

# Limitations in Delineating Lake Shoreline in Cloud Contaminated Landsat Images



Kate E. Richardson<sup>1</sup>  
with  
Ramesh Sivanpillai<sup>2</sup>

1. Department of Ecosystem Science and Management
2. Department of Botany University of Wyoming

# Water



- ❧ Vital to the Western US
  - ❧ Arid (precipitation <10 in/year)<sup>2</sup>
  - ❧ Semi-Arid (precipitation 10-20 in/year)<sup>2</sup>
  
- ❧ Storage
  - ❧ 13 major reservoirs in Wyoming<sup>1</sup>
  - ❧ Numerous smaller ones
    - ❧ Most of them are not gauged

# Remote Sensing



❧ **Remote sensing** is defined as the technique of obtaining information about objects through the analysis of data collected by special instruments that are not in physical contact with the objects of investigation.<sup>4</sup>

# Remote Sensing



- ∞ Data collected in several regions of the spectrum
  - ∞ Visible (blue, green, red)
  - ∞ Infrared (near, mid- and far)
- ∞ Previous studies have shown water can be distinguished from other features
  - ∞ (Fraizer et al. 2000)<sup>3</sup>

# Landsat



- ❧ Thematic Mapper on Landsat 5
  - ❧ Data from 1984 to 2011
  - ❧ 6 bands
    - ❧ 3 visible
    - ❧ 3 infrared
  - ❧ 30m x 30m resolution
  - ❧ Collected every 16 days

# Unsupervised Classification



- ❧ Pixels in the Landsat image are combined to generate information classes
  - ❧ Similar features have similar reflectance values
    - ❧ Values are grouped into classes
      - ❧ Classes are labeled (i.e. water, land, clouds)

# Problem Statement



- ❧ It is difficult to obtain cloud-free Landsat images for most of WY
  - ❧ Snow/ice for the winter/spring
  - ❧ More problematic as we go north & higher in elevation
  
- ❧ Good chance during a short window of time
  - ❧ June through Oct
    - ❧ One image for every 16 days
    - ❧ Summer clouds and shadows could be a problem

# Landsat images



Cloud free image



Cloud covered image





# Landsat images



- ❧ Cloud contamination can result in data gaps
  - ❧ Images are collected (185 km x 185 km) every 16 days
  - ❧ Loss of one images – have to wait another 16 days
  
- ❧ Can we extract useful information from partially covered (i.e., thin layers of clouds and shadows) Landsat images?



# Study Objectives



- ❧ Assess the impact of clouds and their shadows on distinguishing water from land
  
- ❧ Study area: Bull Lake and adjacent area
  - ❧ (7km x 14km window)
  
