Tufts UNIVERSITY
GRADUATE SCHOOL OF ARTS AND SCIENCES
Urban and Environmental Policy and Planning

Jess Wilson, Spring 2020
UEP 235: Advanced Geospatial Modeling

JUSTICE FOR ALL:

Vulnerability Analysis of the Effects of Storm Intensity and Flooding on Environmental Justice Communities in Metro Boston

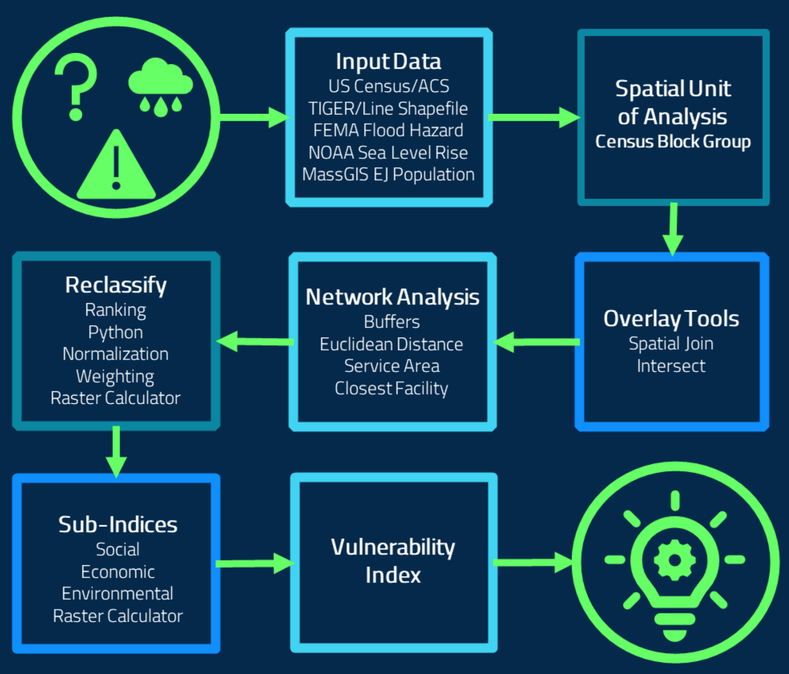
Introduction

The state of Massachusetts identifies an Environmental Justice (EJ) community as a community where any of the following criteria apply:

- Block group whose annual median household income is equal to or less than 65 percent of the statewide median ($62,072 in 2010); or
- 25% or more of the residents identify as a race other than white (considered Minority Populations); or
- 25% or more of households have no one over the age of 14 who speaks English only or very well (MassDEP, 2020).

Although only one of the above criteria must apply for a community to be deemed an EJ community, there exists a clustering of communities along the coastline of the Metro Boston area in which two or three of the criteria apply (MassGIS, 2020). Increased flooding events are expected for coastal cities as climate change exacerbates storm intensity and sea level rise. However, communities facing financial and language barriers are undoubtably more vulnerable to these storm and flood events than communities who have disposable income and are fluent in English. The social, economic, and environmental vulnerability of these communities to climate change related storm and flood events in Metro Boston has not yet been quantified. This project aims to discover which communities in Metro Boston are the most vulnerable to these events, in terms of social, economic, and environmental factors, and why this is the case.

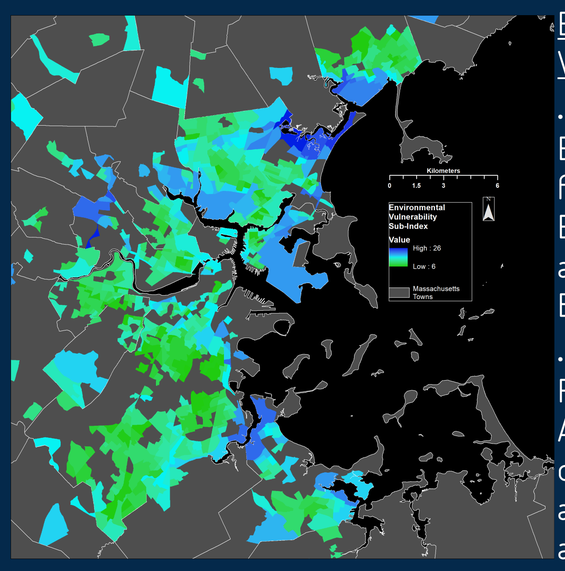
Methods



I used overlay tools including intersect and spatial join in order to match the Census Data values to the Census EJ values so that EJ Communities contained census block group level data for economic and social determinants .The FEMA Flood Hazard layer was overlaid with the Sea Level Rise and Coastal Flooding layer to match census block group flood data with census block group sea level rise data for environmental determinants (see all factors analyzed below).

