Exercise 12: LiDAR

83 Points scaled to 20 Points

Introduction

In this exercise you will work with different aerial light detection and ranging (LiDAR) datasets collected over different areas in West Virginia. All data were downloaded from the *West Virginia Elevation and LiDAR Download Tool* (http://data.wvgis.wvu.edu/elevation/) made available by the WV GIS Tech Center and West Virginia View. Data have been provided for areas around the cities of Kingwood, Parsons, and Petersburgh. All data were collected during leaf-off conditions and support the creation of 1 m spatial resolution raster grids. All used a near infrared (NIR) laser.

Objectives

- *Interpret LiDAR data and relationships between return intensity and land cover*
- *Generate a variety of raster grids from LiDAR data*
- *Use interpolation and raster analysis methods applied to LiDAR point clouds and derived raster grids*

Prerequisite Materials

- Modules: Digital Terrain Analysis and LiDAR
- Videos
    - Lab 12 Intro: https://youtu.be/FG9SKIH7q5A
    - Visualize Point Clouds: https://youtu.be/R7Ocgb2pDpU
    - LAS Datasets: https://youtu.be/rq0-XKiRzHs
    - LiDAR Rasterization: https://youtu.be/PyUyS65LVKE
    - Raster Calculator: https://youtu.be/2fDysFAO75c
    - Conditional Statements: https://youtu.be/WQoZGVSNK9g

Data

- The point cloud data have been provided as separate tiles, and the tiles have been partitioned into three folders to differentiate data for the three different areas. All point clouds have ground classification applied (Ground = 2 and Unclassified = 1).

Background Questions

Question 1. Explain the purpose of the following components in a LiDAR system: laser scanner, global navigation satellite system (GNSS) receivers, and Inertial Measurement Unit (IMU). (8 Points)

Question 2. Explain the following terms related to LiDAR scanning specifications: pulse rate, scan frequency, and maximum scan angle. (8 Points)

Question 3. Explain the concept of RGB Encoding for LiDAR data. (4 Points)

Question 4. What is a key-point in a LiDAR point cloud? (4 Points)

Question 5. Explain the difference between discrete return and full waveform LiDAR. (4 Points)

Parsons

We have already processed the LiDAR data for the area around Parsons, WV. We have created the following surfaces:

- Hillshade (**parsons_hs.tif**): Hillshade image derived from DEM
- Hillshade DSM (**parsons_hs_dsm.tif**): Hillshade derived from digital surface model (DSM)
- DEM (**parsons_dem.tif**): digital elevation model (DEM) or digital terrain model (DTM) that includes only ground returns or the ground surface
- DSM (**parsons_dsm.tif**): digital surface model (DSM) calculated from first returns.
- First Return Intensity (**parsons_frst_int2.tif**): return intensity raster
- nDSM (**parsons_ndsm.tif**): normalized digital surface model (nDSM), which represents height of features above the ground (DSM – DEM)
- LAS Dataset (**parsons_lasdataset.lasd**): LAS dataset referencing the LAS data tiles

