Climate Change, Urban Heat Islands and Tree Canopy in Rhode Island

Hot summer days and oppressive heat waves are becoming more frequent and longer in duration, subjecting Rhode Island residents to an increased risk of health effects. Specifically, in Rhode Island an increase in the maximum daily temperature from 75 to 85°F was associated with a nearly **24%** increase in the rate of emergency department visits for heat-related illness between 2005 and 2012 and a **4%** increase in all-cause mortality from 1999 to 2011 (Kingsley et al., 2016). This suggests Rhode Islanders are at increased risk of heat-related illness at temperatures as low as **85°F**. On average, southern New England has experienced one heat wave each year for the last 50 years. In 2021, Rhode Island experienced three heat waves over the summer, which has happened in only 11 other years.

Extreme heat is compounded in cities which are subject to the urban heat island effect. Cities and urban areas are hotter than rural areas because the dense manmade infrastructure (like buildings and roads) absorb, retain, and emit more heat (energy) than natural spaces.

Infrastructure and green spaces are not distributed uniformly across urban spaces, so some areas (with more roads and buildings) are substantially hotter than others with more trees.

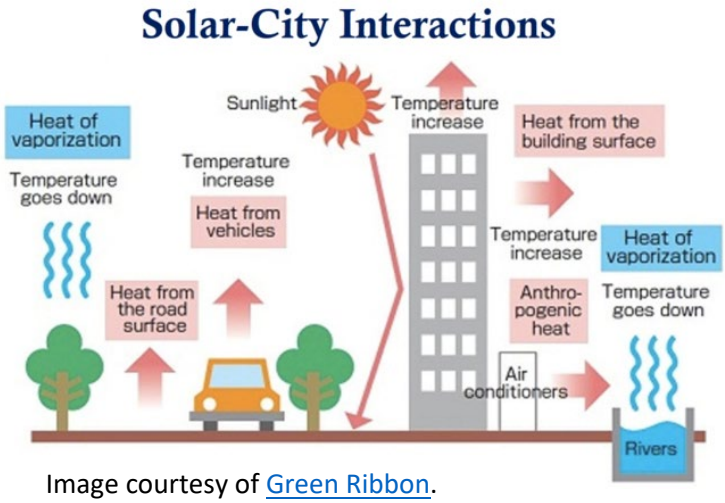


Image courtesy of Green Ribbon.

How Past Urban Planning Decisions Impact the Present

Historical development patterns and targeted disinvestment from decades ago remain visible today in their impacts on the landscape and social inequities in cities. Highways were used to divide cities and segregate cities. In many cities, historically white neighborhoods are cooler with more trees, while historically Black neighborhoods are hotter with fewer trees.

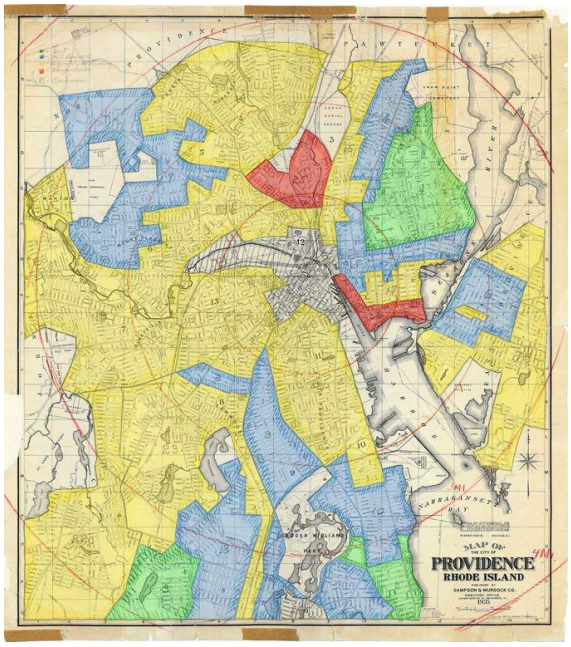


Image courtesy of Uprise RI.

Redlining is one of the most profound and well-known processes for systemic disinvestment and housing discrimination. In the 1930s and 1940s, the Home Owners' Loan Corporation (HOLC), a federal agency, assessed the level of neighborhood risk for banks making loans and assigned A to D grades. Neighborhoods with less desirable characteristics were given lower grades – those with minority, especially African-American, and immigrant communities were often graded as "Fourth Grade" or "Hazardous," which translated to the riskiest category for loans. These grades were color coded into "mortgage security" maps. Because these maps directly influenced access to mortgage lending and at least partially influenced neighborhood demographics, they have contributed to persistent inequality. Recently there has been increasing interest in understanding the effects on environmental conditions, like who has access to greenspace, and health outcomes.

