VNIR - TIR Image Analysis of Yellowstone National Park

Lab #2: October 18, 2023
Due: November 8, 2023

I. Introduction

For this lab assignment, you will be investigating a time series of Yellowstone National Park *(September 1990, September 2000, and September 2010)*. The primary focus is to work with Thematic Mapper (TM) data collected from Landsat 5 on 9/14/90; only two years after the large wildfires devastated the park. You will then compare the image with ASTER data collected over the next two decades (9/8/00 and 9/29/10). You will be analyzing the data to infer surface land cover over time. Finally, you will also get an introduction to TIR data. The written report should be similar to lab assignment #1 and focus mainly on the latter parts of this handout. Before writing this report, make sure you incorporate any feedback from the TA on your first lab. Remember to turn in this completed lab document and email your write up to the TA by **November 2nd.**

II. Data Exploration

- start ENVI and proceed with the lab
- open the following file: ***TM091490*** in the lab#2 folder, but *don't* display an image yet
- first, go to *File → Edit ENVI Header* on the main menu and click on the file name.
  - what is the sensor type, pixel size, and wavelength region of this file?

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- now, create a *true color composite* from the data set and use the various stretches under the *Enhance* menu on the Image window to create an image that best highlights the ground features
- Describe which one you feel is the best and why?

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- open the Cursor Location / Value window by double clicking the image window, or by right clicking on the image, and selecting ***Cursor Location/Value…***
- scroll the cursor over the zoom window
  - what values are associated with each pixel? _____
  - can you figure out the spatial resolution of the image using this approach?

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- now open the ***TM091490.txt*** file (in the same folder) using *Notepad* or *WordPad* in Windows *(hint: right-click on this file and use the "Open With" command)*
  - take note of what this file contains and any possible important information

III. VNIR/SWIR: Spectral Analysis

- the raw DN values of a typical Landsat TM image must be converted to actual reflectance values
- this has already been done for you and saved as file ***TM091490_refl***
- load this file and open it in a new display window with bands 7, 4, 2 in R, G, B
- load the same band combination for the ***TM091490*** file in another display window and link the two files using *Tools → Link → Link Displays ...*
- call up the spectral plot window under: *Tools → Profiles → Z Profile (Spectrum)* for each window and compare the spectra for several regions
  - what do you notice between the two spectra for any given pixel, and do any of the reflectance spectra look familiar from the class notes?

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- finally, navigate to the following pixels by using: *Tools → Pixel Locator* tool and entering their pixel coordinates into the sample and line fields
- describe their spectra and a possible surface composition
- ***surface units:***
  - (3498, 3869) _____
  - (3339, 4100) _____
  - (3310, 4217) _____
  - (3132, 4147) _____

- to verify your identification, now open Google Earth and locate Yellowstone National Park
  - zoom in to the general area of the satellite image *(hint: look at the* rivers to help you locate yourself)
  - now try to identify the locations from above, zooming in until you can better see the surface units *(note that some features may have changed with time. Hint: the clock icon in Google Earth may help!)*

VI. Temporal Change

- go back to your Landsat TM ground reflectance image
- place the SWIR bands 4,7,5 into R,G,B, respectively
- open the ASTER SWIR file (***AST090800swir)*** from 2000 in a separate display
- place the SWIR bands 8,6,4 into R,G,B, respectively

- ***in your lab write-up interpret the observable differences on the ground between the two images and the physical processes that have occurred during the ten years from 1990 to 2000***
  - pay close attention to the fire scar boundaries and note any other differences in the surface units of this part of Yellowstone National Park

V. Image Classification

- on the main menu bar, click on *Classification* → *Unsupervised* → *IsoData* to bring up the classification tool window
  - select the ***AST090800swir*** file and click OK
  - in the IsoData Parameters window that appears, change the following:
    - Number of Classes: Min to 1 and Max to 5
    - click the *Memory button* and then Click OK

- you should now have a new file appear in the Available Bands List
  - load that file and describe the patterns of the five classes?

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- use Google Earth to help you verify/validate the classes
  - what do the main colors in the classification correspond to on the ground?

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- now go back to the *Classification* menu and click on *Unsupervised* → *K-Means* to call up a new classification window
- again, select the ***AST090800swir*** file and click OK
  - in the IsoData Parameters window that appears next change:
    - leave the Number of Classes set to 5
    - click the *Memory button* and then click OK

- load this *K-Means* file into a new display window
  - again, link the displays by using *Tools* → *Link* → *Link Displays ...* and click in either of the image window to "flicker" back and forth. ***Describe the similarities/differences in your report, and what may be causing them.***

- as you move around one image, the other will track your movements and if you click in one window the other image will appear
  - note an area where you see differences between the two classifications and describe that area *(use Google Earth to help if needed)*

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- finally, save one of these classifications images as a new JPG file in your home directory. *You decide which one relays more information*
- ***be sure to describe this figure and include it as Figure 1 in your report***

IV. Introduction to TIR data

- open the ***AST092910tir*** image and once again use the *File* → *Edit ENVI Header*.
- record the sensor type, pixel size, and wavelength region.

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- go to *Basic Tools* → *Preprocessing* → *Calibration Utilities* → *Calculate Emissivity* and click on *Reference Channel*
  - select the ***AST092910tir*** file**,** use ***band 14*** as the emissivity band (reference channel) and change the Assumed Emissivity Value to: **0.99**
  - save the temperature and emissivity files to memory

- load the temperature image into a display
  - what do you notice about the temperature of the regions of the image (particularly those that you examined using the VSWIR data)? Where is the hottest temperature pixel located? *(hint: histograms and density slices are your friend here!)*

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- ***plot the emissivity spectrum of that pixel, include it, and describe it in you report as Figure 2. Remember to label the axes and give your plot a title***.
- Hint: place the emissivity image in another display window and link the two images. You can navigate to the hot pixel in your temperature image and the spectrum in your emissivity image should correspond to that hot pixel
- you can choose to end here or proceed to section VII below for extra credit

VII. 2021 Caldor Fire, California ***(optional Extra Credit for up to 10 additional pts.)***

- this lab focused on the time frame following a large wildfire; however here you will investigate an active wildfire: the 2021 Caldor Fire that burned between August 15 and October 6, 2021
- you will use ASTER nighttime TIR data collected on August 30, 2021
- load the ***ASTER_TIR_active_wildfire*** image and open it in a new display window with bands 14, 12, 10 in R,G, B
  - investigate the scene and find the wildfire. *(Hint, look for the bright pixels)*

- under the *Enhance* menu on the Image window, perform a *(Image) Linear* stretch enhancement
  - how does this change you interpretation of the active fire region?

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- now, using the *Reference Channel* approach described in section VI, determine the maximum temperature of the wildfire. _____
- next, use a density slice and put the top 10% of the highest temperature into a group colored red
  - where do these hottest pixels tend to group in relation to the fire?

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- from the ASTER TIR data can you determine the direction of fire spread?

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- **Include the temperature image with the top 10% density slice applied as Figure 3 in the report, being sure to describe it**