1. **Mosaicing (joining images), Filtering (smoothing images), and Contrast Enhancement**
2. **Image windowing (subsetting / cropping)**
3. **IDRISI to ArcMap**

Task #1: Mosaicing (joining images), Filtering (smoothing images), and Contrast Enhancement

Introduction:
Mosaicing is the seamless joining or stitching of adjacent imagery. Joining Landsat imagery that was collected along the same satellite path (one image taken after the other) is straightforward: with very little time elapsing between imagery collection, the atmosphere and sensor properties do not change (that much). However, when joining adjacent imagery from *different* paths, several days to a couple of weeks can pass. As such, there is a need to adjust the radiometric differences between the images in an effort to make the join appear seamless. Mosaicing is not a perfectly clean process: it often requires additional image processing to remove some of the 'noise' near the stitch. This can be achieved through 'filtering'.

Filtering uses a neighborhood of pixels (e.g., 3x3, 5x5) to make improvements to an image and/or to highlight something in the image. As examples, 1) a filtering process called 'smoothing' uses a roving window (neighborhood analysis) to eliminate noise in an image, and 2) a filtering process called a 'high pass filter' accentuates change between adjacent pixels to bring out linear features or to accent breaks between areas. A simple filter that smooths out the high and low DNs is a mean filter. You'll use this filter on the set of image that you moscaic.
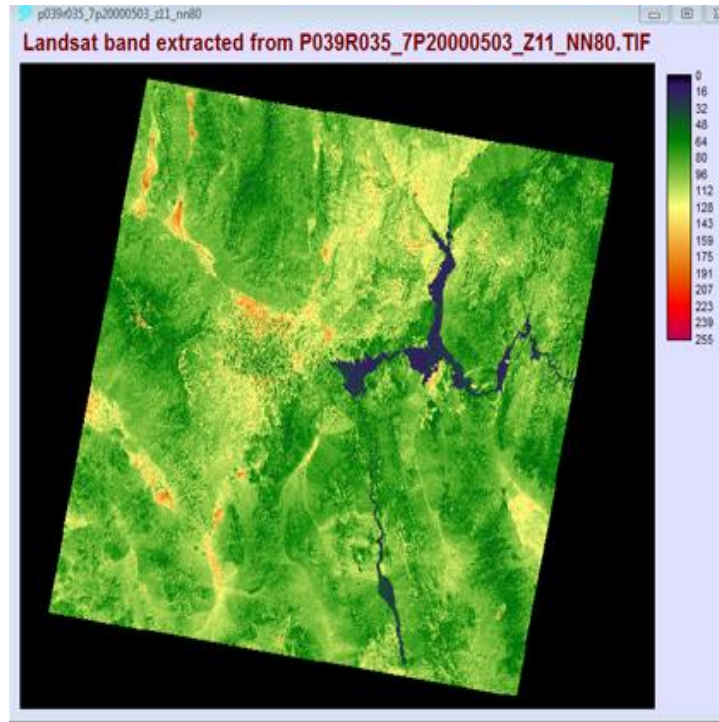
Contrast enhancement lets a user maximize or stretch a range of useful DNs in an image. The contrast enhancement process helps distinguish patterns, shapes, etc., on your image. It is a particularly helpful tool in contrast poor areas, such as snow cover or a bright desert surface. These areas typically display only a small range of the sensor's available radiometric resolution.

