Lab Report

Title: Lab 2, Part 1 Deliverable
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Date: 11/2/22

Project Repository: https://github.com/and03449/GIS5571.git
Google Drive Link: N/A
Time Spent: 48 hours

Abstract
This lab consists of two ETLs: LiDAR data from the MN DNR's FTP server as well as temporal weather data from PRISM. Using these ETLs and ArcGIS Pro I will perform spatial analysis in both a 2D and 3D format as well as create a temporal space time cube visualizing PRISM data.

Problem Statement
Spatially and visually explore 2D and 3D LiDAR data from the Minnesota DNR's FTP server by creating an ETL of the data and running spatial analysis in ArcGIS Pro. Similarly, analyzing weather data over time by building an ETL of the data from PRISM.

Table 1. Requirements needed for building LiDAR and PRISM ETLs

#	Requirement	Defined As	(Spatial) Data	Attribute Data	Dataset	Preparation
1	LiDAR DNR Data	Raw LiDAR data including elevation in SW Minnesota	Elevation	N/A	https://resources.gisdata.mn.gov/pub/data/elevation/lidar/examples/lidar_sample/las/	None
2	PRISM Climate Data	Temporal US weather data over 30 years		Weather temps, precipitation	https://prism.oregonstate.edu/normals/	

Input Data
LiDAR data from the MN DNR's FTP server

PRISM collects climate data from a large number of monitoring stations to offer a variety of spatial and temporal analyses as well as a sophisticated quality control on data. The most impressive aspect of this data is that it was first collected in 1895 and continues to be collected today (*PRISM Climate Group at Oregon State University*, n.d.).

The MN DNR collects and manages LiDAR data using remote sensing to track distance and elevation. The base LiDAR data points can be converted to many different data types depending on the desired end results (*LiDAR Data Needs Survey*, n.d.).

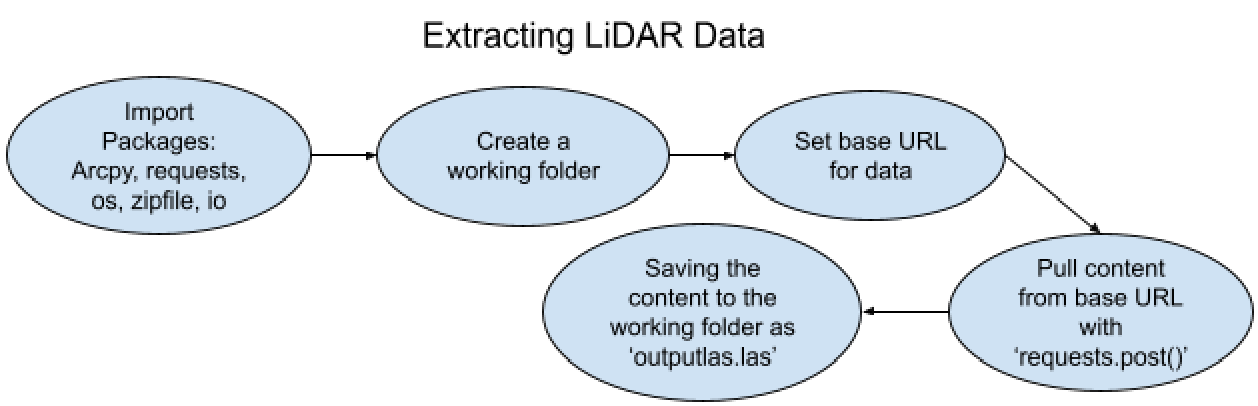
Table 2. Datasets Needed for Data Visualization

#	Title	Purpose in Analysis	Link to Source
1	DNR LiDAR Data	Visualizing elevation over multiple file types	https://resources.gisdata.mn.gov/pub/data/elevation/lidar/examples/lidar_sample/las/
2	PRISM Climate Data	Visualizing climate data	https://prism.oregonstate.edu/normals/

