Urban Warming & Health

US EPA Webcast
Improving Heat Health Resilience through Urban Infrastructure Planning and Design

Aug 19, 2015

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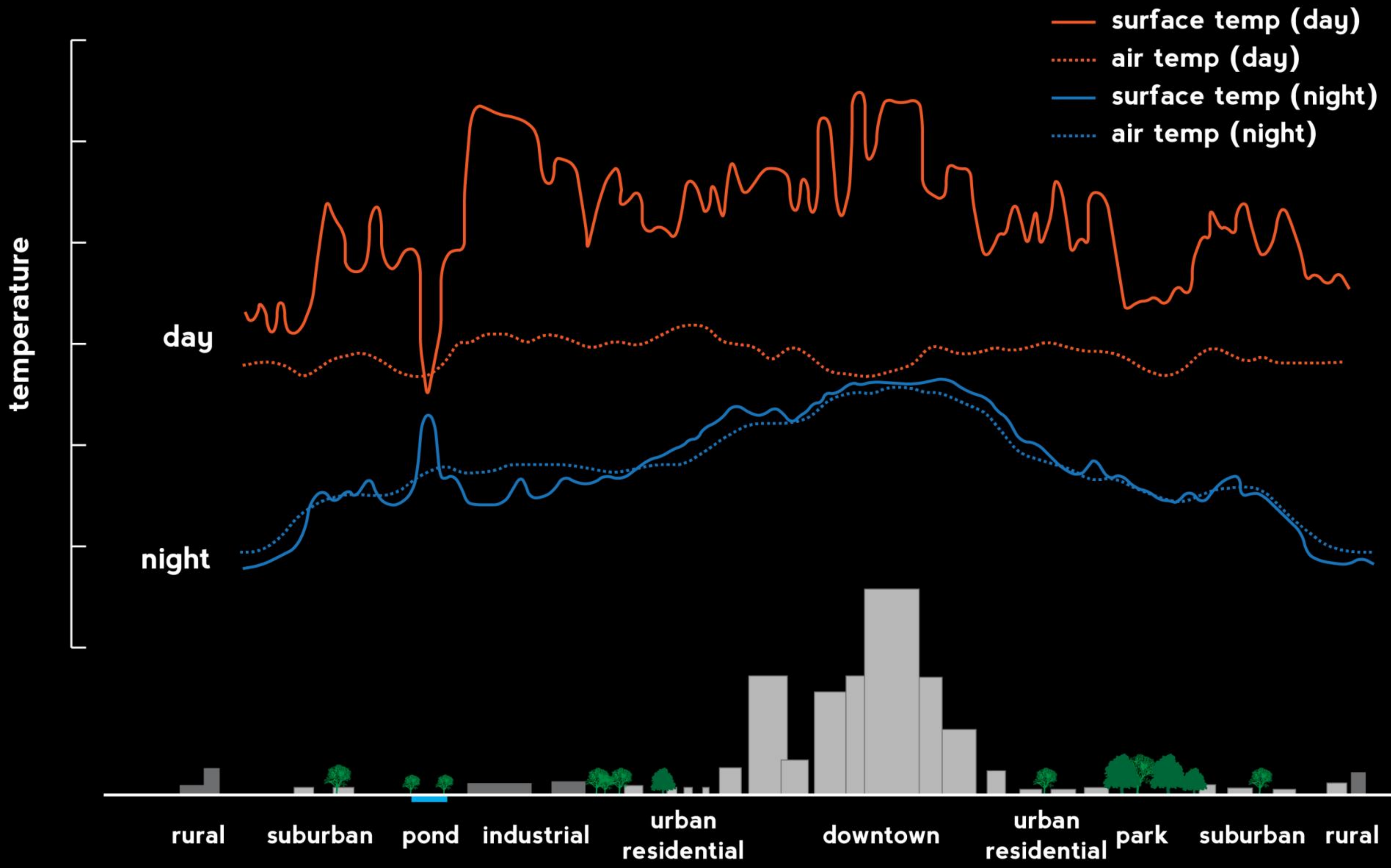

adapted from USEPA, http//www.epa.gov/heatisld/images/UHI_profile-rev-big.gif

CULE

Climate, Urban Land-use, and Excess mortality

Atlanta   Philadelphia   Phoenix

urbanization → **climate** → **health**

buildings
transportation
land cover

temperature
precipitation
storms

heat-illness
famine
vector-borne
ozone
allergies

urbanization → **climate** → **health**

urbanization	climate	health
buildings	temperature	heat-illness
transportation	precipitation	famine
land cover	storms	vector-borne
		ozone
		allergies

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PLOS ONE

Avoided Heat-Related Mortality through Climate Adaptation Strategies in Three US Cities

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Abstract

Heat-related mortality in US cities is expected to more than double by the mid-to-late 21st century. Rising heat exposure in cities is projected to result from: 1) climate forcings from changing global atmospheric composition; and 2) local land surface characteristics responsible for the urban heat island effect. The extent to which heat management strategies designed to lessen the urban heat island effect could offset future heat-related mortality remains unexplored in the literature. Using coupled global and regional climate models with a human health effects model, we estimate changes in the number of heat-related deaths in 2050 resulting from modifications to vegetative cover and surface albedo across three climatically and demographically diverse US metropolitan areas: Atlanta, Georgia, Philadelphia, Pennsylvania, and Phoenix, Arizona. Employing separate health impact functions for average warm season and heat wave conditions in 2050, we find combinations of vegetation and albedo enhancement to offset projected increases in heat-related mortality by 40 to 99% across the three metropolitan regions. These results demonstrate the potential for extensive land surface changes in cities to provide adaptive benefits to urban populations at risk for rising heat exposure with climate change.

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Data Availability: The authors confirm that all data underlying the findings are fully available without restriction. Data are available from Dryad under the DOI: 10.5061/dryad.14g40.

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Introduction

Human health effects associated with rising temperatures are expected to increase significantly by mid-to-late century. A large body of work now estimates an increase in mean global temperature from pre-industrial averages of more than 2°C by late century under mid-range emissions scenarios [1]. A smaller but growing body of work has sought to estimate the effects of projected warming on heat-related mortality. Employing health impact functions derived from epidemiological studies of historical warm season mortality rates, recent work projects an increase in annual heat-related mortality of between 3,500 and 27,000 deaths in the United States by mid-century [2]. Studies focused on individual cities estimate an increase in annual heat-related mortality by a factor of 2 to 7 by the mid-to-late 21st century [3–5].

The urban heat island effect compounds the potential effects of urban heat island effect may further increase heat-related mortality is not well established.

Here we examine the potential for urban heat island mitigation as a climate adaptation strategy to reduce projected heat-related mortality in three large US cities by mid-century. Future year climate and seasonal mortality are modeled across the metropolitan statistical areas (MSAs) of Atlanta, Georgia, Philadelphia, Pennsylvania, and Phoenix, Arizona to capture a wide continuum of climatic, geographic, and demographic characteristics known to underlie population vulnerability to extreme heat. Using coupled global and regional scale climate models together with an environmental health effects model, we project the number of heat-related deaths expected for these regions in 2050 in response to a "business as usual" (BAU) and an array of urban heat management scenarios characterized by variable land cover modifications. Employing separate health impact functions

Stone B Jr, Vargo J, Liu P, Habeeb D, DeLucia A, et al. (2014)

