GST 105: Introduction to Remote Sensing Lab Series

Lab 3.2: NDVI and Tasseled Cap

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Introduction

Band ratios and transformations are often created as additional image datasets that can be used in subsequent image processing steps or as derivative images that can provide additional information regarding land cover. This lab will focus on two common methods, the Normalized Difference Vegetation Index (NDVI) and the Tasseled Cap transformation. Students will run the NDVI using the Image Analysis window and Raster Calculator so they can gain experience using different methods to process imagery. An additional supplemental task is provided if the student is interested in exploring ModelBuilder and using a Python script to process imagery.

Your instructor may require that you provide screen captures, exported files and/or responses to review exercises. The review exercises included throughout the lab can also be found in the Review Exercises section. Please check with your instructor for the requirements specific to your class.

The Spatial Analyst Extension is required to complete this lab.

Objective: Perform NDVI and Tasseled Cap on a Landsat TM Image

This lab includes the following tasks:

1. Create an NDVI Dataset
2. Create a Tasseled Cap Dataset

Lab Settings

Required Virtual Machines and Applications

Windows Machine User Account	Train
Windows Machine User Password	Train1ng$

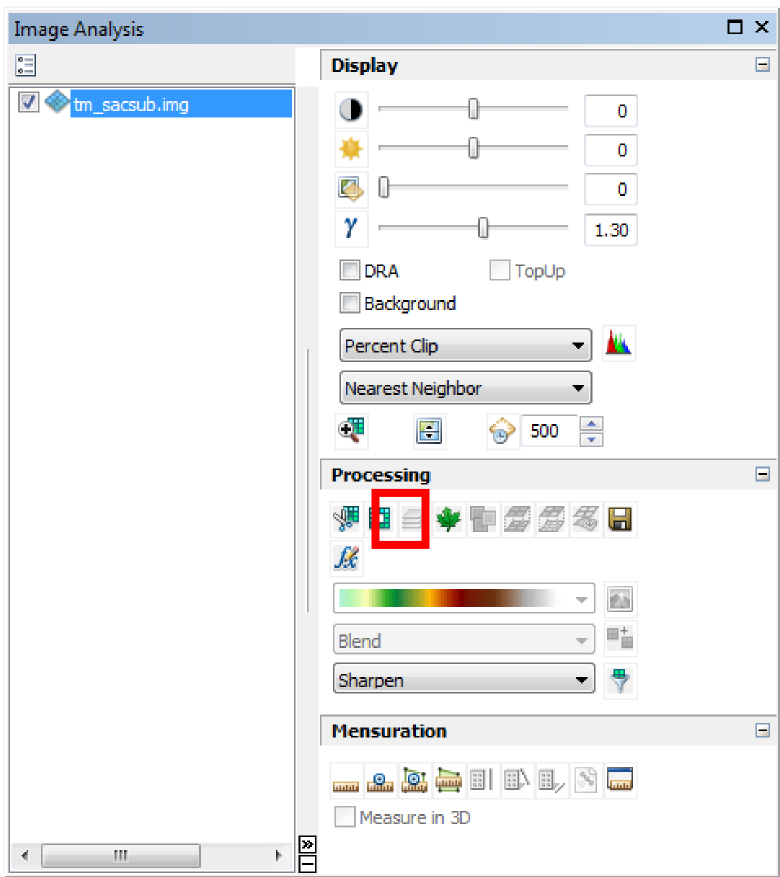
This lab will use the **tm_sacsub.img** file that is located in the *Lab 3\Data* folder.