Sub-Index	Factor	Sub-Index Weight (%)	Total Index Weight (%)
Economic	Low-Income ($)	50	33.33
	Car Ownership (%)	20	
	Insurance (%)	30	
Environmental	Proximity to Landfills (m)	10	33.33
	Flood Risk (m2)	10	
	Hurricane Risk (m2)	20	
	Proximity to Major Roads (m)	10	
	Proximity to Closest Hospital (mins)	30	
	Grocery Store Service Area (#)	20	
Social	Non-English Speaking (%)	30	33.33
	Children and Elderly (%)	50	
	Minority Populations (%)	20	

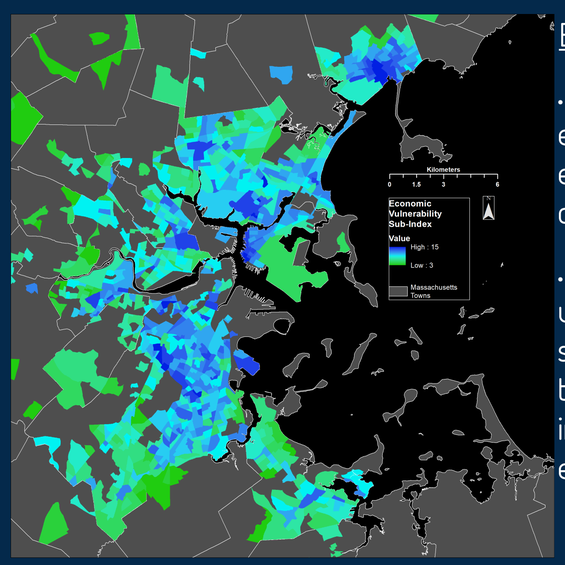
Vulnerability Sub-Indices



Environmental Vulnerability:

- Assessed proximity of EJ communities to flood zones by using Euclidean Distance and/or creating Buffers.
- Conducted Closest Facilities and Service Area analyses to determine proximity/ accessibility to hospitals and grocery stores.

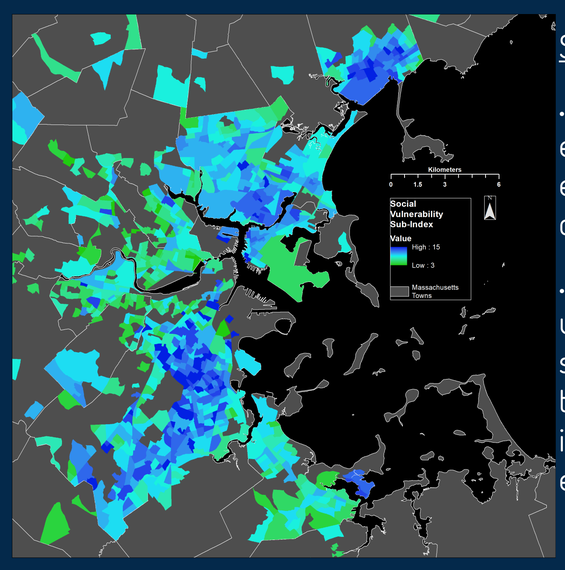
EJ Communities' Environmental Vulnerability to Storm Intensity and Flooding in Metro Boston, MA.



Economic Vulnerability:

- Using quantiles, evenly divided data for each factor into 5 categories
- Reclassified data using python on a 1-5 scale: least vulnerability to greatest vulnerability in a storm/flooding event

EJ Communities' Economic Vulnerability to Storm Intensity and Flooding in Metro Boston, MA., 2020



Social Vulnerability:

- Using quantiles, evenly divided data for each factor into 5 categories
- Reclassified data using python on a 1-5 scale: least vulnerability to greatest vulnerability in a storm/flooding event

EJ Communities' Social Vulnerability to Storm Intensity and Flooding in Metro Boston, MA, 2020

