University of Texas at Austin

Sea Level Rise and Manhattan

How Climate Change Will Impact a Climate Denier, Bigly

Nicholaides, Kindra
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Introduction:

Manhattan is home to 1.6 million people and more than 300,000 businesses. It is also an island of relatively low elevation. As the planet's average temperature increases, the melting of glaciers will significantly increase the volume of water in the oceans and cause sea levels to rise. Many people living in coastal areas will be displaced. Many major metropolises will be adversely affected. This is one of many issues caused by man-made climate change. We need solutions and immediate action.

In this time of urgency, the next Leader of the Free World is a man who not only is ignorant of these issues but calls it a hoax. President-elect Donald Trump is a climate denier.

Figure 1 A real tweet from our future president. Sad.

Like it or not, if these problems are not addressed, we will soon see irreversible damage to homes, cities, and infrastructure. When the seas rise, Manhattan, among many other cities will be affected. Ironically, this vulnerable area also happens to be the home of 13 Trump-named buildings and a major center of his investments and other real-estate holdings.

The aim of this project is to see at what point Trump's buildings will be flooded by the rising sea level. This assumes his continued denial and inaction during his presidency and his appointment to offices such as the head of the EPA of fellow climate denier. While the results will happen very quickly in geologic time, they may not occur in Trump's lifetime. In any case, it still feels like Karma in action.

Projected rates of sea level rise vary greatly. There are many variables that should be taken into account including a rate that may accelerate. Predictions range from millimeters a year to centimeters a year, which is the worst case scenario as reported by the New York Times. Because Trump winning the 2016 election *is* the worst case scenario, I use the worst case scenario estimate in my calculations.

Problem:

How long will it take sea level to rise enough to flood Trump-owned Manhattan buildings?

I created a map of Manhattan elevation with a layer containing the locations of his 14 buildings. I then created binary rasters of the rising sea levels at constant intervals. From here I will determine which of the buildings will be flooded and approximately when. Rates of sea level change will most likely not be a linear function but for the purpose of this project, I will assume it is a simple function of rise/time.

Data Collection:

1. From the USGS National Map websitehttps://viewer.nationalmap.gov I downloaded 5, 1-meter resolution DEMs from the National Elevation Dataset that covered the entire island of Manhattan.
    - Zip files contained .img files
    - Spatial reference of NAD 1983 UTM Zone 18.
2. From http://ny.curbed.com/maps/donald-trump-ny-real-estate-development I gathered all the names and addresses of Trump owned buildings on Manhattan onto a spread sheet.

Pre-Processing:

1. With the Mosaic tool, I created a single raster from the 5 .img DEM files and symbolized the resulting file according to elevation values so that all elevations 0 and below would be blue.

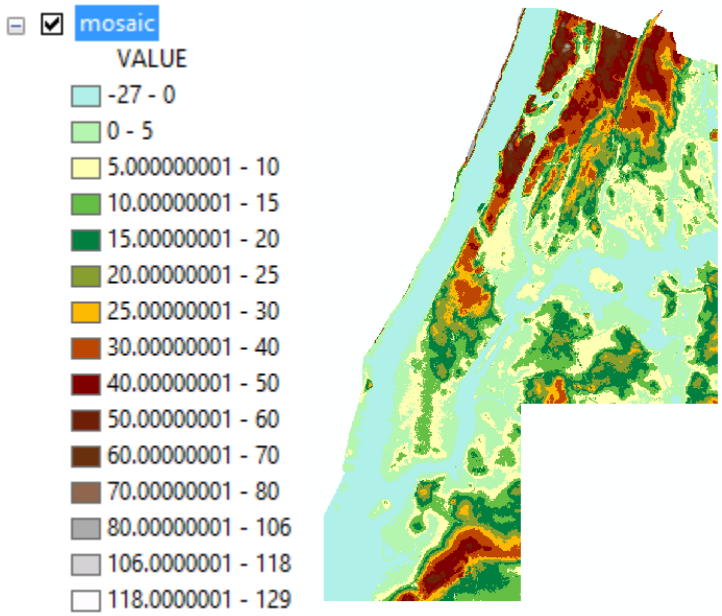

Figure 2 Mosaic DEM of Manhattan with appropriate symbolization of elevations.

