Assessing Heat Vulnerabilty and Cooling Resources

A Case Study of Boston

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UEP 232, Intro to GIS
Spring 2015

Introduction

Boston's heat-related mortality rate is expected to triple in the next thirty years, meaning that heat will kill 54 people, on average, annually.[1]

The populations most vulnerable to heat include older adults, young children, individuals living alone, those with chronic illnesses (particularly cardiovascular or mental diseases), urban residents, minorities, people of low income, people with less education, and people without access to air conditioning.[2] To locate these populations in Boston, this project uses a national Heat Vulnerability Index (HVI) to identify eleven heat vulnerable census tracts.

Method

This project adapts a study by Reid et. al. for the City of Boston.[3] That study applied a primary component analysis to 10 variables, yielding four factors:

1. Social/Environmental Vulnerability
2. Social isolation
3. Prevalence of no air conditioning
4. Proportion of elderly/diabetes

The sum of four factors is the HVI score. We multiply each variable in Table 1 by the weightings in Reid et. al. to produce the four factor and HVI composite scores for each census tract. The data are displayed by standard deviation (SD) to decrease the influence of outliers.

We next aim to identify areas of Boston with high vulnerability to heat without access to public cooling resources, such as pools, parks with spray features, and community centers open during heat waves. (See Table 2 for data sources.) After geocoding addresses, we checked 91 locations for positional accuracy against an orthographic image of the city. The spray features were repositioned from the street address to the actual location of the feature. We then conduct a network analysis around these points to identify a half-mile walkshed for these locations.[4]

Table 1: Boston Heat Vulnerability Variables Based on Reid et al. 2009

Category	Data Source (Year)	Variable
Demographic variables	American Communities Survey 5-Year Estimate (2013)	Percent population below the poverty line
		Percent population with less than a high school diploma
		Percent population of a race other than white
		Percent population living alone
		Percent population ≥ 65 years of age
		Percent population ≥ 65 years of age living alone
Land Cover	National Land Cover Database (2011)	Percent census tract area not covered in vegetation
Diabetes Prevalence	Behavioral Risk Factor Surveillance System (2010)	Percent population ever diagnosed with diabetes
Air Conditioning	American Housing Survey (2007)	Percent parcels without central AC
		Percent parcels without AC of any kind

