Application of Hyperspectral Remote Sensing at Edwards Air Force Base

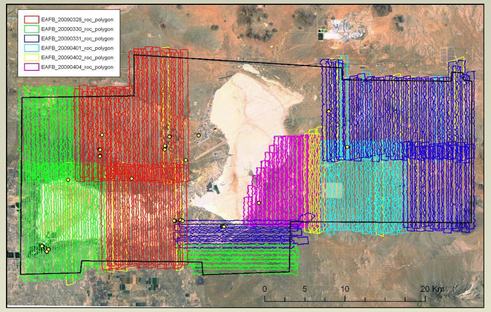
Introduction

Edwards AFB requires remotely-sensed data to facilitate determining how plant communities change spatially over time, modeling ecosystem health, and predicting sensitive species habitat. The hyperspectral imagery collected at Edwards AFB will be used in future surveys to evaluate recovery of various habitats from mission related projects, activities and operations, as well as the implementation of environmental projects to benefit the Mojave Desert ecosystem. This imagery will also be used to determine habitat stability, help establish an environmental baseline, and support the regional recovery effort for some of the goals and objectives of the Mojave Desert Recovery Plan.

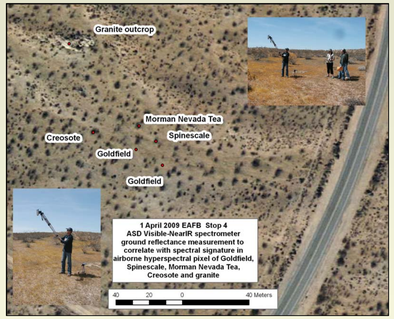
Data Collection

Airborne Data Collection

- Over 400 square miles of hyperspectral data collected over Edwards AFB
- Airborne AISA EAGLE Visible to near-IR (VNIR ca. 400 – 1,000 nm spectral range)
- Spectral resolution of around 5 nm (VNIR)
- Project area flown March 28th - April 4th, 2009
- 190 flight lines, 128 separate bands, spatial resolution 1m



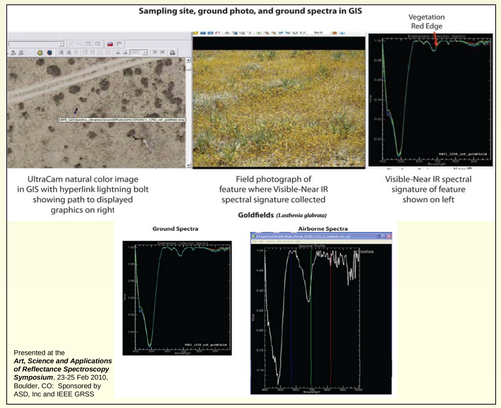
Hyperspectral flight lines color-coded by day of acquisition with ground spectral sites (yellow dots).



Ground Spectra Collection

- Ground spectra measured with an ASD FieldSpec® handheld spectrometer
- 100 ground spectra (VNIR), photographs, field observations and GPS locations recorded
- Data collected March 31st - April 23rd, 2009
- GIS integration of ground spectral library, photographs and field observations

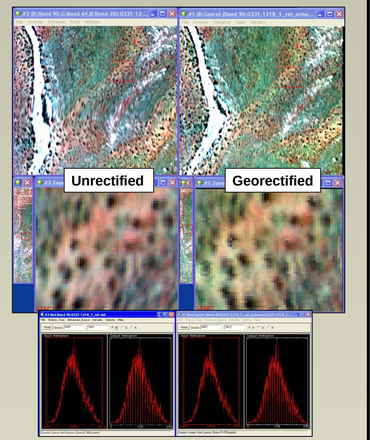
Spectral Quality of Ground & Airborne Data



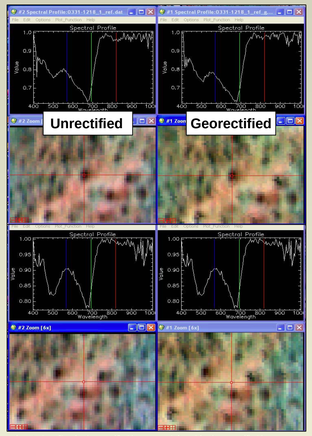
- Atmospherically corrected and continuum removed spectra were correlated over the Piute Ponds pilot-project area.
- The spectral quality of airborne pixels compares favorably with spectra collected on the ground at the same location.
- Spectra collected for known plant species on the ground are represented in the airborne data cubes. Therefore, each plant species has a much greater probability of being successfully identified in processing and mapping the airborne images.

Spectral Quality of Georectified Data Cubes

- Hyperspectral pixels are subjected to considerable shifting, rotating, and resampling during the georectification process.
- Visual comparison of unrectified and georectified images reveals subtle changes of some feature edges (at a pixel level) and even more subtle changes of color; however the histograms of the unrectified and rectified data are remarkably similar, confirming the effectiveness of the nearest-neighbor resampling technique for preserving spectral integrity.



Unrectified flight strip on left and rectified flight strip on right (red boxes show same area. Remarkably similar histograms of unrectified (left) and rectified (right) pixels in the enlargement views.