Clipping the raster to the area of interest

- I created a Zero Contour.
- Using the Feature to Polygon tool, I turned the polyline into a polygon.

- With the Extract by Mask tool I clipped the mosaic raster to the polygon.

Additionally, I rotated the Data Frame 28 degrees so that the northwest side of the island is vertical.

2. In Google Maps I entered each address of a Trump building to find the X and Y coordinates in decimal degrees and then entered that into the Excel spreadsheet. These X and Y coordinates are in WGS 1984 spatial reference system.

	A	B	C	D	E	F	G
1	ID	Y	X	name_of_building	address	zip	
2	1	40.769326	-73.9816	Trump International Hotel and Tower New York	1 Central Park W	10023	
3	2	40.762609	-73.9737	Trump Tower	725 5th Ave	10022	
4	3	40.766649	-73.967	610 Park Avenue	610 Park Ave	10065	
5	4	40.767416	-73.9617	Trump Palace	200 E 69th St	10021	
6	5	40.763437	-73.9698	Trump Park Avenue	502 Park Ave	10022	
7	6	40.791291	-73.9785	Trump Place	160 Riverside Dr	10024	
8	7	40.765607	-73.9765	Trump Parc	106 Central Park S	10019	
9	8	40.765577	-73.9763	Trump Parc East	100 Central Park South	10019	
10	9	40.752584	-73.9683	Trump World Tower	327 E 47th St	10017	
11	10	40.762882	-73.9657	Trump Plaza	61st St	10021	
12	11	40.725497	-74.0055	Trump SoHo New York	246 Spring St	10013	
13	12	40.706954	-74.0097	40 Wall Street	40 Wall Street	10005	
14	13	40.760497	-73.9789	1290 Avenue of the Americas	1290 Avenue of the Americas	10104	
15							
16							

Figure 3Excel sheet of address and XY coordinates of Trump's buildings on Manhattan

- From the Table of Contents, I accessed the Properties of this new layer and changed the Coordinate System from the data frame's NAD 1983 UTM 18N to match the XY coordinates in WGS 1984.
- I saved the excel sheet as a .CSV file and then on my map I used the Add Data button to import this sheet as discrete points with attached attributes so I could label these points.
- I exported this data as a shapefile so that it is editable if necessary.
- I added labels, converted them to annotation, adjusted their placement and saved them as a separate layer file so I could toggle the labels on and off.

