Green is the New Black: Adapting to Extreme Heat in Cities

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anomaly

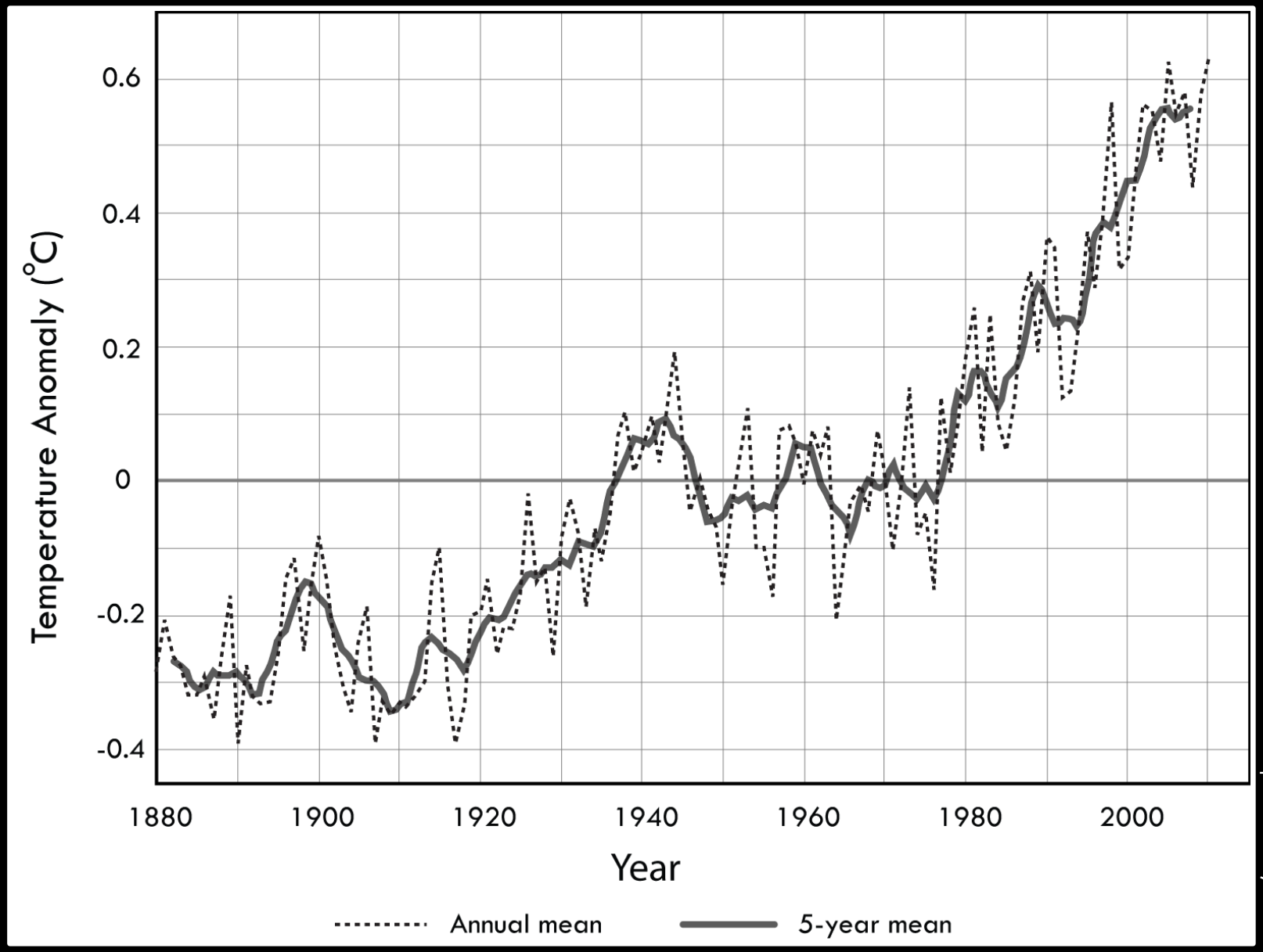
risk

response

anomaly

Something that deviates from what is standard, normal, or expected

Global temperature anomaly



Urban temperature anomaly

NASA

Drivers of the urban heat island

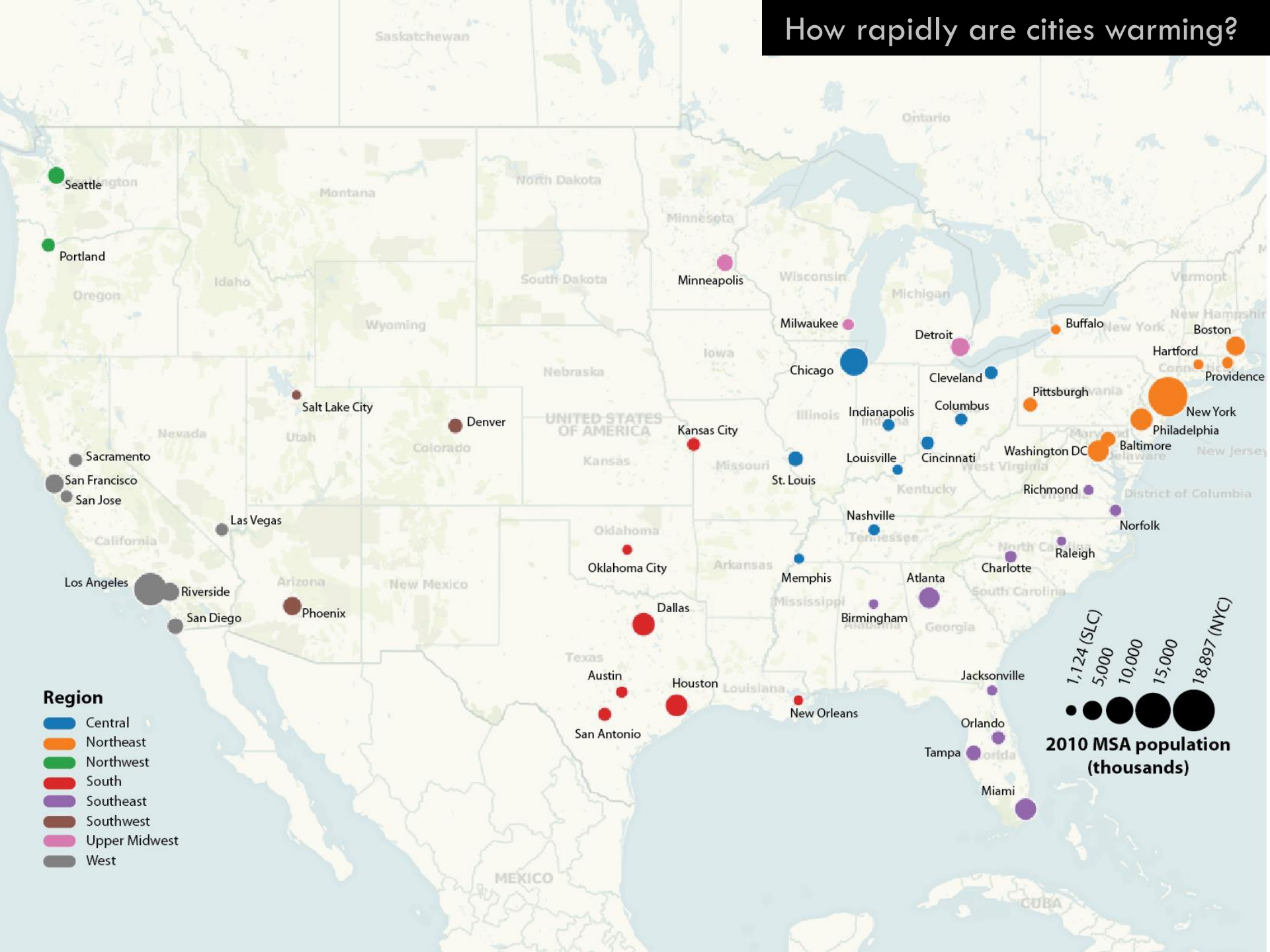
1. Loss of natural vegetation

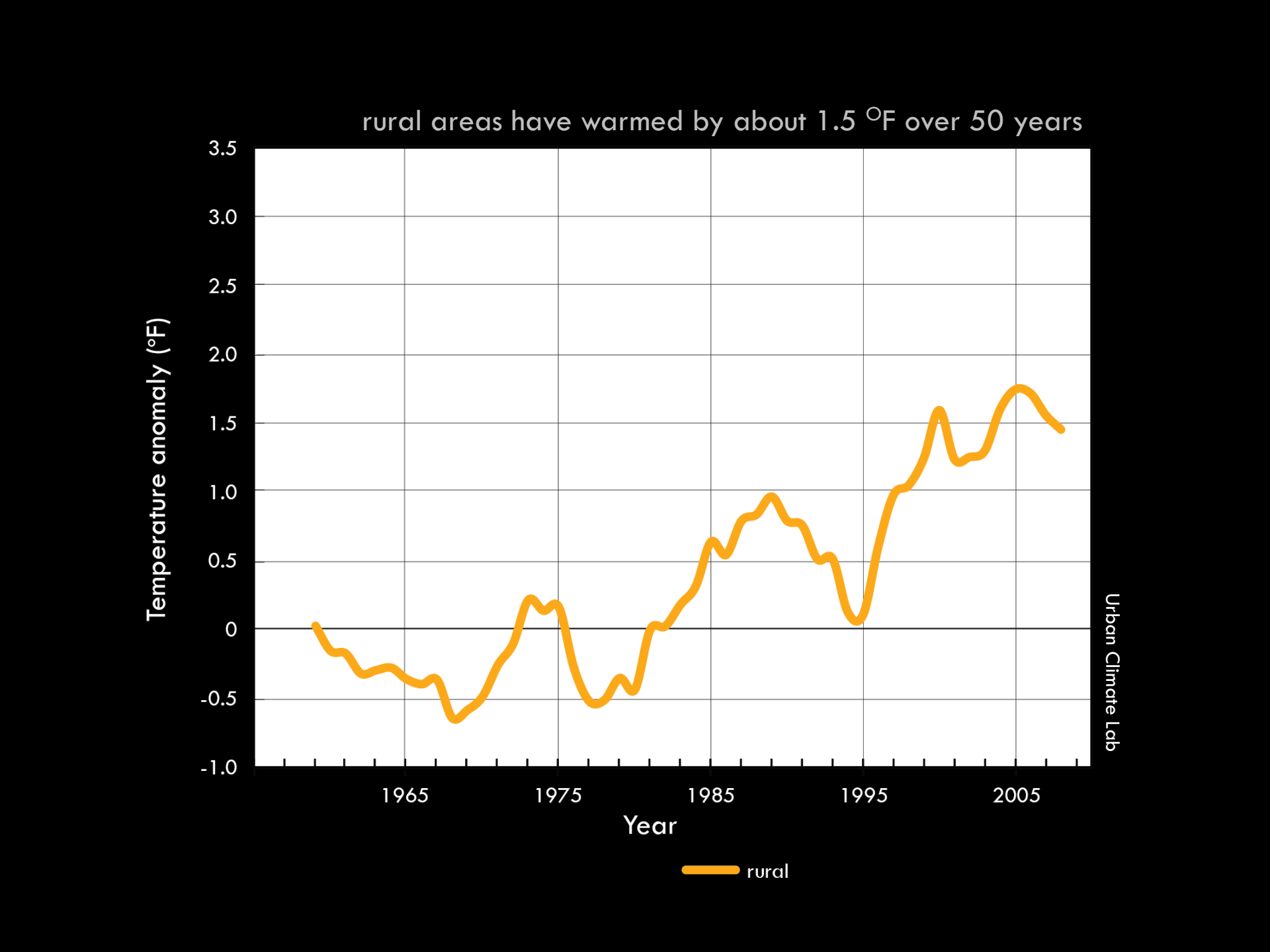
2. Replacement of vegetation with impervious materials