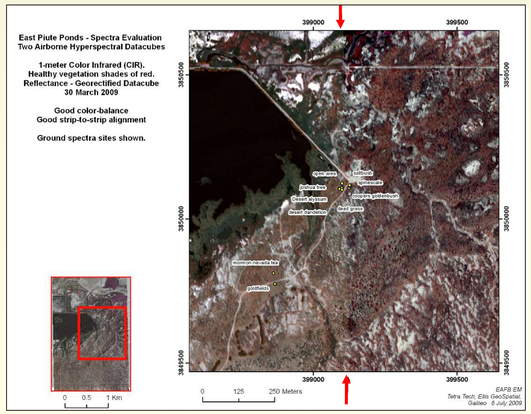


Spectral profiles for 2 unrectified images on left and for 2 georectified images on right. The spectral profiles are extracted from the 128 VNIR bands stacked below the pixel in the crosshairs on the images.

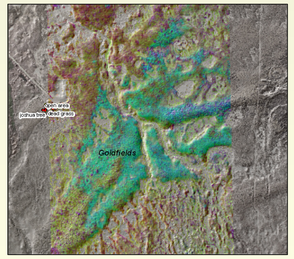
- Spectral profiles of matching pixels in the unrectified and georectified imagery range from visually identical to very similar.
- The spectral profiles confirm that the georectified imagery has pixels with spectral characteristics identical to (or very similar to) the original unrectified data cubes. This spectral quality is critical for production-style processing and mapping using georectified data cubes.

Spatial Quality of Georectified Data Cubes

The spatial fit of the georectified flight strips is good compared with the UltraCAM orthorectified aerial photography of EAFB, and the LiDAR DEM.



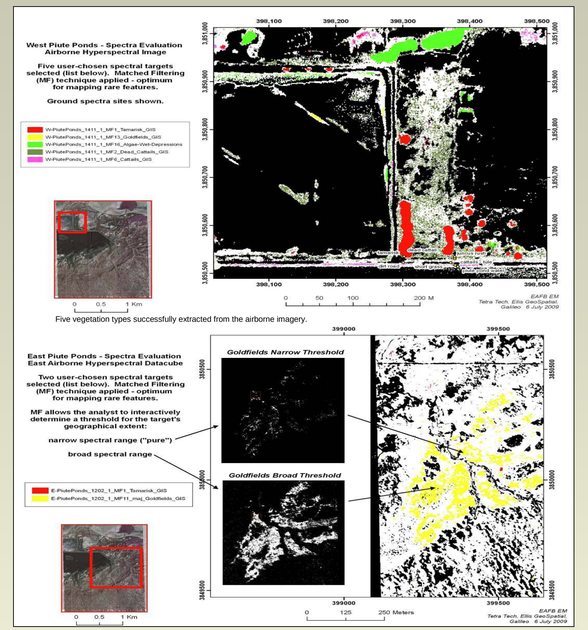
Red arrows point to seams between adjacent flight strips, showing very subtle differences and demonstrating consistent georectification.



Matched Filter (MF) probability map of Goldfields vegetation overlaid on hillshade LiDAR DEM

Piute Ponds Image-Processing & Mapping Pilot Project

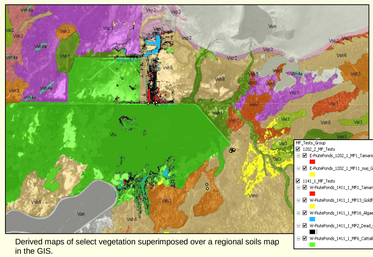
A mapping pilot project was completed at Piute Ponds, a freshwater marsh area located in the southwestern portion of Edwards AFB, to evaluate the spectral richness and consistency of the airborne hyperspectral data. The reflectance georectified datacubes were used to facilitate integration with the many ground spectra training sites.



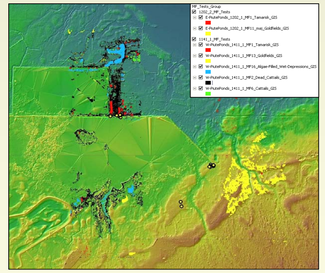
Five vegetation types successfully extracted from the airborne imagery.

Results

- The airborne VNIR data cubes have enough spectral variation and depth to effectively map plant species and many different plant communities. Several plant species were successfully differentiated and identified using ENVI image-processing algorithms.
- The ground spectral library matches the airborne spectra very well, making the ground spectra an invaluable resource for interrogating the airborne data cubes about specific targets.
- Superimposing the spectra demonstrates the importance of elevation and topographic relief to the geographical distribution of vegetation types.



Derived maps of select vegetation superimposed over a regional soils map in the GIS.



Derived maps of select vegetation superimposed over the color-coded & hillshade LiDAR DEM.

- Superimposing the spectra demonstrates how existing maps can be correlated with and upgraded.
- The Piute Ponds pilot project clearly demonstrates that the spectral and spatial quality of the georectified imagery enables excellent mapping of different types of vegetation.

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