Lab Report

Title: Lab2 Part 1
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Project Repository: https://github.com/TzuYuMa/GIS5571/blob/main/Lab2/Lab2_1.ipynb
Time Spent: 28

Abstract

In Part 1 of Lab 2, our tasks involve requesting LiDAR data from the Minnesota DNR's FTP server, gaining expertise in the transformation of LiDAR data in .las format into various representations such as raster, cube, and TIN. We will also employ Arcpy to export the resultant data. Furthermore, we will conduct a comparative analysis of spatial data, exploring the differences between 2D and 3D views while utilizing the same dataset. Lastly, we will focus on constructing an ETL process for downloading annual 30-Year Normals in .bil file format for precipitation data from PRISM, converting this data into a spatiotemporal cube, and creating an animation to visualize the timeseries.

Problem Statement

In Part 1 of Lab 2, we can break it down into three distinct tasks:

Part 1.1

Create an ETL process to download .las files from the Minnesota DNR, convert them into DEM and TIN formats, and subsequently export them as PDF documents.

Part 1.2

Conduct a comparative analysis of the .las files by visualizing them in both 2D map and 3D scene environments to identify differences and similarities.

Part 1.3

Develop an ETL process for downloading annual 30-Year Normals files from PRISM, convert them into space-time cube representations, and finally, export animations for visualization.

Table 1. Data description

#	Requirement	Defined As	(Spatial) Data	Attribute Data	Dataset	Preparation
1	LiDAR	Point cloud	.laz / .las	Elevation	Minnesota DNR	Convert .las to las dataset first.
2	Annual 30-Year Normals	Precipation Normals	.bil	Precipitation	PRISM	ETL

Input Data

We will obtain the LiDAR data from the Minnesota DNR and the 30-year annual precipitation normal data from PRISM (Table 2) via API requests. After downloading the data, our next steps involve converting this data into TIN and DEM formats and subsequently creating the spatiotemporal cube.

Table 2. Input data

#	Title	Purpose in Analysis	Link to Source
1	Aitkin/ 1942-32-08.las	To convert to TIN and DEM.	MN DNR
2	30-Year Normals	For creating the space time cube	PRISM

Methods

Part 1.1

For the conversion of the .las files, the process involves initially requesting the .laz files from Minnesota DNR, followed by obtaining an unzip tool to decompress these .laz files into .las format. Initially, the choice of downloading .laz files was made to save storage space. However, I found that I only need to download a single tile, and this particular tile isn't excessively large. Consequently, I concluded that downloading .las files is a significantly faster and more efficient approach in this case.

Subsequently, a LAS dataset is created, and the data is transformed into TIN and DEM representations. Finally, the results are exported as a PDF file.

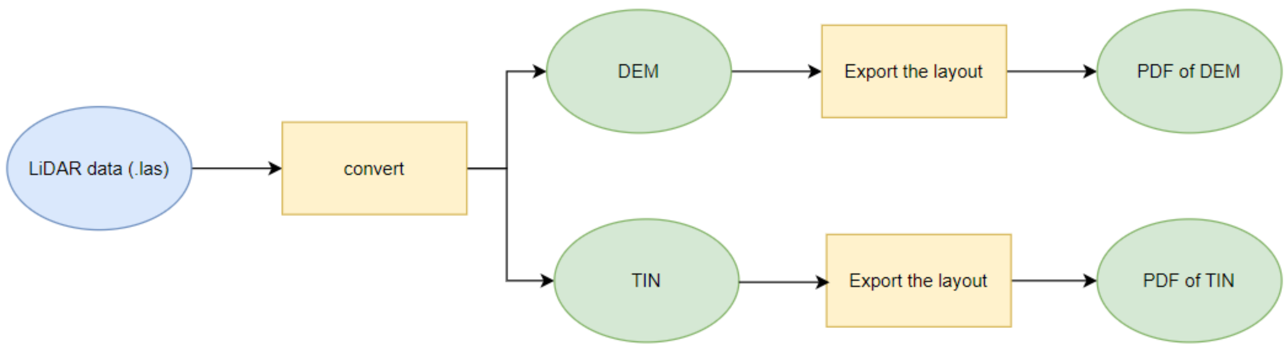

Figure 1. Data flow of part 1.1

Part 1.2

For the exploratory data analysis in both 2D and 3D, I employ maps and a Global Scene to compare these two visualization methods.