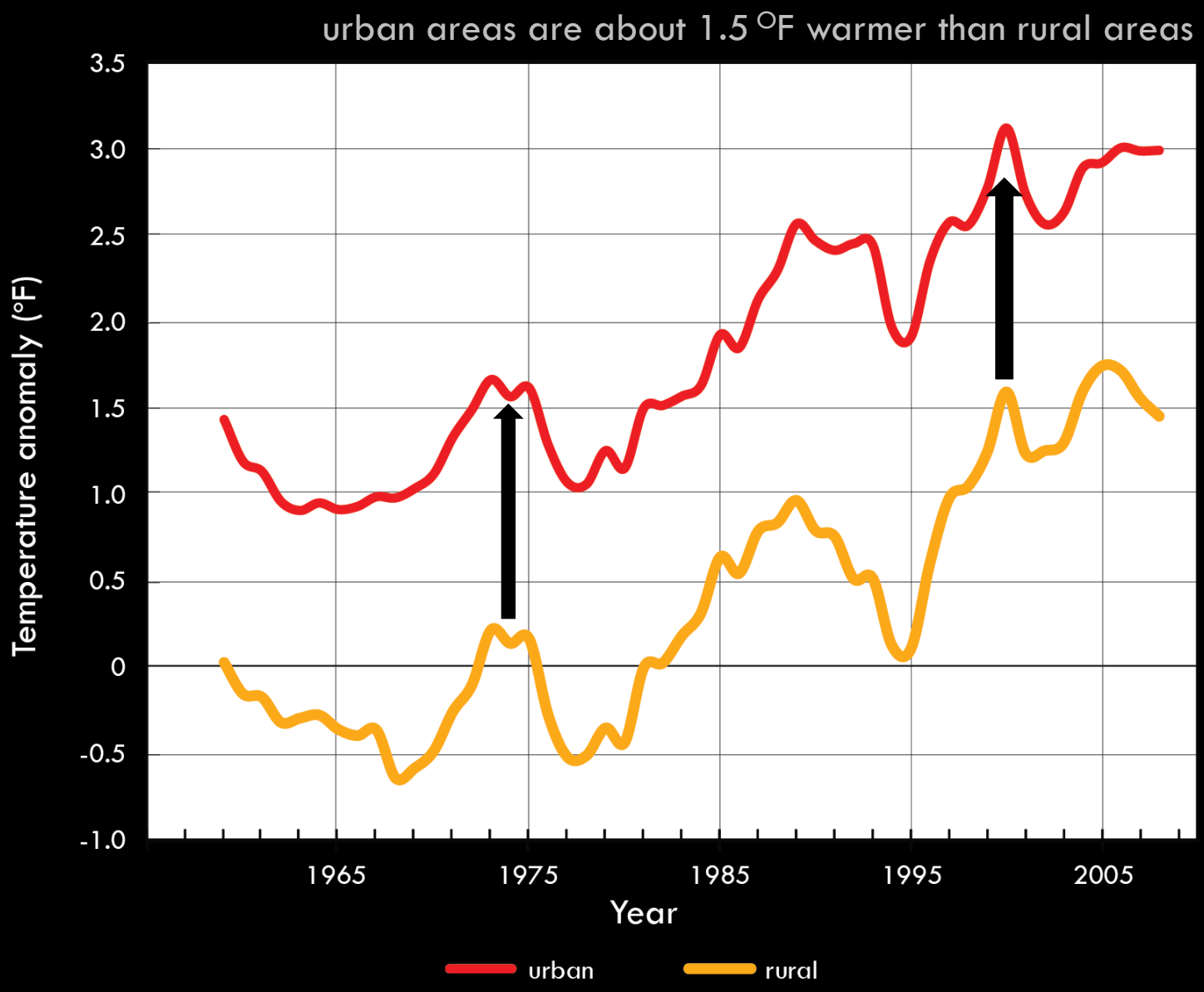
3. Waste heat from vehicles, industry, building air conditioning

4. Trapping of heat by building “canyons”

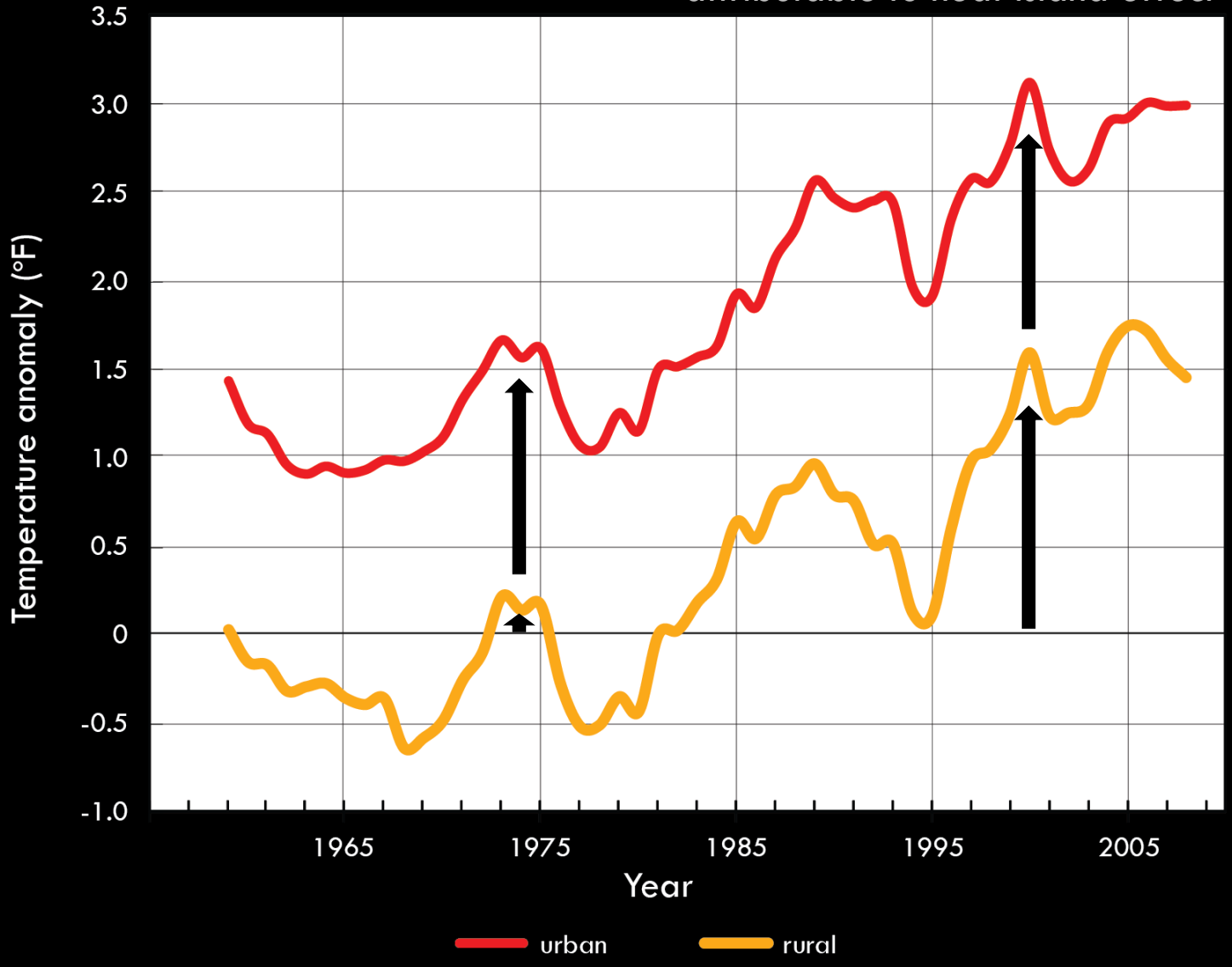
How rapidly are cities warming?



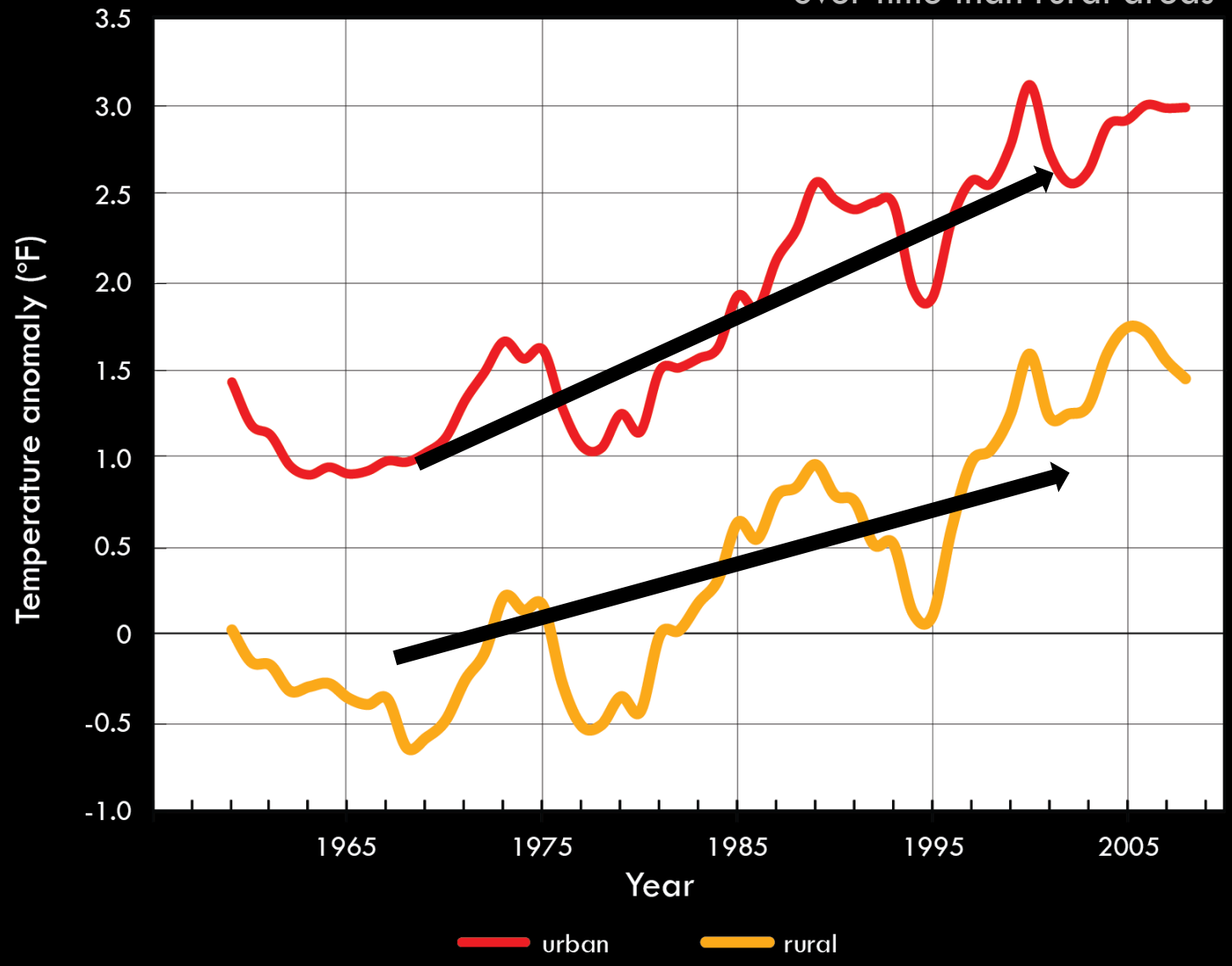

rural areas have warmed by about 1.5 °F over 50 years
Temperature anomaly (°F)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
-0.5
-1.0
1965
1975
1985
1995
2005
Year
rural
Urban Climate Lab

