A Community Science Campaign to Map Extreme Heat Locations in Worcester, Massachusetts

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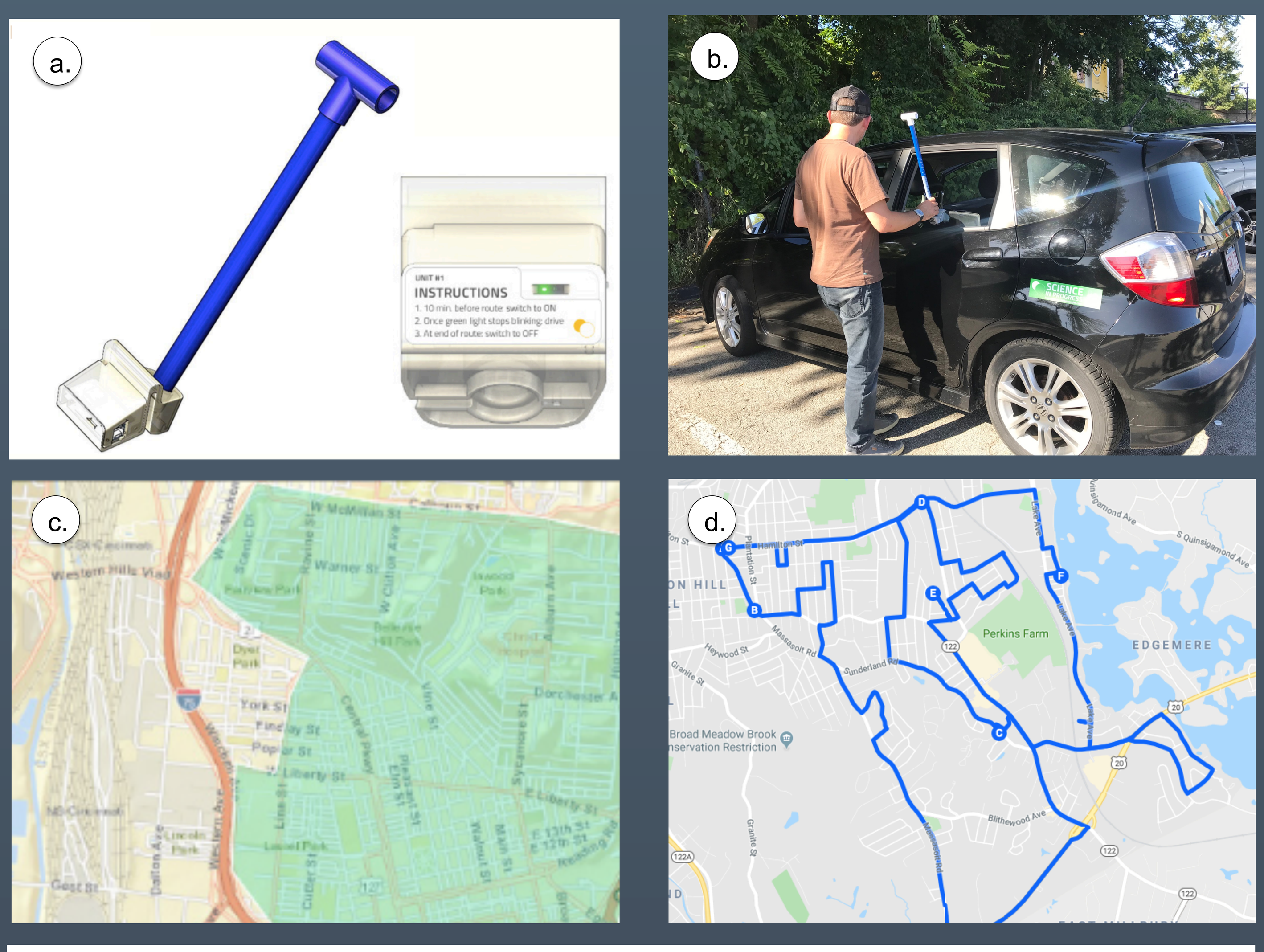
Overview

