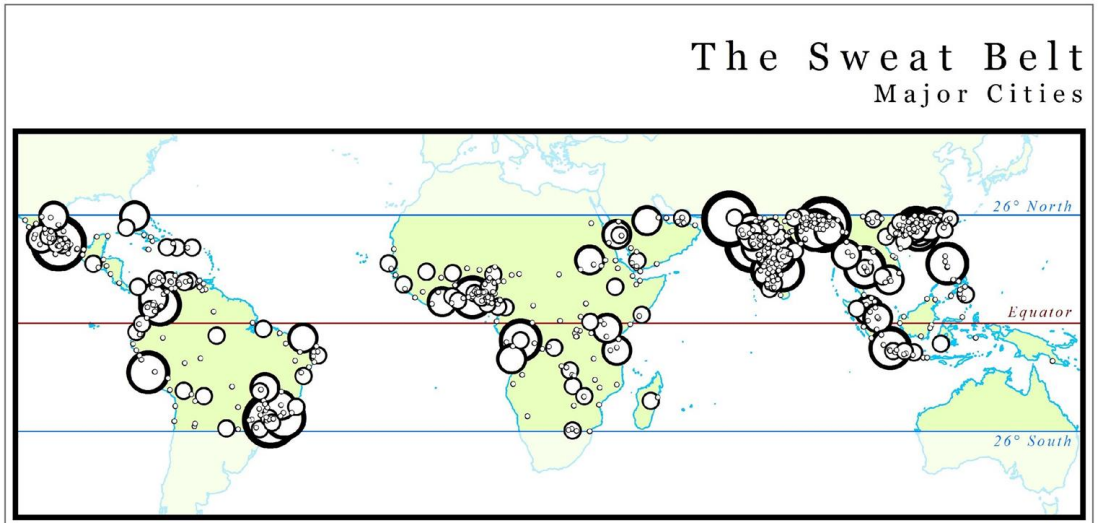
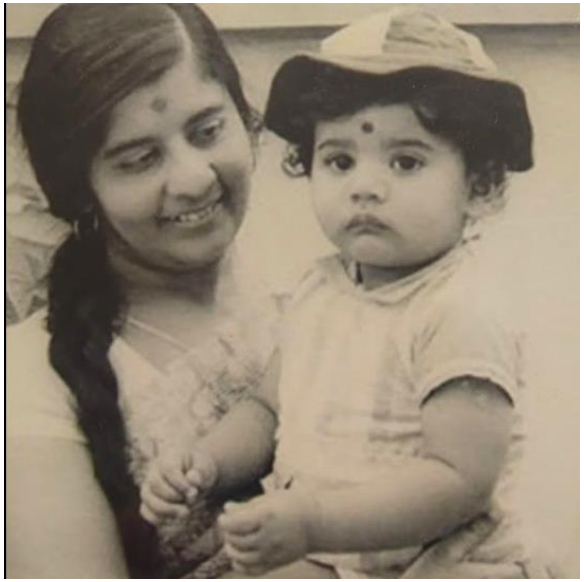
URBAN HEAT & COMMUNITY SCIENCE