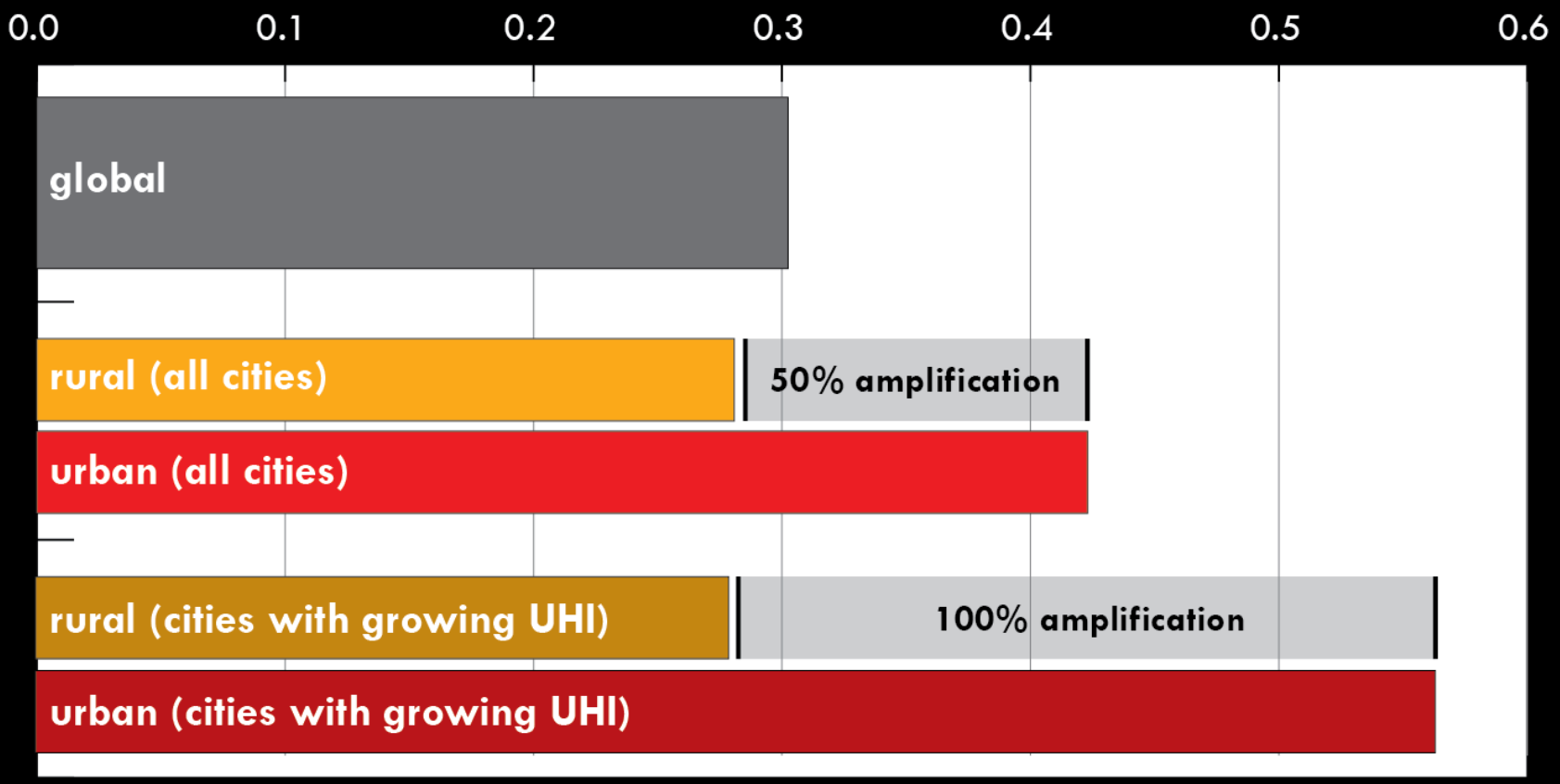

urban areas are about 1.5 °F warmer than rural areas
Temperature anomaly (°F)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
-0.5
-1.0
1965
1975
1985
1995
2005
Year
urban
rural

most of the temperature anomaly in cities is attributable to heat island effect



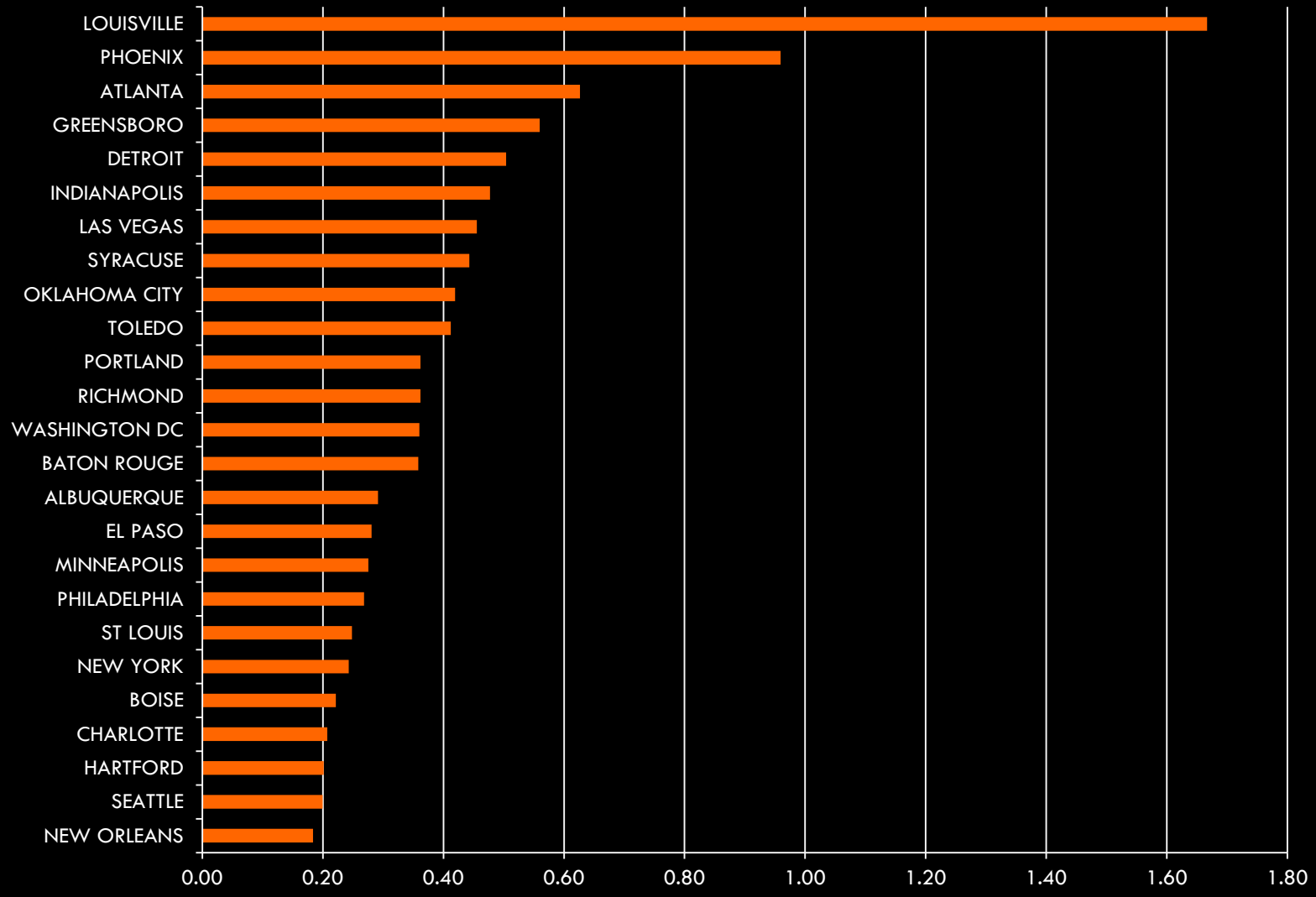
urban areas are warming more rapidly over time than rural areas





global vs. urban rates of warming (°F/decade): 1961-2010

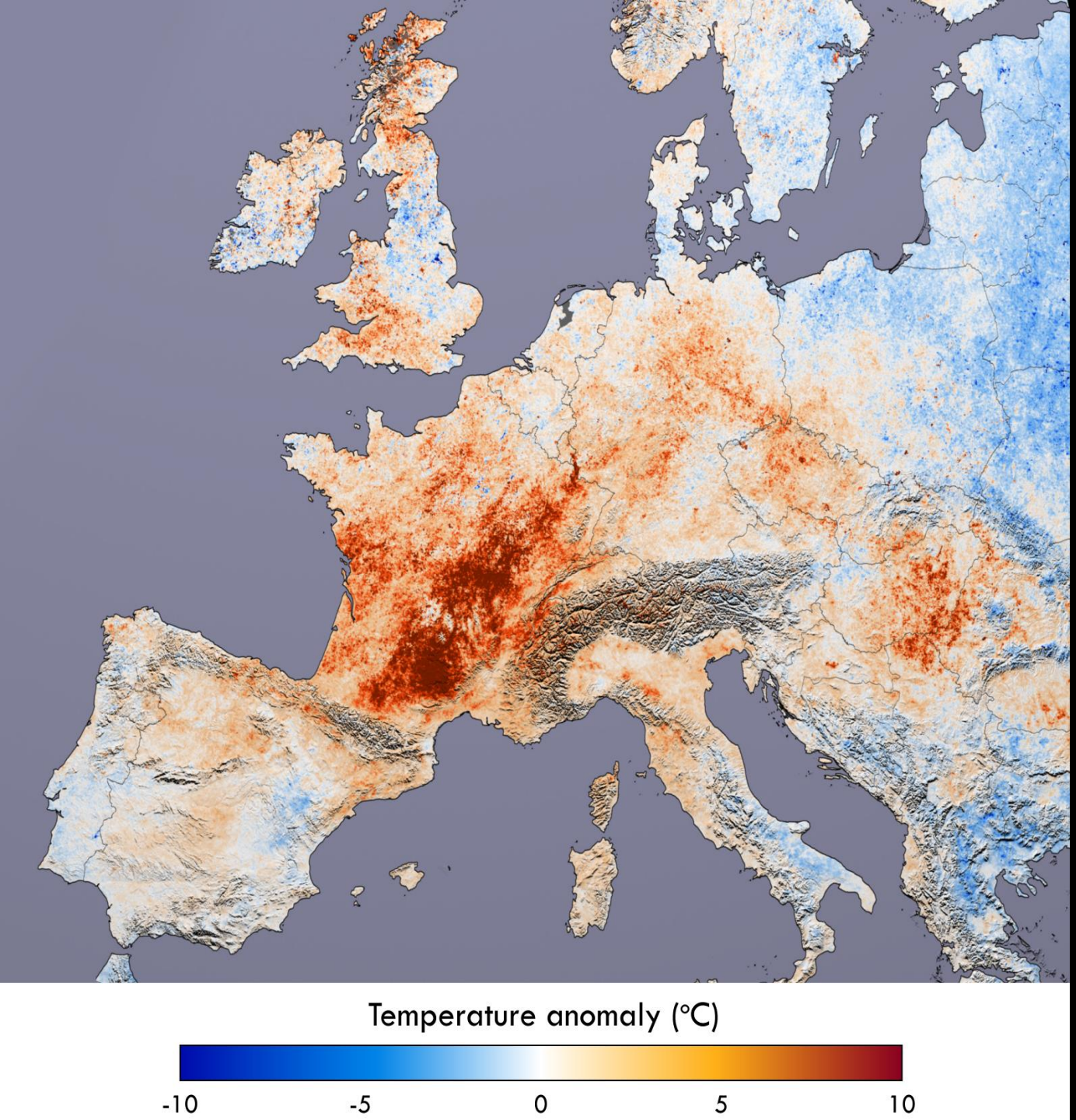
Urban warming rankings



warming in excess of rural trend (°F/decade)

risk

exposure to danger, harm, or loss



European heat wave of 2003

NASA

2003 European heat wave

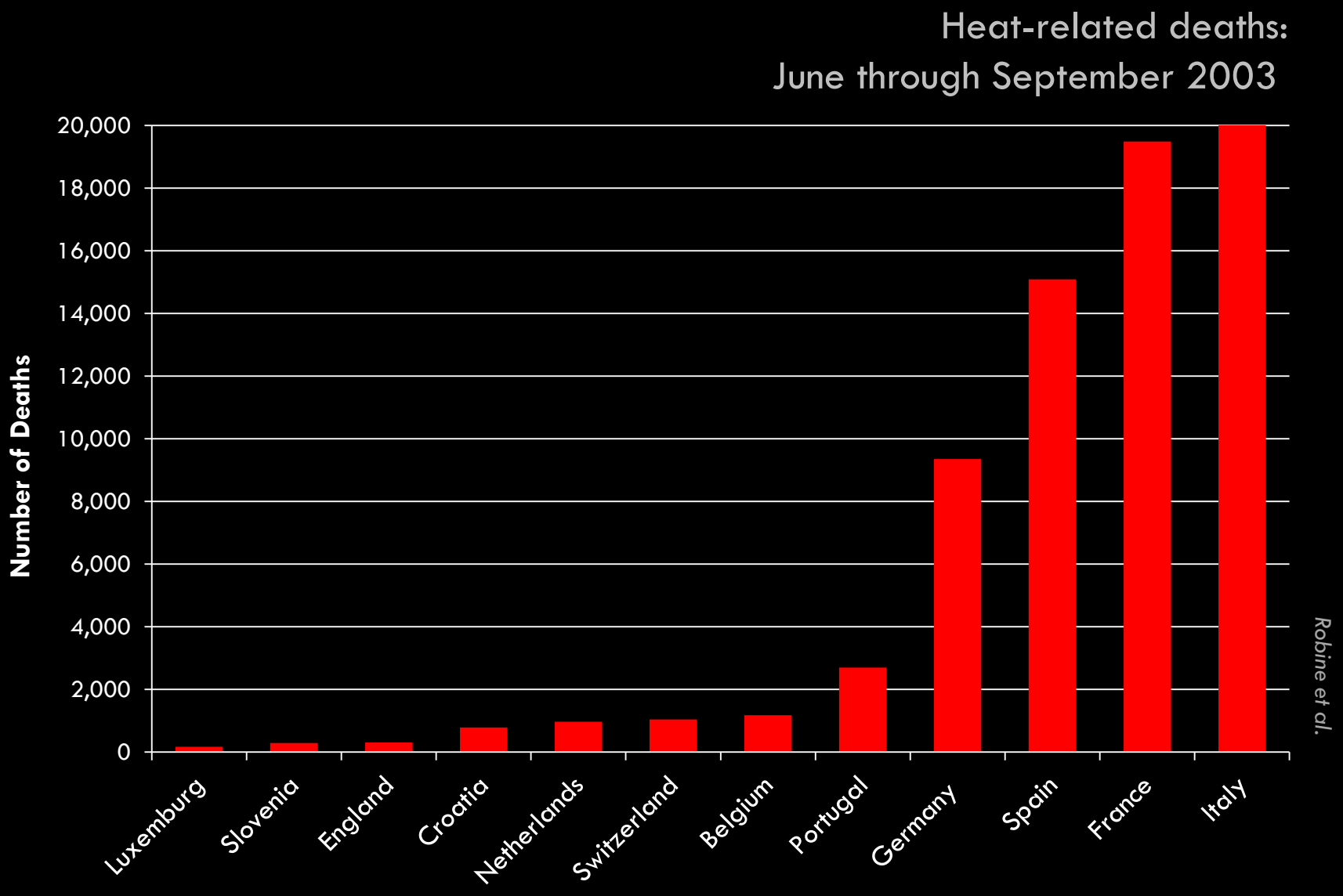
Associated Press

High temps in Paris exceeded 100°F and low temps close to 80°F for two week period

