

Watershed Impact Analysis Using AVIRIS and Field Data

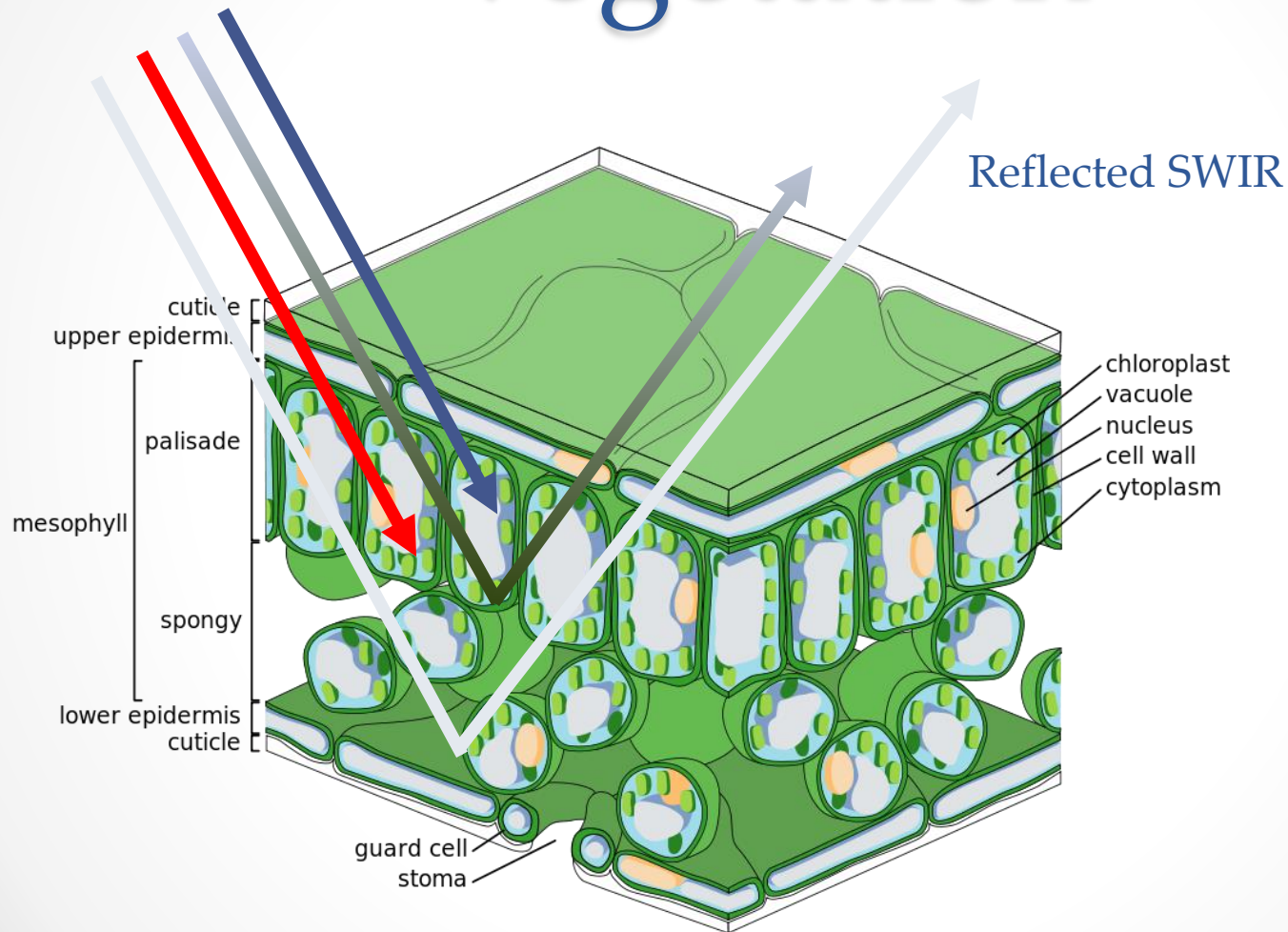
Introduction

- Western North Dakota is experiencing one of the largest oil booms in US history. Government agencies, including Federal, Tribal, State, and County, are trying to keep pace with monitoring the activity in the oilfield. One of the effects of the increased activity is the possible environmental impact that may go unnoticed due to the limited staffing of these agencies.