Communities face an unprecedented challenge of preparing for a global climate system marked by new extremes and uncertainties. Urban areas face threats from increasing intensity, duration, and frequency of climate-induced extreme weather events. Extreme heat events will exacerbate risks to residents in urban areas who are already exposed to higher temperatures due to the urban heat island effect. Temperature and humidity effects are distributed unevenly across the urban landscape and interact with social factors that make some residents more vulnerable to extreme heat events than others. This project examines the distributional effects of temperature and humidity in Worcester, MA, and engages communities in community science and awareness raising.[1] Ultimately, the spatial analytics will support efforts to help communities identify and prioritize strategies to mitigate or respond to extreme heat events.



a) Instrument used to collect heat and humidity data; b) Volunteer affixing instrument to a car; c) Example polygon created by leadership team to denote area one set of volunteers would cover; d) Example driving route

Community Science Data Collection

On 20 August, 2019, sixteen volunteers traversed eight study areas across Worcester, Massachusetts to collect 63,407 measurements of temperature and humidity. Eight polygons were identified covering the city and capturing the full range of land cover types. Driving routes were developed for each polygon. Traverses were conducted by mounting sensor equipment on cars and driving designated routes at 6am, 3pm, and 7pm on a hot, clear day. Sensors track GPS location, temperature, and humidity at one-second intervals through each one-hour traverse.[1]

This study framework has been conducted in multiple urban cities, including Baltimore, Boston/Cambridge, Portland, OR, and Washington, DC. For more information see https://capastrategies.com/capa-heat-watch/

Afternoon Traverse (3-4 pm)

