

Exercise 5: Band Ratios

160 Points scaled to 20 Points

Introduction

In this exercise, you will explore a variety of band ratios using multiple imagery datasets.

Objectives

- *Generate and interpret band ratios*
- *Explain why specific band ratios are useful for their intended task*
- *Visualize band ratios and make map layouts*

Prerequisite Materials

- ❖ Modules: Ratios and Spectral Enhancements
- ❖ Videos
 - Lab 5 and 6 Intro: https://youtu.be/QBF_K5_ei3g
 - Band Ratios: <https://youtu.be/S9QMajTvF5M>
 - NBR with Raster Functions: <https://youtu.be/IdO1BvZ-Iaw>
 - Raster Calculator: <https://youtu.be/2fDysFAO75c>
 - Raster Reclassify: https://youtu.be/u4zwIUbxq_I

Data

Here we describe the data provided in each map in the project file.

- ❖ Vancouver Map: Sentinel-2 MSI multispectral image for area around the city of Vancouver in British Columbia, Canada collected on 7/29/2020.
 - Band 1 = Blue
 - Band 2 = Green
 - Band 3 = Red
 - Band 4 = Red Edge 1
 - Band 5 = Red Edge 2
 - Band 6 = Red Edge 3
 - Band 7 = NIR
 - Band 8 = NIR (Narrow)
 - Band 9 = SWIR 1
 - Band 10 = SWIR 2

- ❖ Glaciers Map: Landsat 5 Thematic Mapper (TM) scenes for an area containing mountain glaciers in the Himalayan Mountains. First image was collected on 6/5/1993 and second image was collected on 8/23/2010.
 - Band 1 = Blue
 - Band 2 = Green
 - Band 3 = Red
 - Band 4 = NIR
 - Band 5 = SWIR 1
 - Band 6 = SWIR 2
- ❖ Poland Map: RGB image of an area in Poland from the landcover.ai dataset (<https://landcover.ai/>) (Band 1 = Red, Band 2 = Green, Band 3 = Blue).
- ❖ Sand Fire Map: The 2016 Sand Fire occurred in the Angeles National Forest east of Los Angeles, California. It began on July 22, 2016. The fire was not contained until August 3, at which point it had burned an estimated 35,000 acres. You have been provided with two Landsat 8 Operational Land Imager (OLI) scenes. The pre-fire scene (**sand_fire_pre_4_17_2015.tif**) was collected on April 17, 2015 while the post-fire scene (**sand_fire_post_4_12_2017.tif**) was collected on April 22, 2017. These data have been processed to surface reflectance.
 - Band 1 = Blue Edge
 - Band 2 = Blue
 - Band 3 = Green
 - Band 4 = Red
 - Band 5 = NIR
 - Band 6 = SWIR1
 - Band 7 = SWIR2

Vancouver Map



Figure 1. Sentinel-2 MSI multispectral image of area around Vancouver British Columbia, Canada.

- ❖ Calculate the normalized difference vegetation index (NDVI) from the Sentinel-2 image of Vancouver.
- ❖ Calculate the normalized difference water index (NDWI) after Gao (1996) and McFeeters (1996) from the Sentinel-2 image of Vancouver.
- ❖ Calculate the normalized difference built-up index (NDBI) from the Sentinel-2 image of Vancouver.

Deliverable 1: Create a map layout containing separate map frames to show (1) a false color composite, (2) NDVI, (3) Gao (1996) NDWI, (4) Feeters (1996) NDWI, and (5) NDBI. Make sure to provide legends for all raster grids and explain the band combinations used in the false color composite. Label each frame so that it is clear what is being shown. Include a main title, citation for the European Space Agency, legends, and a scale bar and north arrow for just the false color composite map. The layout will be partially judged based on neatness, use of space, and symbology used. (20 Points)

Question 1. Provide the equation for NDVI. Explain why it is useful for mapping vegetation and vegetation health. (10 Points)

Question 2. Provide the equation for the Gao (1996) and McFeeters (1996) NDWIs. Explain why they are useful for differentiating water from other surface materials. (10 Points)

Question 3: Provide the NDBI equation. Why is it useful for differentiating built-up areas from other surface materials? (10 Points)