Introduction

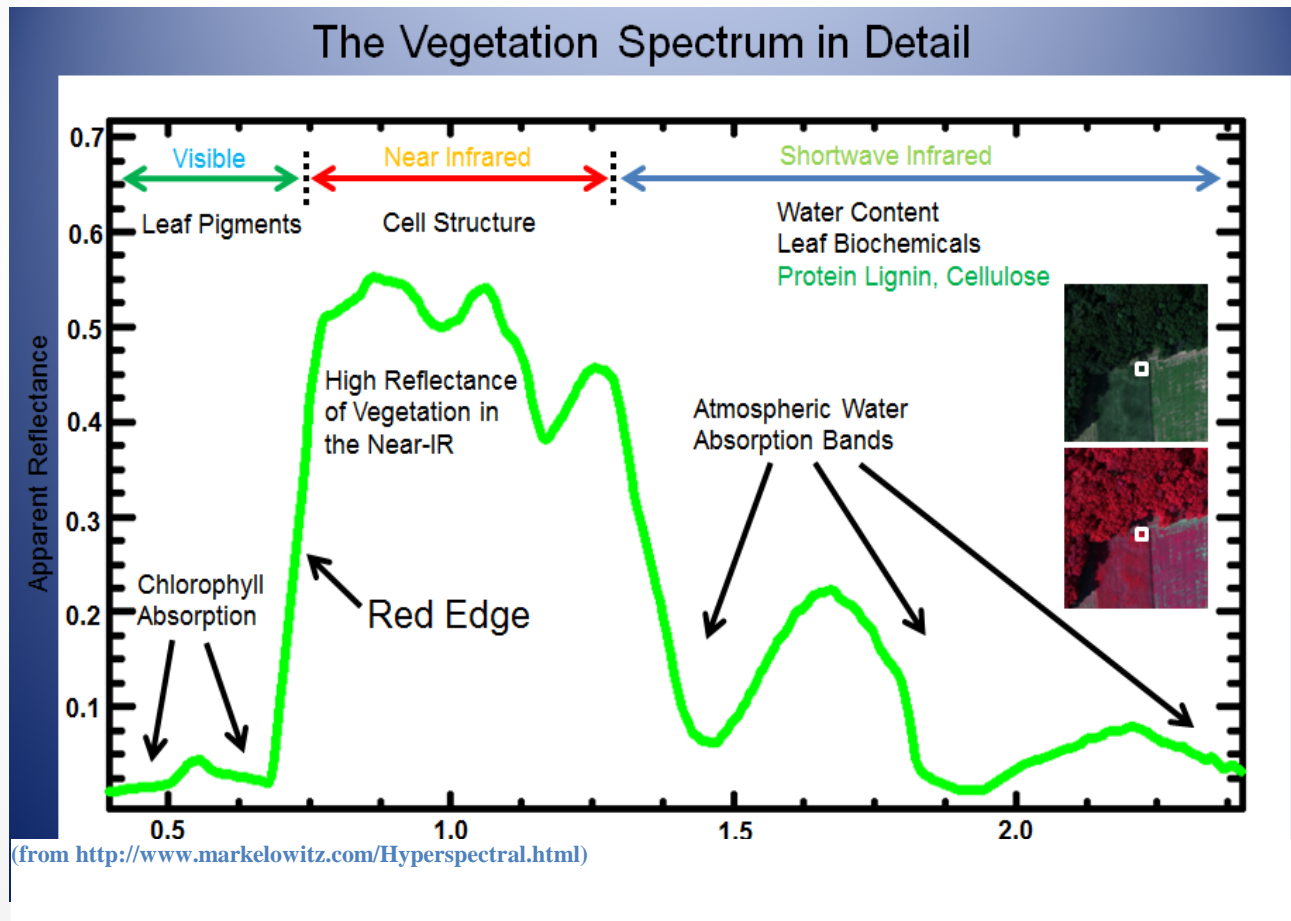
- Through a study of the effects of agricultural chemical runoff on watersheds, this research project will create a procedural list of steps through field, laboratory, and remote sensing data analysis. These steps can then be applied to determine impacts of oilfield activity in Western North Dakota.