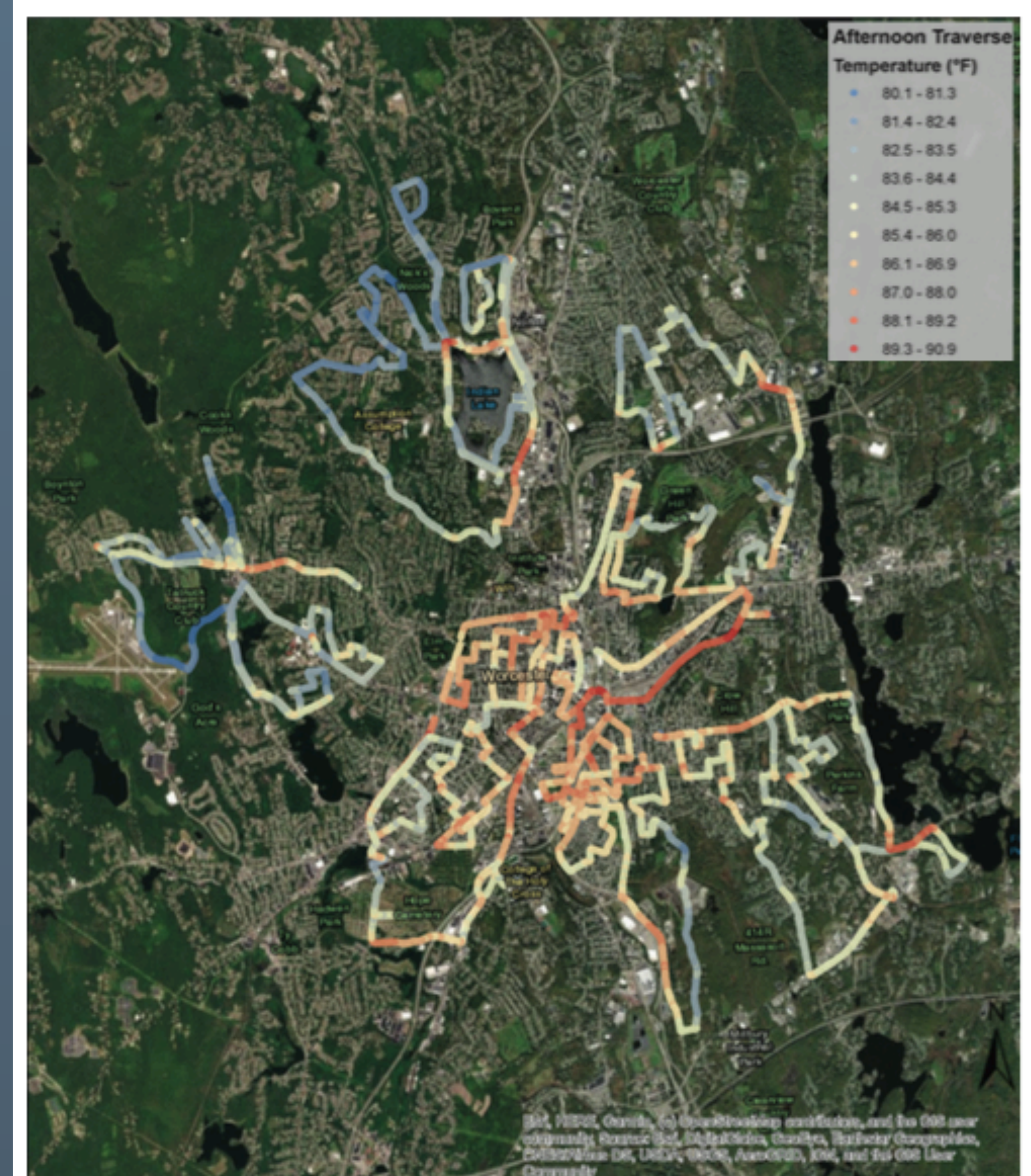


Figure 5: Worcester 3-4PM Traverse Point Temperature (°F)

Morning Area-Wide (6 - 7 am)