Vivek Shandas, PhD

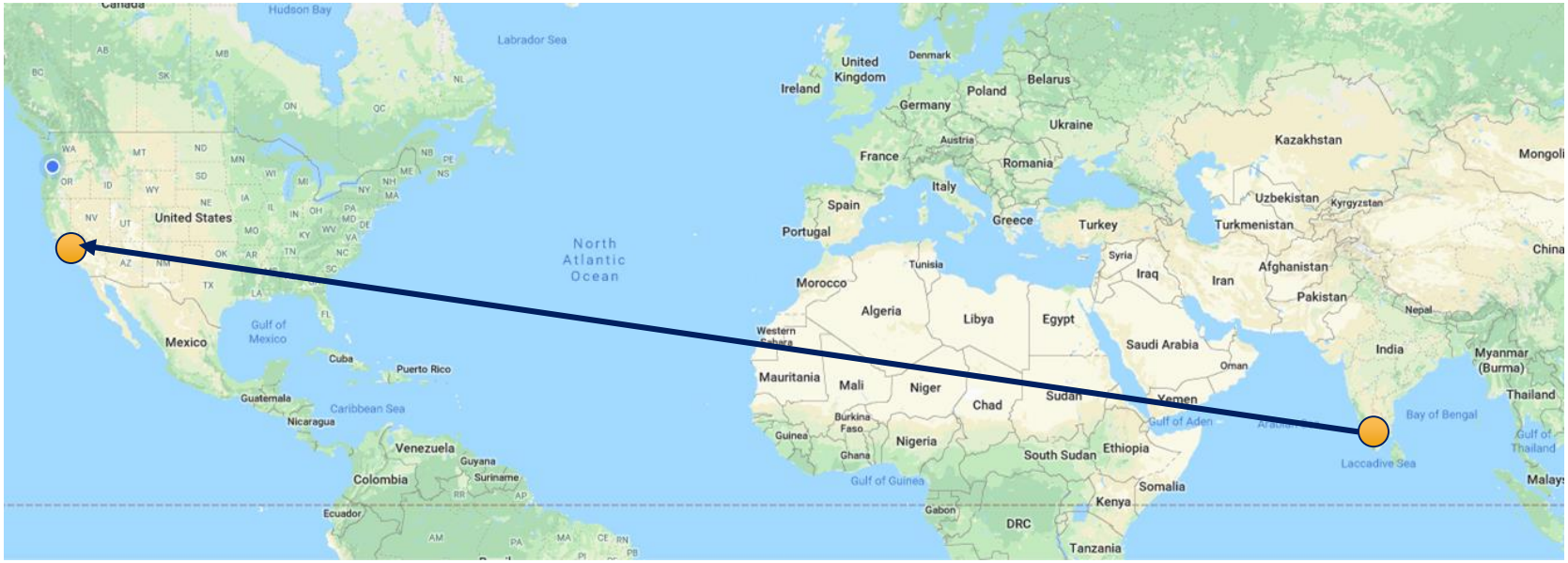
CAPA STRATEGIES

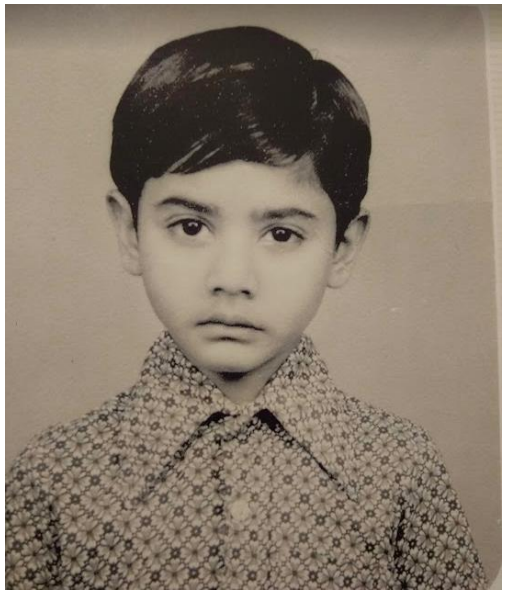
A Little About Me

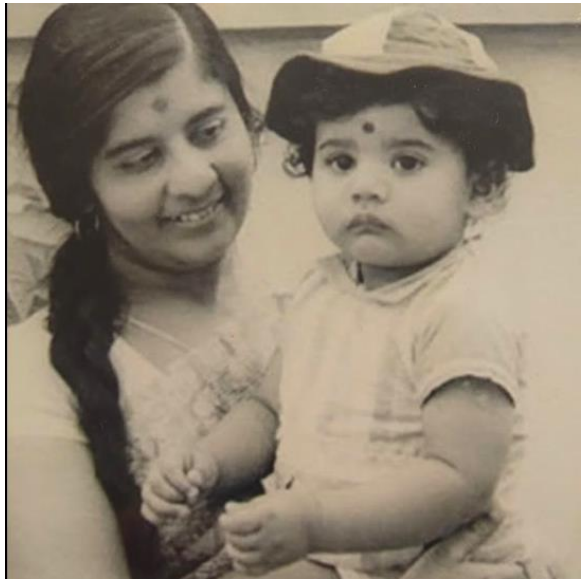




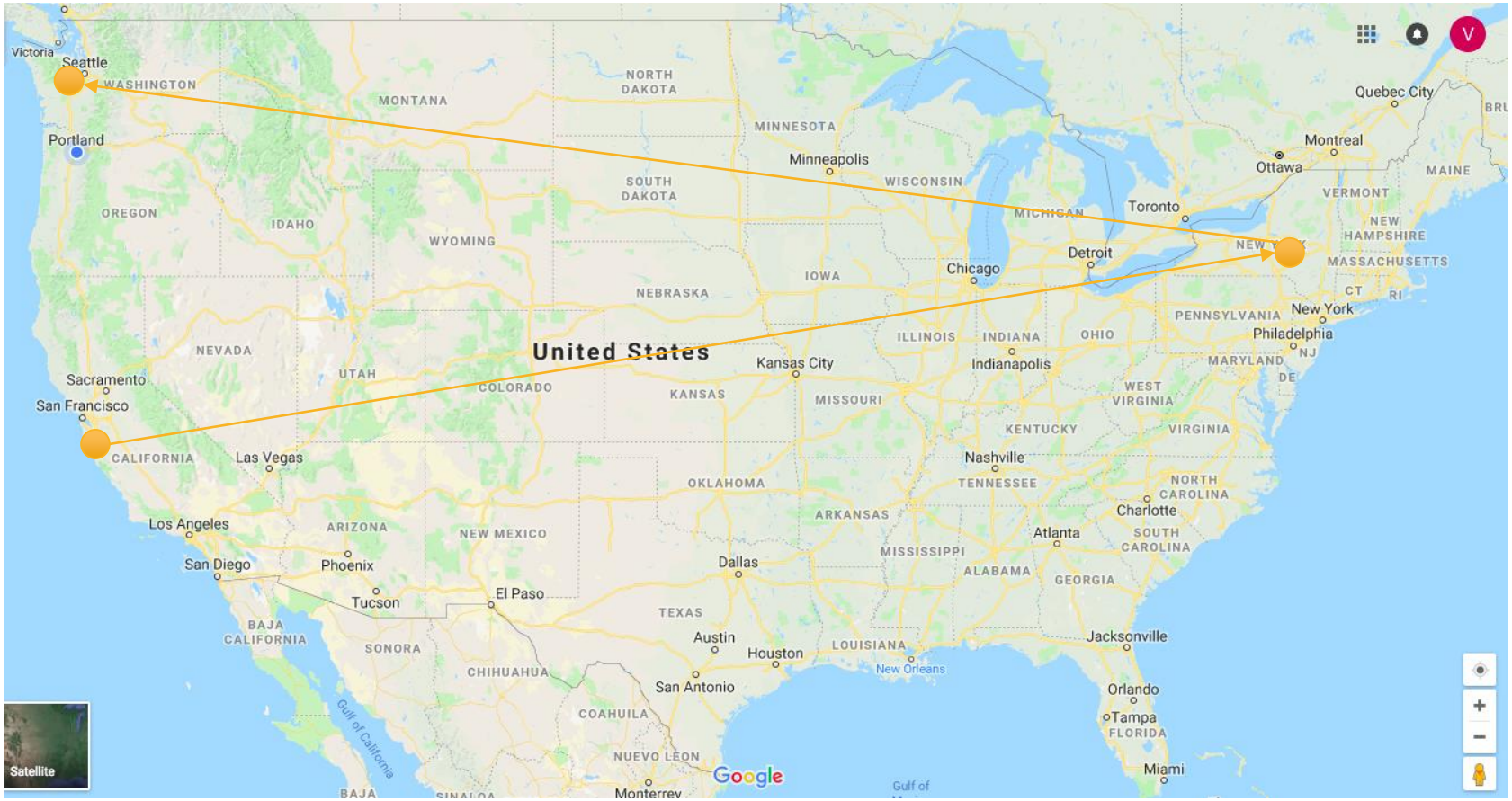
From the Sweat Belt to the Golden Belt