- ❧ Materials:
  - ❧ 3 Landsat images
    - ❧ 1986, 2002, 2007

# Signatures in a cloud free image

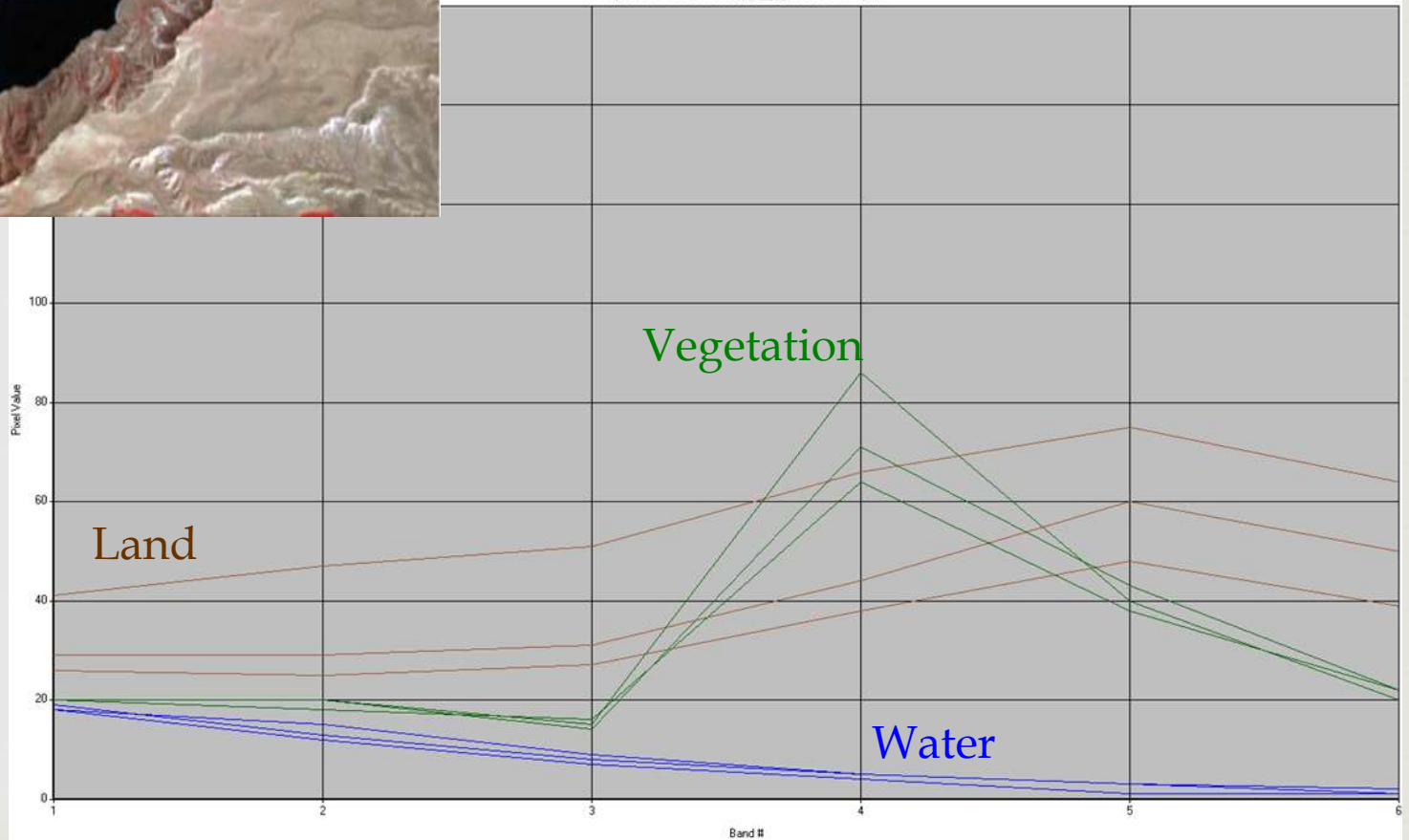


1986

Spectral Signature