Methods

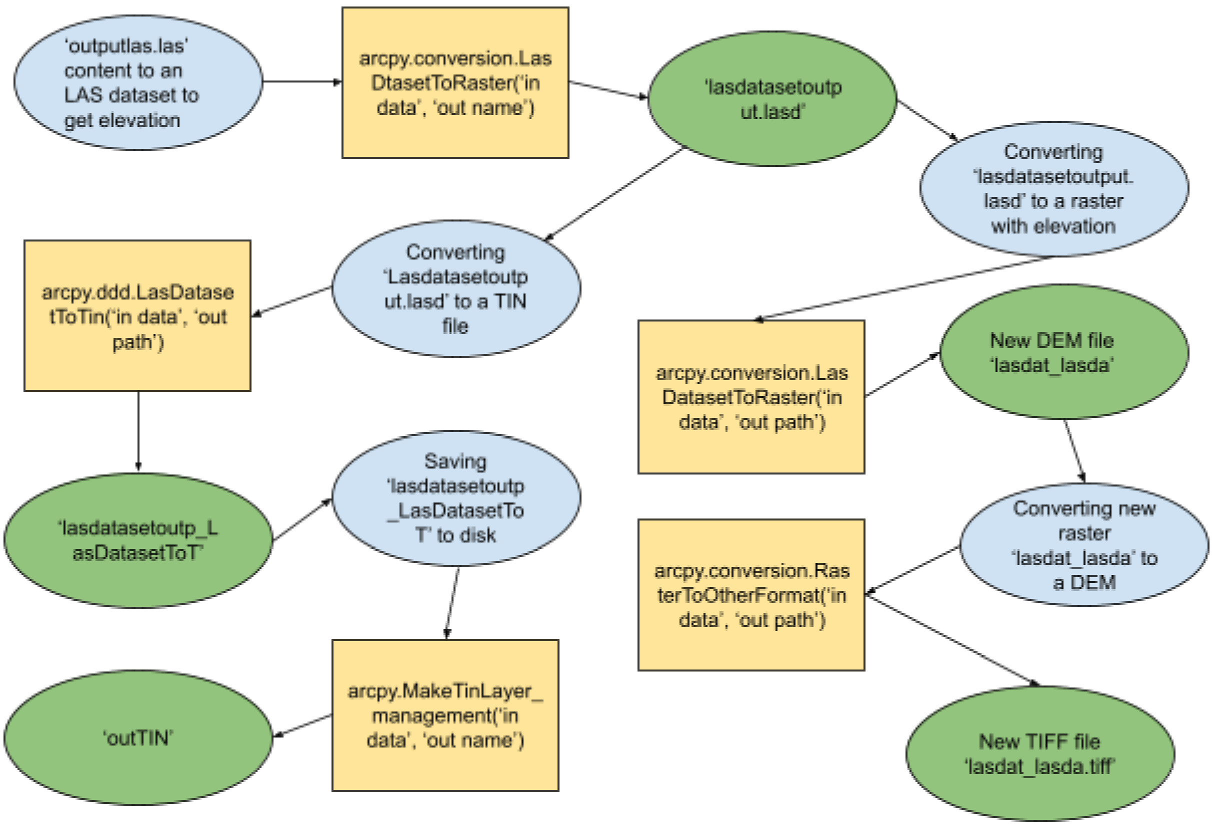
DNR LiDAR Data Exploration:

The first step to accessing the DNR LiDAR elevation data is to extract the raw data from the MN Geospatial Commons website (*Index of /Pub/Data/Elevation/Lidar/Examples/Lidar_sample/Las*, n.d.). The data on the website is in an LAS file so to extract the data using the 'requests' package I pulled content from the url and then using the 'os' package I was able to save the extracted data to a local working folder.



