SERDP
Strategic Environmental Research and Development Program

Application of Hyperspectral Techniques to Monitoring and Management of Invasive Weed

Conservation
CS-1143

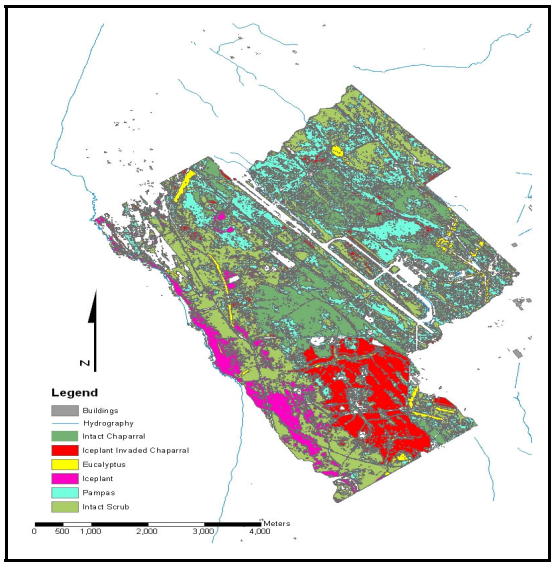
Background:
The rapid spread of non-native invasive plant species, including noxious weeds, is causing irreparable damage to the natural resources on military installations. This research moves beyond current remotely sensed vegetation indices and classification algorithms to take advantage of information generated from high-resolution spectra.

Objective:
The objective of this project is to develop and demonstrate a new remote sensing methodology using hyperspectral imaging (HSI) for mapping invasive weeds. The expected outcome is a predictive model of potential weed invasion integrating HSI information with a geographic information system (GIS) of broad applicability to military installations.

Process/Technology Description:
Five bases from the Southeastern, Southwestern, and Northwestern ecoregions of the United States, each with different weed types and intensities and patterns of environmental disturbances, were selected to demonstrate, refine, and validate the methodology. These case studies have demonstrated the portability of the methods under various types of military activities. Airborne flightlines were identified to provide data for mapping various species of weeds. The combination of HSI tools and images provides a robust protocol for monitoring weed invasions.

New support vector machine learning tools were utilized to characterize habitats and identify weeds using HSI. The Hierarchical Foreground Background Analysis (HFBA) is one example of a multiscale resolution analysis used to link the spectral variation for each pixel with variation in the spatial domain. The HFBA decomposition is coupled with a wavelet-based multiscale resolution in the spatial domain. This method addresses issues with spectral features.

Results:
Field measurements of the ecological and spectral characteristics of noxious weeds and native species have been completed at the selected bases. Corresponding GIS databases were acquired, and NASA's Airborne Visible/Infrared Imaging Spectrometer has been flown at high spatial resolution (i.e., approximately 4-meter pixels) over multiple flightlines. Its capability to map weeds with distinctive spectral features relative to background vegetation has been demonstrated. The invasive weed maps for Vandenberg AFB, Yuma Proving Ground, and Camp Pendleton have been tested, and the research team is currently in the validation stage for mapping weeds at Fort Benning and Aberdeen Proving Ground. The team also has developed modeling techniques to predict the probability for further invasion and is now able to identify installations that are vulnerable to weed invasion. A primary finding has been that several standard HSI analysis methods produce good results at most bases and for most weeds, suggesting that training can be standardized and that unique methods will not be required in most cases.



Spectrally derived weed map Vandenberg AFB.

Expected Benefits:
In the short-term, this project will improve understanding of the distribution of major invasive weeds on military bases and the environmental conditions associated with their distributions and spread. The long-term benefit will be the development of a timely and cost-effective method for mapping weeds that can be used to develop an accurate distribution of their coverage and to monitor their spread to new locations. These new tools will assist natural resource managers in evaluating their invasive species control approaches. Initial estimates indicate that remote sensing surveys can dramatically increase the survey area while reducing associated costs by over 90 percent.
(Anticipated Project Completion – 2005)

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