

# BYE BYE BASEMENT

## WHEN BOSTON FLOODS, WHO BEARS THE BRUNT?

### BACKGROUND

Global warming is driving momentous changes across the globe with equally significant consequences for human societies. Sea level rise is the most visible and talked-about effect of global warming, but it is by no means the only one. As the earth's atmosphere warms, its oceans do as well, causing more frequent and more intense storm systems, and the migration of large storms into latitudes that previously could not support them. In 2012, Hurricane Sandy, the largest Atlantic hurricane on record, brought unprecedented fury to New York City, flooding large parts of Manhattan with up to 10 feet of storm surge.

Boston, a comparatively short distance north of New York, could be next in line for similar damage. The large, low-lying area in and around the city center is particularly vulnerable, but the city as a whole lies fairly close to sea level. In the event of freak storm, catastrophic flooding will occur. This project examines the human impact of an extreme flooding event, using a theoretical storm modeled after the 7.8-foot storm surge seen in New York during Hurricane Sandy. Across the globe, negative environmental impacts are disproportionately borne by poor people of color, particularly in developing nations. Here we examine whether a similar story will play out if and when a hurricane brings high waters to Boston: when the waters rise, whose basement will flood? In particular, we investigate whether one or more racial groups are disproportionately affected, and whether an economic disparity exists between those flooded and those left unharmed.

### METHODS

First, the extent of flooding in the event of an extreme storm was calculated from the storm surge recorded during Hurricane Sandy and a digital elevation model (DEM) of Massachusetts available from MassGIS. We added the mean storm surge observed during Hurricane Sandy to Boston's mean higher high water (MHHW) to yield the elevation of floodwaters in Boston during such an event. Cells in the DEM both below the flood elevation and hydrologically connected to the sea were extracted from the DEM, producing a map of areas that would be inundated by the hypothetical storm. To examine the human impact of the flooding, we defined a study area of all counties within 10 miles of Boston in which inundation would occur.

We calculated the overall population percentage of the 6 racial groups available on the census: white, black, Native American,

Asian, Latino, and mixed or other in the study and flooded areas. The percentage of each racial group in the flooded area was divided by the percentage of the same racial group in the overall study area to quantify proportional impact. Proportional impact is the percentage of the ideal, equitably-distributed impact each group suffers. In an equitable distribution of impact, the percentage of each group in the impact zone should match their respective percentages in the overall study area. If an ethnic group is more prevalent in the study area than in the flooded area alone, its proportional impact would be below 100%, indicating that this group of people were less than equitably affected. Conversely, if a racial group is more prevalent in the flooded area than the study area, they bear an undue share of the burden.

We also calculated the mean income of the whole study area, expressed as percent of Massachusetts median household income. We performed the same calculation for the flooded area only to compare the mean of the flooded area and the overall mean of the study area.

### CONCLUSIONS

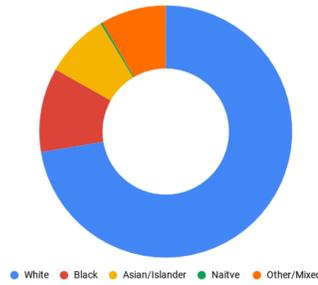
We found significant racial and economic disparities between those impacted by an extreme flooding event and the study area as a whole. In particular, white and black people were proportionally under-affected while Asian, Latino, and people of mixed backgrounds bore a disproportionately high impact.

White people, despite making up 73.4% of the study area's population, made up only 59.7% of people in the flooded area; they were underrepresented by 18%. Similarly, black people were underrepresented by 26%. Asians and Pacific Islanders suffered the highest proportional impact, being overrepresented in the pool of flooding victims by 30%. Latinos were also greatly over-affected, being overrepresented in the flood zone by 22%. Native Americans were not significantly over- or under-affected. These results highlight the extreme racial inequalities of who is affected by the consequences of global warming, even in progressive cities like Boston.