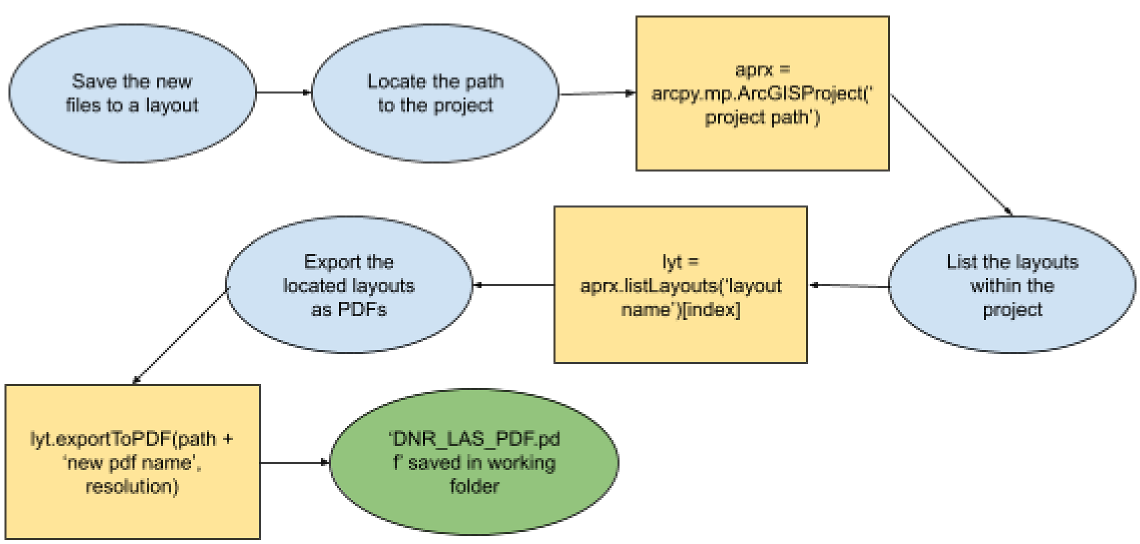
Once the data has been pulled from the website and saved to the local working folder, I then use the Data Management tool - Create LAS Dataset - to create a dataset from the extracted data. For the next step in exploring the LAS dataset, I converted the LAS dataset to a DEM with the Conversion Tool "LAS Dataset To Raster" to create an elevation raster dataset. Then used the Conversion Tool "Raster To Other Format" to save the raster as a DEM. Similarly to the steps to create a DEM, I used the Conversion Tool "LAS Dataset To TIN" to convert the LAS dataset to a TIN. Then, to save the new TIN format, I used the Data Management Tool "Make TIN Layer" to save the new TIN file.

LiDAR Data Exploration



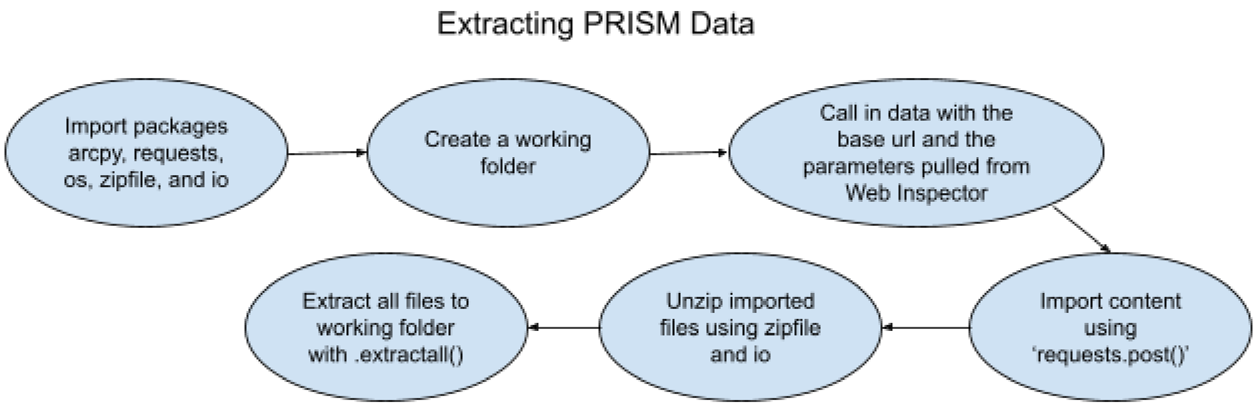
Lastly, to export a visualization of the new DEM and TIN files, I created a layout with maps and legends of each of the new files and then exported them to a PDF saved in the local working folder (I was having some problems exporting the PDF, sometimes it did not show the layouts so I have manually exported a version to the linked GitHub page above as well)