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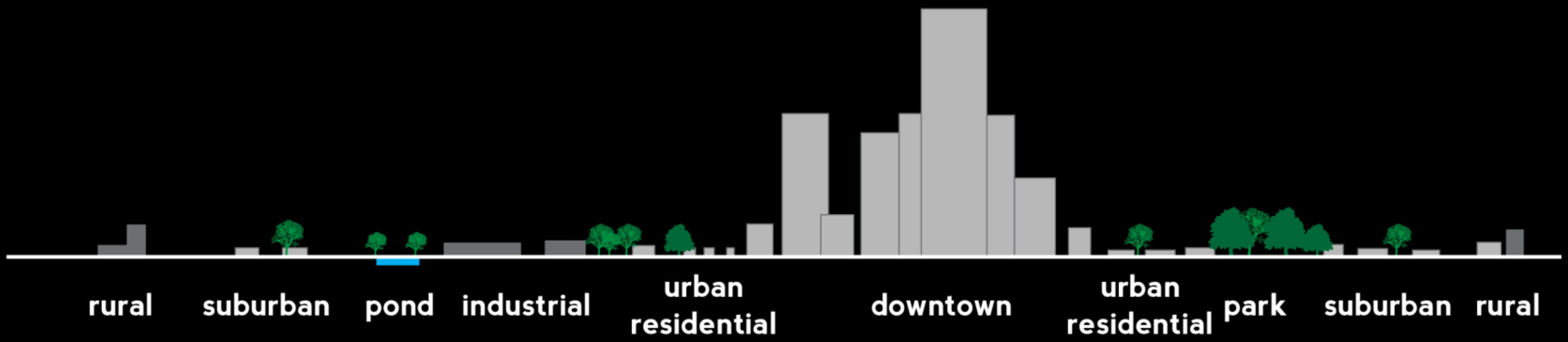
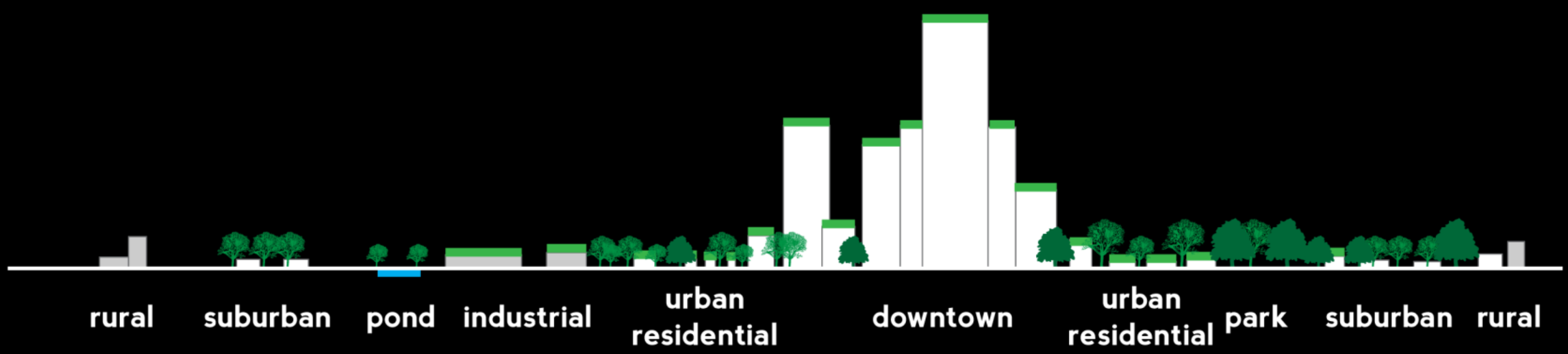
Business as Usual



Scenarios



Existing Parking Lot

American Society of Landscape Architects http://www.asla.org/sustainablelandscapes/Vid_UrbanForests.html

Retrofitted Parking Lot

American Society of Landscape Architects http://www.asla.org/sustainablelandscapes/Vid_UrbanForests.html

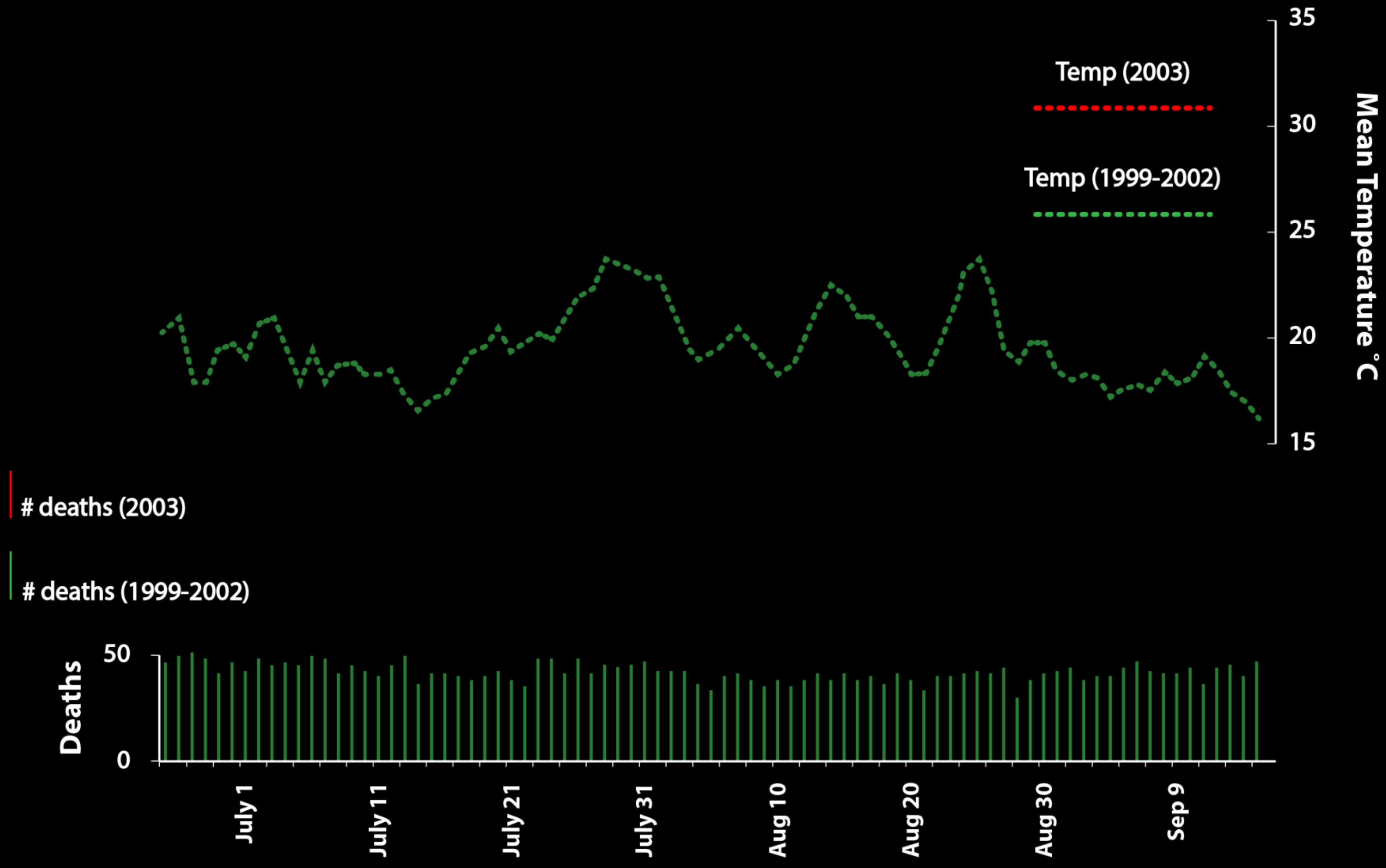
Existing Streetscape

American Society of Landscape Architects http://www.asla.org/sustainablelandscapes/Vid_UrbanForests.html

Retrofitted Streetscape

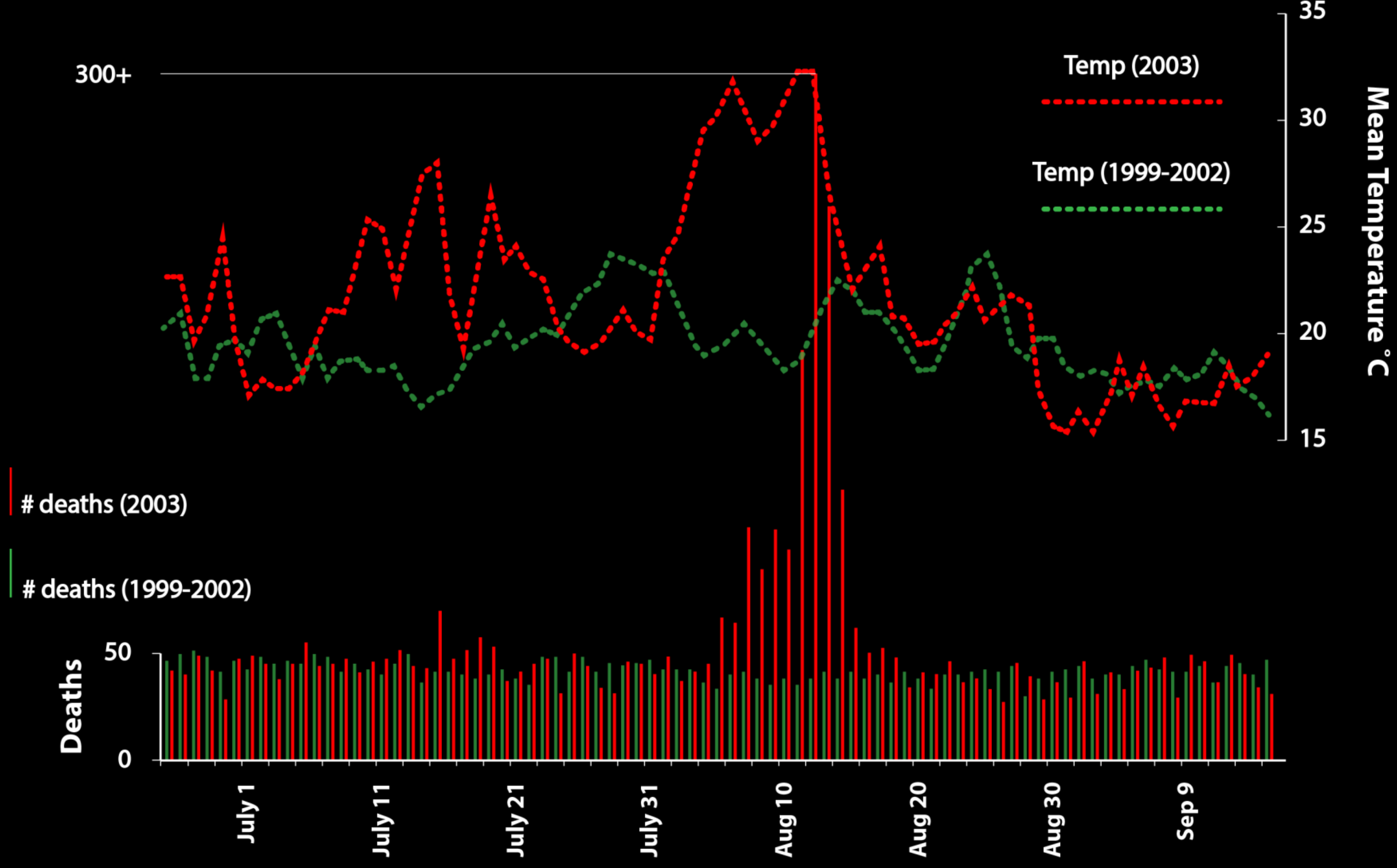
American Society of Landscape Architects http://www.asla.org/sustainablelandscapes/Vid_UrbanForests.html