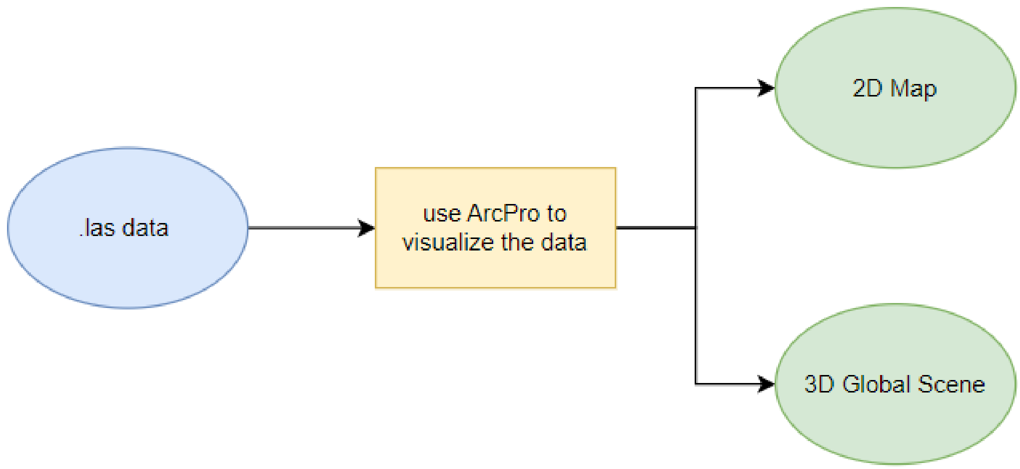

Figure 2. Data flow of part 1.2

Part 1.3

When building the ETL process for visualizing PRISM data, the workflow encompasses several key steps. To begin, I initiate the process by requesting data from an API and subsequently converting it into a spatiotemporal cube. Following this, I create an empty mosaic and add the raster data into the mosaic dataset. In the next phase, I establish and populate a Variable field within the mosaic Footprints table, alongside a Timestamp field. To introduce time-based mosaic functionality, I utilize the Build Multidimensional Info tool. Lastly, I employ the Make Multidimensional Raster Layer tool to enable the conversion and visualization of the data in a time-enabled mosaic. Eventually, I can create a space-time cube from the Multidimensional Raster Layer.

