Greening and Health Equity Direct Benefits

CA CAT Public Health Work Group Meeting

Oct 17, 2017
Sacramento, CA

Jason Vargo
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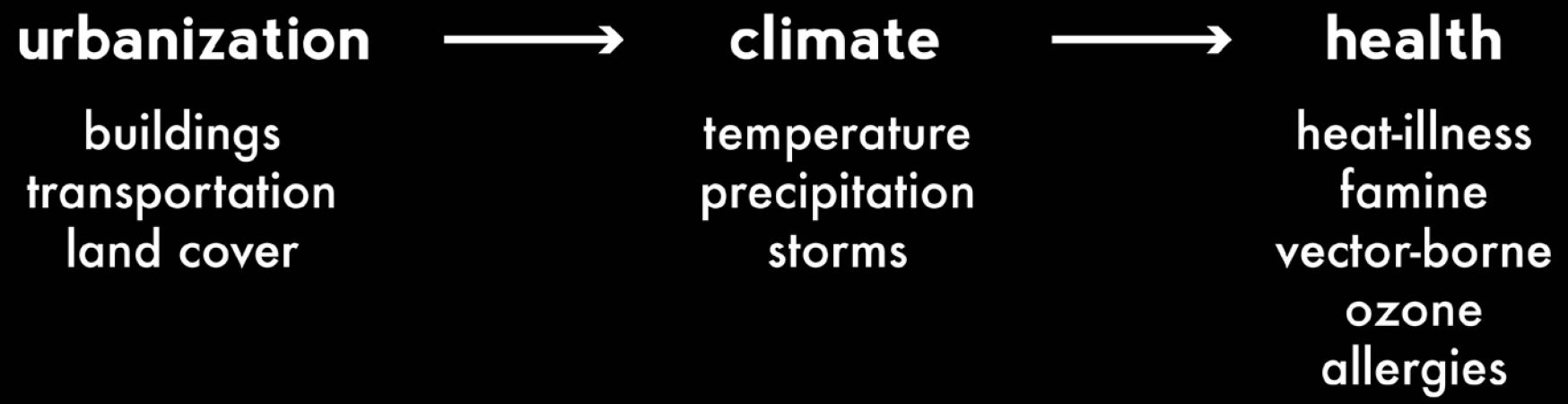
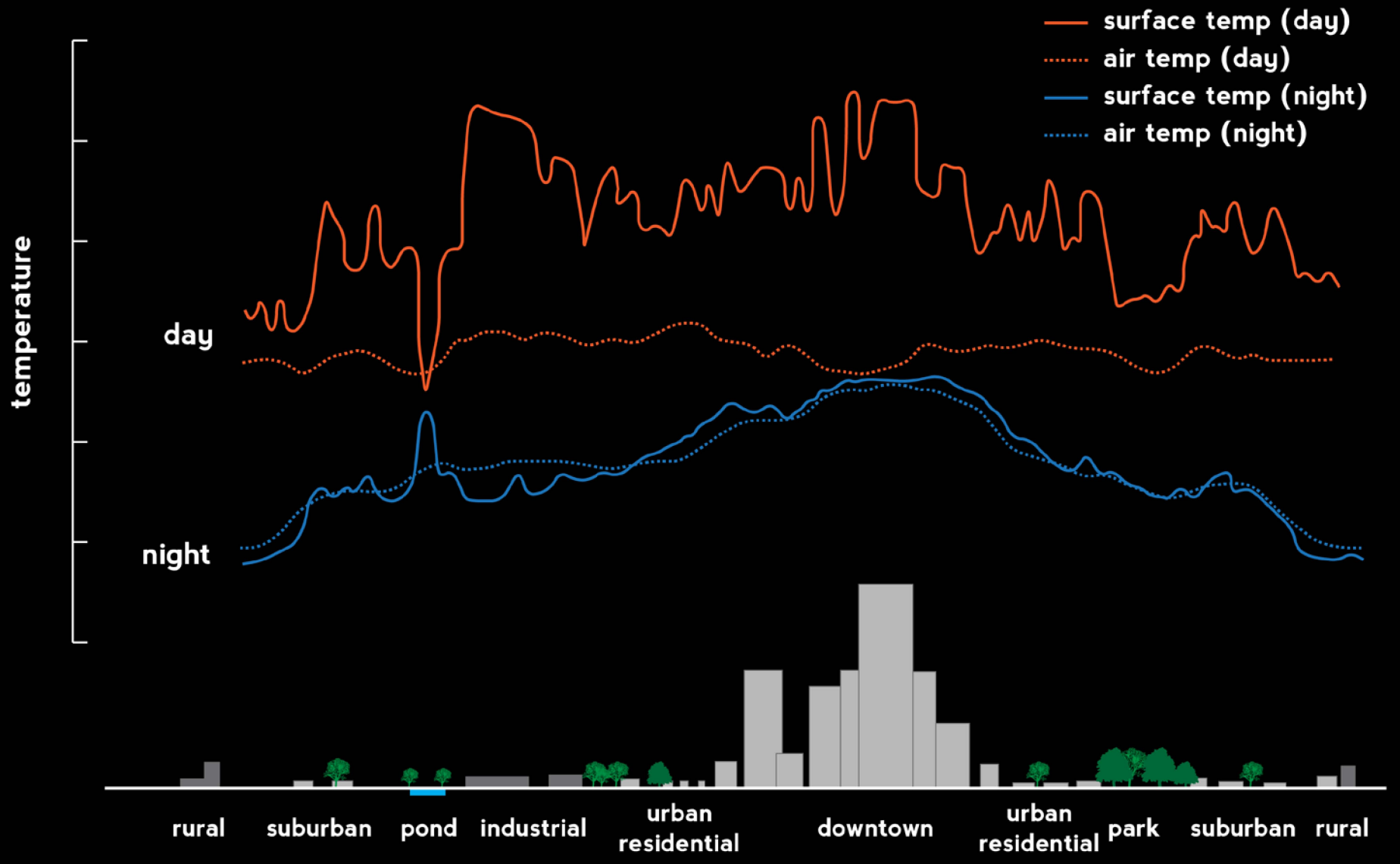
climate → **health**

temperature
precipitation
storms

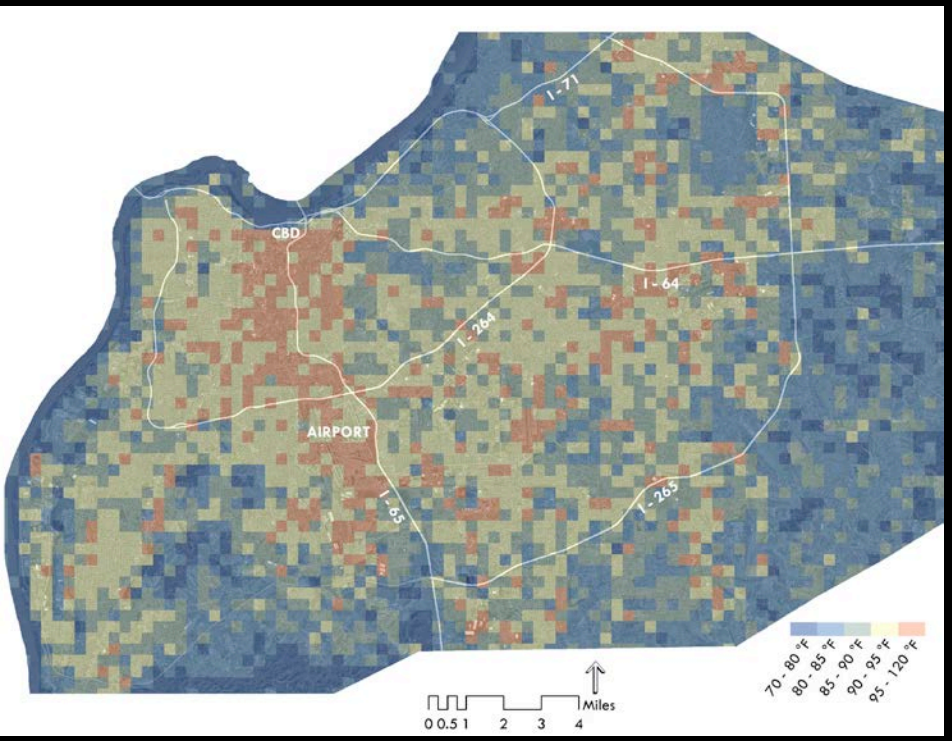
heat-illness
famine
vector-borne
ozone
allergies