Figure 1: Social/Environmental Vulnerability

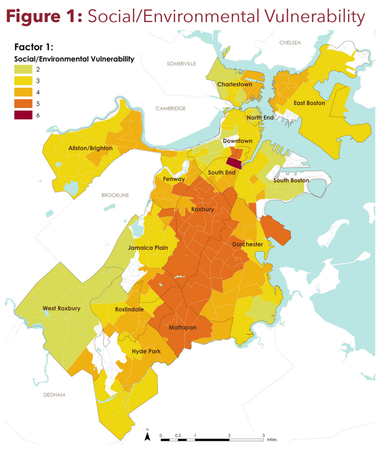


Figure 2: Social Isolation

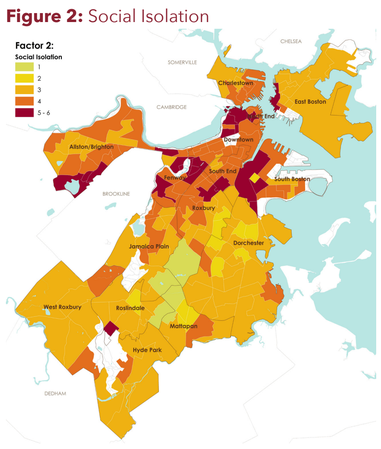


Figure 3: Prevalance of No A/C

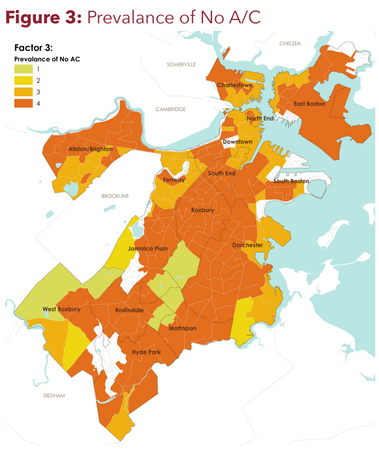
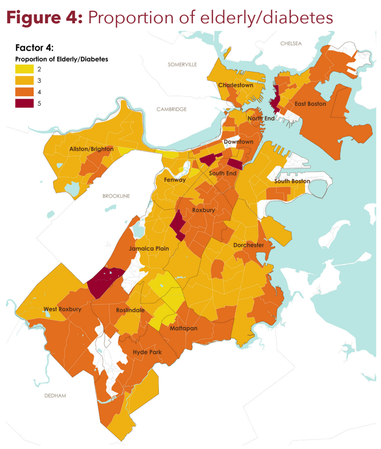
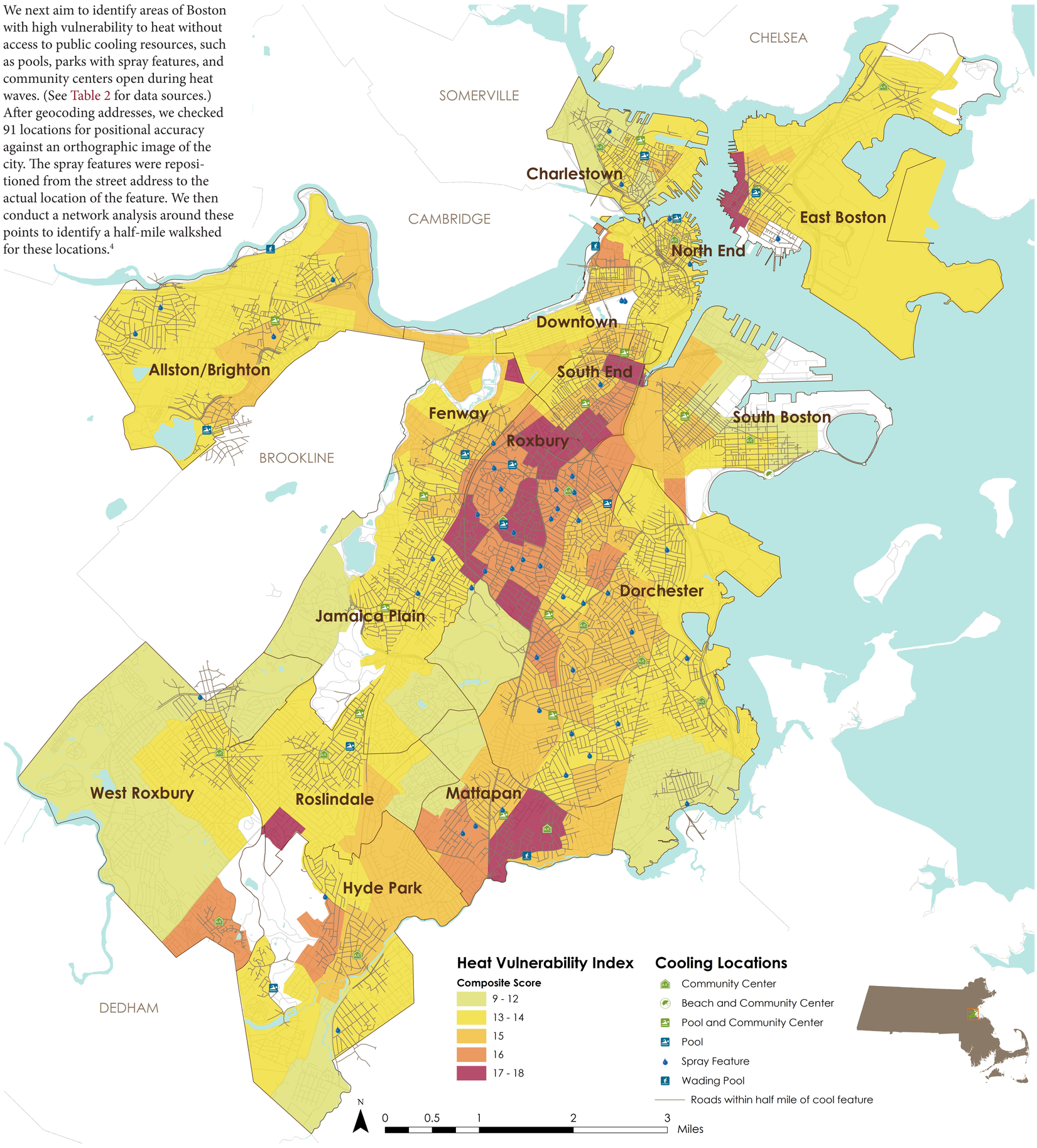


