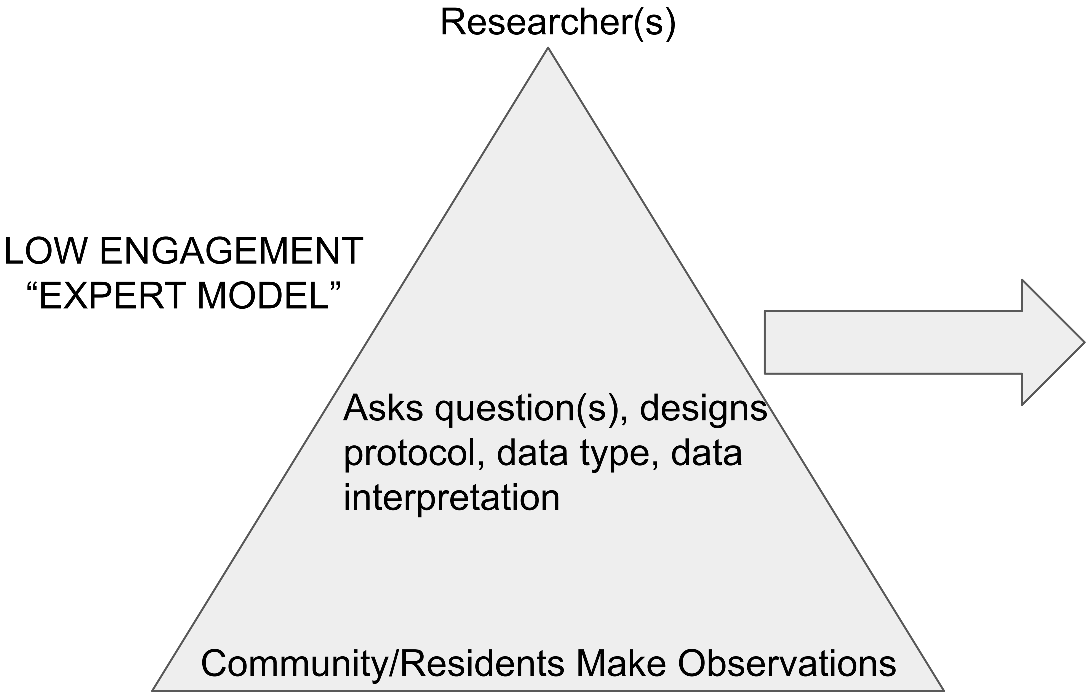
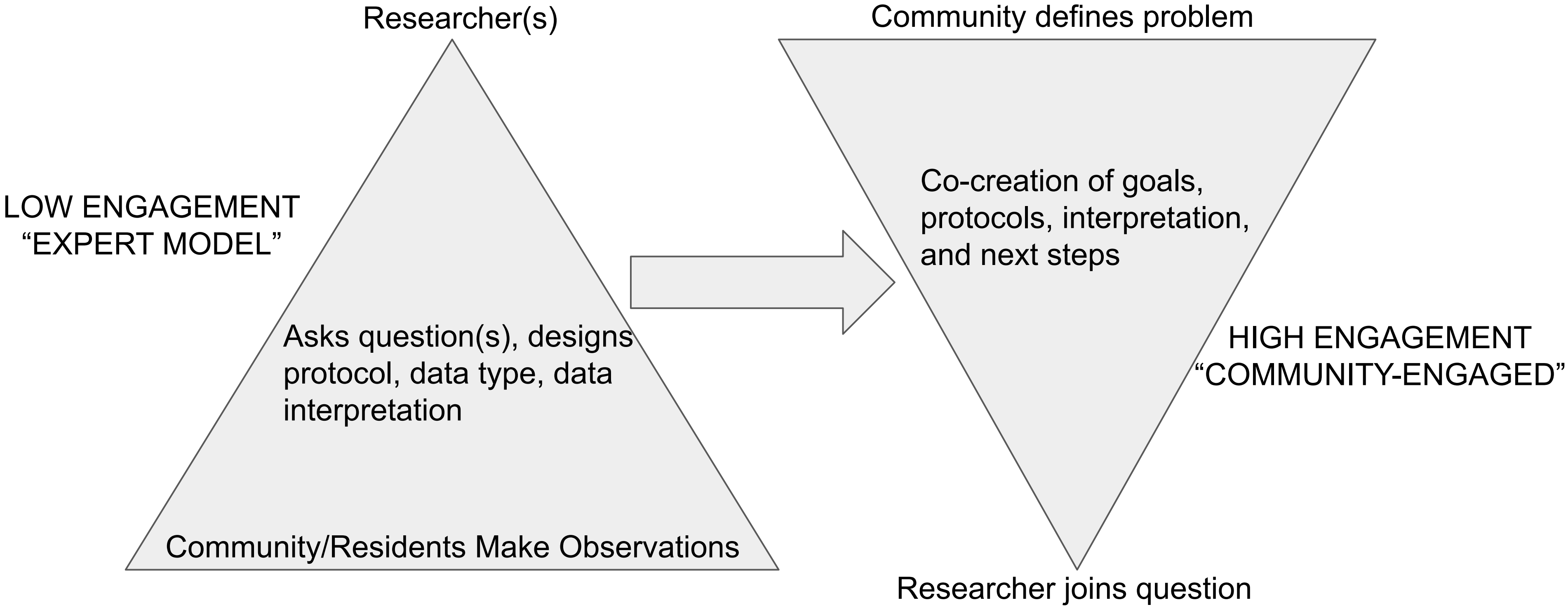
MC5 | Part 2 | Managing Heat Islands: Community Engagement & Action

Vivek Shandas, Portland State University
Jeremy S. Hoffman, Science Museum of Virginia
with David Sittenfeld, Museum of Science-Boston

Engaging public in science: **expert** vs. **community**



Engaging public in science: **expert** vs. **community**



Expert model projects: key aspects

Bonney et al., 2009

Expert model projects: key aspects

- Science is central
- Volunteers are additional, non-expert lab members
- Volunteers are not included in the development of the science question or the dissemination of results
- Relatively low engagement in this respect

Bonney et al., 2009

Expert model projects: key aspects

- Science is central
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- Volunteers are not included in the development of the science question or the dissemination of results
- Relatively low engagement in this respect

Box 1. Model for developing a citizen science project.

1. Choose a scientific question.
2. Form a scientist/educator/technologist/evaluator team.
3. Develop, test, and refine protocols, data forms, and educational support materials.
4. Recruit participants.
5. Train participants.
6. Accept, edit, and display data.
7. Analyze and interpret data.
8. Disseminate results.
9. Measure outcomes.

Bonney et al., 2009

Community-engaged projects: key aspects

THRIVING EARTH EXCHANGE

Communities & Scientists Working Together

Community-engaged projects: key aspects

- Highly place-based, community involved, honors local knowledge
- Researchers seen as extension of community’s needs
- Focused on justice, community empowerment, and improving governance
- Community-driven question creation

THRIVING EARTH EXCHANGE
Communities & Scientists Working Together

Expert model project example: **eBird**

ebird.org

Expert model project example: **eBird**

- Volunteers train and make observations of birds in the area
- Data are uploaded to a database
- Researchers can leverage data in studies (dozens published in 2020 alone!)
- Extremely popular!

ebird.org

Community-engaged project example: **Ixchel & AGU**

https://thrivingearthexchange.org/project/ciceroberwyn-il/

Community-engaged project example: **Ixchel & AGU**

- "Assessing Flooding and Hydrodynamics for Community Revitalization"
- Stormwater and sewage regularly backs up into houses and basements.
- **Ixchel** is a grassroots organization that brings together and empowers Cicero and Berwyn residents to address and dismantle structural racism to ensure access to equitable education and environmental justice.
- Dr. Joseph Schulenberg, Civil and Materials Engineering Department at University of Illinois-Chicago

https://thrivingearthexchange.org/project/ciceroberwyn-il/

Community engagement as a spectrum

Level of Engagement

Community engagement as a spectrum

Level of Engagement

LOW ⟷ HIGH

“EXPERT MODEL”

“COMMUNITY-ENGAGED MODEL”

Measuring Urban Heat: Three Methods

Satellite Based

Ground Stations

Mobile Traverses

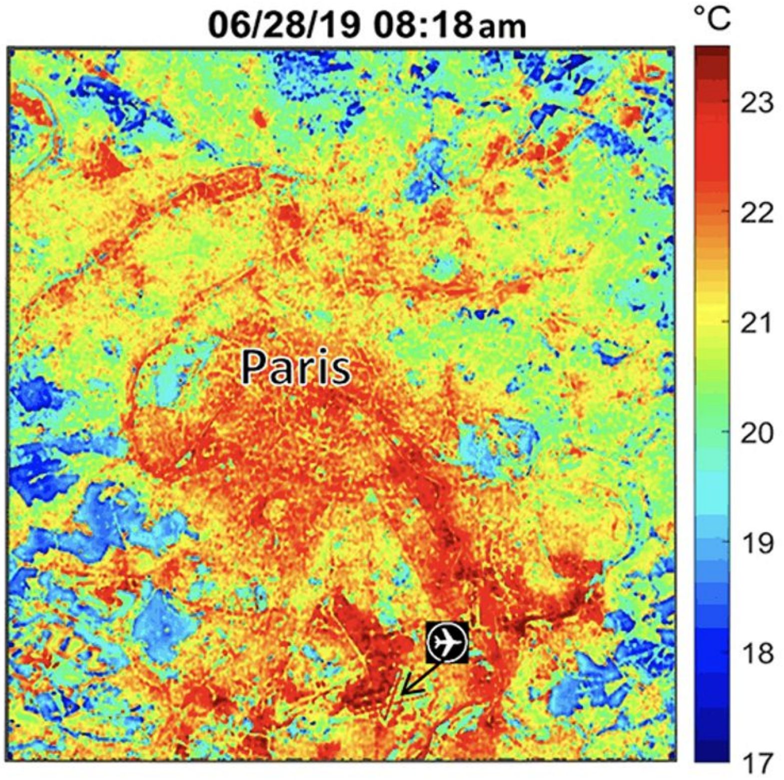
Satellite Derived Heat Surfaces

Strengths

- Freely available across the world
- Seasonal availability
- Intra-urban variation detectable
- Extensive literature and research
- Potential connections to land use