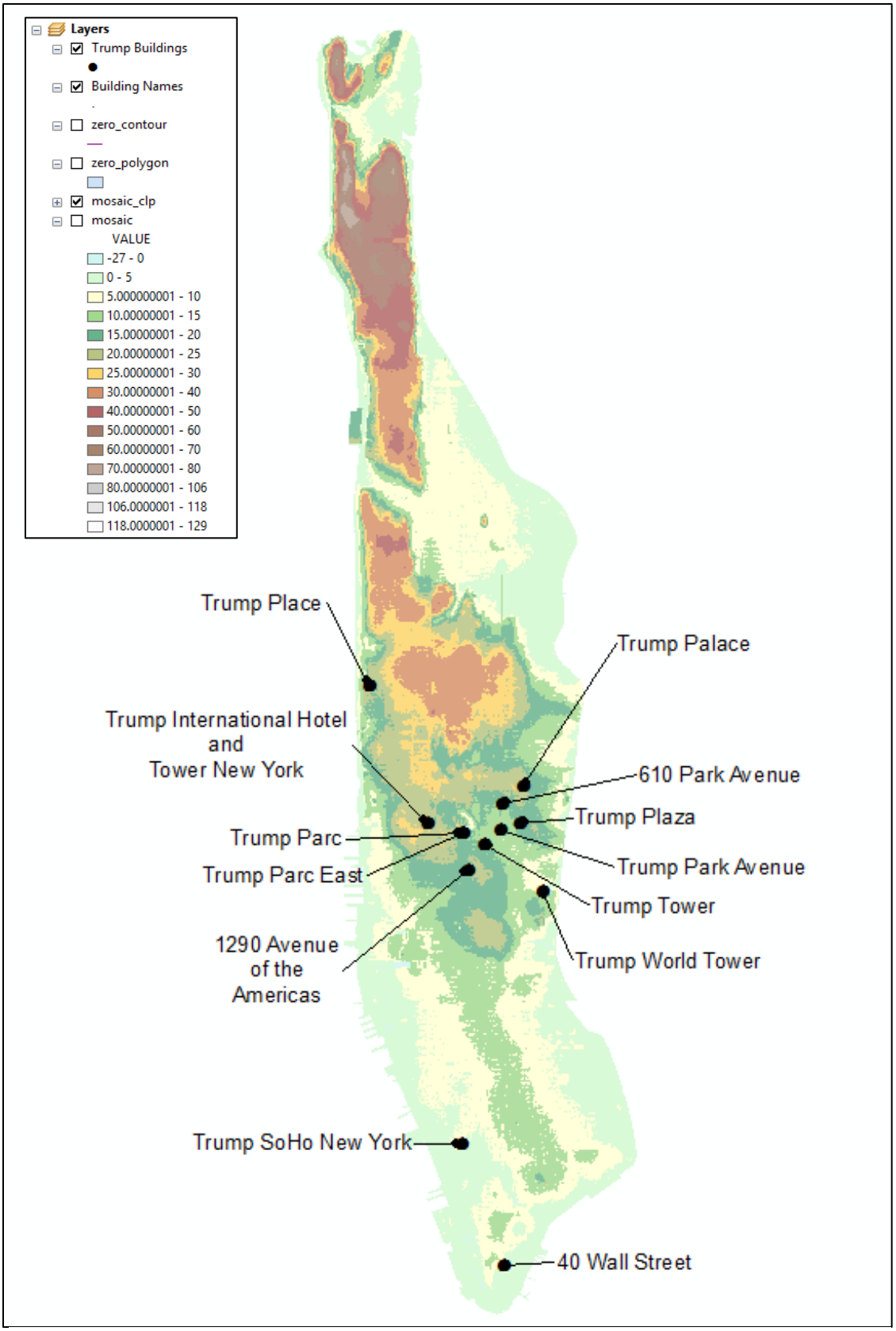

Figure 4 Preliminary Map of Manhattan as a clipped mosaic, symbolized elevation, and with current sea level elevation,

Data Processing and Analysis:

1. To get an idea of the relative elevations of Trump's buildings, I created contours on a 5-meter interval up to 40 meters above sea level. Upon preliminary inspection it looks like all the buildings are within 10 to 25 meters above sea level.