Figure 4: Proportion of elderly/diabetes





Results

Figures 1-4 show the four factors that contribute to the main Heat Vulnerability Index composite map. Our analysis identifies eleven census tracts in Boston with high HVI scores of 17 or 18. A table of these census tracts is provided below.

The overlay map shows that most of the eleven census tracts have access to cooling resources with the exception of two census tracts in Fenway and Roslindale, and parts of Mattapan and Roxbury.

Population within walking distance of cooling feature

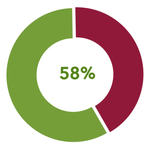
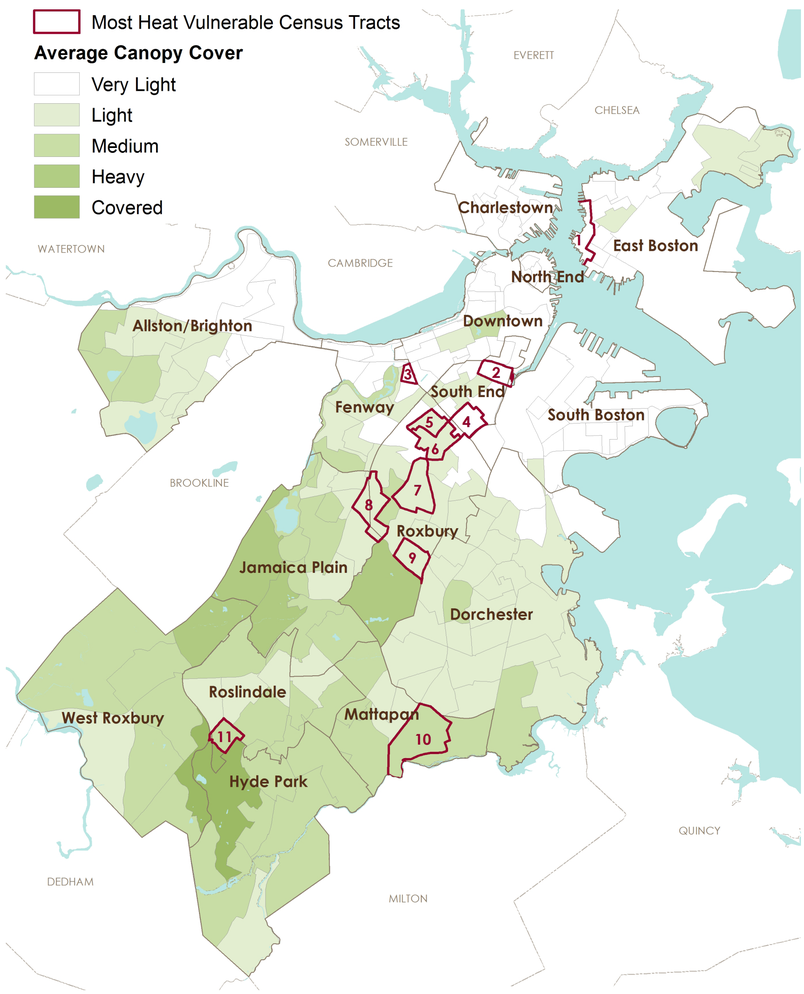


