

Exercise 9: Symbolizing Image Data

In this Exercise you will work with symbolizing multiband raster image data in ArcGIS. You will also calculate the normalized difference vegetation index (NDVI) using the **Raster Calculator Tool** and the red and near infrared bands. We will make use of Landsat 5 Thematic Mapper (TM) data for the Monongahela National Forest in West Virginia.

Topics covered in this exercise include:

1. Symbolizing image data in ArcGIS Pro
2. Interpreting band combinations relative to land cover conditions
3. Creating and interpreting the NDVI

Step 1. Open a Map Project

First, we need to download and open the **Exercise_9.aprx** file.

- Download the **Exercise_9** data from <https://www.wvview.org/>. All lab materials are available on the course webpage and linked to the exercise. You will need to extract the compressed files and save it to the location of your choosing.
- Open ArcGIS Pro. This can be done by navigating to All Apps followed by the ArcGIS Folder. Within the ArcGIS Folder, select ArcGIS Pro. Note that you can also use a Task Bar or Desktop shortcut if they are available on your machine.
- After ArcGIS Pro launches, select "Open another project."



- Navigate to the directory that houses the material for this course. The project files are in the **Exercise_9** folder where it was saved on your local machine.
- Select **Exercise_9.aprx**. Click OK to open the project.
- If necessary, navigate to the WV map.

Note: If you'd prefer, you can also just click on the **Exercise_9.aprx** file within the uncompressed folder directly to launch ArcGIS Pro.

This project contains only one map. Within this map, the image of interest is loaded.

ArcGIS Pro by default symbolizes the first band with the red channel, the second band with the green channel, and the third band with the blue channel. For this image from the Landsat 5 Thematic Mapper (TM) sensor, the bands have the following designations:

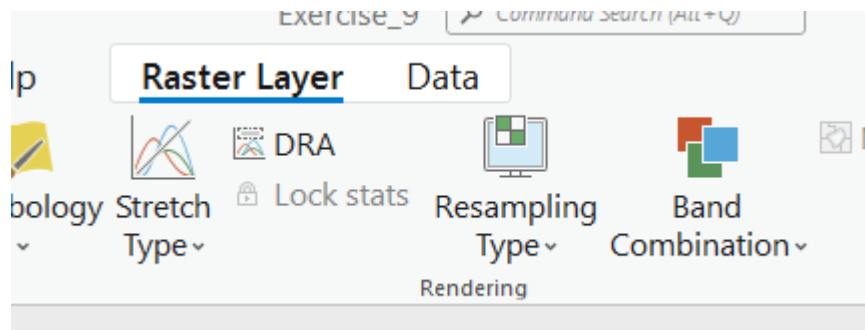


- Band 1 = Blue (450 – 520 nm)
- Band 2 = Green (520-600 nm)
- Band 3 = Red (630 – 690 nm)
- Band 4 = Near Infrared (NIR) (760-900 nm)
- Band 5 = Shortwave Infrared (SWIR) 1 (1,550 to 1,750 nm)
- Band 6 = Thermal (10,400 to 12,500 nm)
- Band 7 = Shortwave Infrared (SWIR) 2 (20,800 to 23,500 nm)

So, by default, ArcMap is using the red channel to display the blue band, the green channel to display the green band, and the blue channel to display the red band. This doesn't make a lot of sense for these data. So, we will change the band combinations.

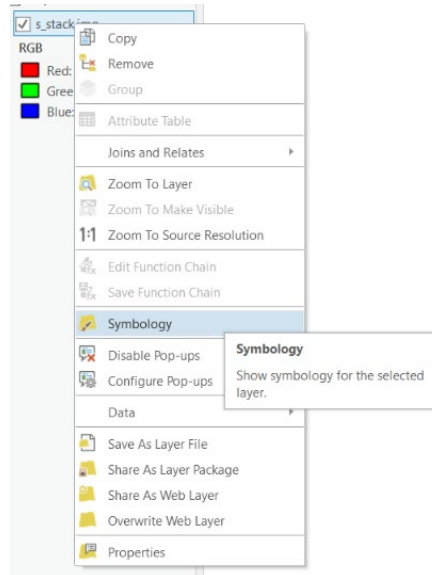
Step 2. Change Band Combinations

Within ArcGIS Pro, band combinations can be changed using the Band Combinations options under the Raster Layer Tab for the raster layer.



