Storm Surge Vulnerability

An Investigation of Storm Surge Vulnerability in Boston and Its Correlation to Man-Made Land

Introduction

Starting around 1803, Boston started filling in land along tidal flats and marshlands surrounding the city. Boston continued expanding its perimeter through the 20th century, and today the majority of Boston's coastline is man-made. Because so much of Boston's land is a product of human manipulation, a lot of Boston's modern day perimeter should naturally be underwater. It's no surprise then, that as sea levels continue to rise, Boston already has and will continue to face many challenges in ensuring storm surge protection to its infrastructure, economy and the communities who live there. This project will determine Boston's most vulnerable areas to storm surges and investigate the correlation between flood vulnerability scores and man-made land.

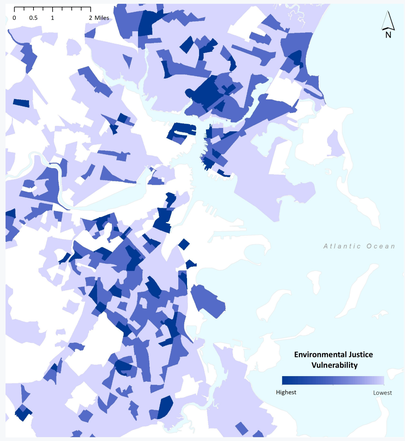
Methods

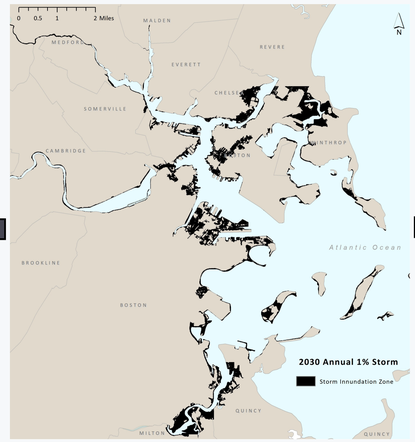
First, I determined the criteria for vulnerable-to-storm-surge areas. Using data based on Boston's Climate Projection Consensus study, I used six datasets that represented storm surge inundation zones for the one-percent annual flood and the ten-percent annual flood each at various sea levels of 9, 21 and 36 inches higher than 2013 levels. Each sea level prediction comes from different climate modeling scenarios, according to the study I used. Generally, the 9 inch sea level rise is expected by 2030, the 21 inch sea level rise is expected by 2050, and the 36 inch sea level rise is expected by 2070. I rasterized these datasets and gave each a vulnerability score of one.

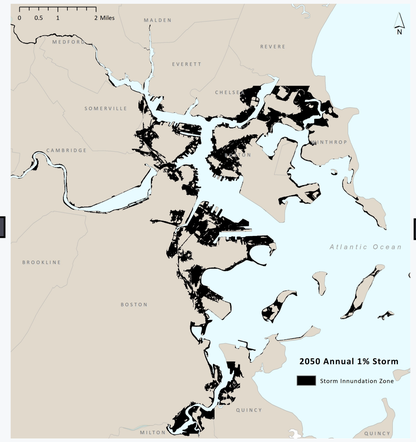
I also considered environmental justice communities as vulnerable-to-storm-surge areas. I classified three categories, minority status, income and household language, as environmental justice criteria. Any census block that had 25 percent or more minority residents, earned a median household income of less than $40,673, or had 25 percent or more households that did not speak English were environmental justice communities. Census blocks then earned a vulnerability score of 0-3 indicating the number environmental justice criteria they satisfied.

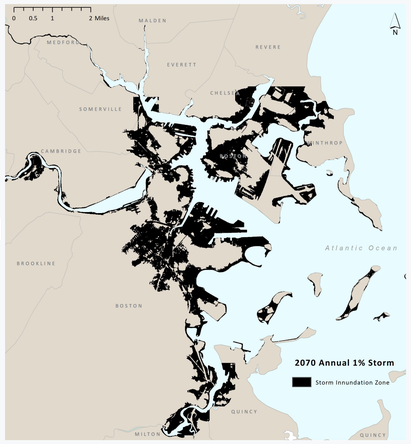
Raster calculator allowed me to determine final vulnerability scores by adding the vulnerability scores generated from the storm surge inundation zones and those generated from environmental justice criteria. I created two maps for the one-percent annual storm and the ten-percent annual storm.

