Lab 2 - Part 1 Lab Report

Title: Lab 2 - Part 1
Notice: Dr. Bryan Runck
Author: Ben Landers
Date: 10/29/2024

Project Repository: https://github.com/blanders98/GIS5571/tree/main/Lab2
Google Drive Link:
Time Spent: 20 hours

Abstract

In this lab, I created an ETL pipeline using ArcGIS Pro notebooks to download, transform, and visualize .las files from Minnesota DNRs server. I then converted this .las file to a DEM and TIN. Next, I used the same ETL pipeline structure to download the PRISM database, which contains annual precipitation data, and converted it to a spacetime cube for animation.

Problem Statement

This lab addresses the challenges of processing LiDAR and precipitation data from online servers and web pages. It aims to create an extract, transfer, and load (ETL) pipeline to automate the downloading of .las files from the Minnesota DNR and annual 30-Year Normals precipitation data from PRISM. Key goals of this lab include converting a .las file into a DEM and TIN, performing 2D and 3D exploratory spatial data analysis in ArcGIS Pro, and transforming .bil files into a spacetime cube for animation export.

Table 1. Data Used in this Lab

#	Requirement	Defined As	(Spatial) Data	Attribute Data	Dataset	Preparation
1	LiDAR Data	MN DNR LiDAR Data (Ramsey County)	LiDAR		Ramsey County .las dataset	
2	Precipitation Data	PRISM 30-Year Normal Precipitation Data	Precipitation		PRISM 30-Year Normal Precipitation Dataset	
3						
4						

Input Data

Table 2. Data Used in this Lab

#	Title	Purpose in Analysis	Link to Source
1	MN DNR LiDAR Data (Ramsey County)	LiDAR data to transform into DEM and TIN	Ramsey County .las dataset
2	PRISM 30-Year Normal Precipitation Data	Precipitation data to transform into spacetime cube	PRISM 30-Year Normal Precipitation Dataset
3			
4			

Methods

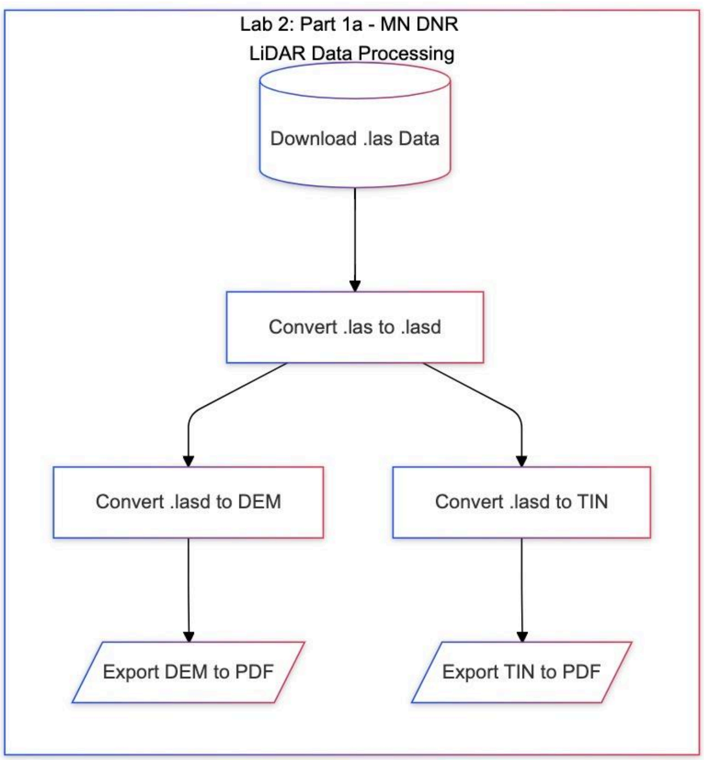

Figure 1. Part 1a data flow diagram (Mermaidchart.com)..

To begin, I used a get request to download and save LiDAR data from the MN DNR server. I then converted the .las file retrieved from the download to a .lasd file, which then allowed me to convert that file into a DEM and TIN using arcpy functionality (LasDatasetToRaster and LasDatasetToTin). I used the ArcGIS Pro GUI to create a layout for the DEM and a layout for the TIN. I manually added the newly created DEM and TIN to each of these layouts accordingly. The arcpy.mp module gave me the functionality to then export each of these layouts to a PDF.