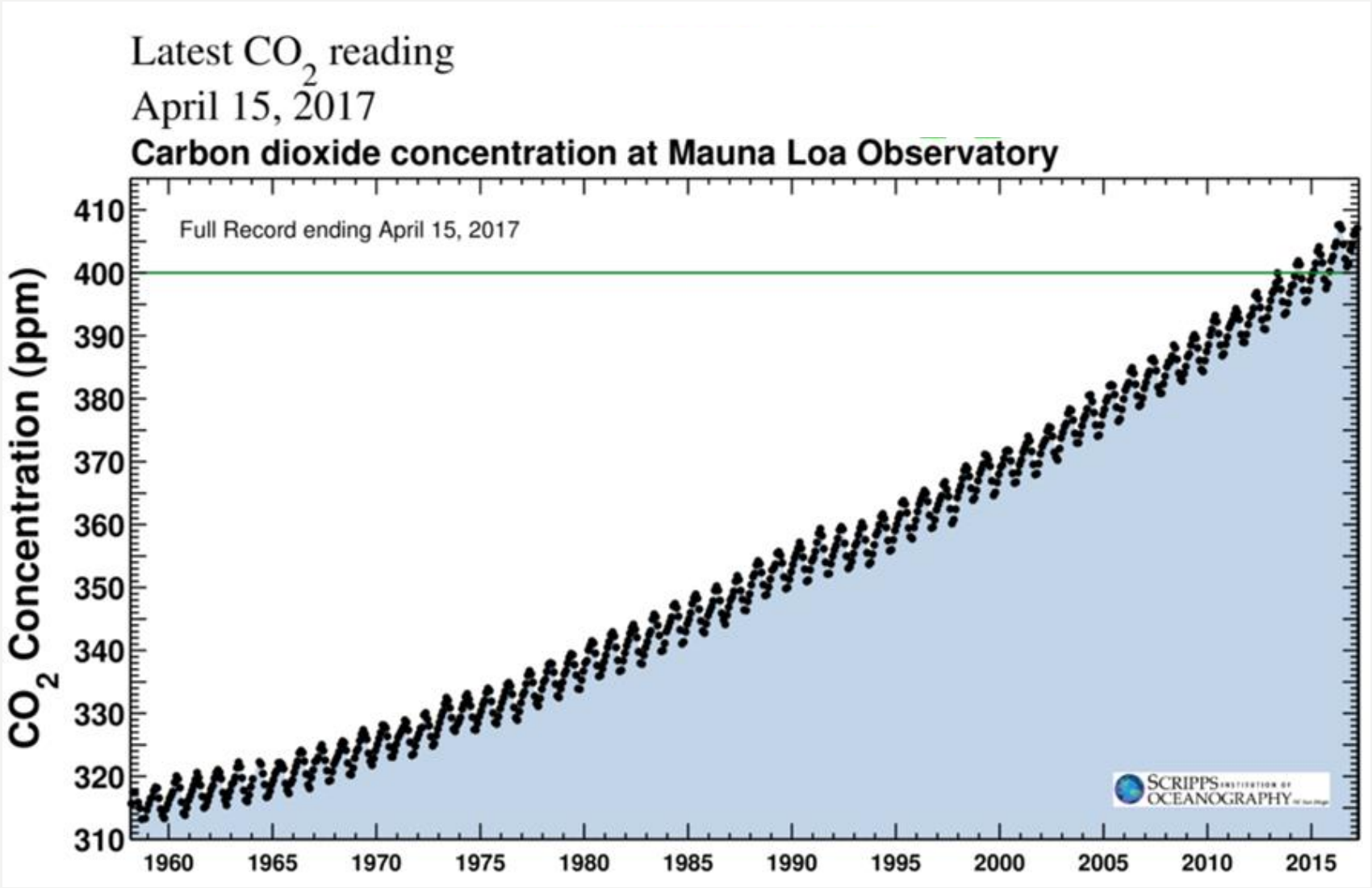


Coast to Coast



We stand now where two roads diverge. But unlike the roads in Robert Frost's familiar poem, they are not equally fair. The road we have long been traveling is deceptively easy, a smooth superhighway on which we progress with great speed, but at its end lies disaster. The other fork of the road – the one less traveled by – offers our last, our only chance to reach a destination that assures the preservation of the Earth." **-- Rachel Carson (1965)**

