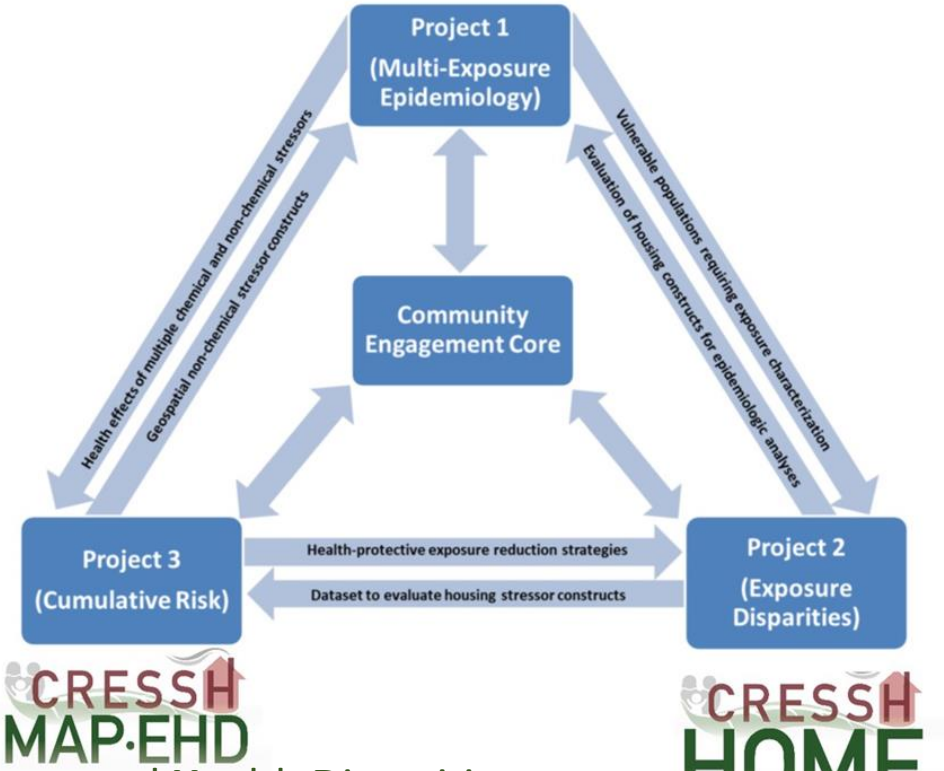
Center for Research on Environmental and Social Stressors in Housing Across the Life Course (CRESSH)

HARVARD T.H. CHAN | BU Boston University School of Public Health

Boston University Superfund Research Program

CRESSH HEAL

Health Effects Across the Lifecourse



CRESSH MAP·EHD

MAPping Environmental Health Disparities

CRESSH HOME

Today's example: Birthweight

Featured speakers

Patricia Fabian, ScD
Research Assistant Professor at the Boston University School of Public Health

Kevin Lane, PhD
Assistant Professor at the Boston University School of Public Health

Antonella Zanobetti, PhD
Principal Research Scientist at the Harvard T.H. Chan School of Public Health

And, behind it all…
Claire Schollaert, MPH!

w/ Jon Levy, Madeleine Scammell & Kevin Lane

Acknowledgements

- Francine Laden, co-director
- Jonathan Levy, co-director
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- Leigh Evans, doctoral student
- Kelvin Fong, doctoral student
- Leila Heidari, doctoral student
- Shane Hennessy, master's student
- Raquel Jimenez, doctoral student
- Kevin Lane, postdoc & faculty
- Caitlin Matthews, master's student
- Zoe Petropoulos, doctoral student
- Jong Eun Rhee, postdoc
- Anna Rosofsky, doctoral student
- Claire Schollaert, master's student
- Madeleine Scammell
- Maayan Yitshak-Sade, postdoc
- Antonella Zanobetti
- Yunke Zhang, master's student
- BUSPH BEDAC
- BU Research Computing Services
- Children's HealthWatch
  - Stephanie Ettinger de Cuba
  - Megan Sandel
  - Sharon Coleman
  - Ana Poblacion
- CRESSH Community Partners
  - Green Roots
  - Health Resources in Action
- Communities of Chelsea & Dorchester
- Funding
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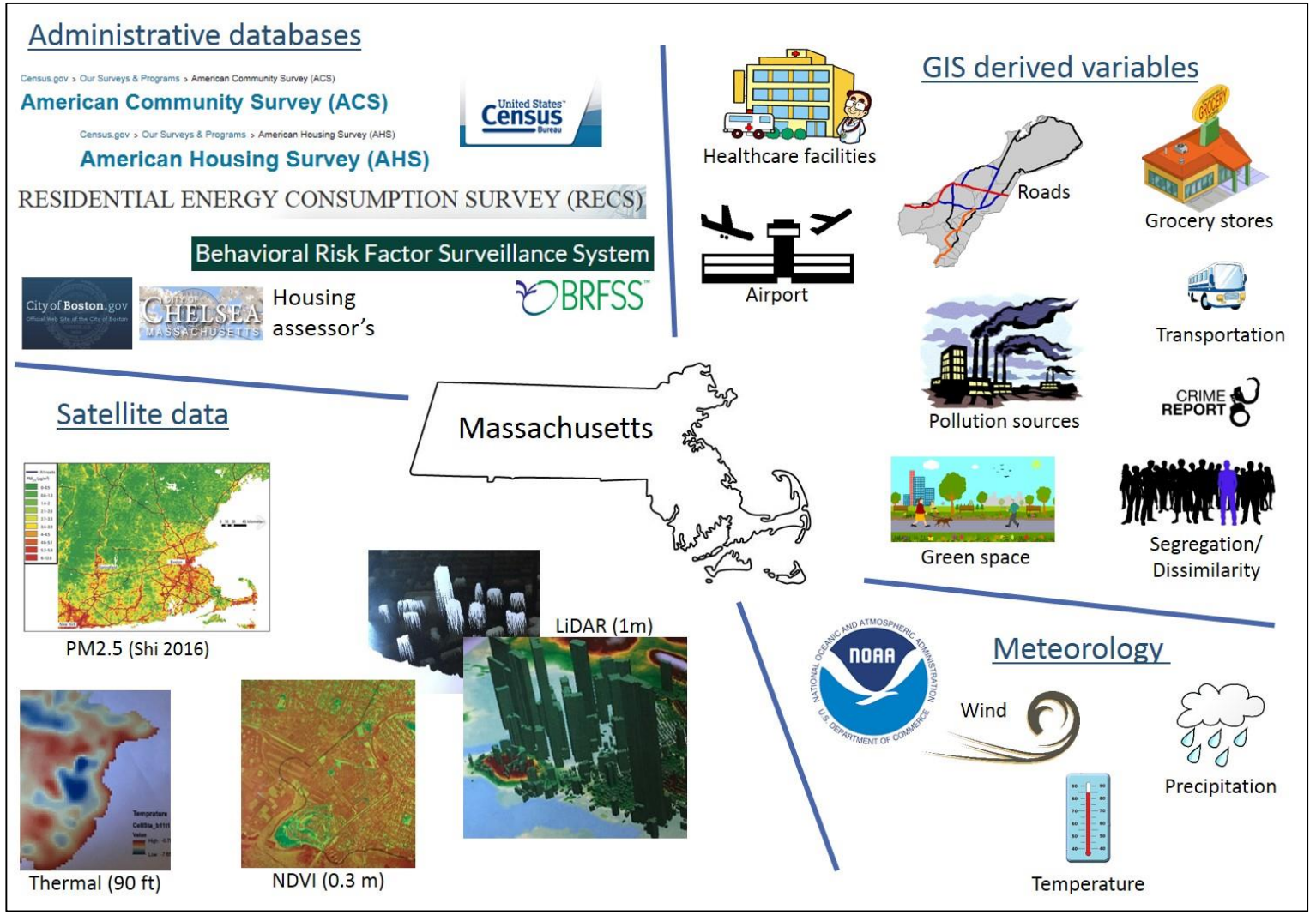
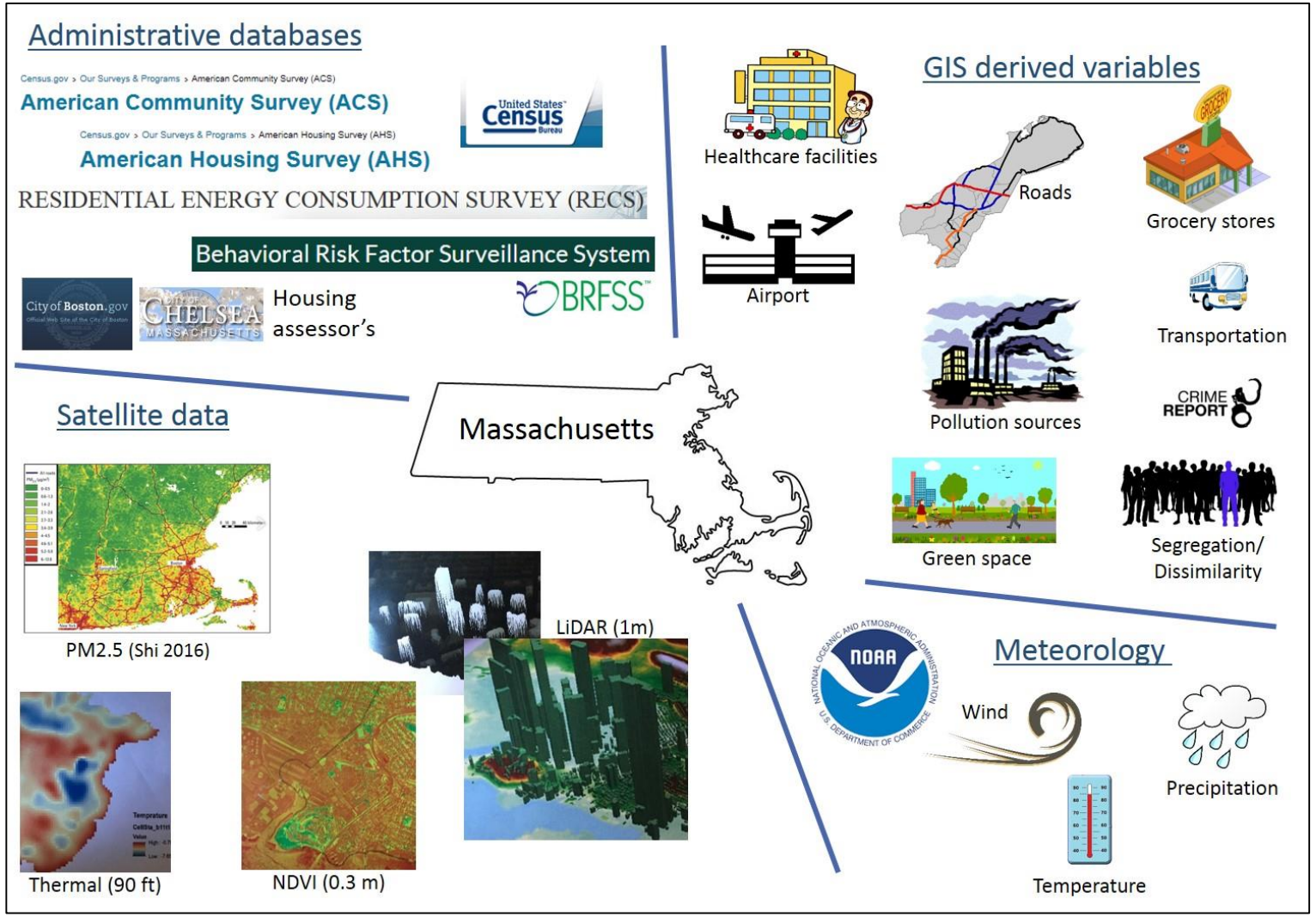
  - NIEHS T32 (T32 ES014562)