Reflectance Spectra of Vegetation

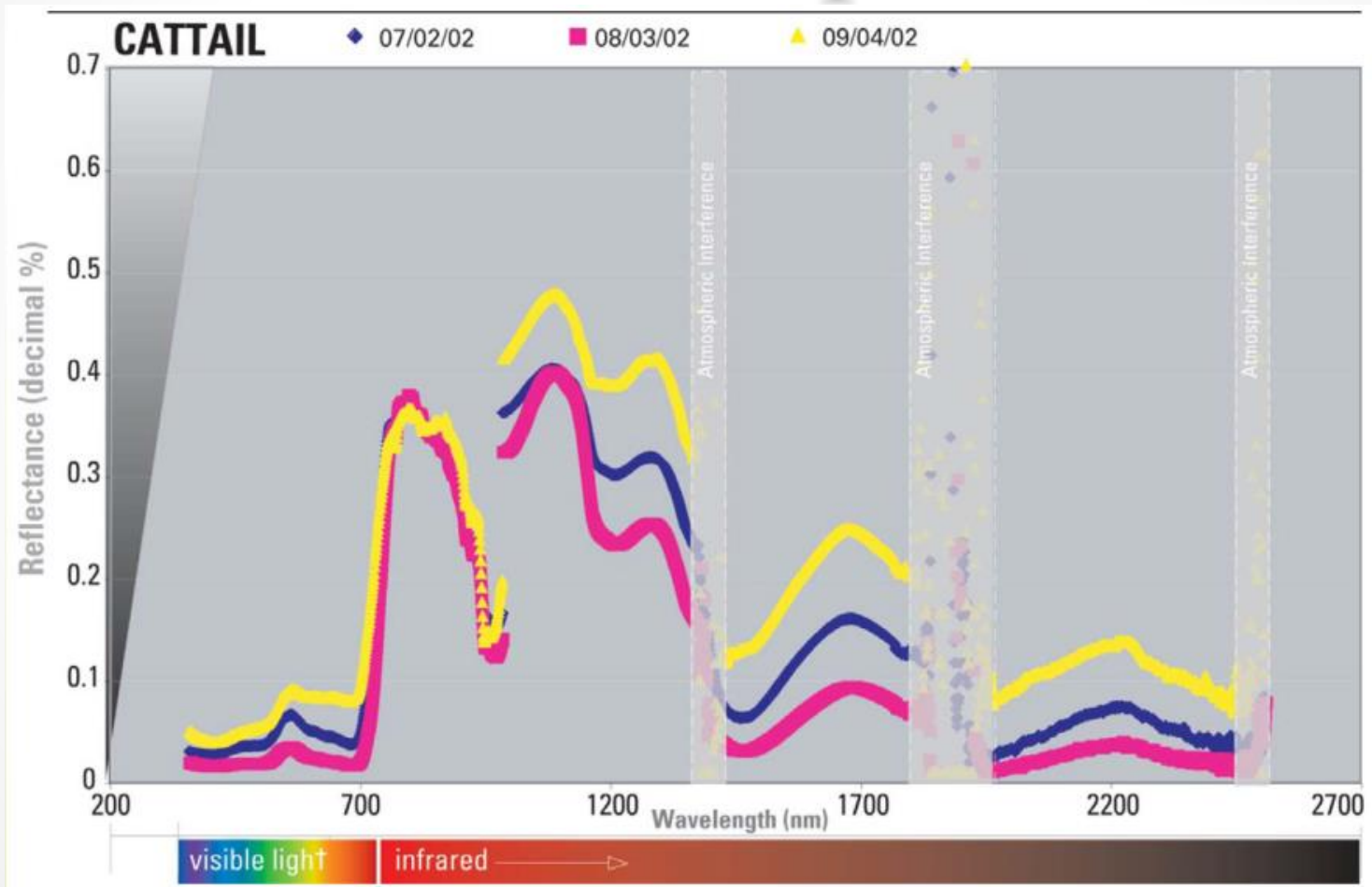


http://en.wikipedia.org/wiki/File:Leaf_Tissue_Structure.svg

Reflectance Spectra of Vegetation

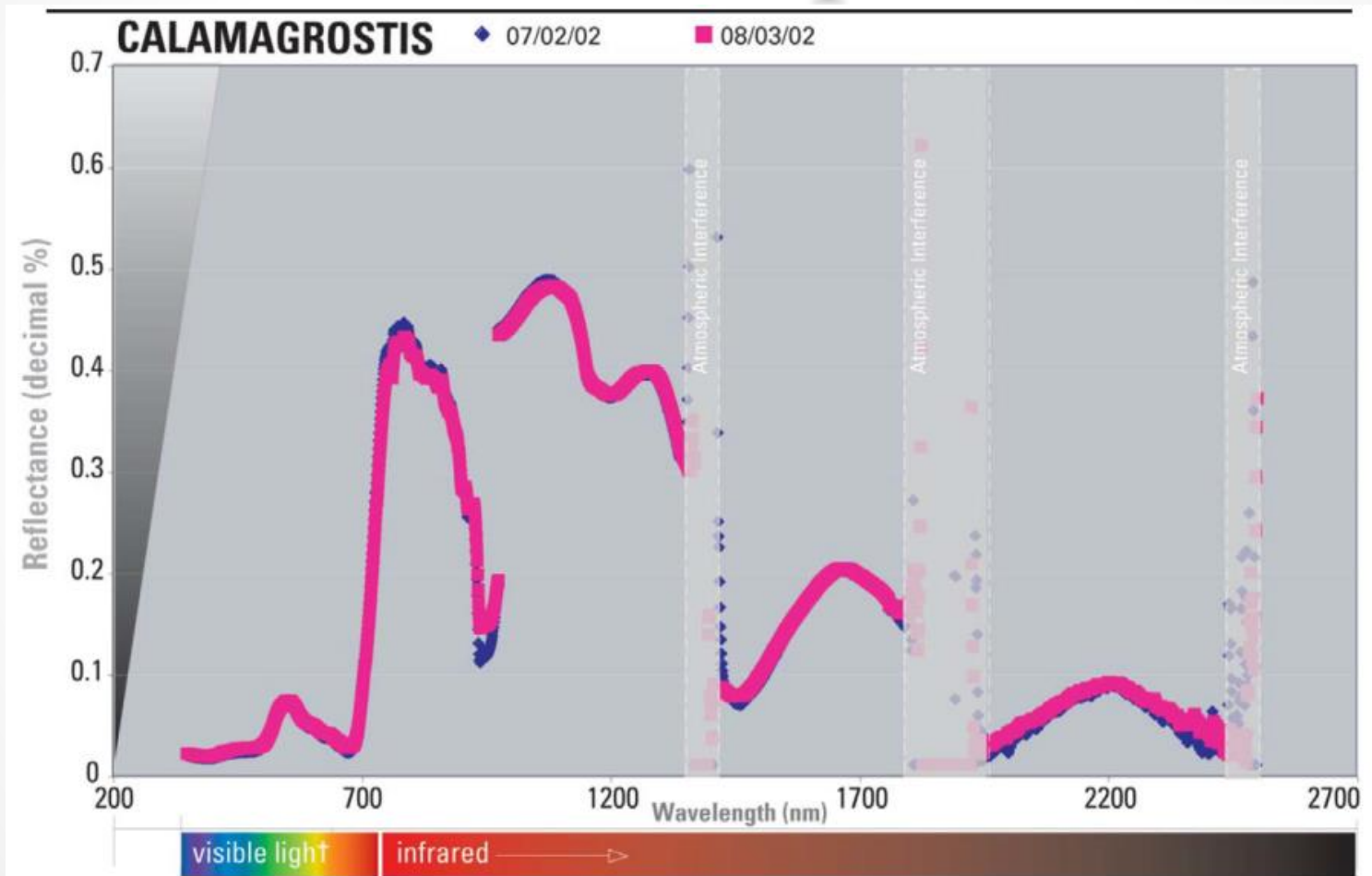


Reflectance Spectra of Wetland Species



Images from: Beerli O., Gelfman, J. and Phillips, R. 2002. Spectral library for vegetation in the glaciated prairie region. Resource Publication W-1, University of North Dakota, Upper Midwest Aerospace Consortium, Grand Forks, ND.

