Residents in Deep Water: Storm Surge Inundation in Cambridge and Somerville

Background

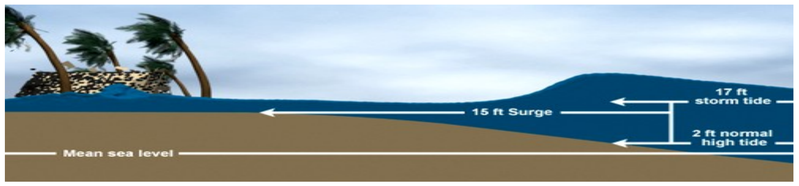

Figure 1: Storm surge inundation (NOAA)

Storm surge is the rise in water level (above normal tide) caused by a storm. Various factors may affect the impact of storm surge on land, such as land elevation, depth of water, and barriers to water flow. Because many of the densely populated cities along the East coast are within 10 feet above mean sea level, these coastal areas are especially vulnerable to storm surge. In coastal areas, hurricane storm surge not only can cause severe flooding and extensive damage but also poses a significant threat to life. The surge generated by Hurricane Sandy in 2012 was responsible for significant damage along the Atlantic coast. In New York City, storm surge from Hurricane Sandy reached 14 feet above sea level and resulted in the major flooding of streets, tunnels, and electrical substations.

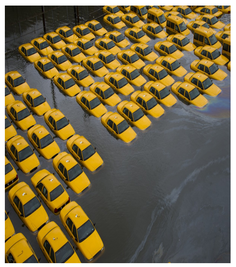

Figure 2: Parked cars submerged in flood waters in the aftermath of Hurricane Sandy (NY Post)

There is growing concern that storm surge flooding will be a chronic problem should hurricane frequency increase as some have projected. When developing disaster preparedness and emergency relief plans, it is important for municipalities to consider how many people will be affected by the impact of storm surge inundation. The purpose of this project is to evaluate the population of areas affected by hurricane storm surge within Somerville and Cambridge, Massachusetts. Such information can help determine which areas may need to be evacuated as severe storms approach.

Figure 3: Subject area - Cambridge, MA and Somerville, MA

Methodology

This model uses data from the US Army Corp of Engineers to represent areas that are expected to be inundated with storm surge from hurricane categories one to four. The data are based on worst-case surge inundation scenarios. This statewide data was clipped to Somerville and Cambridge, as shown in Figure 4. The model also uses 2010 Census data to estimate populations at the block level. Block level aggregation was used instead of block group level aggregation to provide more precise estimates. Census data was clipped to the two towns also, as shown in Figure 5.

To model the relationship between inundation zones and population, I performed the following steps:

- Turned the Census block into centroid points using the feature to point tool.
- Joined the Census blocks and surge zone layers using the union tool.
- Selected all centroid points within Cambridge
- Exported the clipped data as a layer
- Used the identity tool to attach each centroid point to the inundation zone
- Used the generated identity layer to calculate the summary statistic of the population, using hurricane categories as the case field
- Repeated the same steps for Somerville

Hurricane Surge Inundation Zones

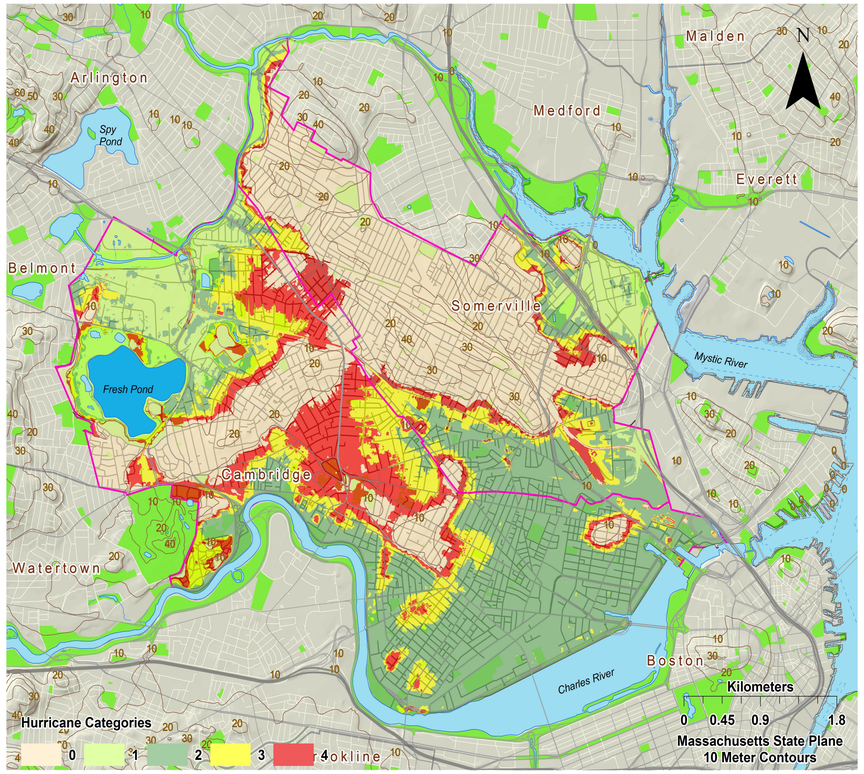

Figure 4: The map reveals inundated zones are largely within areas of lower elevation. Based on the data, much of the Somerville area appears to be of higher elevation, which seems to contribute to lower surge inundation vulnerability than Cambridge.