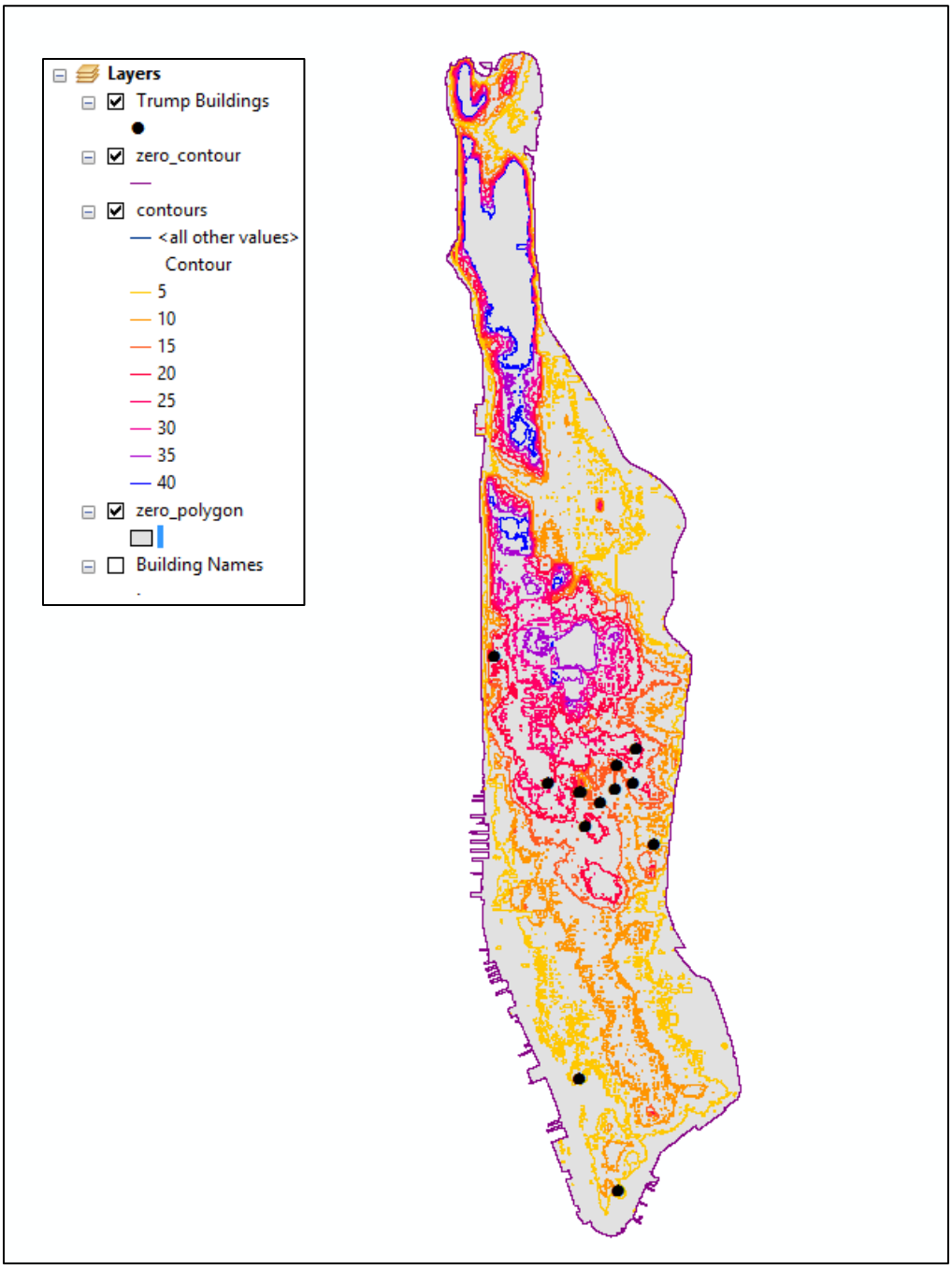

Figure 5 Contour Map

2. I used the raster calculator to create a series of 5 new binary rasters from the Elevation (mosaic) raster. Figure 5 shows how I use the conditional command "Con" to set all cells with an elevation less than 5 meters to a value of 1 and the rest get a null value. This way I can set the cells to blue to symbolize the area of Manhattan that is covered in water at this point. I create one for every 5 meters of sea level rise up to 25 meters. By the time the sea level has risen 25m, all of Trump's buildings will be underwater and only a small portion of Manhattan will remain unflooded.