Mapping Spatial Patterns in Environmental Health Disparities (MAP-EHD) project



- Area of focus: Massachusetts (when available expanded to US)
- Principles:
  - Publicly available
  - Potentially modifiable
  - Potential drivers of exposure or health disparities
- Data sources
  - Administrative databases
  - Satellite data
  - GIS estimated data
- Hosted on a public story map website

Mapping Spatial Patterns in Environmental Health Disparities (MAP-EHD) project



- Compiled datasets
  - Greenness
  - Walkability
  - Census
  - Housing
  - Land surface temperature
  - Meteorology
  - And more…
- Indexes
  - Heat vulnerability
  - Environmental quality
  - Racial, economic, education segregation and dissimilarity
  - Community health center accessibility
  - Food access
  - And more...

CRESSH MAP-EHD Indexes

Mapping Spatial Patterns in Environmental Health Disparities (MAP-EHD) study
Project Lead/Contact: Patricia Fabian (pfabian@bu.edu)
https://sites.sph.harvard.edu/cressh/project-3/

6 Environmental quality index (EQI)

Environmental quality index (EQI)

Census tract score indicating overall environmental burden from industrial operations and pollutants, including air toxics, underground storage tanks, highways, Superfund sites, C21E sites, major facilities, and polluted waters. Publication in progress.

Map shows deciles of EQI at the Census Tract level in Massachusetts, 2011-2016. Higher values of EQI indicate greater environmental burden

Availability:

Data: Environmental quality index (EQI)