Alternatively, band combinations can be changed by changing the layer symbology. We will demonstrate this method here.

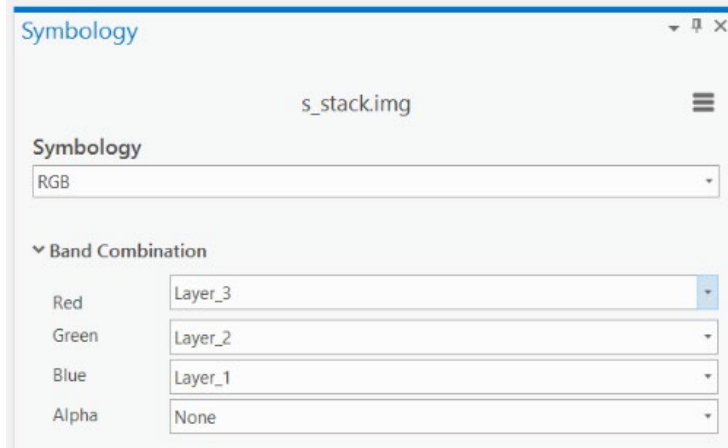
- Right-click on the **s_stack.img** layer in the Contents Pane.
- The Symbology Pane should load.
- Change the band combinations so that Layer_3 (**red**) is displayed using the red channel, Layer_2 (**green**) is displayed using the green channel, and Layer_1 (**blue**) is displayed using the blue channel.
- The display should update automatically.



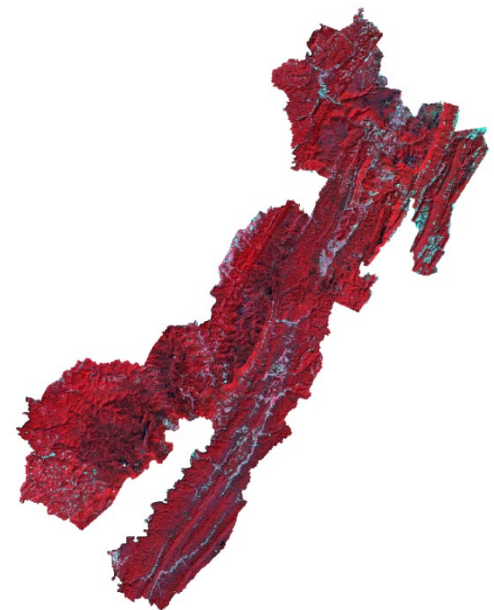
Since we are using the color channels to symbolize the same color (red = red), this simulates our perception of color. Thus, this is a simulated true color image.

We will now produce a standard false color image in which the red channel shows Layer_4 (near infrared), the green channel shows Layer_3 (red), and the blue channel shows Layer_2 (green).

- Right-click on the **s_stack.img** layer in the Contents Pane.
- The Symbology Pane should load.
- Change the band combinations so that Layer_4 (NIR) is displayed using the red channel, Layer_3 (red) is displayed using the green channel, and Layer_2 (green) is displayed using the blue channel.
- The display should update automatically.



Question 1. Red areas in this image generally represent healthy vegetation, such as trees. Explain why this is the case for this image composite based on the spectral reflectance of vegetation. (4 Points)



Hint: Class notes and these webpages may help with interpretation of images:

https://science.nasa.gov/ems/08_nearinfraredwaves/

<https://physicsopenlab.org/2017/01/30/ndvi-index/>

Question 2. Conifer trees tend to look darker in this image than deciduous trees (darker shades of red). Explain why this is the case. (4 Points)

Question 3. This is a summer, leaf-on image for this area. How might you expect this standard false color composite to look different if a winter image was used as opposed to a summer image? (4 Points)

Another commonly used band combination for Landsat 5 TM is red channel = SWIR 2, green channel = near infrared, and blue channel = green.

- Create the false color composite described above. Reference the band designations provided above.

Question 4. Barren or non-vegetated areas tend to take on a red or pink color using this false color composite. Based on spectral reflectance, why is this the case? (4 Points)

Another commonly used band combination for Landsat 5 TM is red channel = near infrared, green channel = SWIR 1, and blue channel = Blue.

- Create the false color composite described above. Reference the band designations provided.