Reflectance Spectra of Wetland Species



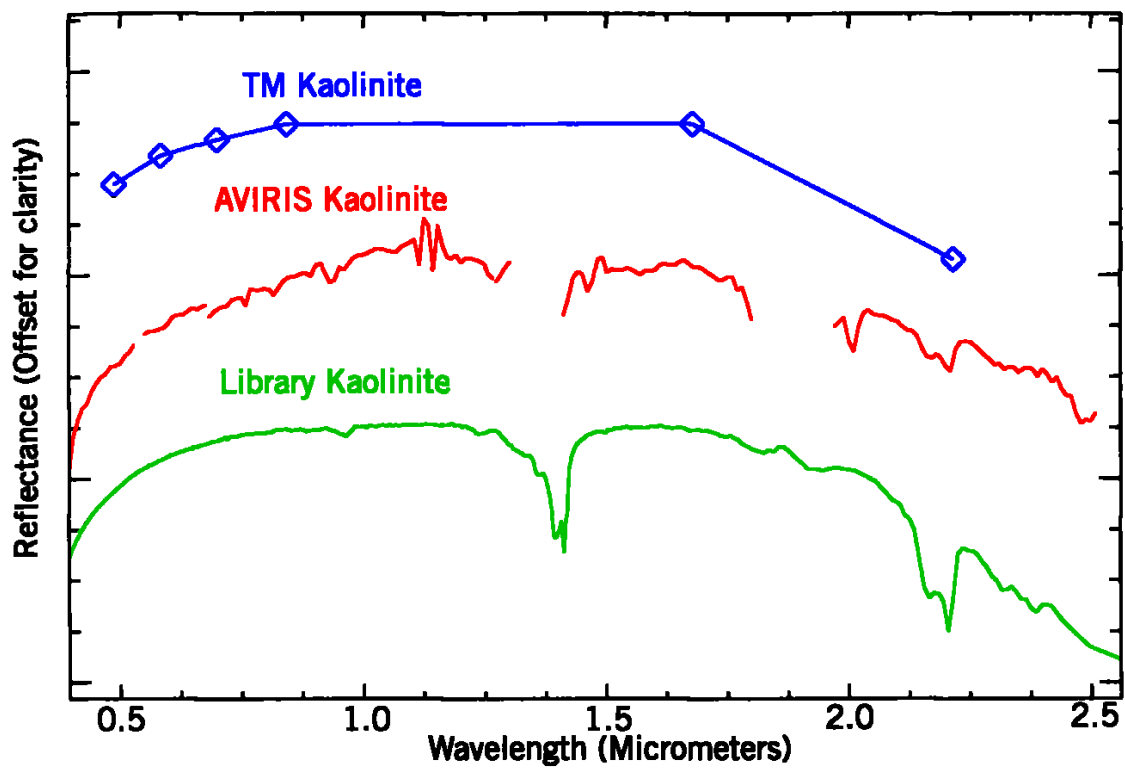
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Advantages of Hyperspectral Data

Instrument	Landsat 7 Enhanced Thematic Mapper Plus (ETM+)	AVIRIS
Channels	<i>7</i>	<i>224</i>
Spectral Resolution	<i>60-270 nanometers</i>	<i>10 nanometers</i>
Spatial Resolution	<i>30 meters</i>	<i>17 meters/~4 meters*</i>

*17 meter spatial resolution using ER-2 platform/~4 meter resolution using Twin Otter platform

