Exercise 11: Digital Terrain Analysis

66 Points scaled to 20 Points

Introduction

In this exercise, you will explore digital elevation models (DEMs), or digital terrain models (DTMs), and derive terrain metrics from them using neighborhood analysis and raster math. Five maps have been provided. The Preston map provides data for a section of Preston County, West Virginia near the town of Rowlesburg. The Canaan map provides data for a section of Canaan Valley, West Virginia while the Seneca map represents the area near Seneca Rocks and Germany Valley, West Virginia. The Horseshoe_Run map provides examples of slope failures. This is just an example and is not required to complete the exercise. Lastly, the Mines map provides two DEMs, one representing conditions before mining and the other representing conditions post-mining. You will use these data to create a DEM of difference to quantify landscape change. All elevation models were derived from LiDAR, which was downloaded using the *WV Elevation and LiDAR Download Tool* (http://data.wvgis.wvu.edu/elevation/) provided by the WV GIS Tech Center and West Virginia View.

Objectives

- *Generate terrain derivatives using raster math and local neighborhood analysis*
- *Explain and interpret different digital terrain variables*
- *Create and interpret DEMs of difference*

Prerequisite Materials

- ❖ Modules: Digital Terrain Analysis
- ❖ Videos:
    - ○ Lab 11 Intro: https://youtu.be/qFlbA7RnR-I
    - ○ Raster Calculator: https://youtu.be/2fDysFAO75c
    - ○ Hillshade: https://youtu.be/IwkHjoe6qBU
    - ○ Terrain Derivatives: https://youtu.be/rW23P5CZXeA
    - ○ Conditional Statements: https://youtu.be/WQoZGVSNK9g

Background Questions

Question 1. Explain the difference between ellipsoidal and orthometric heights when referencing elevation measurements. (4 Points)

Question 2. What is the purpose of a Z-factor when calculating digital terrain variables? (4 Points)

Question 3. Explain the difference between slope in degrees vs. slope represented as a percentage. (4 Points)

Question 4. Explain the difference between profile and plan curvature. (4 Points)

Question 5. Explain the difference between horizontal and vertical datums. (4 Points)

Seneca

In the Seneca map, we have provided several topographic derivatives generated from a LiDAR-derived DEM for the area near Seneca Rocks in West Virginia. The derivatives include a hillshade, topographic slope, topographic aspect, slope position, topographic roughness, topographic dissection, and heat load index. Use the lecture module and these examples to answer the following questions.
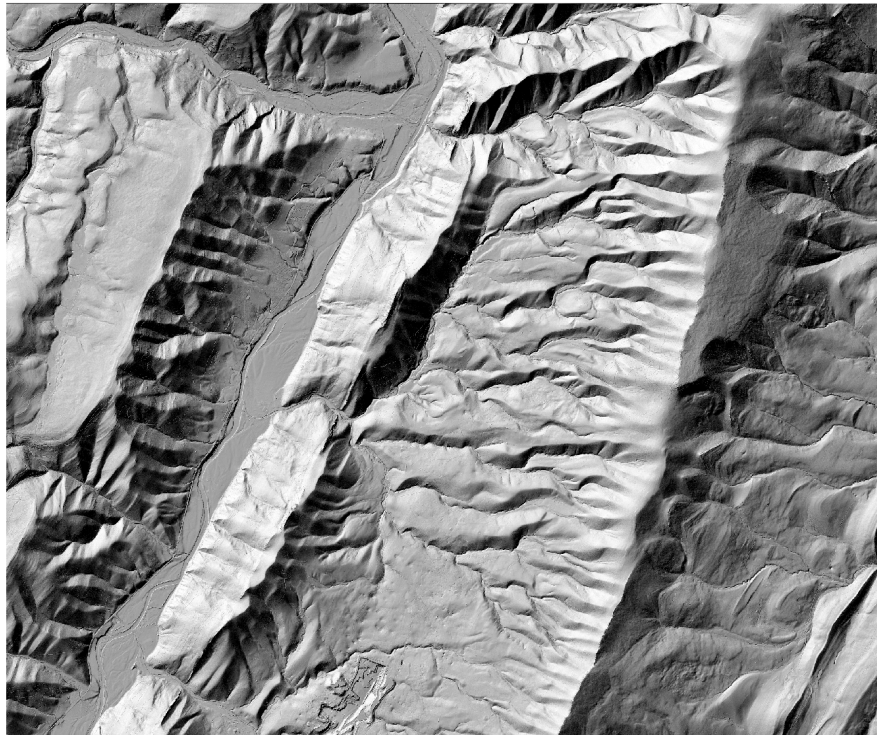

Figure 1. Hillshade for area near Seneca Rocks in West Virginia.