Weaknesses

- Exaggerates temperature ranges
- Coarse pixel size (30m, 90m, 1km…)
- Rooftops as opposed to street-level
- Discrete differences between land covers
- Translation to policy remains unclear



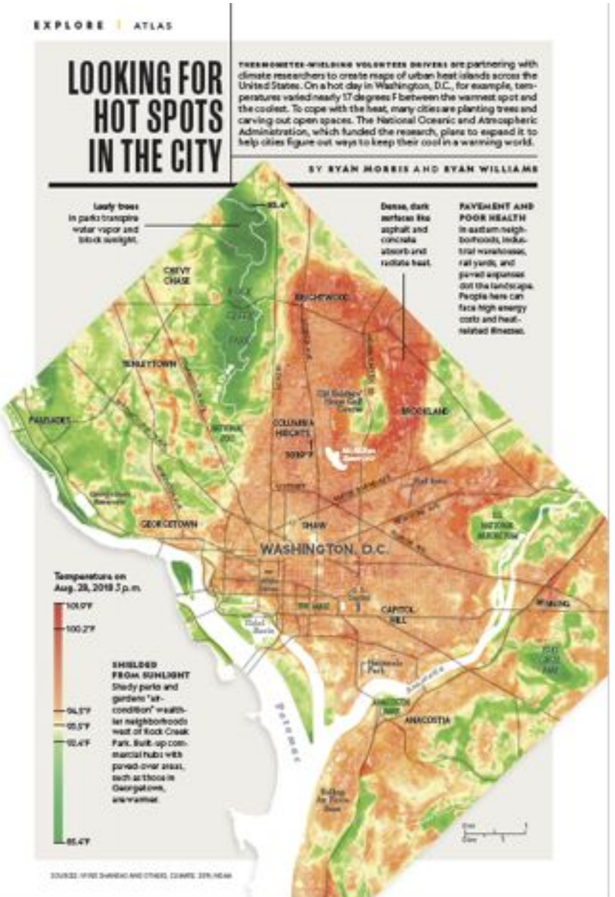
Near-Surface Urban Heat Data

Strengths

- Engages community in their place
- Established ‘civic legitimacy’ of scientific process and results
- High resolution outputs (1m, 10m)
- Diurnal profile of air temperatures
- Policy applications are evident

Weaknesses

- Coordination of local community groups requires time and strategy
- Not free due to engagement and analysis
- Seasonal differences not [yet] available
- Clouds or rain can create delays
- Generalizable models are still forthcoming



Urban heat data as a spectrum

Robustness of Data

LOW HIGH

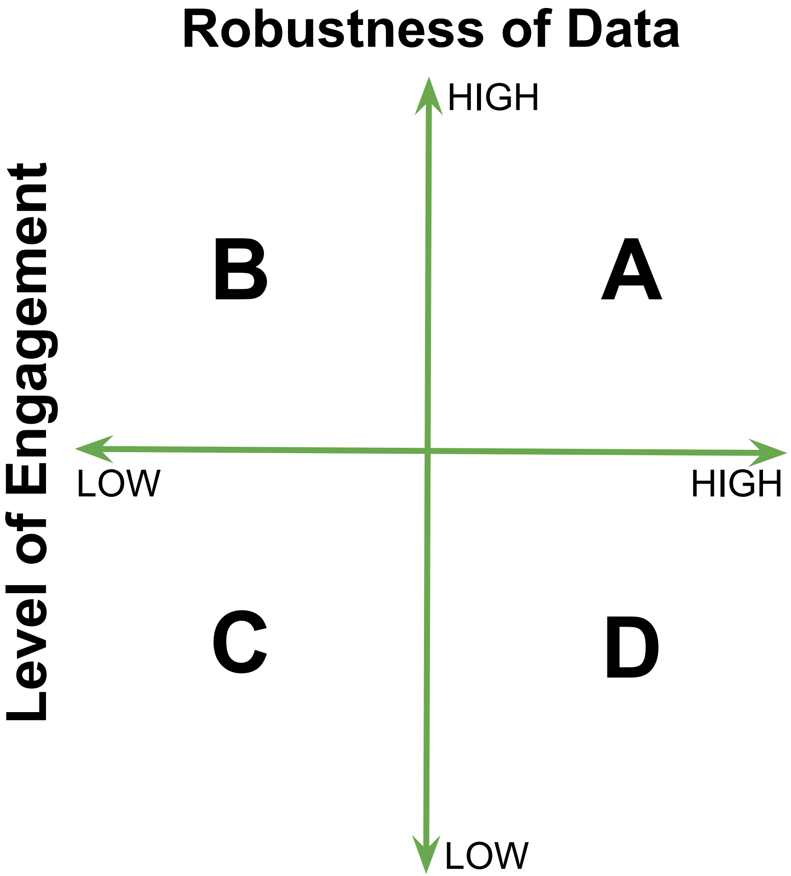
Integrating Urban Heat Data and Community Engagement

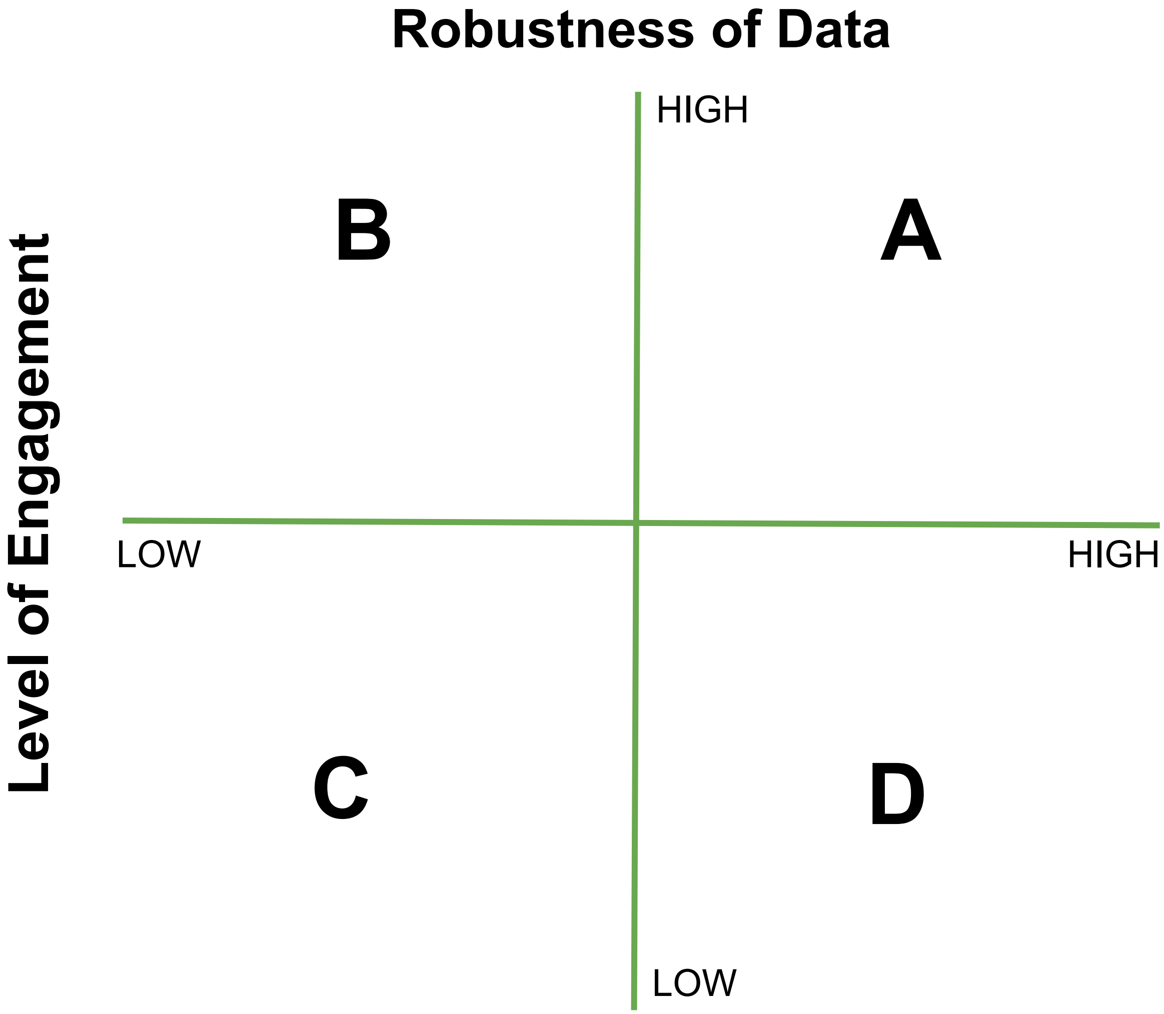
A: People, Place, & Perspective: Consensus on goals, problems, and effective implementation