1 Create an NDVI Dataset

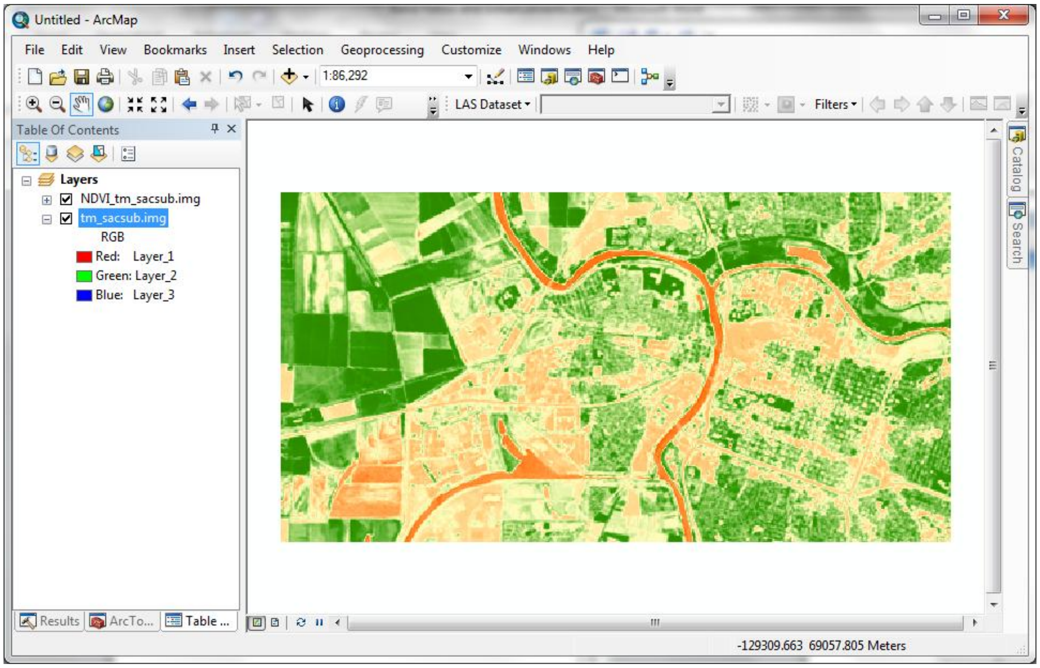
In the sub-sections below, we will explore three methods of creating an NDVI dataset.

1.1 Create an NDVI Dataset using the Image Analysis Window

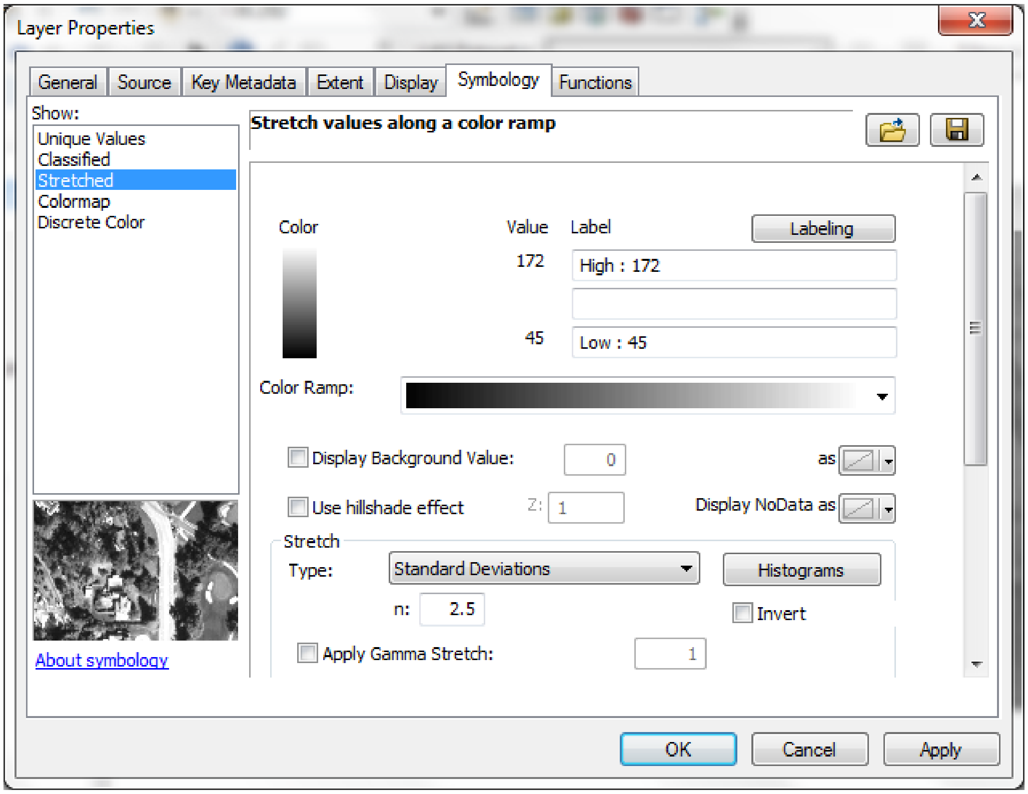
1. Log into the computer, using the information provided in the Lab Settings section.
2. Add **the tm_sacsub.img** into a blank map in ArcMap.
3. Activate the **Image Analysis** window.
4. Select the image and click the **NDVI tool** outlined in the image below.