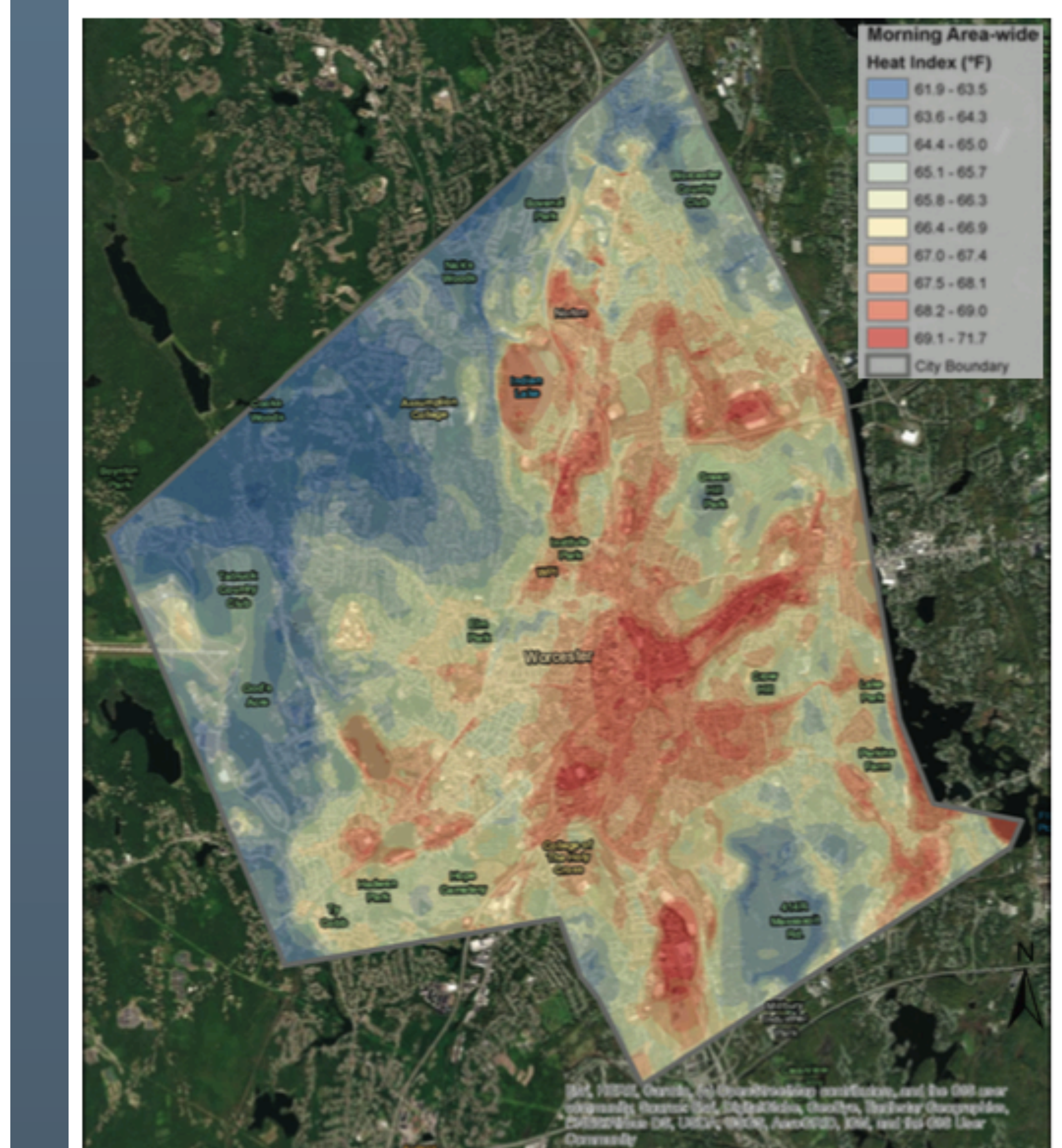


Figure 4: Worcester 6-7AM Area-Wide Heat Index (°F)

Afternoon Area-Wide (3-4 pm)