B: Expert Applications: Specialized knowledge without stakeholder involvement/support

C: Status Quo: Confrontational debate and no improvements

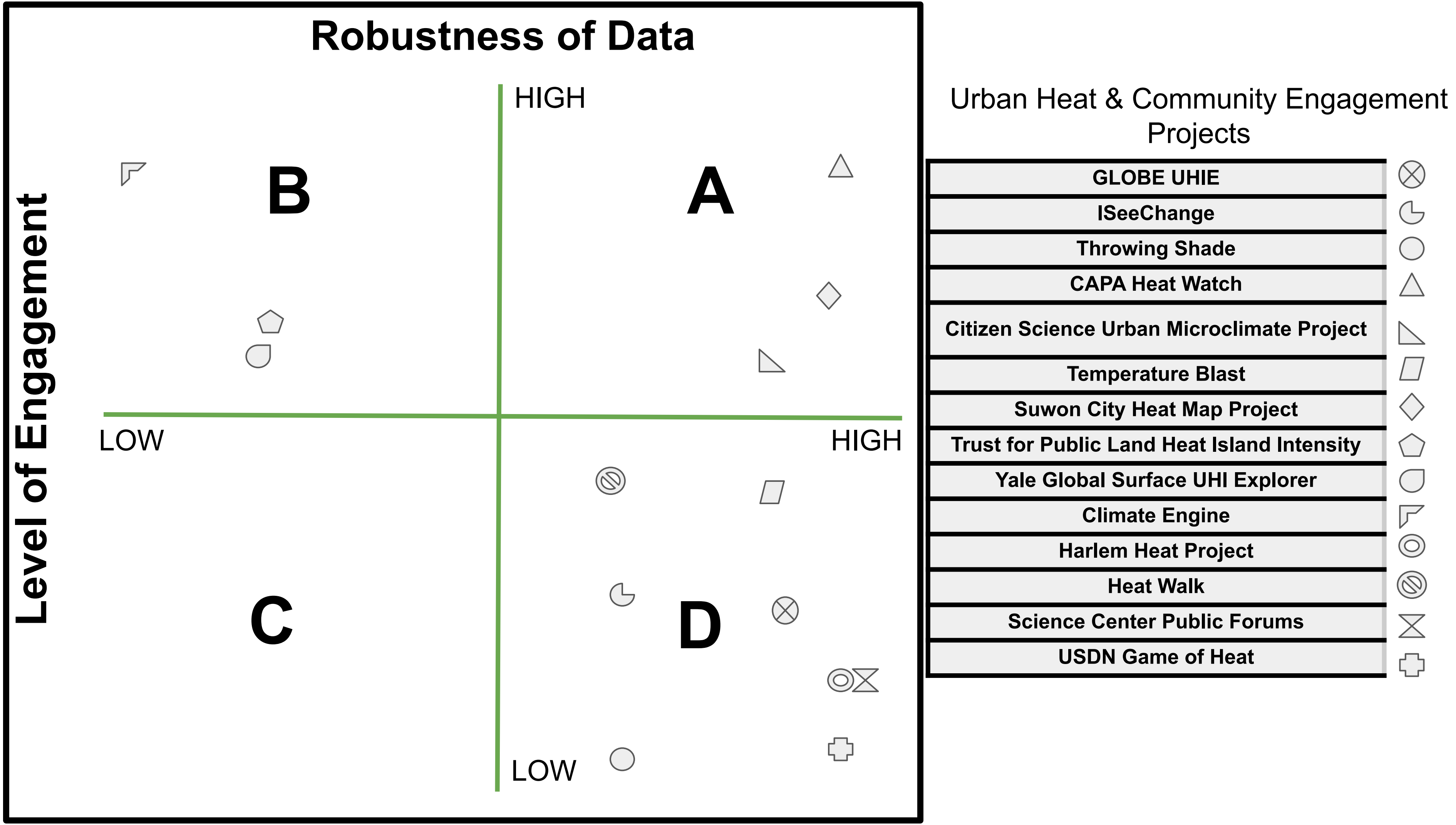
D: Mediated Discussion: Consensus on goals and problems with no help on how to achieve





Urban Heat & Community Engagement Projects

- **GLOBE UHIE**
- **ISeeChange**
- **Throwing Shade**
- **CAPA Heat Watch**
- **Citizen Science Urban Microclimate Project**
- **Temperature Blast**
- **Suwon City Heat Map Project**
- **Trust for Public Land Heat Island Intensity**
- **Yale Global Surface UHI Explorer**
- **Climate Engine**
- **Harlem Heat Project**
- **Heat Walk**
- **Science Center Public Forums**
- **USDN Game of Heat**


Robustness of Data
Level of Engagement
HIGH
LOW
HIGH
LOW
A
B
C
D
Urban Heat & Community Engagement Projects
GLOBE UHIE
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Throwing Shade
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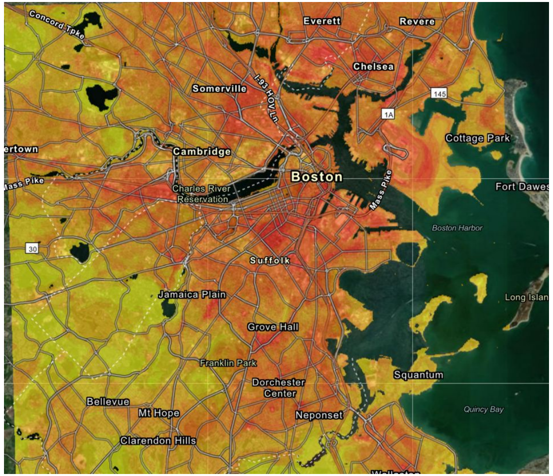
Climate Engine
Harlem Heat Project
Heat Walk
Science Center Public Forums
USDN Game of Heat

Wicked Hot Boston:

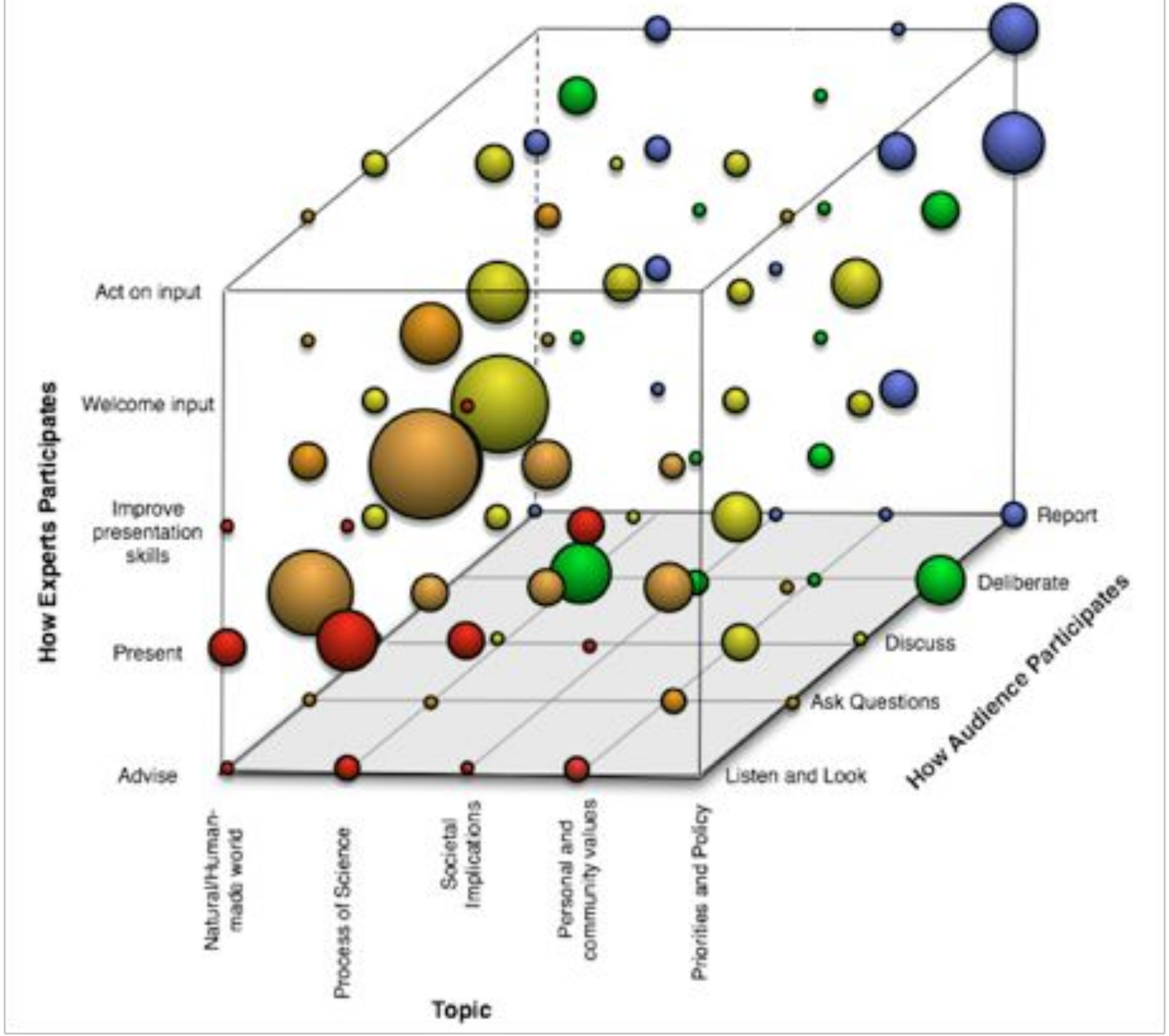
Community Science for Building Extreme Heat Resilience and Addressing Public Health Disparities