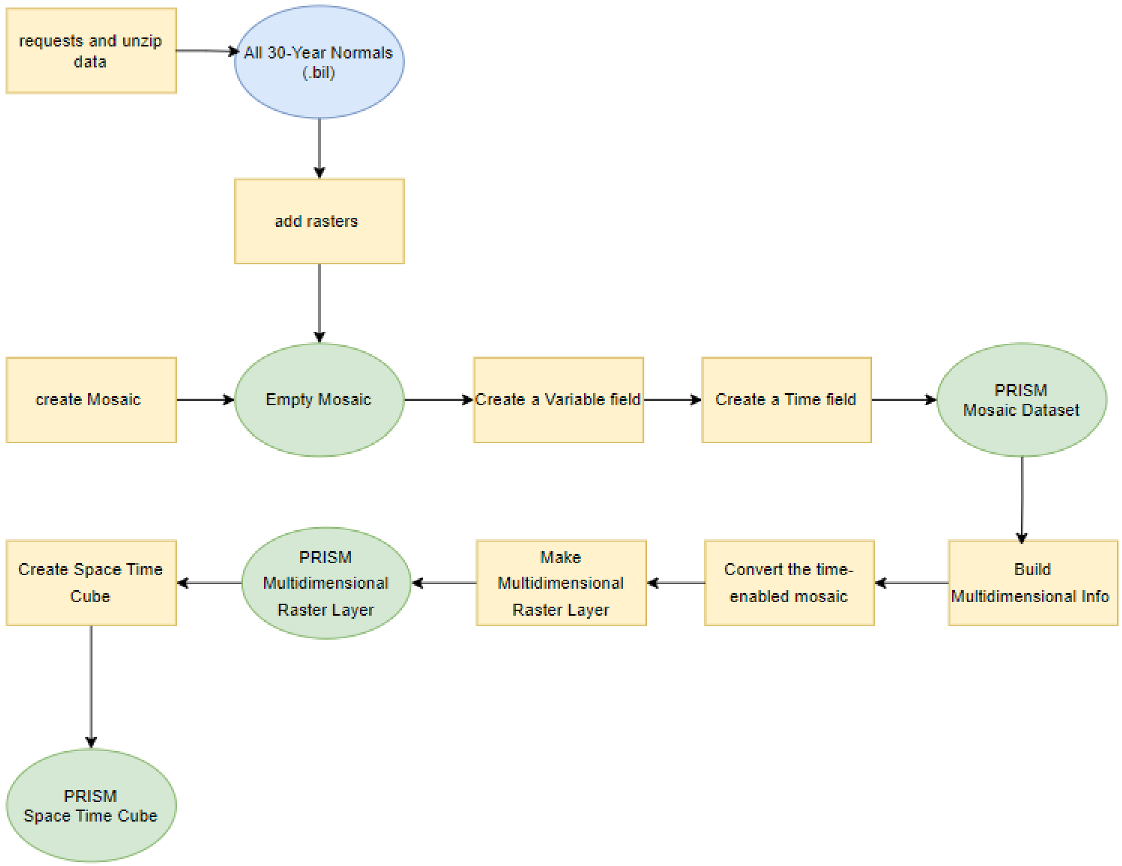

Figure 3. Data flow of part 1.3

To export the animation, I achieved this by creating keyframes at first and then exporting the animation as a GIF file.

Results

Below are the results of this Lab (Figure 3 to 6), which encompass the output of the DEM and TIN derived from the Minnesota DNR LiDAR .las file, as well as the exploratory analysis conducted in both 2D and 3D using the LAS dataset and the Space-Time Cube.

In Part 1.1 (Figure 4 and 5), at first, I was concerned about the size of .las files, so I choose to download .laz files and then unzip them. This decision was influenced by the perception that it might save storage space, particularly given that the Minnesota DNR provided unzip tools. However, I soon realized that these steps were unnecessary since I only needed to download a single tile, and storage wasn't a concern. Most of my time in this part was spent on figuring out the tools and methods to convert the .las files into DEM and TIN formats.

In Part 1.2 (Figure 6), I thought I needed to use Arcpy to convert the data into a 3D scene for comparison. After investing a significant amount of time in finding a solution, I discovered that ArcPro had a Global Scene feature that could convert maps to 3D. To visualize the data, I can use symbology pane to visualize data in various ways, such as points, contours, edges, and surfaces. Within each option, I could adjust the display details as needed.

In Part 1.3 (Figure 7), I closely followed the instructions provided in a blog to build the space-time cube. This part consumed most of my time. I encountered challenges, especially when working with a large volume of point cloud data, which led to extended processing times when displaying the results as time series. Additionally, I faced difficulty in finding the specific tool to export the animation, so I resorted to exporting the result as a GIF file.