Findings in Rhode Island

Similar efforts have been undertaken in Rhode Island. Inspecting data collected at four periods (6-7AM, 3-4PM, 7-8PM and 12-1AM) on a summer day in 2020 shows the differences in temperature across Providence and Pawtucket and how the temperature changes over the course a summer day, pictured below. Heat index is a measure of the air temperature and humidity, which reflects the temperature the human body actually feels. The starkest different in the heat index across the cities was during the afternoon – where some areas were as much as 13˚F hotter than the coolest areas.

The average afternoon heat index for Census tracts were analyzed to determine if there is a relationship with demographic characteristics (like identifying as a minority or living below the poverty line), historical housing policy, and current tree canopy.

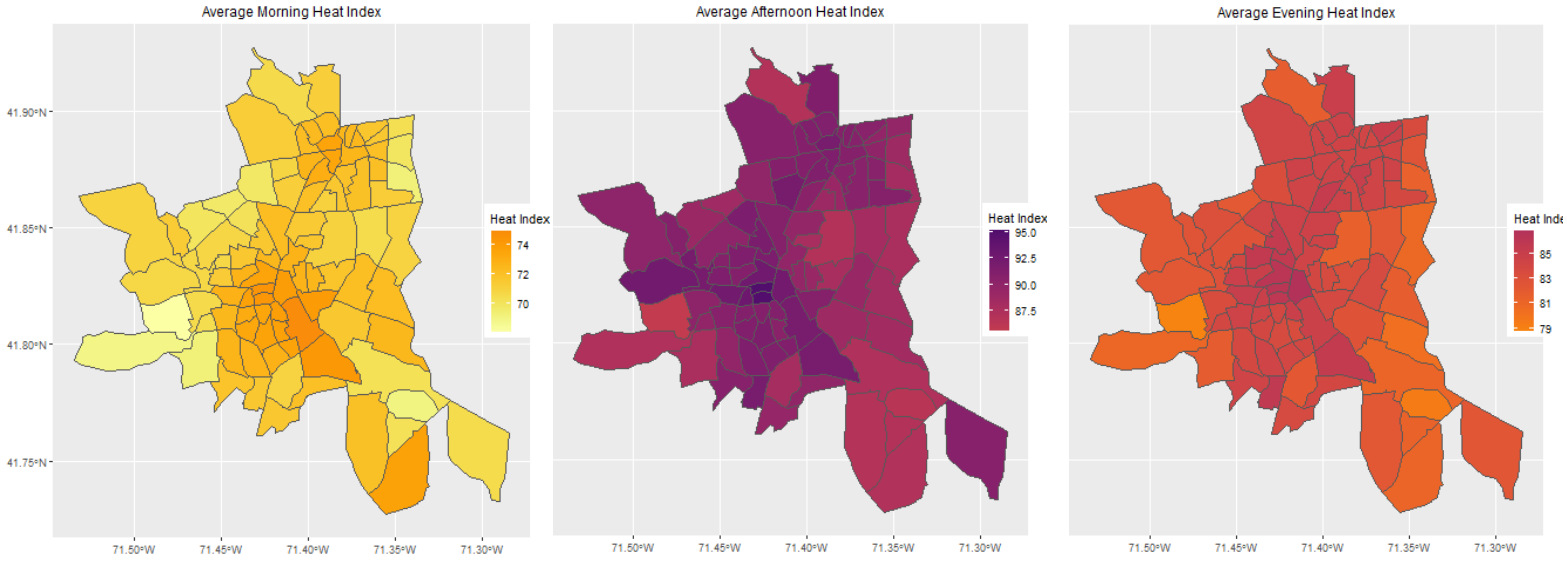
Statistical analysis of the average afternoon heat index demonstrated a statistically significant association between increase in percent poverty, poorer HOLC grade, and decreased percent tree canopy with *higher temperatures*. The model accounted for 69% of the variation in the data, indicating it provided a substantial but not complete explanation of the differences in average afternoon heat index. But certainly, a place to start in addressing these inequities.

On average for every 1% increase in tree canopy, the average heat index is reduced by almost 0.16˚F. While this may seem like a small change, it suggests that efforts to increase tree canopy can add up to meaningful improvements.

Table 1
Fully Realized Linear Regression Model Results
R^2: 0.689

Coefficient	Estimate	Standard Error	p-value
Intercept	90.004	0.55	**$2*10^{-16}$**
Percent Poverty	-0.064	0.016	**0.002**
HOLC Grade	0.953	0.0160	**0.02**
Percent Minority	0.007	0.006	0.443
Percent Tree Canopy	-0.157	0.046	**0.006**
Note: Bolding indicates statistical significance.			

Figure 1. Distribution of average heat index in Providence at morning (6-7 AM), afternoon (3-4 PM) and evening (7-8 PM). Midnight (12-1AM) is not pictured. Color for all images is set to the same, continuous scale.



This report was prepared by Caroline Hoffman, MPH, based on a project for her Master of Public Health, titled "Inside the Urban Melting Pot: Exploring the Effects of Redlining and Greenspace on Heat Distribution in Providence, Rhode Island."