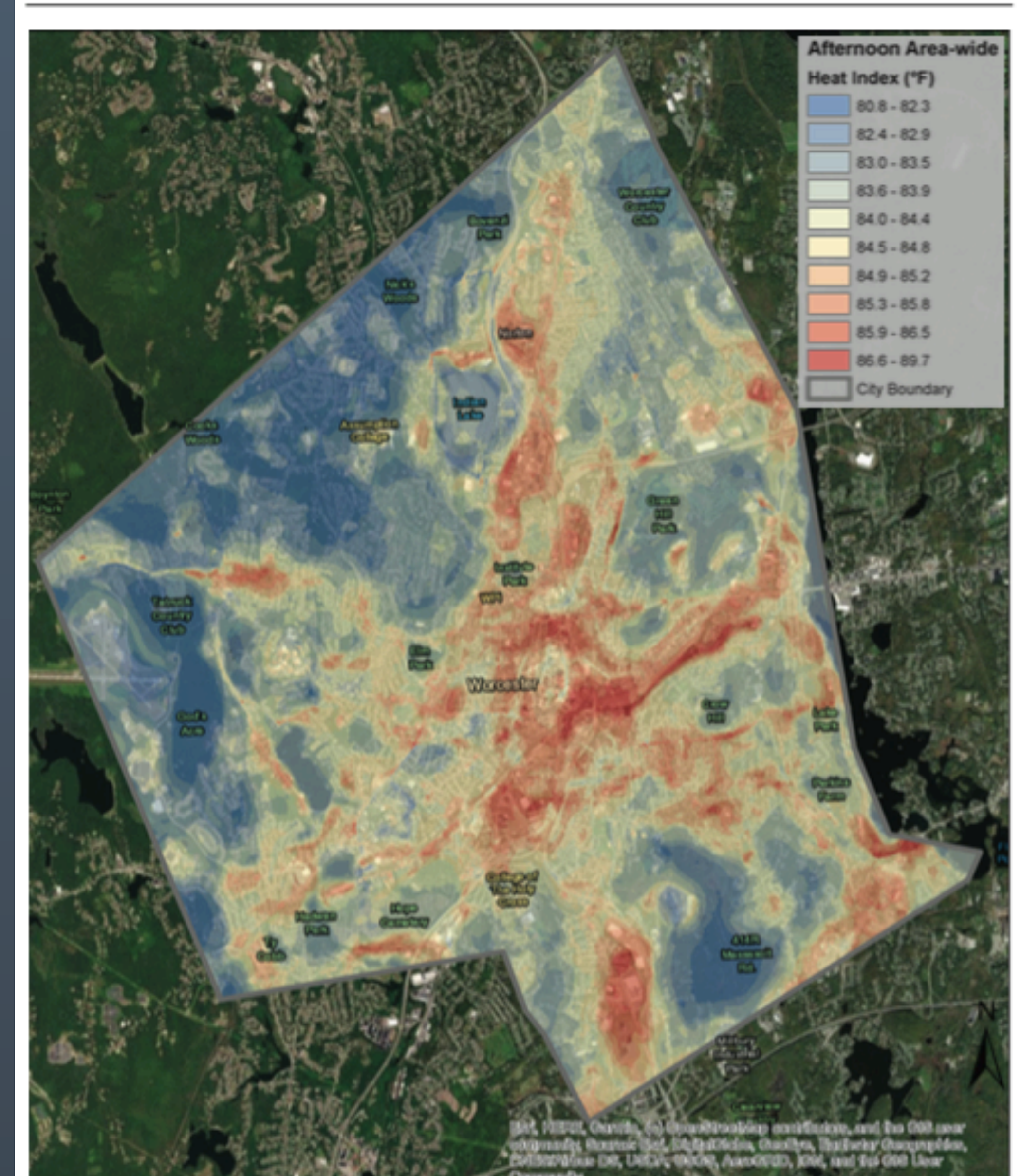


Figure 6: Worcester 3-4PM Area-Wide Heat Index (°F)

Evening Area-Wide (7 - 8 pm)

