Project Goal

The goal of this research project is to demonstrate the value of utilizing remotely sensed imagery, namely hyperspectral imagery such as that from Hyperion, for detecting, monitoring, and/or predicting the spread of an invasive species, such as tamarisk.

Societal Impact

In 2005, approximately $500M was budgeted by U.S. Federal Agencies for the management of invasive species. Despite extensive expenditures, most of the methods currently used to detect and quantify the distribution of these invaders are often ad hoc. More efficient methods to detect/predict the occurrence and monitor the population sizes of these species are greatly needed.

The invasive species known as salt cedar or tamarisk (Tamarix ramosissima) is a particular problem in the U.S.’s desert southwest, where it is displacing the native cottonwood, willow, and other native plants. Tamarisk shrubs, or trees, are extremely competitive against native vegetation because they aggressively consume the water supply. Since tamarisk can re-grow from root crown buds, even after burning, the current management practices for tamarisk involve combinations of chemical, mechanical, and biological techniques. Thus, detection of tamarisk when it is in its earliest growing stages, through the use of remote sensing, could greatly reduce the cost associated with this invasive species.

Methodologies

In this NASA-funded project, researchers are developing hyperspectral-based models for detecting invasives in remotely sensing imagery. These models incorporate image processing and pattern recognition techniques, such as advanced
hyperspectral feature extraction (including discrete wavelet transforms and stepwise linear discriminant analysis) and classification (including maximum likelihood and nearest neighbor classifiers). Quantitative verification and validation of these algorithms, in terms of target detection accuracies and false alarm rates, are being conducted via a testbed of hyperspectral signatures, where the ground truth, in terms of tamarisk presence or absence, is known.

This project is part of an ongoing collaboration between Mississippi State University, Colorado State University, USGS, and NASA researchers. Collaborators at Colorado State University and USGS have supplied the necessary ground truth via field surveys. Collaborators at NASA have supplied hyperspectral signatures from handheld sensors, as well as ASTER co-registered HYPERION imagery of the field sites. The ground truth and hyperspectral data were both collected in the Grand Staircase-Escalante National Monument, in southern Utah. All model design, algorithm development, experimental analysis, and V&V have been conducted by the Mississippi State University researchers.

**Results**

The results of this research project clearly demonstrate the viability of applying remotely sensing imagery, particularly hyperspectral such as that of HYPERION, to the problem of invasive species detection. As expected, the results show that the tamarisk detection accuracy depends on both spatial and spectral resolutions. The newly developed image processing and pattern recognition methods resulted in accuracies as high as 90% for discriminating tamarisk from native vegetation, such as cottonwoods and willows, when the input hyperspectral sensors had a spectral resolution in the range of 30-100nm and a spatial resolution that allowed for target abundances to be greater than 50%, i.e. mixed pixels had at least 50% ground coverage of tamarisk. These results are very promising and clearly indicate the power and practicality of hyperspectral remote sensing for invasive species detection.

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