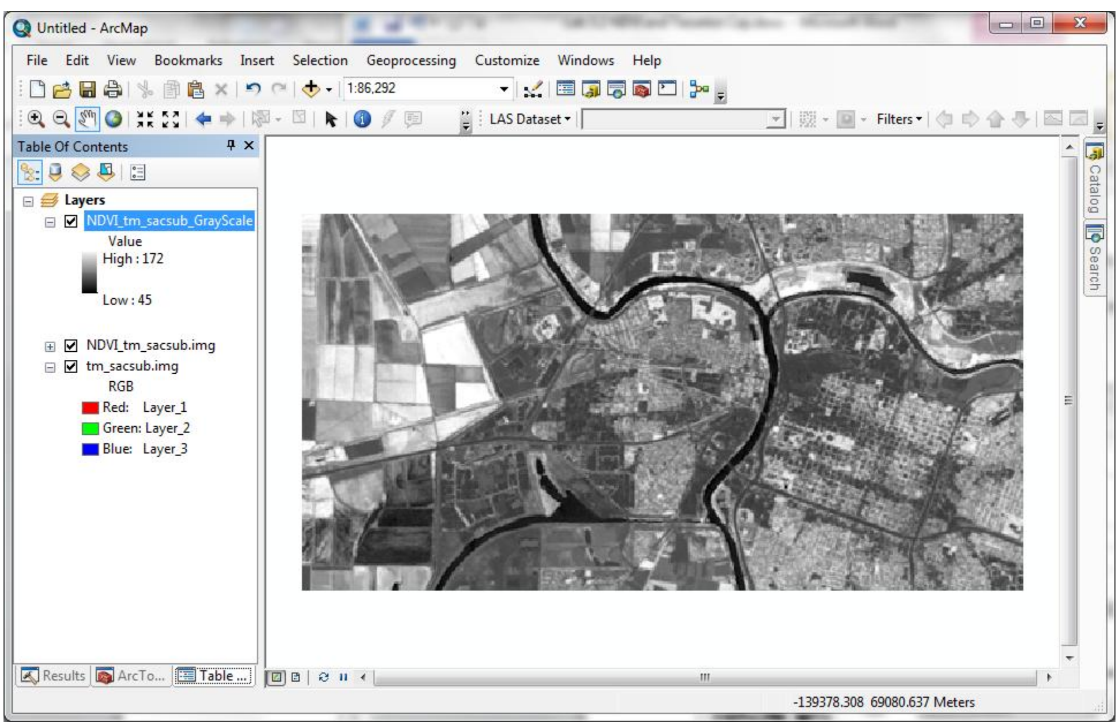
The following image appears in the map viewer.



5. Make a copy of this layer (by right-clicking on the **NDVI_tm_sacsub.img** file) and choose **Copy**.
6. **Paste** the layer into the Table of Contents.
7. Rename the layer **NDVI_tm_sacsub_GrayScale**.
8. Bring up the **Properties** for the grayscale image and choose the **Symbology** tab.
9. Click on **Stretched** in the left-hand column.
10. Choose **Standard Deviations** for the **Stretch Type**.
11. Click **Yes** to Calculate Statistics (if prompted, click **OK)**.



The image should now appear similar to the screen-shot below.



Comparing the two different visual representations for the NDVI image, answer the following:

Make sure to consider the NDVI algorithm and the sensor bands used in the NDVI computation.