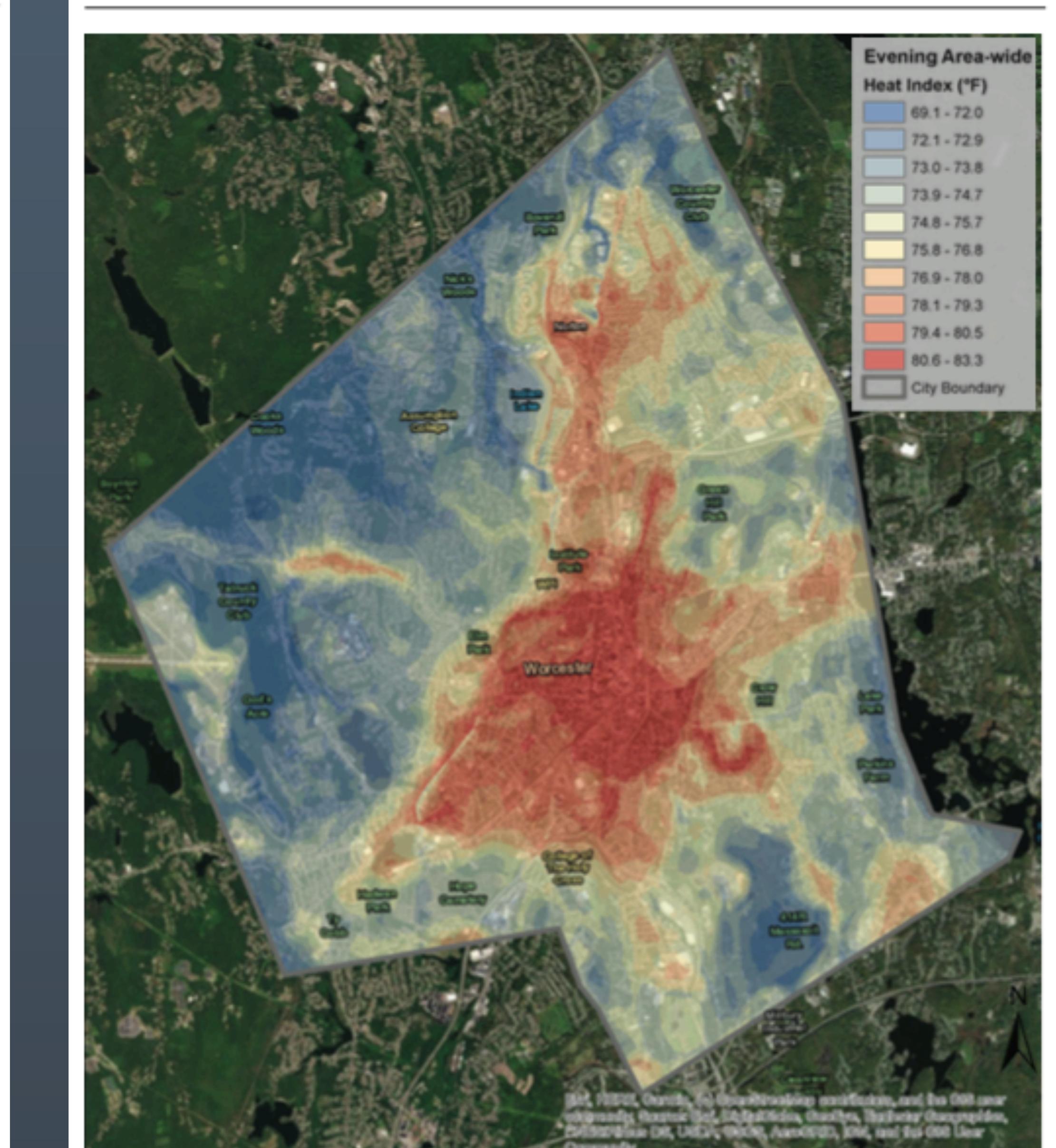


Figure 8: Worcester 7-8PM Area-Wide Heat Index (°F)

Modeling Methods

To model observed temperatures based on LULCs, spectral data from the Sentinel-2 satellite constellation was used. LULC attributes were described using two indices: Normalized Difference Vegetation Index (NDVI) and the Normalized Built-up Area Index (NBAI). To account for the distance-decay effect in relation to LULCs and their impacts on temperatures at a given location, each band in the analysis was transformed with a moving window average of varying spatial distances. Random Forest (RF) regression was used to build a predictive model between LULC indices and temperature.[2]

Findings

The maximum temperature recorded was 90.9 F (in the afternoon traverse), with a highest concurrent temperature differential of 16.9 F (in the evening traverse). The models show extreme heat areas in the afternoon in a confined downtown area and following the Shrewsbury Street corridor, an area of dense commercial activity and traffic. The urban heat island effect is most pronounced in the evening hours, with higher temperature differentials and a wide swath of the urban center retaining heat. The models show industrial areas heating up early in the day and releasing heat by evening.