Since my Birth

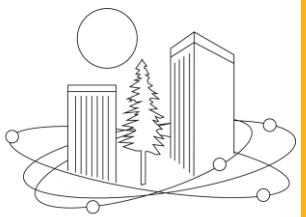


The Great Transition

- Holocene – *(Greek): ὅλος (holos, whole or entire) and καινός (kainos, new)*
  - Growth and impacts of the human species worldwide
  - Creation of modern culture through our experience
  - Expansion of the humans across the earth

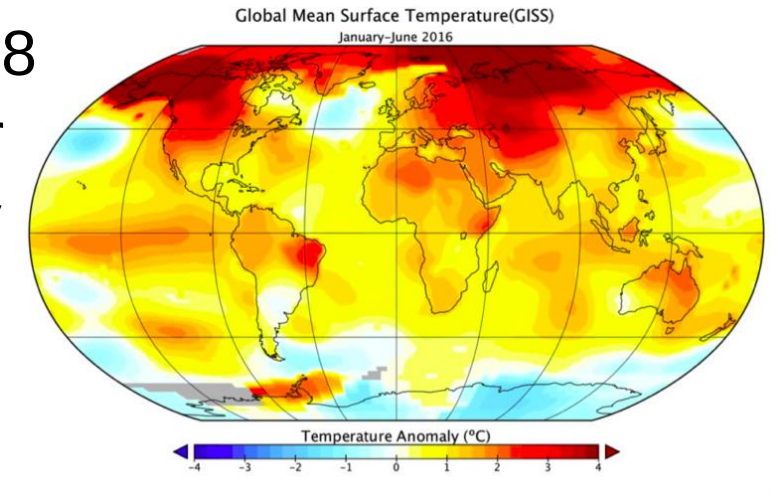
From Holocene….

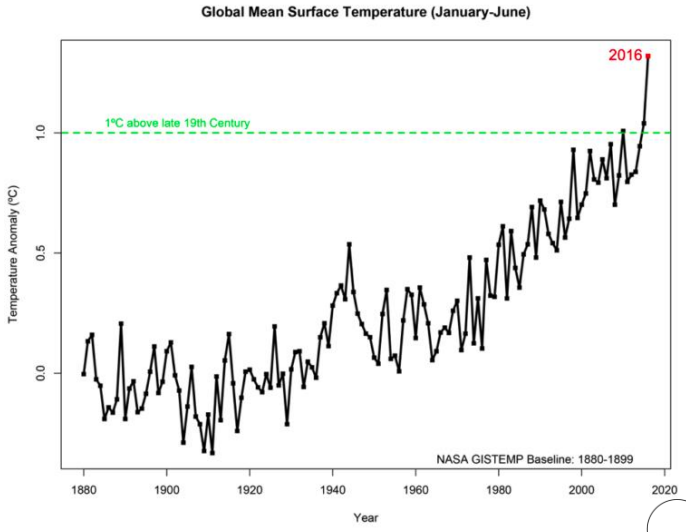
- …***to Anthropocene*** *(Greek, ἄνθρωπος)* the *human epoch* creating fundamental changes on the earth system
  - Climate change
  - Biodiversity loss
  - Excess nitrogen and phosphorus
  - Stratopheric ozone depletion
  - Ocean acidification
  - Fresh water consumption
  - Land use change
  - Air Pollution
  - Chemical Pollution



Record Breaking Temperatures

- The temperatures for 2018 were about 1.8^{0}C warmer than the late 19th century average
- July 2018 in California was the hottest month ever recorded
- Most recent Climate Assessment Report confirms the human role in floods and heat waves.