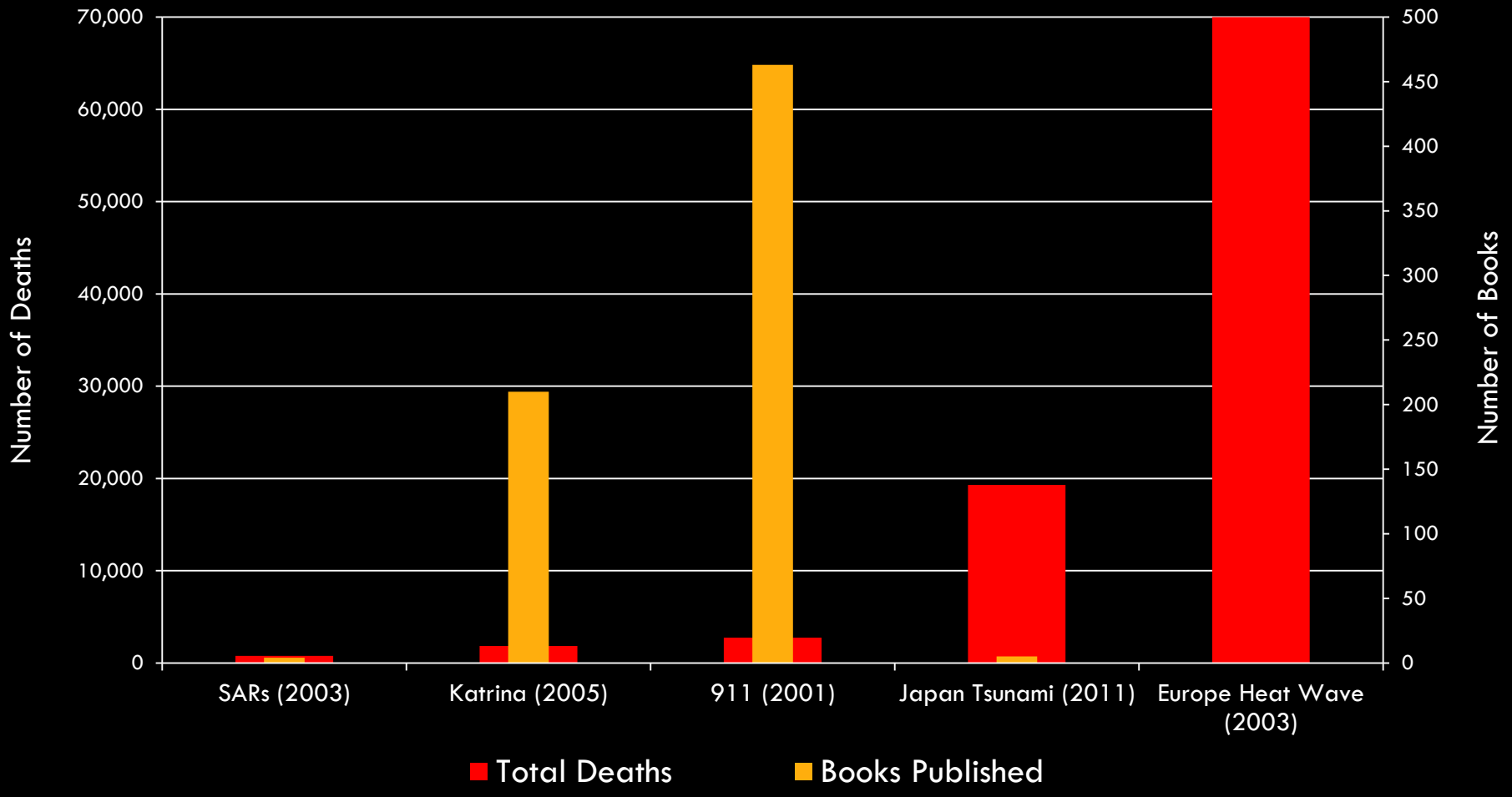
Highest rates of heat-related fatalities in largest cities

Four French cities found to exhibit temperatures 50% greater than nearby rural areas

Heat waves of this magnitude projected to occur every two years on average by 2040

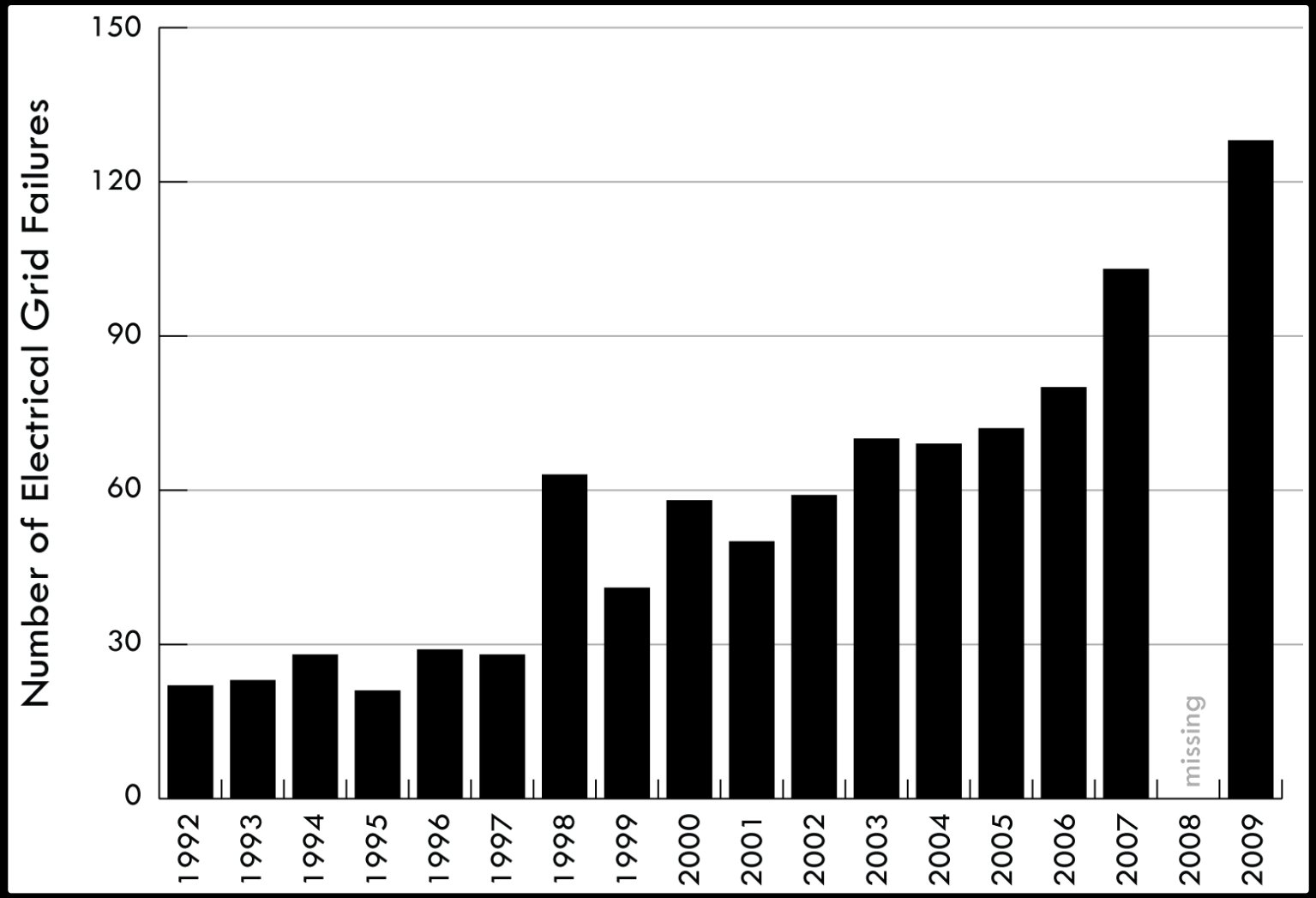

Heat-related deaths:
June through September 2003
Number of Deaths
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Luxemburg
Slovenia
England
Croatia
Netherlands
Switzerland
Belgium
Portugal
Germany
Spain
France
Italy
Robine et al.

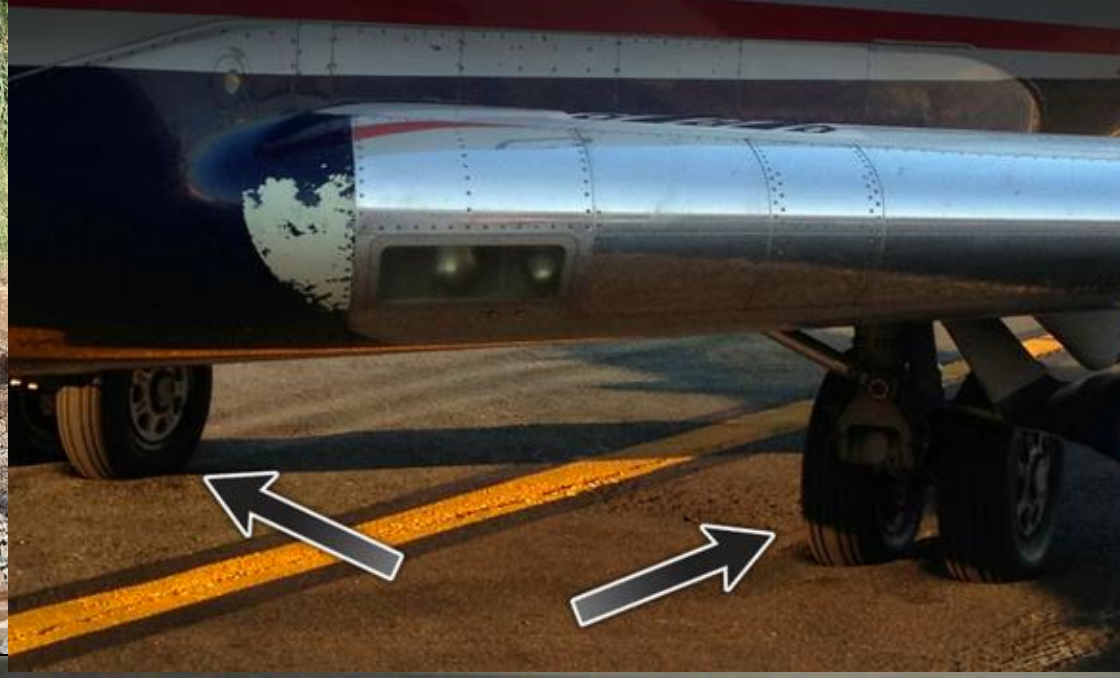
Underestimating extreme heat: the books-to-bodies ratio



