GEOG 660: Lab 1 (Introduction to LiDAR)

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Overview

As the first lab of the course, this assignment was a nice introduction to LiDAR Remote Sensing. As a point of reference, I have decided to create a GitHub repository containing my work for the class. You can find a link to the repository here: `https://github.com/Argentum133/LiDAR_RS_GEOG660`.

Part I. Annotated Review

1. Citation of the Article

For the first part of the assignment I chose to use Dr. Laura Duncanson's paper because her work with Dr. Ralph Dubayah seemed apt to include as they are professors of our department [*Duncanson and Dubayah*(2018)]. I'm currently using LaTeXto write up my documents so the citation method might seem a bit wonky. I am also using the AGU method of citation and citing directly from a bibtex file which is my first time using it.

References

[*Duncanson and Dubayah*(2018)] Duncanson, L., and R. Dubayah, Monitoring individual tree-based change with airborne lidar, *Ecology and Evolution*, *8*(10), 5079–5089, doi:https://doi.org/10.1002/ece3.4075, 2018.

2. Review Component

The basis of this paper is about using LiDAR to monitor trees. While traditional satellite based remote sensing techniques have been employed by researchers, they generally lack the precision required to assess the individual characteristics of trees. From Earth's orbit, many of these features become aggregated. Dr. Duncanson suggests that LiDAR might be a good tool at assessing trees at a more precise scale. While there are many ecologically variables of interest, the scientific basis of this study concerns itself with how tree biology will effect forests' role in Earth's Carbon cycle. As Carbon is a major source of concern in terms of climate change, understanding the ecological effects of trees may prove valuable. In the study they used 2 sets of LiDAR data, the first flown using the University of Florida's Optech Gemini ALTM and the second with NASA Goddard's Lidar, Hyperspectral and Thermal Imager (G-LiHT).

3. Analysis Component

The paper was very interesting to read. Knowing Dr. Duncanson and Dr. Dubayah's work involving UMD's GEDI, it enlightened some of the research interests of their work. Dr. Duncanson has on occasion talked about how forest's contain a lot of Carbon, but it really isn't clear how exactly they capture it. Furthermore she has addressed outside of her research about how there is a lot of uncertainty in how much Carbon already exists within forest's and exactly how much they are in-taking and emissing back into the atmosphere. In one of Dr. Duncanson's seminar talks she addressed how future efforts should be directed in fine-tuning some of the algorithms they employed throughout this paper. While my interests lie more in Earth Systems specifically in the atmospheric domain, I did find Dr. Duncanson's work to allow me to greater appreciate the research interests in biogeography. A point of concern made in the paper is how sampling must be conducted very cautiously with great detail being made in the measurements of ground test points. This highlighted the importance of both the mathematical rigour of the detection algorithms as well as those of the in-situ measurements. Her work along with those at UMD's GEDI team will continue to provide the scientific community with a greater understanding of forest ecology and their role in the Carbon cycle.

4. Article Abstract

Abstract

Understanding the carbon flux of forests is critical for constraining the global carbon cycle and managing forests to mitigate climate change. Monitoring forest growth and mortality rates is critical to this effort, but has been limited in the past, with estimates relying primarily on field surveys. Advances in remote sensing enable the potential to monitor tree growth and mortality across landscapes. This work presents an approach to measure tree growth and loss using multidate lidar campaigns in a high-biomass forest in California, USA. Individual tree crowns were delineated in 2008 and again in 2013 using a 3D crown segmentation algorithm, with derived heights and crown radii extracted and used to estimate individual tree aboveground biomass. Tree growth, loss, and aboveground biomass were analyzed with respect to tree height and crown radius. Both tree growth and loss rates decrease with increasing tree height, following the expectation that trees slow in growth rate as they age. Additionally, our aboveground biomass analysis suggests that, while the system is a net source of aboveground carbon, these carbon dynamics are governed by size class with the largest sources coming from the loss of a relatively small number of large individuals. This study demonstrates that monitoring individual tree-based growth and loss can be conducted with multidate airborne lidar, but these methods remain relatively immature. Disparities between lidar acquisitions were particularly difficult to overcome and decreased the sample of trees analyzed for growth rate in this study to 21% of the full number of delineated crowns. However, this study illuminates the potential of airborne remote sensing for ecologically meaningful forest monitoring at an individual tree level. As methods continue to improve, airborne multidate lidar will enable a richer understanding of the drivers of tree growth, loss, and aboveground carbon flux.

Part II. Exploring Lidar Data in ArcGIS

5. Three attributes for symbolizing

1. Elevation
2. Class
3. Return

6. Two tools from the 3D Analysis toolbar

1. LAS Dataset to Raster: Converts a LAS dataset to a raster using elevation, intensity, or RGB values stored in the lidar files referenced by the LAS dataset.
2. LAS Dataset to TIN: Creates a triangulated irregular network (TIN) from the lidar files referenced by a LAS dataset.