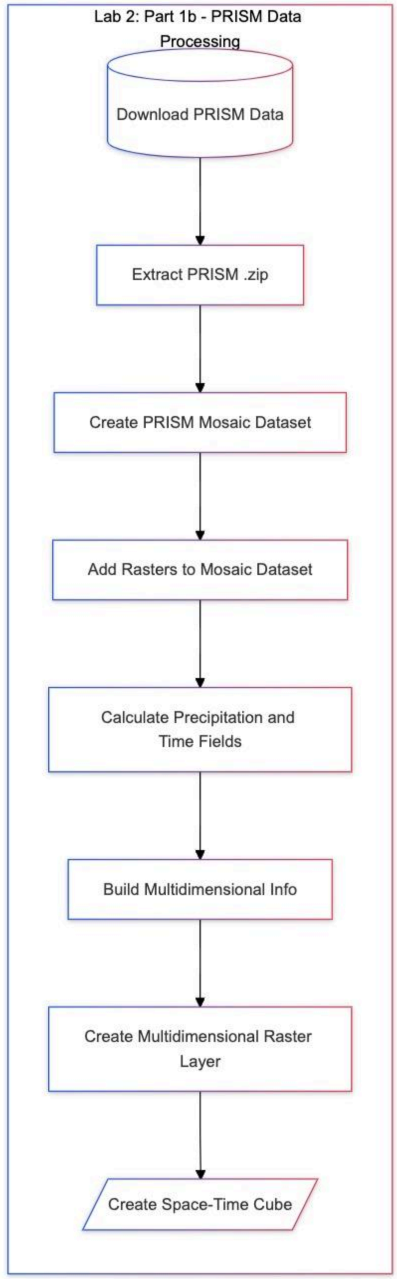

Figure 2. Part 1b data flow diagram (Mermaidchart.com).

For the second part of the lab, I used a get request to download the PRISM 30-year normal precipitation data. I then began to transform the data retrieved from this download so I could create a spacetime cube from it. To do this, I started by creating an empty mosaic dataset and then adding the raster data within the PRISM dataset to the mosaic. I then set the Variable field in the mosaic dataset to Precip and calculated the Timestamp field based on the OBJECTID so it would create an annual timestamp starting from 1991. Next, I set multidimensional parameters for the mosaic dataset, defining the main variable as Variable (Precip data) and Timestamp as the temporal variable. I followed this by creating a multidimensional raster with the mosaic dataset as an input using arcpy.md.MakeMultidimensionalRasterLayer. Finally, I created a spacetime cube with arcpy.stpm.CreateSpaceTimeCubeMDRasterLayer using the multidimensional raster as the input, and saving it as a NetCDF file. Unfortunately, I could not get the spacetime cube to render on my ArcGIS Pro.

Results

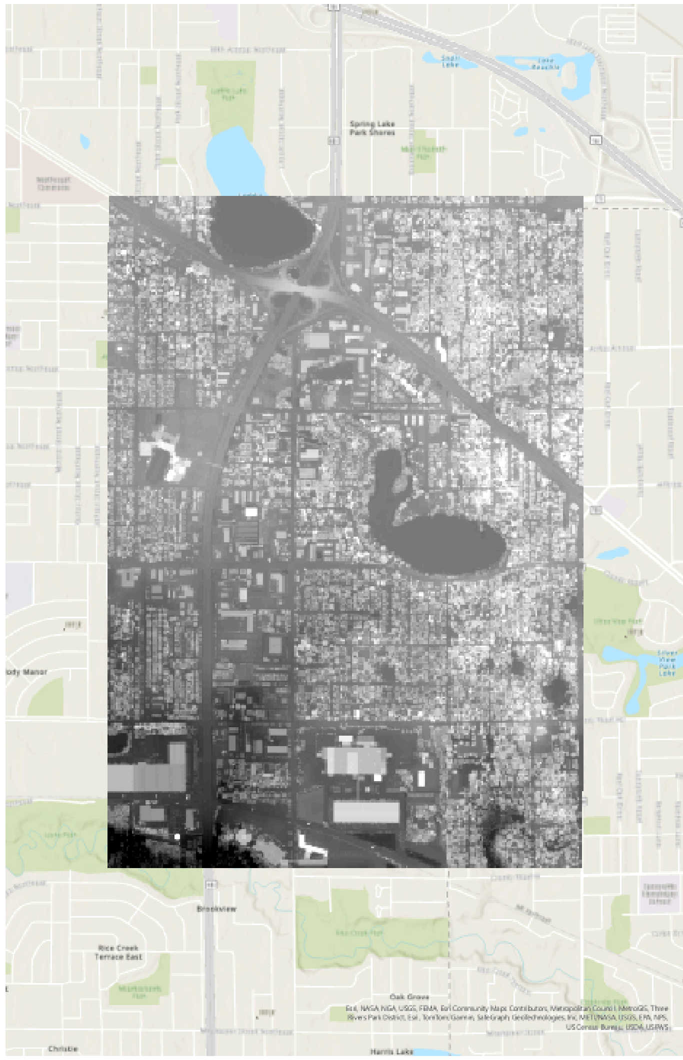

Figure 3. DEM Output.

