

Demo 05: Working with satellite imagery

This lab will teach you some of the key techniques to working with multi-spectral satellite imagery. You will learn how to process Landsat satellite data downloaded from governmental sources and perform a series of standard analyses. This will be a somewhat less intense lab, but by the end you should have a new Landsat image for your study area along with a series of useful data created from this image.

I. First, prepare the demonstration data

- a. Download and extract **Demo5_Data.zip**
 1. Make sure you save it someplace permanent
- b. Launch ArcMap.

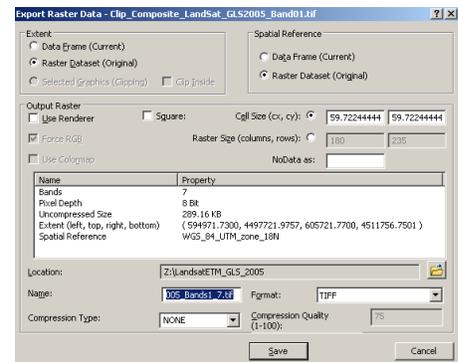
II. Layer Stack: Combining layers stored as multiple files into one multiband image

- a. When you download most multispectral satellite imagery each band comes as a separate gray-scale image file.
- b. The image we will be using here is a Landsat ETM+ image from 2000. So you should have 8 files, each called **Landsat_ETM_GLS2000_Band##.tif**
- c. Our first task will be to stack these into one image
 1. This will let us see more than one band at time, in the Red Green and Blue “Guns”
 2. Also, few GIS tools will work with the bands as separate files.
- d. To stack these images together
 1. First, add all eight of the images into a new ArcMap document.
 - i. Before proceeding, verify that you have a spatial reference by looking at the coordinates in the bottom right corner.
 2. In the Table of Contents, put the images in ascending order (Band 1 above Band 2 etc)
 3. Now look at the individual images. Try to get a sense for what each band is.
 - i. Pay special attention to Bands 6 and 8
 - a. Band 6 is the lower resolution (60 m) Thermal Infrared.
 1. In this case the file has the same resolution as the others, even though it does not look like it. I did this to overcome a glitch in the new version of ArcGIS.
 - b. Band 8 is the higher resolution (15 m) Panchromatic band (it is basically like a black and white photo, though it also includes the near infrared wavelengths as well)
 - ii. Our final image will have the resolution of the highest resolution band.
 - a. Each lower resolution band will have repetitive data (i.e. duplicate pixels)
 - b. Band 8 is the highest and it repeats data elsewhere.
 - c. Thus, if we include it, all of the other bands will have repetitive data and the file size will be huge
 - d. So, we will leave Band 8 out of our layer stack.
 1. It has useful information and we will use it later, so you should still save it.
 4. Now, go to the Image Analysis window (**Windows** → **Image Analysis**)
 5. Holding Shift or Control click on bands 1 -7 in the Image Analysis window
 - i. They should all be selected
 - ii. Double check that they are in the correct order before proceeding
 6. In the **Processing** section, the Composite Bands  tool should now be available. Click it
 7. You should now have a temporary layer called **Composite_Landsat_ETM_GLS2000_Band01.tif**
 - i. This image is all 7 of the bands stacked into a single image (even though it says Band01).
 - ii. If you go to **Layer Properties** (double-click on the layer name) you can set which bands are being displayed.
 - iii. Set the bands to 4 in the Red Gun, 3 in the Green and 2 in the Blue. This is the standard display for Landsat, it shows the differences in the near Infrared well.

8. At this point you could make this permanent, but because this image covers all of Michiana we will first crop it.
9. Once you are satisfied with the layer stack, you should remove layers 1-7 (but make sure you leave 8)