Question 5. What types of landscape/land cover features are well differentiated using this band composite? Explain your reasoning. (4 Points)

Step 3. Create NDVI

Lastly, you will create an NDVI using the red and near infrared channels. We will do this using the **Raster Calculator Tool** available in the Spatial Analyst Toolbox. Here is the formula:

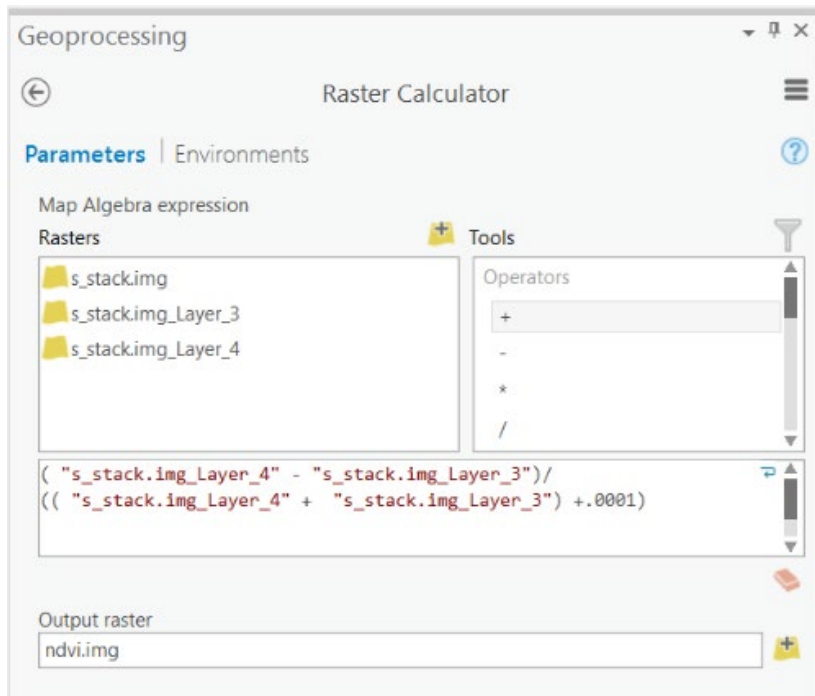
$$\frac{\text{Near Infrared} - \text{Red}}{\text{Near Infrared} + \text{Red}}$$

- Click on the Tools icon in the Analysis Tab in the Geoprocessing area. This will open the Geoprocessing Pane.
- In the Geoprocessing Pane, select Toolboxes. This will open the ArcToolbox directory.
- Navigate to Spatial Analyst Tools followed by Map Algebra.
- Click on **Raster Calculator**.
- Build the following syntax:

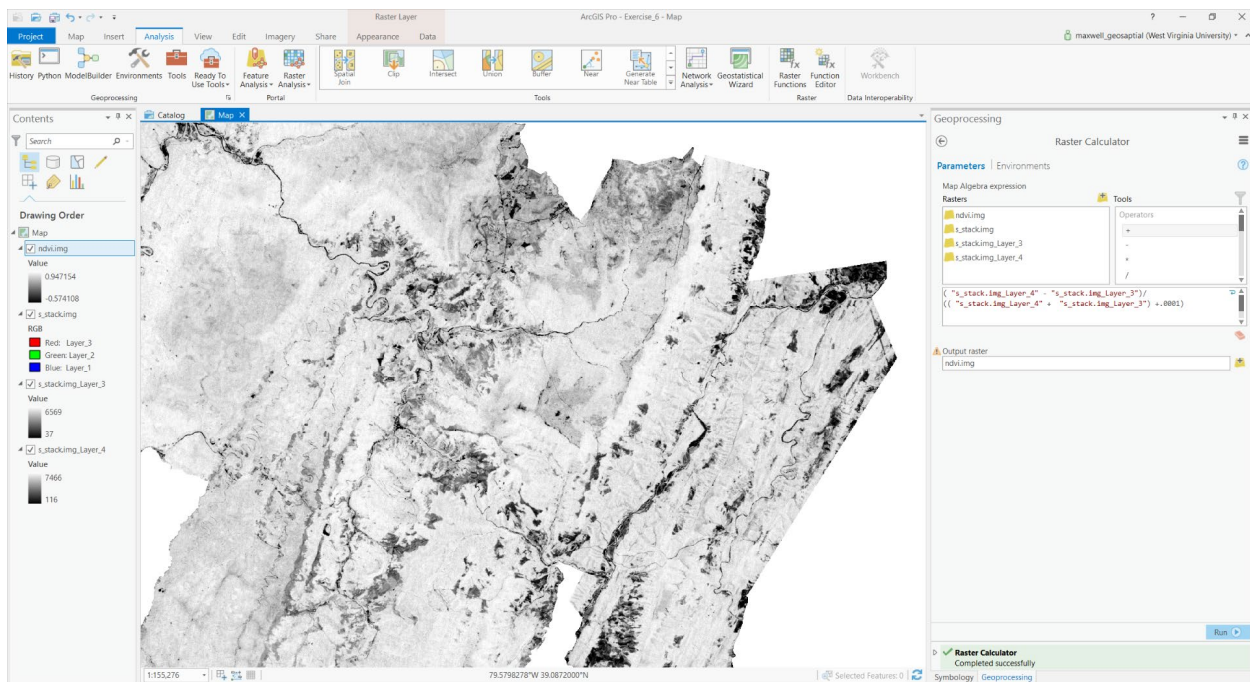
```
("s_stack.img_Layer_4" - "s_stack.img_Layer_3")/  
(("s_stack.img_Layer_4" + "s_stack.img_Layer_3") +.0001)
```