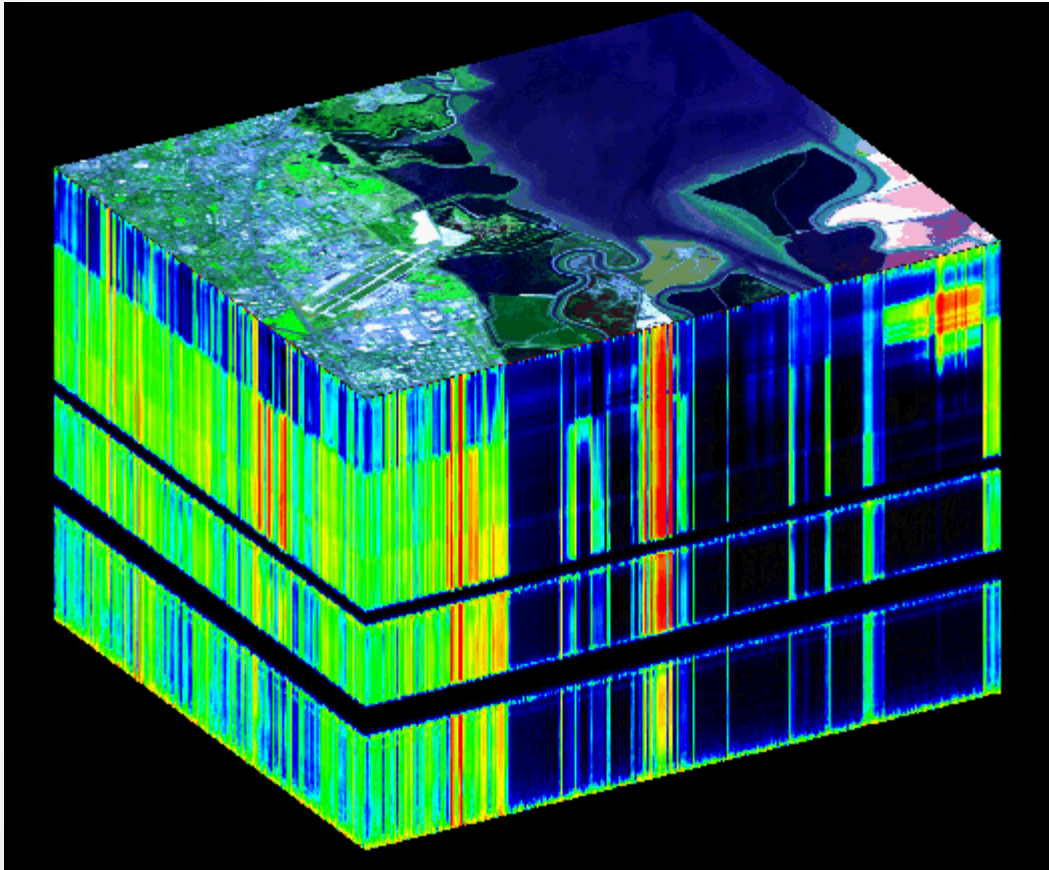
Advantages of Hyperspectral Data



Comparison of the multispectral bands of Landsat TM (bands 1-5 and 7), AVIRIS, and field spectroscopy.

(Available at: http://www2.brgm.fr/mineo/final.htm#_Toc51129503)