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

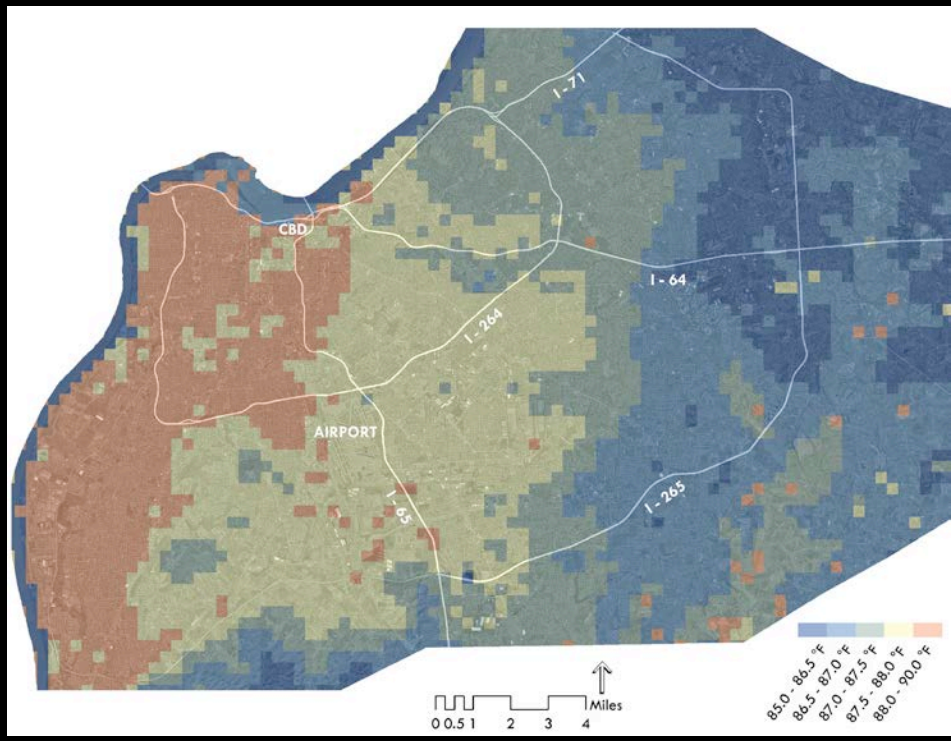


adapted from USEPA, http://www.epa.gov/heatisld/images/UHI_profile-rev-big.gif

Prioritizing human health

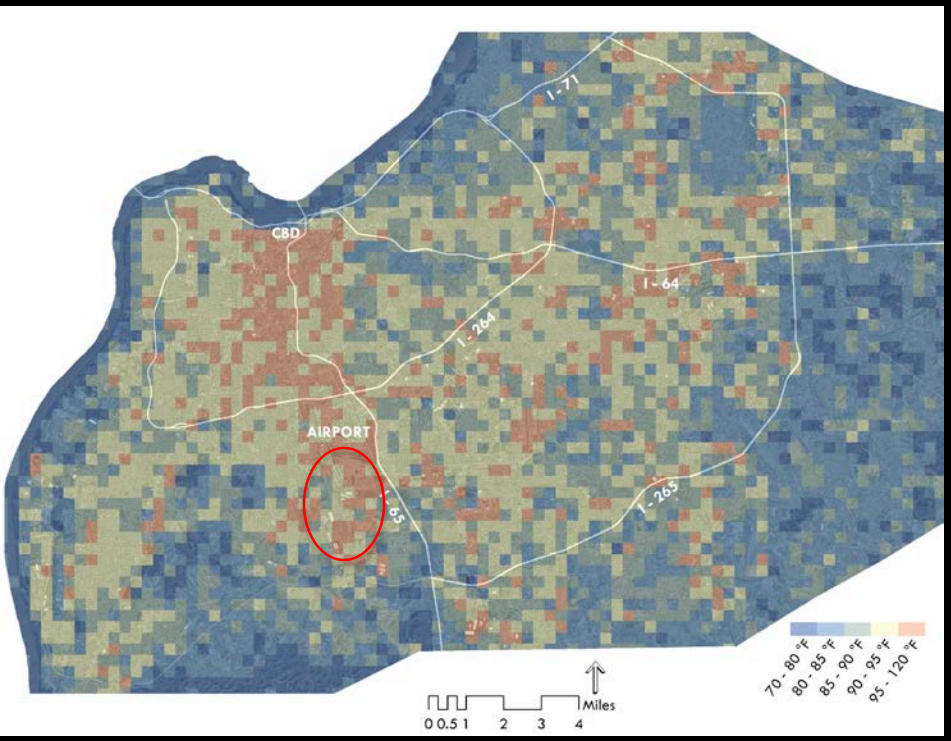


land surface temperature

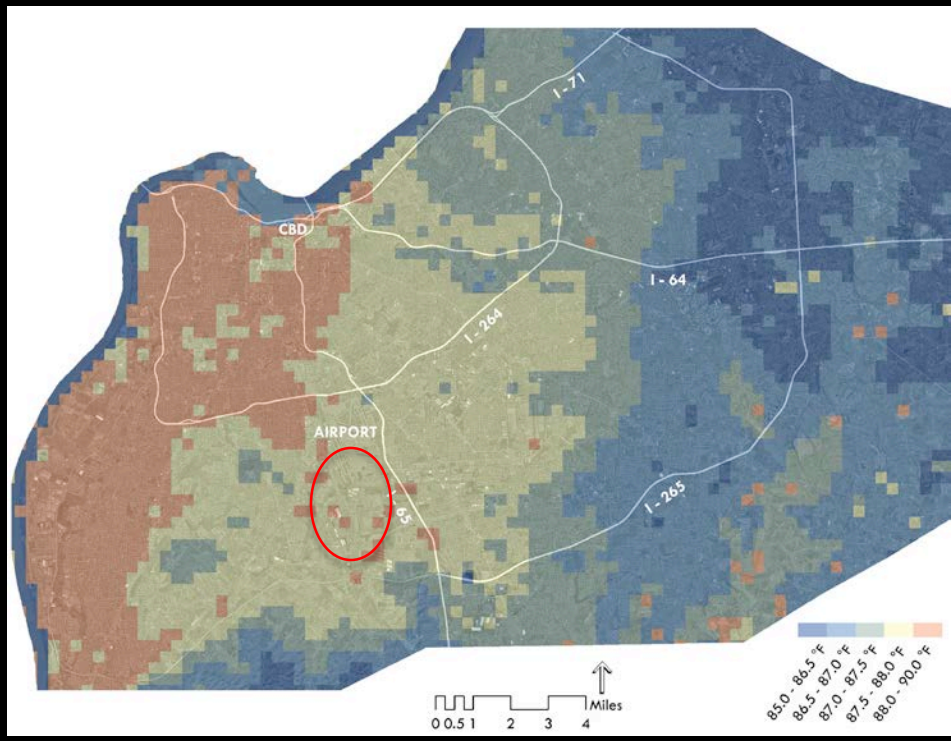


air temperature

= industrial

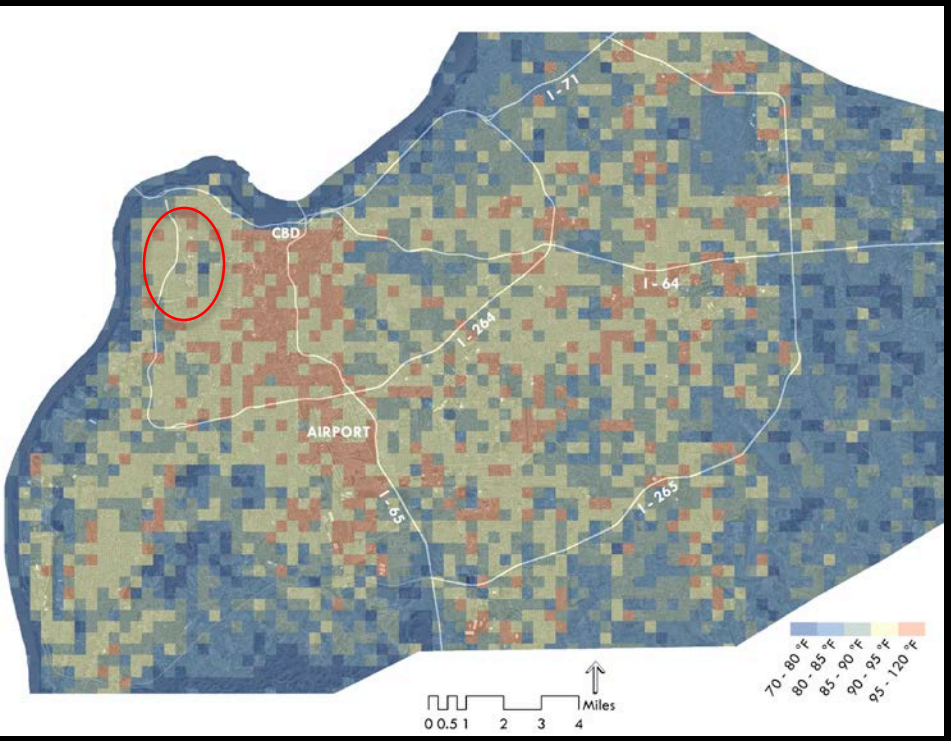


land surface temperature

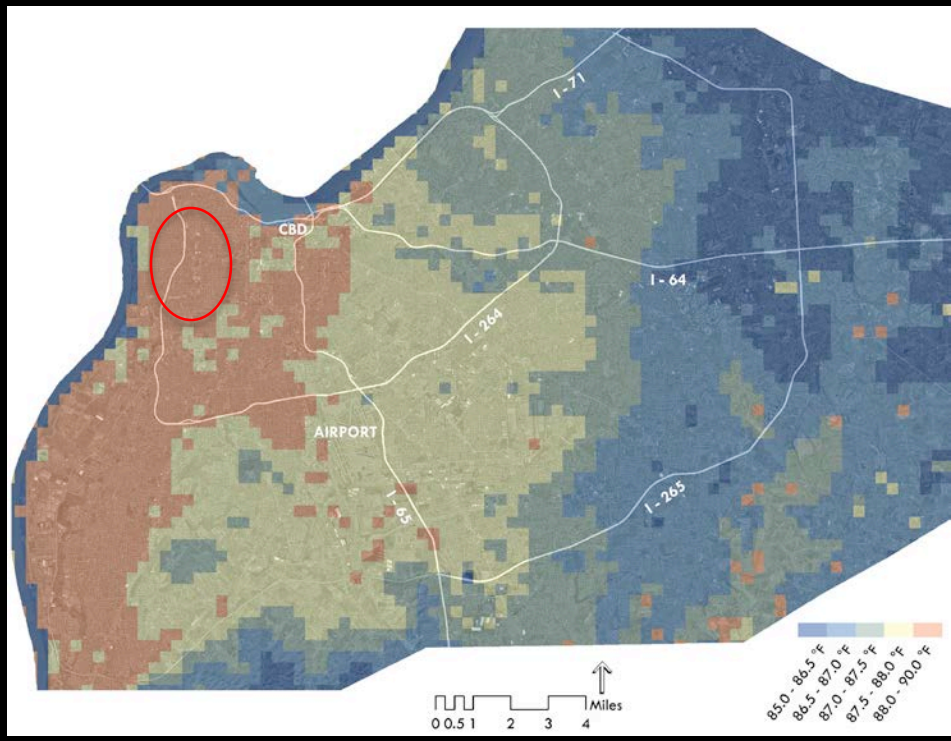


air temperature

= residential

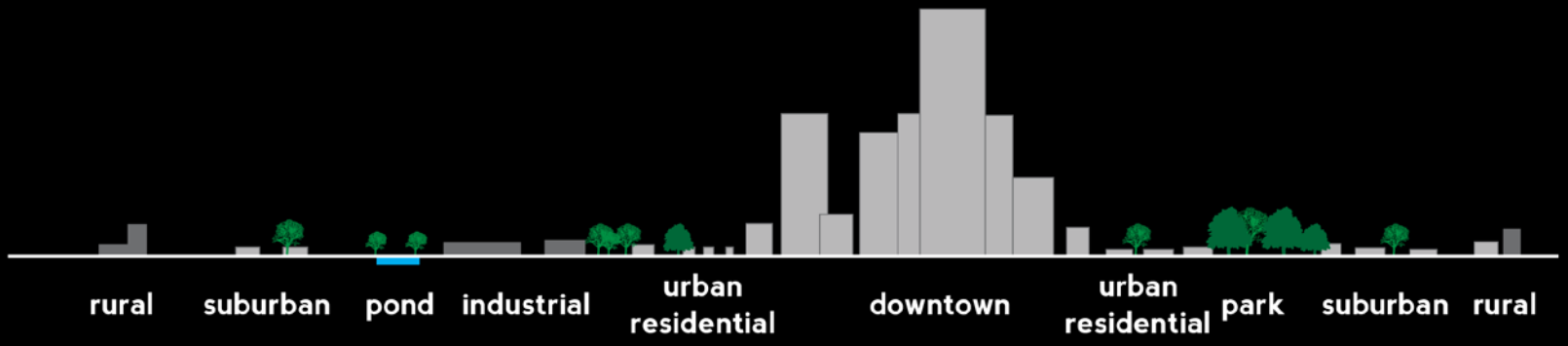


land surface temperature

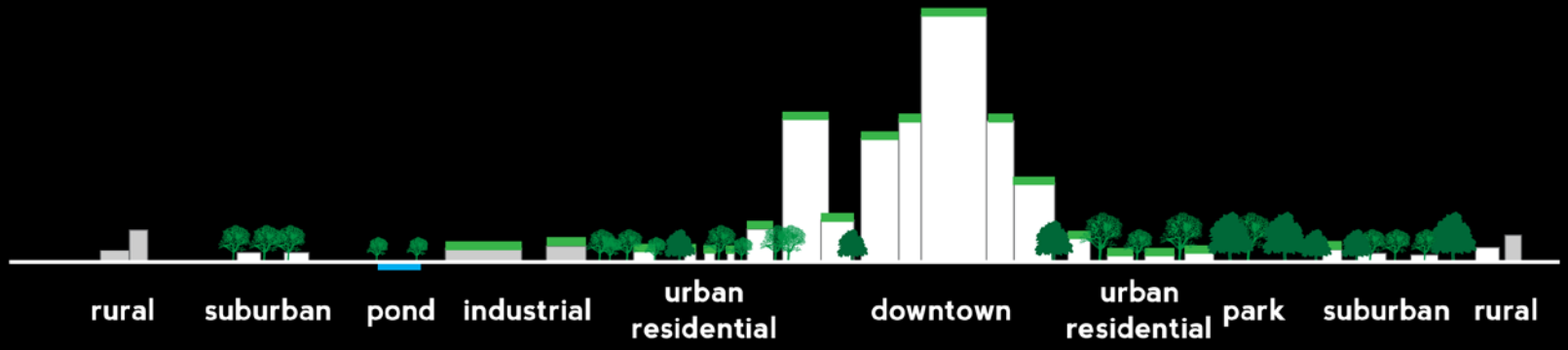


air temperature

Business as Usual



Scenarios



Existing Parking Lot

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

Retrofitted Parking Lot

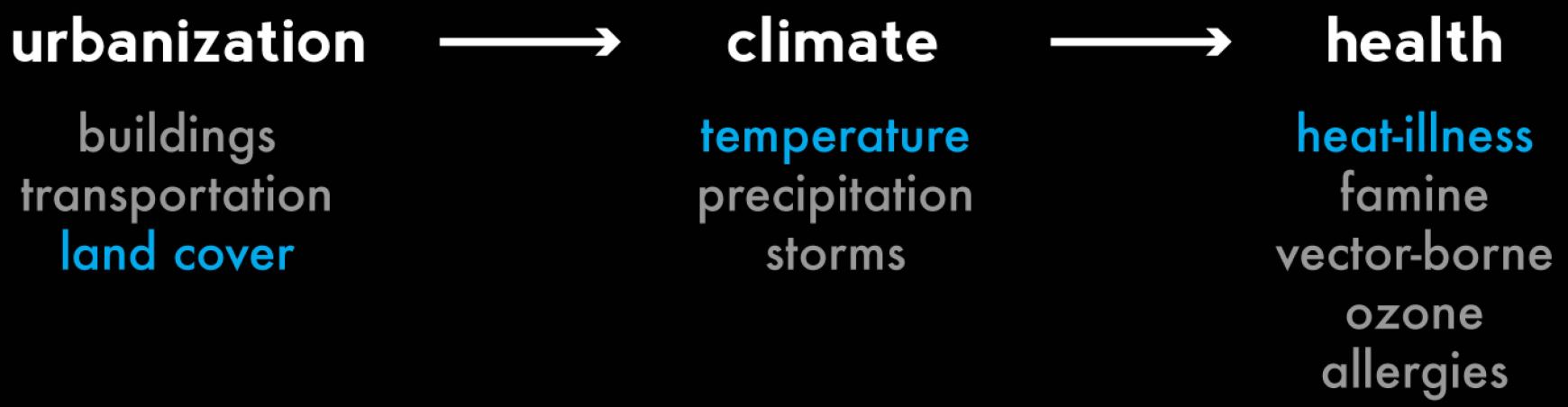
American Society of Landscape Architects http://www.asla.org/sustainablelandscapes/vid_UrbanForests.html