7. Two Methods to Change Classification

1. Change LAS Class Codes: Modifies the classification codes for LAS files referenced by a LAS dataset. This tool will completely change one classification code to another, which is particularly useful for updating the classification of LAS files generated prior to the introduction of classification standards in the LAS 1.1 specification. The tool can be used to ensure such data conforms to the current standards.
2. Set LAS Class Codes Using Features: Changes lidar classification codes assigned to lidar points based on their proximity to feature data.

8. File Formats, Organizations, ASCII/binary

The LAS file is an industry-standard **binary** format for storing airborne lidar data. It was developed by the the American Society for Photogrammetry and Remote Sensing (ASPRS).

9. Three types of ESRI datasets

1. LAS dataset
2. Mosaic dataset
3. Terrain dataset

Part 3. LAS Datasets and the LAS Toolbar

For the exercises I have opted to use ArcGIS Pro as opposed to ArcMaps. The study area I have selected is Camden Yards, the baseball stadium that is used by the Baltimore Orioles MLB team.

Question 10.

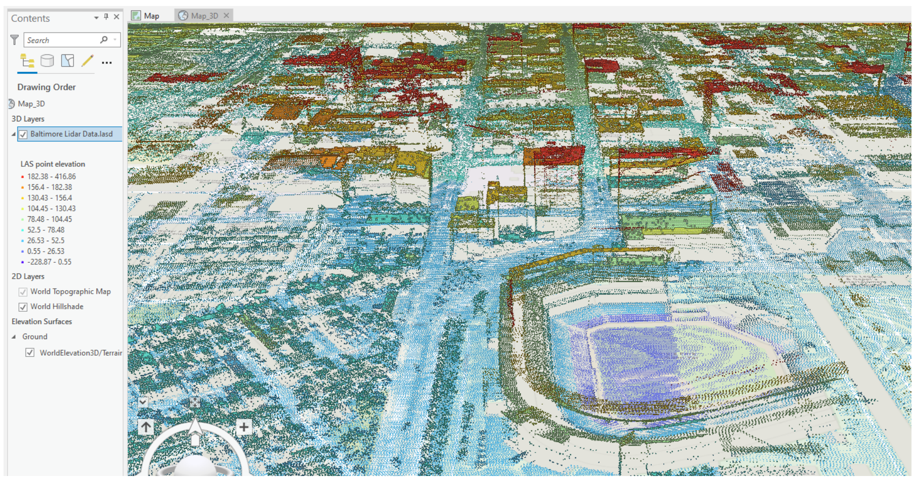
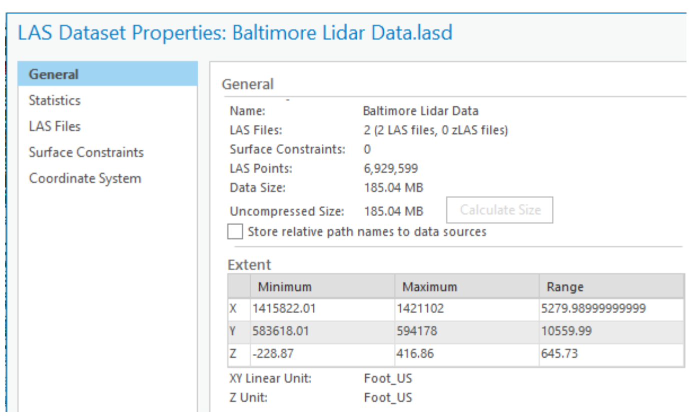


Figure 1: LAS Elevation in ArcGIS Pro.

From the figure below we see a z range of -228.87 ft to 645.73 feet.



LAS Dataset Properties: Baltimore Lidar Data.lasd

General
Statistics
LAS Files
Surface Constraints
Coordinate System

General

Name: Baltimore Lidar Data
LAS Files: 2 (2 LAS files, 0 zLAS files)
Surface Constraints: 0
LAS Points: 6,929,599
Data Size: 185.04 MB
Uncompressed Size: 185.04 MB Calculate Size
Store relative path names to data sources

Extent

	Minimum	Maximum	Range
X	1415822.01	1421102	5279.98999999999
Y	583618.01	594178	10559.99
Z	-228.87	416.86	645.73

XY Linear Unit: Foot_US
Z Unit: Foot_US

Figure 2: Elevation Statistics.

Question 11.

From the classification method, we see Unassigned areas, Ground, Building, Noise, and Overlap.