Extreme Heat and Excess Mortality



Vandentorren, Stéphanie, Florence Suzan, Sylvia Medina, Mathilde Pascal, Adeline Maulpoix, Jean-Claude Cohen, and Martine Ledrans. "Mortality in 13 French cities during the August 2003 heat wave."American Journal of Public Health 94, no. 9 (2004): 1518-1520.

Extreme Heat and Excess Mortality



Vandentorren, Stéphanie, Florence Suzan, Sylvia Medina, Mathilde Pascal, Adeline Maulpoix, Jean-Claude Cohen, and Martine Ledrans. "Mortality in 13 French cities during the August 2003 heat wave."American Journal of Public Health 94, no. 9 (2004): 1518-1520.

Health Impacts

Study	Temperature metric	Relative risk	Mortality type	Study population
Zanobetti and Schwartz, 2008	mean daily apparent temperature (May-Sept)	1.018 (1.0109, 1.025) per 5.55°C (O_3 and $PM_{2.5}$ adjusted)	non-accidental	all ages in 9 US cities (1999–2002)
Medina-Ramon and Schwartz, 2007	minimum daily T (May-Sept) above 17°C; measured as 2-day cumulative T	1.0043 (1.0024, 1.0061) per 1°C (O_3 adjusted)	all cause	all ages in 42 US cities (1989–2000)

Health Impacts

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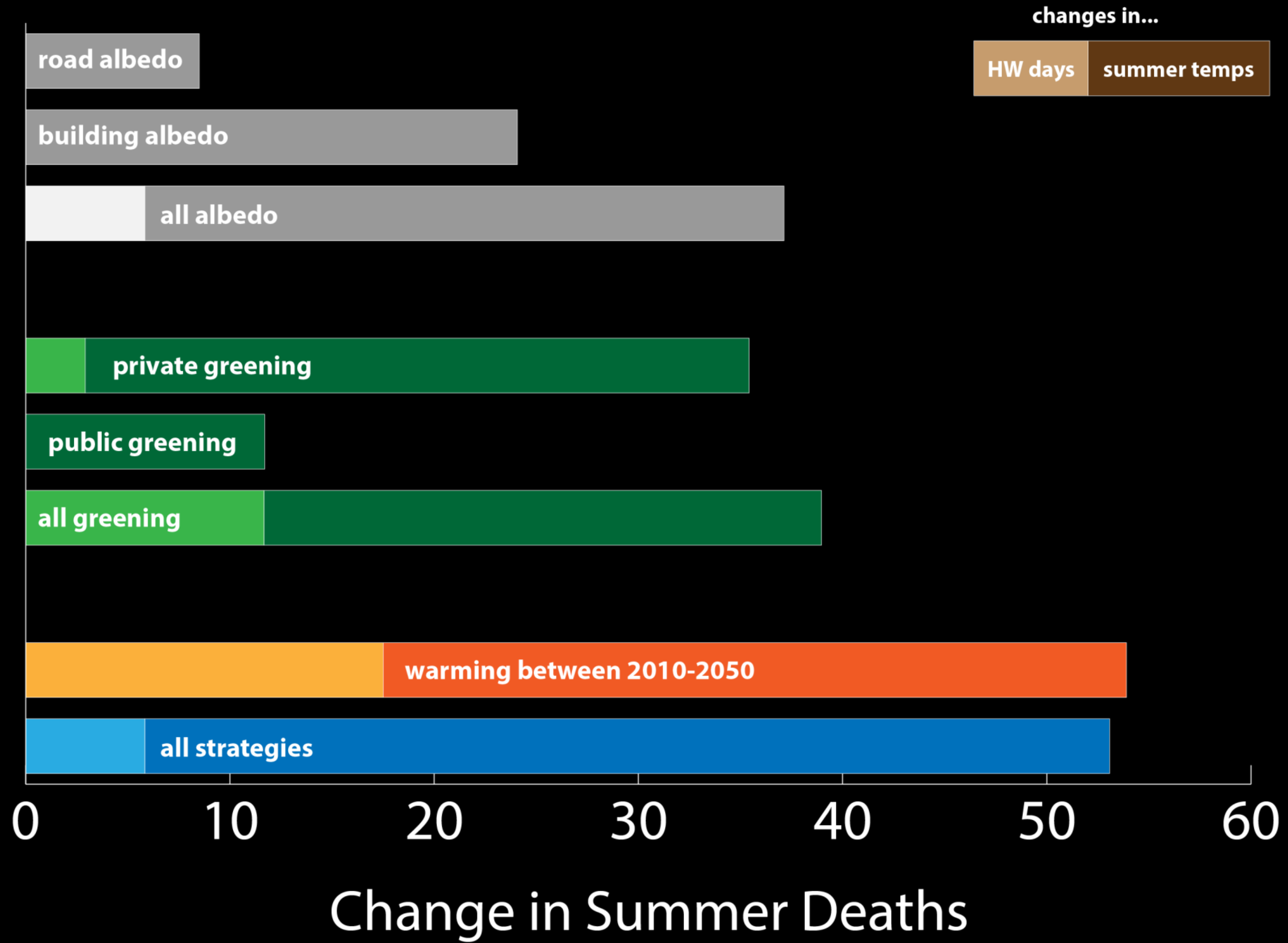
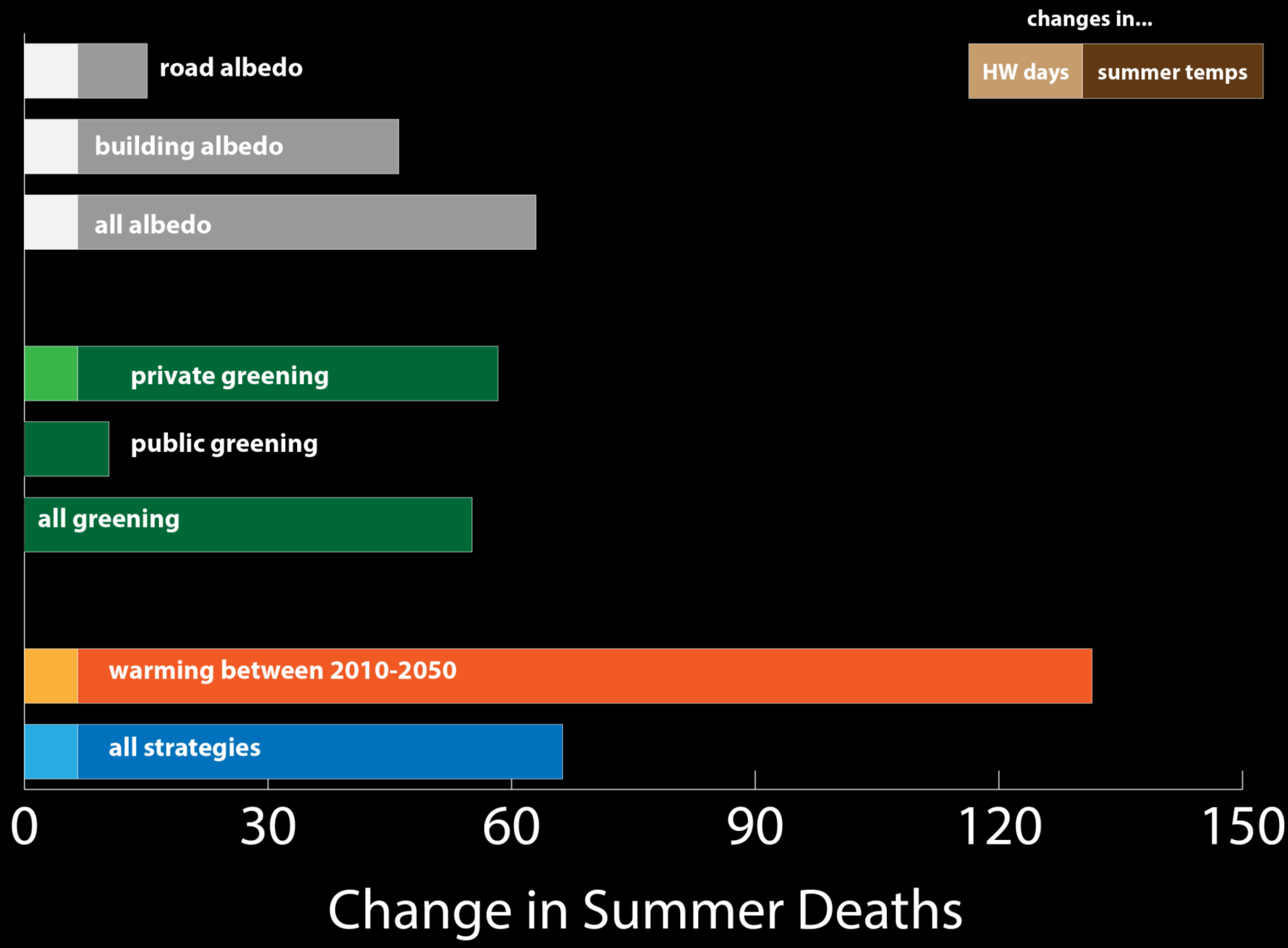
Anderson and Bell, 2011	heat wave periods classified as 2 or more days with mean daily T above 95th percentile of 1987–2005 average for May-Sept	1.0367 (1.0295, 1.0439) per heat wave day	non-accidental	all ages in 43 US cities (1987–2005)