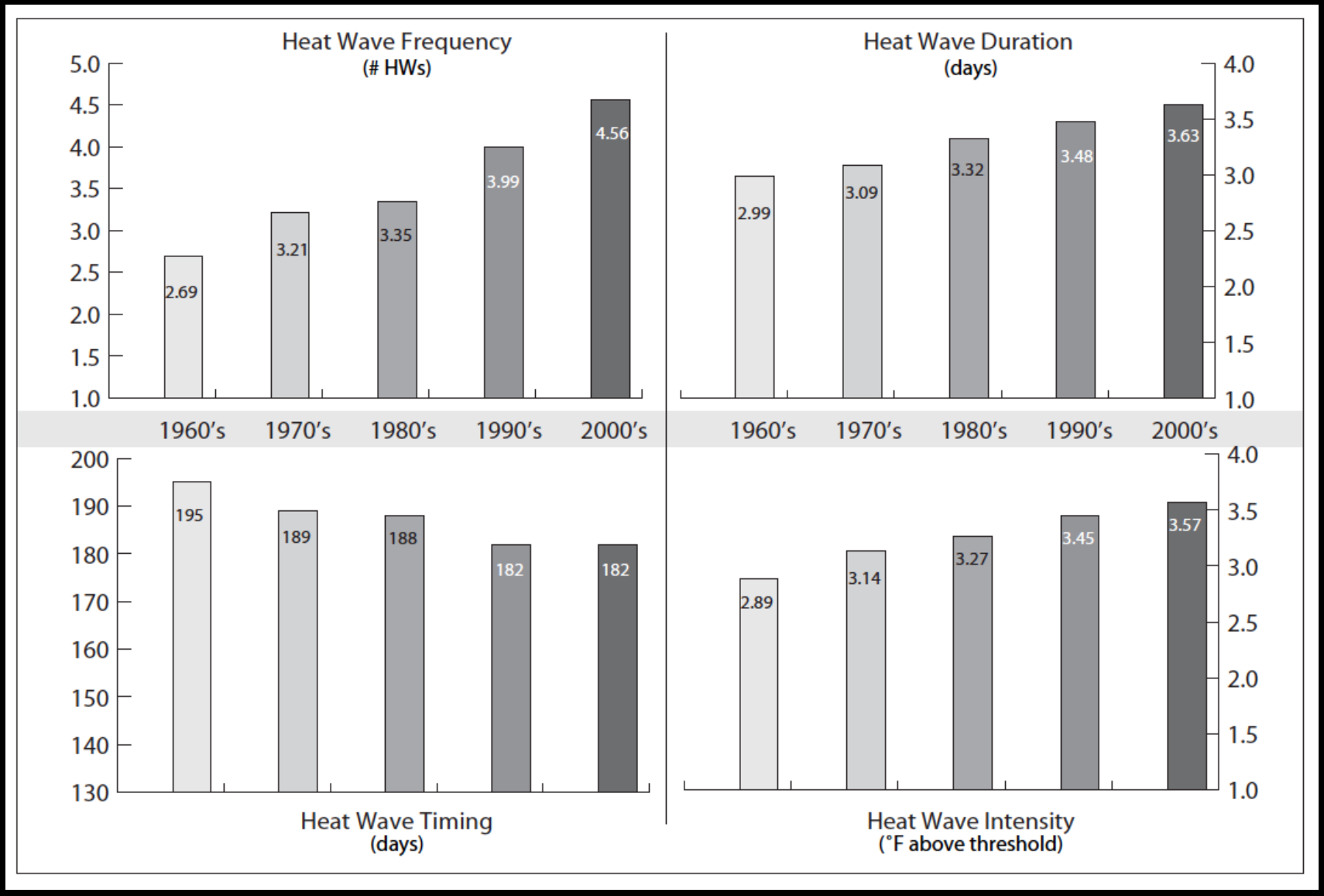

003/45/7844
ISAT GeoStar 45
23:15 EST 14 Aug. 2003

Trends in electrical system failures





heat waves in US cities are hotter, longer, more frequent, and earlier in the year



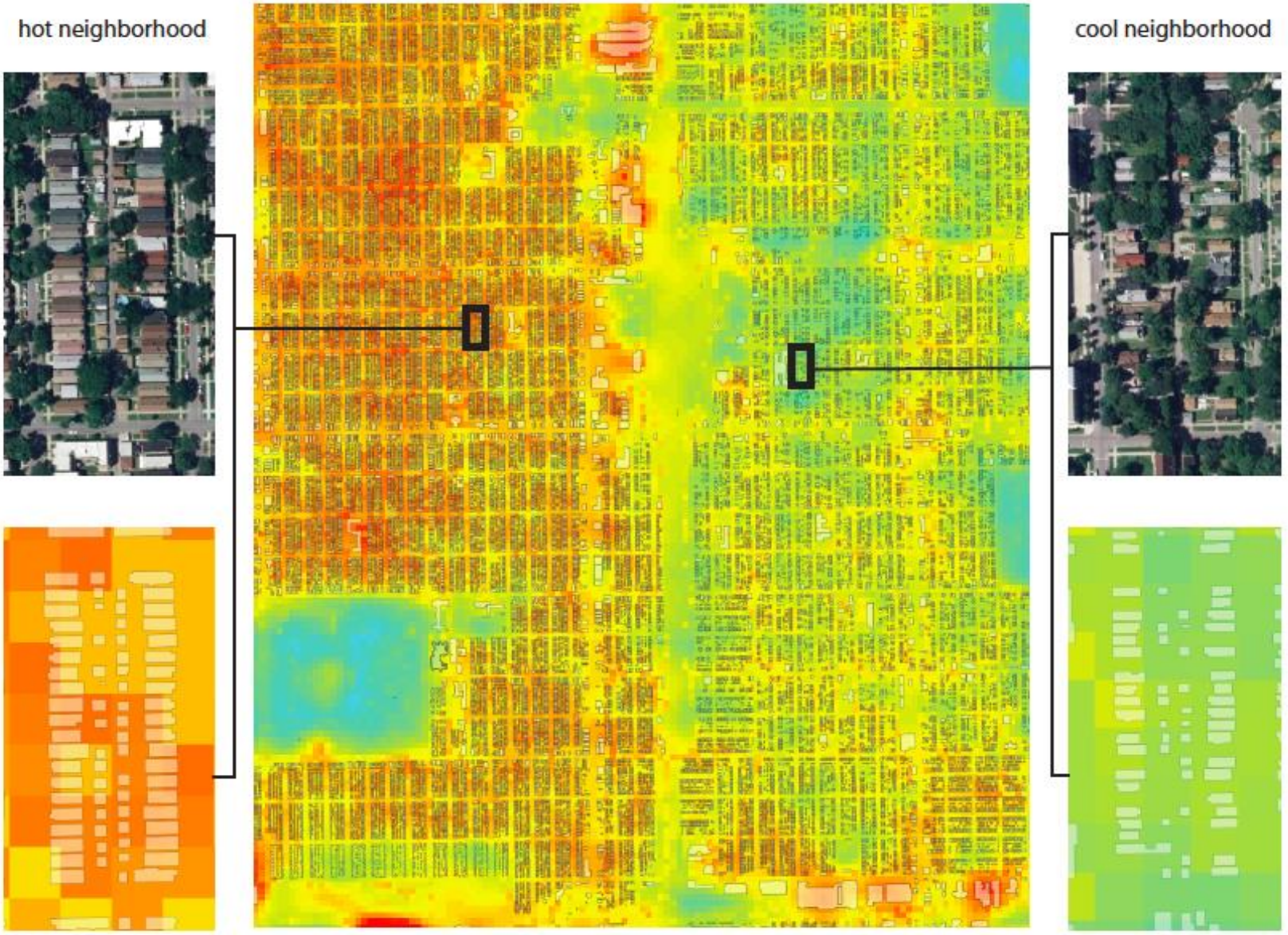
Habeeb, Vargo & Stone

response

a behavior that results from an external stimulus

Jason Vargo

sun screening



Seattle's Green Factor

A1 - Landscaped Area <24" Soil Depth

A2 - Landscaped Area >24" Soil Depth

A3 - Rain Garden

B1 - Groundcovers <2' Height

B2 - Plants >2' Height

B3 - Small Tree

B5 - Medium Tree

B6 - Large Tree

B7 - Large Existing Tree

C1 - Green Roof 2-4" Growth Medium

C2 - Green Roof >4" Growth Medium

D - Green Wall

E - Water Feature

F1 - PermeablePaving 6-24" Subgrade

F2 - Permeable Paving >24" Subgrade

G - Structural Soil Systems

H1 - Drought Tolerant/Natives

H2 - Rainwater Cistern

H3 - Public Visibility

H4 - Food Cultivation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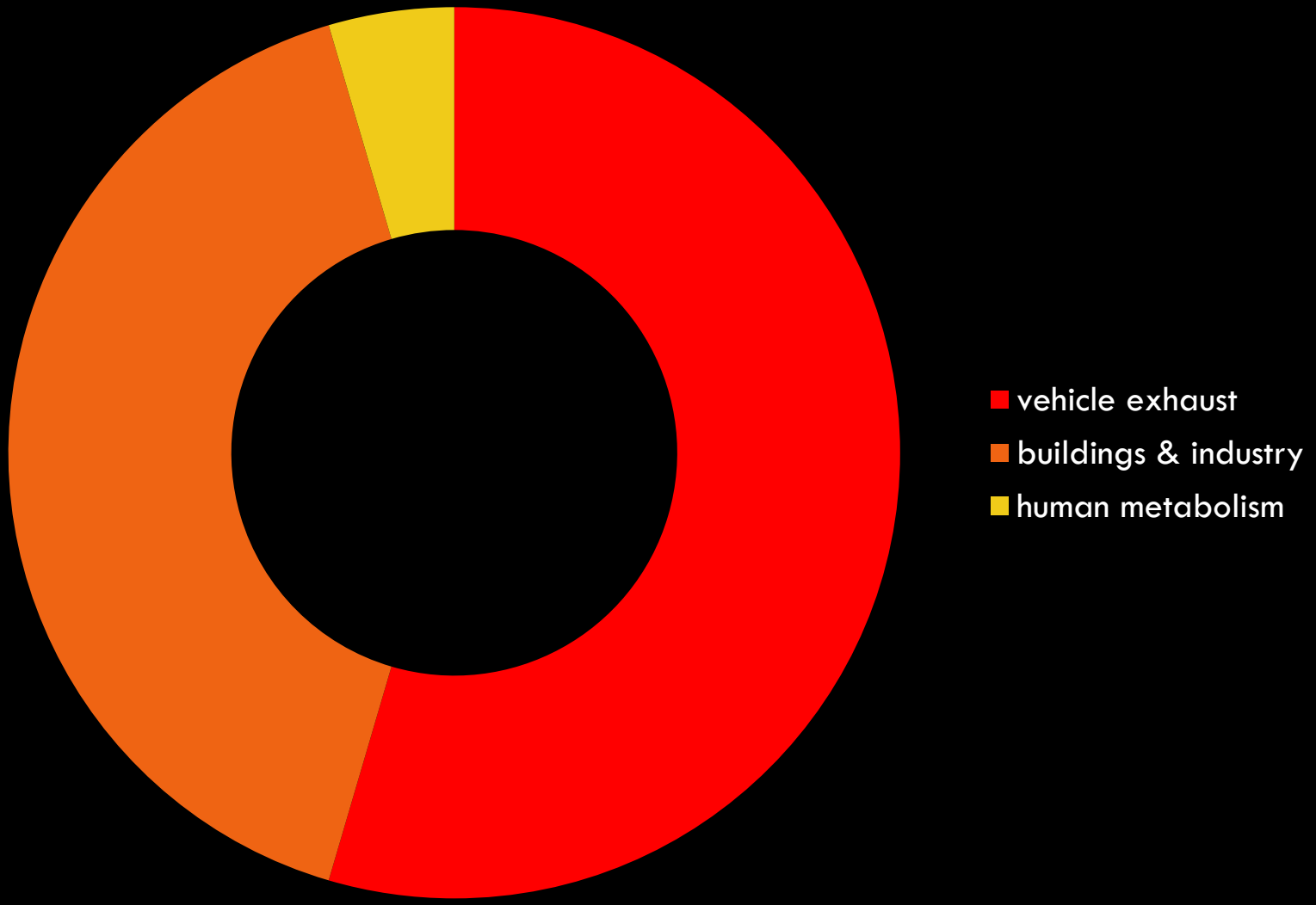
carbon cooling