WICKED HOT BOSTON



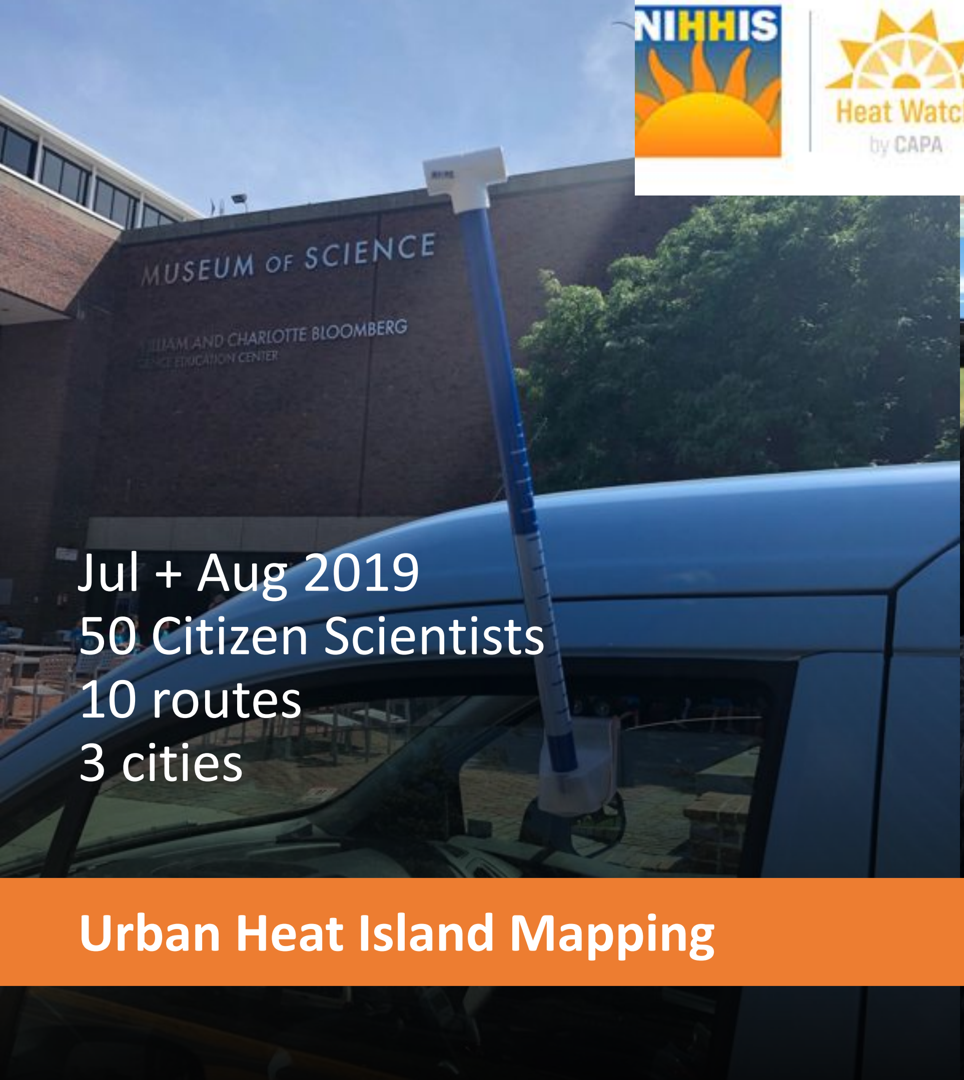
David Sittenfeld
Museum of Science, Boston

NOAA — ISEECHANGE — Northeastern University Marine Science Center — Museum of Science. — scistarter People-powered science.



Dimensions of Public Engagement with Science, NSF DRL 1010831, L. Bell 2011

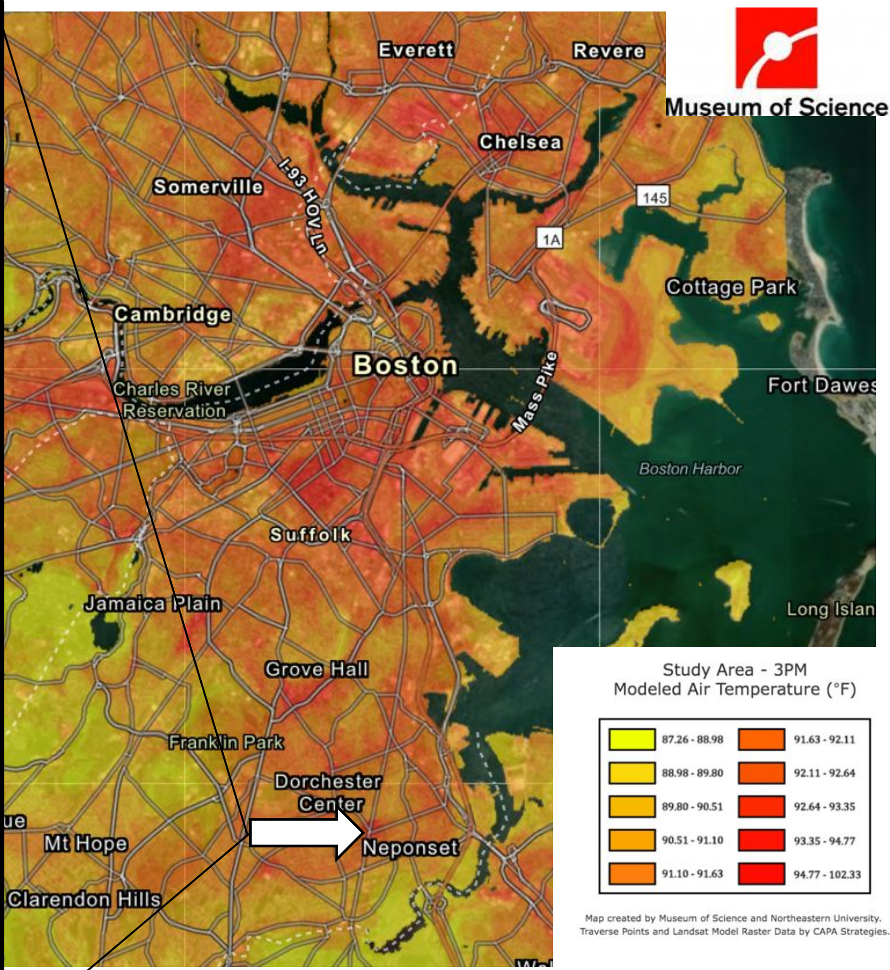
NIHHIS | Heat Watch by CAPA | CPO Climate Program Office — Advancing scientific understanding of climate, improving society's ability to plan and respond



Jul + Aug 2019
50 Citizen Scientists
10 routes
3 cities

Urban Heat Island Mapping

Museum of Science



Ashmont, 102.6 degrees F

Our cat's f

WICKED HOT BOSTON

eat the heat

I SEE CHANGE

scistarter
People-powered science.

Fershid Aspi

Brookline, Massachusetts, US Jul 30, 2019

97.21 °F

Barren intersection in Chinatown. Hot spot to wait at the signal.

79.3°F

Nancy Smith

Boston, Massachusetts, US Jul 17, 2019

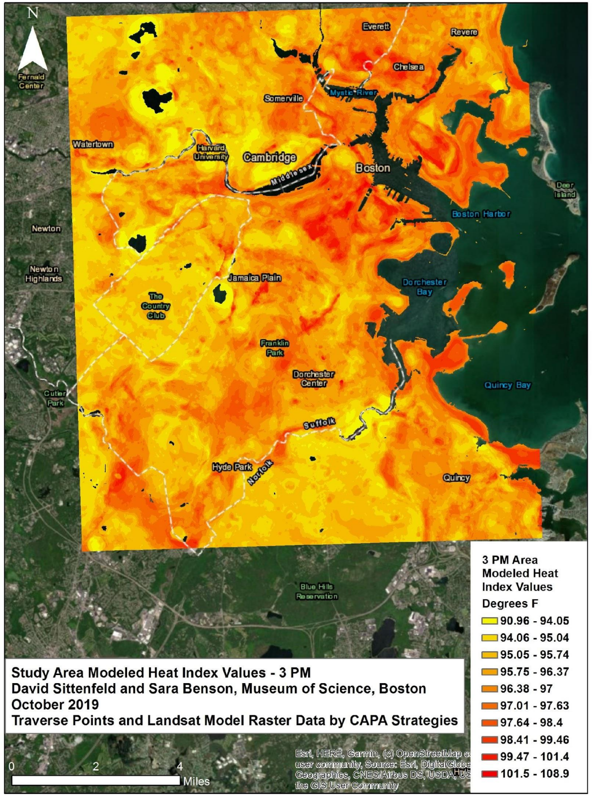
96.59 °F

Extreme Heat

Seating in my car in Roxbury and driving imto Dorchester

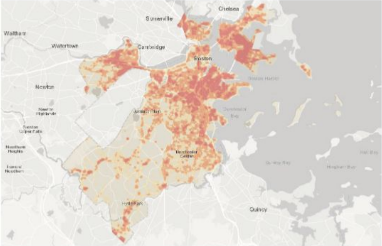

Brookline Spatially Modeled Heat Index
7pm-8pm
CAPSULE A


SECTION 1: CONSIDER STAKEHOLDER PERSPECTIVES
15
MINUTES


N
Fernald Center
Everett
Revere
Chelsea
Mystic River
Somerville
Watertown
Harvard University
Cambridge
Middlesex
Boston
Deer Island
Boston Harbor
Newton
Newton Highlands
Jamaica Plain
The Country Club
Dorchester Bay
Franklin Park
Dorchester Center
Quincy Bay
Cutler Park
Suffolk
Hyde Park
Norfolk
Quincy
Blue Hills Reservation
3 PM Area Modeled Heat Index Values
Degrees F
90.96 - 94.05
94.06 - 95.04
95.05 - 95.74
95.75 - 96.37
96.38 - 97
97.01 - 97.63
97.64 - 98.4
98.41 - 99.46
99.47 - 101.4
101.5 - 108.9
Study Area Modeled Heat Index Values - 3 PM
David Sittenfeld and Sara Benson, Museum of Science, Boston
October 2019
Traverse Points and Landsat Model Raster Data by CAPA Strategies
0
2
4
Miles

