

Where Are The Target Areas For Installing Green Roofs In The City Of Boston?

BACKGROUND

Boston has a hot summer humid continental climate. Summers are typically warm and humid, while winters are cold and stormy, with occasional periods of heavy snow. Spring and fall are usually cool to mild, with varying conditions dependent on wind direction and jet stream positioning. The coastal location of Boston on the North Atlantic moderates its temperature but makes the city very prone to Northeast weather systems that can produce much snow and rain.

However, Boston is a relatively old U.S. city that sits close to sea level. It has 235 miles of combined sewer/stormwater systems (CSOs) with 37 active CSO outfalls. In rain events over half an inch, these systems can get overloaded. In order to avoid backing up into houses and streets, they discharge combined sewage and stormwater at outfalls into rivers and streams that flow in and around the city. This increase of sewage in our waterways impacts swimming and contact recreation, as well as adds to nutrient overloads that negatively impact the ecosystem. In addition, many of the older buildings in Boston are built on pilings that depend on the ground beneath for support. In some cases, the lack of stormwater recharge for groundwater supplies is compromising the stability of buildings in the city.

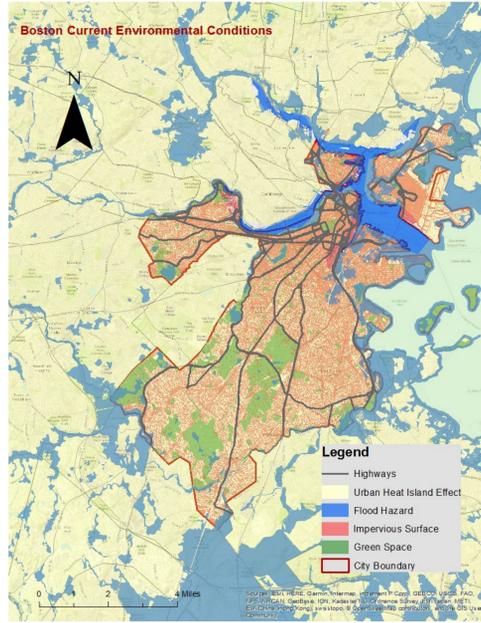
In many other cities across North America, installing vegetated roof on rooftops is becoming an effective method to mitigate stormwater runoff from impervious surfaces by collecting and retaining precipitation. Such "green roof" reduces the volume of water that needs to be both transported and treated by infrastructure and natural waterways, effectively avoiding overburdening of facilities and rivers. Besides, there are other multiple environmental benefits to the inclusion of green roofs in an urban environment, such as effectively reducing surface and air temperature in cities.

Studies show that currently the population in Boston is aging, becoming more diverse in its young part, increasing in inequality in socio-economic status, and increasing in needs for support for minority groups and immigrants. More green roofs are needed to serve the socially vulnerable population to enhance social resilience. In this project, I hope to detect in Boston where, in the vulnerable communities, the city needs to install green roofs to integrate the ecological design with community planning.

This study aims to answer: (1) What areas in Boston have the most severe environmental issues, such as air pollution, urban heat island effects, flooding, etc.? (2) Where are the vulnerable communities with concentrated aging population, or children, or low-to-no income population, or population with medical illness? (3) What kinds of rooftops in vulnerable communities in Boston is suitable for installing green roofs? Can they help solve the environmental and social issues in the City of Boston?