Exporting the New Files to a PDF

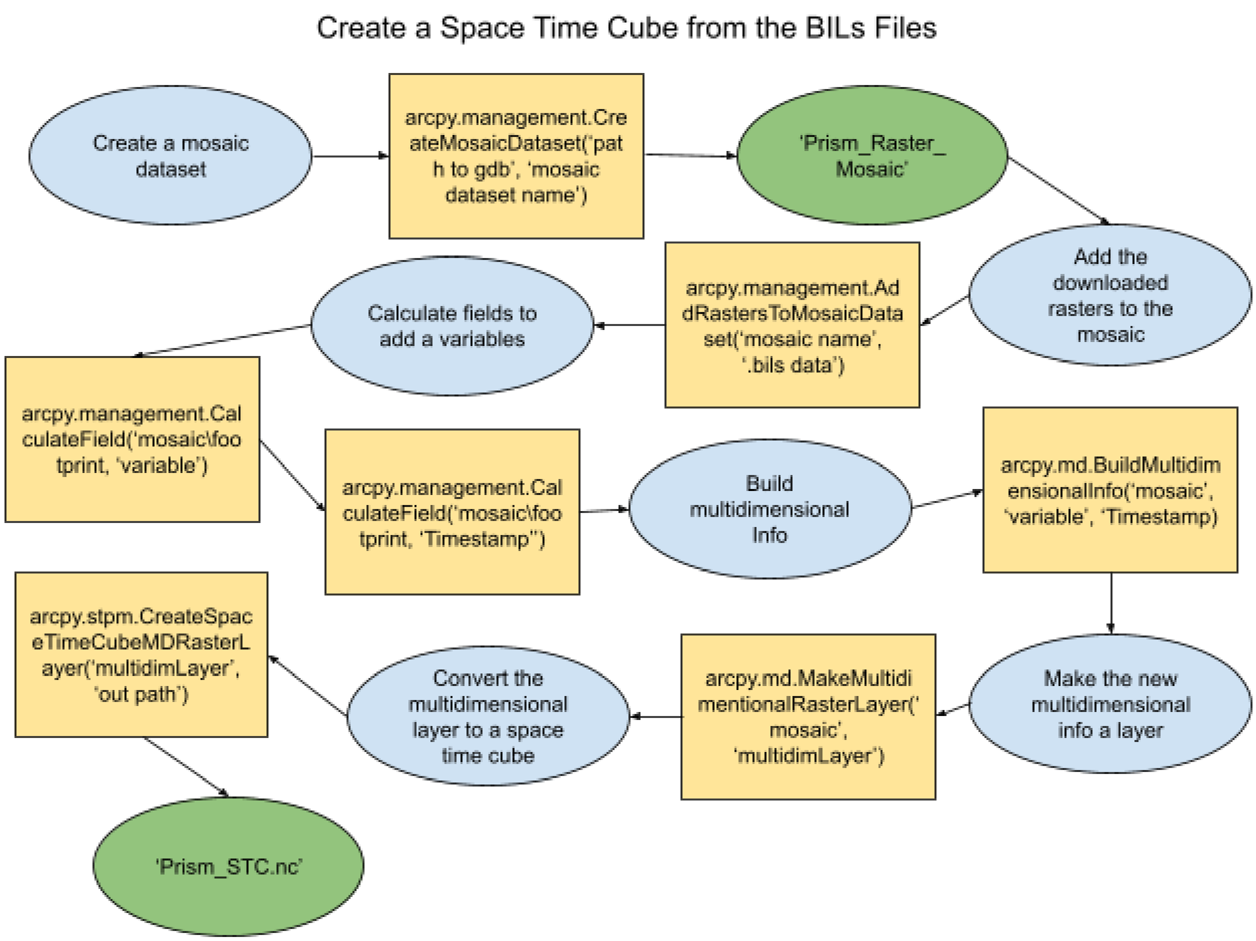


PRISM Data Exploration:

Similarly to the DNR LiDAR data above, the first step to extracting the PRISM climate data is to locate the data on the base URL and then pull the parameters of the data from the Web Inspector. This data is collected over 30 years (1991 - 2020) so the files are exported into zip files. Using the ‘zipfile’ package the files are extracted into many different file types but the ones we are interested in are the .bil (Band Interleaved by Line) files.



Now that the files are extracted the data can be compiled into a space time cube through a series of steps (Buie, 2020):