1. Make a folder in your z: or c: drive called 'mosaic'
2. Using the USGS Glovis site, **find and download into your 'mosaic' folder the following two Landsat TM 4/5 scenes:**
   a. Jan. 8, 2011 Path 17, Row 38
   b. Jan. 15, 2011 Path 18, Row 38
3. These two adjacent images cover most of south GA and a small bit of southeast SC. From east to west, the two scenes were collected Jan. 8, 2001 and Jan. 15, 2011, respectively.
4. Unzip the files, delete the zipped source files.
5. In IDRISI, create a new project that points to the folder in which you placed your two Landsat scenes. How do you do this? Ask your neighbor.
6. For both scenes, convert your 7 Landsat TM 4/5 bands from .TIF to .RST files WITH MATCHING BAND suffixes (and make sure you output the new files to the correct folder)
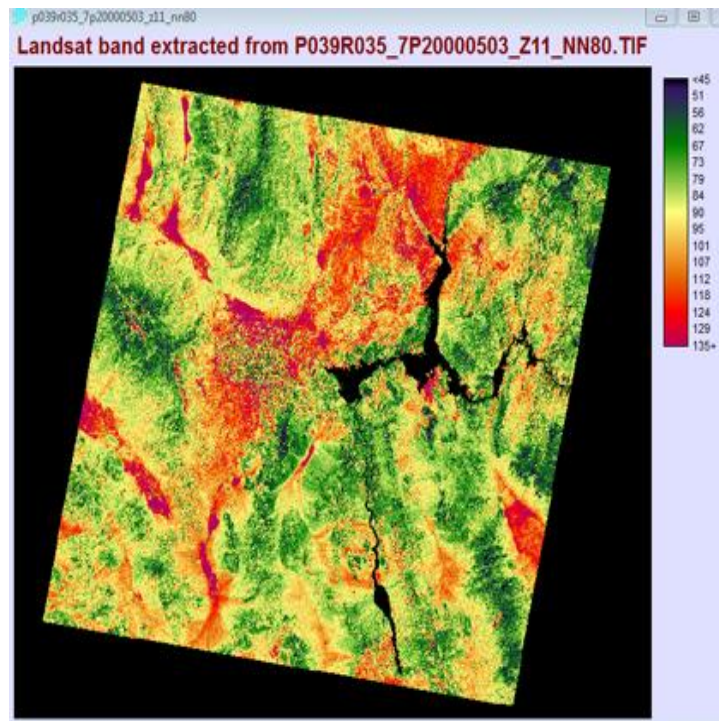
7. Open the MOSAIC tool: In IDRISI go: Image Processing > Restoration > MOSAIC
8. For this practice session, pick a band in the visible to mosaic. I picked Band 1 (this is blue on Landsat 4/5 TM).
9. Changing the 'Overlap method' to 'average' will produce less noise along the actual stitch between the two paths BUT --- leaving the default ('Cover') selected will not change the actual radiometric values as much (thus, if you plan to classify your data, use 'Cover' instead of 'Average').
   a. NOTE: You can use the MOSAIC tool to join many contiguous bands together (not just two like we are doing in this exercise).
10. Having just mosaiced, now is a good time to work with FILTERS. A good basic filter and one that removes annoying anomalously bright / dark DNs is a low pass filter.
11. In IDRISI, go: Image Processing > Enhancement > FILTER. Run a 'Mean' '3x3'. This will probably improve the overall quality of the mosaiced image. Experiment. Change the neighborhood size. Compare results.
12. Mosaiced image too dark? Too bright? Not enough contrast? Remember - you can always change / enhance the <u>contrast</u> of an image in IDRISI. *However, it's VERY helpful to first get to know your data in a histogram form.* Graphic histogram output can and **should** serve as a guide for contrast enhancement (coming up in a later step)!
13. To make a histogram of your image: Go: Display > HISTO. Set the 'Class width' to 1 and leave the other defaults. Click 'ok'.
14. You will probably see a lot of 0 values (this is the background of the image). This histogram is very flat and dull. We don't care about more than half of the DNs --- Those that have very low counts.
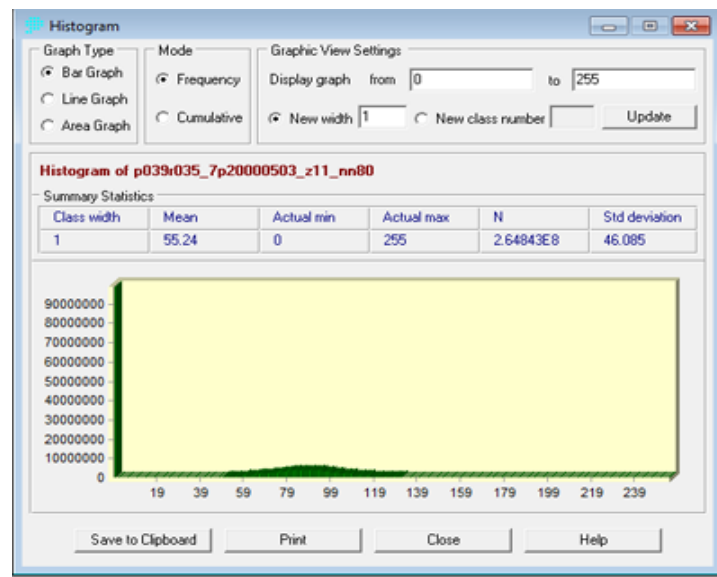
15. Change the 'from' and 'to' values in the "Graphic View Settings" to maximize the range. For example, from the histogram above, I'd use 45 to 135 (and then click on the 'update' button). *Basically, the histogram helps you decide how to set your contrast level.*
16. So.. by using 45 to 135 (instead of 0 – 255) my panchromatic image (in this case, of Las Vegas) changed from this:

Landsat band extracted from P039R035_7P20000503_Z11_NN80.TIF

to this:

Landsat band extracted from P039R035_7P20000503_Z11_NN80.TIF

17. After identifying the best 'from' and 'to' values for **your** mosaiced image, open up the 'Layer properties' of the image.
18. How exactly do you change the contrast values? In IDRISI: From the 'Composer' window, select the button for 'Layer properties'. Experiment with the 'Display Min' and 'Display Max' text boxes. Enter your end-member (from and to) values.

19. Delete both sets of Landat imagery and all other files from this Task to save space.

Task #2: Image Windowing (subsetting / cropping)

Introduction:
In some cases, remote sensing gurus (you!) will not be interested in all of the area covered by a particular scene (each Landsat scene covers 13,000 mi.^2). Processing an entire scene can be time and processor intensive. As such, it is important to know how to crop out (or, in IDRISI terms, 'window') the specific area of interest. In this task, you will extract from a Landsat scene the immediate area surrounding **Denver International Airport (DIA).**

1. From USGS Glovis, download the almost cloud-free Aug. 13, 2000 **Landsat 7 SLC-ON** scene that contains DIA. DIA is centered roughly at 39.85 N lat. and -104.67 long (Note: the minus sign for longitude means 'West'). Using the Glovis viewer, you can find the path and row numbers for DIA from the provided lat. / long. information.
2. I suggest making a new folder called 'dia' and starting a new IDRISI project in that folder (this makes the file import/conversion process easier).
3. As usual, unzip and import (convert) all bands from .tif to .rst.
4. Let's use Landsat 7 ETM+ Band 8 (what is this band?) to view the scene. This band is good because of the higher spatial resolution.
5. How do you find DIA? Use the histogram feature (Display > HISTO) to fine-tune the contrast settings. Remember: Take the histogram Min. and Max. (the 'hump' in the histogram) and place these values in the 'Display Min/Max Contrast Settings' in the Layer Properties 'Display Parameters'. I used 45 (Min) and 100 (Max) for a nice view.
6. Find and then zoom precisely to DIA like so:

7. Great. Now we have identified our area of interest (or 'region' of interest, ROI) using a 15 m spatial resolution image.
8. Now (**and this is important**) find the same area (centered on DIA) on **Band 3**.