Atlanta

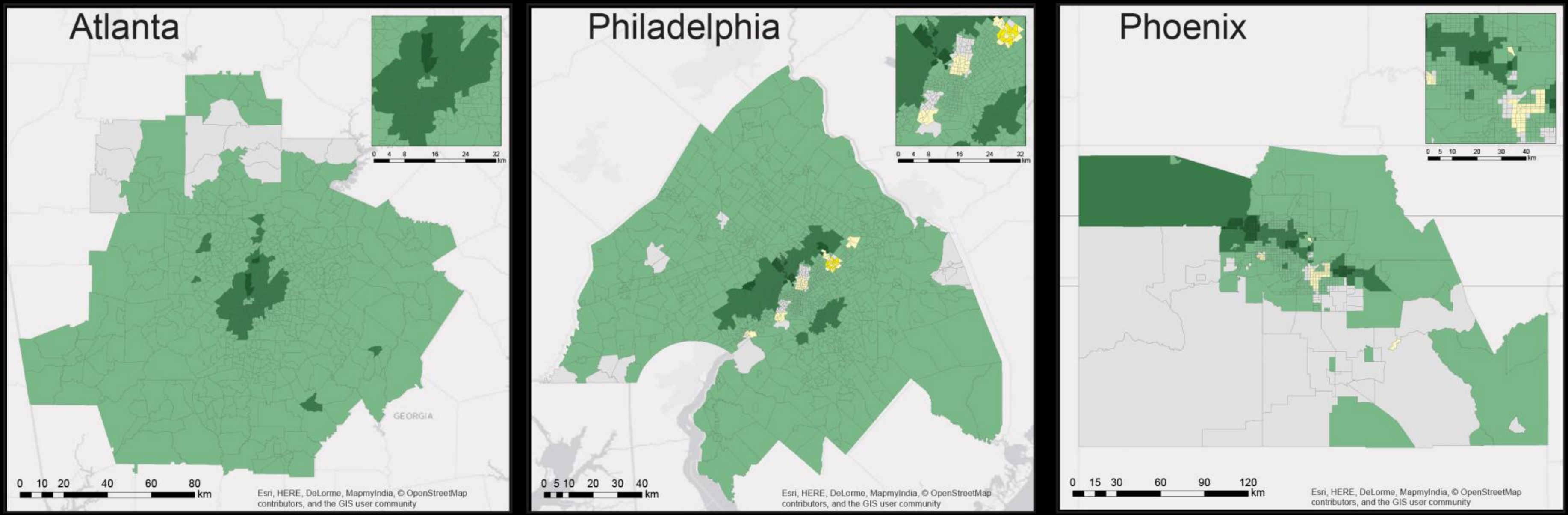

changes in...
HW days
summer temps
road albedo
building albedo
all albedo
private greening
public greening
all greening
warming between 2010-2050
all strategies
0
10
20
30
40
50
60
Change in Summer Deaths

Phoenix



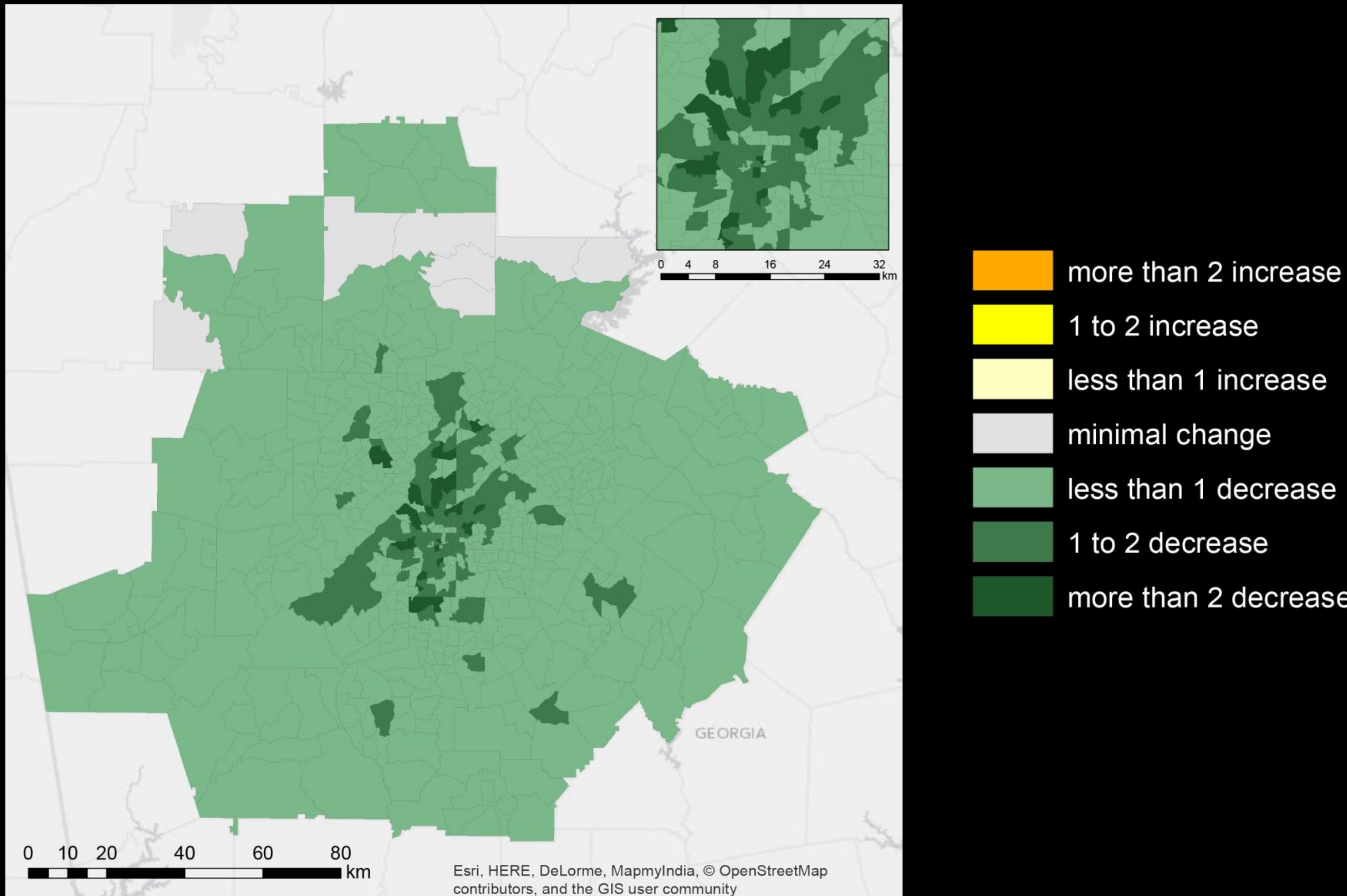
changes in...
HW days
summer temps
road albedo
building albedo
all albedo
private greening
public greening
all greening
warming between 2010-2050
all strategies
0
30
60
90
120
150
Change in Summer Deaths