Population Density

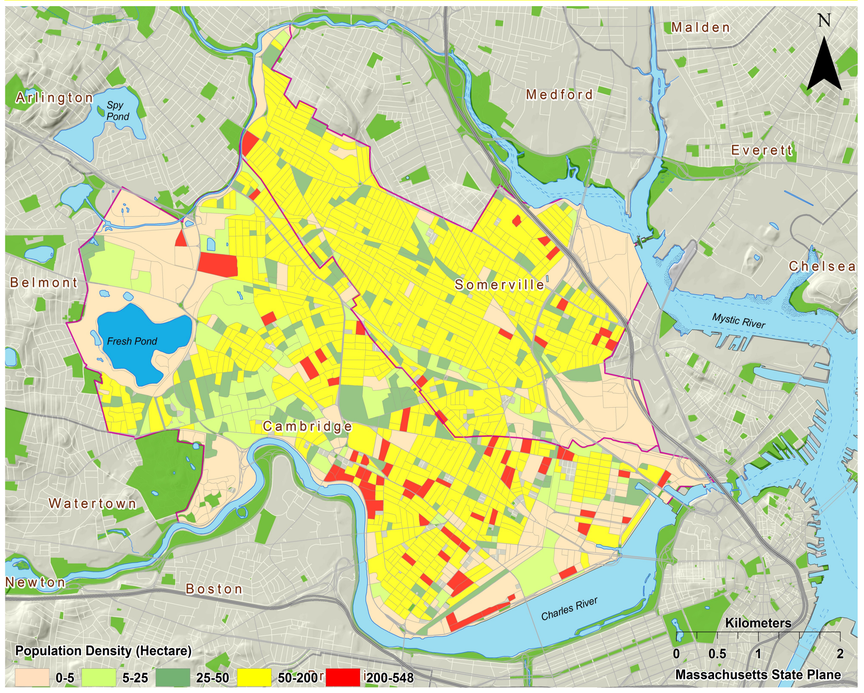

Figure 5: At a block level of aggregation based on 2010 Census data, the map reveals the population density per hectare as appearing more diverse in Cambridge than Somerville. In both towns, areas with the highest population density appear to fall within inundation zones.

Findings

As depicted in Figure 4, the extent of inundation appears to be greater in Cambridge than Somerville. Areas not exposed to storm surge seem to be those of higher elevation – a factor that may attribute to the difference in magnitude between the two towns. For the most part, referring to Figure 5 shows the population of areas with no inundation as moderately dense. The population density of category one inundated areas is generally low. Categories two through four inundation zones feature diverse population densities, but moderately dense areas appear to be most common.

This model sought to obtain the data needed to summarize the population in each town that would be affected by the different types of hurricane. Of the total population in Cambridge (105,162) depicted in the map, the data shows 16% lies in areas not exposed to storm surge, 2% in category one surge, 48% in category two surge, 67% in category three surge, and 84% in category four surge. Of the total population in Somerville (75,754) depicted in the map, the data shows 70% lies in areas not exposed to storm surge, 1% in category one surge, 12% in category two surge, 21% in category three surge, and 30% in category four surge.

As seen in Figure 6, under all hurricane categories, it looks as if the residents most affected by storm surge inundation are located in Cambridge. Based on the graph, more residents in Somerville appear to be located areas not exposed to storm surge.

This model likely under or over-estimates the population density because (1) the information does not reflect population changes since the 2010 population estimates, and (2) the centroid points capture only one inundation category when some census blocks lie within multiple zones.

Future research could look at land use within the inundation zones to assess the impact on area businesses. Looking at the types of land use areas might help to estimate the numbers of jobs that might be displaced as result of storm surge damage.

Surge Inundation: Population Impact

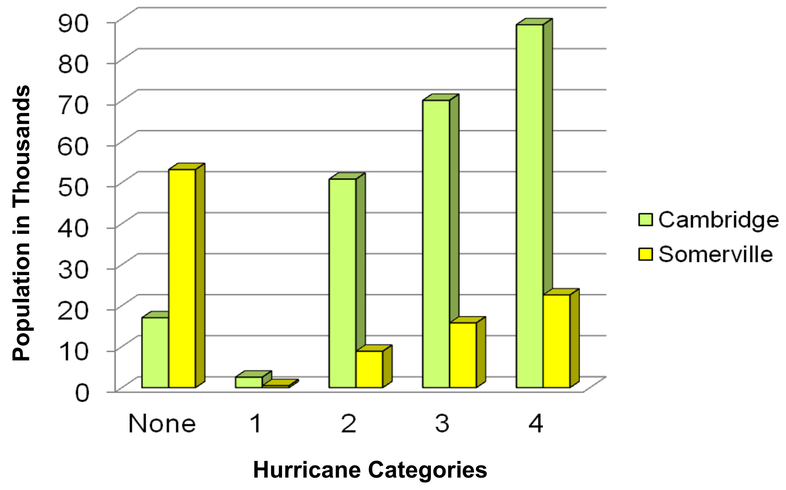

Figure 6: This graph shows the distribution of residents in areas affected by worst-case hurricane surge inundation scenarios. Hurricane category none refers to areas not exposed to storm surge. Categories two through four are the accumulation of population values generated by the model. The graph shows Cambridge residents suffering the greatest impact.

Data Sources:

Hurricane Surge Zones: U.S. Army Corps of Engineers, New England District 2013

Block Population: U.S. Census, 2010 via Tiger

Cartographer: Nicole Smith

Fundamentals of GIS (NUTR 231)

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