Waste heat in cities

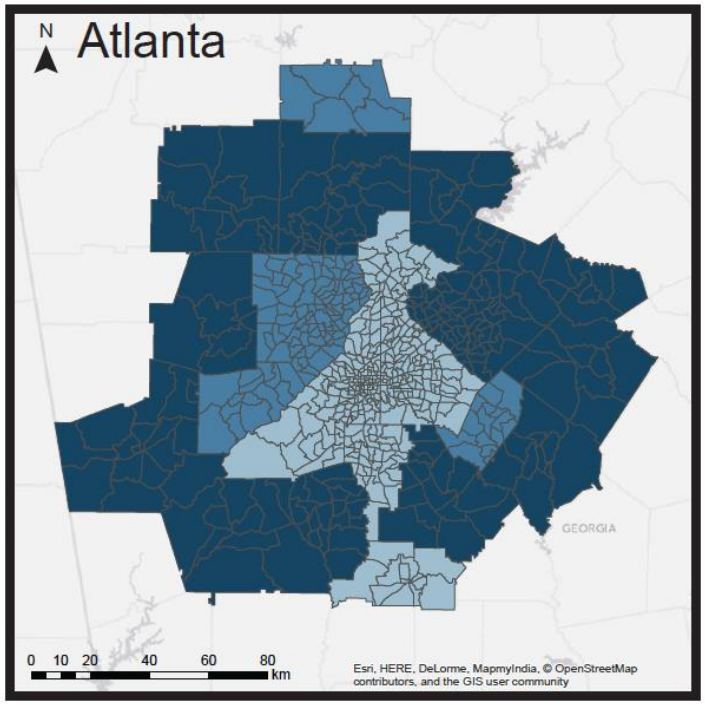


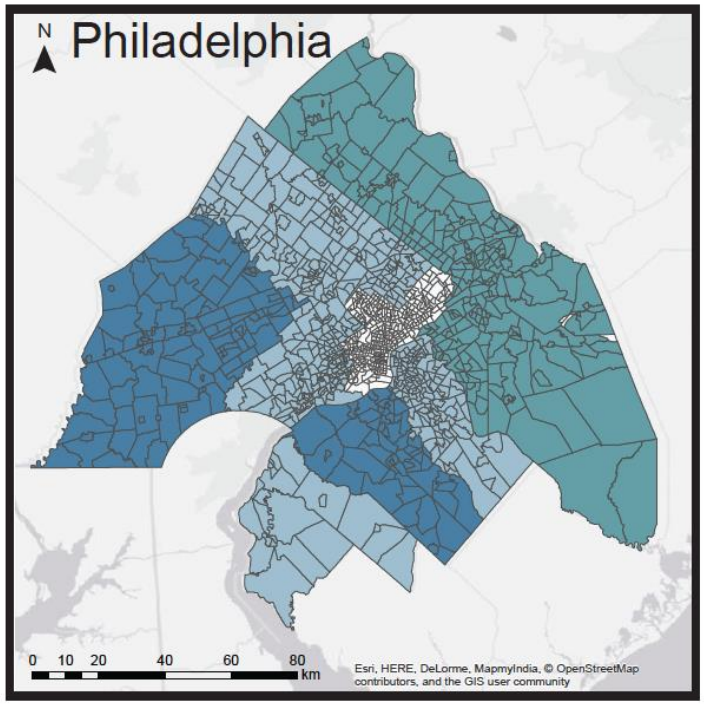
Sailor & Lu

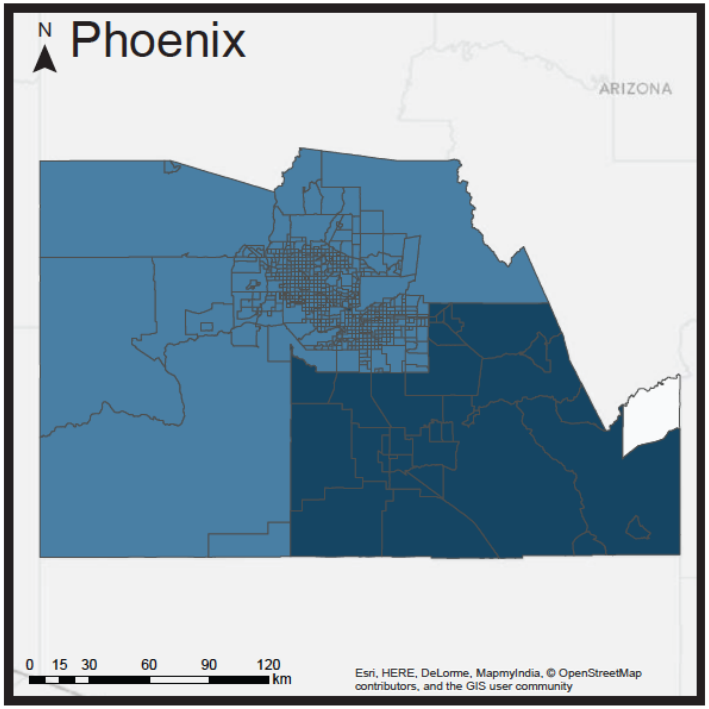
Climate, Urban Land Use, and Excess Mortality (CULE) study

Can climate-responsive design reduce heat-related deaths?

How will population change by 2050?



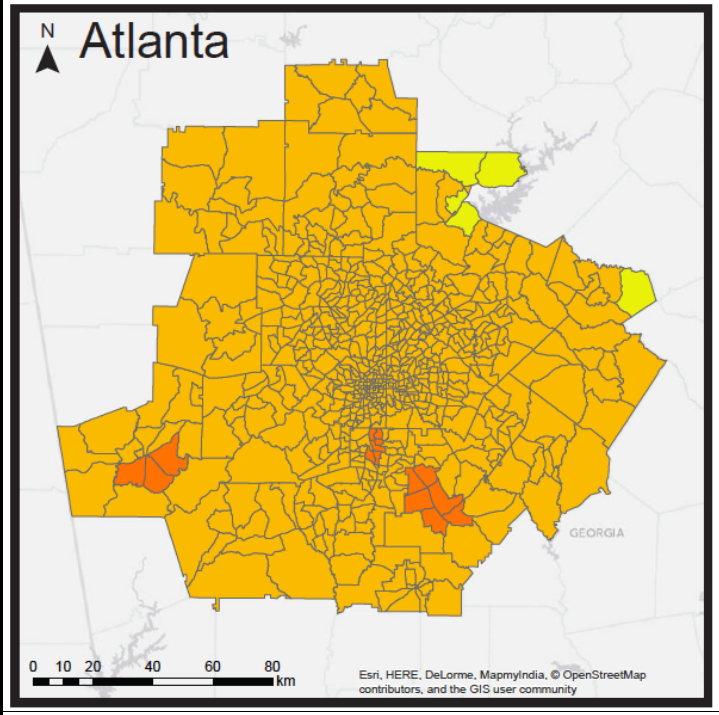


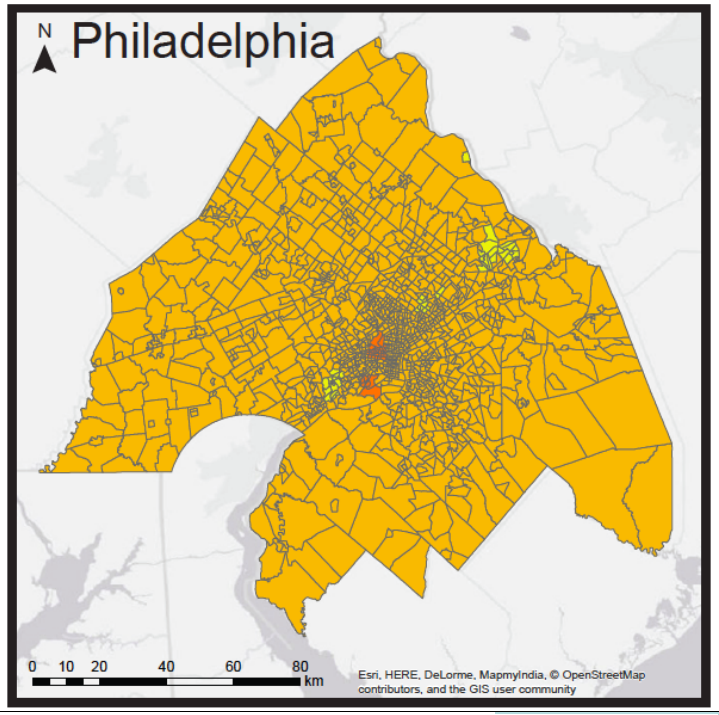


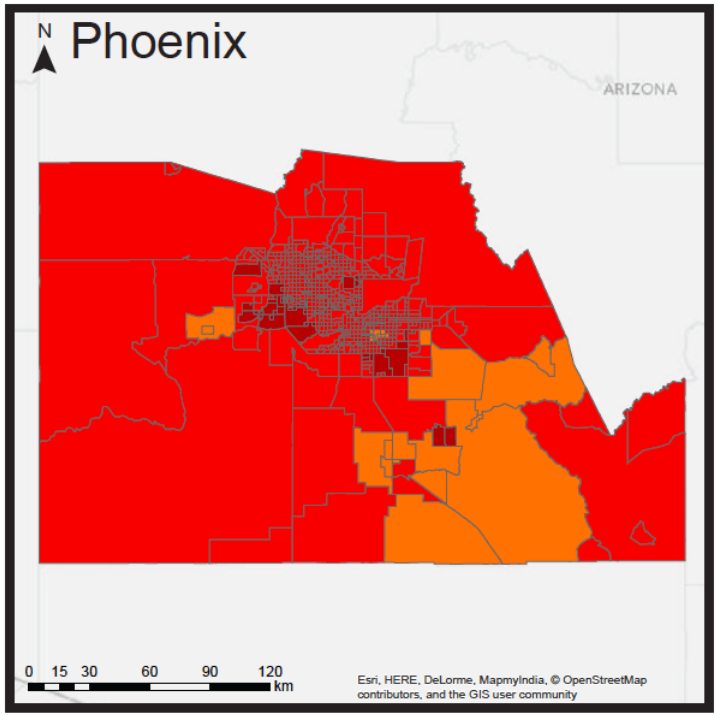
Population Change

- population decrease or no change
- less than 30% increase
- 30 to 50% increase
- 50 to 85% increase
- more than 85% increase

How will climate change by 2050?







Temperature Change (˚C)

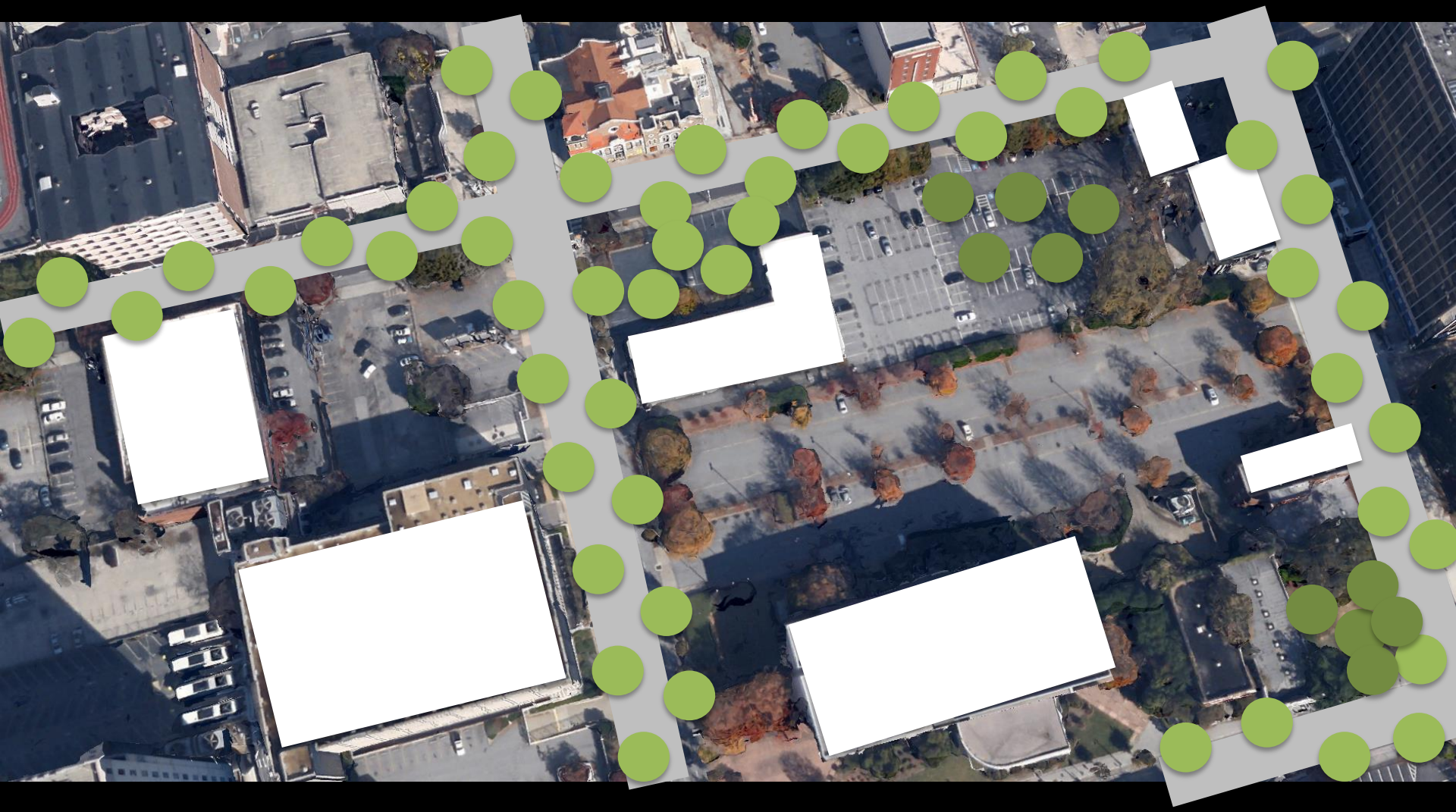
- less than 1 C
- 1 to 1.5 C
- 1.5 to 2 C
- 2 to 3 C
- more than 3 C