CITIZEN SCIENCE IN BOSTON

In the summer of 2019, the Museum of Science led a citizen science project to map the air temperatures experienced by residents in the summer. Dark, dense materials like asphalt in cities absorb heat during the day and release it back into the air at night, a phenomenon known as the Urban Heat Island effect. Hot summer nights can exacerbate the health effects of daytime exposure to high temperatures by disrupting sleep and increasing stress and dehydration. With the help of the Museum of Science, volunteers attached temperature sensors to their cars and bikes to collect data in Boston, Cambridge and Brookline. Partner scientists are using the data to create a map of temperatures that residents experience in their neighborhoods.



Source: Climate Ready Boston Map Explorer

GO BOSTON 2030

Reducing transportation emissions

Go Boston 2030 is the City's long-term plan to transform Boston's transportation system. In accordance with the 2014 Climate Action Plan Update, Go Boston 2030 adopted climate responsiveness as a guiding principle and set goals to make Boston a city where all residents have better and more equitable travel choices, where efficient transportation networks foster economic opportunity, and where the City has taken steps to prepare for climate change.

By emphasizing accessibility, safety and reliability, Go Boston 2030 will make it easier and more attractive for Bostonians to go car-free. Actions to shift travelers from driving alone to choosing shared and active transportation modes will make travel more efficient, reduce total vehicle miles traveled in Boston, and help decrease our transportation carbon emissions.

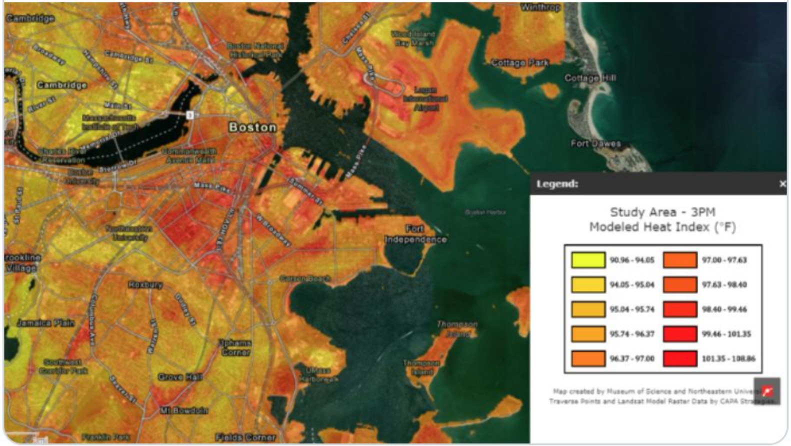
Since the plan's adoption, the City has invested in 30 new staff positions and started implementing many of the projects it laid out, including new bus lanes along priority corridors, mobility hubs, and key bike infrastructure connections.

Boston Environment @BostonEnviro

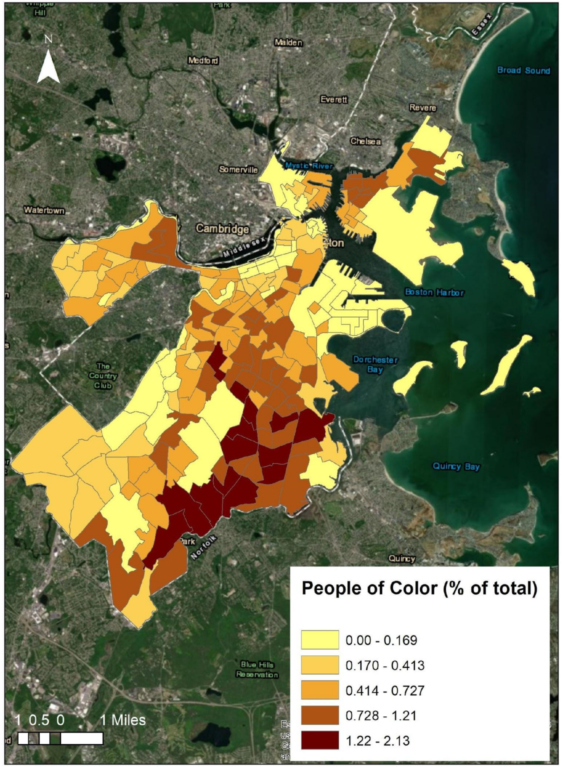
As the #climate continues to change, #Boston will see extremely hot days. To better understand where in @CityOfBoston we will see the hottest temps, we partnered with @museumofscience this summer. From @WBUR this am: wbur.org/earthwhile/201... #climateresilience #wickedhot

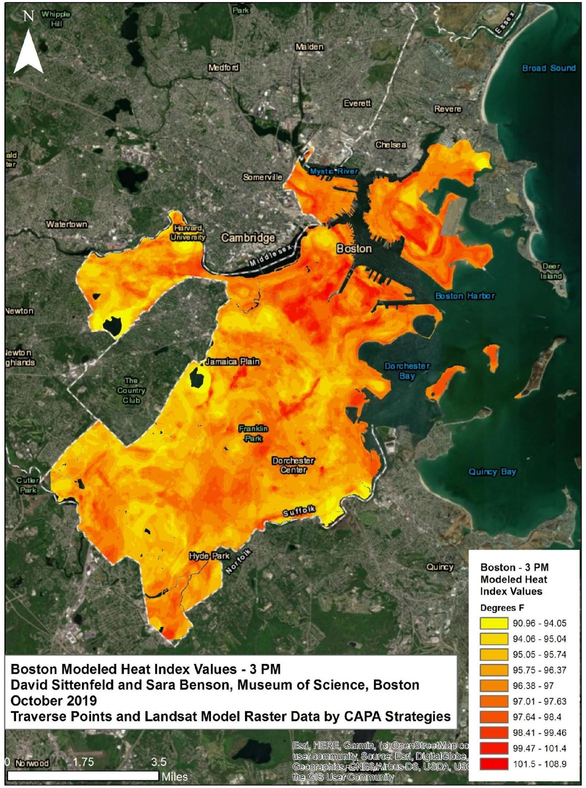
Earthwhile @EarthwhileWBUR · Nov 23

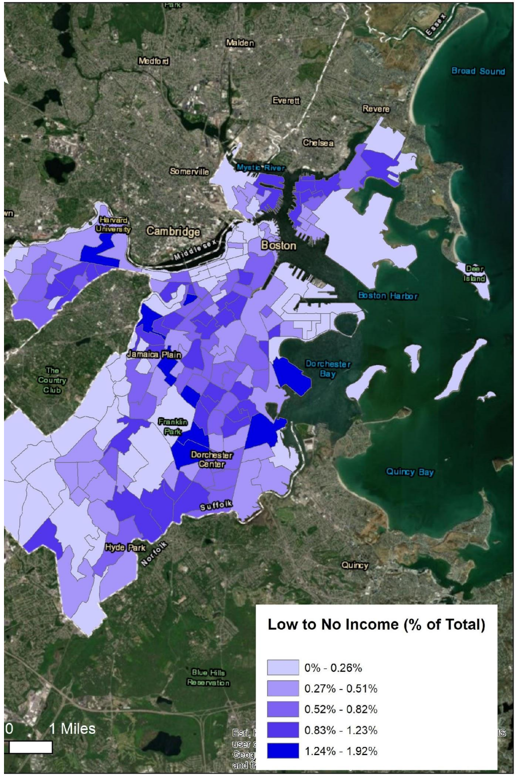
Coming Monday on @MorningEdition, @MiriamWasser looks at a novel @museumofscience project to map Boston's hot spots, block by block. The results may surprise you. Listen Monday 5-9 am!



