FORECASTING RANGELAND CONDITION WITH GIS IN SOUTHEASTERN IDAHO

Executive Summary
Significant Findings and Achievements

- The credibility of all geospatial models rests upon the model's correspondence with the real-world. All too often however, GIS and remote sensing techniques are being used to develop models that have few similarities to conditions found in the field. In an effort to pursue rapid publication some scientists have evidently overlooked ground validation and opted instead to correlate their results with the results of another model that was previously published in a respected journal. Scientists at Idaho State University's GIS Training and Research Center (GIS TReC) have never lost sight of the importance of validation, and all models described in this final report include robust error assessment and validation with pertinent field data. Furthermore, these field data are well documented (cf. chapters 1-5) and are made readily available to the scientific community and the general public through the GIS TReC's website (http://giscenter.isu.edu/ research/techpg/ nasa_oneal/results.htm).

- Understanding and reporting error and bias is critical to the proper and ethical use of geospatial technologies as a decision support tool. We investigated the effect of geo-reference and co-registration errors using ground control platforms, surveyed locations (+/- 1 cm horizontal positional accuracy), and high spatial resolution aerial imagery (0.15mpp). The results of this effort (cf. chapter 6) allowed researchers to quantitatively address co-registration error using an ingenious use of inexpensive blue-tarps and QuickBird satellite imagery. The results of this study demonstrate that accurate co-registration between field sites and satellite imagery can increase producer's accuracy substantially (e.g., from 37.5% to 100% accuracy as shown in the study detailed in chapter 12).

- One student who completed his MS thesis under this grant, Mansoor Raza, documented a bias in aerial photograph interpretation by investigating the agreement between cover type determinations made at three high spatial resolutions (0.15, 0.30, and 1.0 mpp). His results (cf. chapter 7) indicate that cover type (e.g., grass, shrub, and bare ground) estimations are profoundly affected by resolution and that percent cover estimations made using one resolution cannot be compared directly with estimations made at another resolution.

  Similarly, models (e.g., NDVI) produced using imagery from one sensor (e.g, Landsat 5 TM) should not be compared directly to models based upon another sensor (e.g., SPOT 5) even when the imagery was collected on the same date. These differences are due to internal differences in the sensors (cf. chapter 10).

- The condition and land cover of arid and semiarid ecosystems --such as those typically considered rangelands-- are greatly influenced by a number of anthropic and environmental factors. The single most influential factor is precipitation (an environmental factor), and, because of this relationship, the use of precipitation as a driver variable in any forecasting model within these regions is critically important to the accuracy of the model. It goes almost without saying then, that the accuracy of the precipitation input layer is also important.

We investigated the use of *in-situ* weather observations, "nearby" weather station observations, and the SOGS weather dataset for use in rangeland condition modeling. The results (cf. chapter 13) suggest the SOGS dataset is required for accurate modeling over any area of interest that is either relatively large or exhibits sufficient relief to disproportionately influence precipitation across a study area.

- Besides precipitation, anthropic factors play a substantial role in determining rangeland condition. In many semiarid ecosystems, cultivated agriculture is not a viable use of the land due to unreliable precipitation patterns. In these areas, livestock grazing is common.

  Livestock grazing in arid and semiarid ecosystems occurs on largely unaltered paddocks. These, in contrast to pasture situations where forage is planted, irrigated, and sometimes mechanically harvested as hay for winter fodder, are left uncultivated by the grazier. The treatment applied to these rangelands is in the form of the livestock itself and the grazier's decision to use *X* number of animals for *Y* number of days.

  The effect grazing animals can have on an ecosystem can be significant and this part of the study focused upon measuring and analyzing soil moisture and land cover response to three treatment types: 1) simulated holistic planned grazing (high stocking rates applied over short time periods), 2) traditional rest-rotation (low stocking rates applied over long time periods followed by periods of partial rest), and 3) total rest (no livestock grazing allowed). The results of this research (cf. chapter 15) are of profound interest and importance: grazing livestock at high stocking rates over short time periods (about 6-7 days) was clearly shown to benefit semiarid rangelands as soil moisture increased by a margin of 10% over the other treatment paddocks used in this study. This suggests that livestock can be better managed using time instead of the quantity of animals.

- Accurately forecasting rangeland condition or predicting changes in semiarid ecosystems is very difficult. This is because the principal driver is precipitation when assuming uniform grazing treatment across the study area. To improve existing modeling software numerous years of land cover data must be allowed as inputs (instead of only two) to better establish trend. In addition, precipitation layers (like the SOGS dataset cf. chapter 13) must be used as site/driver variables. The results of research specifically exploring forecasting models in semiarid ecosystems are given in chapter 16.

- Several hundred people participated in formal public outreach events sponsored by this study (the annual Geospatial Range Sciences Conference and World GIS Day events) and broadened their knowledge of GIS and remote sensing applications to solve real-world problems. Countless other people have benefited from this study, its research results and data sharing as many have visited the study's website, http://giscenter.isu.edu/research/techpg/nasa_oneal/template.htm.

- Two papers have been published in peer reviewed journals and one additional paper is currently in review.