Climate-responsive design strategies

Increased reflectivity of roadways

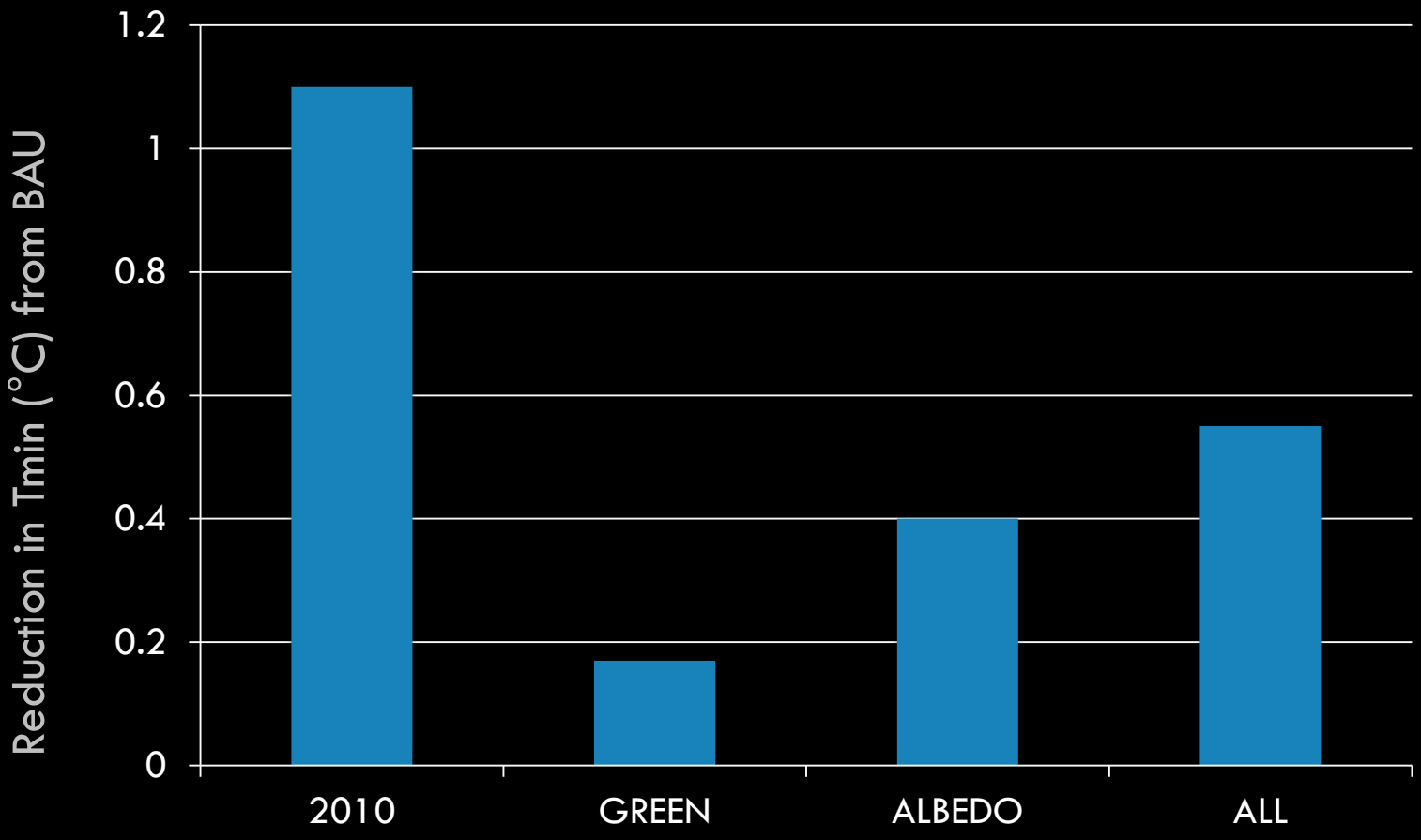
Increased tree canopy cover

Cool roofing materials

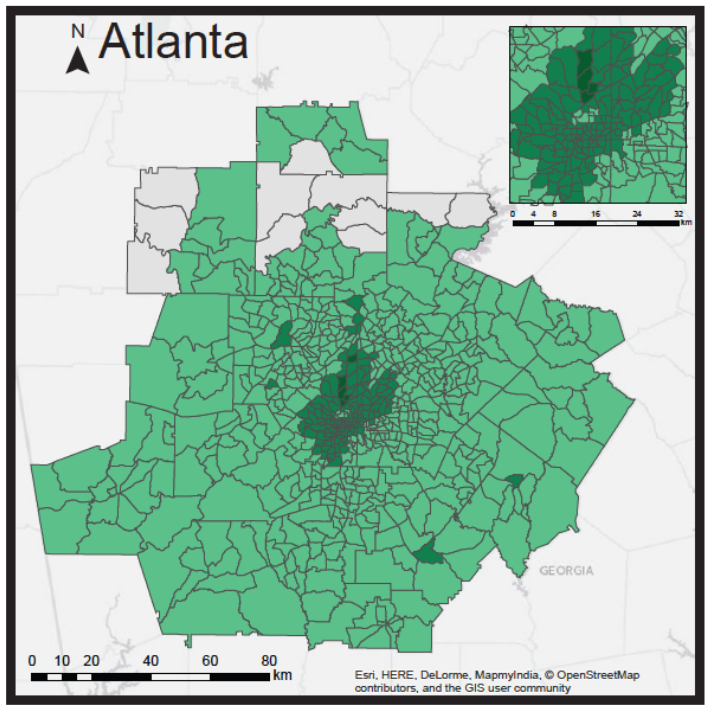


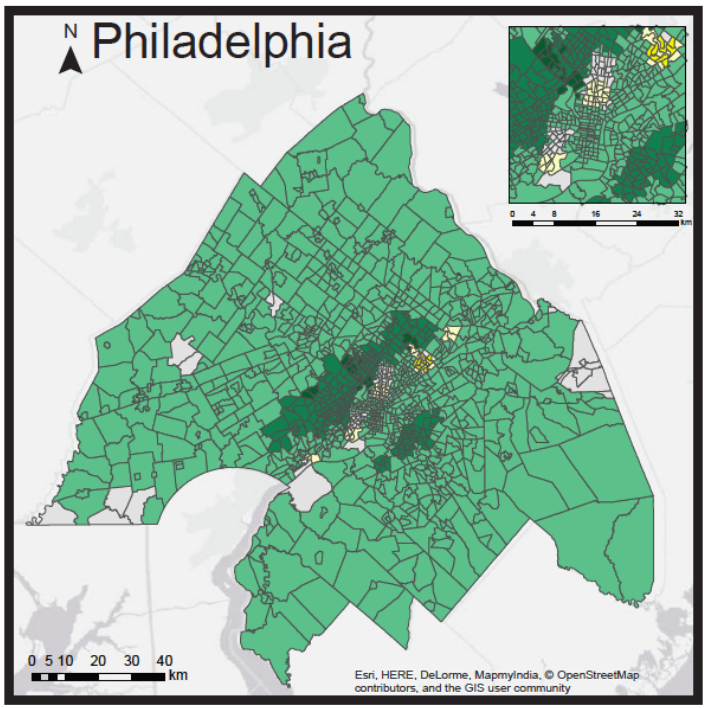
New green spaces

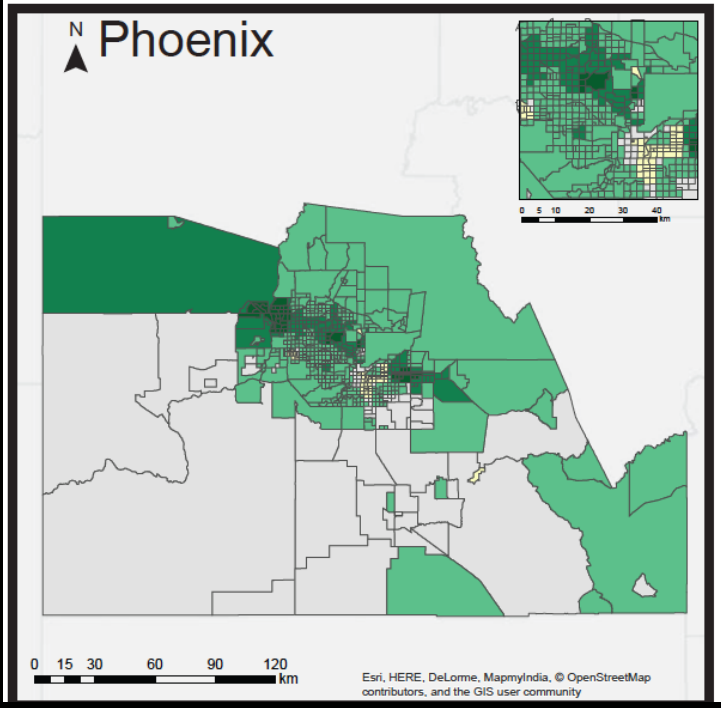
Temperature change from 2050 BAU scenario in Atlanta



Change in heat mortality (per 100,000 population)