10:13 AM · Nov 25, 2019 · Twitter Web App

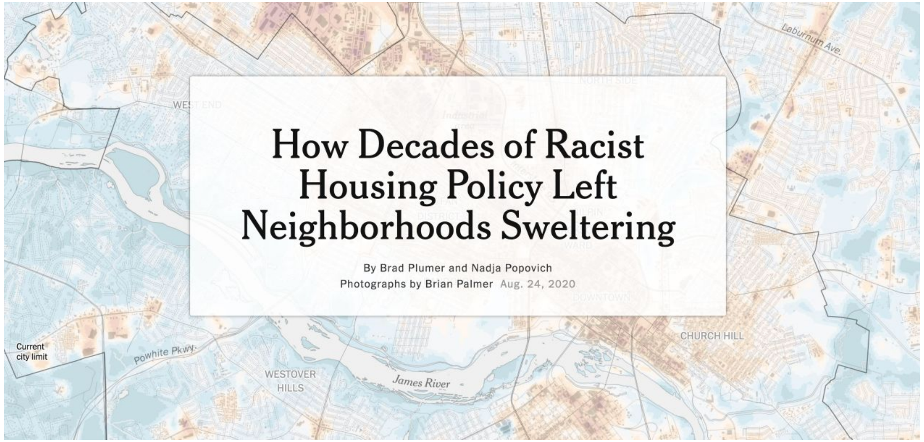






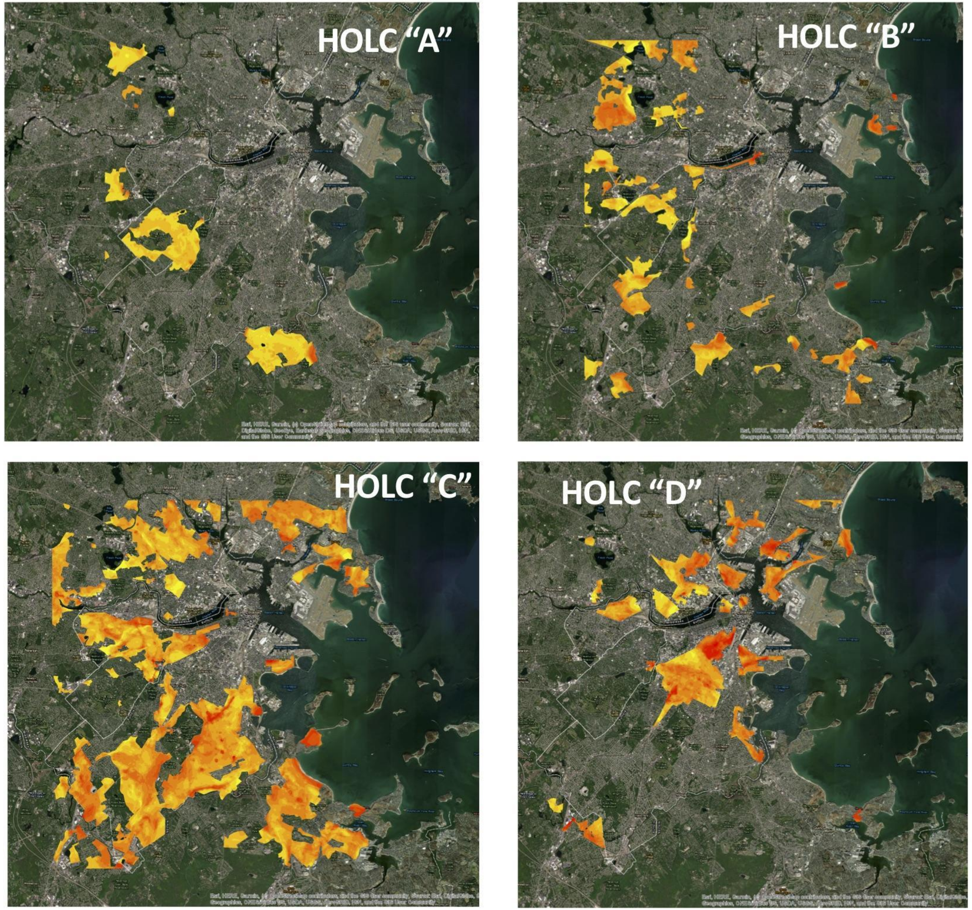
Socioeconomic data from Climate Ready Boston data archive, S. Atyia Martin, 2015 (Mapped by D. Sittenfeld)

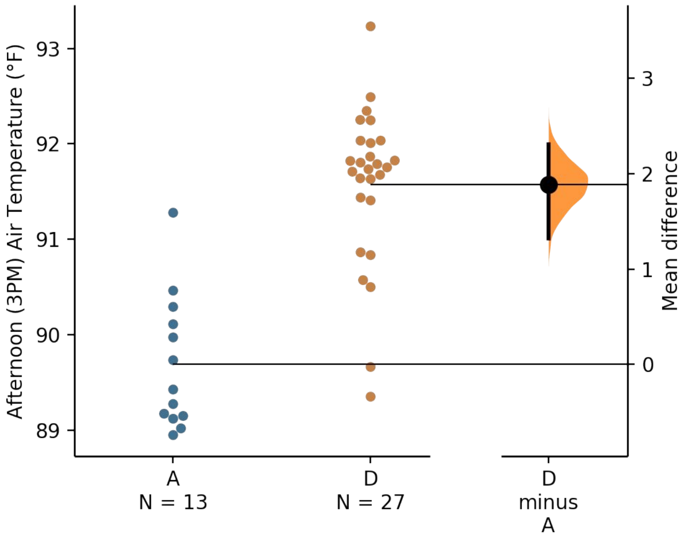
The New York Times

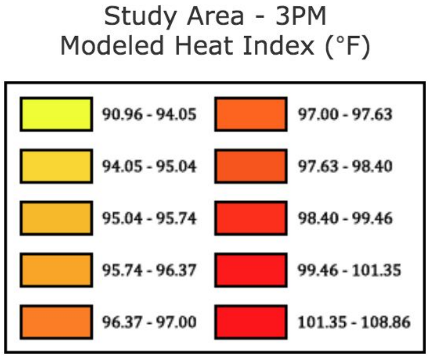


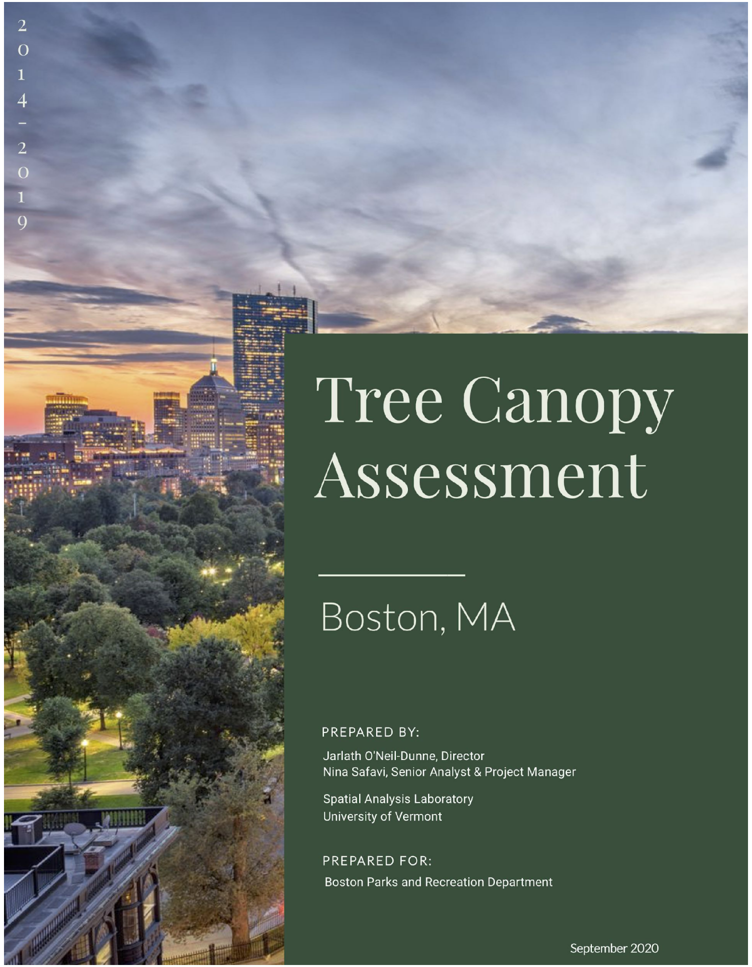
The Effects of Historical Housing Policies on Resident Exposure to Intra-Urban Heat: A Study of 108 US Urban Areas

Jeremy S. Hoffman, Vivek Shandas, and Nicholas Pendleton, *Climate* 2020, 8(1)


HOLC "A"
HOLC "B"
HOLC "C"
HOLC "D"


Afternoon (3PM) Air Temperature (°F)
93
92
91
90
89
Mean difference
3
2
1
0
A
N = 13
D
N = 27
D
minus
A


Study Area - 3PM
Modeled Heat Index (°F)
90.96 - 94.05
94.05 - 95.04
95.04 - 95.74
95.74 - 96.37
96.37 - 97.00
97.00 - 97.63
97.63 - 98.40
98.40 - 99.46
99.46 - 101.35
101.35 - 108.86


2014–2019

Tree Canopy Assessment

Boston, MA

PREPARED BY:

Jarlath O'Neil-Dunne, Director
Nina Safavi, Senior Analyst & Project Manager

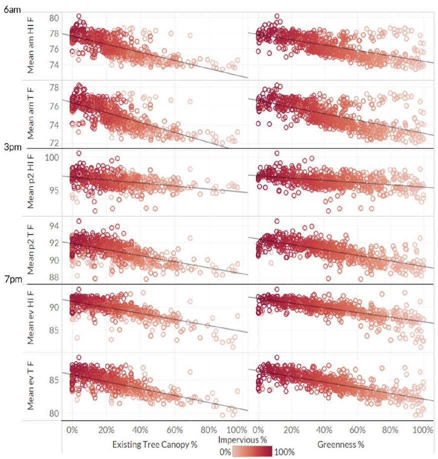
Spatial Analysis Laboratory
University of Vermont

PREPARED FOR:

Boston Parks and Recreation Department

September 2020

Heat Island Effect



Tree canopy can help mitigate the heat island effect, particularly in densely urbanized and industrialized areas. In Boston, there is a statistically significant negative relationship between tree canopy, "Greenness," and air temperature, indicating that areas with higher tree canopy and "Greenness" help reduce the urban heat island effect, as shown in Figure 22. The red color ramp corresponds to the percent impervious. Darker reds indicate higher amounts of impervious. The urban core and north-eastern parts of Boston, where there is low tree canopy, experience have the greatest urban heat island effect.