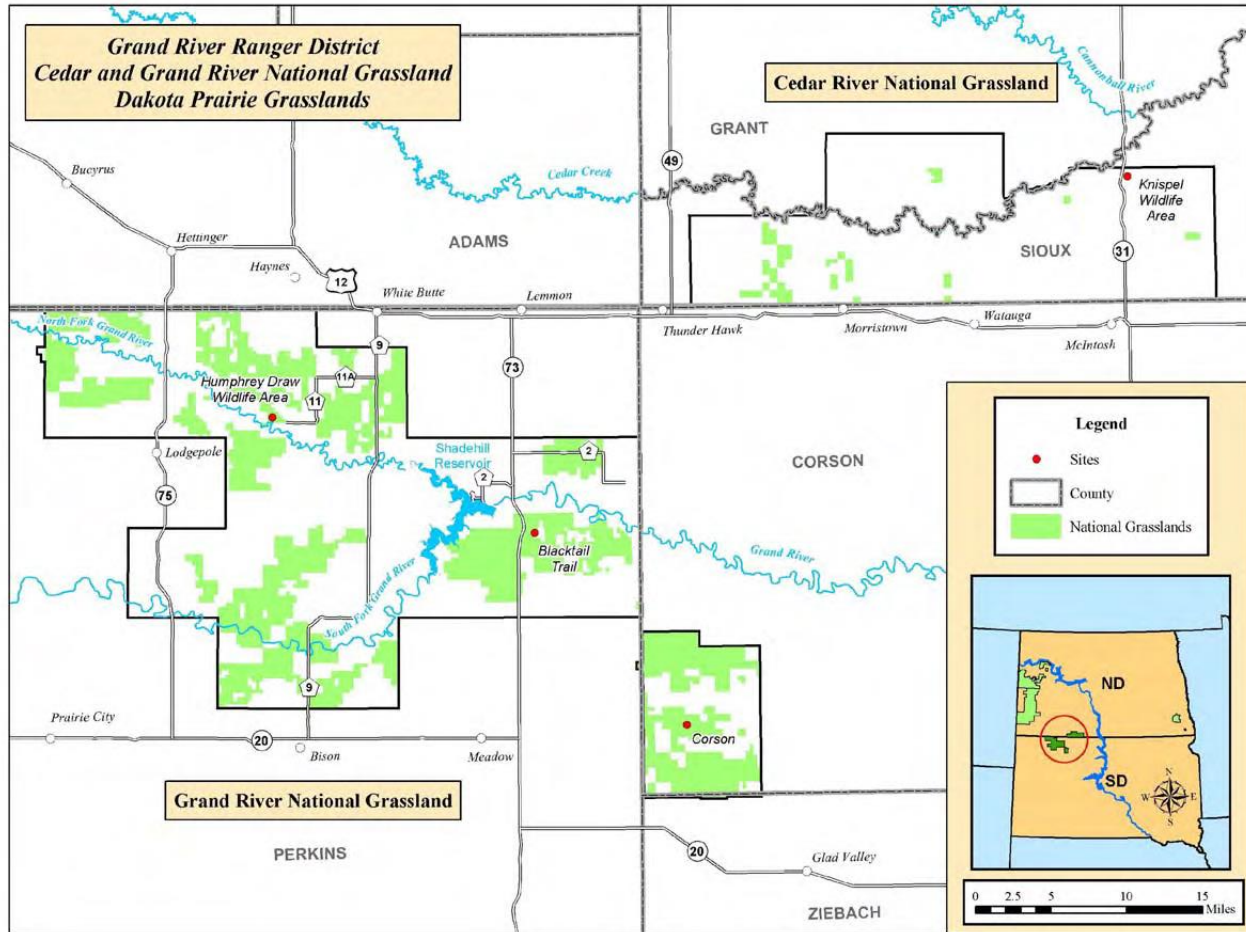
Advantages of Hyperspectral Data



AVIRIS Data Cube:
Three-dimensional
array of x-y
coordinates and 224
bands.

Courtesy NASA/JPL-Caltech

Research Area

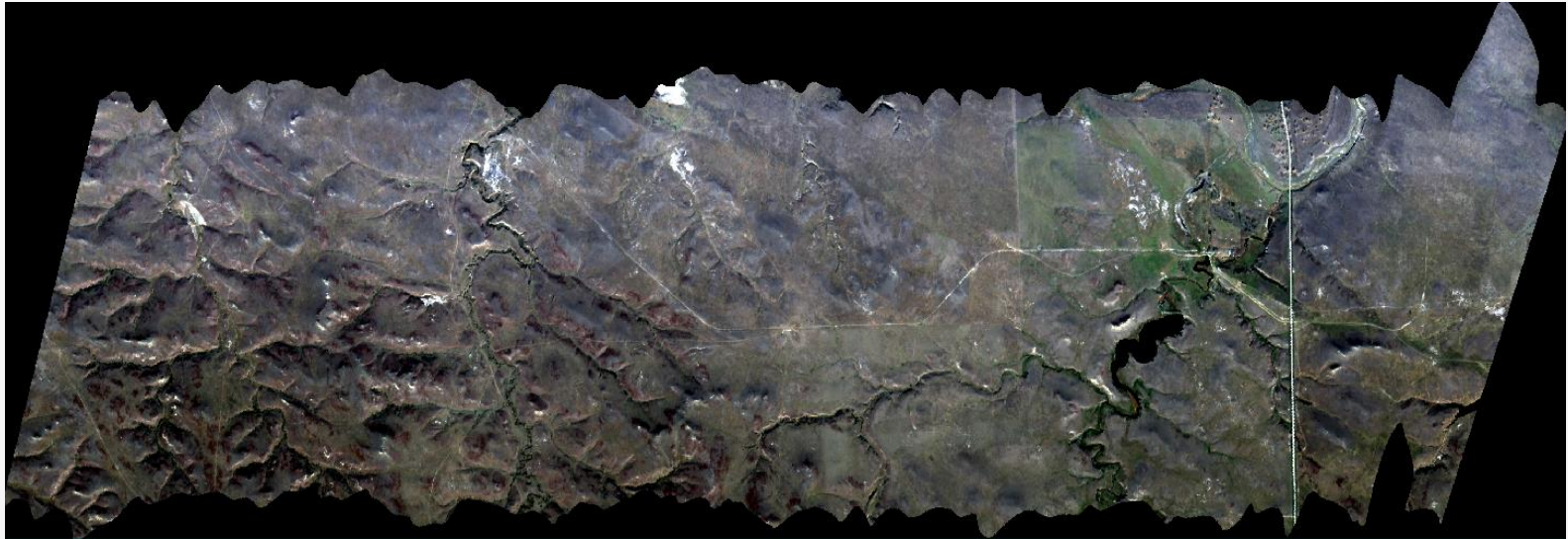


Research Proposal Steps

- Step 1. Secure AVIRIS data from area covering wetlands.
- Step 2. Identify wetland species within target area.
- Step 3. Collect soil and water samples from wetlands within the study area.
- Step 4. Setup greenhouse study using species identified in the target area. Control groups will be used as a baseline for each of the species. Agricultural chemicals identified in the soil/water samples will be applied to the greenhouse plants.
- Step 5. Create spectral library of plant species in the greenhouse study for contaminated and uncontaminated plants.

Current Status

Secured AVIRIS data from area covering wetlands.