Note that you are adding 0.0001 to the denominator here to avoid a divide by zero error.

- Name the Output raster **ndvi.img**. Save it in your local **Exercise_9** folder.
- Click Run to execute the tool.

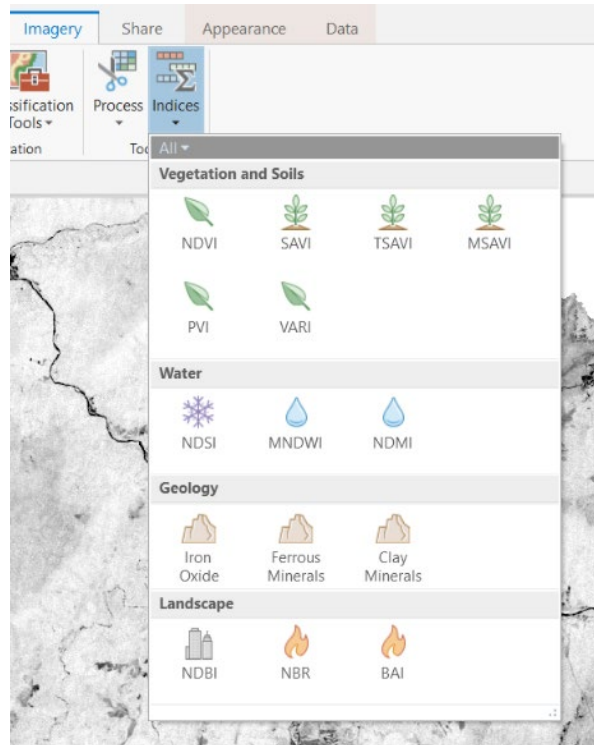


Once the tool executes the new raster grid should be added to your Contents Pane and map.

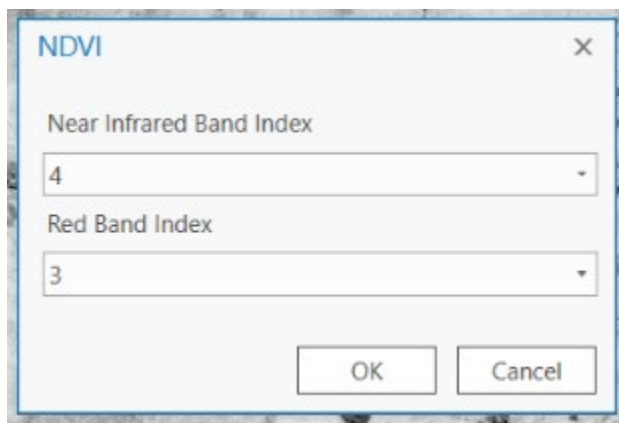


Question 6. High values of NDVI indicate green, healthy vegetation whereas low values indicate non-vegetated areas or unhealthy vegetation. Explain why this is the case based on the spectral reflectance of vegetation. (4 Points)

Note: The NDVI can also be calculated in ArcGIS Pro using the **NDVI Tool**. This tool can be found in the Indices list under the Imagery Tab along with many other ratios.



This tool will ask you to specify which layer in the multiband raster is the near infrared band and which is the red band.



If you are interested in working with imagery, I would suggest experimenting with image analysis tools available in ArcGIS Pro.

END OF EXERCISE