Figure 22: Relationship between the 2019 Existing Tree Canopy percentage (left), Greenness percentage (right) and mean air temperature (T) in Fahrenheit and Heat Index (HI). Temperature data is from the Wicked Hot Boston Project, researchers at the Museum of Science, Boston and the Helmuth Lab at Northeastern University. Temperature data was collected during hour long periods at 6am, 3pm and 7pm on 7/30/19 for East Boston and 7/29/19 for the rest of Boston.

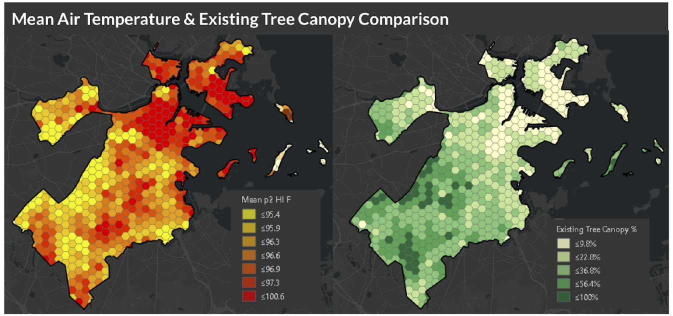


Figure 23: Heat Island metrics are summarized by 25-acre hexagons. 2019 Existing Tree Canopy (right) and Mean heat Index measured in Fahrenheit (left) for 3pm show that areas with low tree canopy experience increased heat.

University of Vermont Spatial Analysis Lab/City of Boston Parks and Recreation

University of Vermont Spatial Analysis Lab

Forest

primary concept: shifting

New England's forests are living climate records. By investigating a cross section from a local Maple tree, visitors will learn to identify tree ring characteristics that document the climate and soil conditions over decades or even centuries. Shorter seasonal cycles are easily recognizable, but there are also larger shifts in the dominant forest species across the region, such as the loss of Eastern hemlock trees as temperatures rise.

Urban

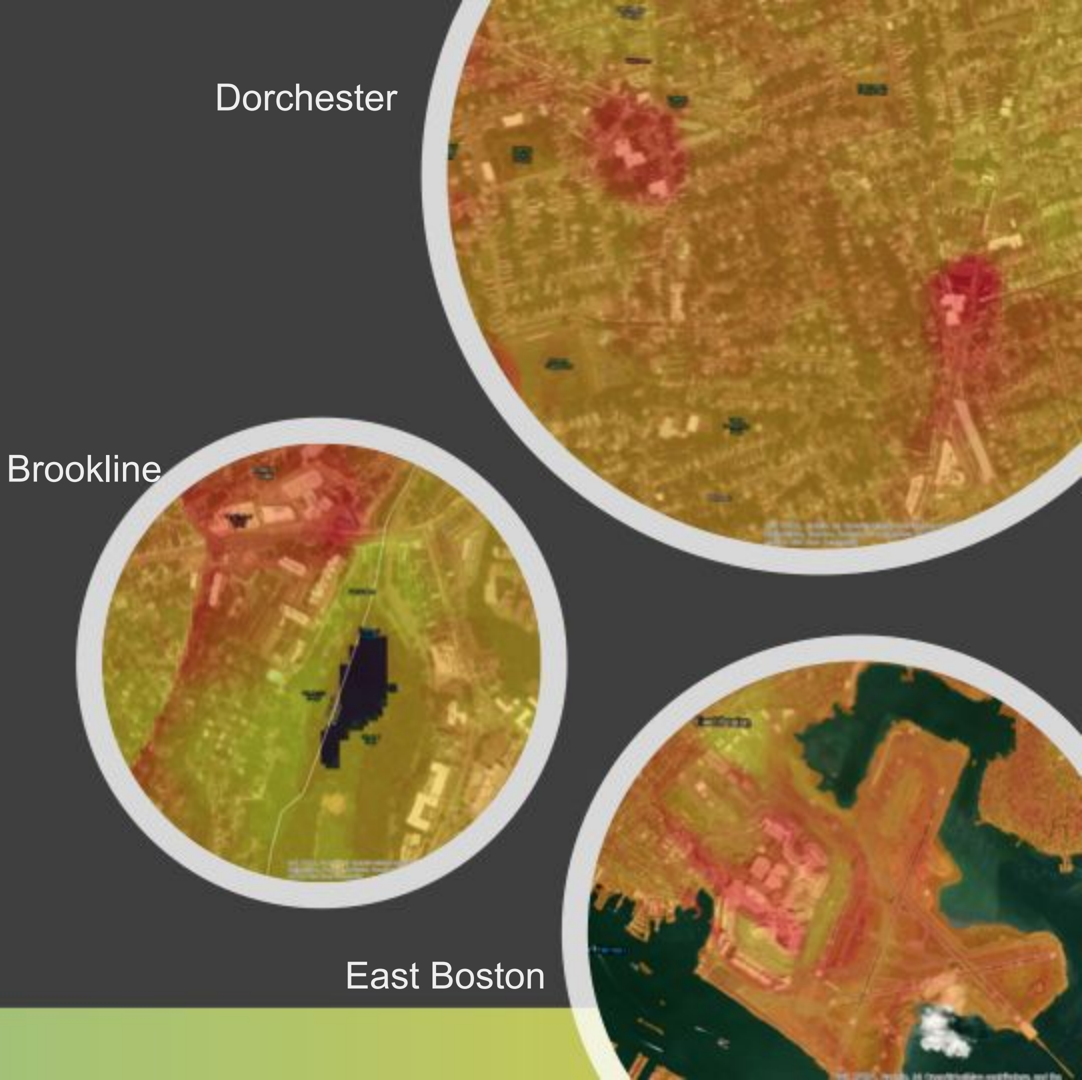
primary concept: adapting

As humans continue to develop more land and encroach on wildlife habitats, animals are beginning to adapt their behaviors and lifestyles to be able to survive in urban areas. Visitors will have up-close encounters with some of the Museum's animal ambassadors, like the American kestrel, and learn how these opportunists take advantage of human-made structures as nesting sites.

Coastal

primary concept: moving

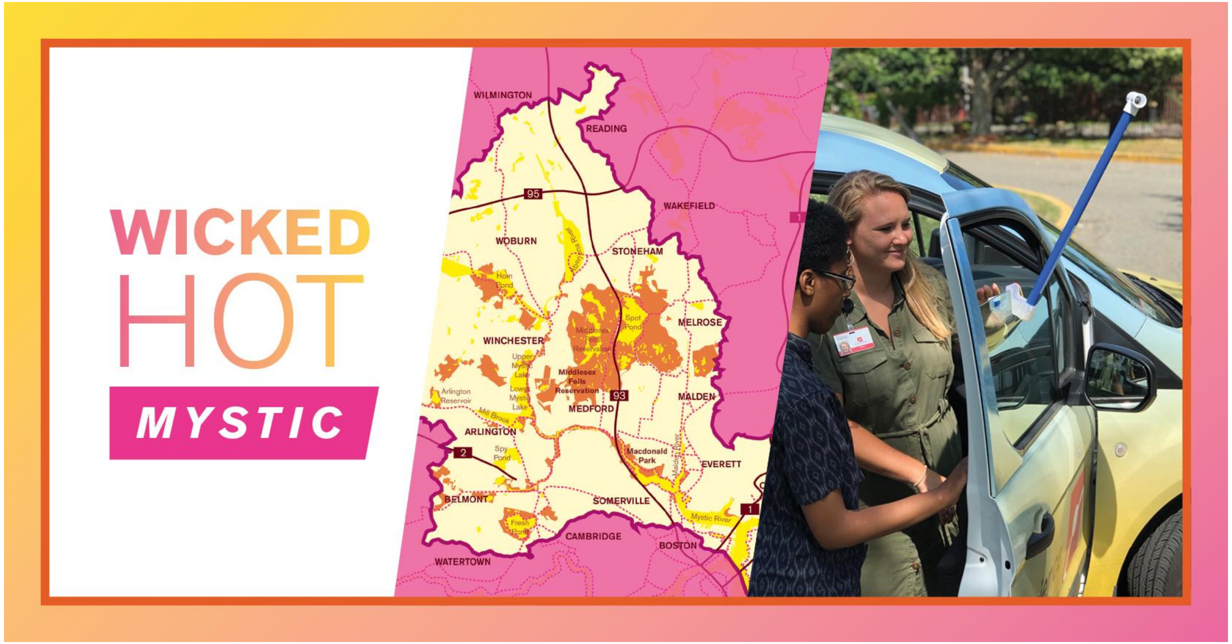
As water temperatures, acidification, and sea level rise continue to increase, the habitat ranges of many local marine animals are moving. Immersive projection interactives will allow visitors to explore how species such as the iconic New England lobster, North Atlantic right whale, and piping plovers are being forced to move to more favorable environments as features change.