9. So.. close Band 8, view Band 3, and again locate DIA.
10. Let's crop ('window') the DIA section using Band 3 as a guide.
11. In IDRISI, go: Reformat > WINDOW.
12. Move your cursor to the far upper-left corner of the zoomed in section of DIA on Band 3. Look at the lower left of your IDRISI screen for the 'c' and 'r' values (column and row). Write these down. They are the 'Upper-left column' and 'Upper-left row' pixel location values.
13. Move your cursor to the far lower-right corner of the zoomed in section of DIA. Look at the lower left of your IDRISI screen for the 'c' and 'r' values for this location. Write the location values down.
14. Next, enter the four values into the 'image window' screen in IDRISI.
15. In a moment, you are going to run a NDVI on the 'cropped' DIA section. *That means you should 'window' which two bands*? That's right -- Bands 3 and 4 (red and near infrared). Set up your values like so (see the image below)... Note: the 'Add prefix to file name' helps distinguish these 'cropped' images from the others in your 'dia' folder - **I strongly suggest that you use this feature (the intuitive prefix I used was 'crop_').**
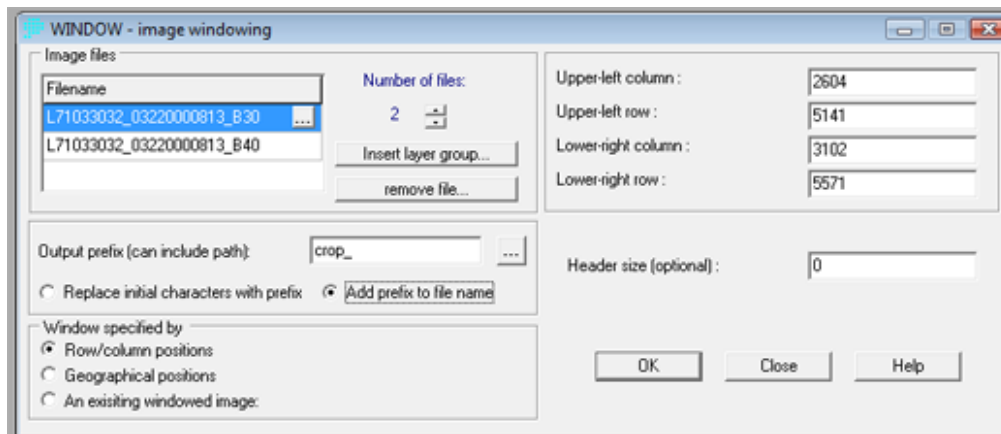
16. Note: Your column/row setting will be offset from mine.
17. Next, run NDVI on your new (smaller) cropped, or 'windowed' Bands!
18. In IDRISI, go: Image processing > Transformation > VEGINDEX. Use NDVI and use Bands 3 and 4. Save the new (Output image) .rst with a name like 'dia_ndvi'
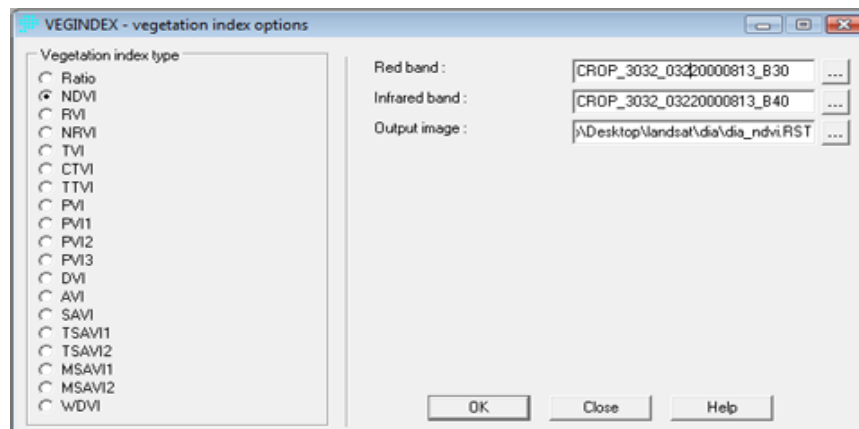
19. When you are done (and after adjusting the contrast of the NDVI a bit), you should see something like this:
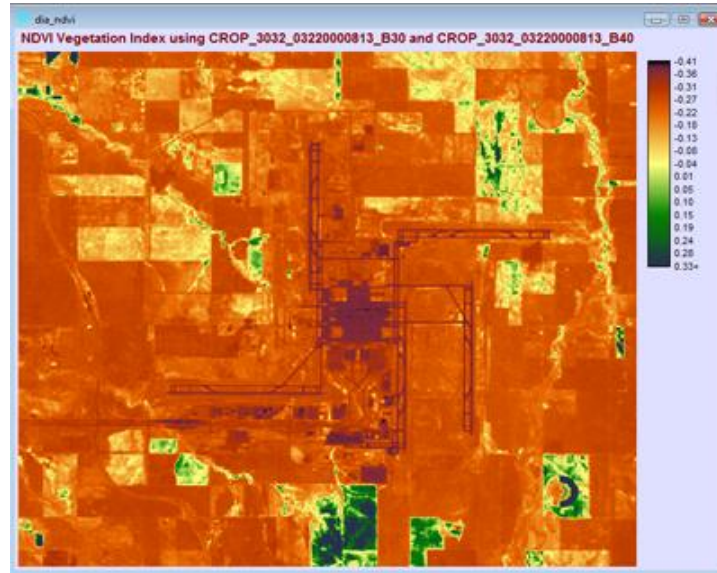
20. Can you tell where the agriculture / riparian areas are near our beloved DIA? Can you see runways, roads, and building roofs? I can!
21. DO NOT DELETE THIS IMAGE (dia_ndvi.RST) -- we'll work with it in Task 3!