Question 6. Explain the concept of a moving window analysis or neighborhood analysis and its use in modeling local terrain characteristics. (4 Points)

Question 7. State and explain the equation for slope position. What do high values indicate? What do low values indicate? (4 Points)

Question 8. State and explain the equation for topographic roughness. What do high values indicate? What do low values indicate? (4 Points)

Question 9. Explain the heat load index. What topographic factors are considered? (4 Points)
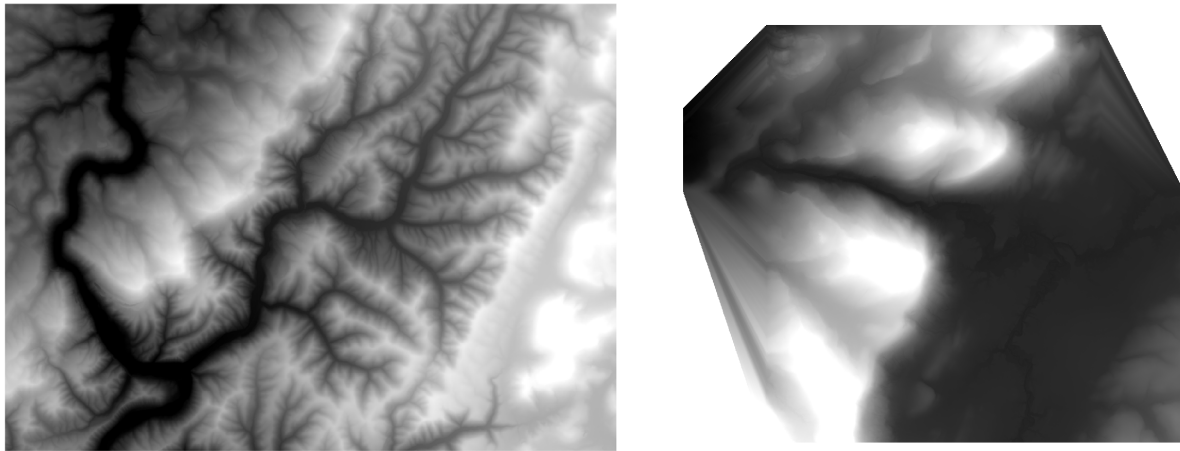
Preston or Canaan

Figure 2. Preston and Canaan Valley DEMs.

Calculate the following digital terrain variables for either the Preston or Canaan DEM data. You do not need to process both datasets. When a neighborhood analysis is applied, use a circular window with a radius of 11 cells. Note that these grids can be created using the Hillshade, Slope, Aspect, Raster Calculator, and Focal Statistics tools.

- ❖ Hillshade
- ❖ Topographic Slope (Degrees)
- ❖ Topographic Aspect
- ❖ Slope Position
- ❖ Topographic Roughness
- ❖ Topographic Dissection

Deliverable 1: Make a map layout that includes multiple map frames to show the following generated layers: hillshade, topographic slope, topographic aspect, slope position, topographic roughness, and topographic dissection. Label each frame with the grid type. The layout will be judged based on neatness, use of space, and appropriate symbology. (15 Points)

Mine and Topographic Change

The mine map contains two DEMs: one representing conditions before mining occurred (**mine_pre.tif**) and the other representing conditions after mining (**mine_post.tif**).

- ❖ Create a DEM of difference by subtracting the pre-mining DEM from the post-mining DEM. Positive values will indicate fill or elevation gain while negative values will indicate excavation or elevation loss. Values near zero indicate no change. The subtraction can be completed using Raster Calculator.
- ❖ Use the Reclassify Tool to bin the data as follows:
    - o < -4 m = Excavation or Elevation Loss
    - o -4 to 4 m = No Change (or, less than 4 m of change will be considered noise)
    - o > 4 m = Elevation gain or fill

Deliverable 2: Make a map layout highlighting areas of fill and excavation. Any change above +4 meters should be classified as fill and any values less than -4 meters should be classified as excavation. Values between -4 and +4 meters should be transparent, since they represent no change. Make sure to provide a legend explaining the layout and generate a hillshade from one of the DEMs to display the classification over. Include ancillary map elements: title, your name, scale bar, north arrow, and legend. The layout will be judged based on neatness, use of space, and appropriate symbology. (15 Points)