Years: 2008 and 2015

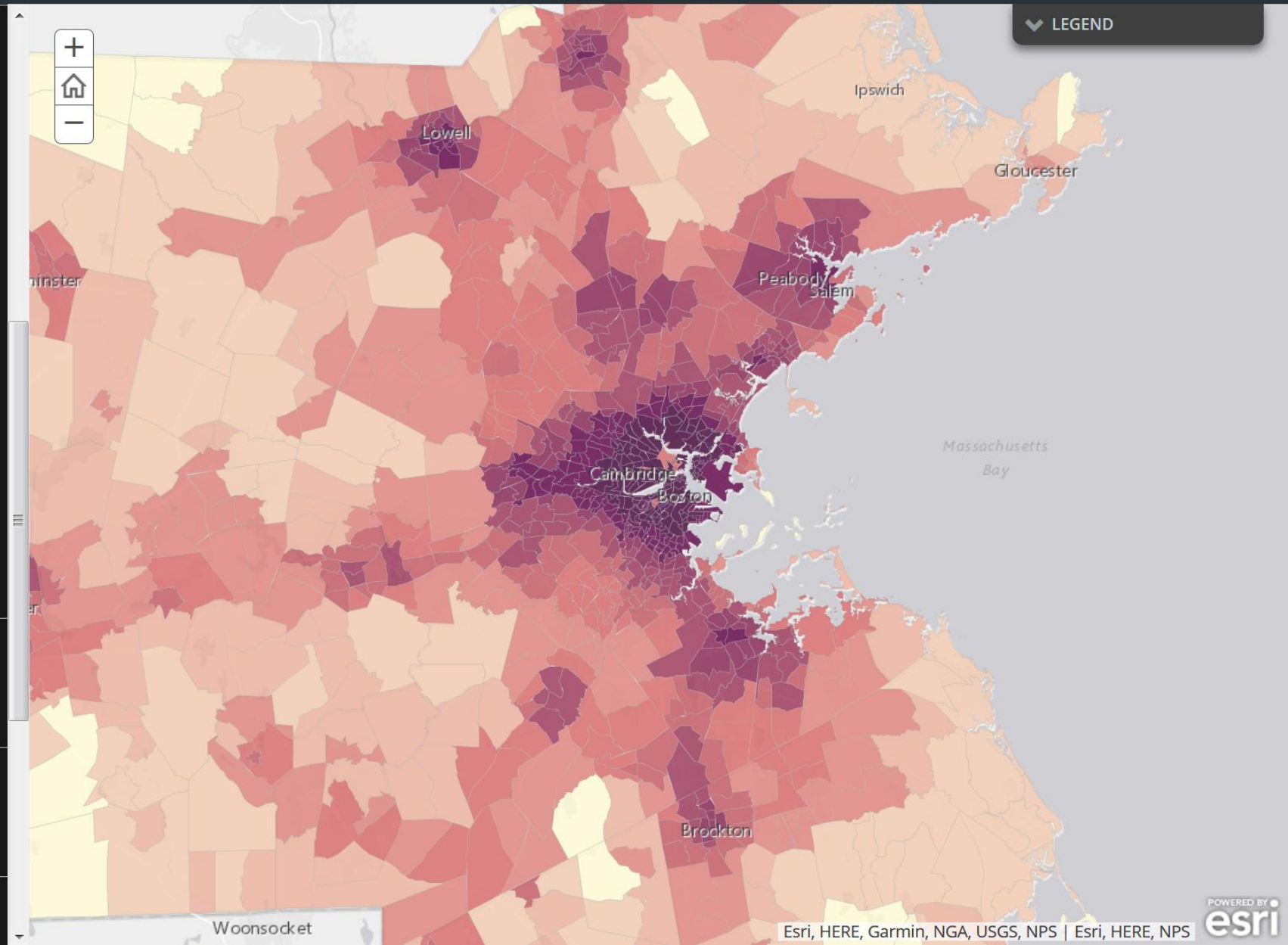
Geographic resolution: census tract

Geographic extent: Massachusetts

7 Greenness (NDVI)

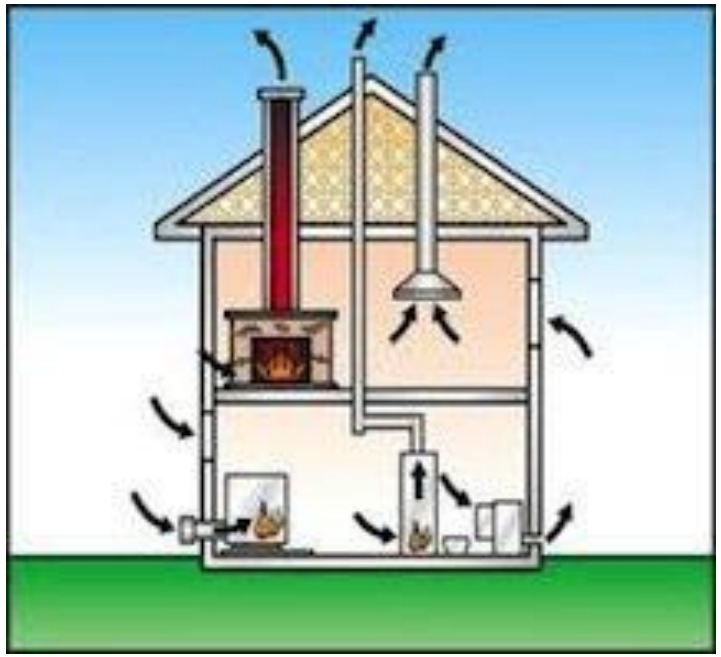
8 Food access index

9 Heat vulnerability index (HVI)



Infiltration Index

Housing: infiltration index



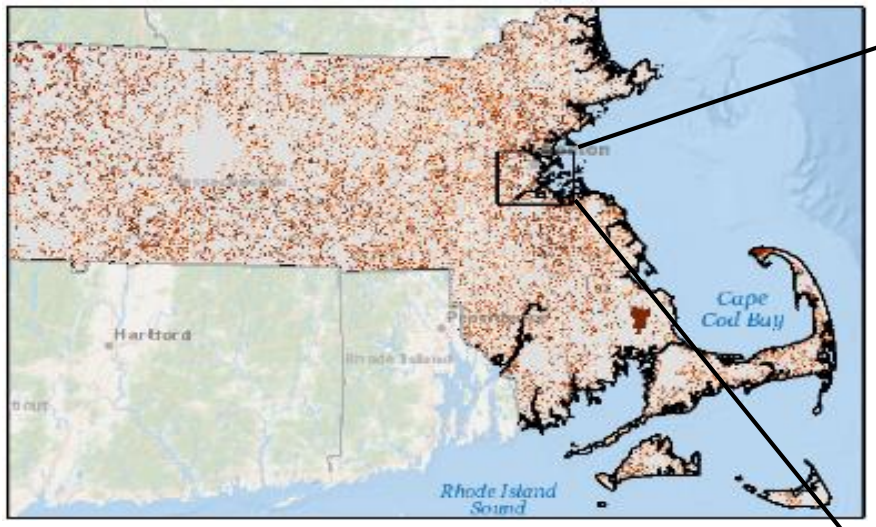
- Ambient concentrations commonly used as surrogate of personal exposure
- Housing important determinant of indoor exposure to ambient pollutants
- Calculated air exchange rate (AER) at each parcel as a function of:
  - Stack effect:
    - *Building height*
    - *Indoor-outdoor temperature differences*
  - Wind effect
    - *Wind speed*
    - *Surrounding shelter*
  - Effective leakage area
    - *Building area*
    - *Age of home*
    - *Income status of household*

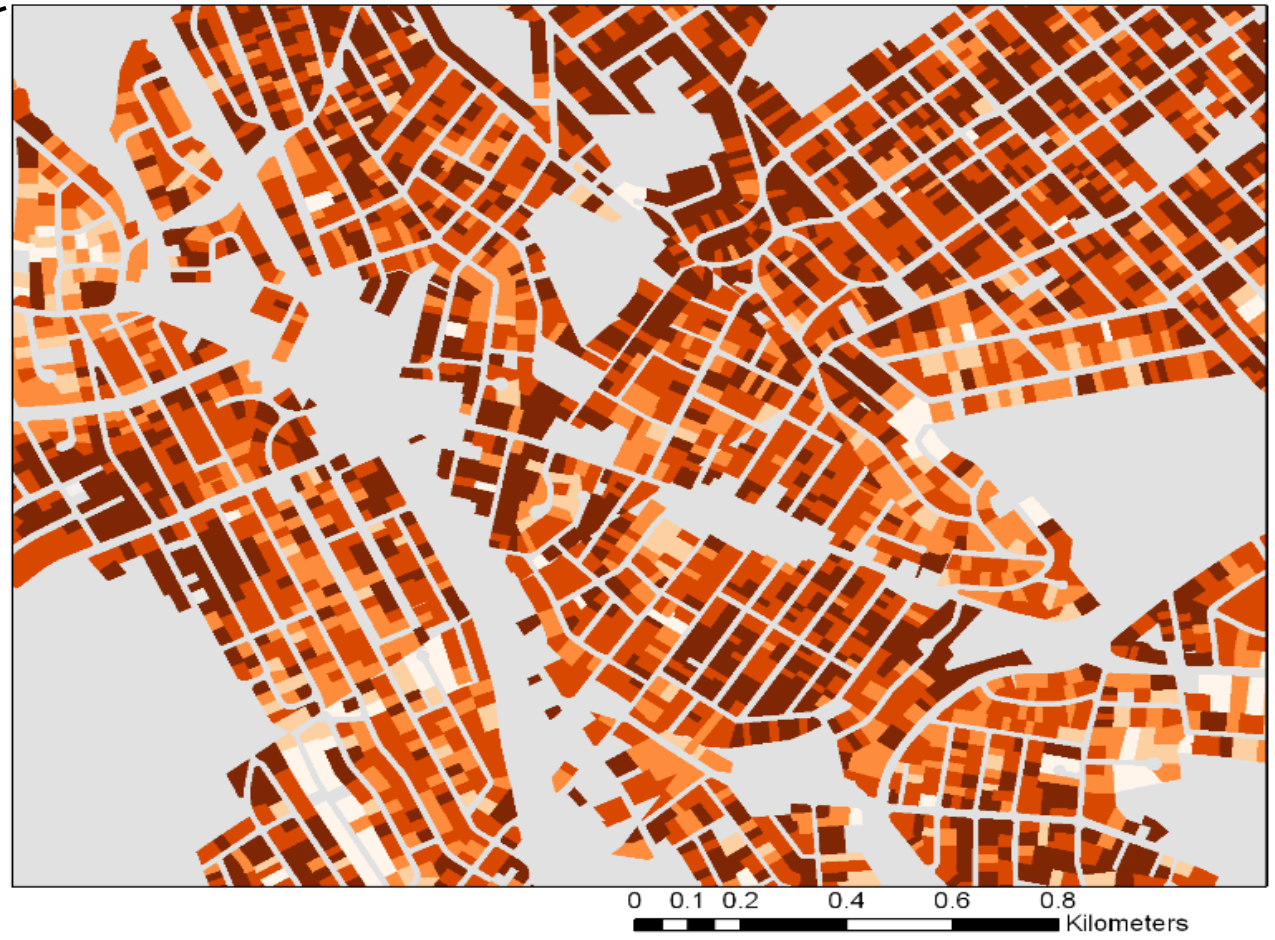
$$AER = \frac{NL}{1000\ x\ H}\left[\frac{2.5}{H}\right]^{0.3} S$$

Sarnat et al. 2013; Breen et al. 2010; Chan et al. 2005

Housing: infiltration index

Air exchange rate (h^{-1}) in Boston residential parcels, Winter 2010





AER (h-1)
- 0.29
- 0.30-0.40
- 0.40-0.55
- 0.56-0.80
- 0.81-2.67
- Not Residential

Adapted from: Rosofsky et al, 2018 *JESEE*

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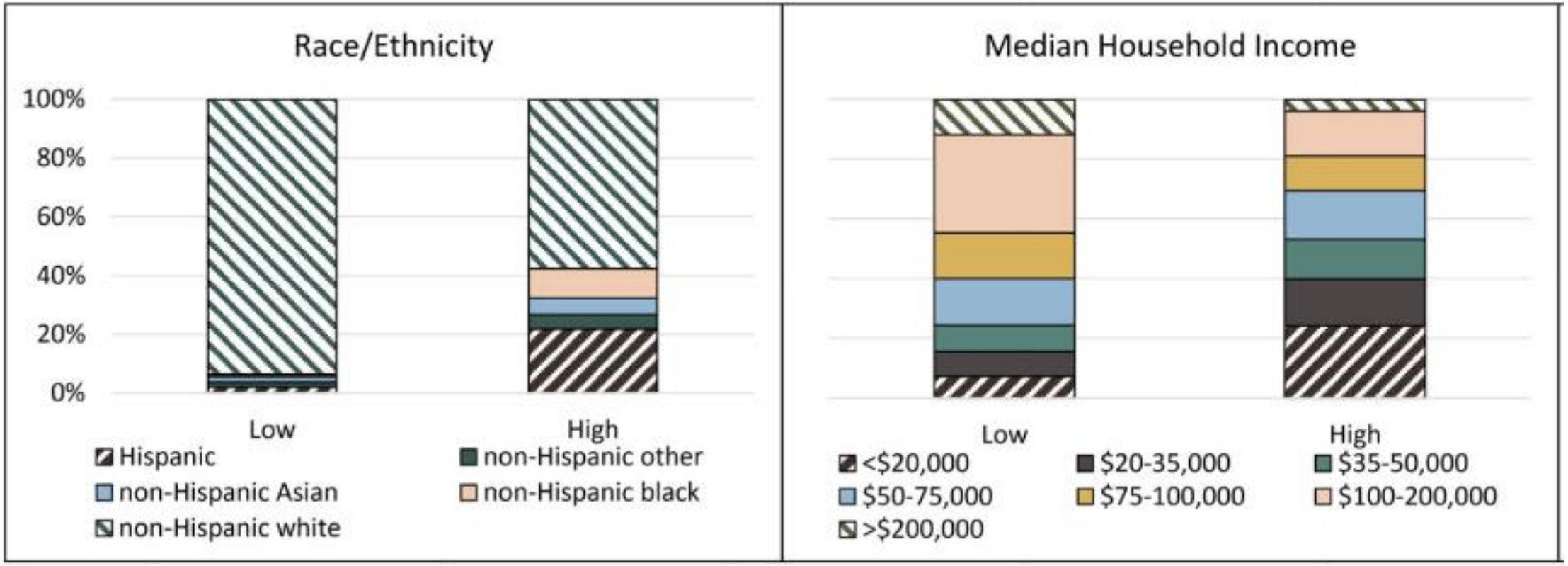
Housing: infiltration index inequality analysis



Sociodemographic characteristics of 2010 US census block groups containing the residential parcels with the lowest AER in areas with the lowest ambient $PM_{2.5}$ (low-exposure, <10th %tile) versus block groups containing parcels with the highest AER and $PM_{2.5}$ (high-exposure, >90th %tile).