Exercise A: *How many bands are in each (the color and the gray scale) NDVI image?*

Exercise B: *What do the various colors represent in the colorized NDVI image?*

Exercise C: *What do the bright and dark areas represent in the grayscale image?*

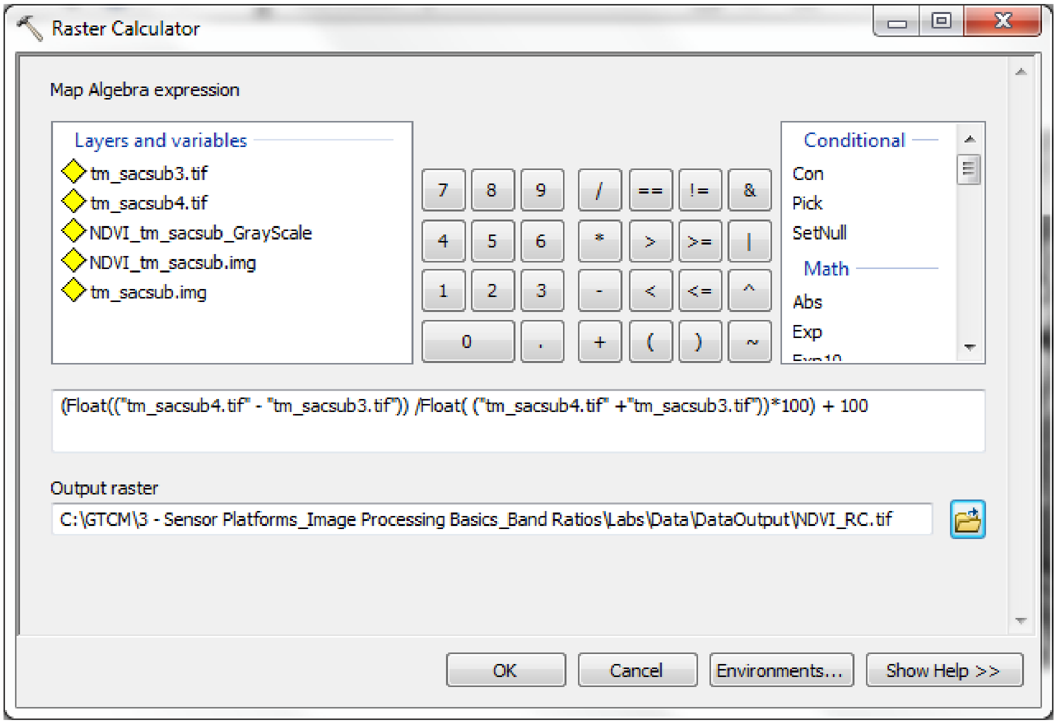
1.2 Create a NDVI Dataset using the Raster Calculator

Make sure to have the Spatial Analyst Extension turned on.

1. Turn off all of the image datasets in the map viewer that were created in the previous section. Do not delete them.
2. Add the individual band files **tm_sacsub3.tif** and **tm_sacsub4.tif** to the Table of Contents.
3. Go to the **Spatial Analyst** toolbox and select the **Map Algebra** toolset and choose **Raster Calculator**.
4. Add the following syntax to the Raster Calculator. It is critical to add the syntax exactly as shown below. Incorrect syntax will result in either erroneous results or errors in processing the NDVI algorithm in the Raster Calculator. Create a ***\DataOutput*** folder if one does not already exist and set as the output location.