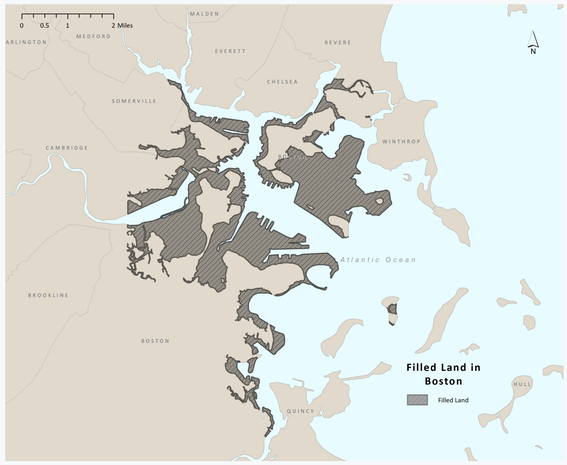
Finally, in my investigation of the consequences of Boston's man-made land, I geo-referenced and digitized a map showing Boston's land in. the 1630's and overlaid this layer on the final vulnerability maps.









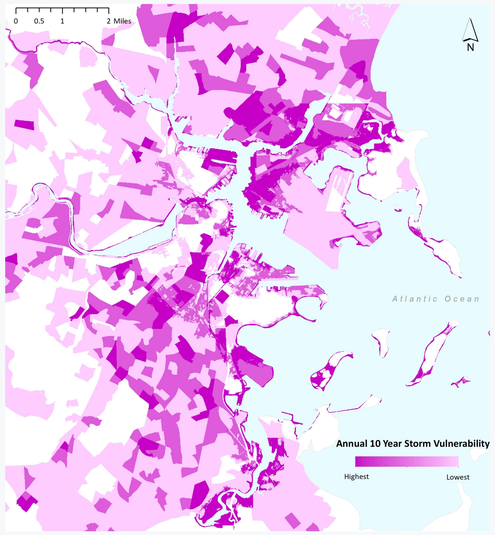


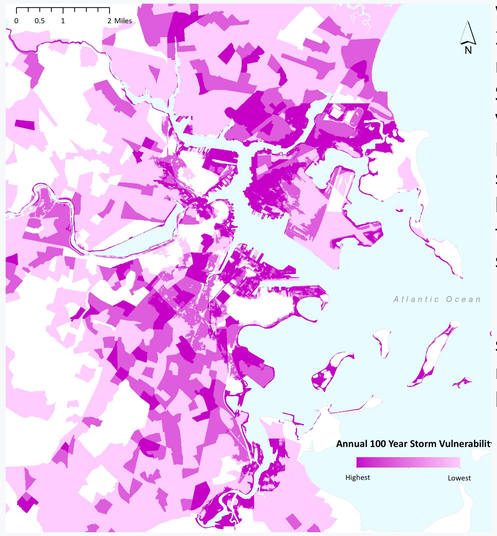
Results

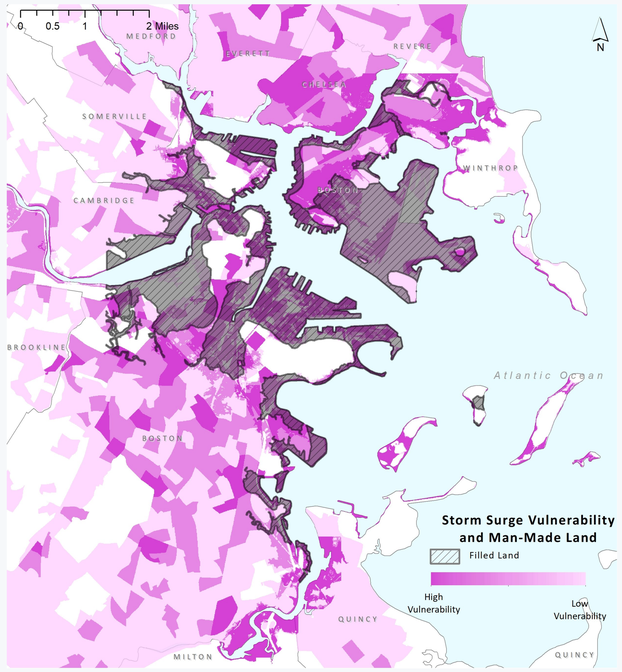
The majority of the highest vulnerable-to-storm-surge areas reside along the coastline as expected. The differences between the Annual 10 Year Storm Vulnerability map and the Annual 100 Year Storm Vulnerability map are slight as the 100 year storm is only marginally darker in a few areas. This marginal difference highlights how many of the most vulnerable areas will almost certainly be flooded by storm surges in the next century, whether those storms be only one -percent or ten-percent likely in a given year. Boston should prepare these areas with the highest vulnerability first.

In investigating the correlation between Boston's storm surge vulnerability and where Boston was filled in, I can see many similarities. Evidence for good correlation between vulnerability and man-made land can be seen especially well when comparing the 2070 Annual 1% Storm map and the final Storm Surge Vulnerability and Man-Made Land map. The shapes of each map have many overlapping features and look quite similar.

It may be safe to say, once again, that maybe humans are to blame for this one.







References and Information

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Sources: Herb Heidt and Eliza McClennen of Mapworks, BostonGIS, MassGIS, ESRI

Projection: NAD_1983_StatePlane_Massachusetts_FIPS_2001

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