Health Impacts



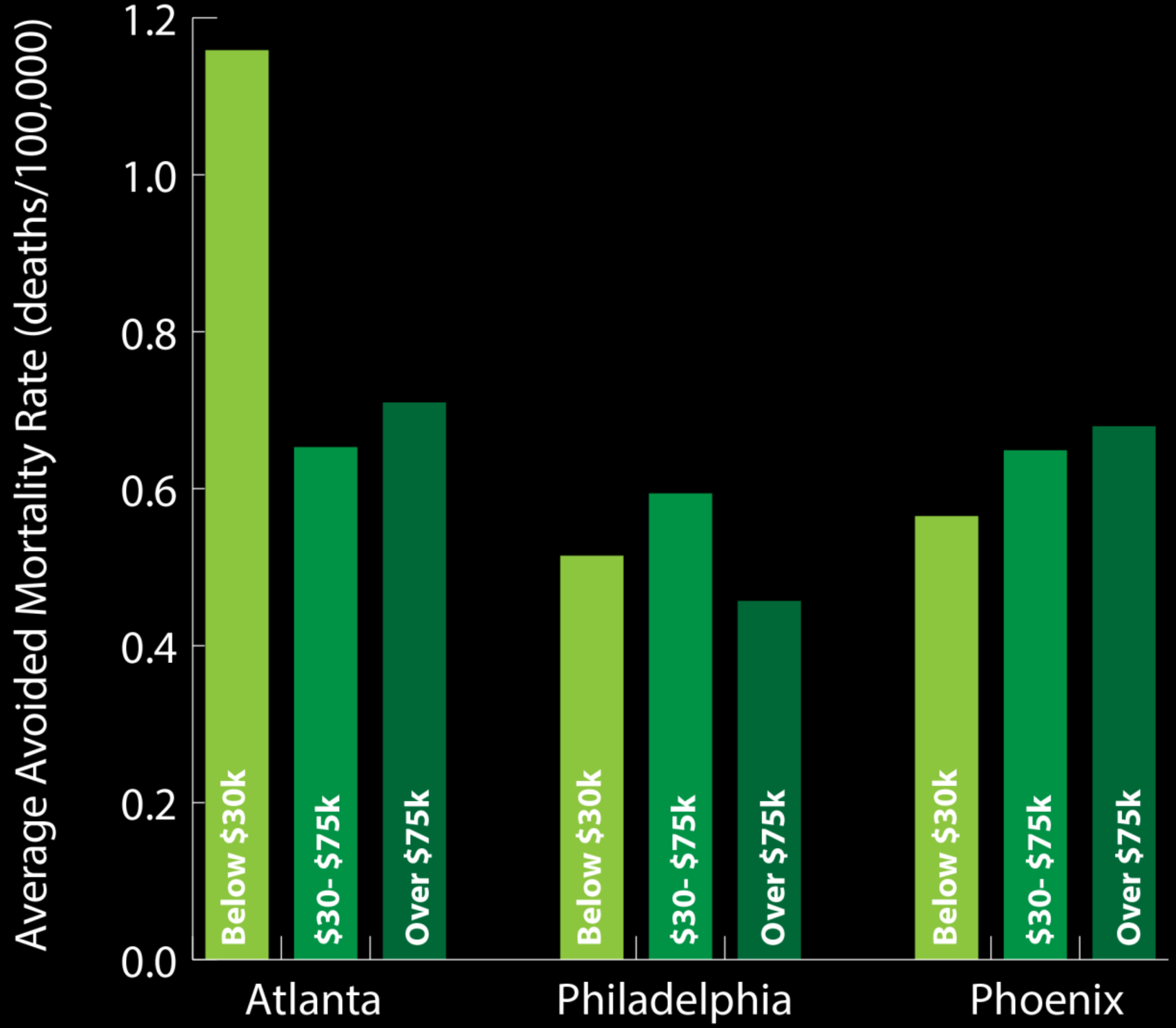
change in mortality/100,000

- more than 2 increase
- 1 to 2 increase
- less than 1 increase
- minimal change
- less than 1 decrease
- 1 to 2 decrease
- more than 2 decrease

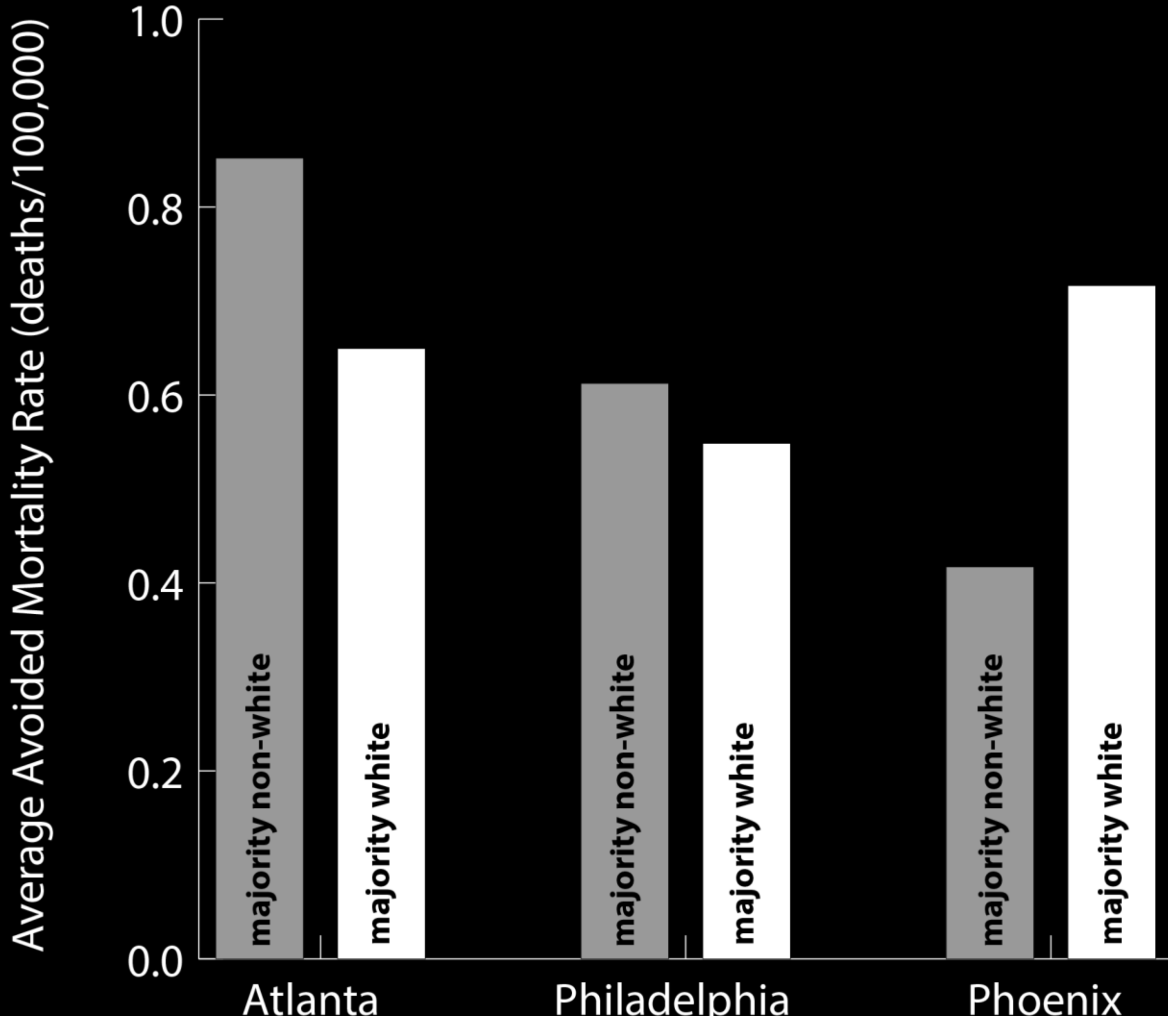


0 4 8 16 24 32 km
more than 2 increase
1 to 2 increase
less than 1 increase
minimal change
less than 1 decrease
1 to 2 decrease
more than 2 decrease
GEORGIA
0 10 20 40 60 80 km
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Median HH Income

