Boston Underwater:

An Assessment of Boston's Vulnerability to Flood Damage in a Hurricane

Introduction

Natural disasters like hurricanes are increasing in frequency and severity as climate change becomes a reality in the 21st century. Boston, Massachusetts has not historically been the target of major hurricanes, so the city was not designed with this hazard in mind. As a result, Boston is not ready to handle the effects of a large storm if one were to travel far enough north to hit the city. Because Boston is on the coast, there is a high risk for severe flooding and subsequent damage to infrastructure. Additionally, Sea level is on track to rise two feet by the year 2050. A risk analysis on Boston and its surrounding towns was performed to display the regions at the highest risk for infrastructure damage due to flooding from a hurricane, taking into account two feet of sea level rise. This analysis shows a potential worst case scenario and can be used to take preventative measures where they are most needed.

Figure 1: Location of Boston within Massachusetts

Data

This analysis is based on a data layer entitled Hurricane Surge Inundation Zones provided by MassGIS. This layer was developed for emergency management officials to show the worst case flood zones based on the category of hurricane that could hit Boston. An elevation layer, also provided by MassGIS, was used to analyze for sea level rise. These layers were used in combination with all buildings in Boston as a polygon shapefile, and with a digitized layer of all subway stations in the Boston T system created based on a subway map provided by the MBTA and a reference map of the city of Boston.

Methods

First, the Hurricane Inundation Zones layer was altered to account for sea level rise. The provided layer shows the potential flood zones for the current state of the ocean, but with increasing sea level the flood waters will inundate further and affect a larger area. A buffer was created around each existing zone to show potential flooding in 2050. These layers were then combined into three categories. The High Risk Zone shows the areas that will flood in a category 1 hurricane. This is the lowest level of hurricane, and the most likely to occur, so the infrastructure in this zone is very vulnerable. The Medium Risk zone shows flooding for a category 2 storm, which is less likely to occur but still requires preparedness action. The Low Risk zone combines categories 3 and 4 storms. A higher category storm is unlikely to occur in Boston because the waters in the surrounding areas are too cold to provide a platform for a large hurricane to form. Most hurricanes form in lower latitude areas where waters are warmer. So, categories 3 and 4 are least likely to occur and demonstrate a low risk zone. The infrastructure layers were then classified based on the risk zone they fell into. If a building fell within multiple zones, or a zone cut through a building, the highest risk zone intersected was used.

Flood Risk Zones

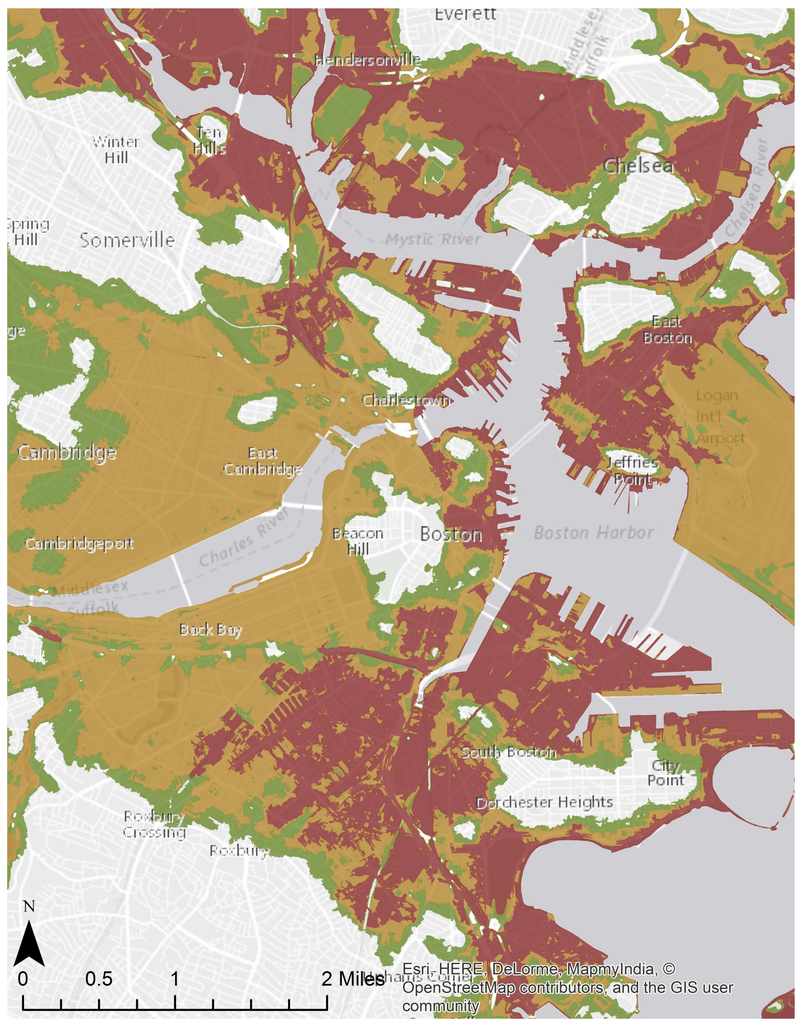

Figure 2: Flood Risk Zones

Results

A map of high, medium, and low risk flood zones accounting for sea level rise until 2050 is visible in Figure 2. The areas of Boston that are at the highest risk include the southern part of the city, the seaport area, and many areas in surrounding towns to the north of the city that border the Mystic and Chelsea Rivers. The land surrounding the Charles River falls primarily within the medium risk zone. The low risk zone falls along the edges of the medium risk zone, and covers much less surface area than both the medium and high risk zones. This means that major flooding and damage to infrastructure throughout the city is a large possibility even in lower category storms. Buildings and subway stations in the high risk zones can be altered to prepare for flooding and reduce the potential for damage.