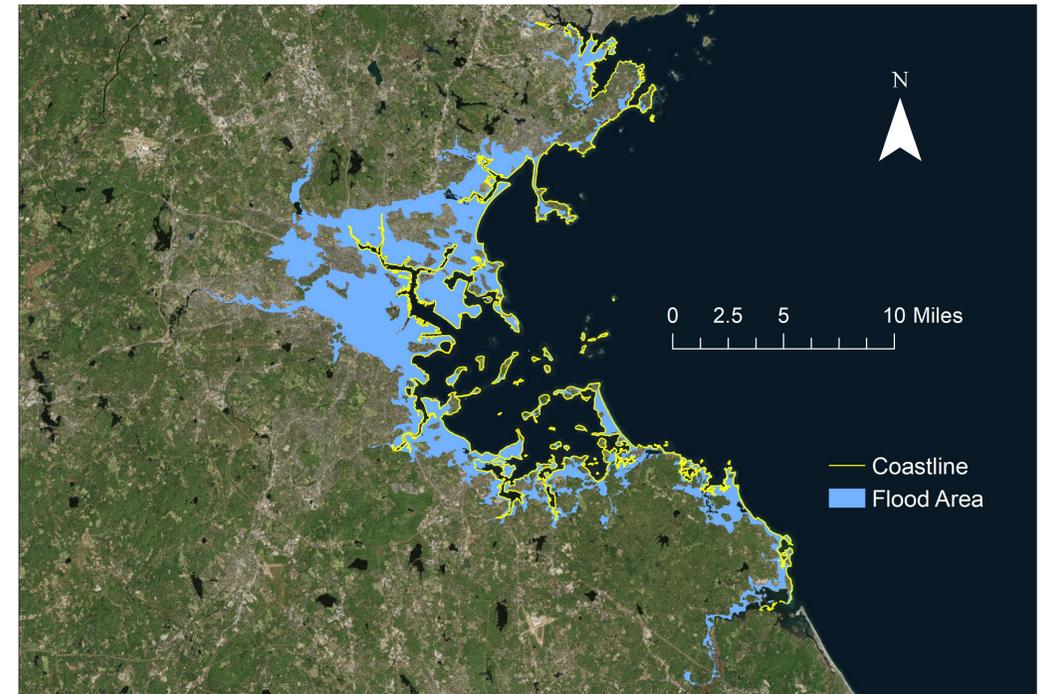
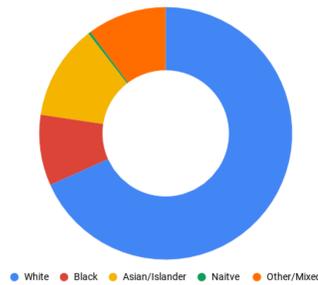
The economic disparities between those affected by flooding and those not revealed a trend similarly in line with global trends in the human impact of global warming. The average household income across the entire study area was \$107063/year, or 160% of the Massachusetts median household income. By contrast, the average income of the flood zone was nearly 35% lower at \$69524/year. Lower-income people were much more affected by flooding, likely due to the high population of low-income Bostonians in and around the city center.