Current Status

Two plant species identified with one specie grown in a growth chamber



Eleocharis palustris – Common Spikerush

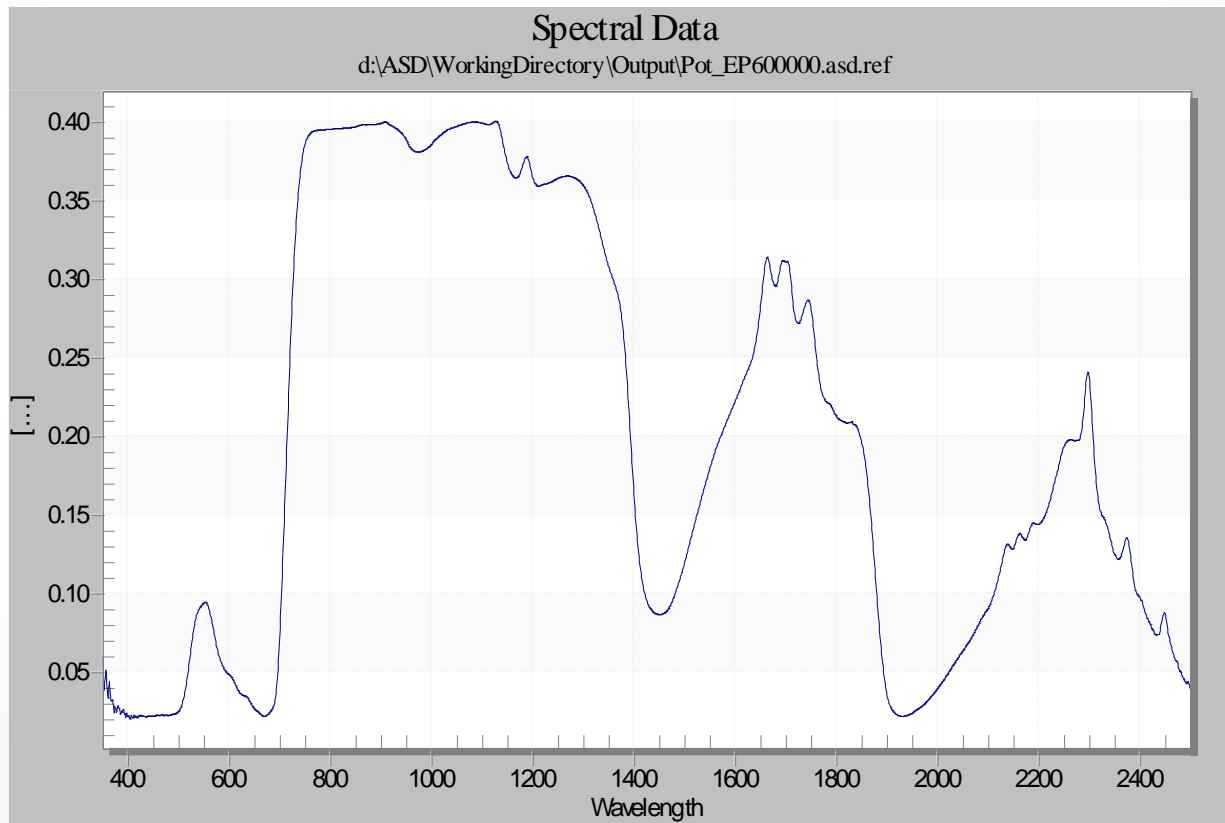
Current Status

- Identifying wetlands close to crops and within coverage of AVIRIS data – ***not completed***



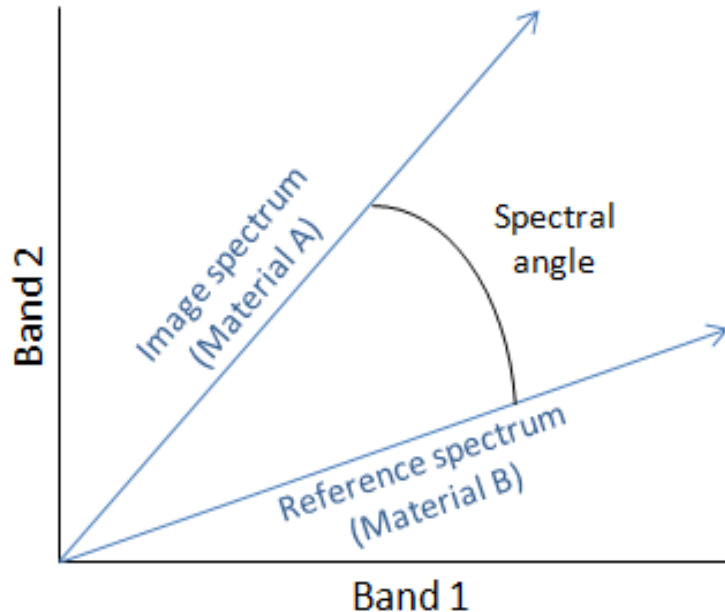
Current Status

Created spectral library of plant specie in the greenhouse



Current Status

Ran algorithms to identify plant species in the AVIRIS datasets. Used Spectral Angle Mapper (SAM) Algorithm in ENVI.