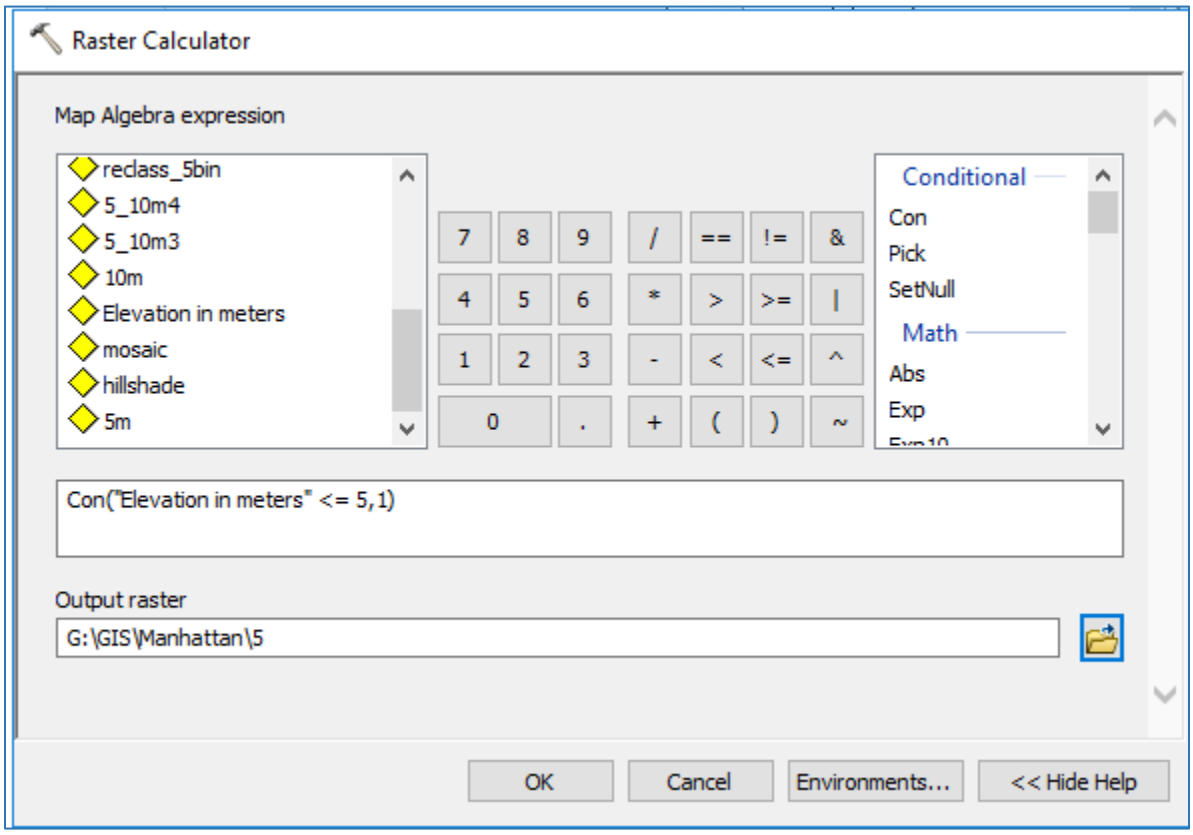

Figure 6 Using raster calculator to create new binary rasters

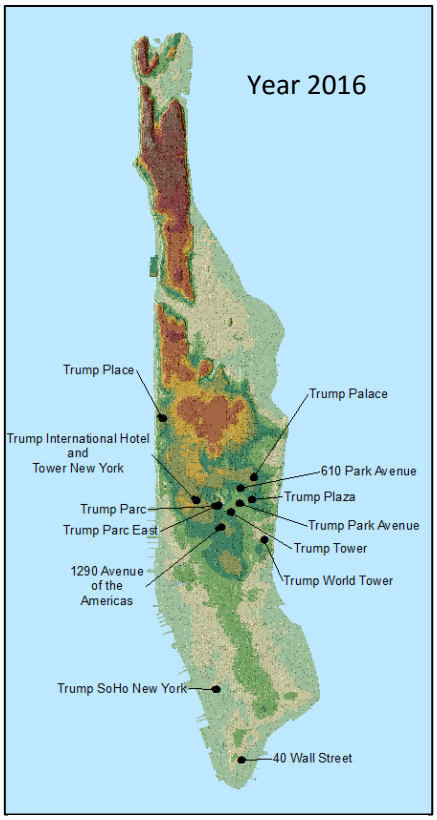

Figure 7a) Current Sea Level

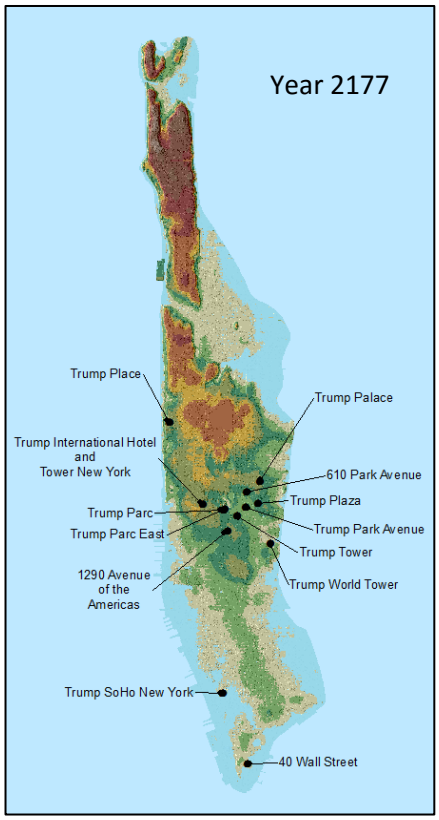

Figure 7b) Sea level rise of 5 meters

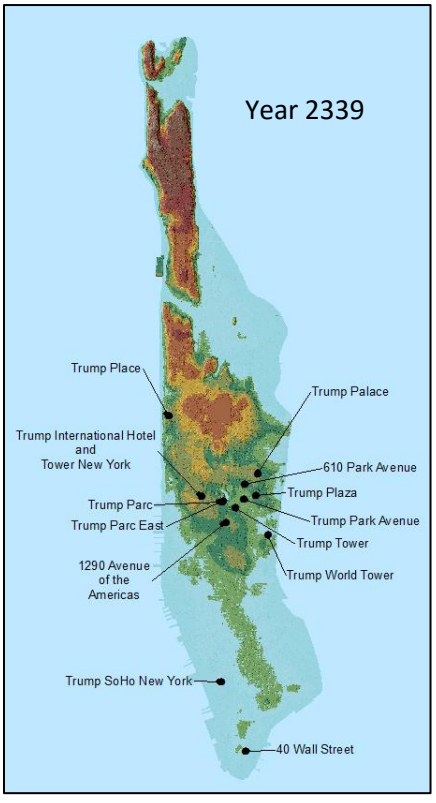

Figure 7c) Sea level rise of 10 meters

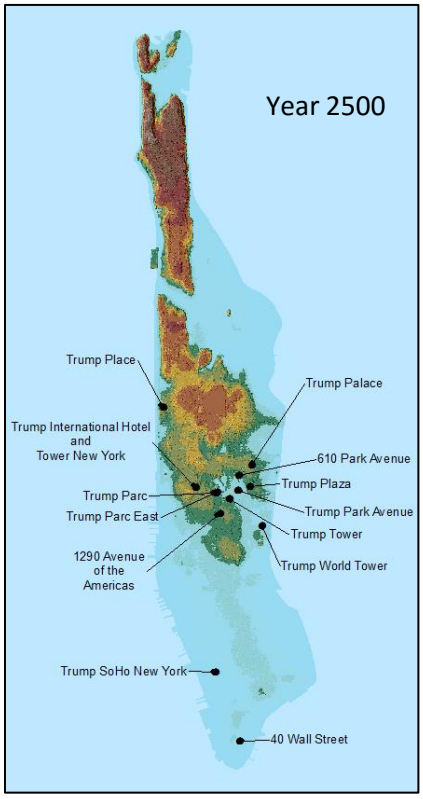