Table 2: Cooling Features Overlay

Category	Data Source (Year)	Description
Cooling Centers	Boston Center for Youth & Families (BCYF) (2014)	BCYF Summer 2014 Cooling Centers & Pools List
Pools & Spray Features	Boston Center for Youth & Families (BCYF) (2014)	BCYF Summer 2014 Cooling Centers & Pools List
	City of Boston (Not dated)	List of Spray Features by Neighborhood
	MassGIS (2014)	DCR pools & spray decks
Roads	MassGIS (2014)	Class 2 – 6 roads in "EOTROADS_ARC"
Demographics	Census (2010)	Total population by block

Table 3: Most Vulnerable Census Tracts

Label	Neighborhood	Population	HVI Score	High Factor Scores	% Canopy Cover
1	East Boston	2197	17	- Social Isolation - Proportion of Elders/Diabetes	0.6
2	Chinatown (South End)	1718	18	- Social/Environ. Vulnerability - Proportion of Elders/Diabetes - Social Isolation	3.9
3	Fenway	2894	17	- Social Isolation	1.5
4	South End	4069	17	- Social Isolation	4.4
5	Roxbury	3168	17	- Social/ Environ. Vulnerability	6.8
6	Roxbury	2543	18	- Social/Environ. Vulnerability	5.9
7	Roxbury	3277	17	- Social/ Environ. Vulnerability	13.6
8	Roxbury	5382	18	- Social/ Environ. Vulnerability - Proportion of Elders/Diabetes	10.4
9	Roxbury	4924	17	- Social/ Environ. Vulnerability	13.5
10	Mattapan	4933	17	- Social/ Environ. Vulnerability	25.9
11	Roslindale	1961	17	- Social Isolation	26.08



Discussion & Limitations

The HVI map is a data-driven method that visualizes both social and environmental factors affecting heat vulnerability in the City of Boston. While serving as a valuable first review of heat vulnerability risk, this project had some limitations. For example, diabetes prevalence is only available at the neighborhood level and air conditioning data from the American Housing Survey is for the Metropolitan Statistical Area. Therefore, using the methodology from Reid et al. 2009, we assign the diabetes prevalence to its respective neighborhood and one rate of AC prevalence to all census tracts.

Note that the walkshed does not consider human behavior and use of cooling facilities. Finally, it could be argued that the weighting on AC is too high. While AC protects against heat, it is a short-term solution that can exacerbate the problem. Burning fossil fuels for electricity contributes to climate change, and air conditioners produce heat that can warm the local environment, thus increasing the urban heat island effect. More sustainable methods of mitigating heat exposure include modifying the built environment by increasing vegetation and the reflectivity of paved surfaces.

References & Notes

[1] Elisaveta P. Petkova et al., "Projected Heat-Related Mortality in the U.S. Urban Northeast," International Journal of Environmental Research and Public Health 10, no. 12 (December 3, 2013): 6734–47, doi:10.3390/ijerph10126734.

[2] Rupa Basu, "High Ambient Temperature and Mortality: A Review of Epidemiologic Studies from 2001 to 2008," Environmental Health: A Global Access Science Source 8 (2009): 40, doi:10.1186/1476-069X-8-40; Julia Kravchenko et al., "Minimization of Heatwave Morbidity and Mortality," American Journal of Preventive Medicine 44, no. 3 (March 2013): 274–82, doi:10.1016/j.amepre.2012.11.015.

[3] "Mapping Community Determinants of Heat Vulnerability," Environmental Health Perspectives 117, no. 11 (November 2009): 1730–36, doi:10.1289/ehp.0900683.

[4] The client for this project uses a half-mile buffer in their analysis, thus a smaller measurement was not used.

Projection for all maps: NAD_1983_StatePlane_Massachuestts_Mainland_FIPS_2001_Feet

Aknowledgements: Data processing for factor analysis conducted by Kate Ito in March 2015 for UEP Field Project.