Poll #1

- Do the concerns of global climate change seem too big for any one person to make a difference?
  - Yes
  - No

Poll #2

- What recent events do you see as directly linked to global climate change?
  - More intense flooding in the midwest
  - Changes in urban crime rates
  - Increasing temperatures in your neighborhood
  - Migration from Latin America to the US
  - Frequency and size of wildfires in CA

Climate Adaptation Planning & Analytics (CAPA)

URBAN HEAT WATCH

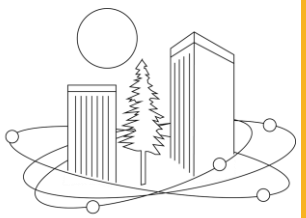
Engage communities in describing and localizing climate-induced hazards

URBAN INSIGHTS

Develop analytical tools for examining scenarios of adaption actions

GROWING CAPACITY

Support capacity building efforts through engagement of decision makers and community groups



CAPA Team

Dana Hellman
Graphic Designer
Hottest place: Miami (FL)

Philip Orlando
Data Scientist
Hottest place: Morgan Hill (CA)

Jackson Voelkel
Geospatial Research Analyst
Hottest place: Nanjing (China)

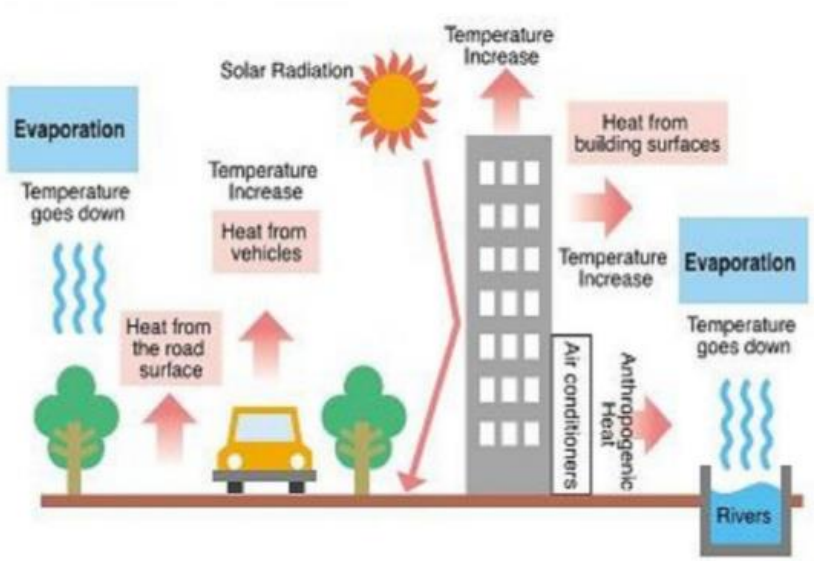
Thea Kindschuh
Engagement Coordinator
Hottest place: El Paso, TX

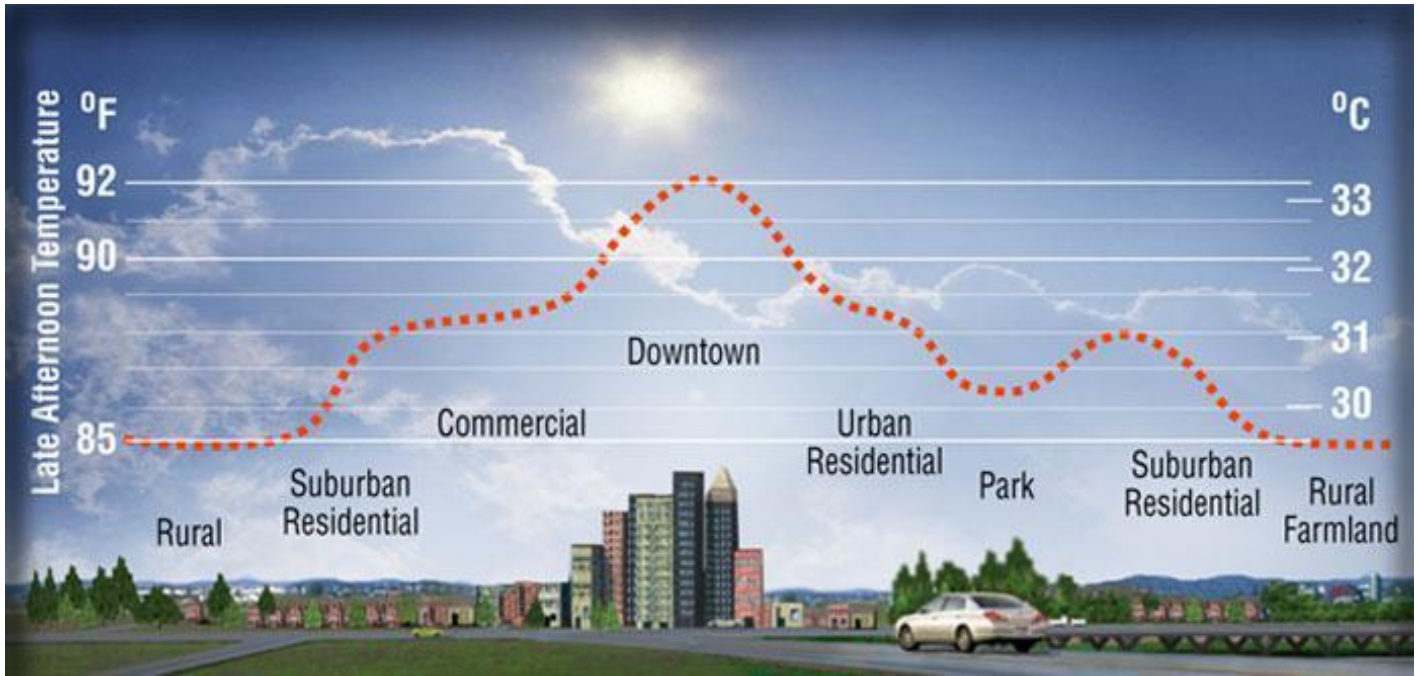
Joey Williams
Operations Manager
Hottest place: Phoenix (AZ)

