Ecological Land Unit Classification Using DEM and Large Scale Digital Geologic Map Databases in the Great Smoky Mountains National Park

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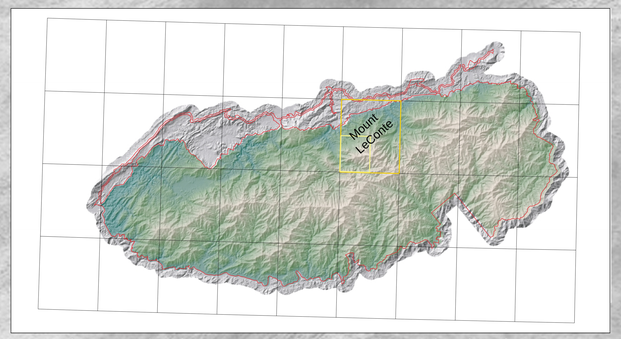
USGS science for a changing world

Introduction

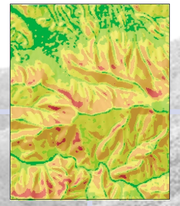
Classifying areas into ecological land units (ELU) are a significant step in locating All Taxonomy Biodiversity Inventory (ATBI) study sites. The USGS Eastern Region Earth Surface Processes Team is developing an analytical geographic information systems (GIS) methodology for developing ELU maps of the Great Smoky Mountains National Park to quantitatively map the complex interaction between parent material, lithology, depositional process and topography. Digital elevation models from the National Elevation Data set (NED) and large scale digital geologic map databases are processed in a GIS to yield very detailed ELU classification data sets. This analysis helps to describe, map and understand the relationship between multiple landscape elements that influence the formation of soils, flora and fauna.

To aid researchers from the National Park Service (NPS), the Natural Resource Conservation Service (NRCS), and The Nature Conservancy (TNC) in selecting sites with a variety of topographic and geologic characteristics a more accurate model of landscape assessment is proposed here. DEM data is processed to derive slope, aspect and surface curvature values for the study area. Slope and curvature data are classed and combined yielding a landform classification map. Aspect data is classed and combined with the landforms to produce a landscape classification map. Similarly, geologic map databases are queried for primary bedrock lithology and surficial material type and origin. Classified landscape data and geologic material data is integrated to produce an ELU data set that depicts 420 classes of unique topographic and geologic attributes. More complex analyses could be performed to derive even more classes by further subdividing component data sets in the process. This model has been developed as an example of the type of analysis which could be produced for the NPS and which would cover the entire park. The product of this methodology represents an application of digital topography and geology to natural resource management.



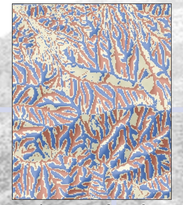
Location map showing Great Smoky Mountains National Park, NED shaded relief data, the 1:24,000 Mount LeConte quadrangle and subset study area.

30 meter DEM of study area



5 classes of slope

- <10 degrees
- 10-20 degrees
- 20-30 degrees
- 30-40 degrees
- >40 degrees



3 classes of surface curvature

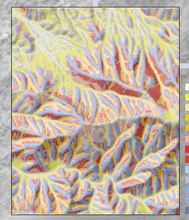
- Concave surface
- Planar surface
- Convex surface

4 classes of aspect

- North facing
- East facing
- South facing
- West facing

1 **Process DEM data into three derivative data sets: slope, curvature, and aspect.**

