Assignment 4:
Introduction to Image Enhancement using Focus

REMS 5001

Overview

Whether to improve human interpretability or machine computations, image enhancements play an important role in the analysis of remotely sensed imagery.

For this assignment you will create and compare two permanently enhanced Landsat composites using PCI Focus: one with a "standard" enhancement (using default options), and a second custom enhancement that emphasizes a specific land cover or theme of features (e.g. forestry, water bodies, urban features, etc.).

A guide to performing the various tasks for this lab within Geomatica Focus has been included. Please read it (and this handout) through carefully before beginning.
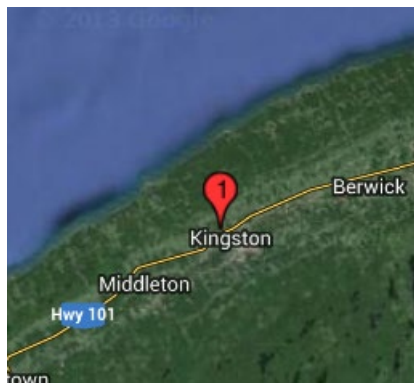
Requirements

Downloading Imagery

Begin by downloading a Landsat scene covering a location of interest. This can be anywhere in the world, but consider choosing a location with a variety of land cover types (forest, agriculture, urban, etc.).

There are many collections of Landsat imagery available for public access. The United States Geological Survey (USGS) offers a vast archive of Landsat imagery that is accessible through their *USGS Earth Explorer*:
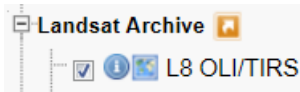
http://earthexplorer.usgs.gov/

You will have to set up an account with them and be logged in to download data. So create an account from the top right corner of the screen.
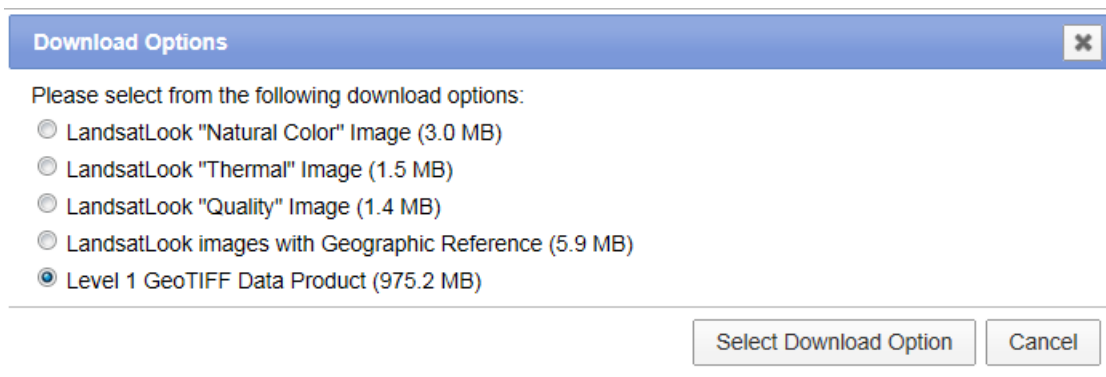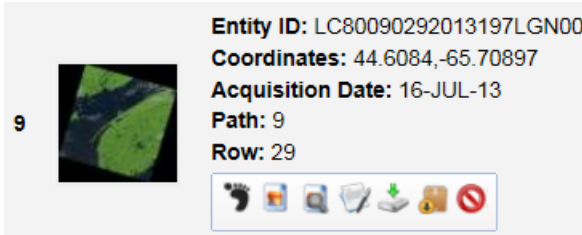
Place a marker where you want to download imagery, or zoom to your area of interest and select the "use map" option in Earth Explorer.

Choose a Landsat archive. 5, 7 (slc on), or 8.

Go to *Results* and locate & download your scene of choice. It's a good idea to note the file name, acquisition date, path and row numbers since this information is a requirement in the data reference.

Ensure that you download the *Level 1* product. Please note, some scenes may not yet be processed and requesting one will have it placed into a cue (a download link will not be immediately available). It can take 2 to 3 days for the imagery to be processed - please take this into account when choosing your scene. This is typically not an issue.

Image Preparation

Before you can perform your image enhancements, you must first extract the Landsat imagery from the downloaded file and create a pix file from the metadata file. As an alternative to the *Importing Multi-File Imagery* section in the *PCI Guide 1* document, you can add the downloaded file to Focus by dragging the `*_MTL.txt` file into the map window. This text file is the scene's metadata.

Once the `PIX` file has been created, clip a subset of the imagery (**A4_*YourSurname*_clip.pix**) to focus in on an area (~30 km x 30 km) of interest to you (a "study area").

Finally, rename each band in your (clipped) `PIX` file to describe their content (e.g. Blue, Green, Red, NIR, etc.) as this will ease viewing composites and analyzing the spectral bands later in this assignment.

Image Enhancements

Begin by choosing a color composite for your study area image (the clipped PIX file). Consider your choice of spectral bands; what features are present within the scene and which are you most interested in analyzing (e.g. forestry practices, water resources, urban sprawl, sediment load, etc.). Spectral plots or profiles may be helpful in deciding which bands are most "separable" for those features.