Tim Hitchins
Software Developer
Hottest place: Boca Raton, FL

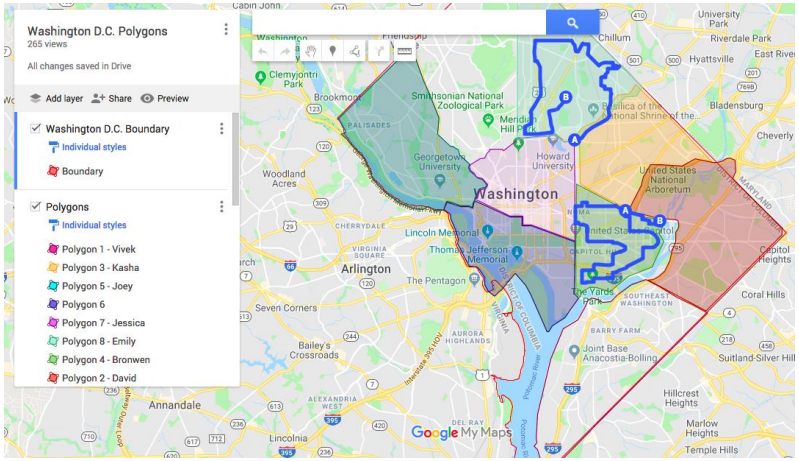
CAPA's Flagship Program

