RISING TIDES AND SOCIAL DIVIDES:
A FLOOD RISK VULNERABILITY ANALYSIS OF BOSTON, 2070

INTRODUCTION

Global sea-level rise is caused by thermal expansion due to increasing ocean temperatures and the melting of land ice. Historically, global temperatures have fluctuated dramatically based on various gravitational effects and cycles of glaciation and warming, but we are now living in an era of unprecedented warmth due to human activity (Kruel 2016). Boston, being a low-lying coastal city, is already at risk of coastal flooding during storms, and this threat will only magnify in the coming decades as sea-level continues to rise and storms intensify (Kruel 2016).

When studying climate change, it is essential that we examine who will be affected first and worst by environmental shifts. The concept of environmental injustice has historically noted that environmental burdens, such as air pollution, are disproportionately felt by low-income communities of color (Di Chiro 2016). As our climate crisis has worsened in the past decades, a similar concept of climate injustice has arisen; nations, particularly developing island nations, that have emitted the lowest amount of greenhouse gases, are disproportionately feeling the detrimental effects of climate change first (Di Chiro 2016). Over the next fifty years, a similar scenario might play out on a local scale in Boston. Which populations are most at risk of flooding due to sea-level rise during an extreme storm? Will minority and low-income populations be disproportionately affected, revealing a climate injustice scenario?

METHODS

I joined the race population by block data from Summary File 1 from MassGIS with a Census Tiger/line file showing Massachusetts census blocks so the Summary File 1 data could be represented as a map layer. I joined a median income dataset to a Census Tiger/line file showing Massachusetts census tracts using a FIPS code. I executed a spatial join between these layers to get an approximate median income by block. Using data from Climate Ready Boston's Sea-Level Rise Inundation projections, I chose the 10% annual flood inundation zone in 2070 layer to show a worst-case scenario. I used a spatial query to select blocks that intersected with the inundation zone. For each race I focused on, I classified the race populations into 5 classes using the Jenks Natural Breaks method. I classified median income using the income brackets of lower, lower middle, middle, upper middle, and upper using the PEW Research Center's classifications of these classes from 2010.

DATA

American Community Survey Table B19013: Median household income in the past 12 months (in 2016 inflation-adjusted dollars), 2017, U.S. Census Bureau.
Climate Ready Boston Sea-Level Rise Inundation, September 2017, Climate Ready Boston.
Summary File 1, April 2012, MassGIS.
Massachusetts Census Blocks, 2010, U.S. Census Bureau.
Massachusetts Census Tracts, 2010, U.S. Census Bureau.

REFERENCES

Di Chiro, G. (2016). Environmental Justice. In Adamson J., Gleason W., & Pellow D. (Eds.), Keywords for Environmental Studies (pp. 100-105). NYU Press. Retrieved April 17, 2020, from www.jstor.org/stable/j.ctt15zc5kw.36

Kruel, S. (2016). The Impacts of Sea-Level Rise on Tidal Flooding in Boston, Massachusetts. Journal of Coastal Research, 32(6), 1302-1309. Retrieved April 17, 2020, from www.jstor.org/stable/44028225

Total Population in Inundation Zone

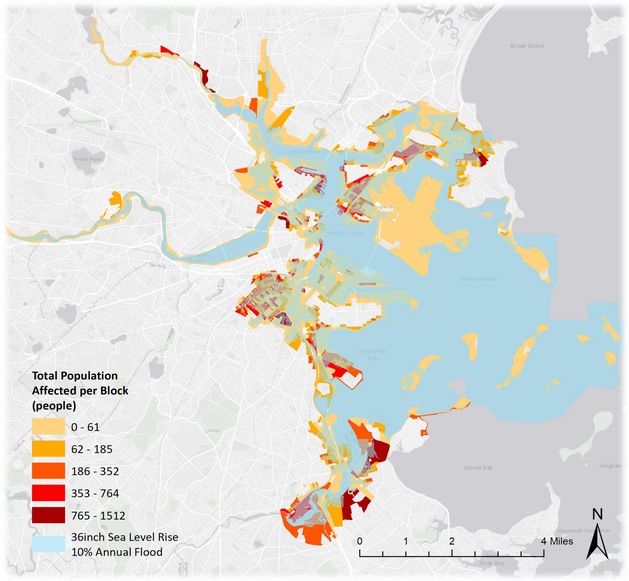


Figure 1. Total population in projected inundation zone during an extreme storm in 2070.

Median Income of Population in Inundation Zone

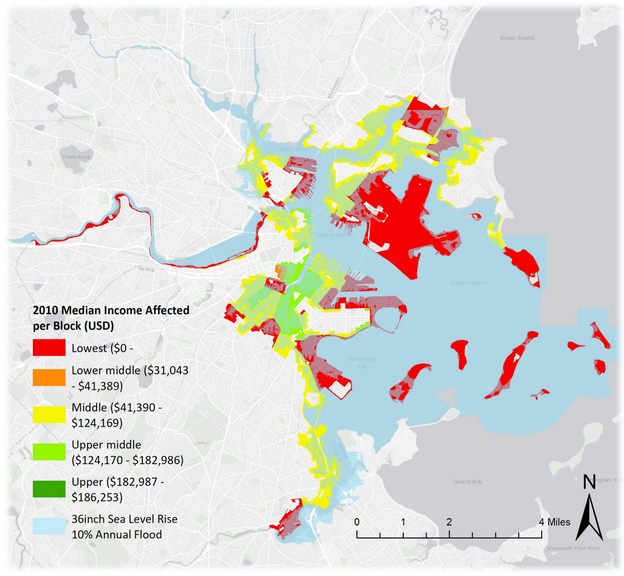


Figure 2. Median income of population in projected inundation zone during an extreme storm in 2070, broken into classes by Pew Research Center 2010 classifications.

