CLASSIFICATION OF ARID RANGELANDS USING AN OBJECT-ORIENTED AND MULTI-SCALE APPROACH WITH QUICKBIRD IMAGERY

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ABSTRACT

The classification of arid rangelands often presents unique problems due to the high reflectance of the soil background, a mixture of green and senescent grasses, and the prevalence of shrubs in grasslands, which can make it difficult to determine the proportion of grass cover from high resolution imagery. On the Jornada Experimental Range (JER), operated by the USDA Agricultural Research Service, ongoing research is aimed at determining the relationship between ground-based observations and remotely sensed data. The goal of this study was to develop a detailed vegetation classification of a 1200 ha pasture in order to ascertain the extent of grassland and identify locations, extent and percent cover values for several grass species. Specific objectives were 1) to develop and evaluate near-earth photography for ground truthing of a QuickBird satellite image, 2) to conduct a multiscale analysis including ground sampling, near-earth photography and satellite imagery, and 3) to combine object-oriented classification with classification and regression trees (CART) in the analysis of the satellite image.

We conducted extensive field sampling (325 plots) by taking photos of the ground vegetation from a height of 2.8 m and used thresholding techniques to determine percent vegetation cover and percent bare soil. Fifty plots were chosen for detailed ground sampling for comparison with the results from the image analysis. The QuickBird image was analyzed with an object-oriented approach using the software eCognition. The first step involves a segmentation of the image based on scale, color (spectral information) and shape, which segments the image into object primitives based on the chosen parameters. Classification is then performed using those objects rather than single pixels. The classification is based on fuzzy logic theory combined with user defined rules. The segmentation was performed at 2 different scales, which was used to construct a hierarchical network of image objects representing the image information in different spatial resolutions simultaneously. This allowed for differentiation of individual shrubs on the lower level, and delineation of broader landscape classes on a higher level. After the shrubs had been classified, they were "removed" from the image so that the segmentation at the higher level did not include the spectral values for the shrubs. This allowed for determination of the shrub-interspace vegetation.

For each image object containing the field plot, several spectral, spatial, and texture characteristics were extracted from the image. Ancillary information included soils, elevation, aspect and slope layers. The data was analyzed using classification and regression trees to determine correlations between features of the segmented image objects and the measured field plot parameters. A decision trees is a non-parametric, hierarchical classifier which predicts class membership by recursively partitioning a data set into more homogeneous subsets. With the help of a decision tree, one is capable of quickly sifting through numerous features associated with the image objects and selecting the best ones. Half of the samples were used to develop the tree, and half were used to validate it.

Results for percent vegetation cover and bare soil calculated from the near earth photography showed close correlation to the ground based sampling and also proved to be a faster assessment tool than ground sampling. One disadvantage was the occurrence of shadow in the photos, which should be eliminated by using shading for the plot. The object-oriented classification of the QuickBird image worked favorably in this study, because shrubs could be classified separately at a finer scale, while the shrub-interspace vegetation could be analyzed at a coarser scale. This allowed us to get a reliable estimate of grass cover and shrub density in the pasture as well as shrub density within different grass species. The rule base derived from the decision tree proved to be successful at differentiating between the dominant grass species as well as defining several classes of percent grass cover. This approach shows promise for identifying detailed vegetation characteristics on arid rangelands. Future research will include refining the predictive ability of the decision tree and determining the possibility of applying this model to other locations and/or to other scales.