**Lab Report 2.1**

Title: Visualizing LiDAR data and creating spacetime cubes.

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**Project Repository:**<https://github.com/tjjohnson1415/GIS5571>

**Time Spent:** 14 hours

**Abstract**

LiDAR data from the Minnesota Department of Natural Resources can be used to create digital elevation models and triangular irregular networks, both of which describe the ground elevation. The results of converting LiDAR data to these forms are exported as PDFs. Precipitation data from the PRISM Climate Group at Oregon State University is available as .bil files, which can be compiled into a space time cube and exported as an animation.

**Problem Statement**

LiDAR is a technology that can be used to measure ground elevation. LiDAR outputs a large dataset of individual points, which by itself isn’t very useful. LiDAR datasets can be transformed into other forms. For this lab, LiDAR data will be converted into a digital elevation model (DEM) and a triangular irregular network (TIN).

A .bil is a format of raster data. Twelve .bil files (one for each month) will be consolidated into a single space time cube and a time series animation will be created.

Table 1: Data used in this lab.

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| **#** | **Requirement** | **Defined As** | **(Spatial) Data** | **Attribute Data** | **Dataset** | **Preparation** |
| 1 | .LAS File | Minnesota LiDAR Data | Point Location | Elevation | [Minnesota DNR](https://resources.gisdata.mn.gov/pub/data/elevation/lidar/examples/lidar_sample/las/4342-13-06.las) |  |
| 2 | .bil File for Precipitation | 30 year Normals .bil files for precipitation from PRISM | Raster | Precipitation | [PRISM Climate Group at Oregon State University](https://prism.oregonstate.edu/normals/) |  |

**Input Data**

The datasets used for this lab are a LiDAR dataset from the Minnesota Department of Natural Resources and 30-year normal .bil precipitation files from the PRISM Climate Group at Oregon State University. The LiDAR data is a set of many points each with a location and an elevation. The precipitation .bil files are rasters of average precipitation data by month over the last 30 years for the entire contiguous United States.

Table 2: Data

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Title** | **Purpose in Analysis** | **Link to Source** |
| 1 | .LAS | Input dataset to convert to DEM and TIN | [Minnesota DNR](https://resources.gisdata.mn.gov/pub/data/elevation/lidar/examples/lidar_sample/las/) |
| 2 | Precipitation .bil Files | Input dataset to convert to a space time cube and create a time series animation | [PRISM Climate Group at Oregon State University](https://prism.oregonstate.edu/normals/) |

**Methods**

**A diagram of a data flow

Description automatically generated**

Figure 1: Data flow diagram for turning a .las file into a DEM and a TIN and exporting them as PDFs.

A zipped .las file was downloaded from the Minnesota Department of Natural Resources. The .las data was converted to a raster (DEM) and a TIN, which were both put into a file geodatabase. Images of the DEM and TIN were exported as PDFs.

**A diagram of a data flow

Description automatically generated**

Figure 2: Data flow diagram for turning .bil files from PRISM into a space time cube and a time series animation.

A collection of twelve .bil files (one for each month) was downloaded from PRISM Climate Group at Oregon State University. The data was unzipped and converted to twelve TIFFs. The twelve TIFFs were added to a mosaic data set, which was manipulated to give it multidimensional metadata. The mosaic dataset was converted to a multidimensional raster layer, from which a time series animation and a space time cube were created.

**Results**

*A black and white image of a landscape

Description automatically generated*Figure 3 shows the digital elevation model (DEM) created from the .las dataset. Higher elevations appear in white, while lower elevations are in black. The edge of the river valley is very apparent as the line where relatively high, constant elevation meets relatively low, constant elevation. Roads can be identified in the higher elevation area as linear features of especially high elevation. Figure 4 shows the triangular irregular network (TIN) created from the .las dataset. Similar features to the DEM can be seen in the TIN. The highest elevation areas are in dark red and the lowest elevation areas are in light blue.

Figure 3: DEM

Table 3 shows the characteristics of the space time cube.

A map of land with different colors

Description automatically generated**Results Verification**

Because DEM and TIN are both ways of visualizing a land surface, they should look similar. Because the same features can be seen in both Figure 3 and Figure 4, they are likely correct.

**Discussion and Conclusion**

I learned how to use LiDAR data and how to transform it into more usable forms. ArcGIS Pro allows LiDAR data to be viewed in both 2D (map view) and 3D (scene view). Figure 5 shows a comparison of these two views. While elevation can be seen in the 2D view through the color, it is much easier to understand the range and the scale of the elevations by viewing them in 3D. I learned how to create space-time cubes and export them as animations. An animation can be found on my GitHub.

**References**

*Prism 4km gridded climate data downloads via web service. (n.d.). https://prism.oregonstate.edu/documents/ PRISM\_downloads\_web\_service.pdf*

Figure 4: TIN

A screenshot of a computer

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Table 3: Space Time Cube Characteristics

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Figure 5: Comparison of 2D map view and 3D scene view for viewing LiDAR data.

**Self-score**

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| --- | --- | --- | --- |
| **Category** | **Description** | **Points Possible** | **Score** |
| **Structural Elements** | All elements of a lab report are included **(2 points each)**:  Title, Notice: Dr. Bryan Runck, Author, Project Repository, Date, Abstract, Problem Statement, Input Data w/ tables, Methods w/ Data, Flow Diagrams, Results, Results Verification, Discussion and Conclusion, References in common format, Self-score | 28 | **27** |
| **Clarity of Content** | Each element above is executed at a professional level so that someone can understand the goal, data, methods, results, and their validity and implications in a 5 minute reading at a cursory-level, and in a 30 minute meeting at a deep level **(12 points)**. There is a clear connection from data to results to discussion and conclusion **(12 points)**. | 24 | **22** |
| **Reproducibility** | Results are completely reproducible by someone with basic GIS training. There is no ambiguity in data flow or rationale for data operations. Every step is documented and justified. | 28 | **28** |
| **Verification** | Results are correct in that they have been verified in comparison to some standard. The standard is clearly stated **(10 points)**, the method of comparison is clearly stated **(5 points)**, and the result of verification is clearly stated **(5 points)**. | 20 | **20** |
|  |  | 100 | **97** |