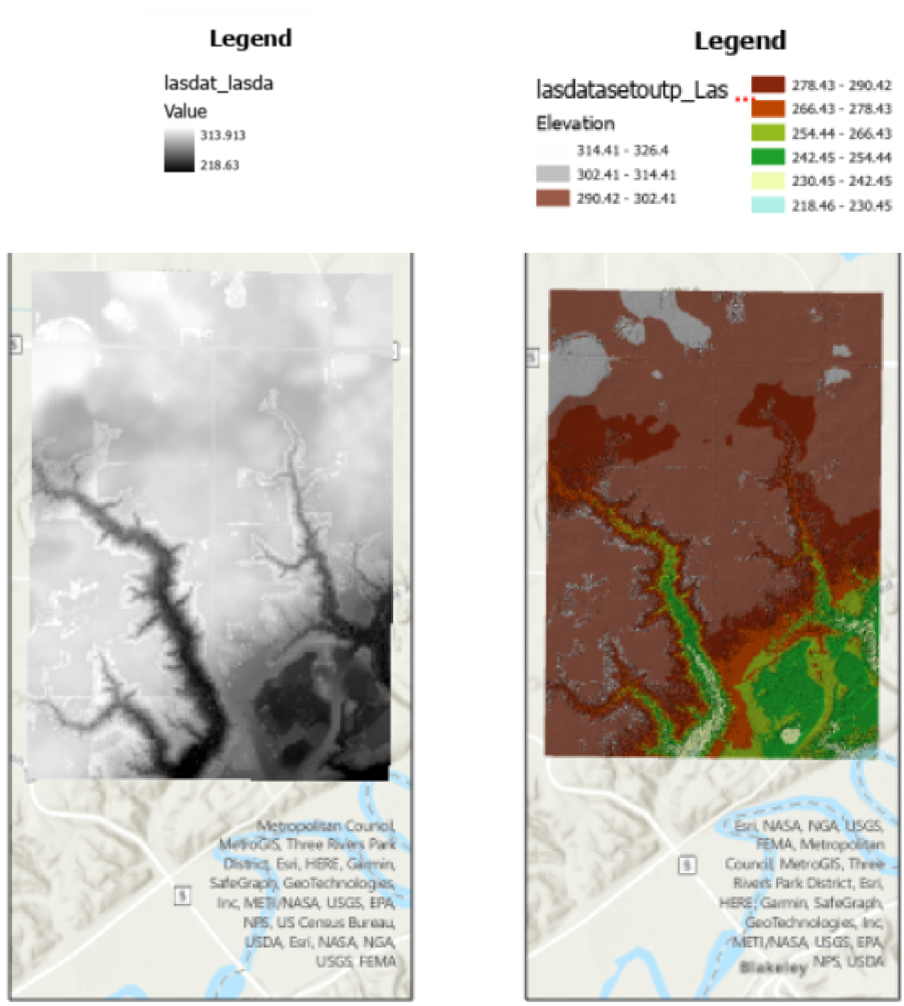


The final output after all of the steps in creating the space time cube is a .nc file which shows precipitation climate across the United States as well as a temporal series showing the change in climate for each year over the 30 year time lapse. To create an approachable exported file, I created a layout of the animated map of the US climate over a 30 year time period. Unfortunately I could not figure out how to do this via arcpy but was able to export the animation manually as a .gif file as seen on the GitHub page linked above.