Figure 7d) Sea level rise of 15 meters

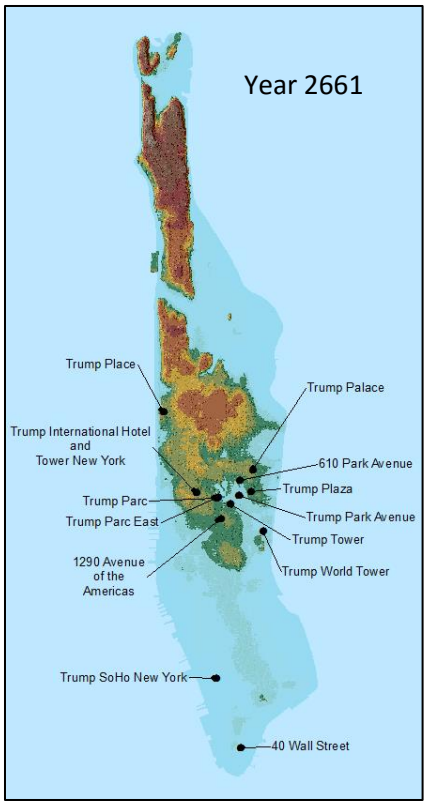

Figure 7e) Sea level rise of 20 meters

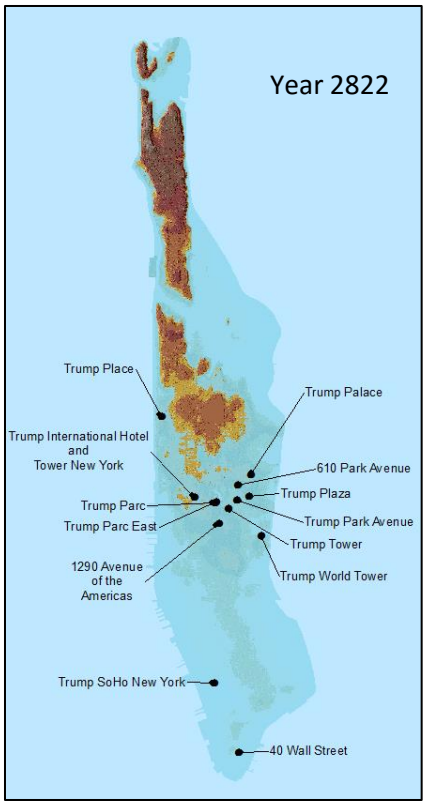

Figure 7f) Sea level rise of 25 meters

Table 1

	Name of Building	Year it will be flooded
1	Trump SoHo New York	2242
2	Trump World Tower	2274
3	40 Wall Street	2306
4	Trump Park Avenue	2435
5	Trump Tower	2532
6	610 Park Avenue	2564
7	Trump Parc East	2564
8	Trump Parc	2597
9	Trump Plaza	2597
10	1290 Avenue of the Americas	2661
11	Trump Place	2726
12	Trump Palace	2790
13	Trump International Hotel and Tower New York	2822

- Assuming a rate of sea level rise to be .031 meters/year and no acceleration or other change in rate, I can calculate the year at which the water will reach and overtake the 13 Trump buildings.