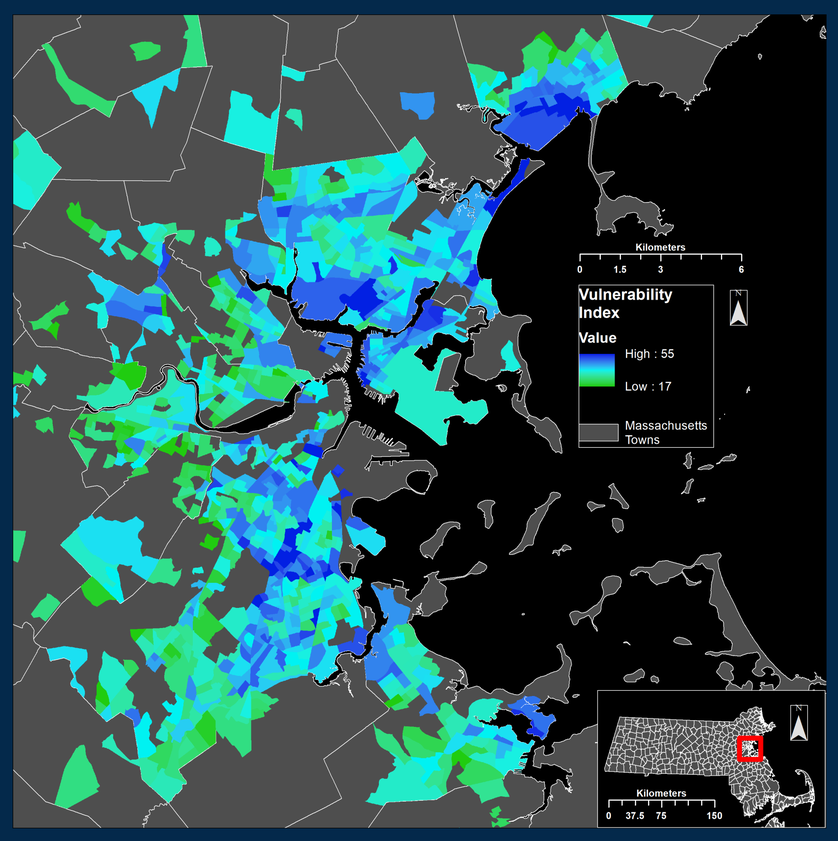
Sub-Index Analysis

- Normalized all sub-index data by repeating 1-5 ranking process listed above for the environmental sub-index factors
- Converted each factor layer from vector polygon to raster
- Applied weights to each raster layer (see table on left) and added raster layers together for each respective sub-index using Raster Calculator
- Joined 3-sub-indices together using Raster Calculator (equal weights for all sub-indices), which resulted in final vulnerability index map

Results

The results of the analysis show that coastal EJ communities in Metro Boston are more vulnerable to the effects of storm intensity and flooding in comparison to inland EJ communities, as we would expect. Considering social, economic, and environmental vulnerability, the communities with the highest vulnerability index scores include Lynn, Boston, Chelsea, Everett, Revere, Malden, and Quincy, Massachusetts.

Final Vulnerability Index:



Final Vulnerability Index for EJ Communities' Social, Environmental, and Economic Vulnerability to Storm Intensity and Flooding in Metro Boston, MA. 2020

Conclusion

It is important with the impending detrimental impacts caused by climate change that we prepare coastal communities and increase their resiliency before disaster strikes. EJ communities should be prioritized in these fortification efforts, and this study helps to identify which communities need the greatest amount of attention and investment when it comes to adaptive and mitigative responses. While this study is the first step in quantifying social, economic, and environmental vulnerability to storm intensity and flooding for these communities, future studies could analyze the resiliency potential of these EJ communities to fully understand the magnitude of the effects of climate change.

Projection & Sources

Coordinate System/Projection:
NAD 1983 State Plane Massachusetts Mainland FIPS 2001 Projected Coordinate System; Lambert Conformal Conic Projection

Data Sources:

- 2020 MassDEP Environmental Justice Populations
- 2010 MassGIS Data from US Census, 2010 Environmental Justice Populations, 2017 FEMA National Flood Layer
- 2017 Massachusetts Office of CZM Sea Level Rise and Coastal Flooding Viewer
- 2013-2018 Social Explorer ACS (5-Year Estimates)
- 2016 US Census Bureau TIGER/Line Shapefiles for State of Massachusetts

Poster Created on May 7th, 2020