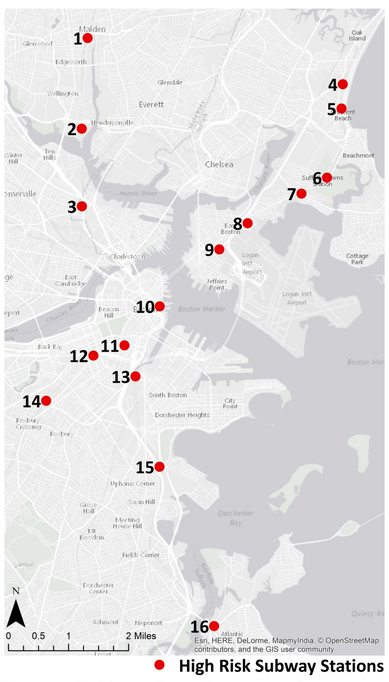

Figure 4: High Risk Subway Stations

High Risk Subway Stations	
Reference #	Name of Station
1	Malden Center
2	Wellington
3	Sullivan Station
4	Wonderland
5	Revere Beach
6	Suffolk Downs
7	Orient Heights
8	Wood Island
9	Airport
10	Aquarium
11	Tufts Medical Center
12	Back Bay
13	Broadway
14	Ruggles
15	JFK/UMass
16	North Quincy

Recommendations

Buildings:

Existing building owners within the High and Medium Risk Zones (see Figure 3)can take these actions to prevent flood damage:

- Install flood openings at the base of the building
- Elevate building utility systems
- Floodproof building utility systems with waterproof materials
- Install passive dry floodproofing systems
- Install barrier measures

When building new structures, the following precautions should be taken into account if the property falls within a risk zone:

- Elevate the structure above the Base Flood Elevation (expected flood height)
- Abandon the lowest floor
- Elevate the lowest interior floor
- Floodproof all utilities

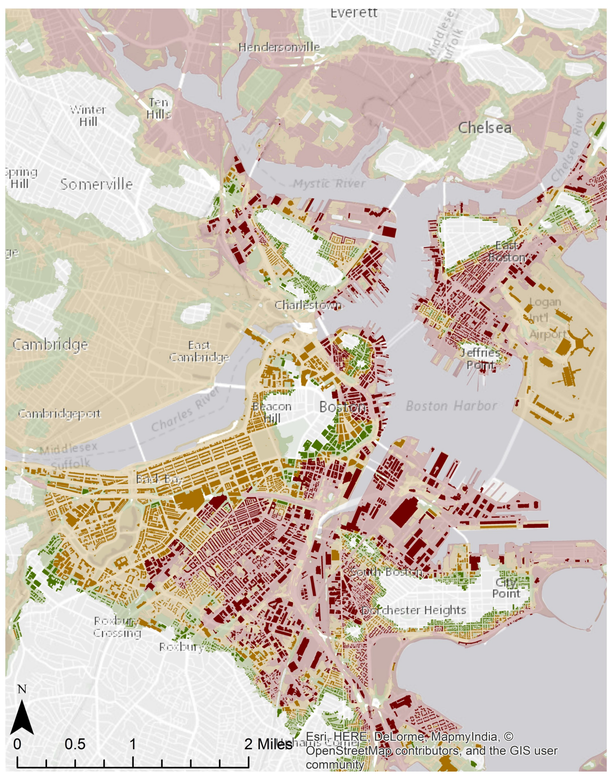

Figure 3: At-Risk Buildings by Flood Zone

Subways:

Subway stations within the High Risk Zone, visible in Figure 4, should implement a flood gate system. A flood gate blocks entrances and prevents water from entering the underground subway system. Models like the Stairwell Flex-Gate by ILC Dover offer a non-obtrusive, preventative way to reduce flood damage. These gates are installed above or beside the entrance to the subway and can be deployed in under 10 minutes when flooding is expected. Flood gates are only relevant for subways that run below ground. As shown in Figure 4, the subway stations that are at the highest risk are spread throughout the city. These stations should be focused on first when preparing for future flooding.

References

Projection: NAD 1983 (2011) StatePlane Massachusetts FIPS 2001 (US Feet)

Data Sources: MassGIS, ESRI

Online Sources: Mass.gov, GlobalChange.gov, Boston.gov, ILCDo-ver.com

Kelly Donohue

December 7th, 2017

CEE187: Geographical Information Systems

Tufts University