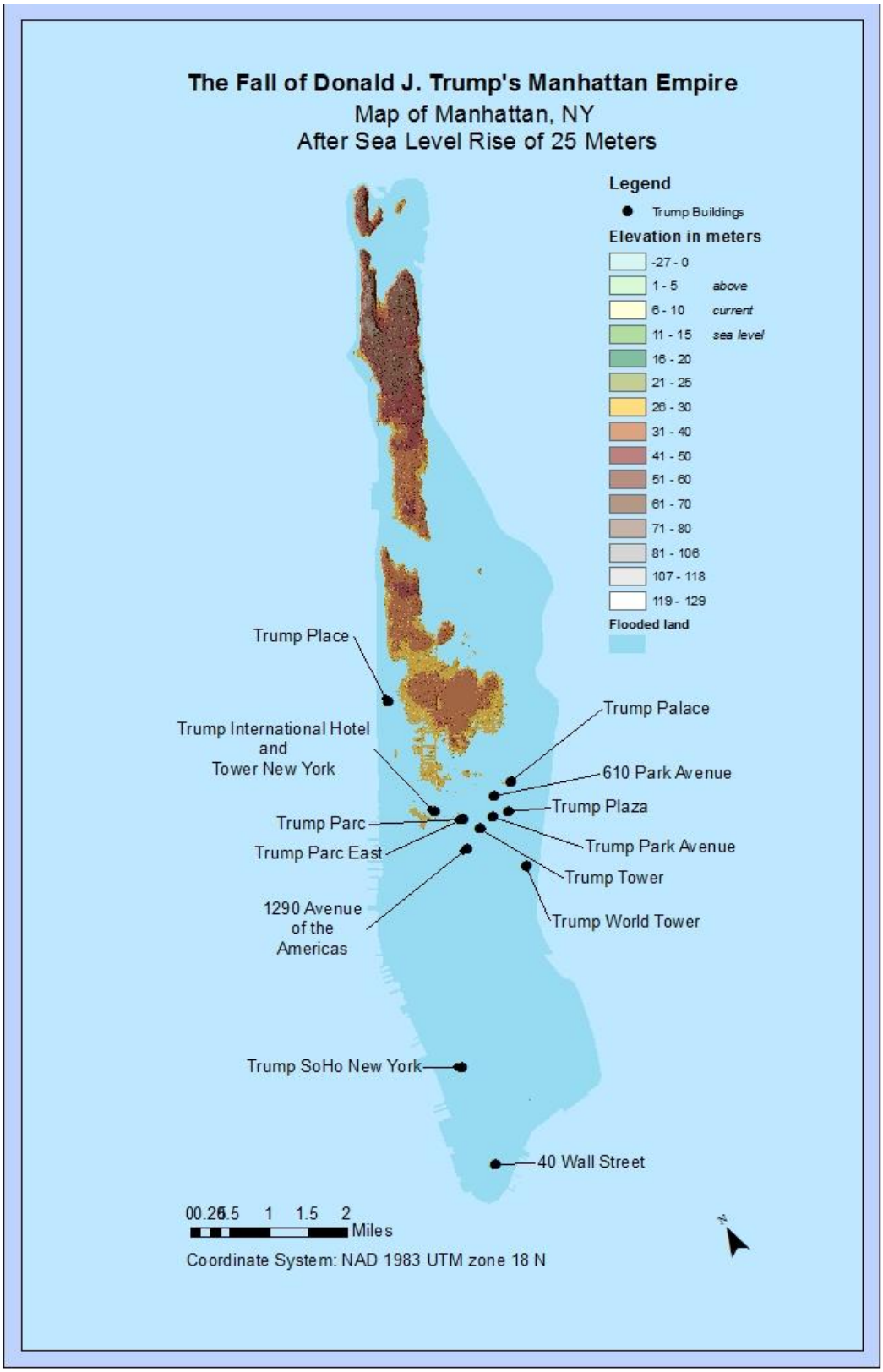

Figure 8 By 2822 Sea level will be 25 meters above present day level and the majority of Manhattan will be covered in water.

Discussion:

The first of Trump's buildings to be directly affected will be Trump Soho, Trump World Tower and 40 Wall Street. They have elevations of 7, 8 and 9 meters above sea level. By the time sea level has risen 10 meters in 2339 they should be well under water (see Figure 7c). Trump Parc Avenue will flood in 2435 with a sea level rise of 13 meters (Figure 7d). The next big hit will be in the years 2532-2661 when 6 of the buildings, including Trump Tower, will be overcome (Figure 7e). The last 3 will hold out until the 28th and 29th centuries before being submerged (Figure 7d). As it is shown in Figure 8, by the year 2822 almost all of Manhattan will be under water.

Conclusions:

It doesn't look like Trump's Manhattan buildings will be directly affected in his lifetime. Karma works slowly in this case. However, while it will take several centuries to flood these buildings, the effects of rising sea level will be felt long before then. Even a sea level rise of 1 meter will affect the island and that could happen within the next 32 years according to the worst-case scenario calculations.

This project is about seeing the silver lining in a dire situation. It is also a little passive aggressive- hoping climate change will punish Donald Trump is a perfect illustration of cutting off the nose to spite the face. And yet it is gratifying to calculate hypotheticals in which one of the most deplorable people in America could be destroyed by the thing whose existence they deny.

Future work:

The next step will be to calculate the percent land lost with each 5 meter increment. I would do that by adding an "Area" field to the attribute tables and letting ArcGIS do the calculations. It would be interesting to see numerically in which 5m increment rise the most land is lost.

Another thing I would like to do is learn how to determine which points are contained within which rasters. I have a raster for the area covered by each 5 meter increase and I have a shapefile containing all the points that represent the buildings of interest. I would like to figure out how to write a script for the Raster Calculator to find which points are contained in each raster.