1 to 2 increase

less than 1 increase

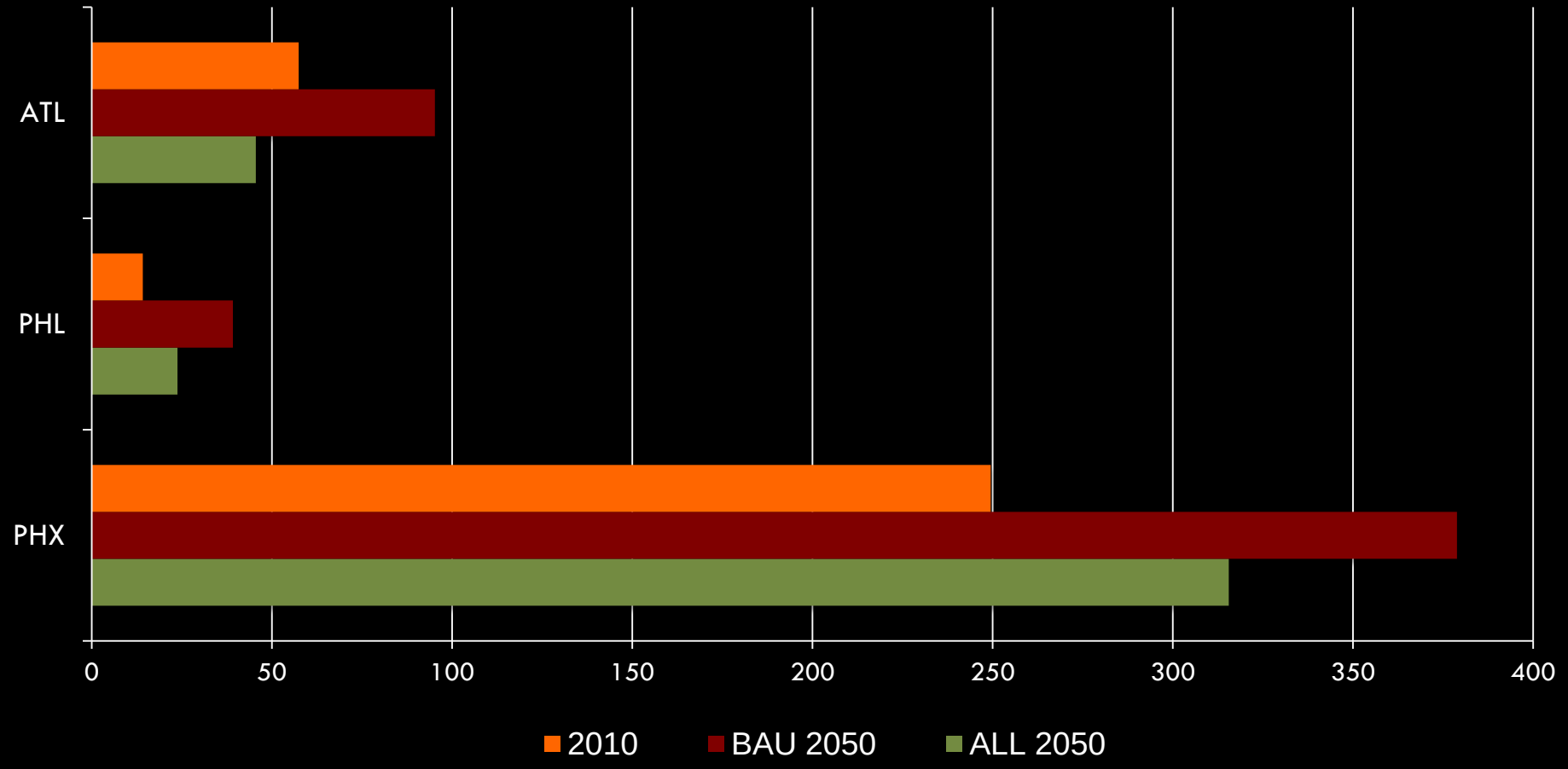
minimal change

less than 1 decrease

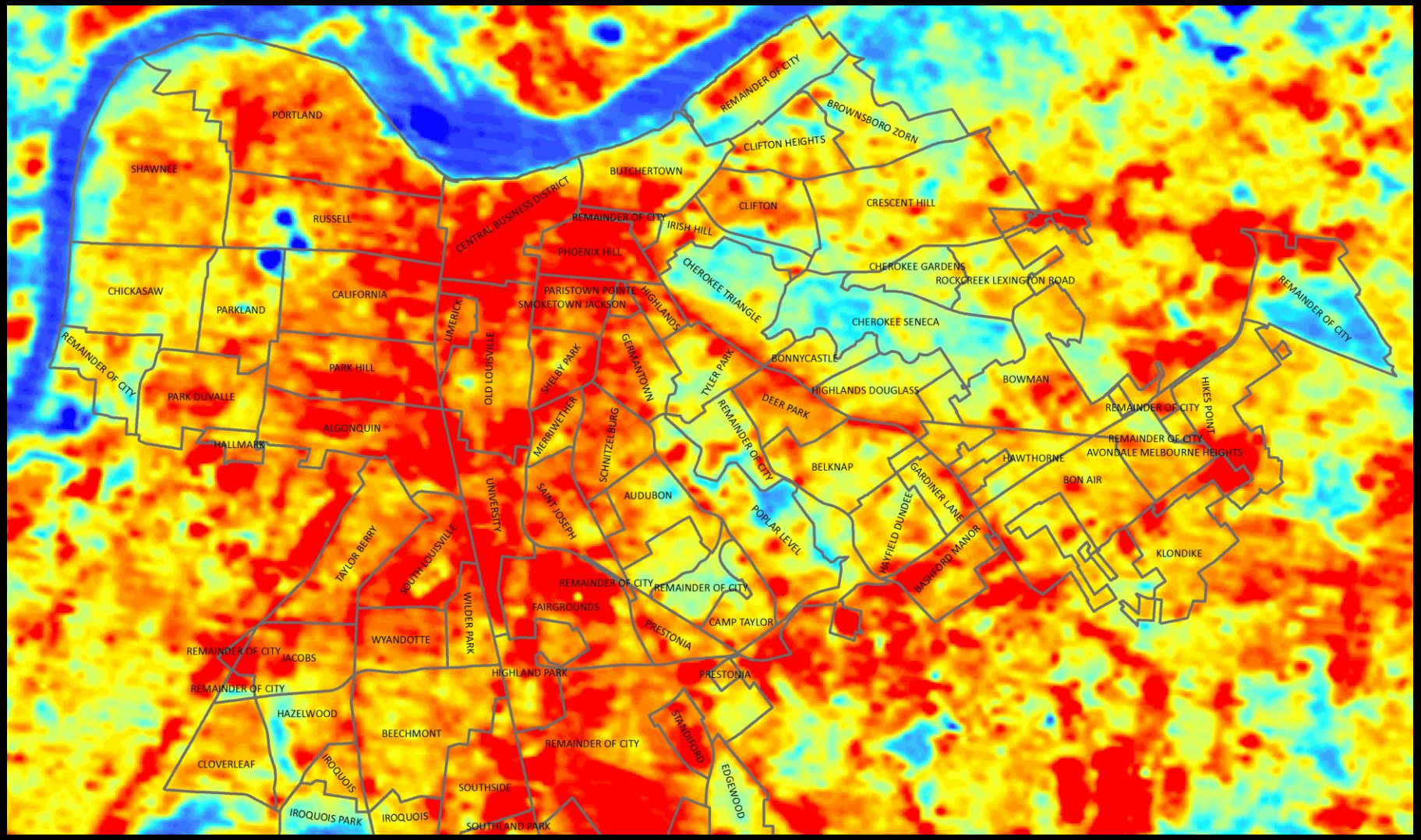
1 to 2 decrease

more than 2 decrease

Annual heat-related mortality by scenario

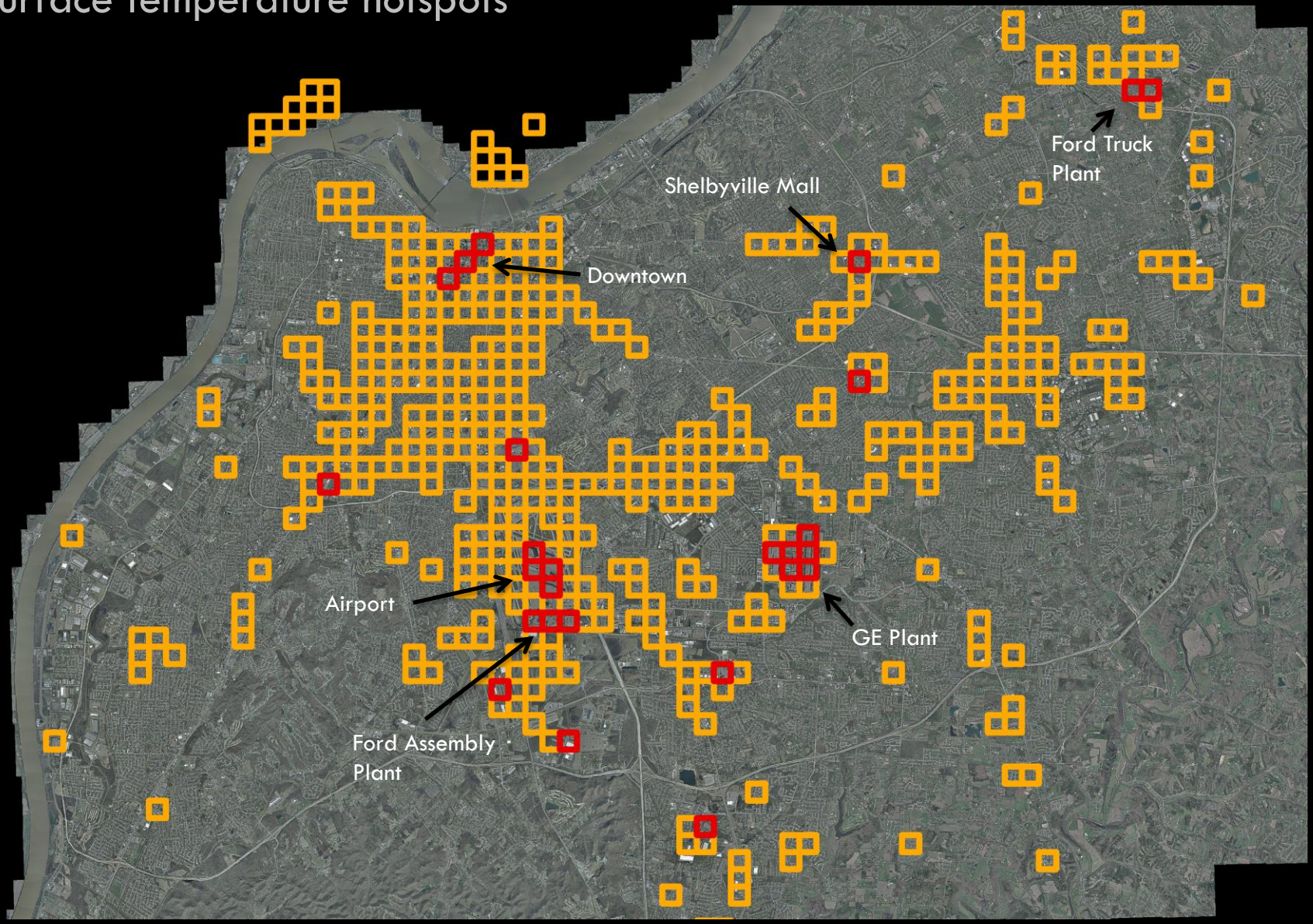


Development of an urban heat management plan for Louisville, KY



Surface temperatures by urban neighborhood: July 5, 2010

Surface temperature hotspots



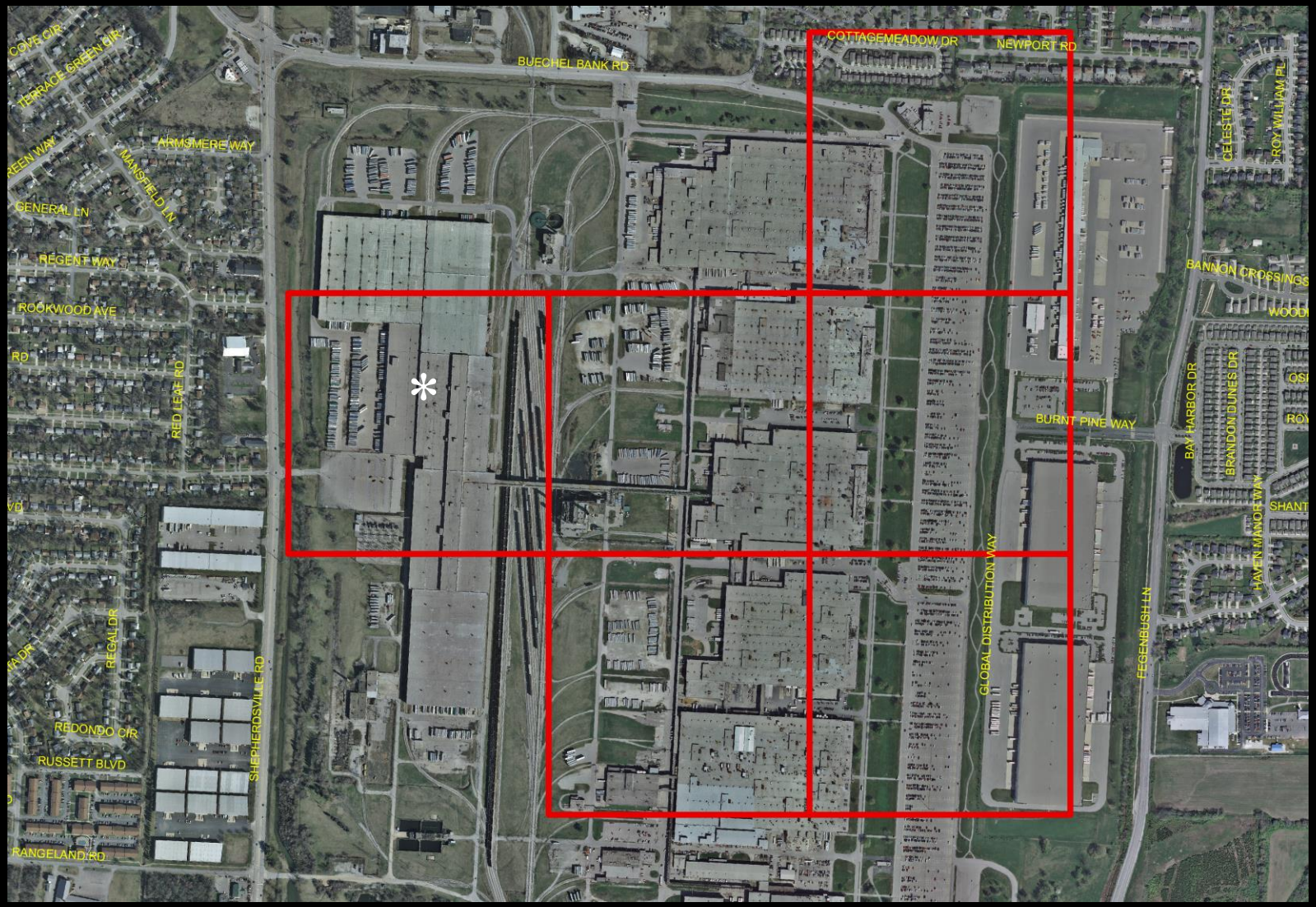
26 cells exhibit average temperatures in excess of 100°F – significant hotspots are highlighted

GE Plant hotspots

*Average cell temperature: 103.1°F

MinT = 87.9°F

MaxT = 118.1°F



Thank you!