Results

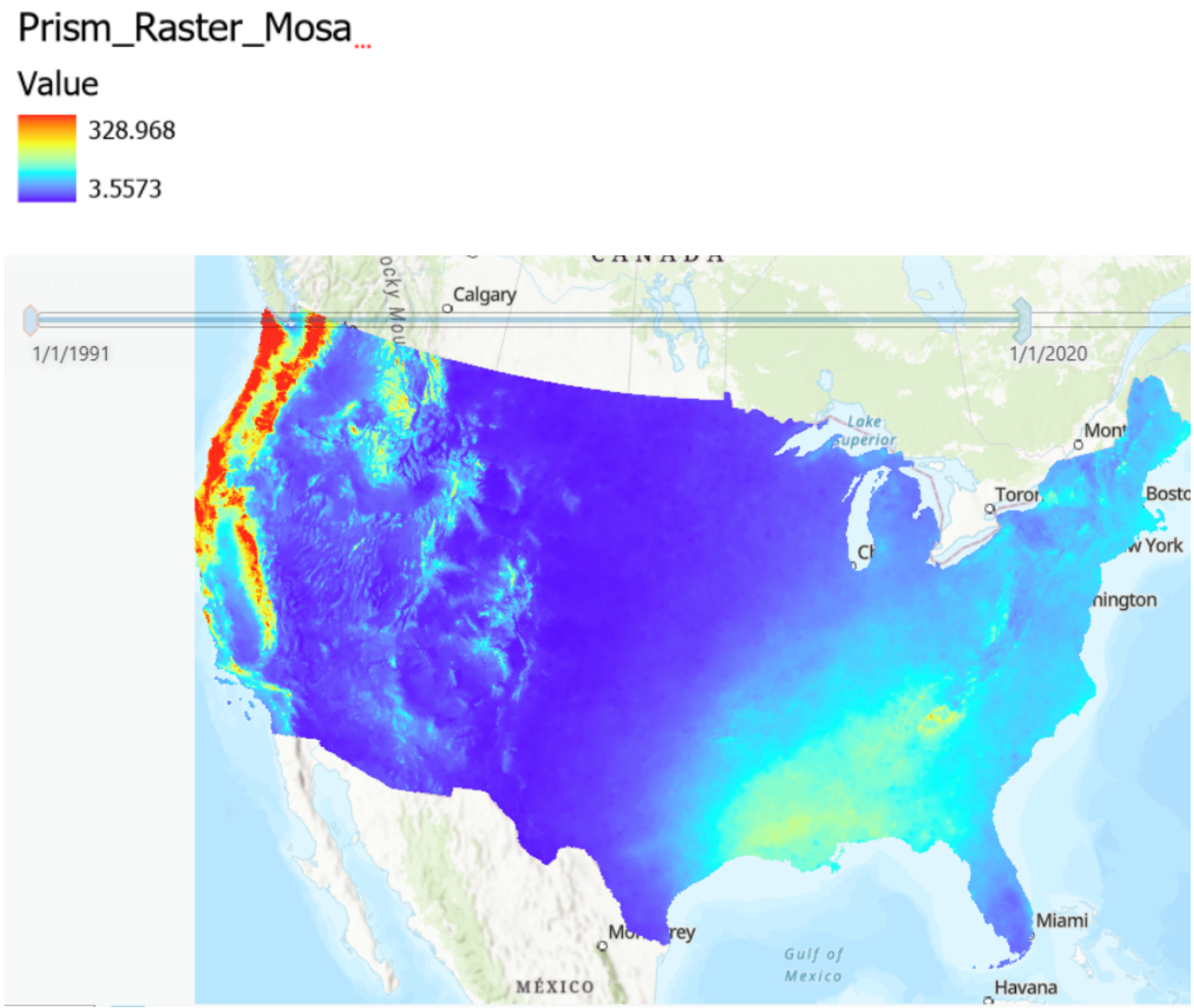
DNR LiDAR Data Exploration Results:

In creating the ETL the data was successfully pulled from the API which was then used to explore the data. By comparing the different data types - TIN and DEM - visually there is a big difference between the two. The DEM (left) is more of a classic raster in black and white and the topography is not as crisp and clear as the TIN file (right). For the DEM file, the legend is a continuous black and white grade where black is the lowest elevation and white the highest elevation.. For the TIN file, the legend contains 9 classifications equally divided over the total elevation.



PRISM Climate Data Exploration Results:

The steps in creating the ETL successfully pulled the data from the API which can then be used to explore and visualize the data. Using the Multidimensional Mosaic Layer, the precipitation data from the PRISM Climate data is visible in the map image below. The legend contains a continuous color ramp where the dark blue is the least amount of precipitation and the red is the highest amount of precipitation. The time animation shows the change from year to year starting with 1991 to 2020. Pictured below is the still image of the precipitation data from 1991.



Results Verification

For the DNR LiDAR data, these results can be verified by running the same methods as I listed above and receiving the same results visually and in the values in the legends. I can also verify the results by visually seeing that each image above is showing the same extent as well as showing elevation data in the way that each format should be - DEM as a continuous raster and TIN as a sectioned raster.

For the PRISM Climate data, these results can be verified in the same manner by running the methods listed above and receiving the same results. Visually the results can be verified by comparing them to the base URL images as well and seeing if there are any discrepancies.

Discussion and Conclusion

Throughout this lab I have learned that the same dataset can be formatted and visualized in many different ways. The different file formats produce different visualizations which allow for the user to select the visualization they would prefer as well as any subsequent analysis they would like to do i.e. there are different analyses available depending on what the data format is. With the PRISM data, I learned a lot about animation and producing a temporally ranged map, although mine was eventually unsuccessful.

References

Animate through time—ArcGIS Pro | Documentation. (n.d.). Retrieved November 1, 2022, from https://pro.arcgis.com/en/pro-app/latest/help/mapping/animation/animate-through-time.htm

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What is a LAS dataset?—Help | ArcGIS Desktop. (n.d.). Retrieved October 31, 2022, from https://desktop.arcgis.com/en/arcmap/10.3/manage-data/las-dataset/what-is-a-las-dataset-.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, 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	**20**
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	**18**
		100	**94**