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

https://louisvilleky.gov/government/sustainability/urban-heat-island-project

www.texastrees.org

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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.

Citation: Stone B Jr, Vargo J, Liu P, Habeeb D, DeLucia A, et al. (2014) Avoided Heat-Related Mortality through Climate Adaptation Strategies in Three US Cities. PLOS ONE 9(6): e100852. doi:10.1371/journal.pone.0100852

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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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Competing Interests: The authors have declared that no competing interests exist.

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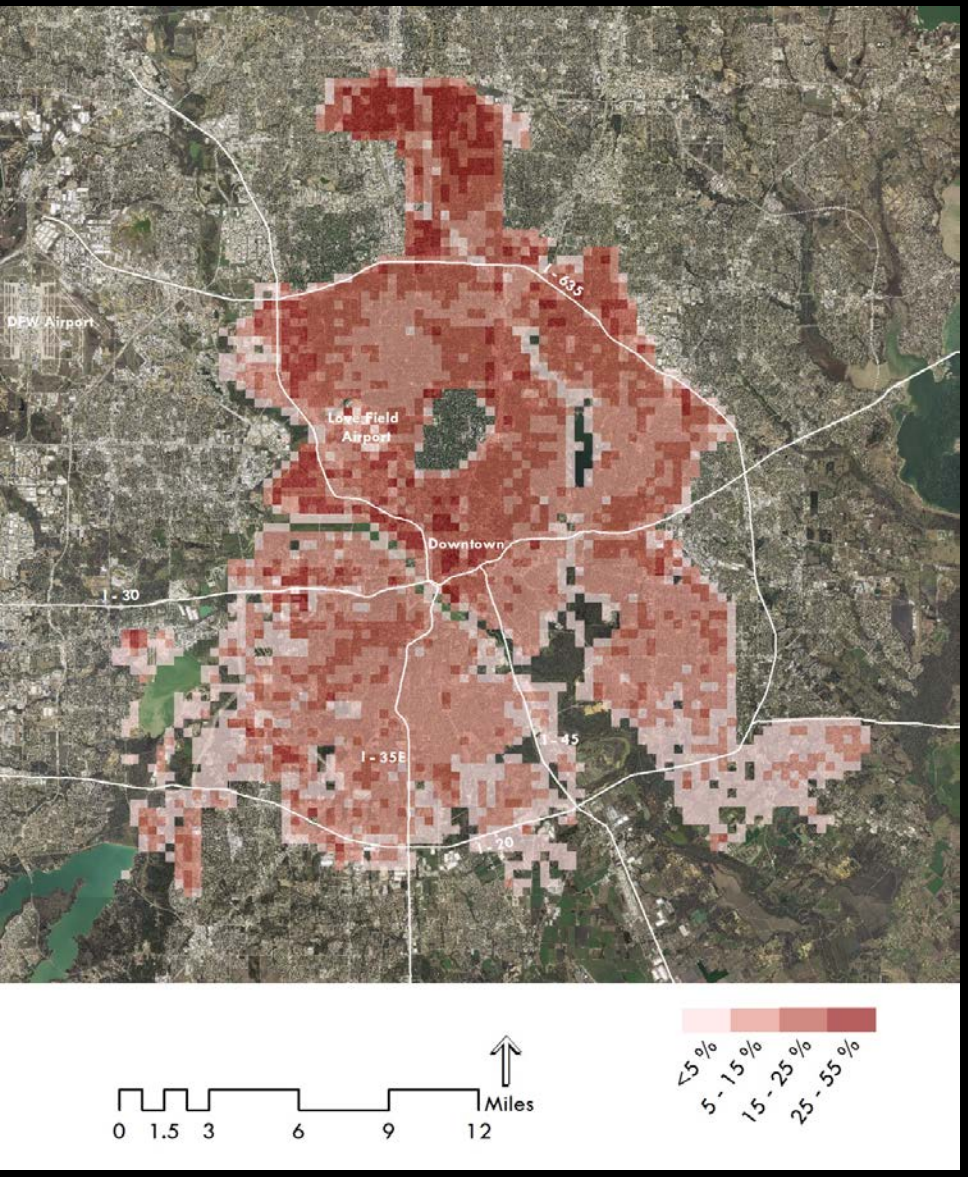
Introduction

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 9,300 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].