SAM plots the bands of interest in n-dimensional space, where n is the number of bands used in the analysis. (From http://www.exelisvis.com/docs/Whole-Pixel_Hyperspectral_Analysis_Tutorial.html)

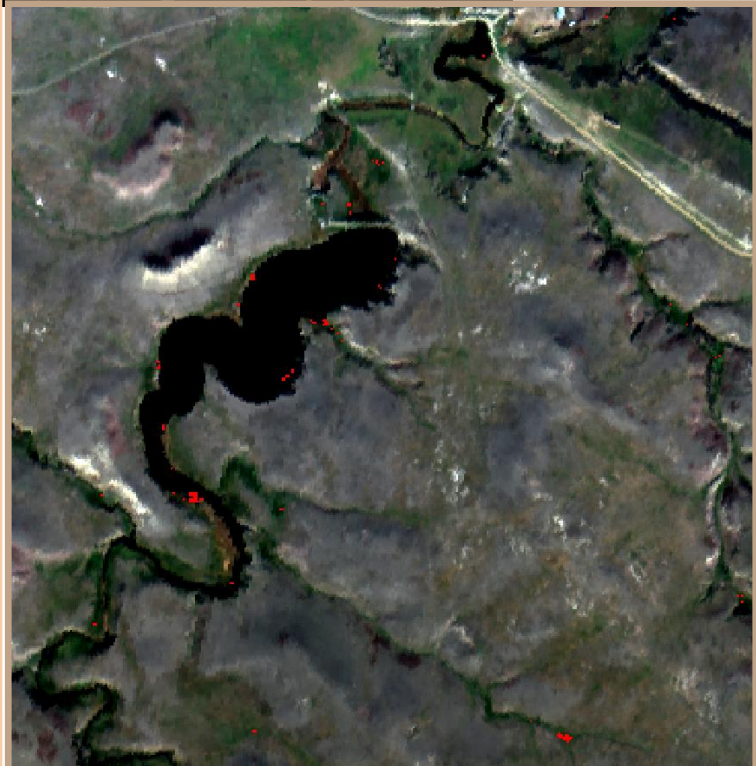
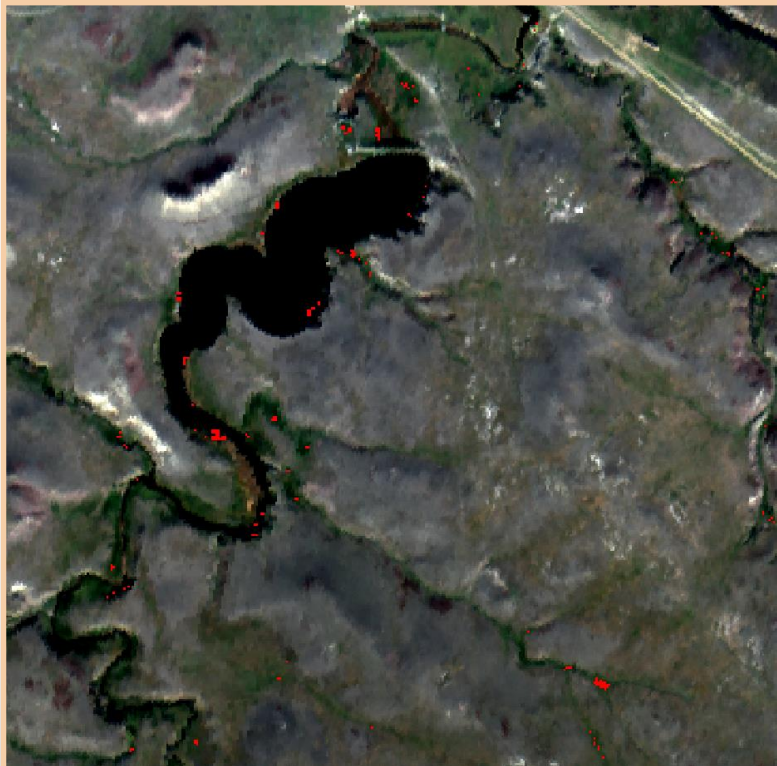
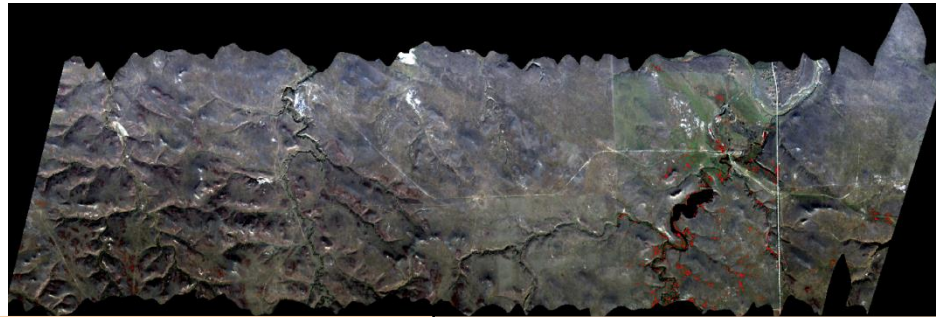
Current Status

Equation for Spectral Angle Mapper (SAM) Algorithm

$$\alpha = \cos^{-1} \left(\frac{\sum_{i=1}^{nb} t_i r_i}{\left(\left(\sum_{i=1}^n t_i^2 \right)^{\frac{1}{2}} \right) \left(\left(\sum_{i=1}^n r_i^2 \right)^{\frac{1}{2}} \right)} \right)$$

Current Status

Possible matches (red pixels) using Spectral Angle Mapper (SAM) Algorithm



Next Steps

- Continue the greenhouse experiment raising wetland plants and creating spectral libraries
- Generate watersheds and flow data in ArcGIS for Western North Dakota
- Perform field sampling and greenhouse analysis from field samples