Mystic River Needs To Cool Off

The Wicked Hot Mystic Project, led by Arlington, will combat extreme heat in parts of the river.

http://www.mos.org/wickedhot



28 Science-to-Civics campaigns

In 2018, NOAA awarded the Museum of Science and its partners a 3-year grant to work with science centers across the U.S. **to engage 28 science centers working with community and civic partners** in projects connecting community science and deliberation to **build community engagement** and **inform local resilience planning** regarding four hazards:

- Heat Waves
- Sea Level Rise
- Extreme Precipitation
- Drought

The Science-to-Civics Process:

Agenda Setting
- Selection of Locally Relevant Citizen Science Project
- Participant Recruitment for Citizen Science Activities
- Introduce Hazard & Resilience Planning Context
- Participant Training
- Data Collection by Citizen Volunteers

Decision-Making
- Convene Public Forum with Diverse Public Audience
- Presentation/discussion of citizen-collected data
- Public deliberation using hazard module

Policy-Forming
- Discussion of locally focused resilience planning question
- Formulate Action Plans and Recommendations
- Call to Action/Sustained Engagement

Our Partners:

NOAA · Northeastern University Marine Science Center · SciStarter · NISE Network · Consortium for Science, Policy & Outcomes at Arizona State University · I SEE CHANGE

NISE NATIONAL INFORMAL STEM EDUCATION NETWORK

Educational Resources | Professional Learning | Events | Impact | Community | About

Citizen Science, Civics, and Resilient Communities (CSCRC)

Citizen Science, Civics, and Resilient Communities (CSCRC) Project

Citizen Science, Civics, and Resilient Communities

Through forums and citizen science projects, museums engage the public in active learning and resilience planning around heat waves, sea level rise, extreme precipitation, and drought.

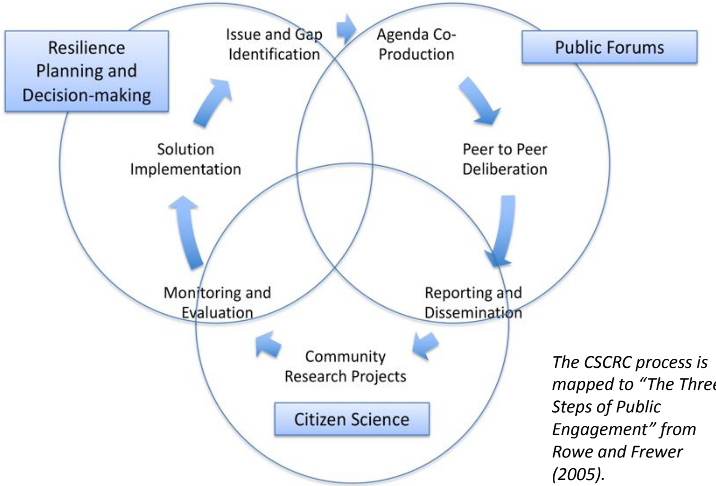
Opportunities for NISE Network partners

- Apply to be one of 20 sites that will be selected to receive a small stipend and support from the project team to organize and implement a science-to-civics campaign in your community
- **Dates and Deadlines:** Applications for a CSCRC project stipend application must be submitted online using Qualtrics by January 15, 2021
  - Optional: Watch Wicked High Tides virtual forum hosted by Museum of Science on November 10, 2020
  - Optional: Watch an online workshop to learn more about the Citizen Science, Civics, and Resilient Communities project
- **Institution Eligibility and How to Apply:** Find more information below

https://www.nisenet.org/CSCRC

The Science-to-Civics Process:

Citizen Science, Civics and Resilient City (CSCRC) Cycle



The CSCRC process is mapped to "The Three Steps of Public Engagement" from Rowe and Frewer (2005).

Our Partners:

NOAA | Northeastern University Marine Science Center | scistarter | NISE Network | Consortium for Science, Policy & Outcomes at Arizona State University | I SEE CHANGE

Thank You!

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Researcher, Helmuth Lab, Northeastern University
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- **Sara Benson/Katie Baur,** MOS
- **Nancy Smith**, Boston Public Health Commission
- **Jeremy Hoffman**, Science Museum of Virginia
- **Julia Kumari Drapkin**, ISeeChange
- **Caroline Nickerson**, SciStarter
- **Brian Helmuth,** Northeastern University
- **Francis Choi,** NOAA/Helmuth Lab

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Northeastern University
Marine Science Center

Consortium for Science, Policy & Outcomes
at Arizona State University

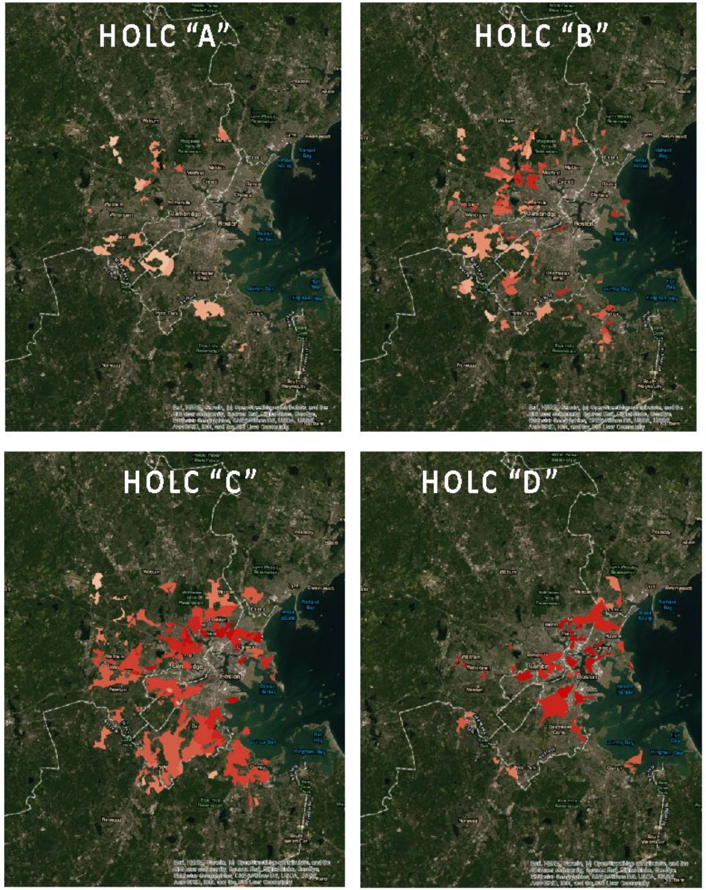
Museum of Science.

scistarter
People-powered science.

NISE
NATIONAL INFORMAL STEM EDUCATION NETWORK

Back to Mentimeter!

Percent Impervious Surface by Redlining "Grade"



Redline Grade	Mean Impervious Surface
A	**31.4%**
B	**47.7%**
C	**55.7%**
D	**66.3%**

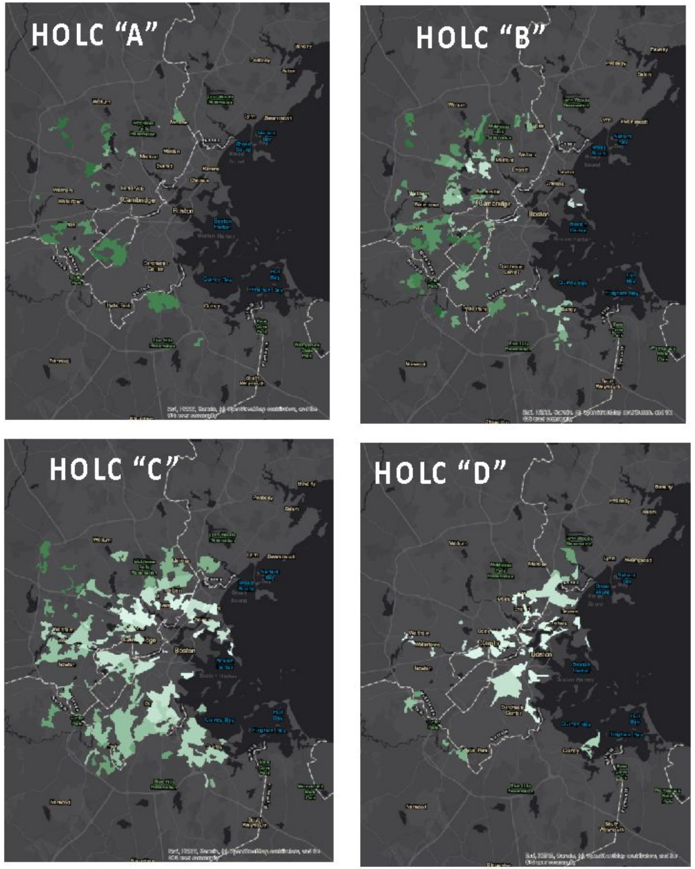
Legend

Percent Impervious Surface

- 0 - 8.6
- 8.601 - 17.2
- 17.21 - 25.8
- 25.81 - 34.4
- 34.41 - 43
- 43.01 - 51.6
- 51.61 - 60.2
- 60.21 - 68.8
- 68.81 - 77.4
- 77.41 - 86

Mapped by D. Sittenfeld, September 2020
Source Data: National Land Cover Database

Percent Tree Cover by Redlining "Grade"



Redline Grade	Mean Tree Cover
A	**45.4%**
B	**31.9%**
C	**22.2%**
D	**12.0%**

Legend

Percent Tree Cover

- 0 - 6.3
- 6.301 - 12.6
- 12.61 - 18.9
- 18.91 - 25.2
- 25.21 - 31.5
- 31.51 - 37.8
- 37.81 - 44.1
- 44.11 - 50.4
- 50.41 - 56.7
- 56.71 - 63

Mapped by D. Sittenfeld, September 2020
Source Data: National Land Cover Database