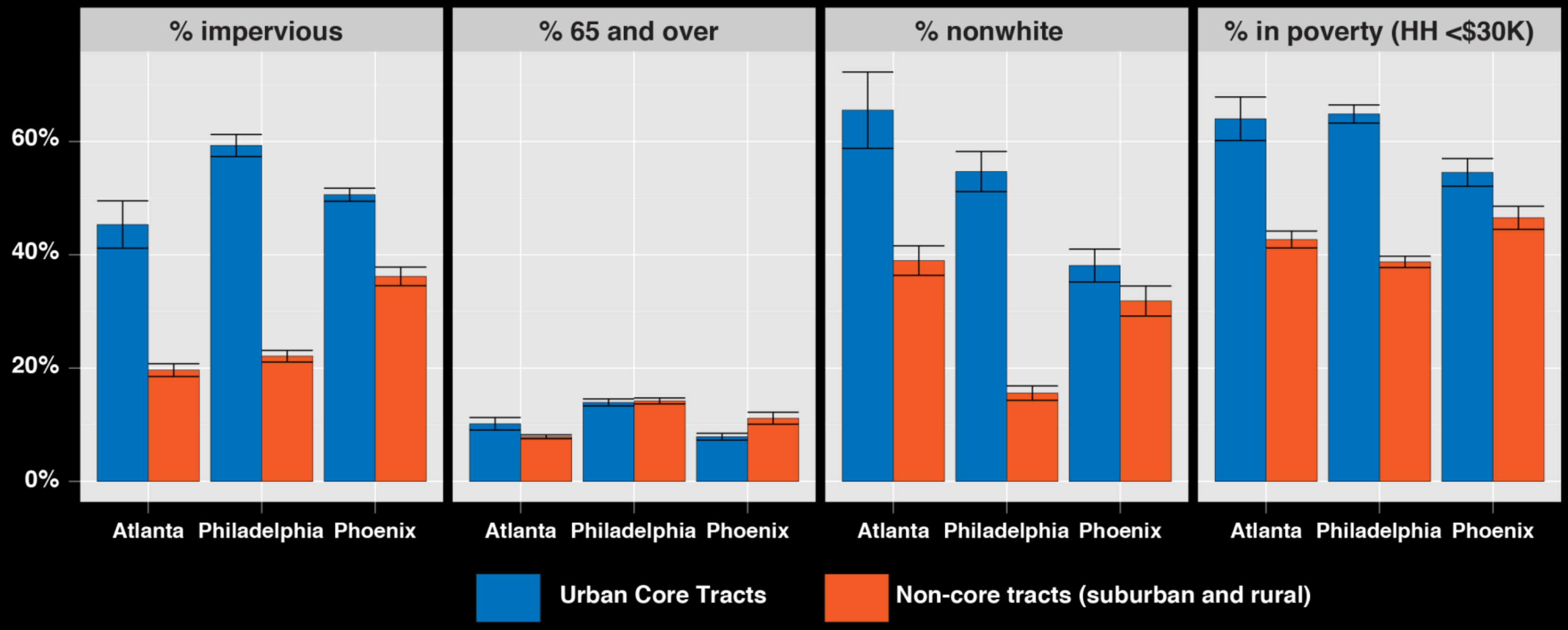


Race

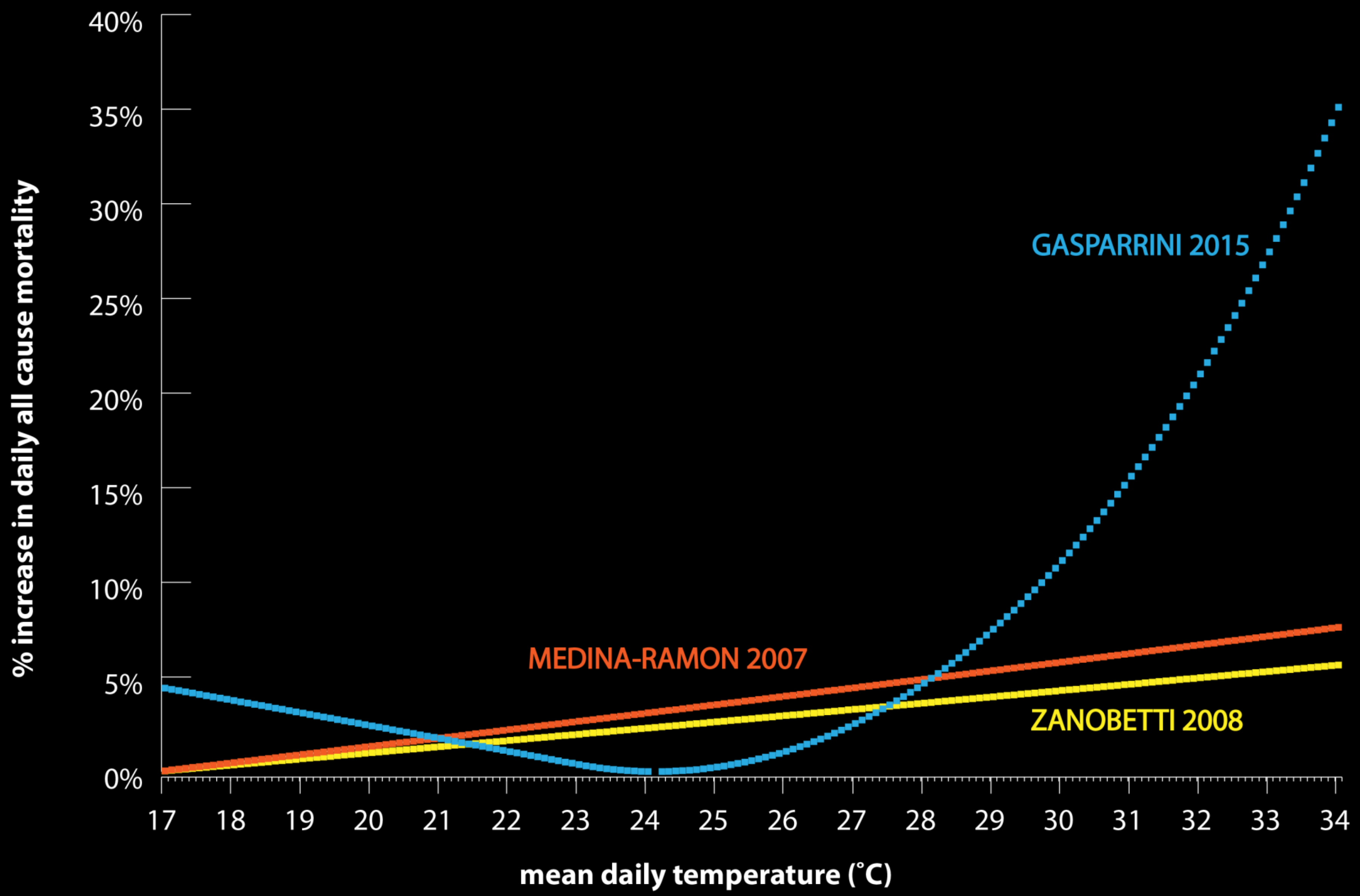


Average Avoided Mortality Rate (deaths/100,000)
1.0
0.8
0.6
0.4
0.2
0.0
majority non-white
majority white
majority non-white
majority white
majority non-white
majority white
Atlanta
Philadelphia
Phoenix