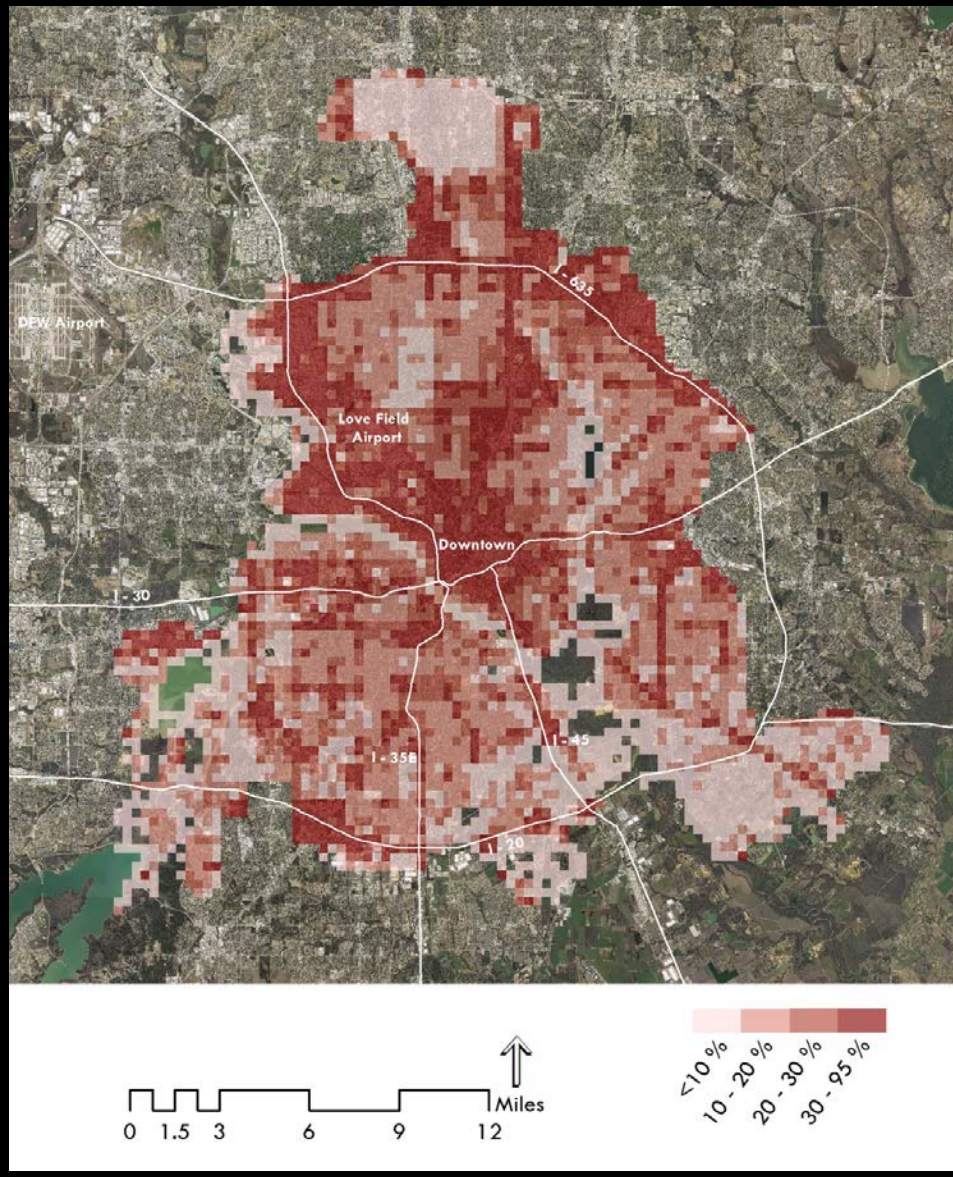
urban heat island effect may further increase heat-related mortality is not well established.