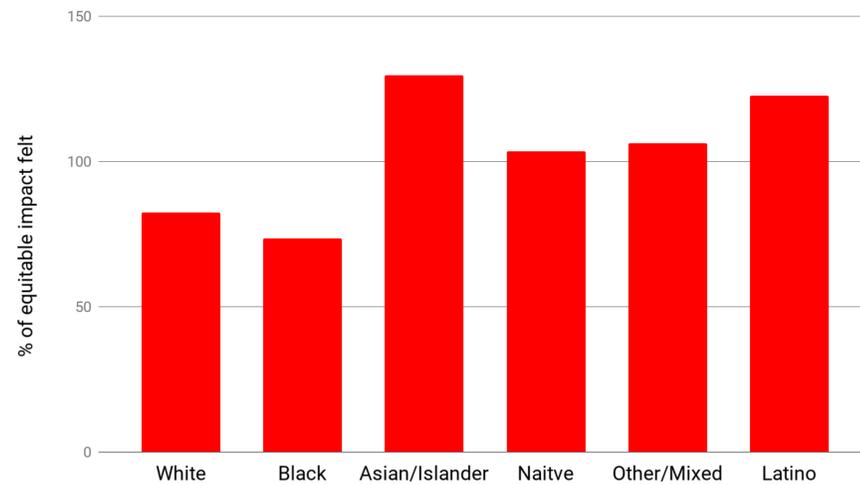
Racial Makeup of Study Area



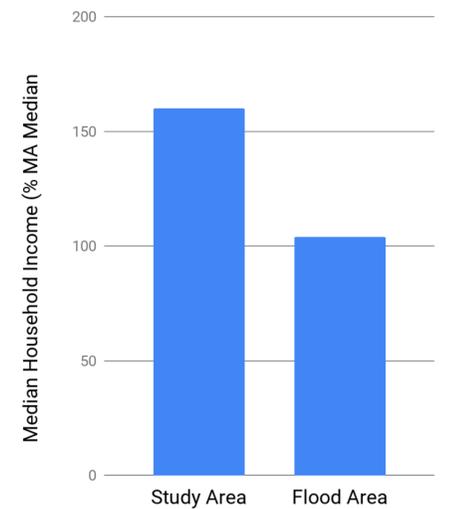
Racial Makeup of Affected Area



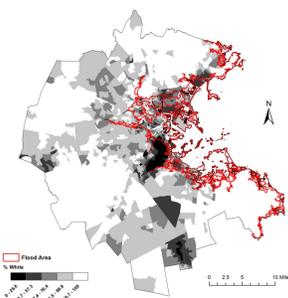
Proportional Impact Across Racial Groups



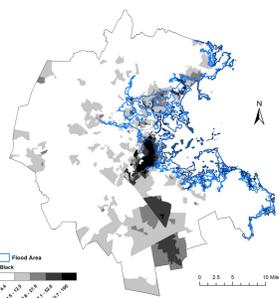
Income in Study and Flooded Areas



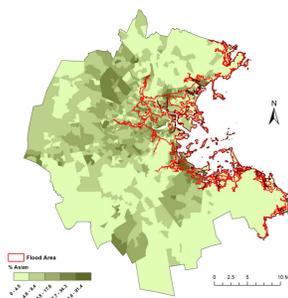
Data Sources: MassGIS, ESRI, NOAA, USGS, US Census Bureau, American FactFinder  
 Eve Mathison GIS 101 05.07.19



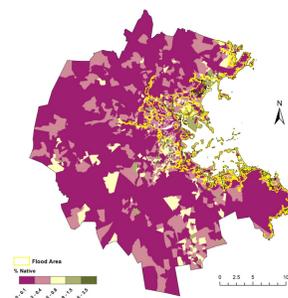
White Population



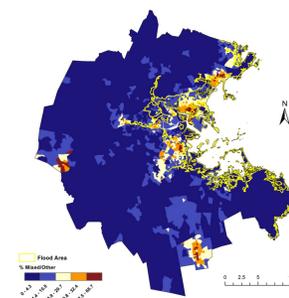
Black Population



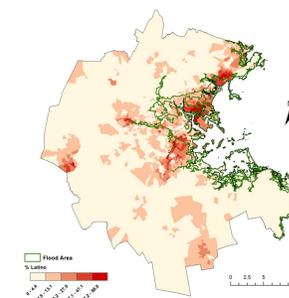
Asian/Pacific Islander Population



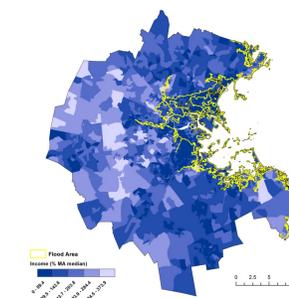
Native American Population



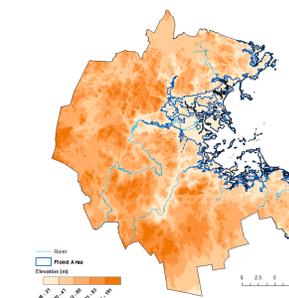
Mixed/Other Population



Latino Population



Household Income



Elevation