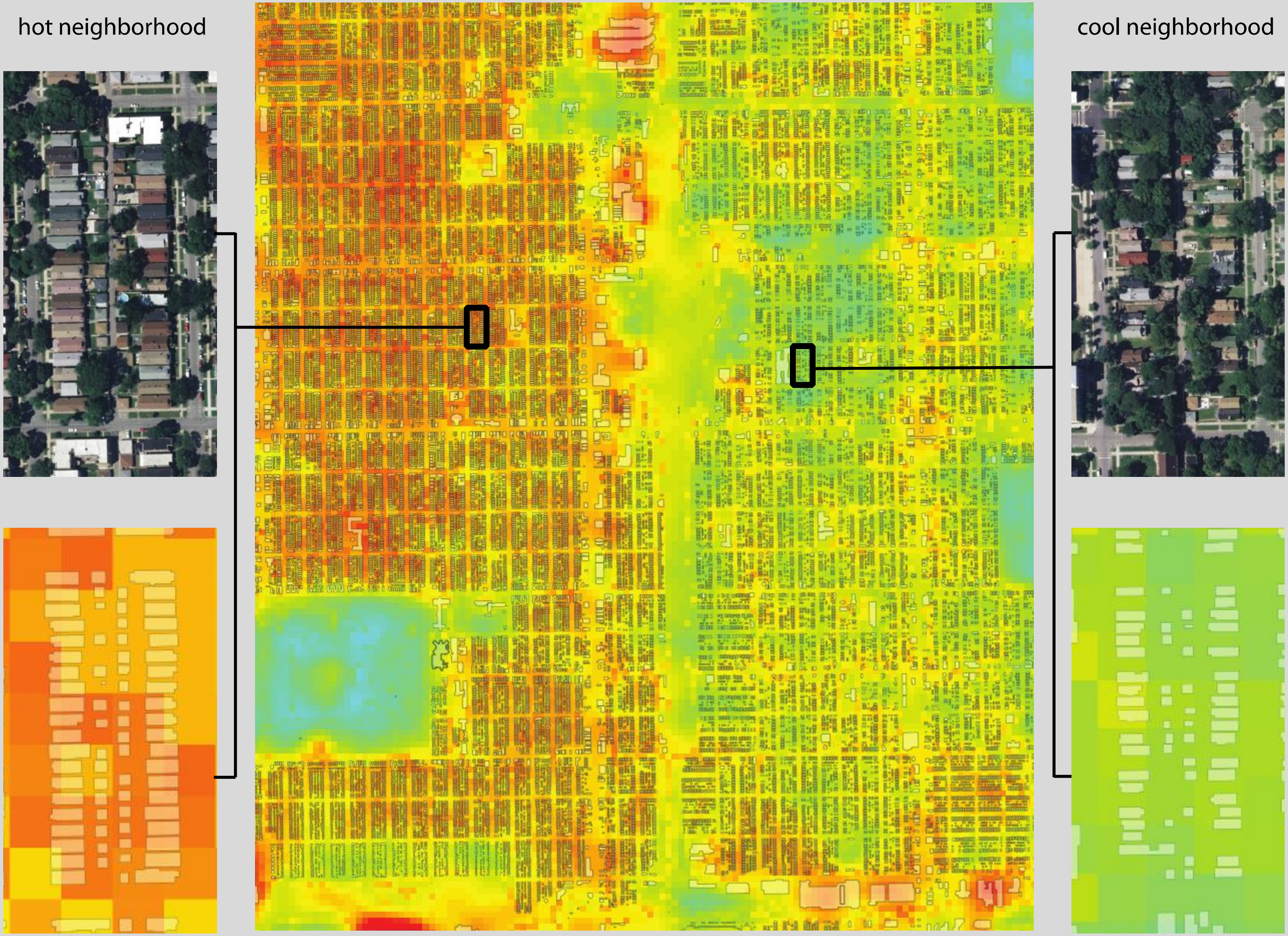
Spatial Patterns



New Directions


40%
35%
30%
25%
20%
15%
10%
5%
0%
% increase in daily all cause mortality
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
mean daily temperature (˚C)
GASPARRINI 2015
MEDINA-RAMON 2007
ZANOBETTI 2008