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

buildings

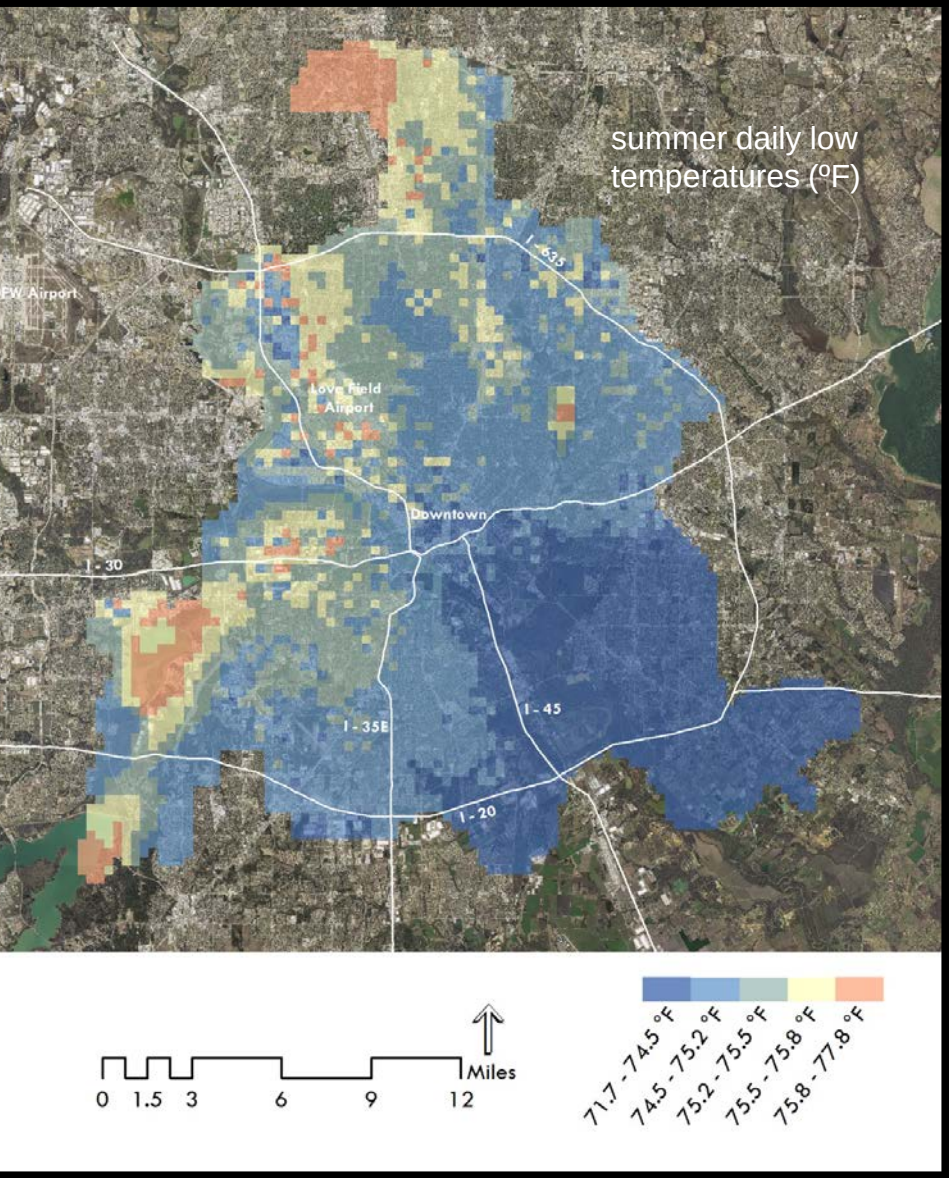


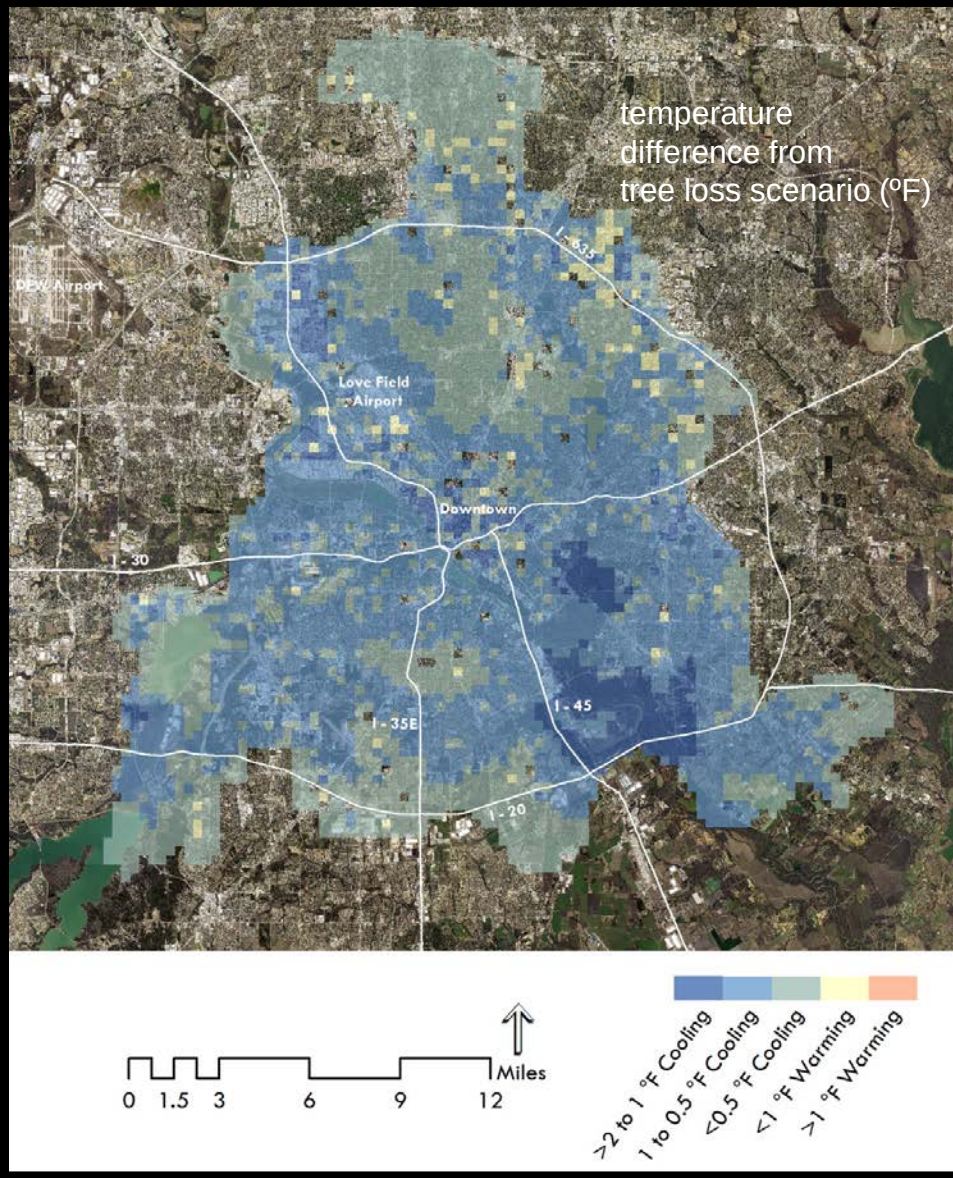
streets & parking lots



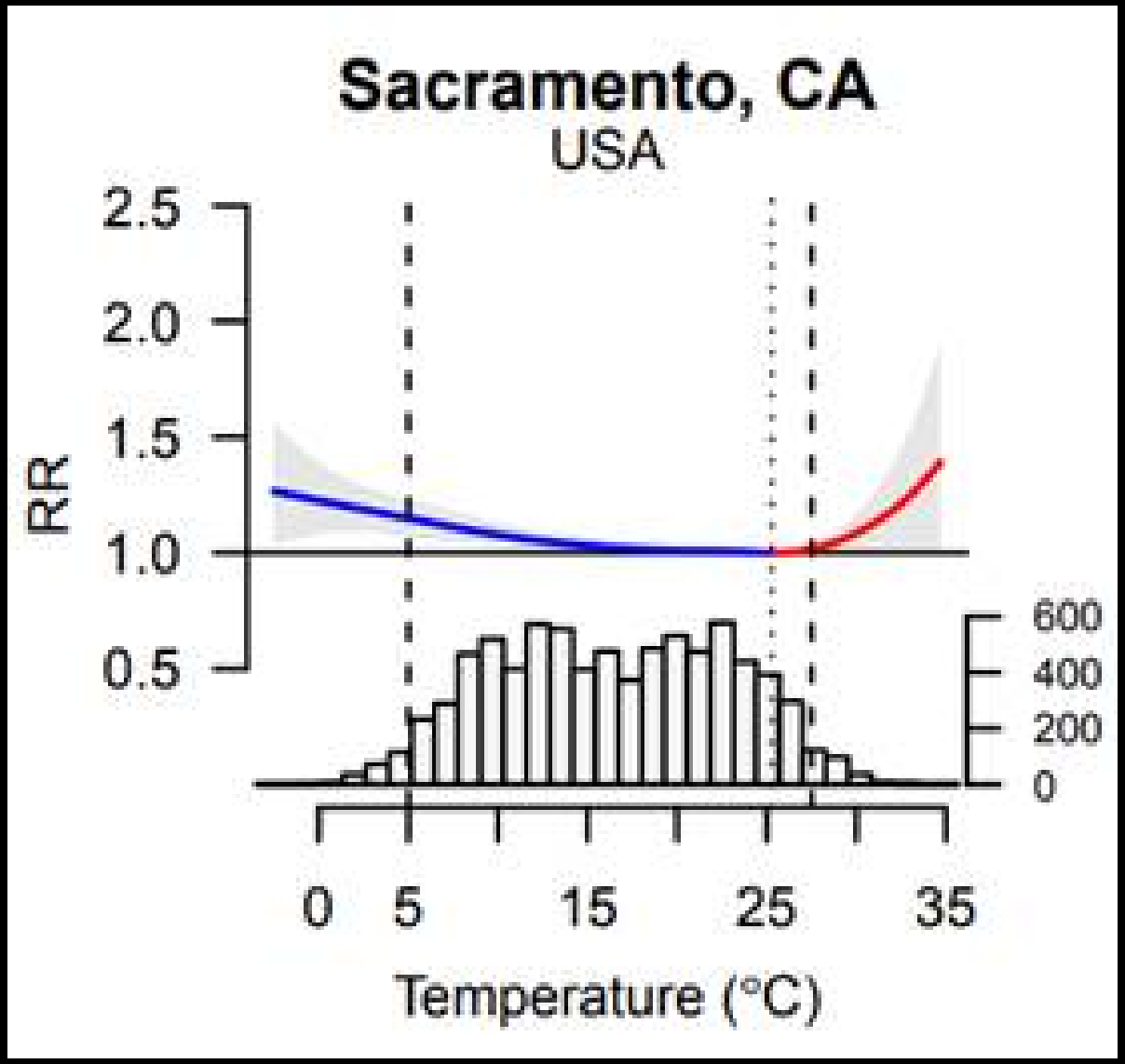
change in tree canopy under greening scenario

