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Exploring Error and Distortion

**Methods**

I began my lab by downloading the data provided in the instructions. For part one of my lab, I added two different data frames, one labeled Albers and the other Mercator. To the Albers layer I added the twocity\_Albers and USA\_48\_Albers shapefiles. I used the Measure Tool to measure the distance between Los Angeles and New York. I changed the units to Miles and noted down the miles found in the Albers data frame. I repeated the same steps to find the distance between Los Angeles and New York using the Mercator data frame. The only difference was that I added the twocity\_Mercator and USA\_48\_Mercator shapefiles instead of the Albers shapefiles. I re-measured the distance between the two cities and noted down the miles.

I performed three different projections and produced a map to illustrate the difference between all three projections for part two of my lab. I started by opening a new map and reprojecting the minn\_county shapefile to North America Albers Equal Area Conic and saving it as minn\_county\_albers shapefile. The new file automatically added to my data frame, and I renamed my data frame Albers. I then created a custom coordinate system by adding a new data frame and using the Project tool once more. I selected the original file for the minn\_county shapefile and reprojected it as minn\_county\_cust\_mercator shapefile. I chose the Mercator (World) projected coordinate system and modified the central meridian to -93. I then selected the geographic transformation for NAD\_83\_to\_WGS\_1984\_1. My new file was added to the data frame, and I renamed the data frame Custom Mercator. I added one more empty data frame and added my original minn\_county shapefile. I renamed this data frame UTM NAD1983 and made sure my coordinate system matched my new file. I calculated the areas for each of my data frames by creating a new column in the attribute table and calculating the geometry for every type of projection. I calculated the area in square kilometers and recorded the area for St. Louis County for each of the three projections. Lastly, I created a comparison map where I put all three data frames into one map.

For part three, I opened a new blank map and added my minn\_count\_dd shapefile to the data frame. I recorded the decimal degree coordinates of the northeast corner of Ramsey County by turning on county labels and using the identify tool. I then reprojected minn\_count\_dd.shp to three different projections by using the Project tool. The shapefile got reprojected to UTM NAD27, Minnesota State Plane South, and Minnesota State Plane Central. I then recorded the coordinates for the NE corner of Ramsey County for each new data frame. Lastly, I opened a new blank map and placed my original minn\_county shapefile to my data frame. I added hlakes\_not\_projected.shp and made a note of where the lakes appeared when using this shapefile. I removed this file and added my Hlakes\_sp\_projected shapefile. I reprojected this shapefile to UTM NAD 83, Zone 15N and added it to my map. I zoomed in to the area of the lakes and curated a small map of the area.

**ResultsA group of different colored maps

Description automatically generated**

Figure : Comparison map of Minnesota using three different projections.

During part one of my lab, I noted that the distance from LA to NY from the Albers projection was 2,440 miles while the distance from LA to NY based on the Mercator projection was 3,131 miles. The true distance between LA and NY is 2,444 miles which means Albers was more accurate than the Mercator projection was. This answer makes sense since the Albers projection preserves area while the Mercator projection preserves shape but changes sizes greatly.

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| --- | --- |
| Albers | 17463.30sq km |
| Custom Mercator | 38278.30sq km |
| UTM | 17450.40sq km |

Figure : Area of St. Louis County using different projections.

The minn\_county shapefiles original coordinate system was NAD 1983 UTM Zone 15N. The area of St. Louis for each projection can be found in figure 2. UTM and Albers had a similar area when compared to Custom Mercator. Figure 1 illustrates how the different projections distort area, shape, distance, or direction of Minnesota. Albers is meant to preserve area or size in each map. There is minimal distortion between Albers two standard parallels. The most distortion happens at distances that are further away from the US. UTM preserves area, distance and shape along any meridian. Both maps look similar due to them preserving similar map properties. Regions with north-south orientation, such as Minnesota, are the least distorted in UTM projection maps. Distortion happens most at places that are further away from the central meridian. The Custom Mercator projection preserves small shape and is most accurate near its central meridian. Due to the change we made to our custom meridian there appears to be minimal distortion where the new central meridian is. The most distortion in a Mercator projection happens towards the poles.

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| --- | --- | --- |
| Projection | x-coordinate | y-coordinate |
| Decimal Degrees | 92.9844005°W | 45.1236210°N |
| UTM zone 15 (meters) | 92.9841824°W | 45.1235968°N |
| Minnesota South State Plane (feet) | 92.9843928°W | 45.1236129°N |
| Minnesota Central State Plane (feet) | 92.9843928°W | 45.1236129°N |

Figure : Coordinates of northeast corner of Ramsey County.

Coordinates for the northeast corner of Ramsey County are displayed in Figure 3. The unprojected lakes originally appeared on the border of Colombia and Ecuador. The data appeared in the wrong place due to the lack of projection coordinate system in the data. Below is a map of Hugo Lakes hugging the northeast corner of Ramsey County due to the new projection that was projected onto the data.

A map of the islands

Description automatically generated

Figure : Hugo Lakes

Citation

Malloy, Nicolas R., and Amy E Rock. Geospatial Concepts. 2nd ed. Textbook Series (imprint). 3., 2021. <https://digitalcommons.humboldt.edu/textbooks/3>