"Standard" Enhancement

Since your PIX file contains raw Landsat DN values, you will need to apply an enhancement to improve the overall quality of contrast throughout the scene. Experiment with the various "standard" enhancements in Focus (e.g. Linear, Root, Adaptive, etc.) and decide which performs "best" for your choice of land cover types.

Save the look-up tables (LUT's) for your enhancement and then test them in Focus by opening your Landsat scene in a new project. Finally, permanently save your LUT enhanced composite as new raster layers in your `PIX` file and again test it by loading the scene into Focus (remember to turn off the automatic enhancement). If the enhancement has been correctly saved to file, the new image should appear as your enhancement does without applying an enhancement function in Focus.

Custom Enhancement

Using the same (non-enhanced) composite, experiment with the look-up table (LUT) editing tools (cut-off & saturation levels, brightness, enhancement functions, etc.) to produce a custom enhancement that is well-suited for your choice of land cover type or theme of features. Be sure to take careful notes on your technique as they will help you explain how to re-create this custom enhancement in your poster.

Consider using a "mask" (or *bitmap*) to study the DN values of your feature(s) of interest. This mask can be used with the histogram tools within Focus to help you determine suitable DN ranges for the *LUT Editor*.

The ability to identify (e.g. coniferous vs. deciduous stands) or interpret subtle changes within (e.g. sediment in water features) the feature(s) of choice should be notably improved over your "standard" enhancement. Remember, that custom enhancements such as this are often achieved at the cost of contrast and visual quality of other features in the scene (e.g. bare soil fields stand out, but forestry is dark/black).

When you are satisfied with your custom enhancement, save your LUT's and permanently enhance your composite as before.

Exporting

Once you have created your permanent enhancements, export each enhanced composite into separate PIX files (`A4_yoursurname_stan.pix` and `A4_yoursurname_cust.pix`). These PIX files must only contain the 3 bands you used and must have the enhancement saved. Confirm that the export and enhancement was successful by loading the PIX images into a new instance of Focus, ArcGIS or GlobalMapper; they should not appear "dark". Note, if you wish to import your image into PowerPoint (or the software you will use to make your poster) you will have to save your image as a tiff or jpeg using the *Export Map* tool under the *File* menu.

Image Interpretation & Analysis

Review your *custom* enhancement and consider how it has improved the interpretability of your selected land cover type(s) as compared to the *standard* enhancement.

How well does your custom enhancement ease your ability to identify or delineate those features? What feature characteristics do their new "colors" represent or exaggerate? What shortcomings did you encounter and what possible improvements do you feel would improve these results?

Summarize your thoughts on these topics and include them in the discussion section of your poster. Be sure to draw on specific examples, using figures & annotation to show the reader the feature(s) of interest.

Note that enhancements inherently change the spectral relationships between bands. Be sure to keep this in mind for any quantitative analysis (e.g. spectral plots) you perform. You may want to use the original (unenhanced) imagery for such work (or for comparison to enhanced values).

Deliverables

Poster

Create a 24 x 36 poster (300 dpi minimum) that presents your standard and custom enhanced imagery (i.e. the GeoTIFF). The poster must be in PDF format and ensure that at least the following items are included:

- overview of project & goals
  - purpose of enhancement

- description of study area
  - including a locator/context map

- discussion of processing performed
  - data preparation
    - download (including settings / parameters), clipping
  - choice of spectral bands
    - why those 3 bands? did you use a spectral plot or profile to choose?
  - choice of enhancements (standard and custom)
    - explanation of enhancements (how do they work?)
    - why that particular function & range of DN values
    - consider including screenshots of histograms of original vs. enhanced

- discussion of enhanced imagery
  - what "colors" do various features appear in the enhancement? Why so?
  - how does your enhancement improve the interpretability of the image?

- data sources & meta-data
  - source/provider
  - spatial coordinate system (projection & datum)
  - platform, scene path/row, acquisition date
  - software / affiliation logos
  - disclaimer

The imagery on the poster should be of suitable size; large enough such that fine details (e.g. roads) are clearly visible, but not so large as to appear "pixelated" (blocky-looking).

Do not submit a detailed procedures (i.e. button-by-button actions) section for this assignment. Instead, describe the steps you took assuming the reader understands enhancements and knows how to operate the software.

Discuss what tasks you performed, what decisions were made, the results obtained and any improvements that could be made (i.e. hind-sight). In addition, be sure to provide the details necessary to enable the reader to assess (accuracies, issues, etc.) and reproduce (parameters, options, etc.) your work.

Digital Data Deliverables

The PIX files, and poster for this lab are to be zipped into a file named **A4_*YourSurname*.zip** and submitted to the associated assignment on Brightspace. This folder should contain your unenhanced clipped composite, standard enhanced clipped composite, & custom enhanced clipped composite. The naming convention for the deliverables is shown below. There will be a penalty for incorrectly named files.

1. Clipped Composite (RGB & no enhancement): **A4_*YourSurname*_clip.pix**
2. Clipped Composite (standard enhancement): **A4_*YourSurname*_stan.pix**
3. Clipped Composite (custom enhancement): **A4_*YourSurname*_cust.pix**
4. Poster: **A4_*YourSurname*.pdf**

Evaluation

The evaluation criteria for this lab will be weighted as seen in the rubric that is associated with the grade item on Brightspace. The rubric provides a good guideline as to what is expected.

Description	Value
Poster	75%
Digital Images	25%

Due: Wednesday, November 13th , 2024 @ midnight.