greening scenario

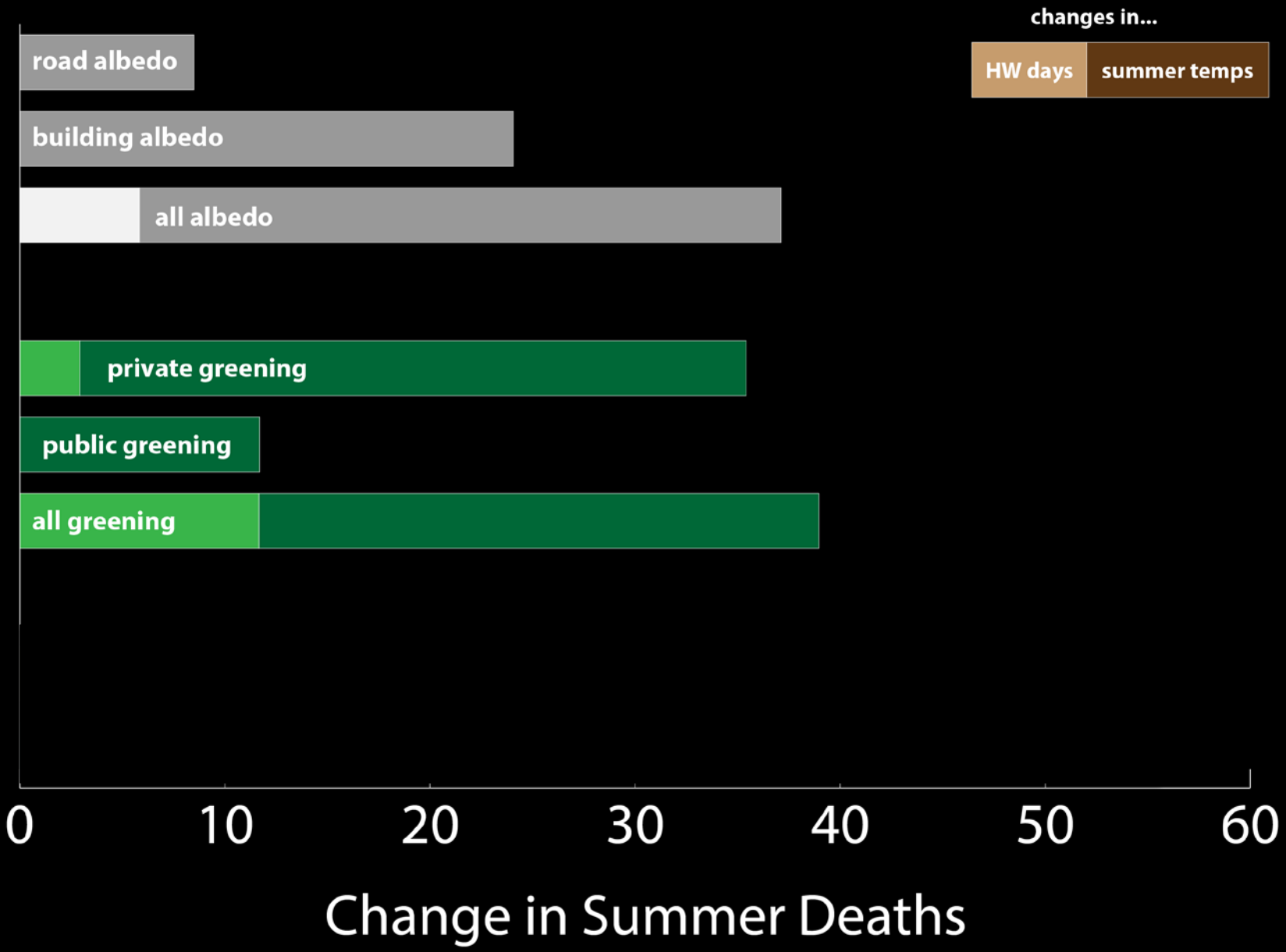




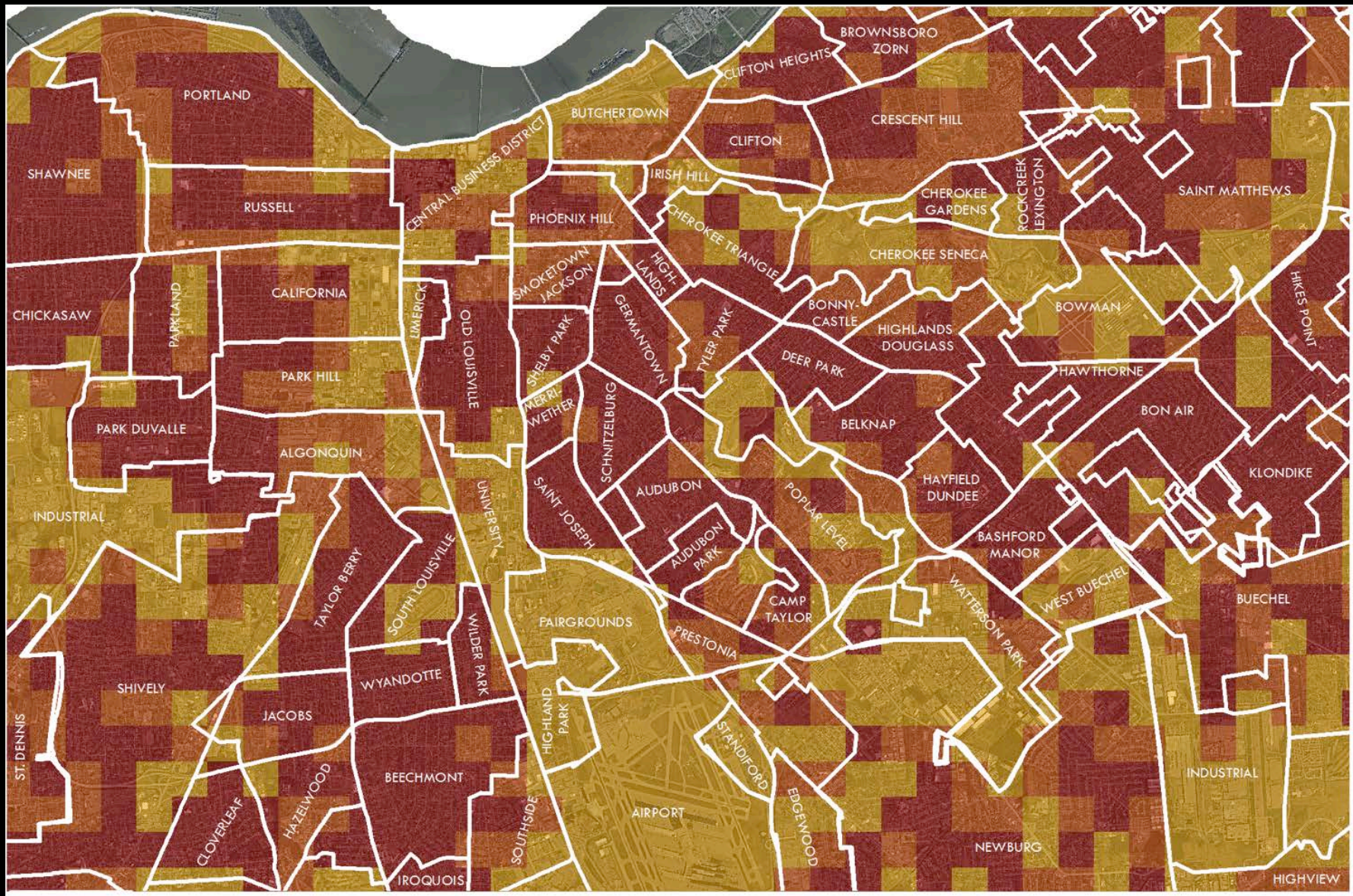
Gasparrini, Antonio, et al. "Mortality risk attributable to high and low ambient temperature: a multicountry observational study." *The Lancet* 386.9991 (2015): 369-375.



Atlanta


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

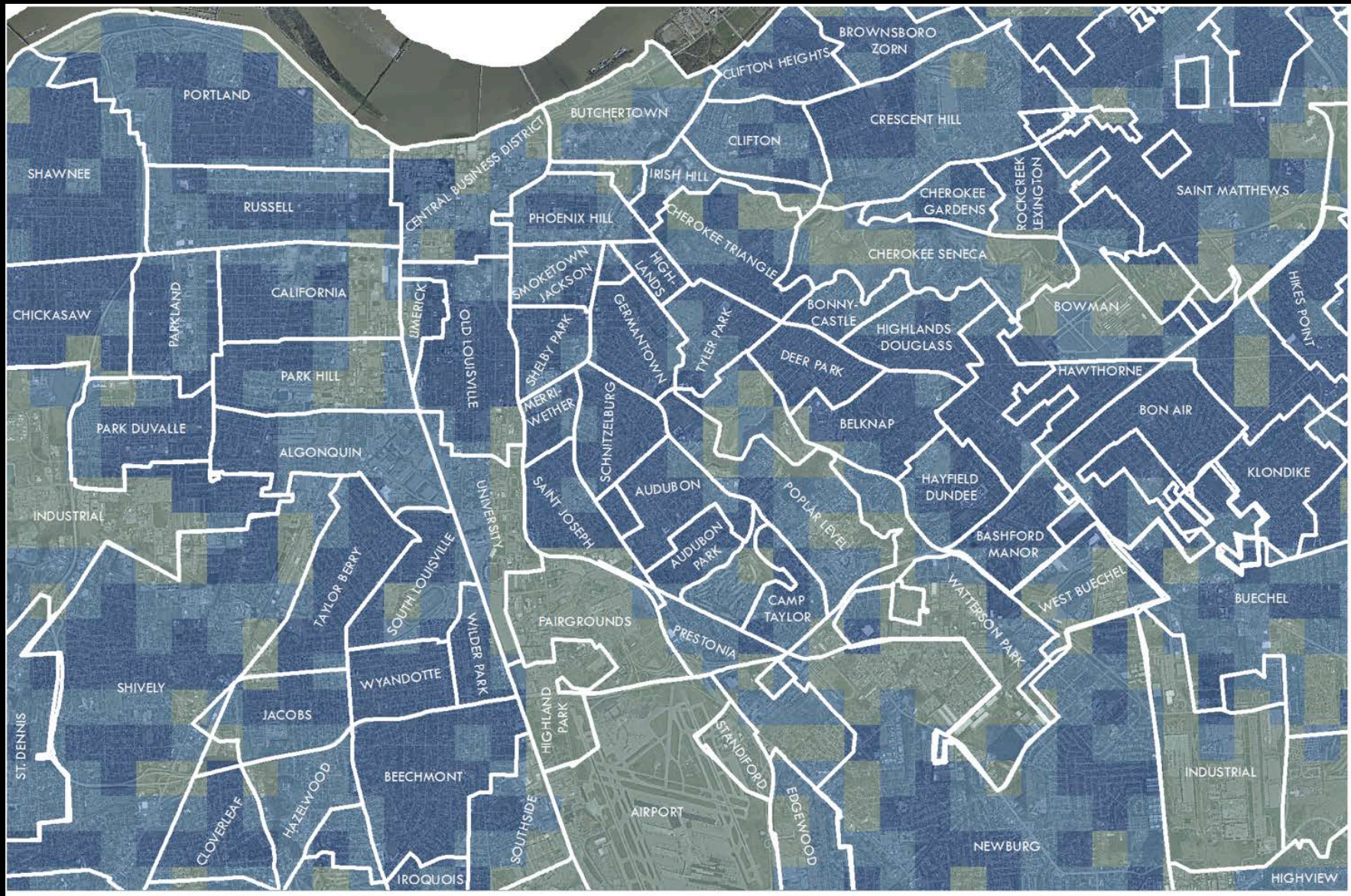

PORTLAND
BUTCHERTOWN
CLIFTON HEIGHTS
BROWNSBORO ZORN
CRESCENT HILL
CLIFTON
SHAWNEE
RUSSELL
CENTRAL BUSINESS DISTRICT
IRISH HILL
PHOENIX HILL
CHEROKEE GARDENS
ROCKCREEK LEXINGTON
SAINT MATTHEWS
CHEROKEE TRIANGLE
CHEROKEE SENECA
CHICKASAW
PARKLAND
CALIFORNIA
LIMERICK
OLD LOUISVILLE
SMOKETOWN JACKSON
HIGH LANDS
GERMANTOWN
BONNY CASTLE
HIGHLANDS DOUGLASS
BOWMAN
HIKES POINT
SHELBY PARK
TYLER PARK
DEER PARK
HAWTHORNE
PARK HILL
MERRI-WETHER
SCHNITZELBURG
BON AIR
PARK DUVALLE
ALGONQUIN
BELKNAP
HAYFIELD DUNDEE
KLONDIKE
INDUSTRIAL
UNIVERSITY
SAINT JOSEPH
AUDUBON
POPLAR LEVEL
BASHFORD MANOR
TAYLOR BERRY
SOUTH LOUISVILLE
AUDUBON PARK
CAMP TAYLOR
WATTERSON PARK
WEST BUECHEL
BUECHEL
WILDER PARK
FAIRGROUNDS
PRESTONIA
SHIVELY
WYANDOTTE
HIGHLAND PARK
JACOBS
ST. DENNIS
STANDIFORD
BEECHMONT
INDUSTRIAL
HAZELWOOD
EDGEWOOD
CLOVERLEAF
SOUTHSIDE
AIRPORT
NEWBURG
IROQUOIS
HIGHVIEW
Change in tree canopy with heat adaptation (%)
0
0.5
1
2
3
4
Miles
0 %
0 - 2 %
2 - 10 %
10 - 30 %