Glaciers

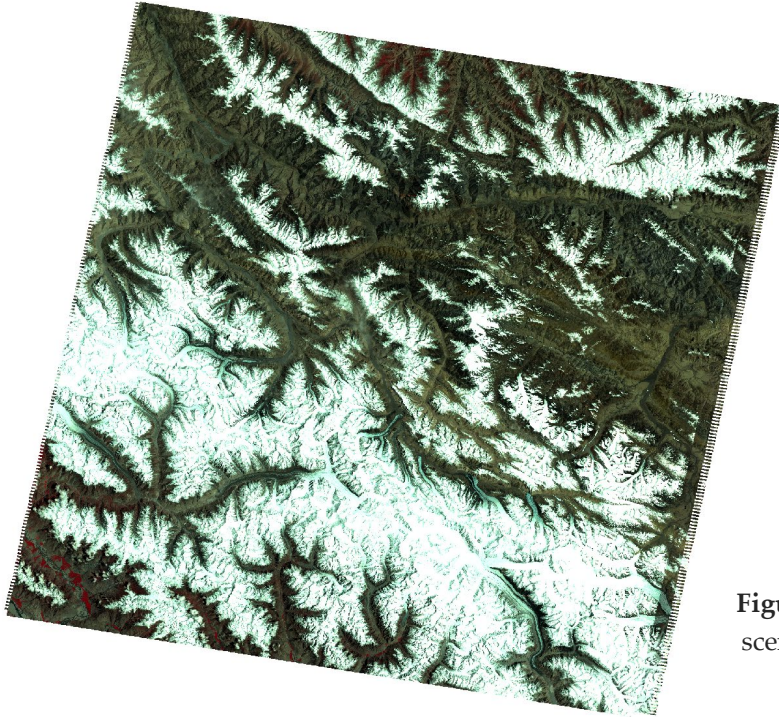


Figure 2. Glaciers in a Landsat 5 TM scene in the Himalayan Mountains.

- ❖ Calculate the normalized difference snow index (NDSI) for each Landsat 5 TM scene.
- ❖ Apply a threshold of 0.4 to differentiate snow from other surface materials.
- ❖ Use the two binary grids to differentiate the following classes: “Never Glacier”, “Glacier Gain”, “Glacier Loss”, and “Glacier.” This will require adding the binary grids together to obtain four unique codes. You will need to add a value to one of the grids so that you actually obtain four unique codes. Or, they cannot both be 0/1 without causing ambiguity in the results.

Deliverable 2: Create a map layout that shows your four class output. “Never” glacier should be transparent and one of the images should be displayed beneath the classification result. Include a main title, citation for the Landsat program, legend, and a scale bar and north arrow. The layout will be partially judged based on neatness, use of space, and symbology used. (20 Points)

Question 4. Provide the equation for NDSI. Explain why it is useful for differentiating snow from other surface materials. (10 Points)

Question 5: List and explain two potential sources of error in this analysis. (10 Points)

Poland

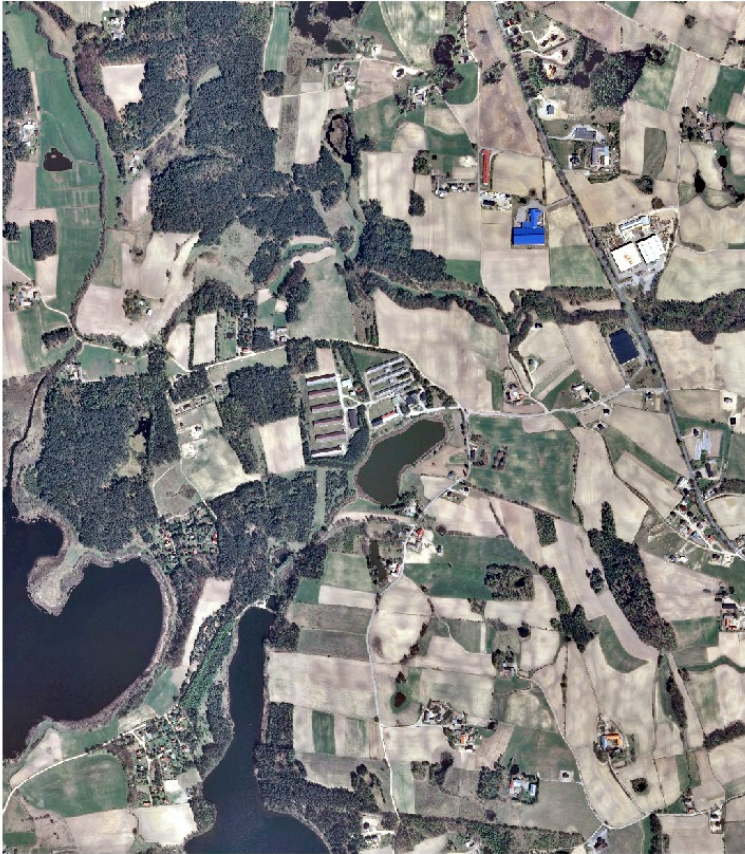


Figure 3. RGB image for small extent in Poland from Landcover.ai dataset.

- ❖ Calculate the visible atmospherically resistant index (VARI) for the Poland aerial image.