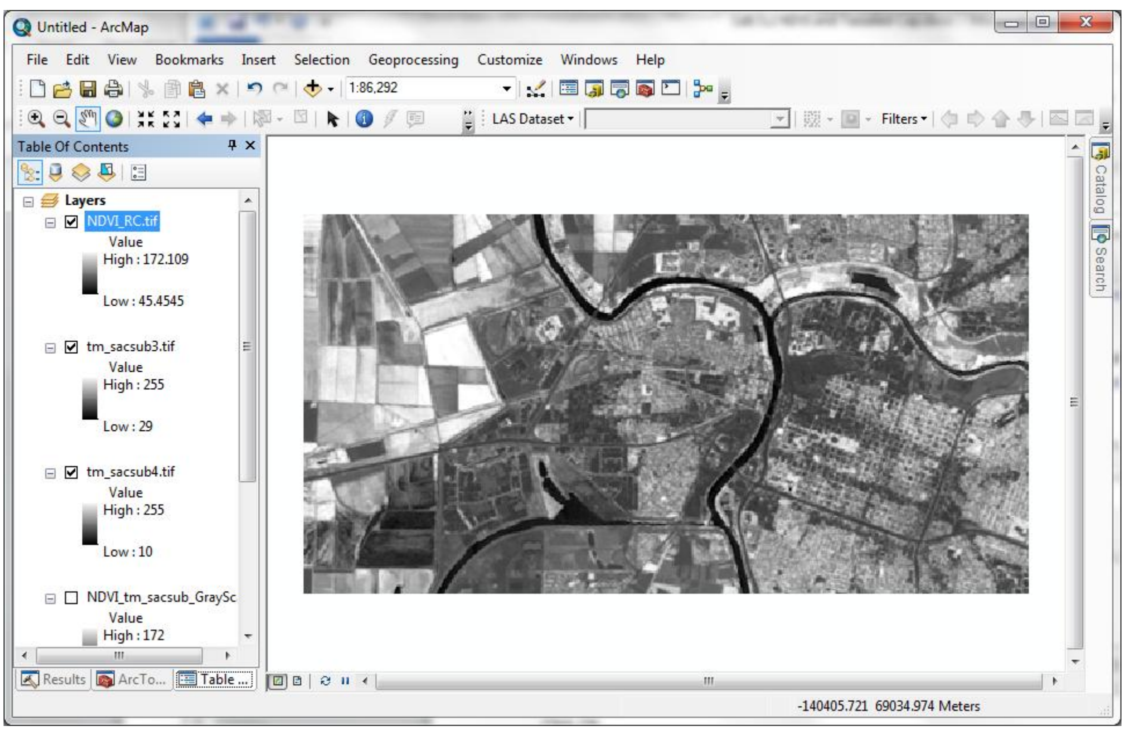
```
(Float(("tm_sacsub4.tif" - "tm_sacsub3.tif")) /Float( ("tm_sacsub4.tif"
+"tm_sacsub3.tif"))*100) + 100
```

5. Choose a name for the output raster.



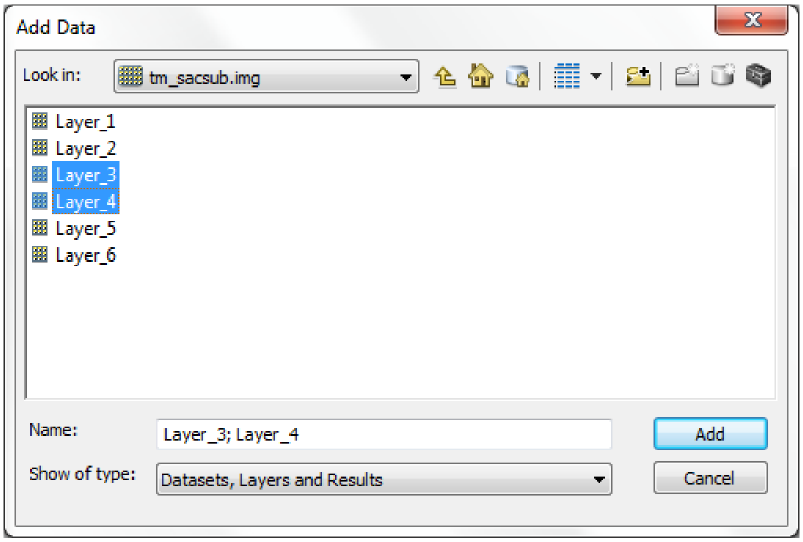
6. Click **OK**.

The map viewer should look similar to the image below.

