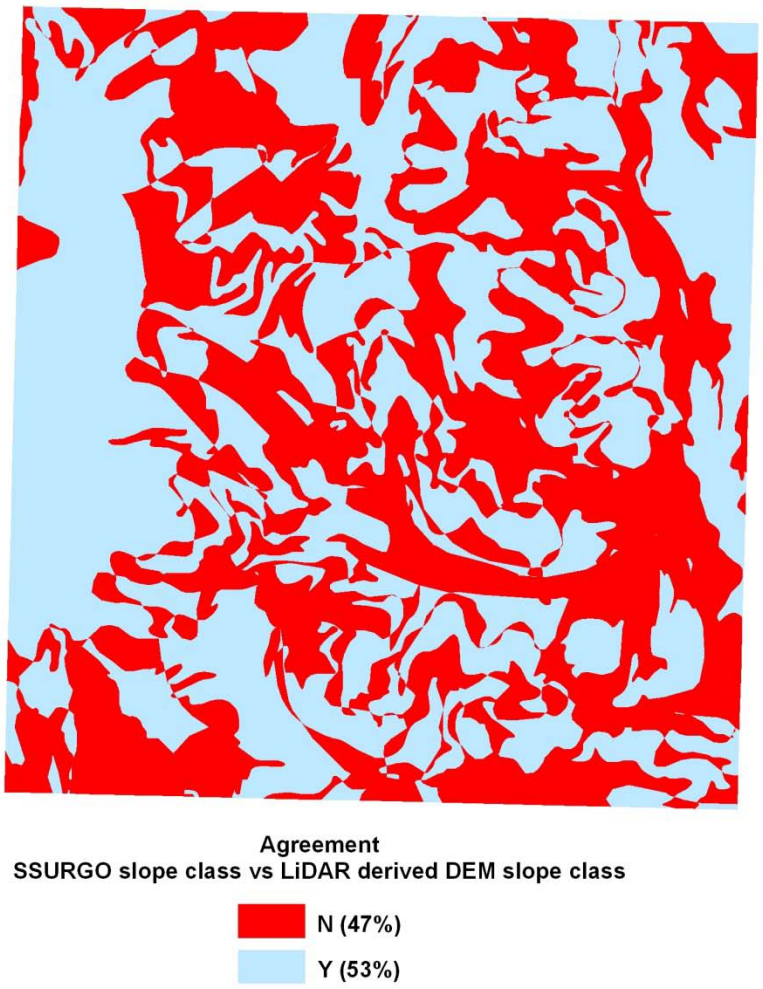


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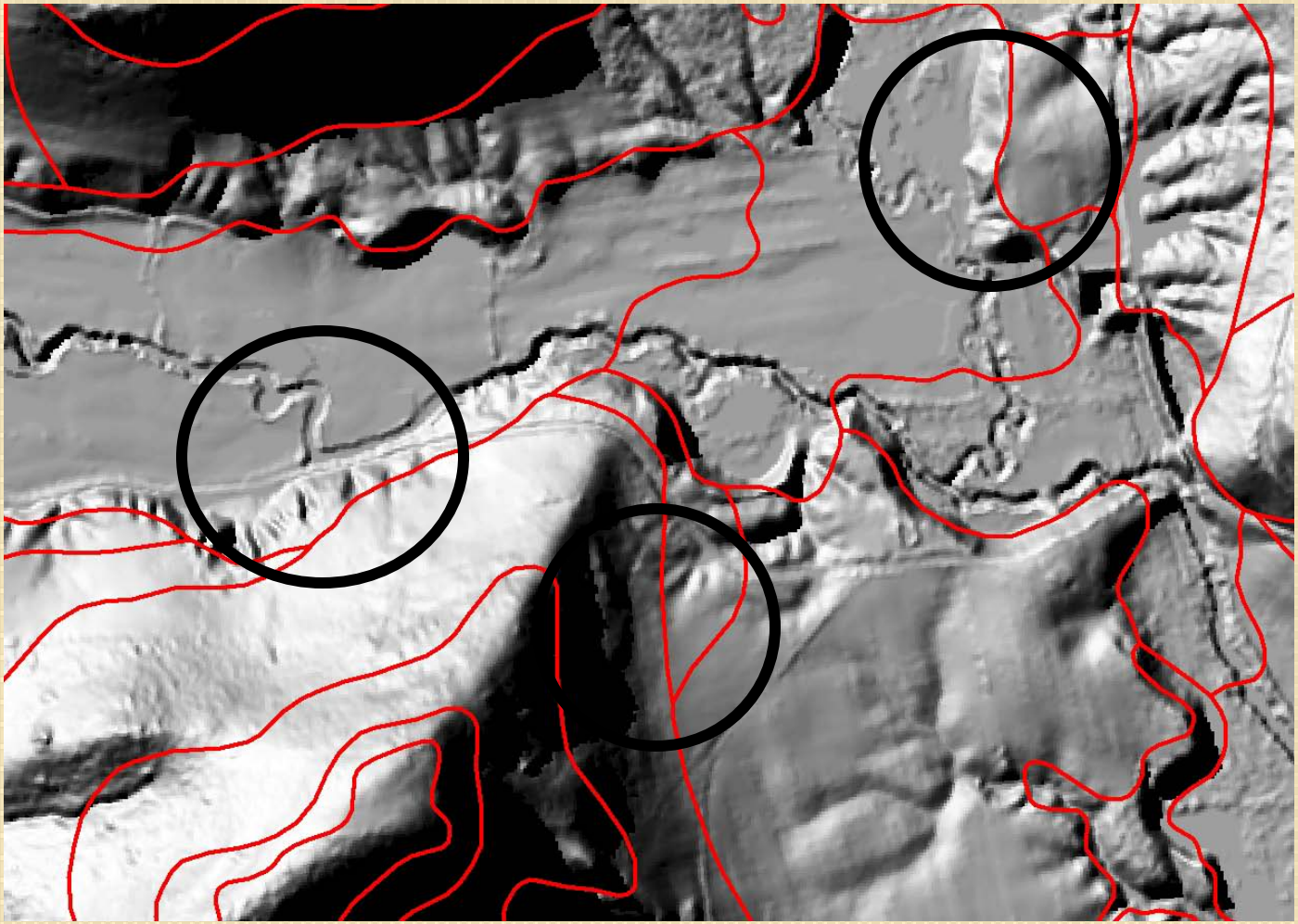

Slope class, landform, soil comparison: LiDAR and SSURGO

# Why bother with digital soil mapping?

"This soil survey project is proving to be a watershed breakthrough in applying GIS and imagery tools to increasing the accuracy of delineations and in the precision with which land segment composition is determined. ….The Soil Inference Engine (SIE) software in concert with the outstanding interpretive advantages afforded by LiDAR imagery as applied by a skilled, knowledgeable staff will result in quite probably the **most accurate** soil survey produced in the glaciated northeast to date." (MO-12 Soil Data Quality Specialist, 2009 Essex County Quality Assurance Review)

25% increase in production in the same VT survey

"Using LiDAR data and the LESS model is like running a 1.0 mile race with a 0.5 mile head start" – Normal, AL MLRA SSO

**Precision** is more likely vs traditional methods

# Current efforts

- Continued development of ArcSIE software for 2010-2011
- Development of Digital Soil Mapping curriculum will be starting this FY

We need to hone our data as better data becomes available, or somebody else will

# Should future efforts include:

- Packaging terrain modeling routines into easier to use modules in ArcGIS?
- Holding digital soil mapping workshops so soil scientists can trade techniques, demo software etc?
- Using digital soil mapping as primary means of completing federal lands initiative?
- Adding a chapter to Soil Survey Manual on digital soil mapping?
- Develop suggested methodology for update activities to assure some standardization?
- Regrouping SBAAG digital soil mapping team to pursue the above?

**You might think your HMO plan is scary, but at least it doesn't use these vintage surgical instruments...hopefully.**

**Amputation Knife (1700s)**

**Skull Saw (1830s-60s)**
This hand-cranked saw's blades were used to cut through sections of the skull, allowing for access by other instruments.

Arthroscopic surgery on shoulder