Adapted from: Rosofsky et al, 2018 *JESEE*

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Heat Vulnerability Index

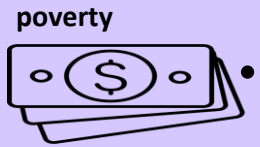
Heat vulnerability index (HVI)

Census tract score indicating heat vulnerability across three dimensions: sociodemographic, environmental/urbanicity, and elderly/social isolation.

Sociodemographic Component

- Hispanic
- Black
- Non-English speaking

- Unemployed
- Below poverty line



- With a disability

Environmental/Urbanicity Component

- Housing density
- Older homes
- Open, undeveloped land
- High building intensity
- Foreign born

Elderly/Social Isolation Component

- ≥65 years old
- ≥65 years old& living alone

From the Noun Project: “Elderly” by Gan Khoon Lay; “home alone” by Miguel C Balandrano, MX; “Language” by ATOM, TH; “disability” by Nathaniel S.; “money” by Luiz Caravalho; “unemployment” by Aneeque Ahmed; “buildings” by Yu Luck; “house” and “clock” by Dinosoft Labs

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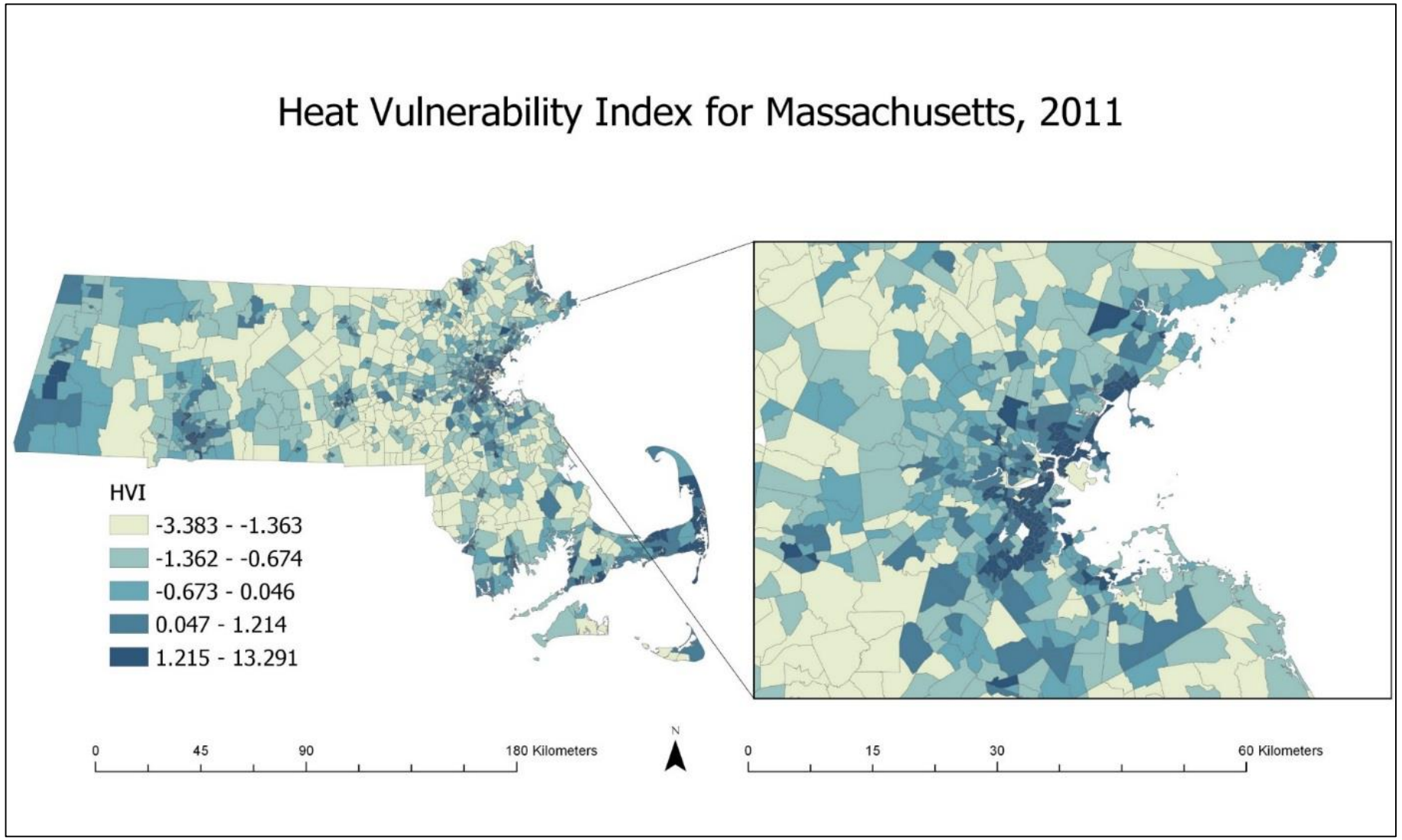
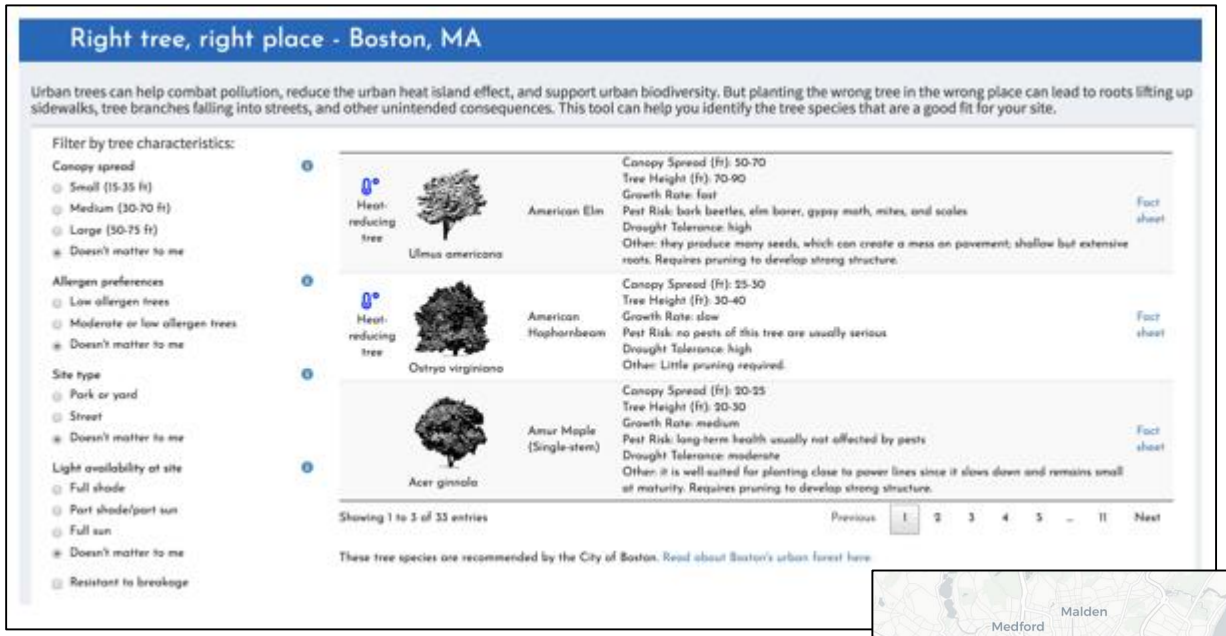
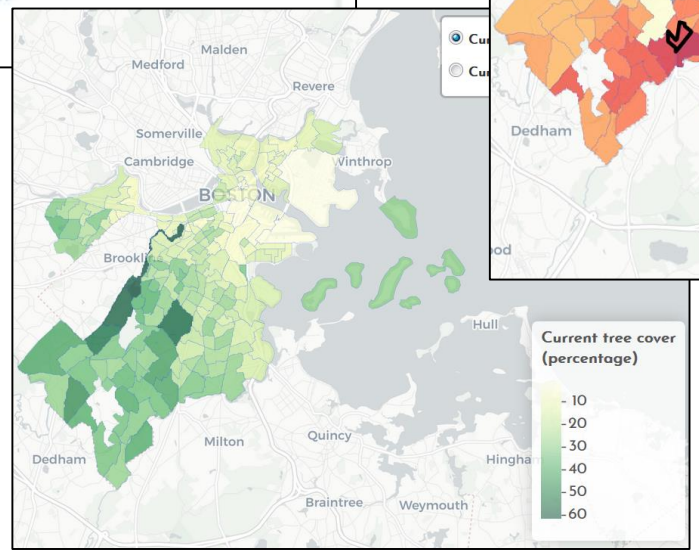
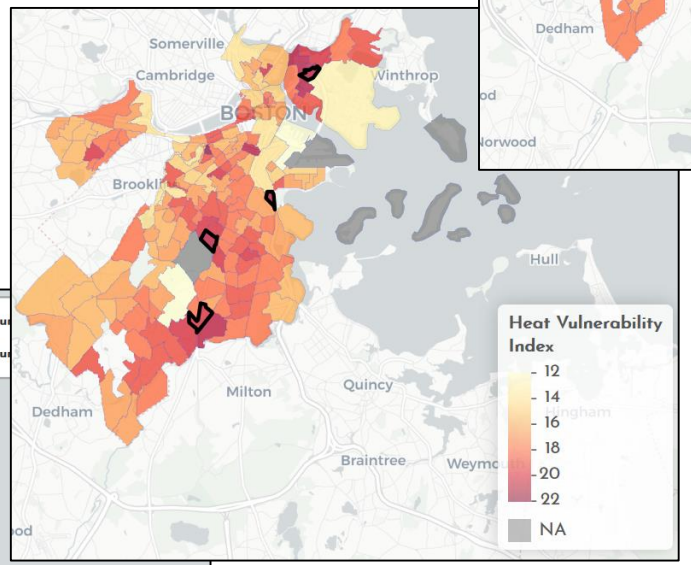
Heat vulnerability index (HVI)