Deliverable 3: Create a map layout that contains two map frames. One should show the input image while the other shows the VARI calculated from it. Include a main title, citation for Landcover.ai, legend for the VARI, and a scale bar and north arrow for both maps. The layout will be partially judged based on neatness, use of space, and symbology used. (20 Points)

Question 6. Provide the equation for VARI. Explain why it is useful for differentiating vegetation from other cover types. (10 Points)

Question 7. Why is it generally preferable to use the NDVI as opposed to the VARI if a NIR band is available? (10 Points)

Sand Fire

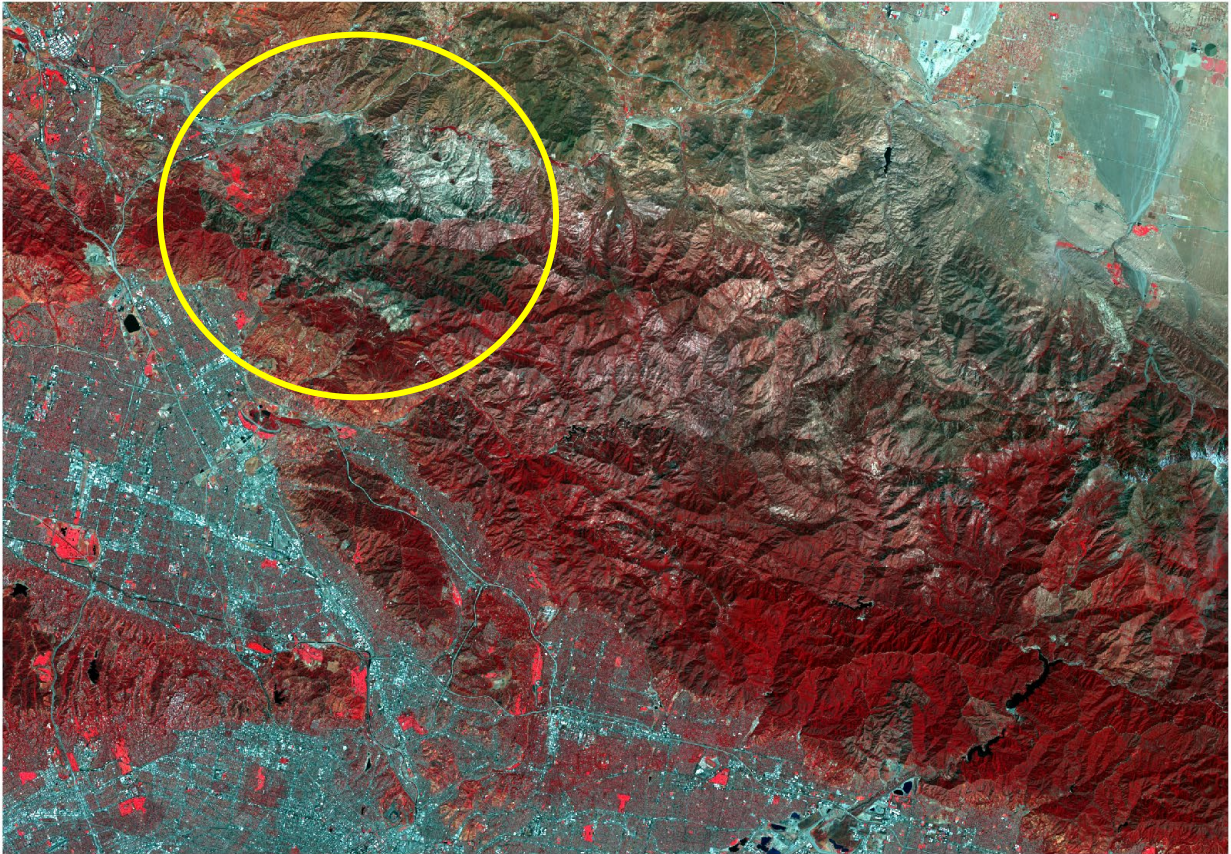


Figure 4. Post-fire Landsat-8 image of Sand Fire in California. Fire location shown using yellow circle.

- ❖ Calculate the normalized burn ratio (NBR) for the pre- and post-fire scenes.
- ❖ Difference the pre- and post-fire NBRs to obtain dNBR.
- ❖ Use the table below and the Reclassify Tool to reclassify the dNBR into four severity bins.

Unburned	< +.1
Low Severity	+ .1 to +.27
Moderate Severity	+ .27 to +.66
High Severity	> .66

Deliverable 4: Create a map layout that contains three map frames. The frames should show (1) the pre-fire image as a false color composite, (2) the post-fire image as a false color composite, and (3) the classified severity output. Include a main title, citation for the Landsat program, legend for the classified severity result, and a scale bar and north arrow for all maps. The layout will be partially judged based on neatness, use of space, and symbology used. (20 Points)

Question 8. Provide the equation for NBR. Explain why it is useful for differentiating fire scars from vegetation. (10 Points)