Spectral Profile for ERDAS\$@\_d\_bt\_19860827mrr.img.uai



# Cloud-free Classified Image

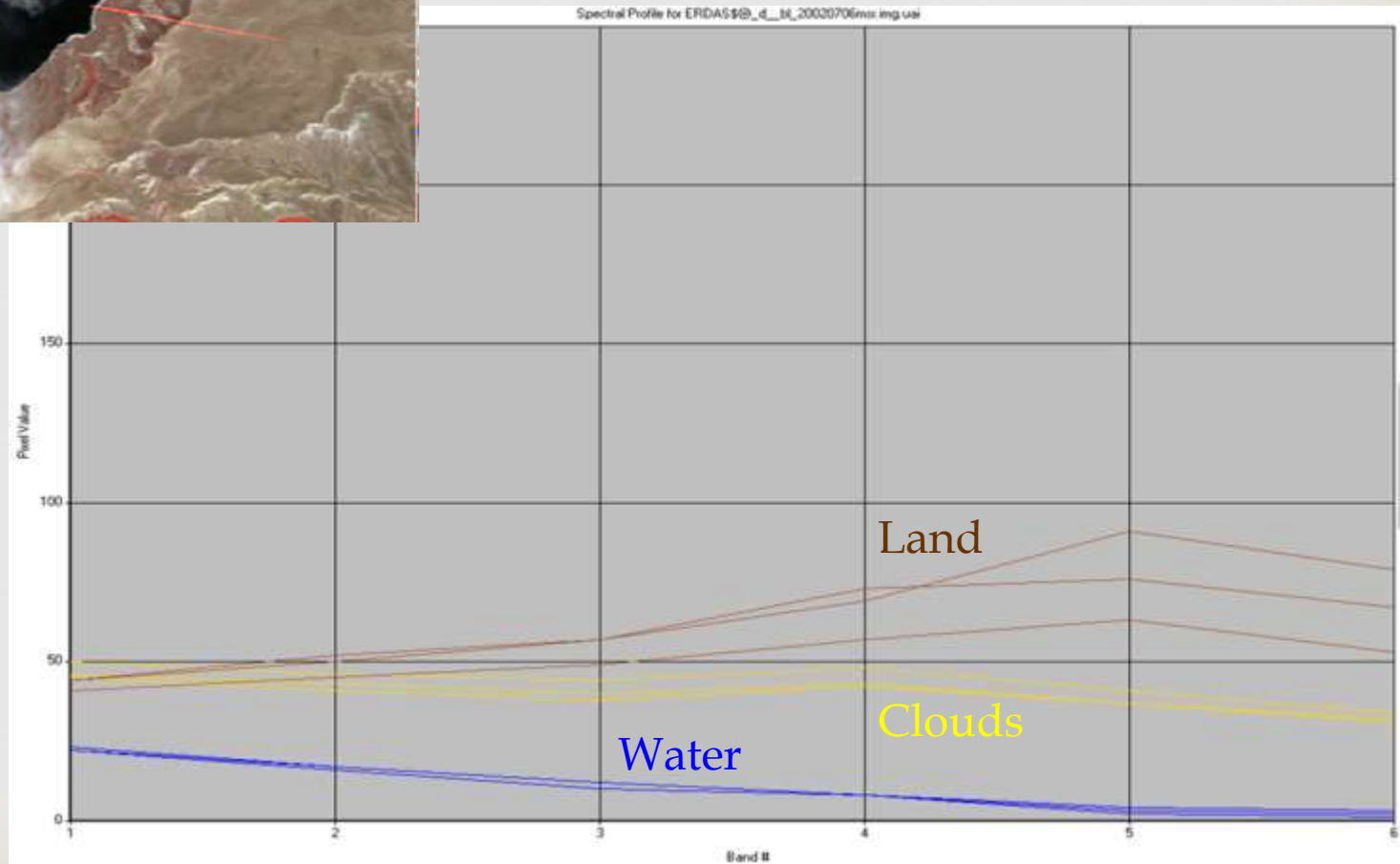


# Signatures when clouds are covering