A Remote Sensing Approach for Determining Vegetation States within Ecological Sites on Semi-Arid Rangelands (Proposed Research)

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The Problem

Rangelands cover approximately 312 million ha within the U.S. and provide forage for livestock, wildlife habitat, and recreational opportunities, as well as natural beauty and wilderness (NRC, 1994). Degradation of this vital resource is an ongoing concern, as this can lead to loss of vegetation and increases in runoff and soil erosion which can lead to other environmental problems. Monitoring these rangeland resources is difficult due to their extensive land area and a lack of man power and funding needed to perform the necessary assessments. However, due to its ability to provide information cheaper and faster than ground-based data collection, remote sensing has the potential to serve as a powerful means of assessing rangeland condition through the identification of vegetation states.

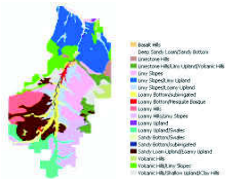
What is a Vegetation State?

The USDA's Natural Resources Conservation Service (NRCS) has established landscape distinctions called ecological sites.

An **ecological site** is:

- a distinctive kind of land with specific physical characteristics that differ from other kinds of land in its ability to produce a distinctive kind and amount of vegetation
- a product of all of the environmental factors responsible for its development (soils, relief or topography, climate, natural disturbances like fire, drought, and herbivory)

Ecological Sites on Walnut Gulch Experiment Watershed



Ecological Sites on Empire Ranch

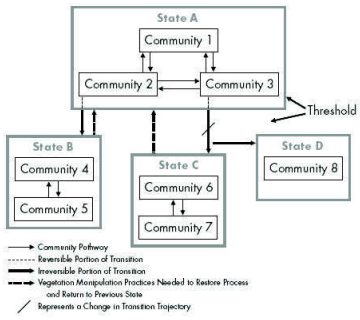
Within each ecological site, there may be several plant communities, known as vegetation states.

A **state** is:

- a recognizable, relatively resistant and resilient complex with attributes that include characteristic climate, soil resource including soil biota, and the associated aboveground plant communities

State and transition models are commonly used to depict the variation due to climatic events, management actions, or both that can exist within states within ecological sites.

State and Transition Model Diagram for an Ecological Site



[USDI-BLM, 2001]

Objectives

1) Develop and validate a method for identifying vegetation state using fine resolution imagery.
2) Develop a procedure for scaling the method from fine resolution to moderate or coarse resolution so that it will be an affordable application for use by other agencies.

Study Areas

Walnut Gulch Experimental Watershed

- USDA operated encompassing the town of Tombstone, AZ located in southeastern Arizona
- 150 km^2 in size and representative of approximately 60 million ha of brush- and grass- covered rangeland found throughout the semi-arid southwestern U.S.
- western half dominated by woody vegetation and eastern half dominated by native grasses
- complex transitional zone located between the two main areas

Walnut Gulch Experimental Watershed (eastern side)

Empire Ranch

- BLM operated located within the Las Cienegas National Conservation Area in the Sonoita Valley of southern Arizona
- encompasses approximately 30,000 ha and is dominated by native grasses

Empire Ranch

Both study sites lie within Major Land Resource Area (MLRA) 41-3 and encompass enough ecological site types to serve as representative subsections of the larger MLRA.

Approach

- The Quickbird and ASTER scenes will be atmospherically corrected and converted to reflectance using the ATCOR module of ERDAS Imagine.

- Areas of interest (AOIs) created from ArcGIS shape files of known ecological site boundaries will be used to subset the satellite scenes into individual ecological site scenes.

- Unsupervised and supervised object-oriented classifications will be performed on the smaller scenes in an effort to distinguish vegetation types.

- Ground data assessing vegetation type and cover will also be collected to coincide with the satellite scene acquisitions to aid in classification.

- Existing state and transition models will be referenced to assess the quality of the classified scenes.

- Comparisons between the classified scenes will be conducted to determine whether relationships exist that will allow the methodology developed using the fine resolution imagery (Quickbird) to be used with more coarse resolution imagery (ASTER).

Satellite Imagery

Quickbird

DigitalGlobe Quickbird is highly accurate, commercial, high resolution imagery.

- Four multi-spectral bands (blue 450-520 nm, green 520-600 nm, red 630-690 nm, NIR 760-900 nm) at 2.4-2.8 m resolutions.
- One panchromatic band (445-900 nm) at 60-70 cm resolution.

Quickbird scene of Tombstone, AZ

ASTER

Advanced Spaceborne Thermal Emission and Reflectance Radiometer (ASTER) is located on the EOS TERRA satellite platform.

- Three bands in the VNIR (green, red, and NIR) at 15 m resolutions.
- Six SWIR bands at 30 m resolutions.
- Five TIR bands at 90 m resolutions.

ASTER scene of Tombstone, AZ

Potential Limitations and Pitfalls

The two major limitations of this project are and

Cost

-The cost of Quickbird imagery is prohibitive for a long-term study and assessment of vegetation state change.

-ASTER imagery, which is considerably less expensive, may prove to be a reasonable substitute.

Weather

- Cloud-free weather at the time of scene acquisition is a requirement. This can be a problem when trying to link the collection of ground data with a scheduled overpass. Unfortunately, there is not much that can be done to overcome this particular problem.

Expected Results and Deliverables

The project will result in a repeatable remote sensing based methodology that can be utilized by resource mangers to identify vegetation states within ecological sites. The method will be applicable using fine and moderate to coarse resolution imagery.

The specific deliverables produced by the project are:

1) the methodology for identifying vegetation states over landscapes using remote sensing technology; and
2) maps identifying vegetation states within ecological sites.

References

National Research Council (1994). Rangeland health: new methods to classify, inventory, and monitor rangelands. National Academy Press, Washington, D.C. p.1.

USDI-BLM (2001). Ecological site inventory. *Inventory and Monitoring Technical Reference 1734-7*, National Science and Technology Center, Denver, CO. BLM/ST/ST-01/0003+1734. p.20.

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