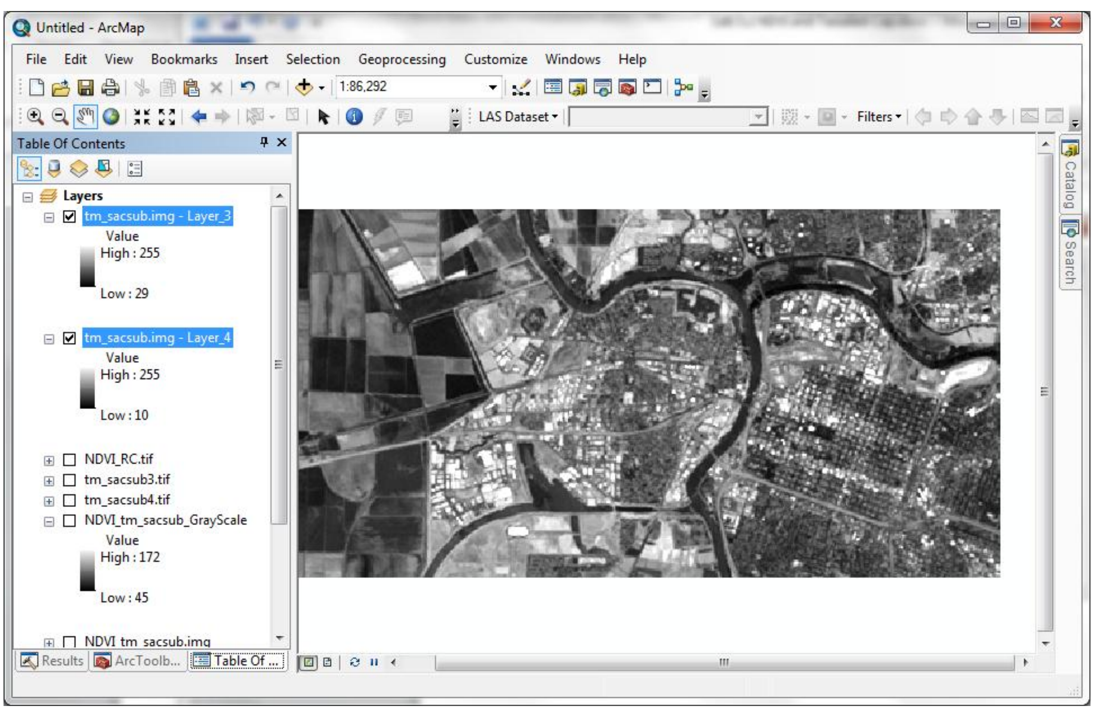


As an alternative to what we just did, individual image bands can be loaded into the map viewer by double-clicking on the full **tm_sacsub.img** file.

It is not necessary for you to perform this process, you should simply be able to recognize the difference in the image band structure versus the procedure described above.