the water body

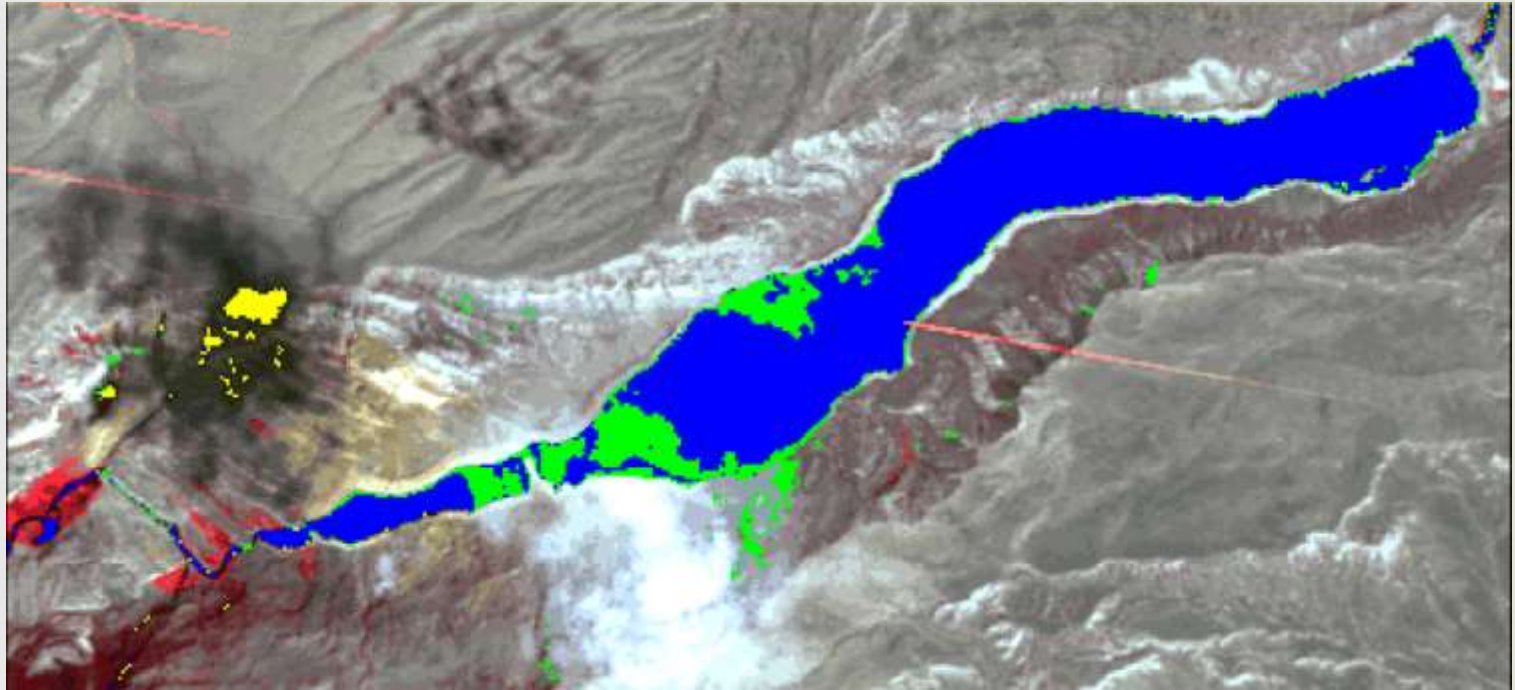


2002

Spectral Signature



# Clouds over Water Classified Image



**Green:** Reflectance values of clouds