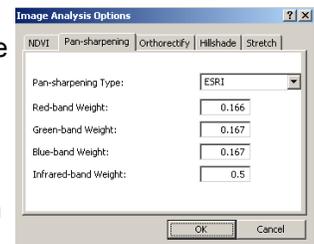
III. Cropping Imagery

- a. Just like last week we will now crop both our new Layer Stacked Landsat image and the panchromatic Band 8 to the extent of your study area.
- b. For the demo, I will be using the extent of the South Bend East and West quad sheets, but you can follow along with your own Quad Sheet.
- c. You should now add the **IN_QuadIndex.shp** layer.
 1. This is the same file that we have used before
- d. Put the **IN_QuadIndex** on top and symbolize it as transparent with a colored boundary.
- e. In the Image Analysis window select the raster layer to be cropped:
 1. Start with **Composite_Landsat_ETM_GLS2000_Band01.tif**
- f. In the main viewer, use the Select Features tool () to select the feature (rectangular polygon) representing the South Bend East and West quad extent.
- g. Finally, in the **Processing** section of the **Image Analysis** window click on the Clip () tool
- h. This will create a new temporary layer that is clipped to the extent of the selected feature.
 - i. Here it is called **Clip_Composite_Landsat_ETM_GLS2000_Band01.tif**
 - ii. You may not be able to see it until you turn the original layer invisible.
- i. Save the temporary layer (as above with the disc icon in the Image Analysis window)
 1. This will bring up the **Export Raster Data** window
 2. Leave most of the options alone.
 3. You set the location and the file name separately here.
 4. Click on the open folder icon () to navigate to the folder you want to save the file in.
 - i. Make sure to save it to a permanent location like an external hard drive or a USB stick,
 5. Call the file **Landsat_ETM_GLS2000_Bands1_7_South_Bend.tif**
- j. You should now repeat the process of clipping and saving with **Landsat_ETM_GLS2000_Band08.tif**
 1. Call the clipped file **Landsat_ETM_GLS2000_Band08_SouthBend.tif**
- k. Remove all of the temporary files (keeping just the new ones you saved)
 1. At this point you should no longer have images that are all of Long Island



IV. Pan-sharpening

- a. Band 8 of Landsat imagery is ideal for Pan-sharpening the other bands.
 1. We can set the properties for how the pan-sharpening is performed in the **Image Analysis Options**
 - i. You get to the options window by clicking the button () directly below the title of the Image Analysis Window and then choosing the Pan-Sharpener tab.
 - ii. Here we can change algorithm used and the weights applied to each band based on the spectrum sampled by the panchromatic band.
 - iii. Just leave it with the default values for now.
- b. Make sure that both **Landsat_ETM_GLS2000_Band08_SouthBend.tif** and **Landsat_ETM_GLS2000_Bands1_7_South_Bend.tif** are present in the Table of Contents
- c. In the Image Analysis Window, Control or Shift Click to select both of these images.
- d. Now you simply click on the **Pan-Sharpener** button () in the Processing section of Image Analysis
 1. The program determines which is the higher resolution and created a new temporary file.
- e. Save this temporary file to your external drive.



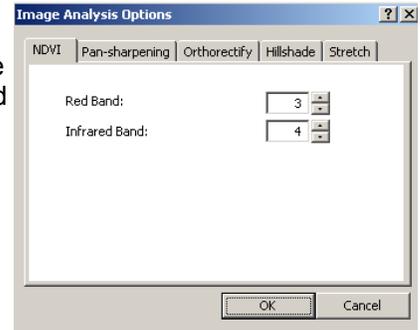
1. **Landsat_ETM_GLS2000_PanSharpened_South_Bend.tif**

V. Vegetation Index

- a. There are several vegetation indices that can be run on satellite imagery.
- b. Here we are just going to use the easier one, the NDVI
- c. NDVI can be run through the **Image Analysis** Window, so make sure it is visible.

1. First, we must set the options by clicking the button () directly below the Title of the Image Analysis Window.

- i. Choose the NDVI tab.
- ii. This time, the setting are actually important. Not all satellites sample the same wavelengths in the same bands. So, before we can run the NDVI we need to tell ArcGIS which band is red and which is the near Infrared
- iii. Here, we are using a Landsat ETM+ image, so the Red is 3 and the Infrared is 4.
 - a. These details are in the lecture powerpoint
 - b. For Landsat MSS (the older sensor) it should be 2, 4
 - c. For ASTER it should be 2, 3.
- iv. Click OK to exit out of the Options



- 2. Select the Multispectral image in the Image Analysis window
 - i. Mine is **Landsat_ETM_GLS2000_Bands1_7_South_Bend.tif**
 - ii. Make sure you are not selecting the Pan-sharpened image
- 3. Then click the **NDVI** tool () in the Processing section.
- 4. This temporary layer is scaled from 0 to 200 with higher values indicating denser / healthier vegetation
- 5. I hate the default color choice here, so I would recommend changing it to something that makes slightly more sense.
 - i. Double-click on the name of this temporary layer in the Table of Contents.
 - ii. Go to the Symbology tab.
 - iii. On the left, under "Show:" change it from **Colormap** to **Stretched**
 - iv. It defaults to a black to white scale. You can change this if you want.
- 6. Now you should make this layer permanent the same way you did before
 - i. Call it **NDVI_SouthBend_Landsat2000.tif**