Task #3: IDRISI to ArcGIS

Introduction:
For your GES4090 projects, many of you are using **a lot** of ancillary information. Groups in the class are including political boundaries, digital elevation models (DEMs), geologic maps, soils maps, hydrography maps, and TIGER files (and more)! These spatial data layers can (in most cases) be directly imported to IDRISI. However, most students in this course are more comfortable 'driving' in ArcMap. Also, ArcMap is perhaps better equipped than IDRISI in terms of raster-based spatial analytical tools. As such, it is important to know how to import IDRISI imagery into ArcMap.

1. ArcMap 10 can directly import IDRISI .rst images by using the 'Add Data' icon in ArcMap. This works fine if the only layer for processing is the .rst layer.
2. Open ArcMap and practice this. Import any .rst layer (like dia_ndvi.RST).
3. HOWEVER -- For your .rst images to match the projection of other USGS ancillary data (dems, DRGs, orthophotos, etc.), you should re-project the IDRISI .rst layers to LATLONG using IDRISI.
4. Open IDRISI and go: Reformat > PROJECT.
5. Navigate to dia_ndvi.rst (this file has a UTM-13n projection, which we'll change to LATLONG). Use the settings in the image below:
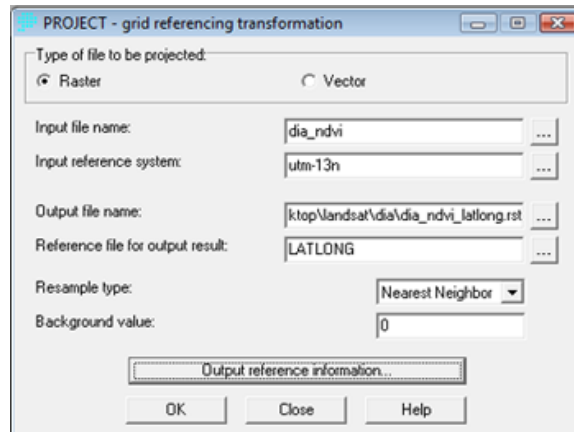