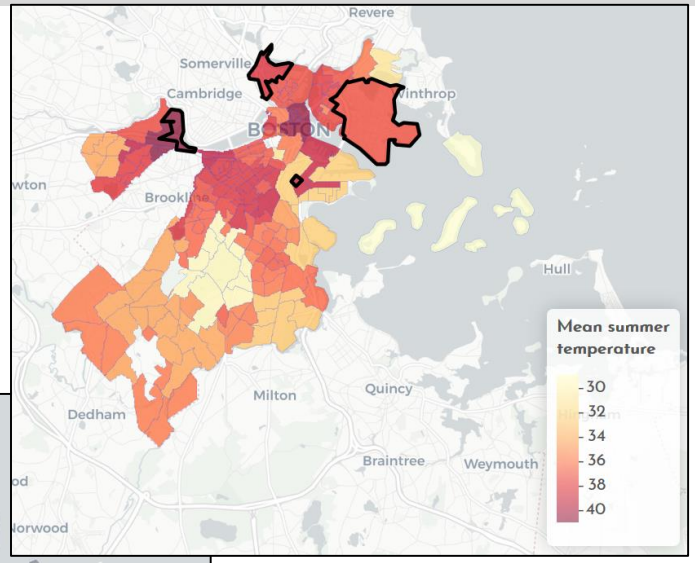


HVI application: Mitigating the Boston urban heat island effect with tree-planting decision support









Credit: Boston University URBAN students: P. Brochu, S. Buckley, L. Butler, C. Connolly, L. Heidari, L. Houttuijn Bloemendaal, T. McCabe, T. Miller, Z. Werbin

Green Space and Birthweight

Greenness

What is it?

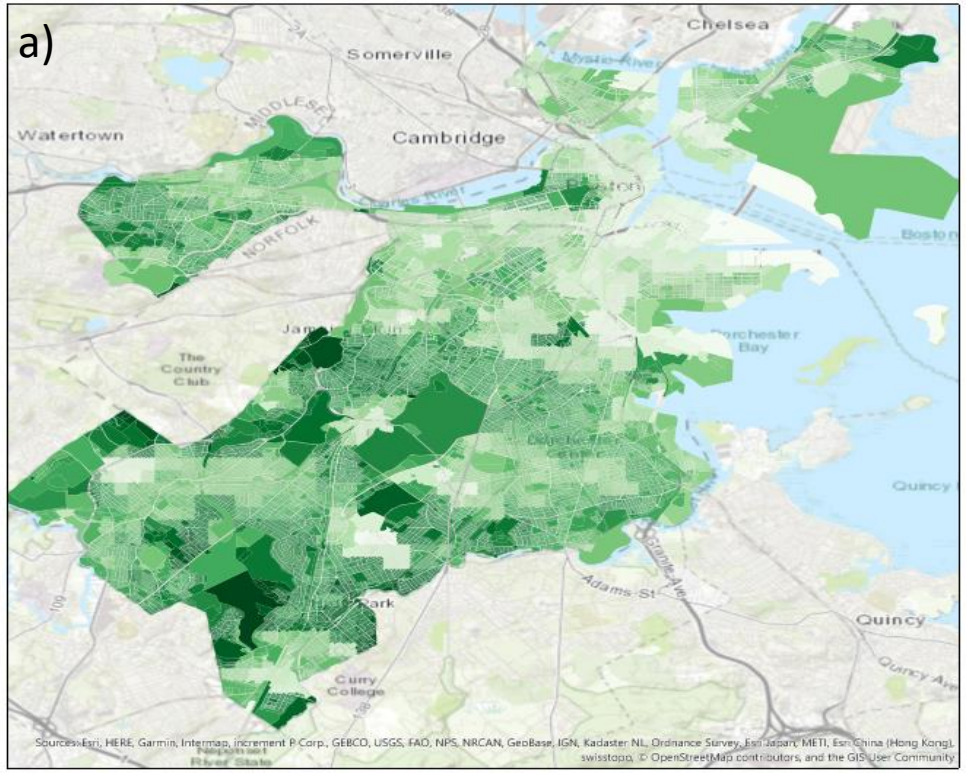
Amount of green space in the neighborhood from trees, plants, forests, parks, and gardens.

Why is it important?

Beneficial effects of exposure to nature.

Mixed results depending on outcome.

- Improvements in:
  - birth weight
  - physical activity
  - mortality
  - depression and depressive symptoms
- Inconsistent results for:
  - Cardiovascular disease
  - Asthma (greenness increase pollen)



Normalized difference vegetation index at 250 m resolution in Boston, July 2000

Greenness (NDVI)

Data Source

- NDVI estimates were obtained from MODIS satellite.

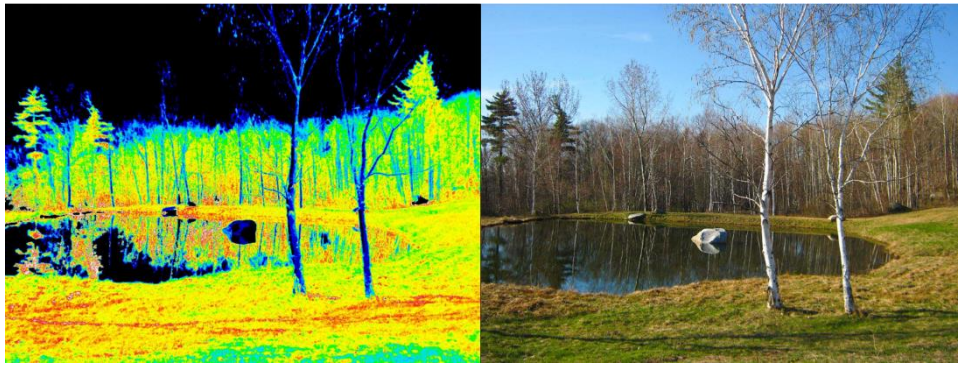
- NDVI is an indicator of photosynthetically active vegetation based on:
  - ➢ land surface reflectance of visible (red) reflection of light
  - ➢ near-infrared parts of spectrum
- Values range from

  -1.0 to 1.0

positive values indicate higher levels of vegetative density

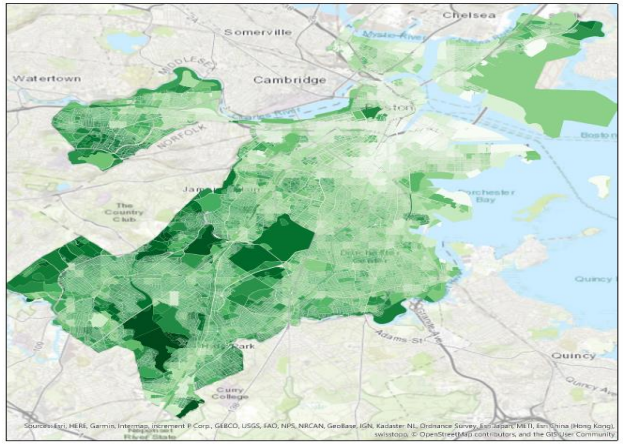
a) Vegetation Reflectance

b)



Example using near-infrared parts of spectrum

c)



Geographic and temporal resolution

- MODIS provides NDVI estimates every 16 days at 250 m resolution
- We downloaded and processed data for 2000-2016
- Average NDVI across parcel