Non-Hispanic Black Population

Figure 3. Non-Hispanic Black population in projected inundation zone during an extreme storm in 2070.

Non-Hispanic Asian Population

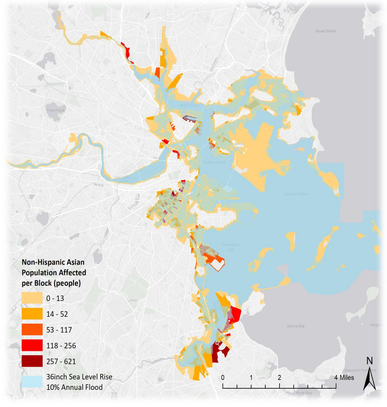


Figure 4. Non-Hispanic Asian population in projected inundation zone during an extreme storm in 2070.

Total Suffolk County Population Breakdown by Race

Figure 7. Total Suffolk County Population Breakdown by Race.

Inundation Zone Breakdown by Race

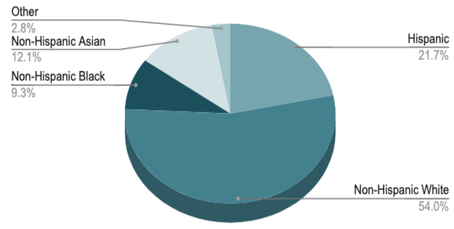


Figure 8. Inundation Zone Breakdown by Race. Shows that Non-Hispanic Whites comprise largest percentage of people living in projected inundation zone.

Proportion of Total Race Located in Inundation Zone

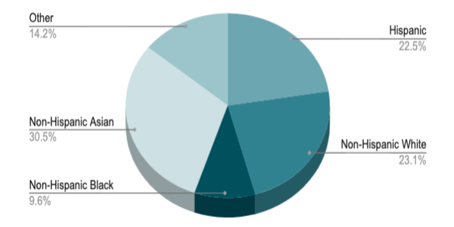


Figure 9. Proportion of Total Race in Located Inundation Zone. Shows that Non-Hispanic Asians are disproportionately affected.

Hispanic Population

Figure 5. Hispanic population in projected inundation zone during an extreme storm in 2070.

Non-Hispanic White Population

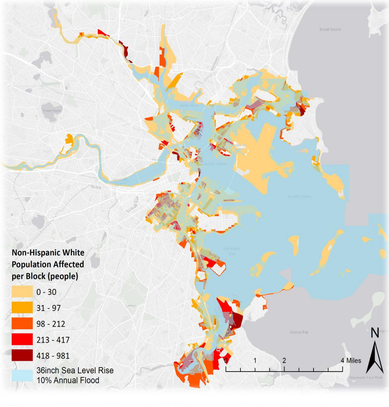


Figure 6. Non-Hispanic White population in projected inundation zone during an extreme storm in 2070.

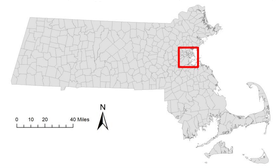
RESULTS

Of the 722,023 people that were living in Suffolk County in 2010, 121,156 (16.78%) residents are projected to be living in a potential inundation zone during a major storm in the year 2070 (Figure 1). Hispanic residents make up 21.73% of the affected population and 19.84% of the Suffolk County population at large (Figures 7 & 8). Non-Hispanic Whites make up 54.04% of the affected population and 48.06% of Suffolk County (Figures 7 & 8). Non-Hispanic Blacks make up 9.27% of the affected population and 19.80% of Suffolk County (Figures 7 & 8). Non-Hispanic Asians make up 12.12% of the affected population and 8.17% of Suffolk County (Figures 7 & 8). These results show that Non-Hispanic Whites make up the largest percentage of the affected population. However, while Non-Hispanic Asians only make up 12% of the total affected population, they are more disproportionately affected than the White population, with around 25% of their total Suffolk County population being affected compared to 19% of the total population of Non-Hispanic Whites (Figure 9). As for income, in the projected inundation zone, the average median income is $78,035.01 (Figure 2). This is considerably higher than the 2010 average median income for Suffolk County at large, which was $58,952.69.

CONCLUSIONS

My results show that Non-Hispanic White people comprise the largest percentage of the population projected to flood during an extreme storm in 2017, but Non-Hispanic Asian people will be disproportionately affected looking at Suffolk County as a whole, perhaps because Chinatown falls in the inundation zone. The fact that the median income of the blocks projected to be affected by flooding was higher than the average median income in Suffolk County might be explained by the fact that some of the wealthiest neighborhoods, such as Beacon Hill, Charlestown, North End, and Back Bay are located along the Charles River, and thus are more at risk of riverine flooding. While this analysis does not reveal a dire climate injustice scenario, it shows that much of Boston could be underwater by 2070, displacing thousands of residents and fits into existing literature by presenting climate change as a human rights issue. Boston city planners could use this analysis to know where to focus on sea-level rise mitigation efforts like seawalls and coastal wetland restoration.

One source of error is that the Census data I used is ten years out of date, and populations and incomes could have fluctuated significantly in that time. Furthermore, due to unavailability of a data layer with median income by block, the income layer is an approximation. Moreover, my spatial query selected every block that intersected with the inundation zone, but some of these blocks were very minimally covered by water while others were completely covered. Finally, race and income are not the only factors that impact someone's vulnerability, and further analysis should also take into account population density, English proficiency, age, and physical ability.



Tufts UNIVERSITY

Cartographer: Tara Steckler, Tufts University Class of 2022

Date: May 4, 2020
Coordinate System: NAD_1983_StatePlane_Massachusetts_Mainland_FIPS_2001
Software: ArcMap 10.7.1