Sea Level Rise Impacts and the Value of Affected Properties in Barnstable, MA
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Introduction
A recent study by the nonprofit organization Climate Central found that over 7.7 million Americans live within 1 meter of the high tide mark along coastlines (Straus et al., 2012). The same study warned of the implications of rising sea levels, and how the increase predicted by the International Panel on Climate Change (IPCC) could have drastic effects on many Americans. This project aimed to model the range of potential sea level rise from the best to worst case scenario (0-6 meters) (IPCC, 2007).

This project aimed to determine if higher value properties along the coast are disproportionately affected by catastrophic sea level rise, using the Town of Barnstable, MA as a case study.

Methods

The first step in this project was projecting all of the acquired data into Universal Transverse Mercator, North American Datum 1983, Zone 19N. Next, a group of 9 elevation contour layers from the Massachusetts Office of GIS (MassGIS) were merged to develop one single elevation layer. These were converted to a raster depicting elevation at a 3 meter scale. A hydrography dataset from MassGIS was then added.

A series of elevation points were then collected and entered into the National Oceanic and Atmospheric Administration’s (NOAA) VDatum to assess Mean Water Height, which depicts the average high tide mark during the last epoch. This “Mean Water Height” was then used as sea level.

I then developed a model to identify the properties that would potentially be affected by projected sea level rise from 0-6 meters with one meter increments. The values determined by the NOAA VDatum were interpolated between each point based on Euclidean distance. A raster calculator was used to identify which areas would be affected by sea level rise, and which areas would not. A cost distance was applied to ensure that areas that were inland and below the sea level rise level but surrounded by higher areas, were not mistakenly identified in the final raster. Finally, the raster was reclassified to show areas affected on a meter increase interval, with any areas higher than 7 meters as one class. This raster was then converted to a vector for final analysis. Property polygons that are potentially affected by projected sea level rise were then identified via a spatial join.

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Results
As projected sea level increases in one meter increments, the average total value of properties decreased. In fact, the relationship between potential sea level inundation and average property value is fairly linear, with an equation of: y = -182,418 x + 2,000,000. It is important to note that this is only the case for the first 6 meters of sea level rise in the town of Barnstable. Similarly, the relationship between total area affected and sea level rise was linear, but with a positive relationship. The equation generated is: y = 1484x + 53921.

Sea level rise has potential to be a major issue in the Town of Barnstable. For example, with a 2 meter sea level rise, 8,557.89 acres of property worth $3,955,664,000.00 would be affected. All other unaffected properties in the town sum to 35,314.17 acres worth $3,981,277,500.00. Nearby half of the property value of the Town of Barnstable lies within 2-3 meters of high tide, which is serious cause for concern.

This is one study that the citizens of Barnstable should be quite concerned about. This 2-3 meter increase in sea level would affect 48.66% of the property value, but only 19.88% of total property area. Similarly, the results for the worst case scenario show 90.93% of the town’s property value, and only 33.45% of the town’s property area, would be affected by a 6-7 meter sea level increase.

Discussion
My model suggests a linear relationship between both property area and value against potential sea level increase. This seems logical, as properties in close proximity to water are generally more sought after. This leads to higher values per area. However, this proximity would make them very properties more susceptible to sea level changes.

The linear relationship between area affected and sea level rise is most likely due to the aspect of the area. Though it was not calculated in the project, it is reasonable to assume a constant slope would equal subject areas to a constantly increasing sea level.

Perhaps the most striking result is the staggering amount of property value hold up within 6 meters of the mean high water mark. As seen in figure 8, only 33.45% of the town’s total area falls in this category, but it encompasses over 90% of the total property value. The potential for catastrophic sea level rise could be a major issue for the Town of Barnstable in the near future.

This project has a few areas where potential errors could have occurred. First, by interpolating the data using NOAA’s VDatum the outputs that led to the final sea level rise data (i.e. figure 4) are heavily influenced by the amount of data points taken. This is unsettling as the entire project is reliant on this data. However, the easiest and most realistic way to combat this issue is by increasing the number of data points taken. The more points that are collected, the stronger the values interpolated will be, and thus the analysis conducted will stronger.

Conclusion
Though it appears that there is some relationship between potential sea level rise and the value of property affected, the statistical significance of this relationship and thus its validity is still unknown. One important avenue for future research is in regards to increasing the precision of the mean high water values, and thus the precision of the properties affected. Also, an increase in elevation precision, perhaps with high accuracy LiDAR data, could lead to very telling trends in sea level impact predictions.