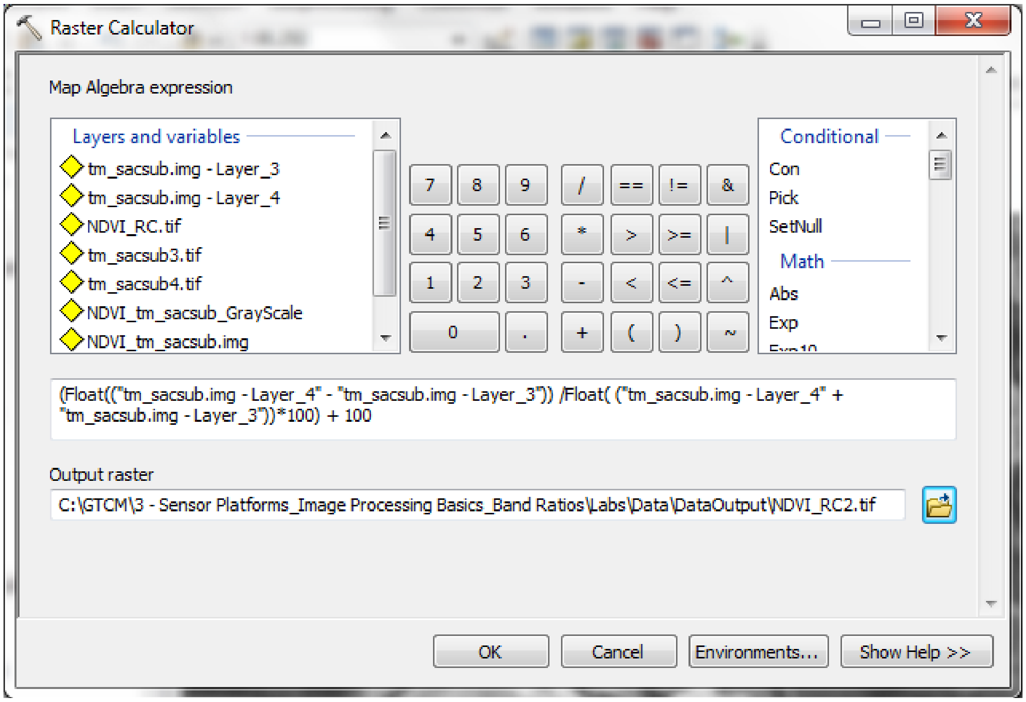


The specific bands can be added by clicking on them. They will show up in the Table of Contents like this. Notice the layer name is: **tm_sacsub.img – Layer 3** and **tm_sacsub.img – Layer 4**.

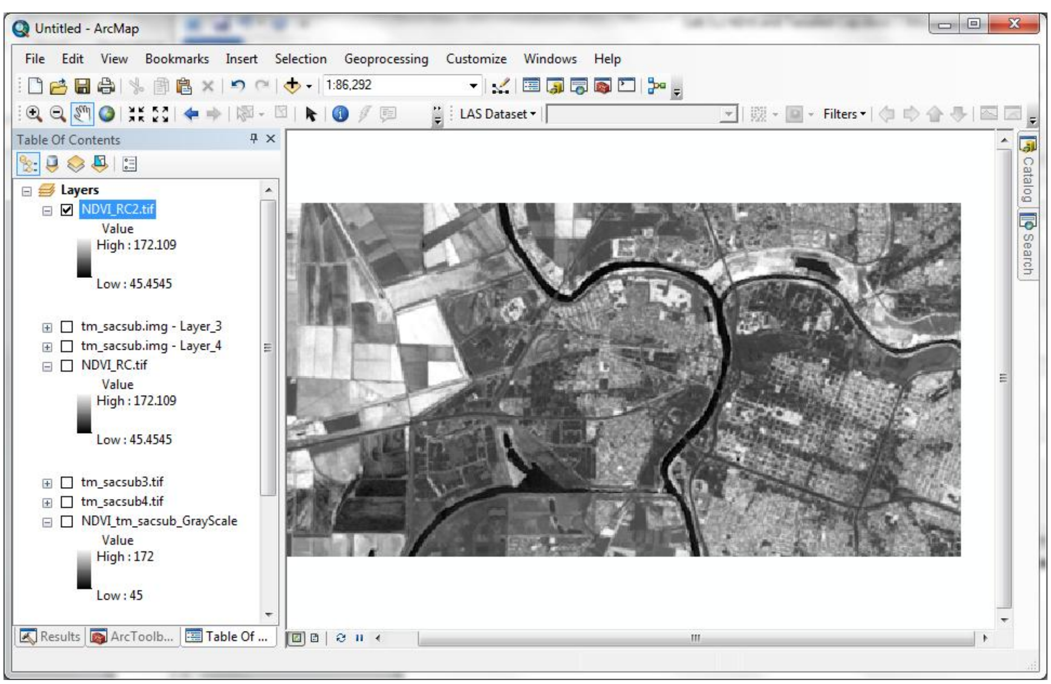


In the Raster Calculator, the following expression will be used. Notice the difference for the input bands for Band 3 and Band 4 versus that used with the individual TIFF image files.

```
(Float(("tm_sacsub.img - Layer_4" - "tm_sacsub.img - Layer_3"))
/Float( ("tm_sacsub.img - Layer_4" + "tm_sacsub.img - Layer_3"))*100) + 100
```



The NDVI output should be exactly the same.



1.3 Use ModelBuilder and a Python Script to Run the NDVI Process

For those students who are interested in exploring additional methods, two other options for running the NDVI are discussed in this supplemental section.