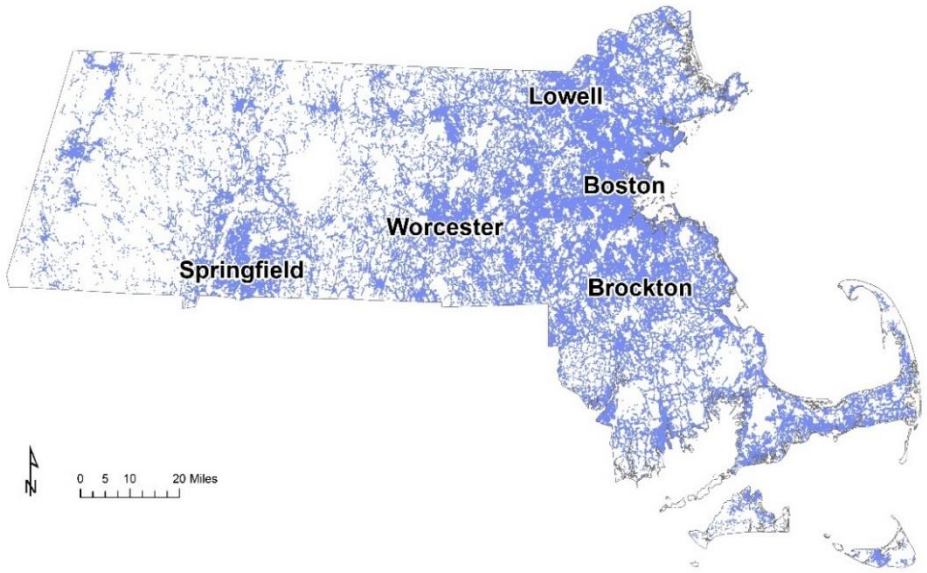
Residential Greenness and Birthweight in MA

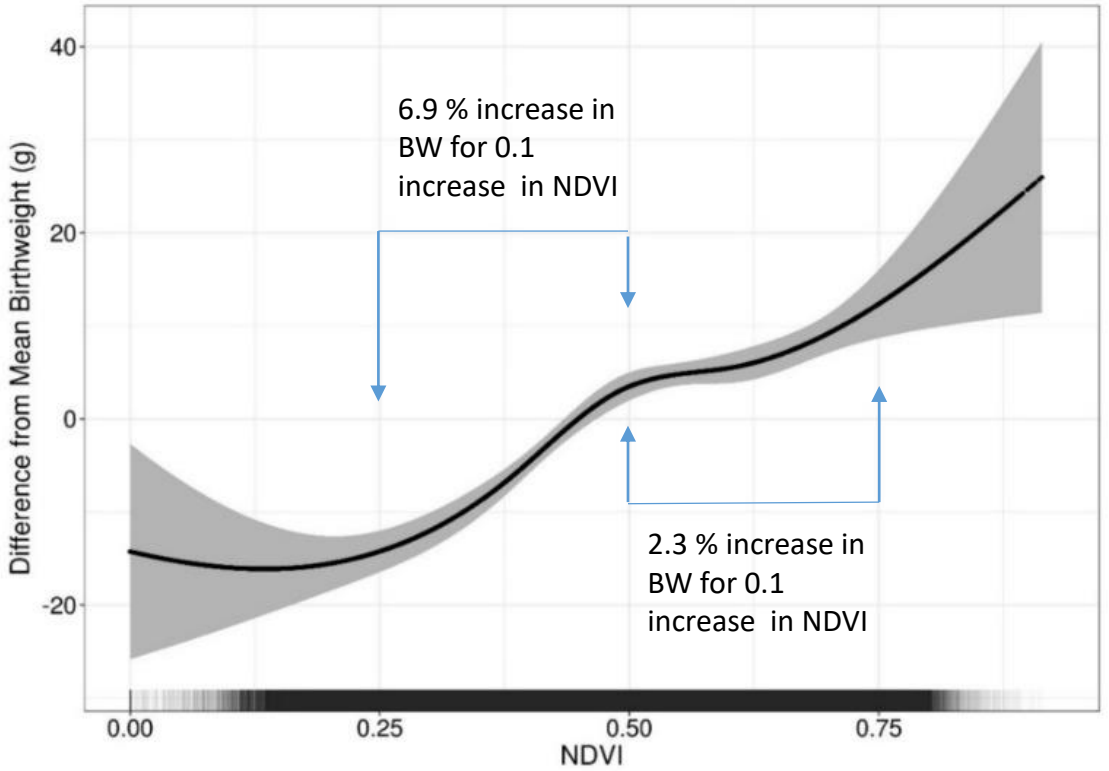
Massachusetts Birth Registry:

Urban areas, 2001-2013

780,435 full-term births

Mean birthweight 3441 gr (7.6 lb)





- Higher greenness associated with higher birthweight (BW)
- Stronger in lower range of greenness
- Beneficial to increase greenness in areas with no or low to medium greenness

Fong KC et al. Int J Environ Res Public Health. 2018; 15(6): 1248.

Combined impact of environmental and built environment exposures on birthweight

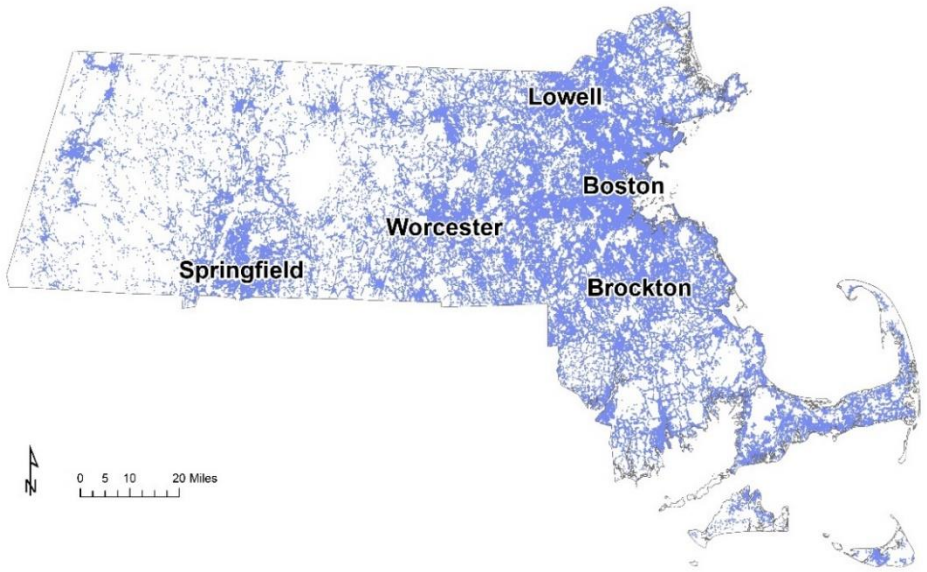
Massachusetts Birth Registry:

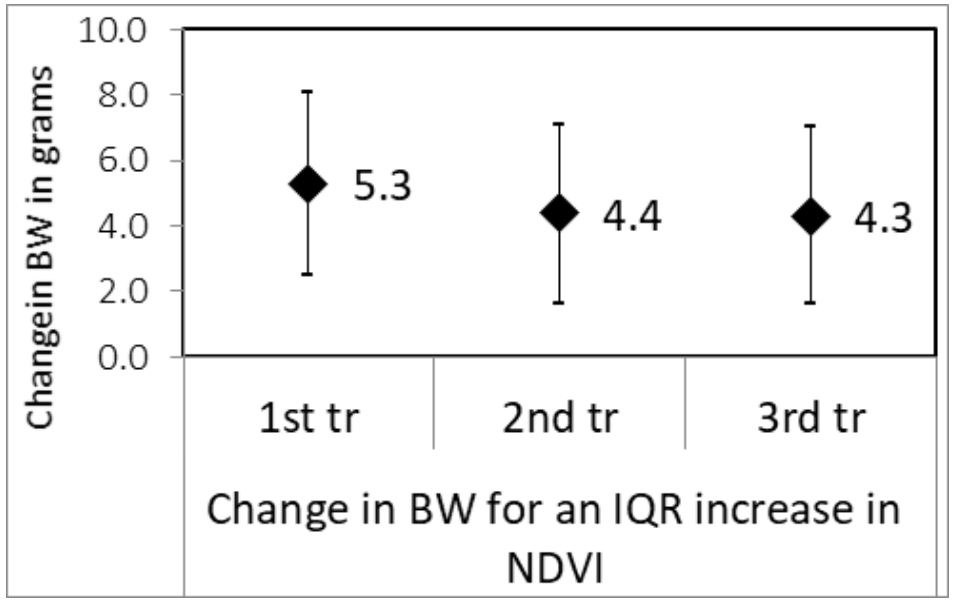
Urban areas, 2001-2011

601,927 full-term births

70% White Mom,

Mean BW 3437 gr (7.5 lb)





- Increase in average NDVI during 1st , 2nd , 3rd before birth were associated with higher birthweight adjusting individual characteristics, and other factors
- NDVI was associated with BW regardless of the trimester

Maayan Yitshak-Sade et al. Under review.

Segregation and Birthweight

Black carbon exposure and extreme concentrations of residential economic and racial/ethnic privilege and deprivation

Nancy Krieger[a,*], **Pamela D. Waterman**[a], **Alexandros Gryparis**[b], and **Brent A. Coull**[c]

Health Place. 2015 July ; 34: 215–228. doi:10.1016/j.healthplace.2015.05.008.

Racial isolation and exposure to airborne particulate matter and ozone in understudied US populations: Environmental justice applications of downscaled numerical model output

Mercedes A. Bravo [a,*], Rebecca Anthopolos [a], Michelle L. Bell [b], Marie Lynn Miranda [a,c]

Environment International 92–93 (2016) 247–255

Race/Ethnicity, Socioeconomic Status, Residential Segregation, and Spatial Variation in Noise Exposure in the Contiguous United States

Joan A. Casey,[1] Rachel Morello-Frosch,[2] Daniel J. Mennitt,[3] Kurt Fristrup,[4] Elizabeth L. Ogburn,[5] and Peter James[6]

Environ Health Perspect. 2017 Jul 25;125(7):077017. doi: 10.1289/EHP898.