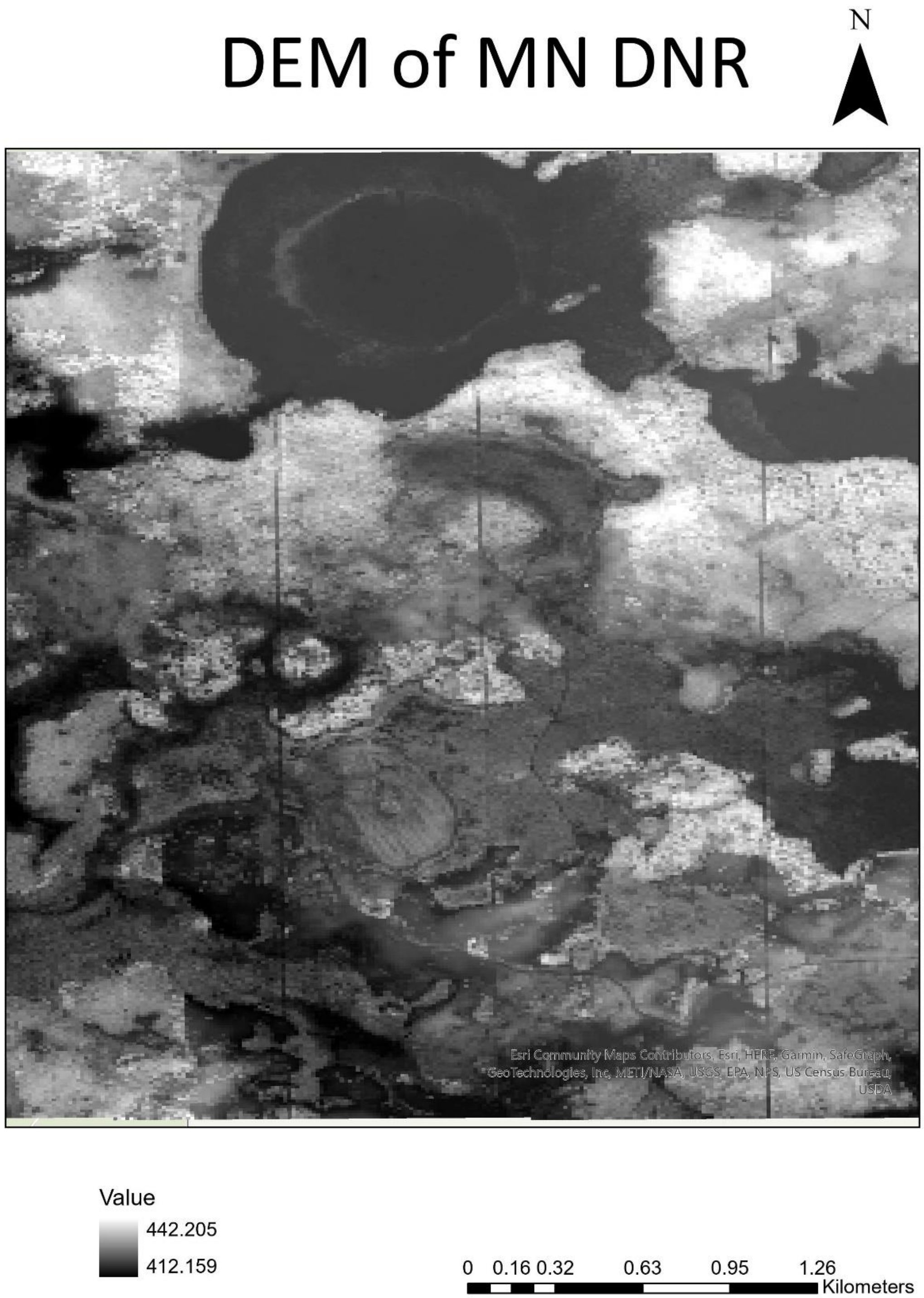

Figure 4. DEM output of .las file

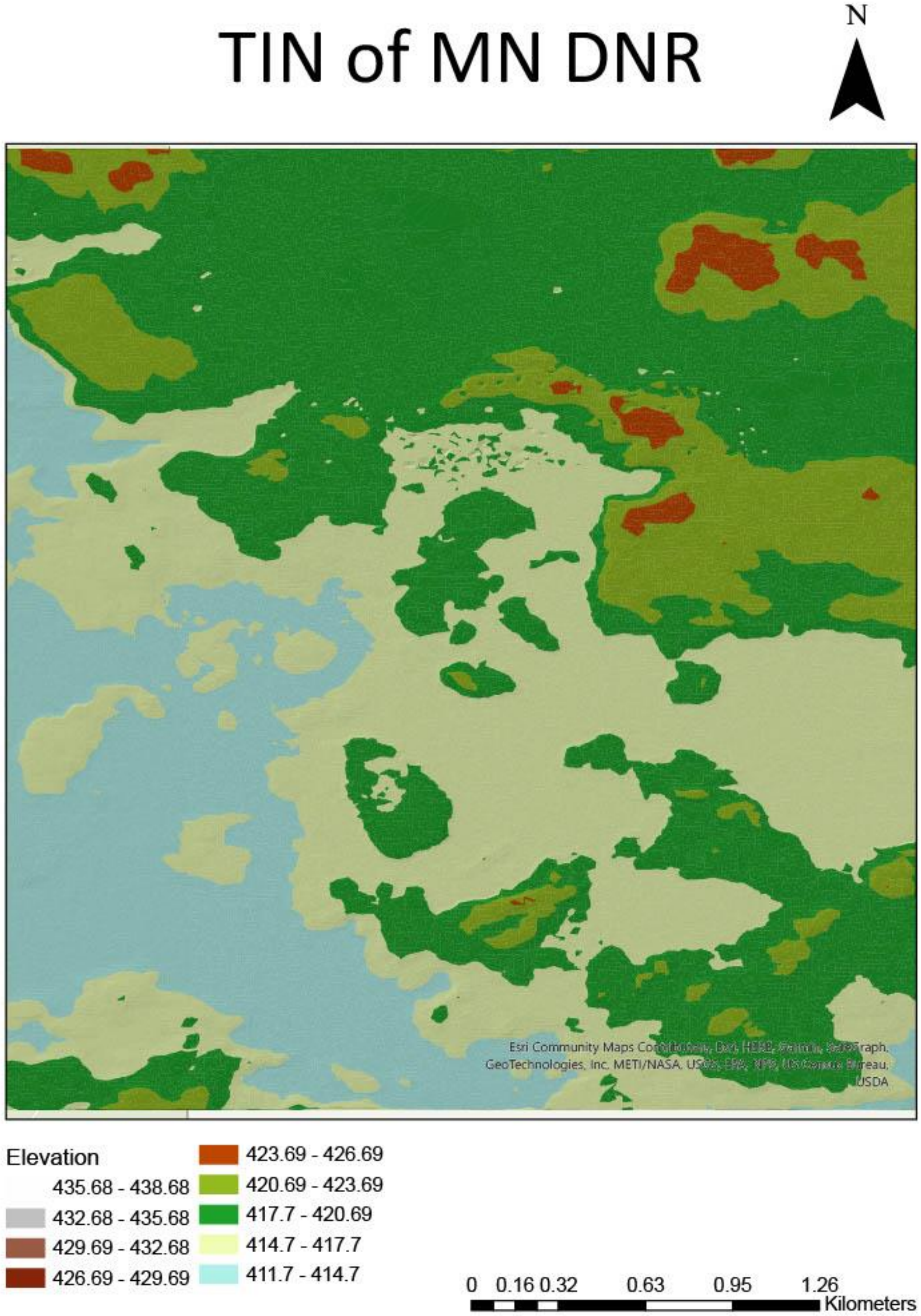

Figure 5. DEM output of .las file