Summer heat mortality under current conditions

0 0.25 0.5 1 1.5 2 Miles

Low Medium High

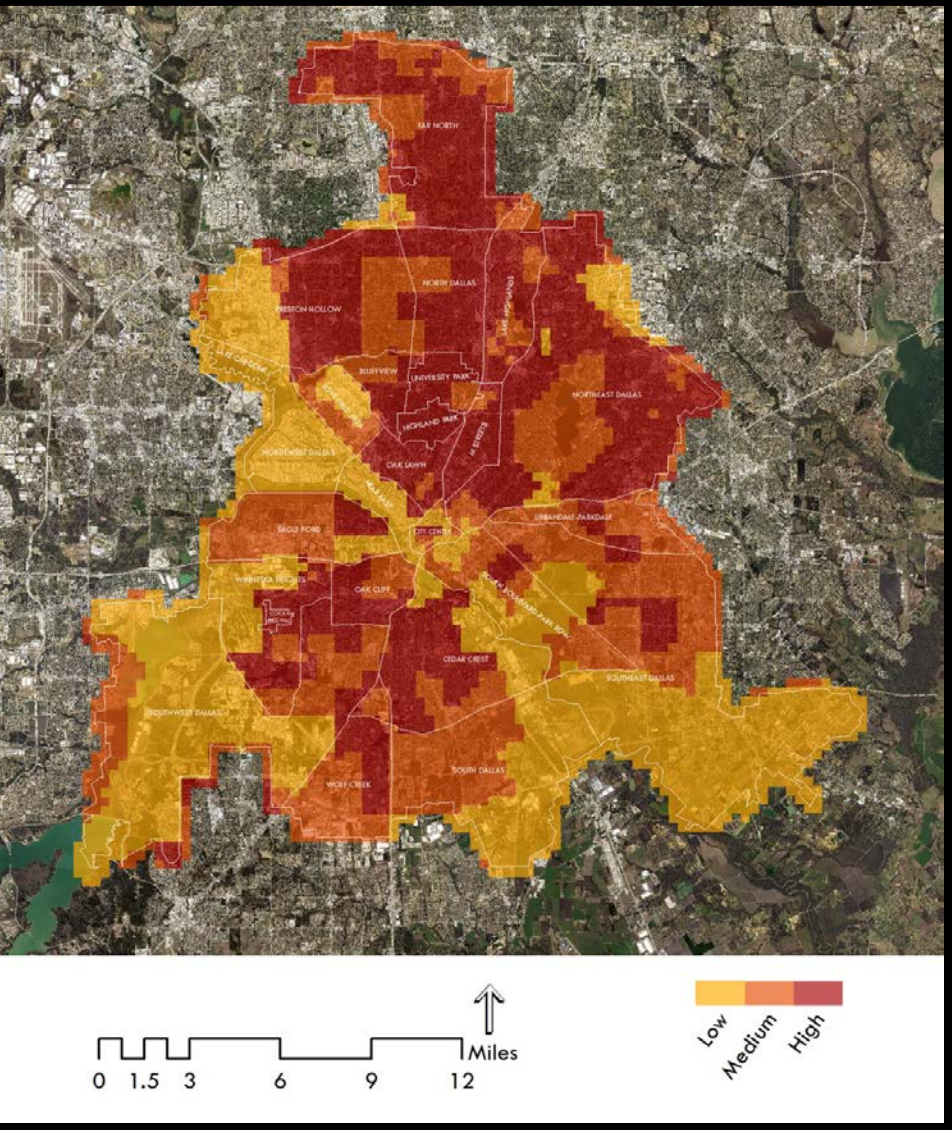


Reduction in summer heat mortality with heat adaptation

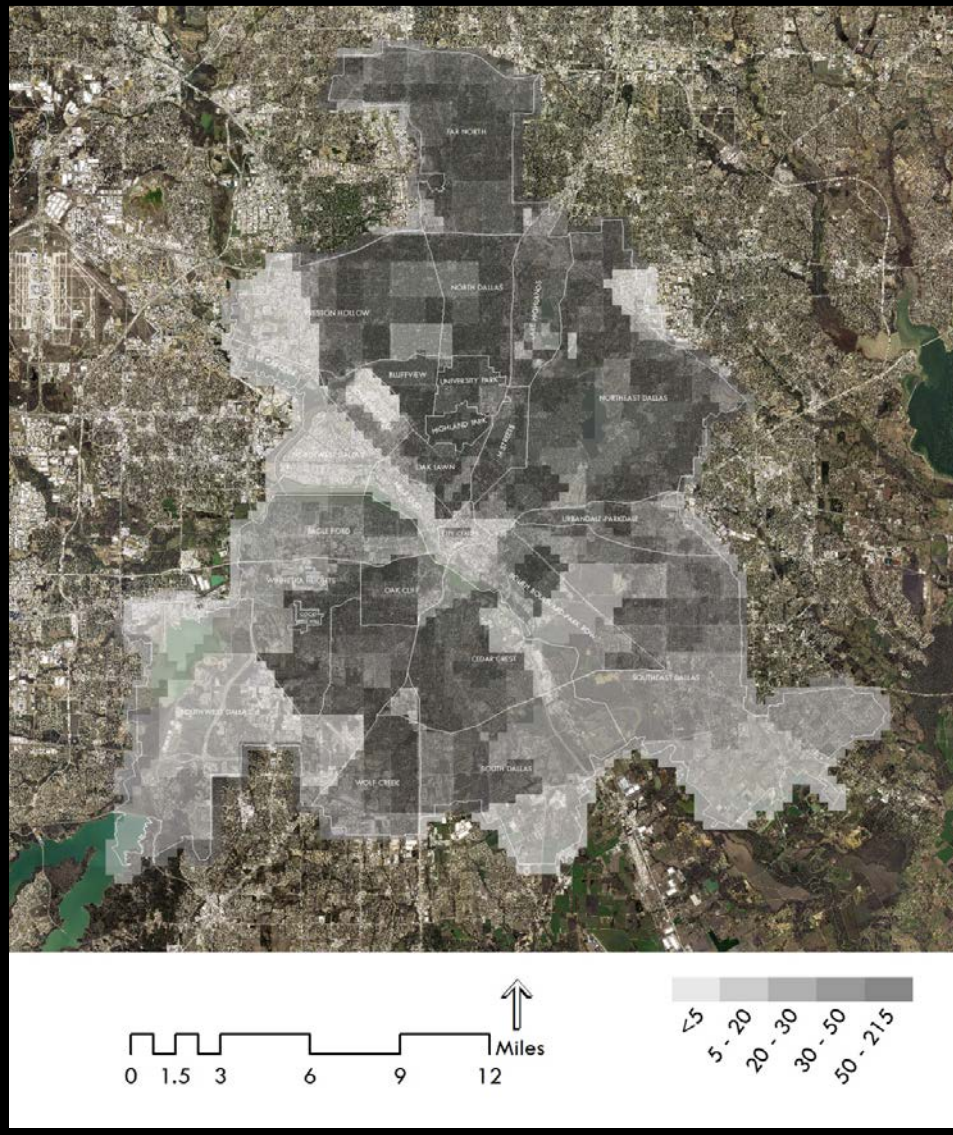
0 0.25 0.5 1 1.5 2 Miles

No Benefit
Low Benefit
High Benefit

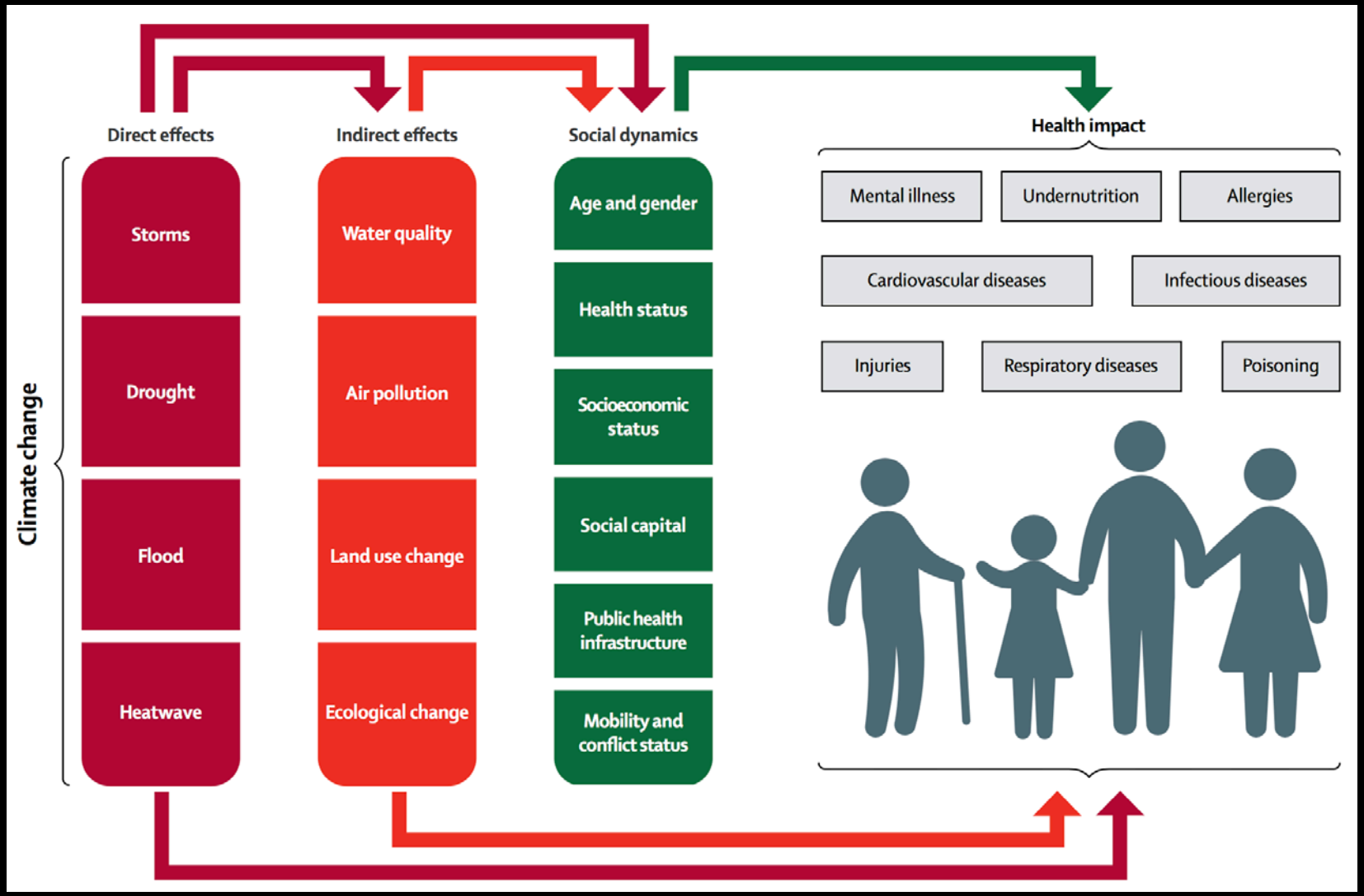
UHI-attributable heat mortality 2011



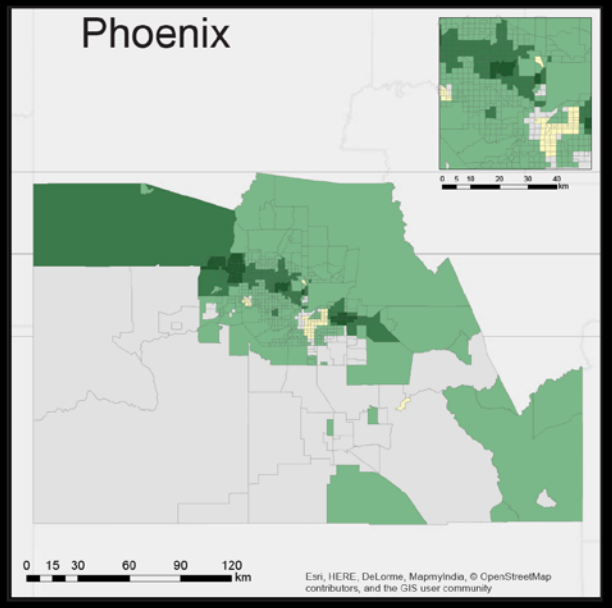
distribution of senior population



Watts, Nick, et al. "Health and climate change: policy responses to protect public health." *The Lancet* 386.10006 (2015): 1861-1914.