over water are similar to that of clouds over land

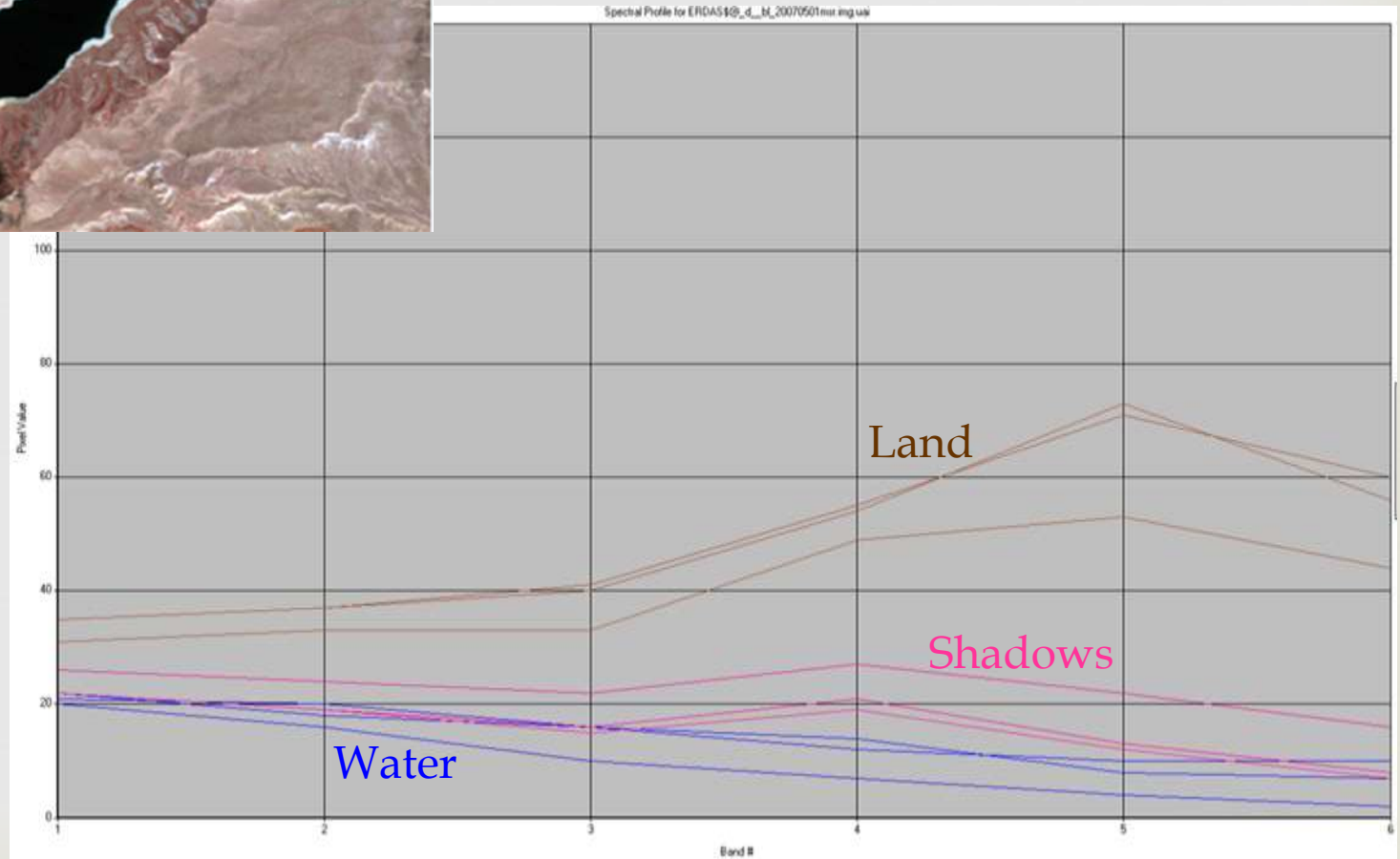
**Yellow:** Reflectance values of shadows are similar to that of shallow water