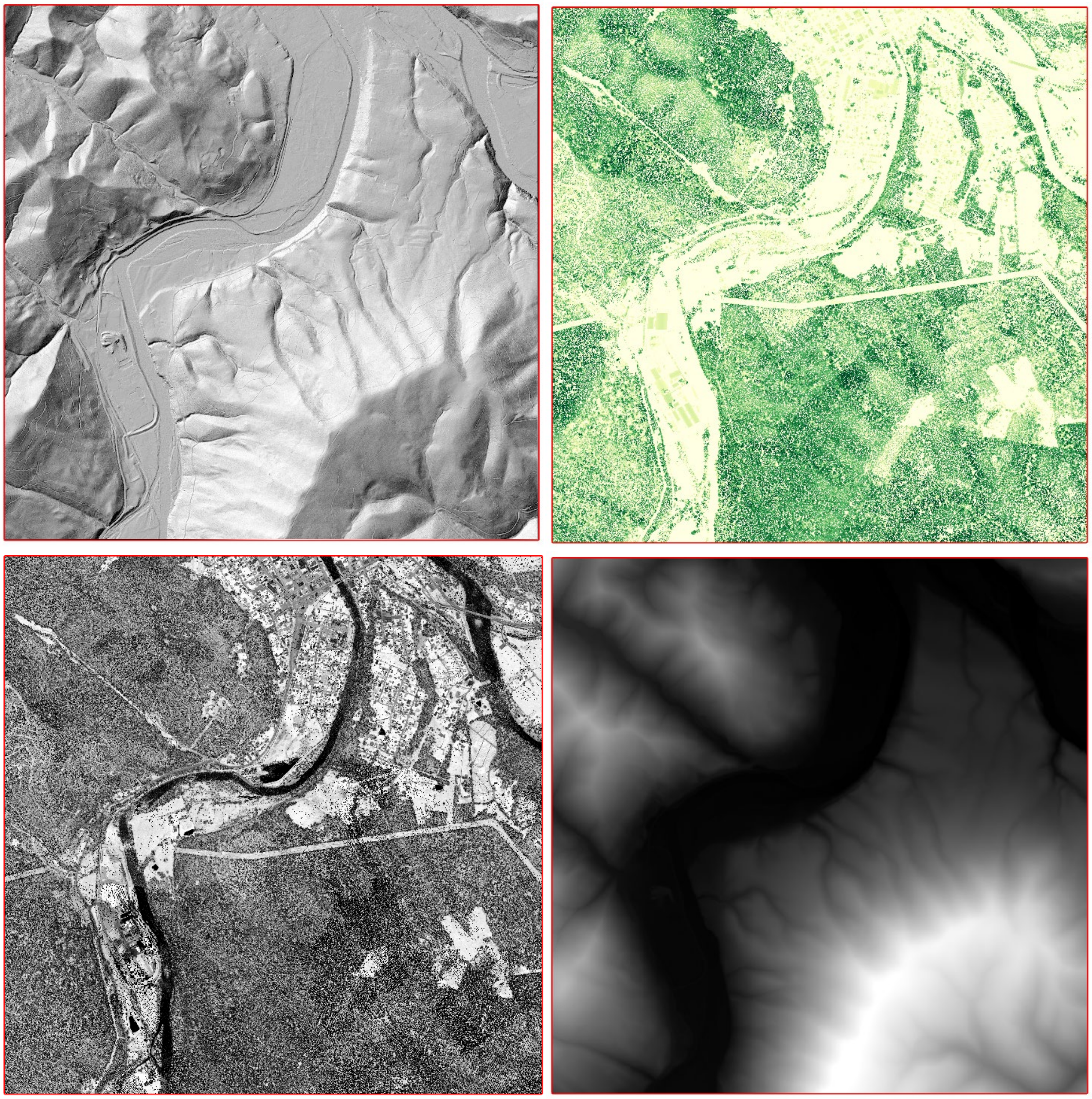

Figure 1. Raster-based LiDAR-derivatives (hillshade, nDSM, First Return Intensity, and DEM/DTM).

Use the first return intensity grid to answer the following questions. It might be helpful to compare the intensity data to the provided National Agriculture Imagery Program (NAIP) orthophotograph.

Question 6. Based on return intensity and spectral reflectance, explain why water tends to yield few returns when using a NIR laser. (4 Points)

Question 7. Based on return intensity and spectral reflectance, explain why grass/herbaceous areas tend to show higher return intensities than paved surfaces, such as roads. (4 Points)

Question 8: Explain why grass/herbaceous areas tend to show higher return intensities than forested areas. (4 Points)

Use the nDSM to answer the following questions.

Question 9: Why would it be inappropriate to term this nDSM a canopy height model? (4 Points)

Question 10: How would you expect the nDSM to be different if the LiDAR data were collected during leaf-on conditions? (4 Points)

Use the hillshade to answer the following questions.

Question 11: Explain how it is possible to resolve landscape features below the tree canopy using LiDAR data. (4 Points)

Question 12. List two uses of hillshades in geomorphology. (4 Points)

Kingwood or Petersburgh

You will now create LiDAR-derivatives on your own. You can process either the Kingwood or Petersburgh data. You do not need to process both. Make sure to watch the linked videos, which explain how to create these surfaces. You need to generate the following:

- LAS Dataset from the LAS point cloud tiles
- DEM/DTM from ground returns
    - Filter to just include ground returns
    - Use Binning method with Linear void filling
    - Use Average cell assignment
    - Use 2 m cell size
- Hillshade from DEM
    - Use Hillshade Tool and DEM as input
- DSM from first returns
    - Filter to just include first of many or single returns
    - Use Binning method with Linear void filling
    - Use Maximum cell assignment
    - Use 2 m cell size
- First return intensity from first returns
    - Filter to just include first of many or single returns
    - Use Binning method with no void filling

    - Use Average cell assignment
    - Use 2 m cell size
    - Once the initial grid is created, use a conditional statement to fill all NoDATA cells with a value of zero
    - You may need to change the Stretch Type to Histogram Equalization to view the data
- nDSM (DSM – DEM/DTM)
    - Use Raster Calculator

Question 13. When creating a first return intensity grid, why is it best to not interpolate across gaps but fill voids with zero values? (4 Points)

Question 14: Why is it best to use Maximum as opposed to Average within each cell when creating a DSM? (4 Points)

Question 15: Why do we calculate a DSM using only the first of many and single returns? (4 Points)

Deliverable 1: Make a map layout that includes multiple map frames to show the following generated layers: DEM/DTM, DSM, nDSM, First Return Intensity, and Hillshade. Label each frame with the grid type. The layout will be judged based on neatness, use of space, and appropriate symbology. (15 Points)