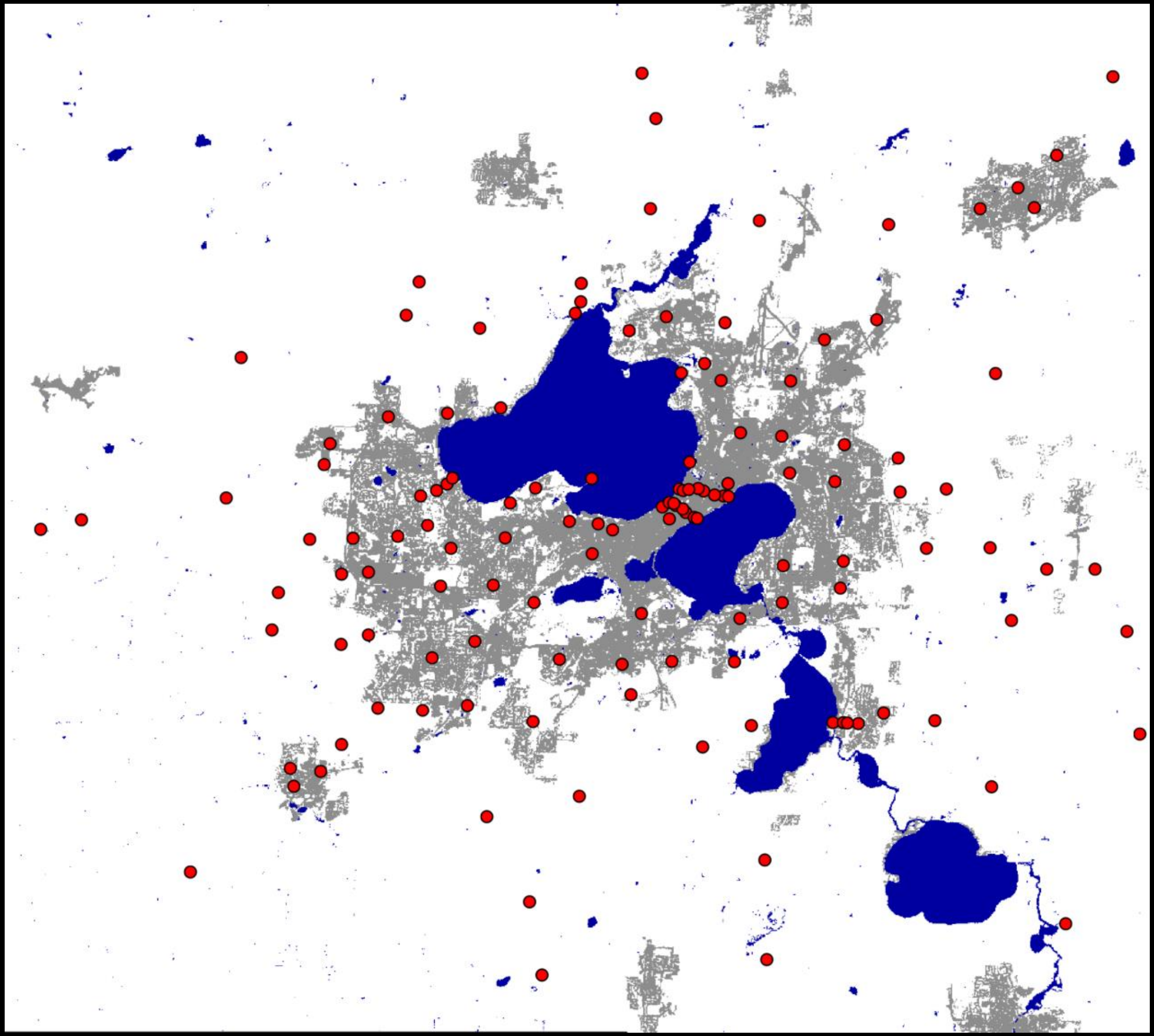
Block Level



71 buildings
39 houses
36% footprint

57 buildings
35 houses
22% footprint

Madison UHI Network



Courtesy: Jason Schatz

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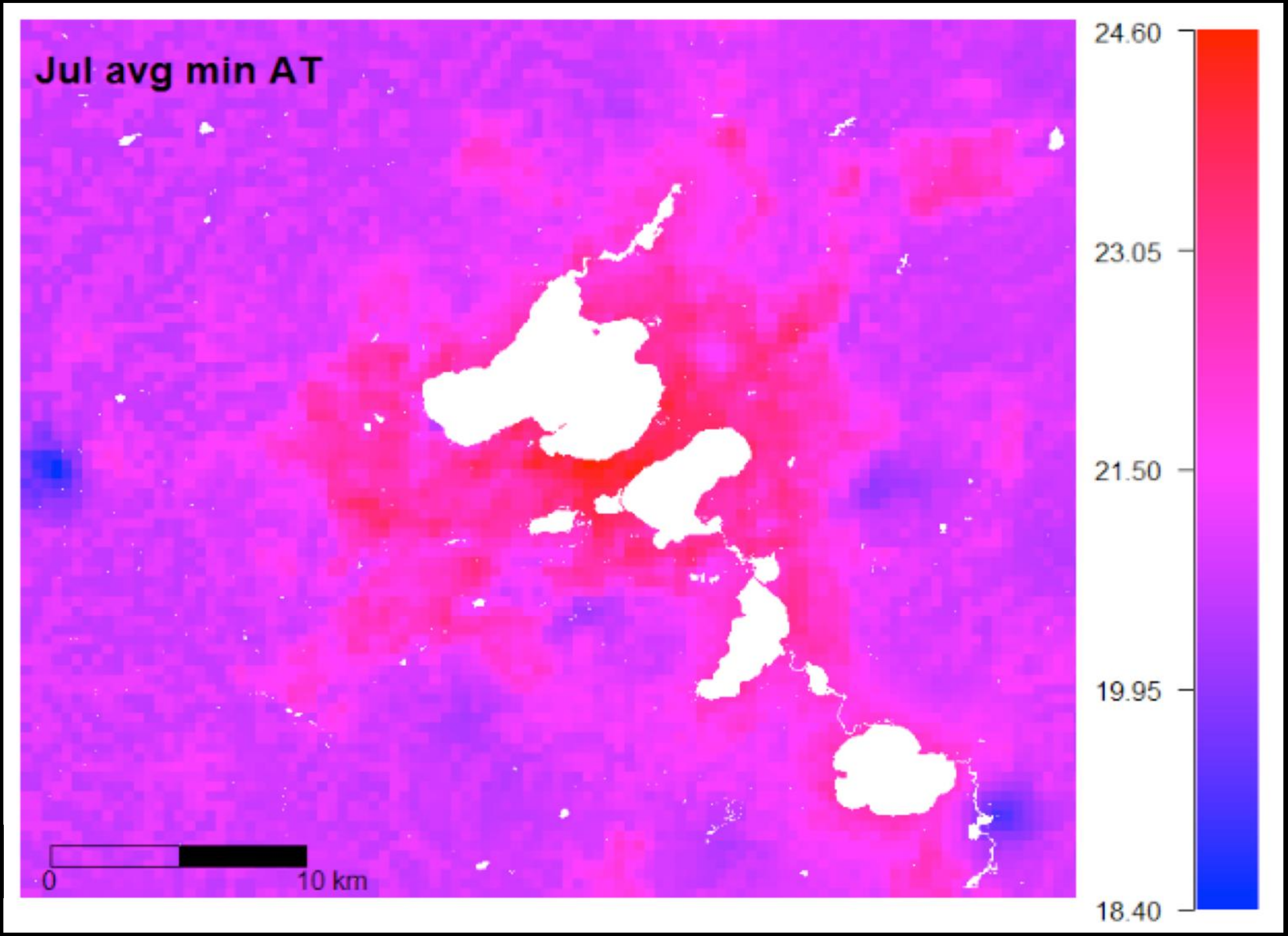
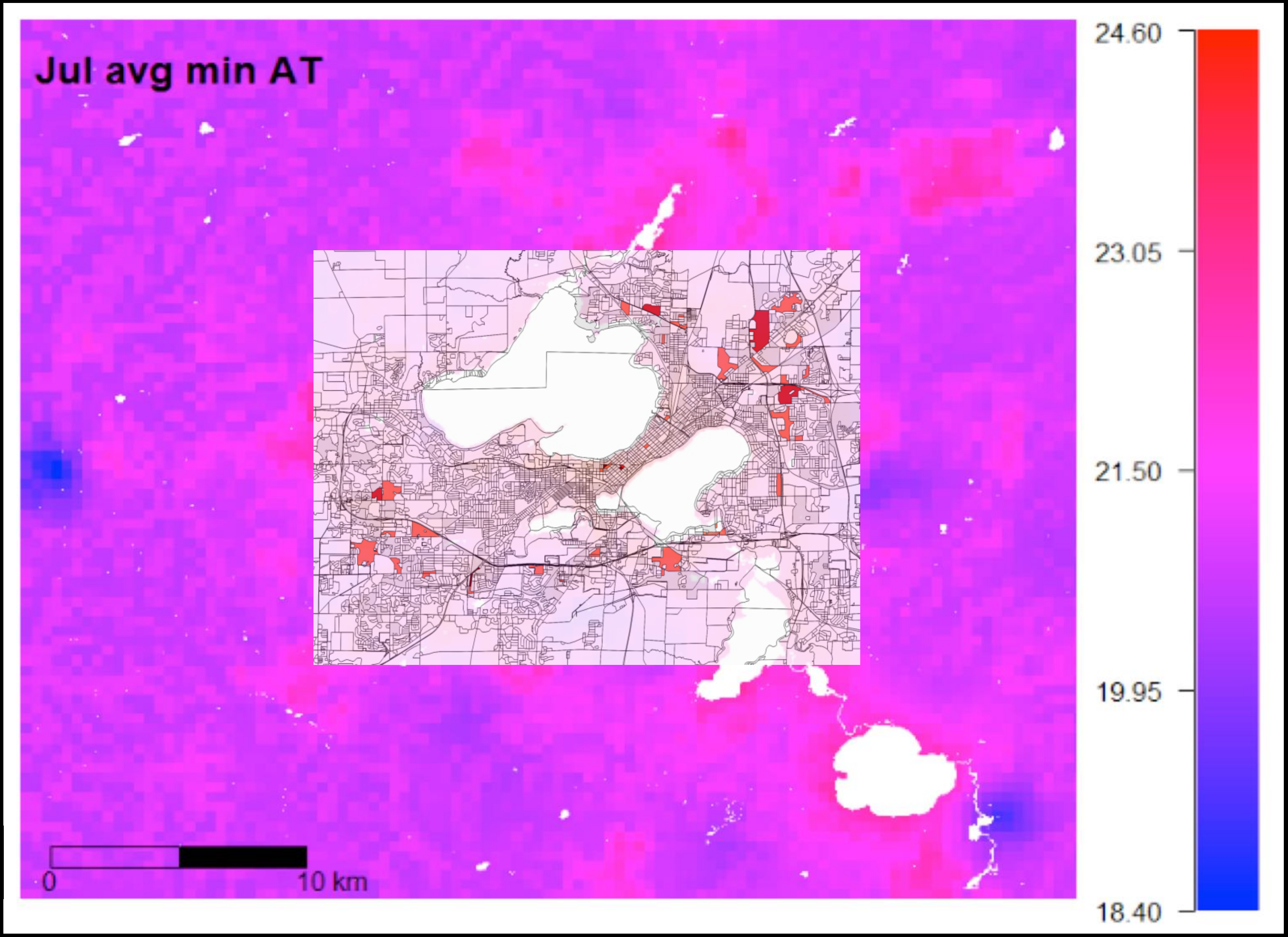
Madison UHI Network



Courtesy: Jason Schatz

Intra-city Heat and Health



Courtesy: Jason Schatz

Heat Waves

Resilience to extreme weather
The Royal Society Science Policy Centre report 02/14

CONCLUSIONS

UHI countermeasures effectively reduce temperatures

By 2050 these countermeasures could offset 50%-98% of increases in heat-related mortality

Research is pushing to quantify the health benefits more accurately

There is ample evidence already to support local action

Combining health benefits with the many other co-benefits of UHI prevention methods is needed and likely to be most effective with public/private partners

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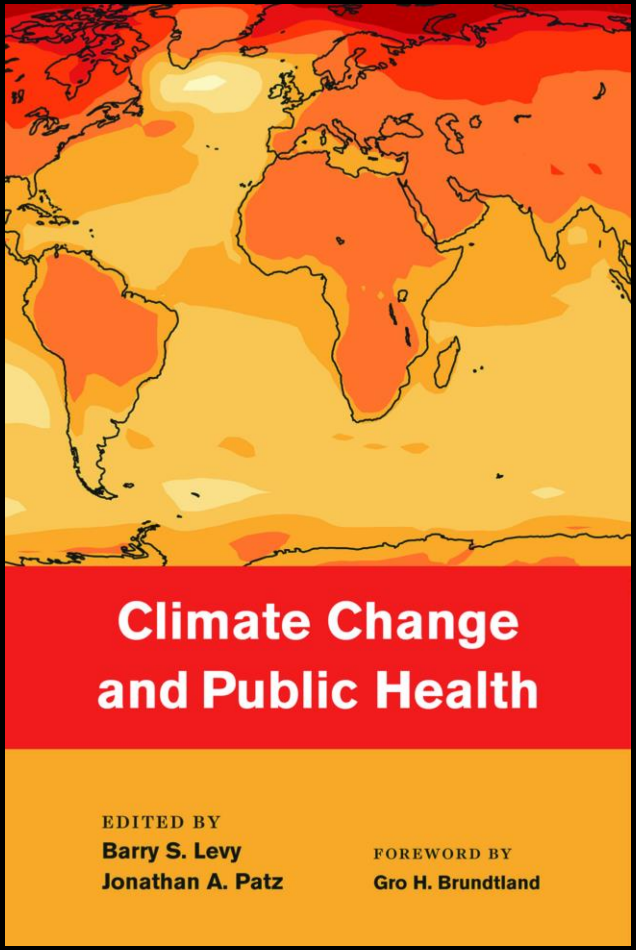
https://moocs.wisc.edu/mooc/climate-change-policy-and-public-health/



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