Pre-Mapping Techniques for Soil Survey Application Using Definiens Developer

Nathan Starman
USDA-NRCS, Arizona State Office

Matt Levi and Craig Rasmussen
University of Arizona
Overview

1. Research software and related applications throughout U of A Cooperative Agreement
2. Focus on Definiens Developer 7.0
3. Assess multi-resolution segmentation tool for soil survey utility
4. Implement 3 phase approach
5. Publish AZ673
Study Area

- Colorado Plateau
- Transition
- Basin and Range

Legend
- az673_elevation
- High: 6469 feet
- Low: 2983 feet

Soil Survey Area:
400,000 acres
Multi-resolution Segmentation

- Algorithm developed to extract image objects, which are homogenous both based on pixel value and on object shape
- Extraction of homogenous image object primitives using a pairwise region merging technique (i.e. bottom up)
- Image layer weights assigned to input layers
- Raster → Vector
Segmentation Methods

• Rulesets were created in Definiens Developer 7.0 to execute multi-resolution segmentation
• Input layers evaluated included slope (5m IFSAR), ASTER and Landsat imagery, and a variety of indices
• Scale was manipulated to determine appropriate polygon density
Expert Knowledge

Landsat B4 (30m)

Near Infrared (0.75 – 0.9 μm)
Vegetation
Soil color

Segmentation

Slope (5m)

Landscape position
Soil depth
Landsat B4 + Slope (5m)
Segmentation Results

• Segmentation of Landsat B4 and slope (5m) layers produced an accurate polygon network of soil-landscape relationships

  - Pre-mapping tool for soil survey
  - Useful on soil survey updates
  - Natural breaks for land management
Implement 3 Phase Approach

1. Landform transects
   - 1,080 points
   - crossed multiple landforms and segmentation lines

2. AOI’s
   - 3 areas of approximately 15,000 acres
   - mapped independently by 2 soil scientists

3. Conventional Soil Survey
   - utilize existing data to produce final product
Phase 1
Landform Transects

• 1,080 points
• Multiple landforms
• Across segmentation lines
• Field validation descriptions:
  - genetic horizons, depth, texture, color, diagnostic horizons, surface fragments, plant community, slope, aspect, pm, classification
Transect 2 – Fan Terraces and Alluvial Fans (granitic)
Transect 3 – Fan Terraces (mixed volcanic)
Results

• Segmentation boundaries effectively differentiated soil map units and geomorphic surfaces
  - indicated by depth to diagnostic horizon, texture, and redness rating (Munsell color)

• All lines may not exactly reflect soil map unit boundaries; however, segmentations effectively separated soils based on physical properties, taxonomic classification, and landscape position.
Phase 2 AOI

• 3 areas of interest
• Approx. 15,000 acres each
• Mapped independently by 2 soil scientists in each AOI
• Software vs. Soil Scientist
• Differences between mappers
• Experience and interpretation reflected in map unit design
Phase 3
Conventional Soil Survey

• Data produced in phases 1 and 2 facilitated completion of the soil survey
• Traditional map unit transects were appended to landform transects
• AOI mapping created legends
• Cooperative agreement advanced research and development for soil survey
Landsat B4 + Slope (5m)
Landsat B4 + Slope (5m) Atmospherically Corrected
Conclusions

• Multi-resolution segmentations clearly separated soil types

• Slope classes and surface reflectance were important for differentiating taxonomic soil classes and individual soil properties
Conclusions

• Results illustrate the utility of automated image segmentation for soil mapping

• Connection between soil properties/classes and auxiliary data (reflectance and DEM)
References

Thank You