The Intersection of Neighborhood Racial Segregation, Poverty, and Urbanicity and its Impact on Food Store Availability in the United States

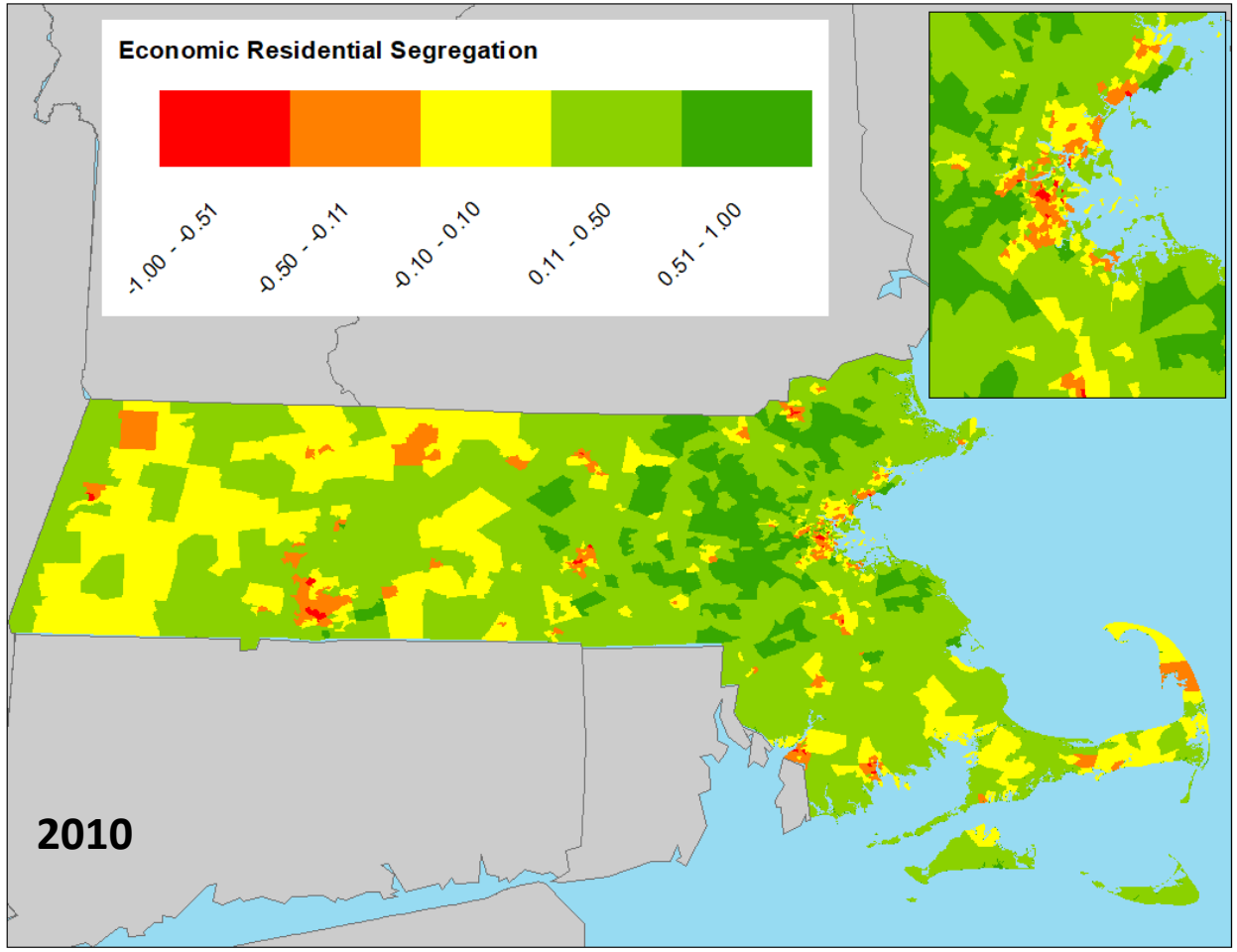
Kelly M Bower, PhD, RN[1,2], **Roland J. Thorpe Jr., PhD**[1,3], **Charles Rohde, PhD**[1,4], and **Darrell J. Gaskin, PhD**[1,3]

Prev Med. 2014 January ; 58: 33–39. doi:10.1016/j.ypmed.2013.10.010.

Census-derived Community Segregation Metrics

- Economic Residential Segregation (ERS)

$$\frac{N_{>100,000} - N_{<20,000}}{N_{>100,000} + N_{<20,000}}$$

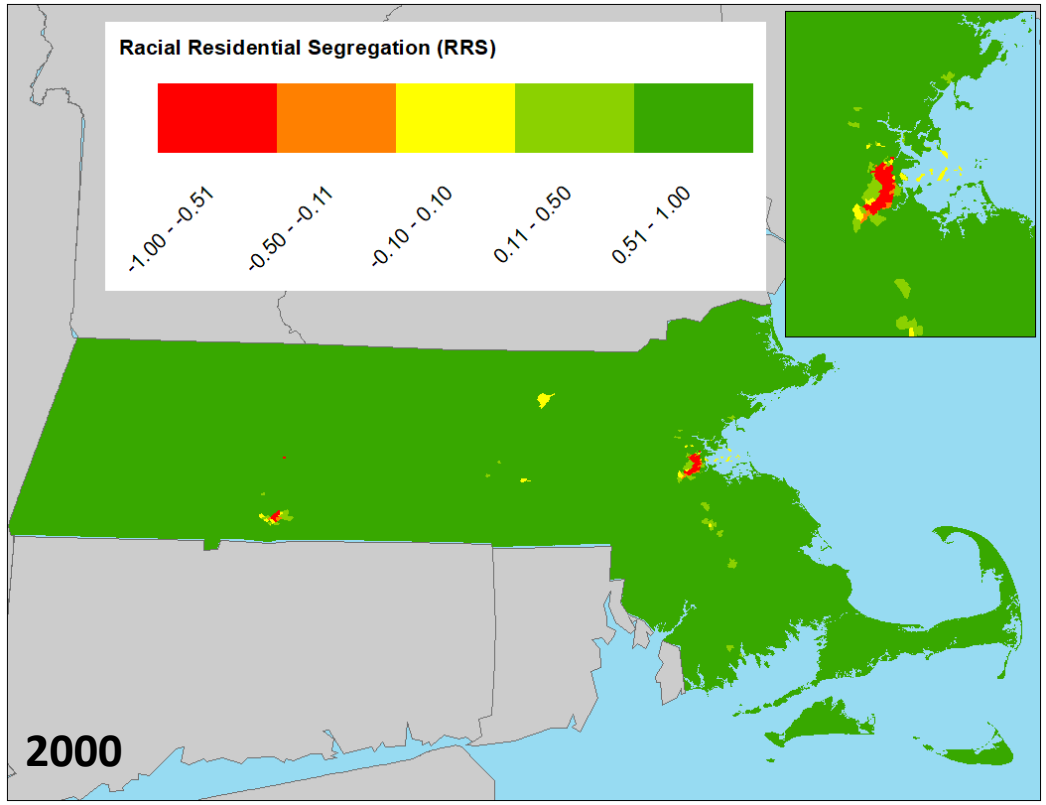


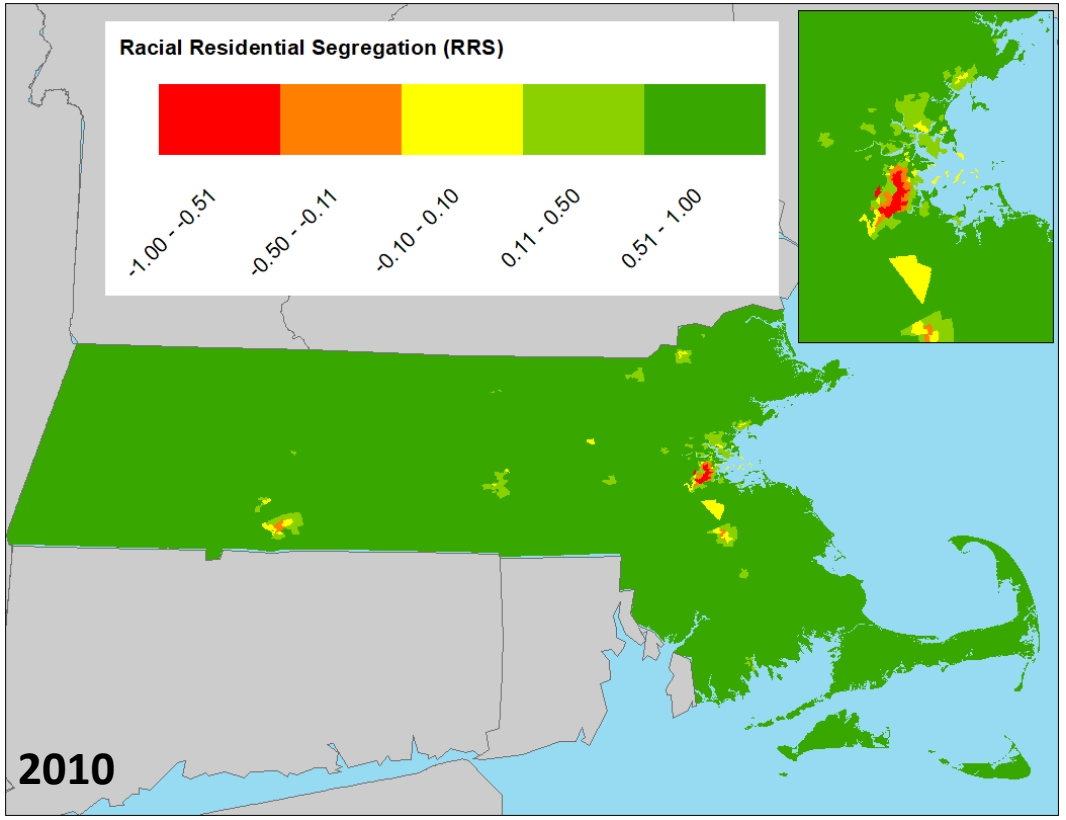
Index of Concentration of Extremes: ERS measures the extent to which low income and high income residents are exposed only to one another within the same Census tract and can range from -1 (low-income isolation) to 1 (high income isolation), with 0 meaning equal distribution of members of both groups.