2 **Slope and curvature data are combined developing a *landform* model.**

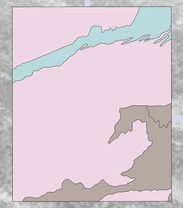


- Plain
- Valleys
- Hillslopes
- Ridges
- Peaks

3 **The combination of aspect and landform data produces a *landscape* model.**

MAP_UNIT	LITHPRI	LITHSEC	LITHTER	FORM	GROUP	SUPERGROUP	ROCKCLASS
Zr	metasandstone	metasiltstone		Roaring Fork Sandstone	Snowbird	Ocoee	METSED
Ze	feldspathic metasandstone	metasiltstone	phyllite and slate	Elkmont Sandstone	Great Smoky	Ocoee	METSED
Zt	Metasandstone	metaconglomerate	metasiltstone	Thunderhead Sandstone	Great Smoky	Ocoee	METSED
Ze	feldspathic metasandstone	metasiltstone	phyllite and slate	Elkmont Sandstone	Great Smoky	Ocoee	METSED
Zac	metasiltstone	slate	metasandstone	Anakeesta	Great Smoky	Ocoee	METSED
Za	metasiltstone	slate	metasandstone, dolomite	Anakeesta	Great Smoky	Ocoee	METSED
Zt	Metasandstone	metaconglomerate	metasiltstone	Thunderhead Sandstone	Great Smoky	Ocoee	METSED
Za	metasiltstone	slate	metasandstone, dolomite	Anakeesta	Great Smoky	Ocoee	METSED

MAP_UNIT	AGE	ORIGIN	RES	COLOR	MINPRI	MINSEC	MINOTH
Zr	Late Proterozoic	rift basin, shallow to deep water with slumping	dimension stone	dark to light brown and green gray	quartz	feldspar	mica
Za	Late Proterozoic	rift basin, turbidite deposits	dimension stone	dark gray, black metasiltstone	quartz	feldspar	mica
Zt	Late Proterozoic	rift basin, deepwater turbidite deposits	dimension stone	light gray, dark gray brown	quartz	feldspar	
Za	Late Proterozoic	rift basin, turbidite deposits	dimension stone	dark gray, black metasiltstone	quartz	feldspar	mica
Zac	Late Proterozoic	rift basin, oxygen-poor, deep water		light gray	quartz	mica	chloritoid
Za	Late Proterozoic	rift basin, oxygen-poor, deep water	sulfide minerals	dark gray, black	mica	quartz	pyrite, pyrrhotite, dolomite
Zt	Late Proterozoic	rift basin, deepwater turbidite deposits	dimension stone	light gray, dark gray brown	quartz	feldspar	
Za	Late Proterozoic	rift basin, oxygen-poor, deep water	sulfide minerals	dark gray, black	mica	quartz	pyrite, pyrrhotite, dolomite



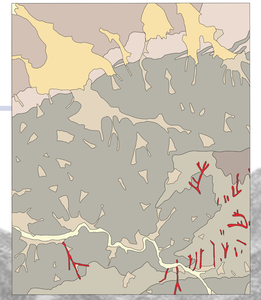
3 classes of primary bedrock lithology

- Metasandstone
- Feldspathic metasandstone
- Metasiltstone

MAP_UNIT	SURF_BED	SURFTYPE	AGE
Qa	Surficial	alluvium	Holocene
Qc	Surficial	colluvium	Holocene (1900-1973)
Qd	Surficial	debris	Holocene (1900-1973)
Qd1	Surficial	debris flow	Holocene and Pleistocene

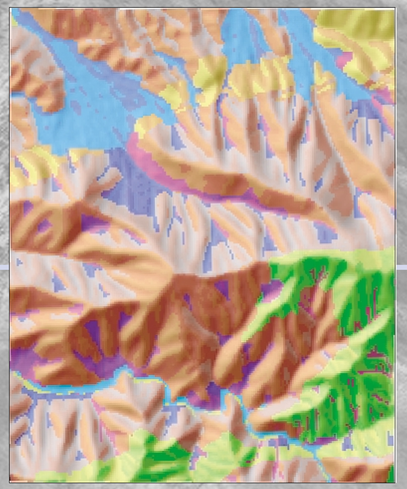
4 classes of surficial geologic materials

- Alluvium
- Colluvium
- Debris fan
- Debris flow



1:24,000 scale digital geologic map database

4 **Query large scale geologic map database to derive primary bedrock lithology and surficial material type data sets.**



5 **Combine lithology and surficial geology to develop geologic parent material inventory layer.**

6 **The final combination of landscape and underlying geologic parent material yields the ecological land unit (ELU) classification map. The ELU map layer has a total of 420 unique classes based on the component data layers. Ancillary data sets could be added or class structures from component data could be manipulated to yield an ELU map product with different criteria.**