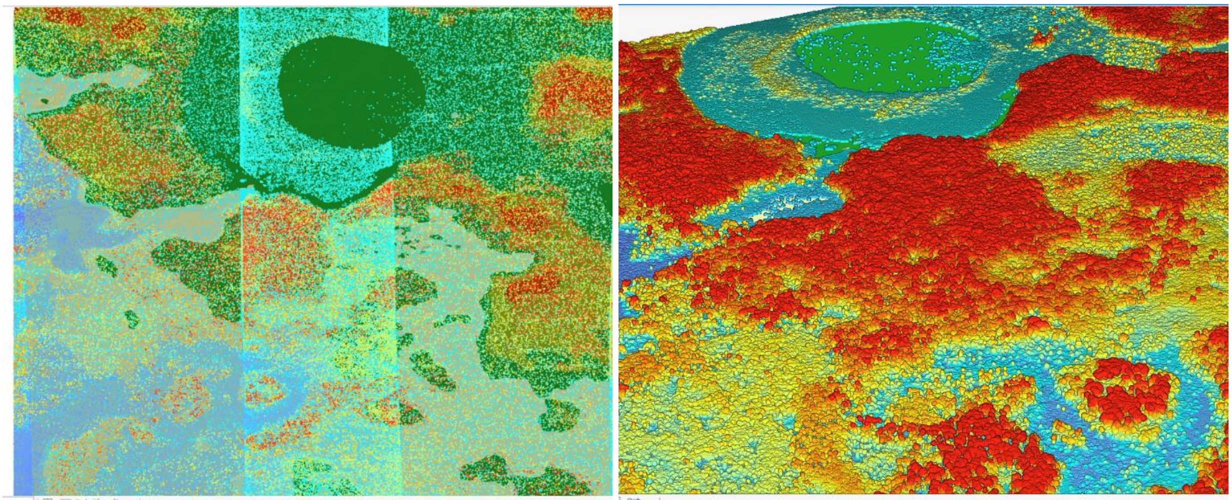

Figure 6. exploratory analysis in 2D (left) and 3D (right) of the LAS dataset.