6. After this file has been projected to LATLONG, open it in ArcMap. You'll notice that the image will have reverted back to a grayscale. This is fine: Use the Layer properties > symbology to find a nice stretched color ramp:
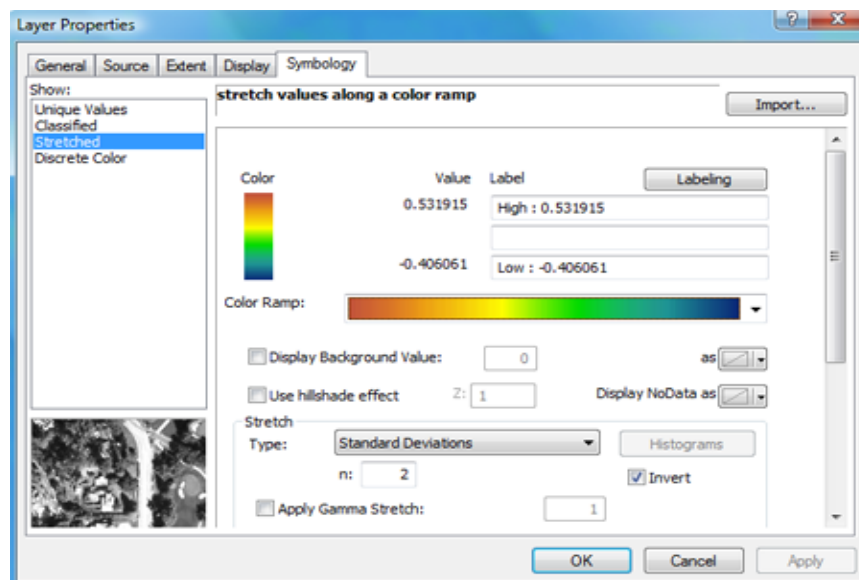
7. Now, let's add some ancillary data! How about a DEM?
8. Let's download a DEM that precisely fits the boundaries of the dia_ndvi_latlong.rst image.
9. Go to the USGS National Map Seamless Viewer and enter the SAME coordinates as your dia_ndvi_latlong.rst image. Here's how this is done (the window on the left is from ArcMap; the window on the right is from the USGS Seamless Viewer):
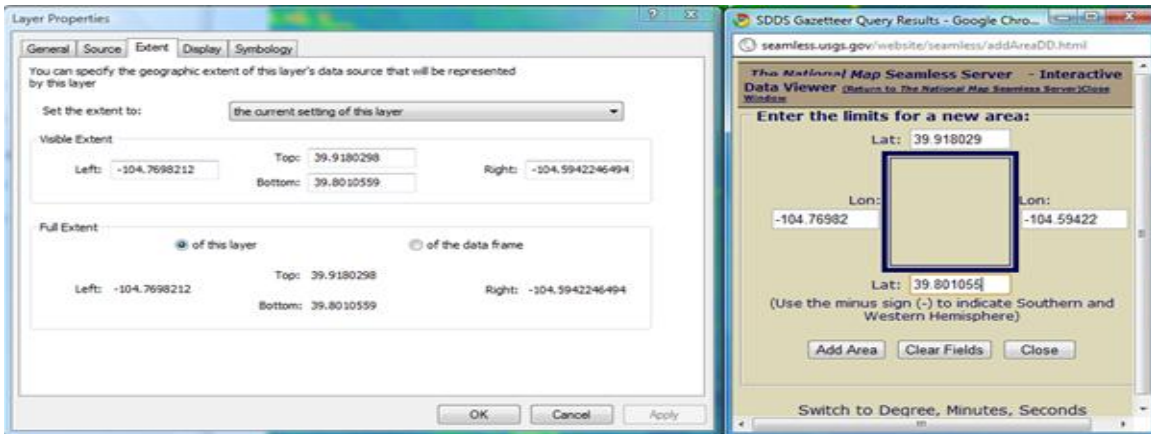
10. There are all sorts of layers available from the USGS - **vector and raster**. For this example, I selected 'National Atlas Airports, National Atlas Steams, National Atlas Roads, 1:100,000 DRG, and National Elevation Dataset (NED) 1/3 ArcSecond DEM. Download these layers (or others), unzip, etc., and import them into ArcMap. The images below show different screen shots from this project (note that the IDRISI-generated NDVI is part of the GIS)!
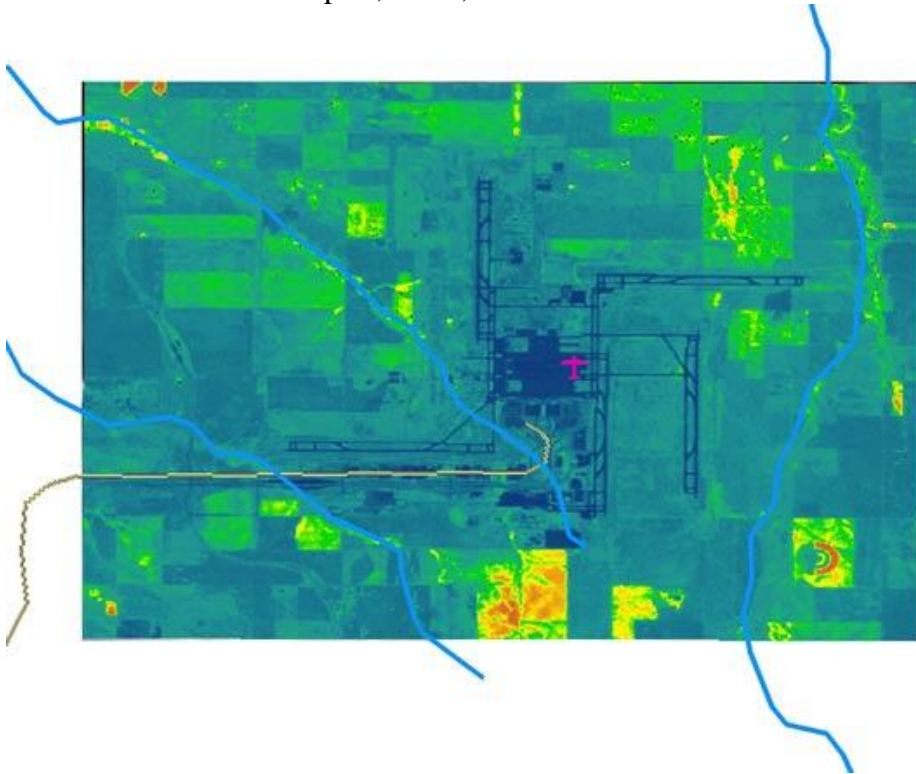
Here's DEM with airport, roads, and streams:

Here's a DRG with airport, roads, and streams.

Here's the NDVI with airport, roads, and streams.

11. A second method to open and manipulate IDRISI .rst files in ArcMap involves exporting the IDRISI format to an ERDAS Imagine (.img) format (strangely enough, the ESRI export formats are funny in that their pixels are a different size - stretched out vertically - and as such do not overlay properly in ArcMap).

12. Let's practice this export / import. In IDRISI, go: File > Export > Software Specific Formats > ERDIDRIS (ERDAS). This process will create a .img file that is easily imported into ArcMap.

13. Use the GreyScale palette (as in the image below):
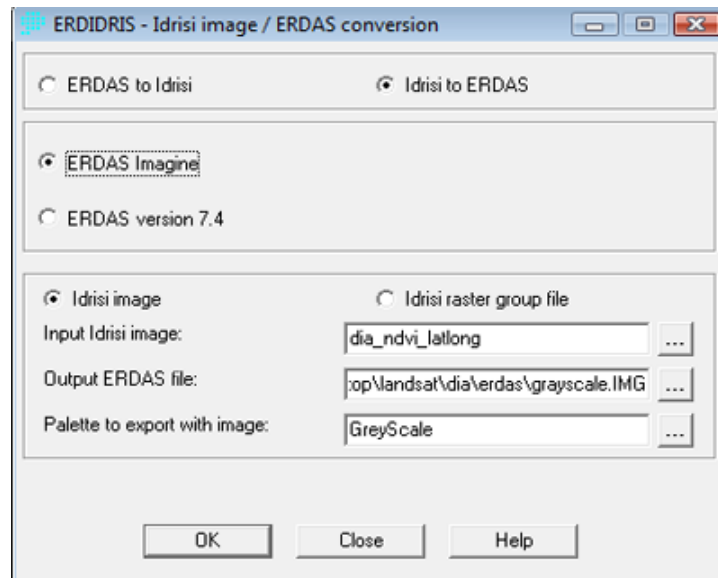
14. Next, with your new .img file created, open ArcMap 10. Use the 'Add Data' icon to add your .img file. Assuming you changed the projection of the .rst file in IDRISI to LATLONG, this export / add data process will work just fine with other USGS data layers.