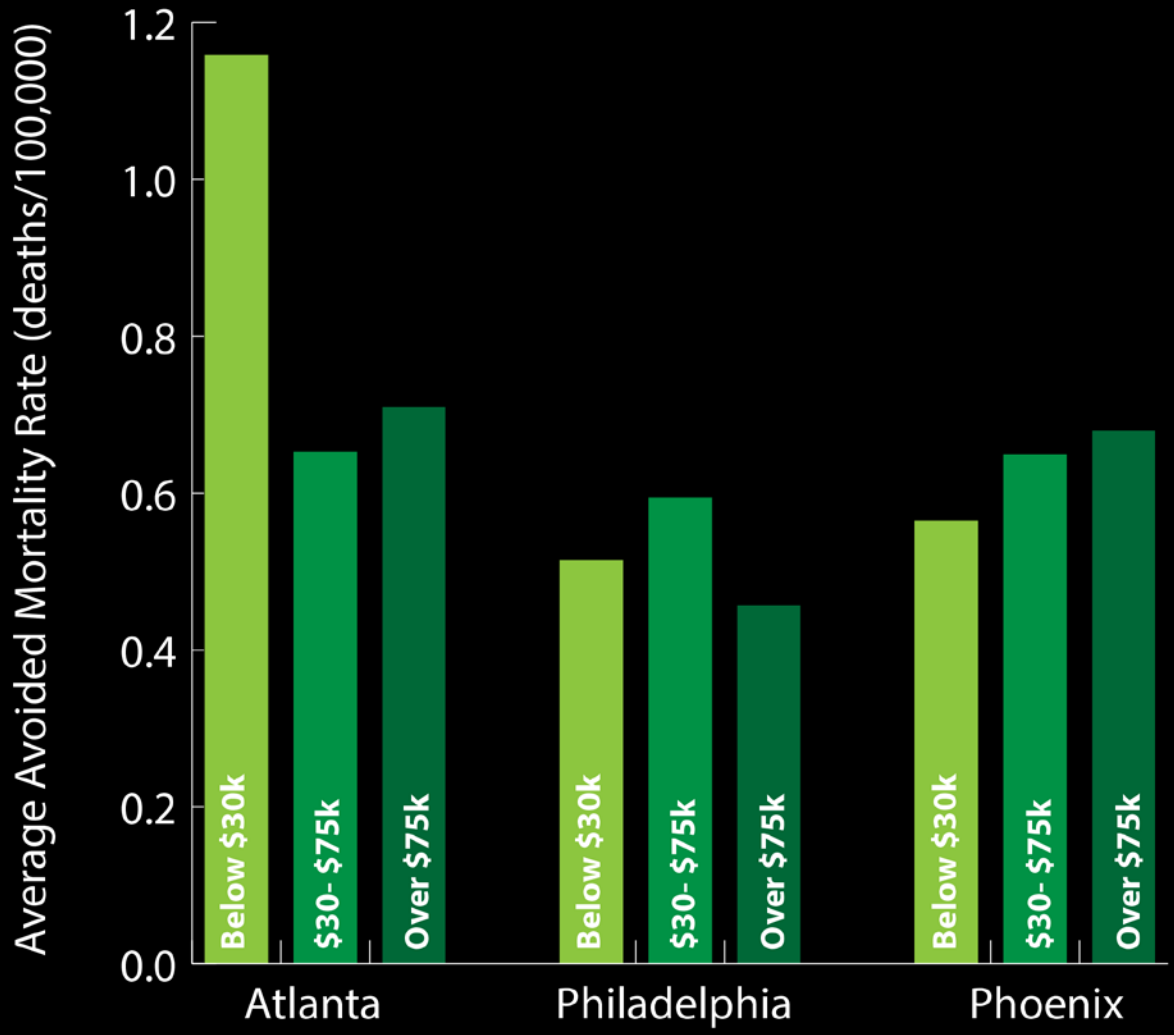
Health Impacts



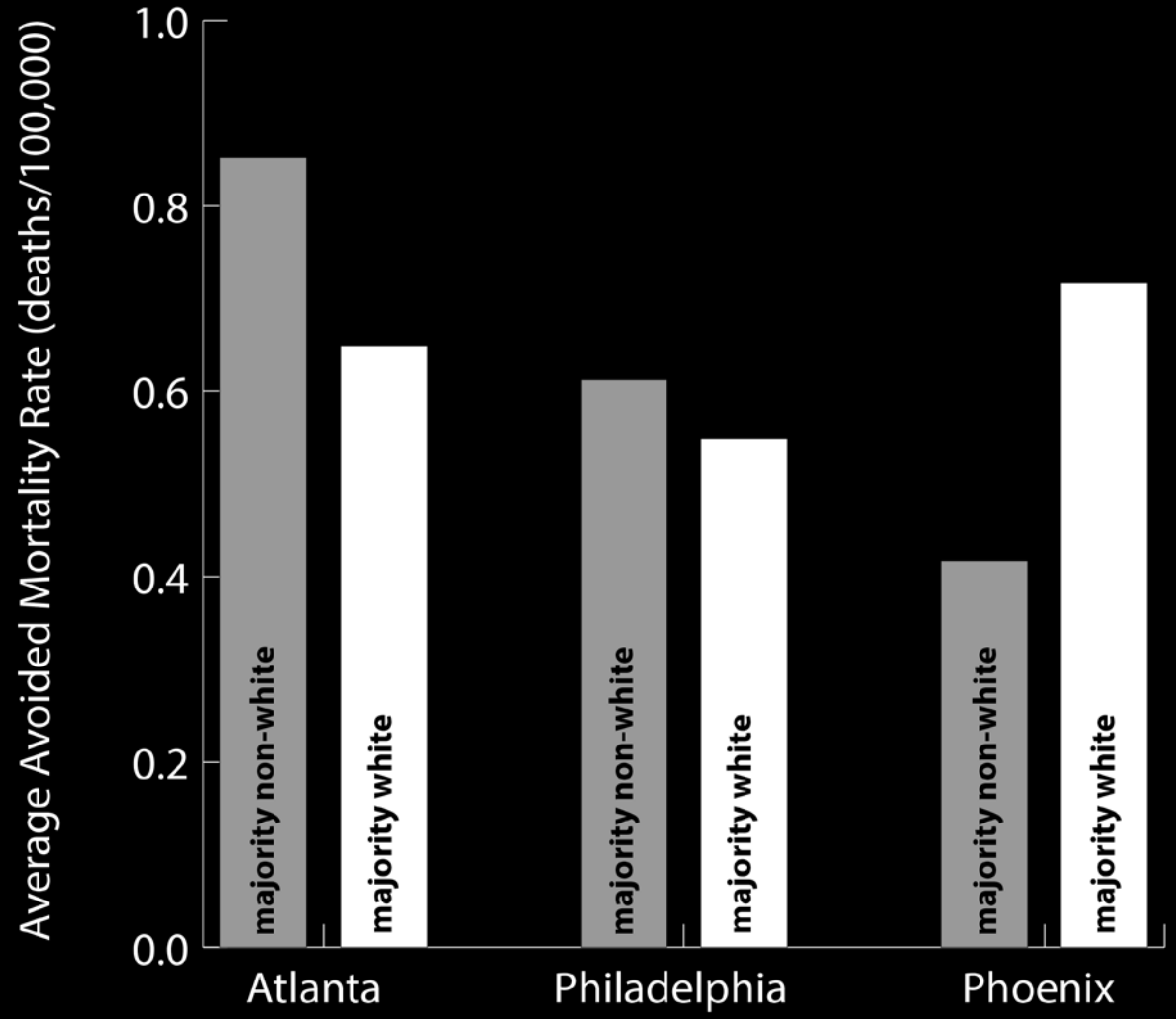
change in mortality/100,000

- 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

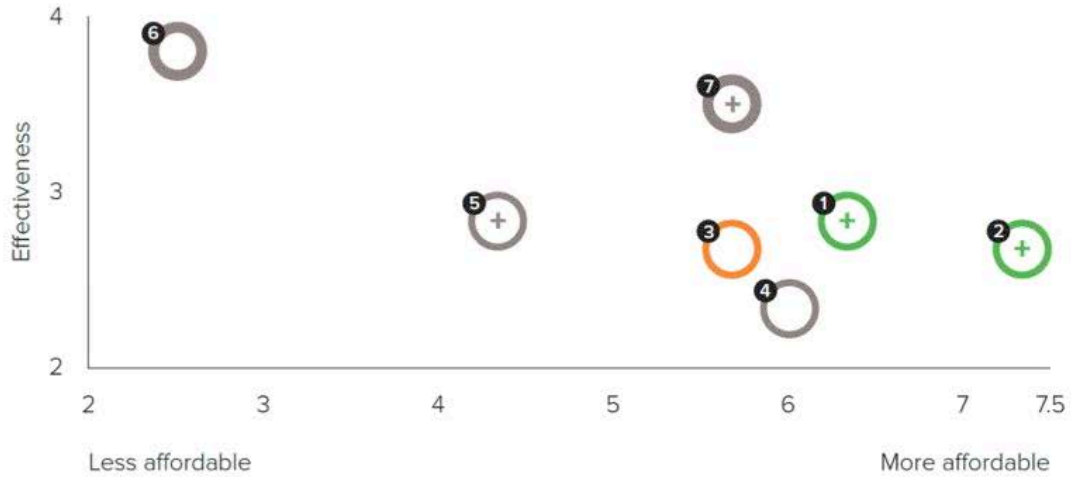
Median HH Income



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

Heat Waves



1 Afforestation
2 Maintenance of existing vegetation
3 Green roofs, vertical greening systems
4 White roofs
5 Urban planning, grid design etc.
6 Air conditioning
7 Insulation

Category of option
Ecosystem-based
Hybrid
Engineering

Strength of evidence
Weaker
Stronger

Additional consequences
Overall positive
Overall negative
Approximately neutral

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

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