Planning Urban Heat Island Mitigation in Boston

Executive Summary

Erin Coutts, Kate Ito, Cecilia Nardi, Trang Vuong

To advance important resilience objectives, in 2015 the Trust for Public Land, the City of Boston, and a variety of partners launched a two-year pilot project to inform and catalyze green infrastructure work in the metropolitan Boston region (The Trust for Public Land, 2015). This project will take place as part of the Trust for Public Land's Climate Smart Cities program and will involve implementing a demonstration project to show how green infrastructure can aid in mitigating climate risks. As the Boston pilot project was getting off the ground, the Trust for Public Land engaged a Tufts' graduate student team in the Urban and Environmental Planning and Policy (UEP) program from February – April 2015 to research the Urban Heat Island (UHI) effect in Boston.

This report examined UHI impacts, green infrastructure mitigation strategies, conducted a Geographic Information Systems (GIS) vulnerability analysis, and developed Boston-specific recommendations for green infrastructure mitigation of the UHI effect. The role of this project was to provide the Trust for Public Land with background research and a preliminary investigation of heat vulnerability in the local context as they begin the longer Climate Smart Cities project.

The UHI Effect

The UHI effect is the phenomenon where urban areas are warmer than their surrounding suburban and rural regions. With 81% of Americans living in urban areas (World Bank, 2015), an aging population, and climate change, the population vulnerable to heat and the UHI effect will likely increase in coming years (Hondula, Georgescu, & Balling, 2014). Consequently, it is important for planners and public health professionals to be aware of its risks. There are three major ways that the UHI effect impacts cities: 1) human health and comfort, 2) increased energy consumption, 3) impaired air and water quality (U.S. EPA, 2008c). These impacts have a disproportionate effect on certain populations, including older adults, young children, those living alone (i.e. in social or geographic isolation), 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 (Basu, 2009; Belmin et al. 2007; Holstein, Canouï-Poitrine, Neumann, Lepage, & Spira, 2005; Kravchenko et al., 2013; Luber & McGeehin, 2008; O'Neill & Ebi, 2009).

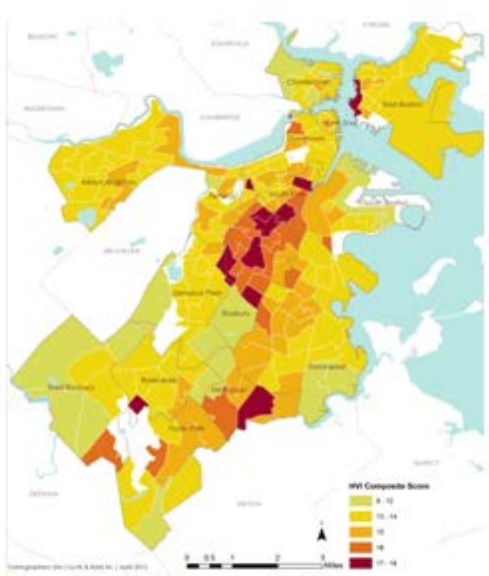

Figure 1: HVI Composite Score

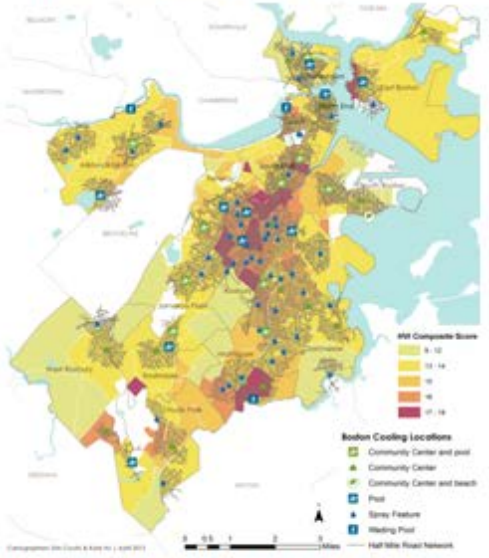

Figure 2: Cooling Features Overlay

Vulnerability Analysis

This paper conducted a GIS heat vulnerability analysis of the City of Boston. A national Heat Vulnerability Index (HVI), created by Reid and colleagues (2009), was adapted to identify heat vulnerable areas within Boston. Reid et al. (2009) mapped 10 vulnerability indicators for heat-related morbidity and mortality at the census tract level in their HVI. Using primary component analysis on the 10 variables at the national level, Reid et al. (2009) found four major factors that explained 75% of the total variance in the 10 vulnerability variables. They labeled the four factors: 1) social/environmental vulnerability, 2) social isolation, 3) prevalence of no air conditioning, and 4) proportion of elderly/diabetes. The composite of all four factors is the HVI score.