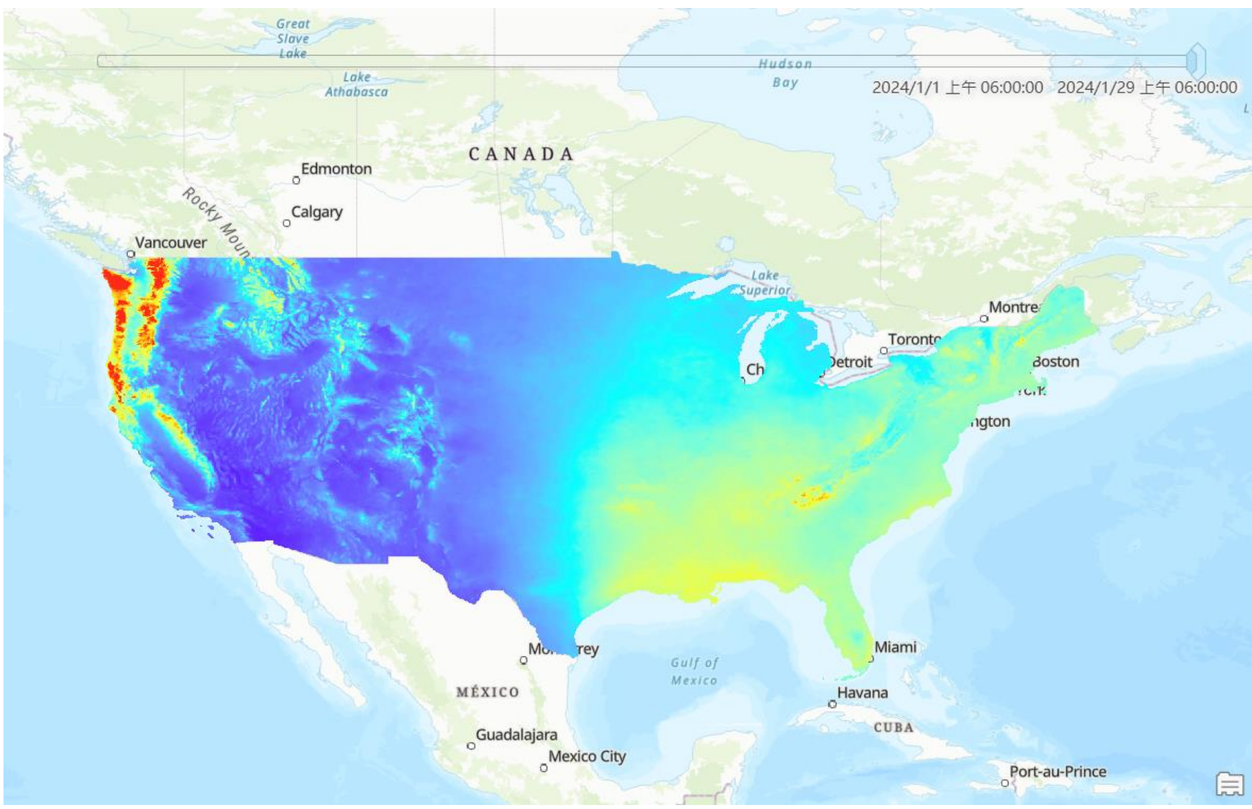

Figure 7. PRISM Annual Precipitation Multidimensional Raster Layer.

Results Verification

To verify the results, I initially ensure that I meet the assessment requirements. Subsequently, I compare my outputs with those of my peers to assess the quality and accuracy of the work.

Discussion and Conclusion

In part 1 of Lab 2, I learned a lot on working with LiDAR data, comparing data between 2D and 3D environments, constructing a space-time cube, and creating animations. Admittedly, all these skills were new to me, and I had to explore various tools and techniques during the learning process. I've also grown accustomed to encountering and troubleshooting errors as I ran my code.

Despite the challenges I faced along the way, the experience was enjoyable, and the sense of achievement when I obtained successful outputs was truly rewarding. It's a testament to the learning journey and the satisfaction of mastering new skills.

References

Animation Basics. (2023). Esri. https://pro.arcgis.com/en/pro-app/latest/help/mapping/animation/overview-of-animation.htm

buie, L. (2020, February 11). Explore Your Raster Data with Space Time Pattern Mining. Esri. https://pro.arcgis.com/en/pro-app/latest/tool-reference/conversion/convert-las.htm

Create Space Time Cube From Multidimensional Raster Layer (Space Time Pattern Mining). (2023). Esri. https://pro.arcgis.com/en/pro-app/latest/tool-reference/space-time-pattern-mining/createcubefrommdrasterlayer.htm

Self-score

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,	28	26

	Flow Diagrams, Results, Results Verification, Discussion and Conclusion, References in common format, Self-score		
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	26
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	19
		100	94