ENVIRONMENTAL CONDITIONS

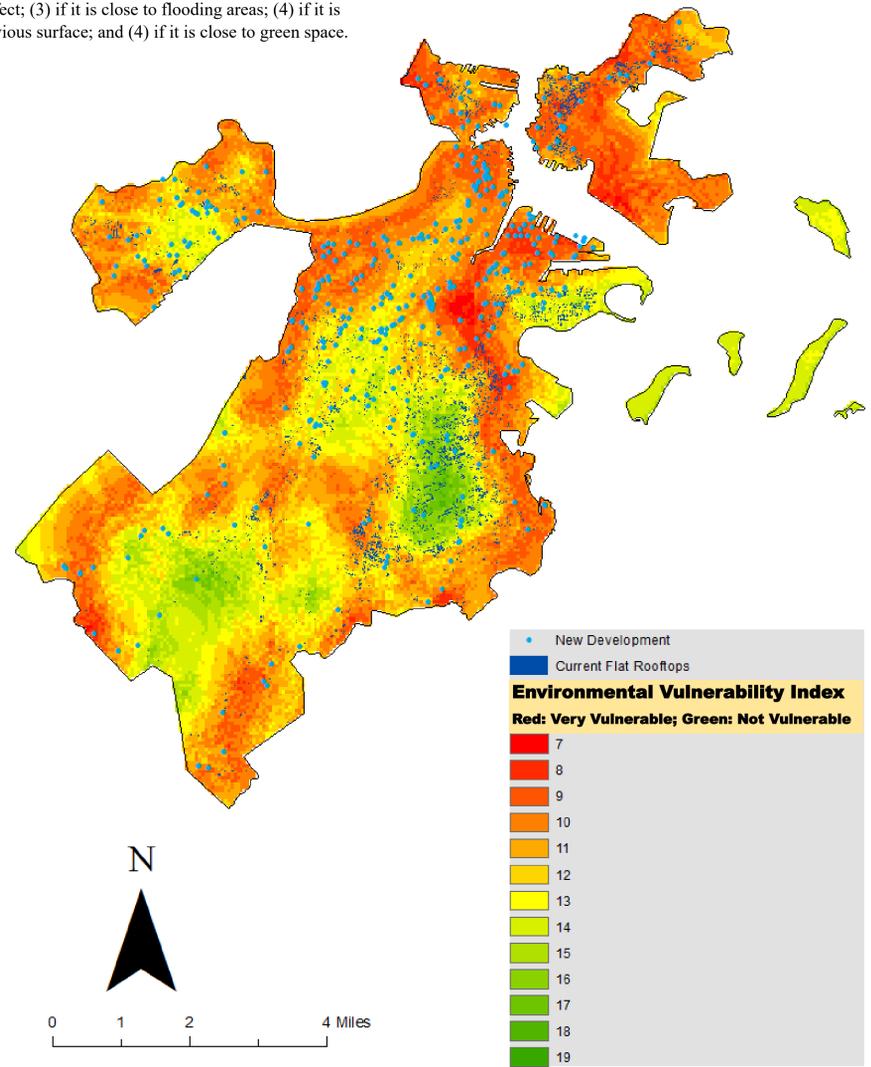
In this study, I analyzed the environmental conditions in the City of Boston. I aimed to find the environmentally vulnerable areas by evaluating the conditions of air pollution (if it is close to highways), urban heat island effect, flood hazard, impervious surface, and green space. The following map shows the environmental conditions in the City of Boston.



Layers	Data Set	Source
Highways	North America Highways	ESRI Data Map 10
Urban Heat Island Effect	Global Urban Heat Island (UHI) Data Set, v1 (2013)	NASA
Flood Hazard	FEMA National Flood Hazard Layer	MassGIS
Impervious Surface	City of Boston MA Impervious Surface	DOIT
Green Space	Open Space	Boston GIS

Environmental Vulnerability Index

Calculated by (1) if it is close to highways; (2) if it is in areas with urban heat island effect; (3) if it is close to flooding areas; (4) if it is covered by impervious surface; and (4) if it is close to green space.



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 Projection: NAD_1983_2011_StatePlane_Massachusetts_Mainland_FIPS_2001
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POTENTIAL GREEN ROOFS

In 1996, the Boston Redevelopment Authority adopted Article 80 to provide clear guidelines for the development review process relating to large projects (adding more than 50,000 square feet), small projects (greater than 20,000 square feet), planned development areas (new overlay zoning districts for project areas larger than 1 acre), and institutional master plans (projects relating to academic and medical campuses). Article 80 was adopted because the parameters of these unique projects rarely fit neatly within the existing zoning code and a more predictable review process was needed.

The Article 80 process may include, but is not limited to, review of a project's impacts on transportation, public realm, the environment, and historic resources. Boston Planning & Development Agency Project Managers assist developers in navigating the Article 80 process. The newest Article 80 was updated by Boston Planning & Development Agency in July 2016. It contains the information of the construction stages (if the it has completed, or under construction, or not started yet). In this study, we will define the constructions from Article 80 which have not started as "new development". Those constructions are the ones that we may negotiate with the City to design green roofs for. The light blue points in the maps represent the new development where we suggest install green roofs in the City of Boston.

For installing green roofs on existing buildings, the first condition should be flat rooftops. In this study, we find the data of flat rooftops of existing buildings from the data set Boston Parcels 2016 Data. The dark blue parts in the maps represent the current flat rooftops in the City of Boston.

Layer	Data Set	Source
New Development	Article 80 Projects As Of July 2016	BostonGIS
Current Flat Rooftops	Boston Parcels 2016 Data (full)	BostonGIS

The map of Environmental Vulnerability Index and potential green roofs shows that most of the current flat rooftops do not locate in the environmentally vulnerable areas. Some of the new development may help install green roofs in those areas. However, the northeast part may need efforts to design green roofs.

The maps of Climate Change Social Vulnerability and potential green roofs show that both current flat rooftops and new development help install green roofs for the social-vulnerable communities. However, the southwest part may need efforts to design green roofs.

CLIMATE CHANGE SOCIAL VULNERABILITY

Currently, Boston is aging, and increasing in inequality in socio-economic status. Older adults, children, low-income communities, and people with medical illness are the most vulnerable populations to environmental issues. This study suggests the City of Boston pay attention to those populations when planning to install green roofs.

The maps at the bottom reflects the climate change social vulnerability in the City of Boston. The darker areas represent larger quantities of low-to-no income individuals, children, individuals with medical illness, and older adults, respectively.

Layers	Data Set	Source
Low-to-no Income Individuals	Climate Ready Boston Social Vulnerability (from Open-Environment and Energy)	BostonGIS
Children	Same as above	BostonGIS
Individuals With Medical Illness	Same as above	BostonGIS
Older Adults	Same as above	BostonGIS