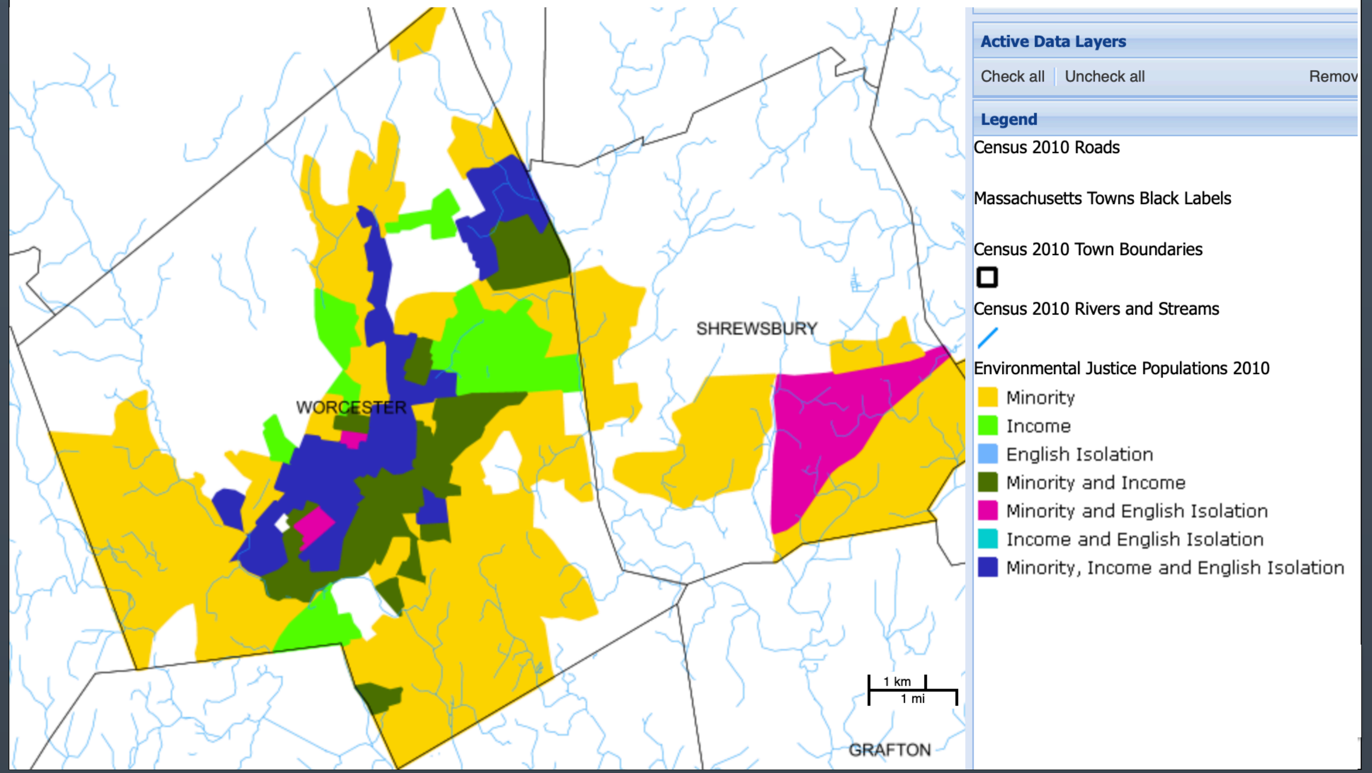
Summary Statistics

Traverse	Temperature (°F)			Heat Index (°F)			# Points
	MIN	MAX	MEAN	MIN	MAX	MEAN	
6 - 7 am	61.2	71.1	65.7	61.7	71.7	66.4	22,431
3 - 4 pm	80.1	90.9	85.0	80.7	90.2	84.3	18,509
7 - 8 pm	68.4	85.3	76.3	68.9	84.3	76.2	22,467

(Min/Max/Mean based on area-wide predictions)

Next Steps: Linking information about heat and vulnerability

Work with local public agencies and private organizations providing services to populations at heightened risk from extreme heat events: build knowledge and awareness, identify best practices, develop effective strategies for the local context.



Acknowledgements

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[1] CAPA Strategies. 2019. Heat Watch Report – Worcester Massachusetts.
[2] Shandas, V., J. Voelkel, J. Williams and J. Hoffman. 2019. Integrating Satellite and Ground Measurements for Predicting Locations of Extreme Urban Heat. Climate. 7(1).