# Signatures when Shadows are Outside the Water Body



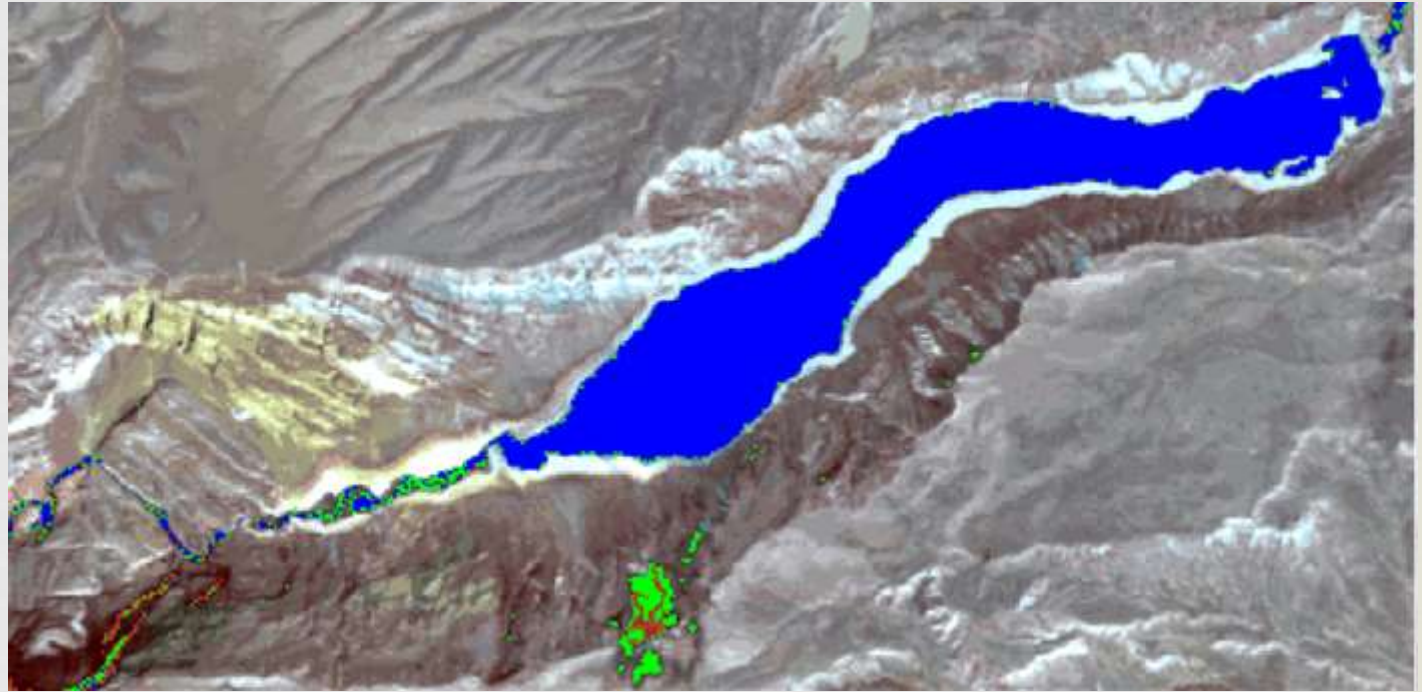
2007

Spectral Signature



# Cloud Shadows Outside the Water Body Classified Image

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**Green:** Reflectance value of shadows is similar to that of shallow water.



# Lessons Learned



## ☞ Clouds and Shadows

☞ Thin layer of clouds/shadows result in misclassification

☞ Over- or under-estimation of the surface area

☞ Location, location, location

☞ Away from the lake – they can be misclassified as water

☞ But can be manually removed

☞ Present along the shoreline or over water

☞ Limited to no-use

☞ Better cloud-shadow screening algorithm are required

# Acknowledgement



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(Department of Botany University of Wyoming)

# Works Cited



- ❧ Department of the Interior: Bureau of Reclamation (2013), Wyoming Lakes and Reservoirs. Retrieved April 20, 2013, from *Reclamation: Great Plains Region, Managing Water in the West*: [http://www.usbr.gov/gp/lakes\\_reservoirs/wyoming\\_lakes.htm](http://www.usbr.gov/gp/lakes_reservoirs/wyoming_lakes.htm)
- ❧ Desert USA (2013), Desert Environment: What is a Desert?. Retrieved April 20, 2013, from *Desert USA*: <http://www.desertusa.com/desert.html>
- ❧ Frazier, P. S., Page, K.J. (2000), Water body detection and delineation with Landsat TM data, *Photogrammetric Engineering and Remote Sensing*, 66 (12), 1461-1467.
- ❧ University of Northern Arizona (n.d.), The Remote Sensing Pages. Retrieved April 20, 2013, from *Department of Geography and Public Planning*: <http://jan.ucc.nau.edu/~geog-p/geog/RemoteSensing/>