Adapted from Massey et al. 2001 and Krieger et al. 2017.

MAP-EHD: Census-derived Community Segregation Metrics

- Racial Residential Segregation (RRS) $\frac{N_{White} - N_{Black}}{N_{All}}$

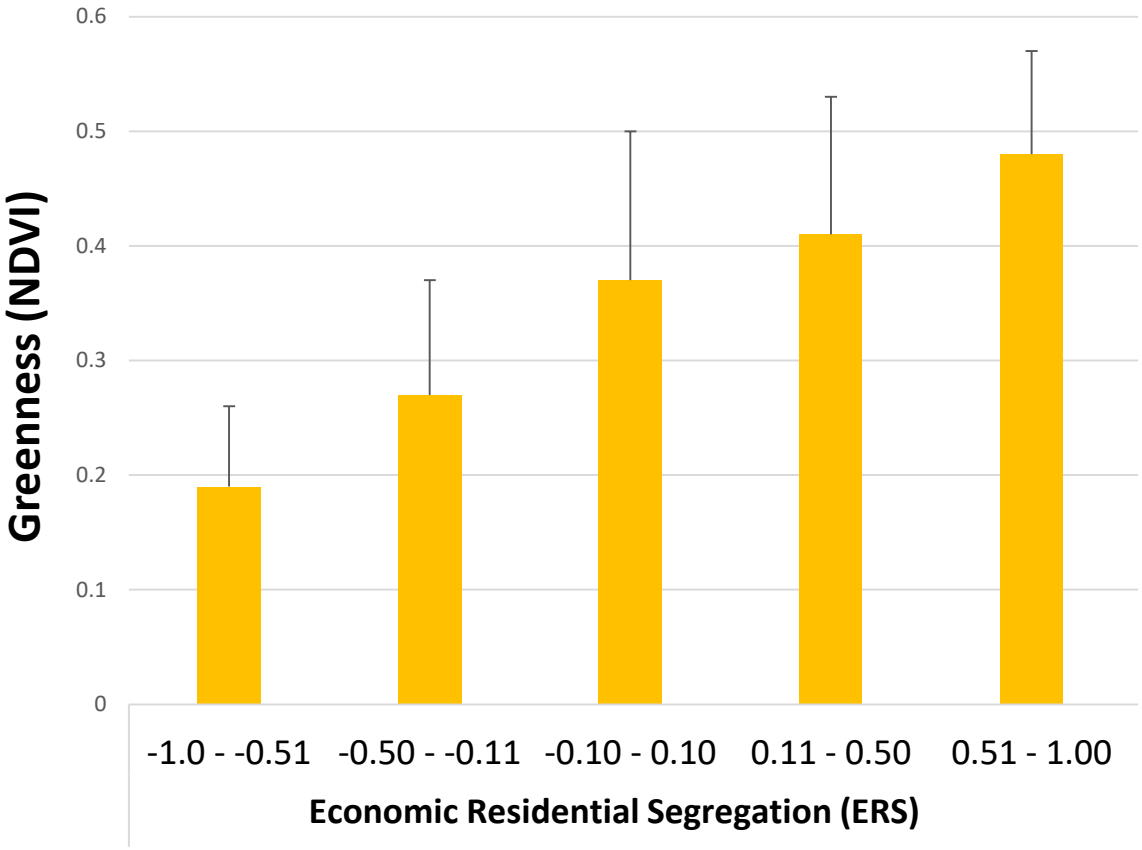




Index of Concentration of Extremes: RRS measures the extent to which black and white residents are exposed only to one another within the same Census tract and can range from -1 (black isolation) to 1 (white isolation), with 0 meaning equal distribution of members of both groups.

Adapted from Massey et al. 2001 and Krieger et al. 2017.

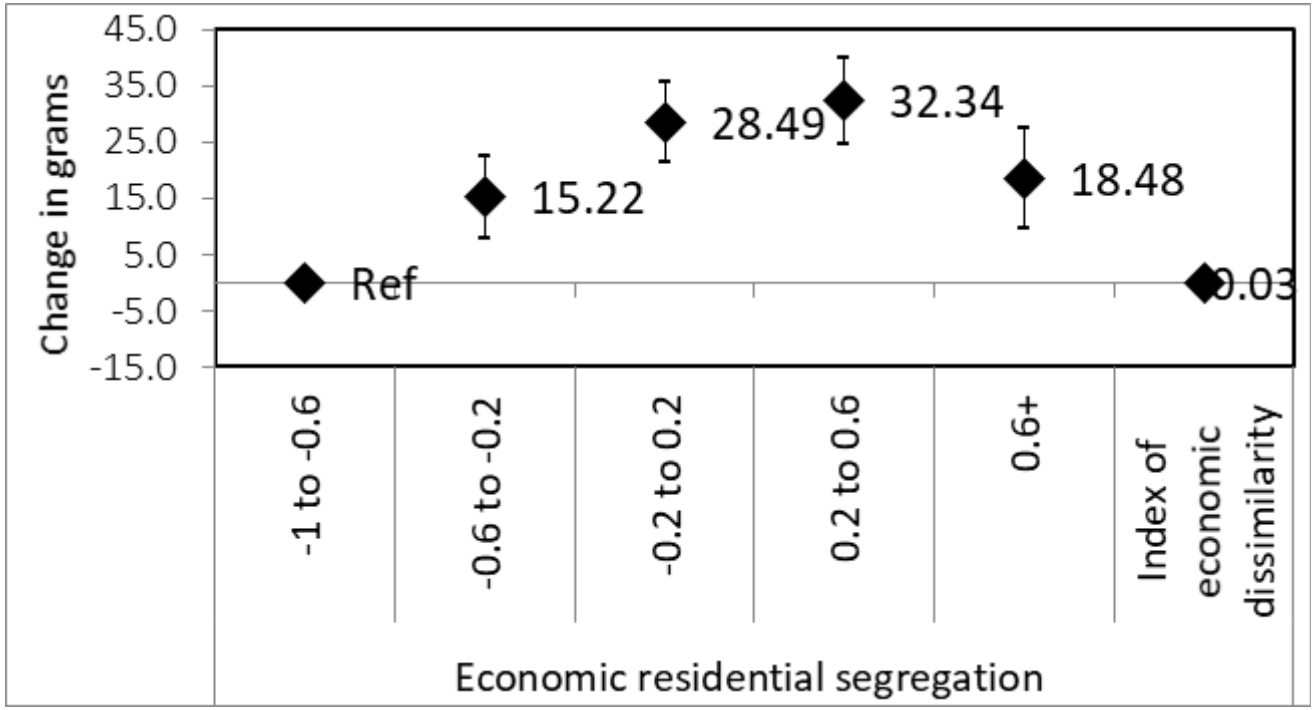
Segregation and Exposure to Greenness in 2015



- Greenness levels were highest in the 0.5 – 1.0 quintile for both RRS and ERS.
- There was a linear relationship between greenness exposure and ERS, but not in RRS.

Is Economic Residential Segregation associated with Birthweight?

- Low birthweight is a risk factor for disease
- Linked ERS to all births in Mass. 2001-2013
- Living in communities with a mix of low and high incomes was associated with higher birthweight than infants born in isolated low income neighborhoods.



Credit: Kelvin Fong et al. In Preparation.

Ideas for applications of CRESSH data

- Epidemiology studies
- Inequality analyses
- Planning (climate, community, emergency, Urban etc.)
- Exposure assessment
- Other?

Questions?

For more information

- CRESSH MAP-EHD Story map https://arcg.is/14HHyu
- CRESSH www.cressh.org
- Contact information:
  - Patricia Fabian pfabian@bu.edu
  - Kevin Lane klane@bu.edu
  - Antonella Zanobetti azanobet@hsph.harvard.edu

- We want your feedback! Please use this link to access our feedback form: https://docs.google.com/forms/d/e/1FAIpQLScKCOlQYZ-OL6W8w2BiuUateN0VwwRtQqI8mI2qYTyyUE1ErQ/viewform