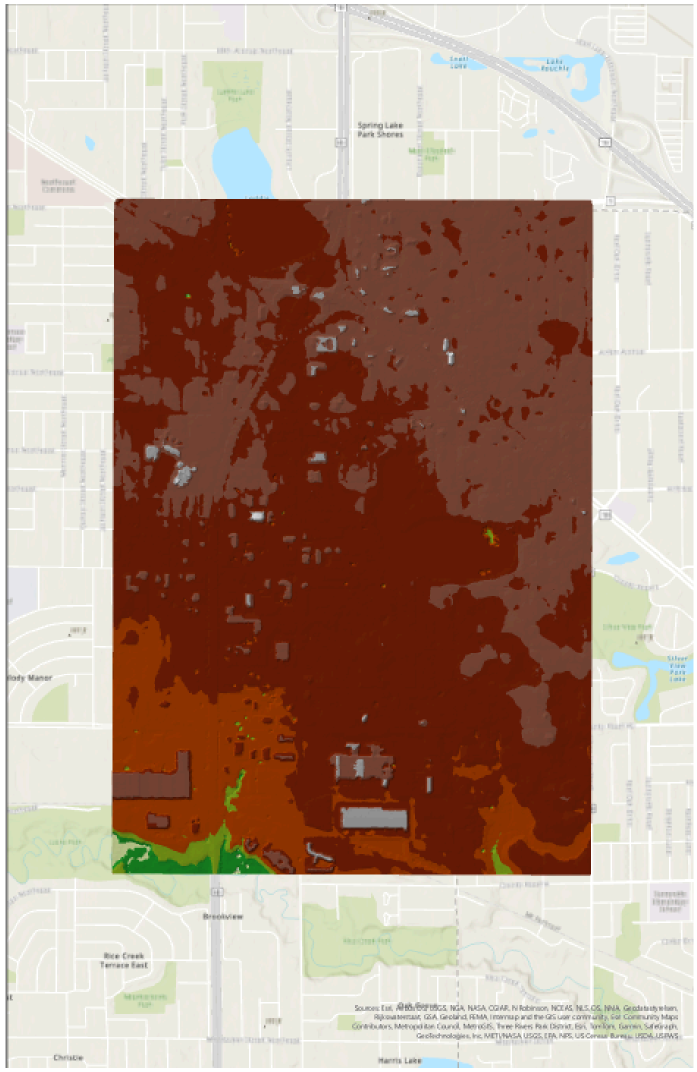

Figure 4. TIN Output.

Results Verification

I verified results by visually inspecting the DEM and TIN outputs for expected patterns, accurate location, and completeness. I also checked my code to ensure I outputted everything to the right locations with the right file structures, which confirmed my file conversions/transformations. I confirmed the final export of all visualizations and data exports.

Discussion and Conclusion

For comparison of the .las file as a 2D and 3D rendering, ArcGIS provides a wide array of features to visualize and analyze the feature in both styles. For 2D visualization, you can display a .las file as a point cloud, you can customize symbology by elevation or classification, and you can rasterize the .las file, as we did in this lab. There are also basic measurement tools that allow for further analysis. For 3D visualization, you can use ArcScene to present the data in a 3D format. ArcScene allows for rotation and tilting of the view, to view the data from different angles. There are also options to adjust sunlight illumination and shading based on the time of day, which can show a shadowing effect.

In conclusion, for part 1 of this lab, I developed an ETL pipeline using ArcGIS Pro to automate data downloading, transforming, and visualizing MN DNR LiDAR data and PRISM precipitation data. I was able to successfully use ArcPy functionality to convert the .las file to a .lasd dataset, then to a DEM, and finally to a TIN. For the PRISM data, I was able to use the precipitation data alongside the temporal side of the dataset to create a spacetime cube which enabled the creation of an animation presenting the data over time, showing precipitation data on an annual basis.

References

OpenAI. (2024). ChatGPT (October 29 Version) [Large language model]. Available at https://chat.openai.com

Self-score

Fill out this rubric for yourself and include it in your lab report. The same rubric will be used to generate a grade in proportion to the points assigned in the syllabus to the assignment.

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	**28**
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	**23**
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	**27**
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	**98**