Additional instructions may be available from your instructor regarding this supplemental portion of the lab.

1. The **Ratios_Enhancements** custom toolbox (in the ***\DemoData*** folder) can be viewed in ArcCatalog or ArcMap and the two models can be reviewed and modified to execute.

   - **NDVI Raster Calculator in ModelBuilder** - This is the Raster Calculator option described above, with the addition of entering a ModelBuilder model.

   - **NDVI v1** – A more involved model that breaks out each component routine of the NDVI so the user can see how the fundamental pieces of the NDVI algorithm is used to compute the NDVI expression

2. A Python script (**NDVI_MapAlgebra.py**) that computes the NDVI routine can also be reviewed in the ***\Scripts*** folder. Students should be familiar with Python, ArcPy, and executing Python scripts for ArcGIS before modifying and attempting to execute the code. This provides another alternative to creating and implementing custom functionality that is not provided "out of the box" with ArcGIS.

2 Methods Used to Create a Tasseled Cap Dataset

The data for this portion of the lab is located in the ***Lab 3\Data*** folder. The tasseled cap individual components and full tasseled cap image have been derived using a Python script developed by the author.

Component	Description
tm_sacsub.img	Source image used in the tasseled cap transformation
tc1.img	Resulting 3-band tasseled cap image
bright1.img	Brightness component for tasseled cap
green1.img	Greenness component for tasseled cap
wet1.img	Wetness component for tasseled cap

The Tasseled Cap transformation is not a ratio, but a series of derived coefficients that have been tailored to a specific sensor (in this case Landsat TM) and applied to different bands of the Landsat TM image. The input for a tasseled cap is the entire image, but accessing different bands and applying the coefficients to each band. The tasseled cap performs some math on the data in the image and creates a resulting 3-band image, representing three biophysical characteristics: Brightness, Greenness, and Wetness.

A Python script (**tasseled_capV1.py** in the ***\Scripts*** folder) developed by the instructor can be used to see the algorithm and code to perform this operation. A user can open this file in a Python editor by right-clicking on the Python file name and choosing **Edit with IDLE**. Alternatively, a generic text editor can open the file. The user should review the data path for the workspace in the Python script before running the script. It is assumed that students have some proficiency and understanding of Python, ArcPy, and ArcGIS to execute the code. If students do not, they should just review the individual components and composite image file shown above.

DO NOT double-click on the file; it probably will not do anything. The version of Python that was provided on the ArcGIS install disk is recommended to be used. This version of Python is supported by the specific version of ArcGIS. No newer or older versions should be used to run Python scripts that use the ArcPy Python modules.

1. Add the individual tasseled cap components into the map viewer:

Components
bright1.img
green1.img
wet1.img

The 3-band tasseled cap image, **tc1.img** can be loaded and viewed. This 3-band image is not normally visually interpreted since it is often difficult to interpret what the different colors mean.

2. Review each band separately

Exercise D: *Complete the table below to explain what the brighter and darker areas in the image represent, based on the specific component.*

Component	Explanation
Brightness	
Greenness	
Wetness	

Conclusion

In this lab, you have been introduced to performing the NDVI, using a number of different methods. These methods illustrate some of the options available to an image analyst to further process image data that do not use "out of the box" functionality. The Raster Calculator, models, and scripts are three different options to an ArcGIS user. In addition, the students were able to review and interpret the output of a custom program that computes the Tasseled Cap transformation for a Landsat TM image. Both the NDVI and the Tasseled Cap are important image processing methods for identifying biomass, healthy vegetation, and various wetland characteristics.

Review Exercises

The review exercises included throughout the lab are listed in this section. You may click the name of each exercise to link to the exercise's location within the lab.

Exercise A: How many bands are in each (the color and the gray scale) NDVI image?

Exercise B: What do the various colors represent in the colorized NDVI image?

Exercise C: What do the bright and dark areas represent in the grayscale image?

Exercise D: Complete the table below to explain what the brighter and darker areas in the image represent, based on the specific component.

Component	Explanation
Brightness	
Greenness	
Wetness	