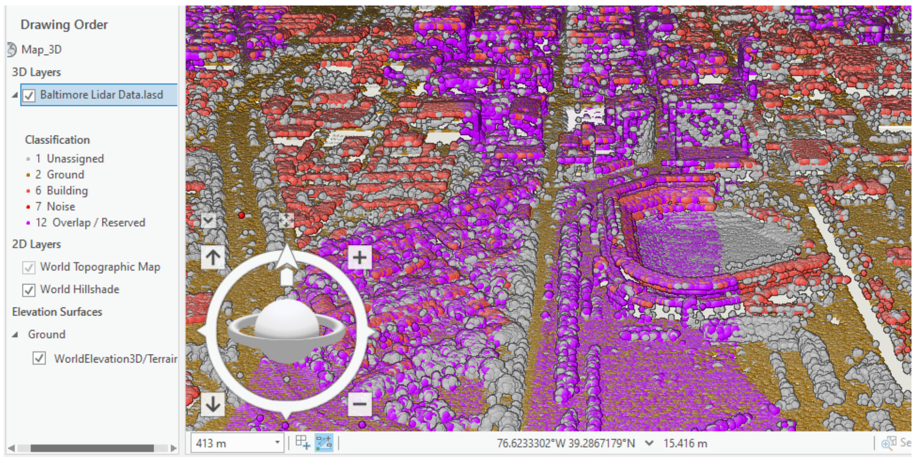


Figure 3: LAS based on Classification in ArcGIS Pro.

Question 12.

Our study area mostly returns first returns. It is not clear, but 2nd returns seem to occur where there might be objects of heights such as buildings or trees.

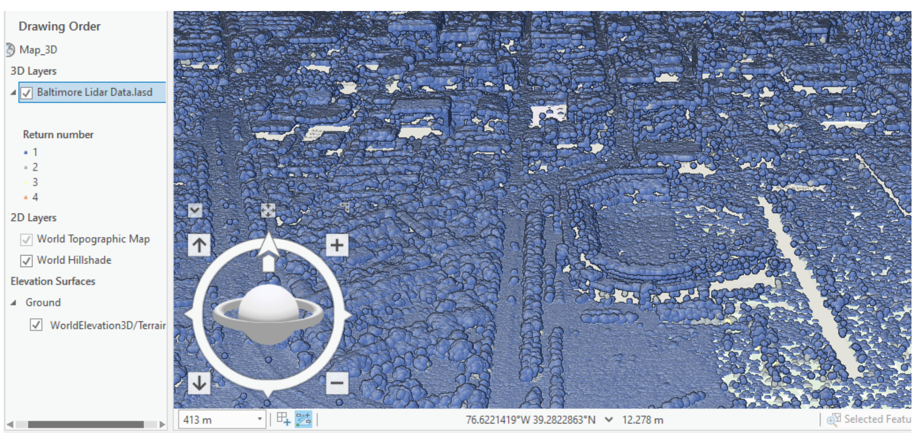


Figure 4: LAS based on Return Number.

Question 13.

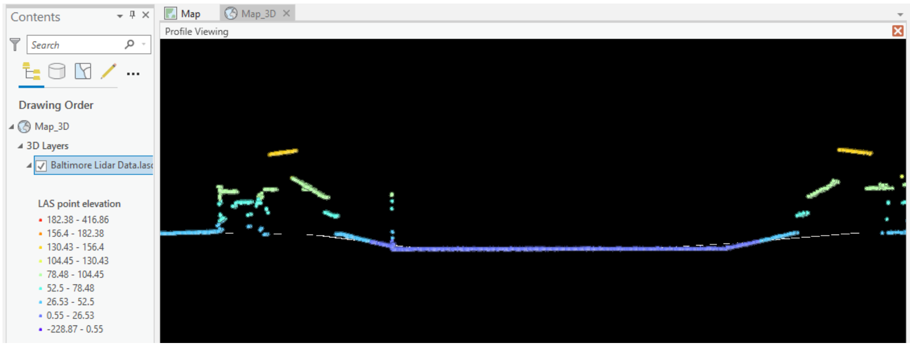


Figure 5: Elevation Profile View.

Question 14.

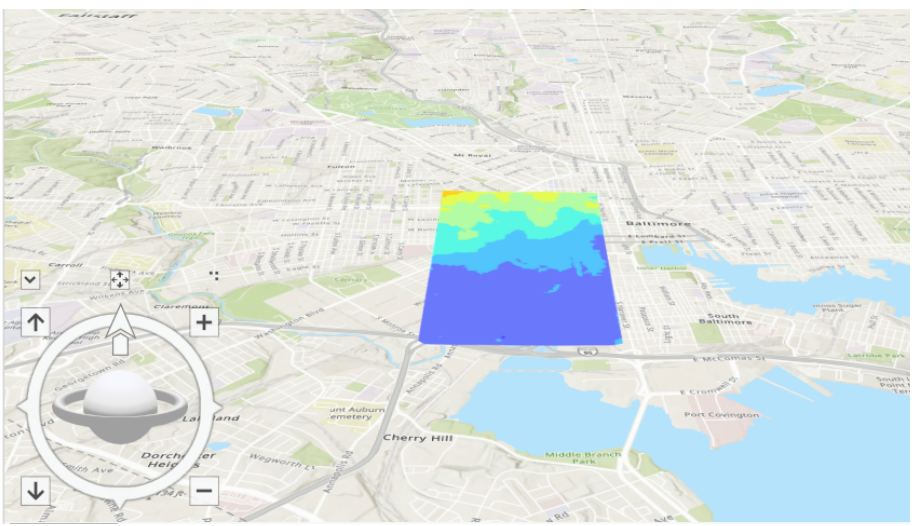


Figure 6: Elevation Surface.