Comparison of the Precision and Accuracy of ALI and ETM+ Data for Semiarid Vegetation Studies

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Land monitoring in semi arid and arid regions is often difficult because of inhospitable, remote terrain and wide expanses of land. For at least the past 20 years, remote sensing, particularly from Landsat satellites, has aided in vegetation monitoring. In the past, investigators have used data from Landsat along with Spectral Mixture Analysis (SMA) to estimate the percent of vegetation green cover (GC). Estimates of uncertainty in the remotely derived estimates of percent green cover were arrived at through comparisons of remote and field-based observations and serve as a basis for comparison of future remote sensing techniques.

This study investigated the capability of the EO-1 Advanced Land Imager (ALI) for measurement of the %GC. In particular, the study investigated three areas: (a) the ability of ALI to determine %GC using the spectral bands functionally equivalent to those found on Landsat's Enhanced Thematic Mapper Plus (ETM+), (2) how well ALI calculated %GC using all nine spectral bands, and (3) how well ALI produced internally consistent images of vegetation cover for quantitative ecological analyses.

Owens Valley, a semi-arid basin in eastern California characterized by drought-tolerant shrubs and grasses (Figure 1), was chosen for this study. ALI and ETM+ each acquired one dataset on June 21, 2001. Concurrently, field data on %GC floristic composition was collected at 27 field sites.

Figure 1. Study area, Owens Valley, California.

By averaging the near infrared (NIR) bands centered at 0.790 μm and 0.868 μm and removing the bands centered at 0.443 μm and 1.25 μm, a six-band ALI data set was created. The ETM+ and ALI data sets were then co-registered to a previously georeferenced data set and the six-band ALI data set was spectrally aligned to the ETM+ data set. Endmember sets were selected for the ETM+ and the ALI data that included spectra from a variety of land cover. An additional endmember was selected utilizing ALI's complete range of nine bands. SMA was applied to the one ETM+ dataset and the two ALI datasets (six-band and nine-band). The resulting vegetation fraction images were used as the remotely sensed estimate of %GC as compared to field data. Field sites were located in each data set and compared with the remotely acquired data to determine the accuracy of the vegetation measurement (Figure 2). The Global Positioning System and aerial photography were used to help accurately locate the field sites.

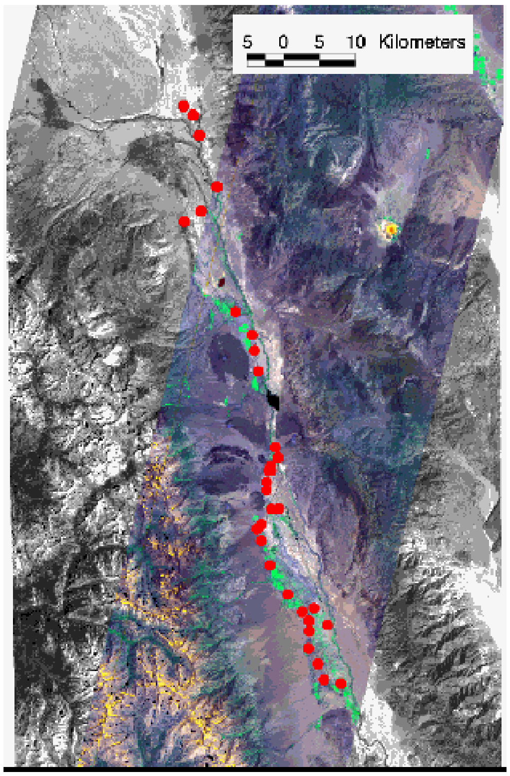

Figure 2. ALI image. Field sites are designated with red circles.

The ability of ALI and ETM+ to estimate vegetation cover relative to field results was compared using criteria that calculated the standard deviation from a perfect fit, a 1:1 line. The deviation from the 1:1 line represents the uncertainty in using remotely sensed measurements as a replacement for field-based vegetation measurements. ALI and ETM+ produced similarly accurate %GC estimates: +/- 6.16 %GC for ALI and +/- 5.61 %GC for ETM+ deviation from a perfect fit with the 1:1 line. Although these uncertainty values indicated little advantage to using ALI over ETM+ for these measurements, other differences between the sensors favored ALI. For example, ALI did not result in as many negative %GC values as did ETM+. And, when profiles across landscapes with low vegetation cover were compared, ALI exhibited lower pixel-to-pixel noise. Using only six ALI bands appeared to produce the same degree of accuracy as using all nine of its bands. This fact can lead investigators to conclude that increased data precision, rather than the number of bands, makes ALI a better, more accurate sensor for estimating vegetation coverage in this type of environment. An alternate conclusion is additional bands should be in spectral regions that can provide new information and not in regions that are highly correlated with existing bands.

Investigators also examined whether ALI was internally consistent. A transect across a center-point agricultural field was extracted for a region where SCA3 (Sensor Chip Assembly) and SCA4 overlapped. Results showed that multispectral band registration was inconsistent between the ALI SCA arrays. However, despite the Band 3 residual anomaly, the percent live cover was very similar for each of the SCA data sets, producing inconsistent measures only where gradients in vegetation cover were very high.

Conclusions:

The investigators found no large and consistent differences between ALI and ETM+ results. The variation in band-registration between ALI SCAs was the only significant negative outcome. Investigators emphasized the importance of being able to obtain consistent measurements of specific geographic regions, particularly in regions of high vegetation variability and when studying annual vegetation changes.