The HVI analysis uncovered eleven census tracts that had an HVI score of 17 or 18 — the highest scores in the Boston HVI (Figure 1). The HVI demonstrated that social factors have a large affect on heat vulnerability. This is further supported by an overlay of cooling features, such as park water features, community centers, libraries, etc., with a half-mile walkshed (Figure 2). Most of the eleven census tracts have access to cooling features with the exception of the census tracts in Fenway, Roslindale, and parts of Mattapan and Roxbury. Due to the time constraints and limited resources of this project, the HVI was only created for the City of Boston. In the future, this methodology should be vetted with experts in the field and validated the Boston-specific HVI against temperature and health data. The HVI is a useful, nationally replicable method that broadly outlines locations of heat vulnerable populations.

Recommendations

This report researched three green infrastructure mitigation strategies — the use of vegetation, roofs, and cool pavement — and community engagement to reduce urban temperatures (Figure 3).

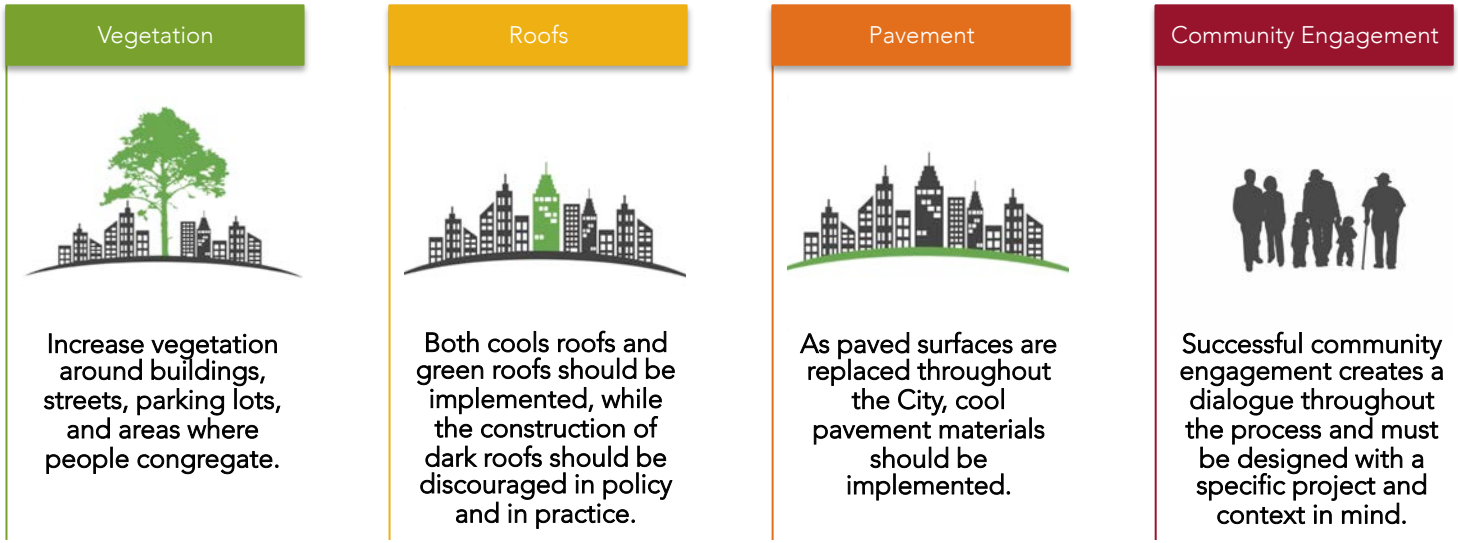

Figure 3: Recommendations

Therefore, this report has two overarching recommendations: 1) consider the above evidenced-based UHI mitigation strategies in the eleven most vulnerable census tracts found in this report, and 2) consider leveraging existing citywide processes in order to help maximize the impact of UHI and heat mitigation strategies in addition to a demonstration project. Strategies implemented on a citywide scale could potentially have a larger population impact. The report further details recommendations for citywide UHI mitigation strategies for Boston in five broad categories: 1) UHI education and awareness, 2) demonstration projects, 3) policy recommendations based on existing City policies and programs, 4) partnership opportunities across different sectors, and 5) community engagement around the specific intervention. In particular, the Boston Complete Streets guidelines may be an especially impactful policy to encourage.

Finally, the HVI analysis can be used as a screening tool to identify where heat vulnerable populations may live and help to direct appropriate UHI mitigation strategies by prioritizing places with need. While the HVI is a data-driven method that can be used to screen locations from an equity lens, further on-the-ground follow up is required. Social aspects of the built environment are also critical to help mitigate the adverse impacts of the UHI effect in Boston.