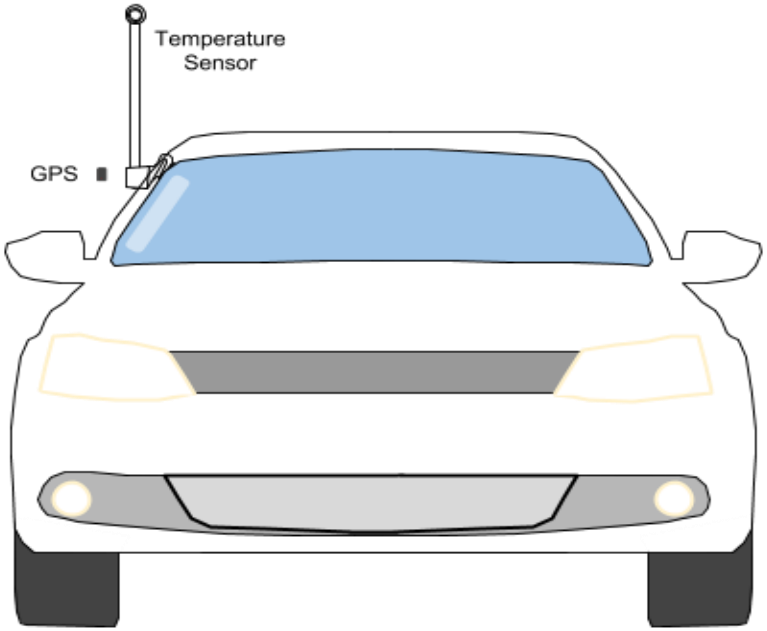
URBAN
HEAT WATCH



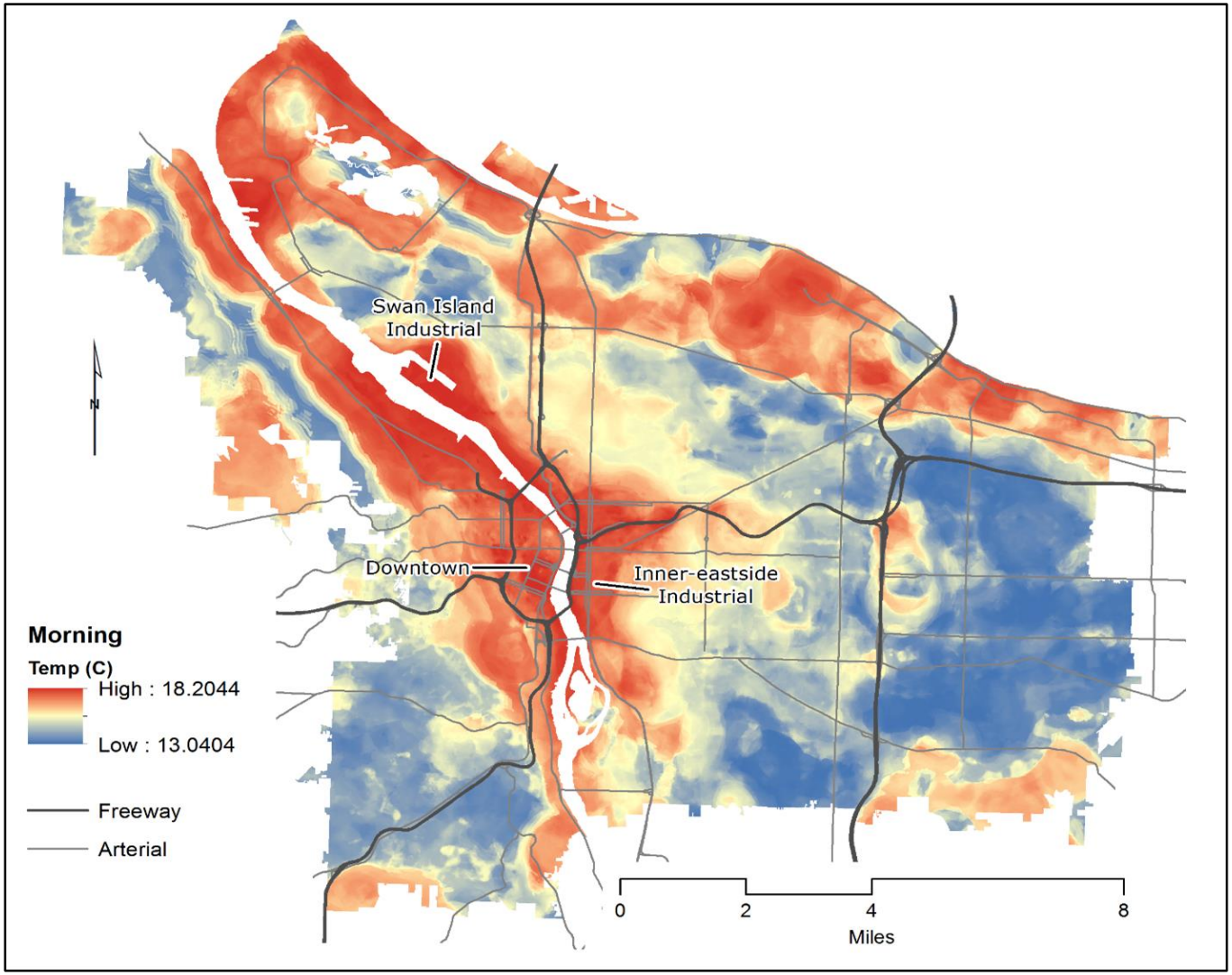


Community Science

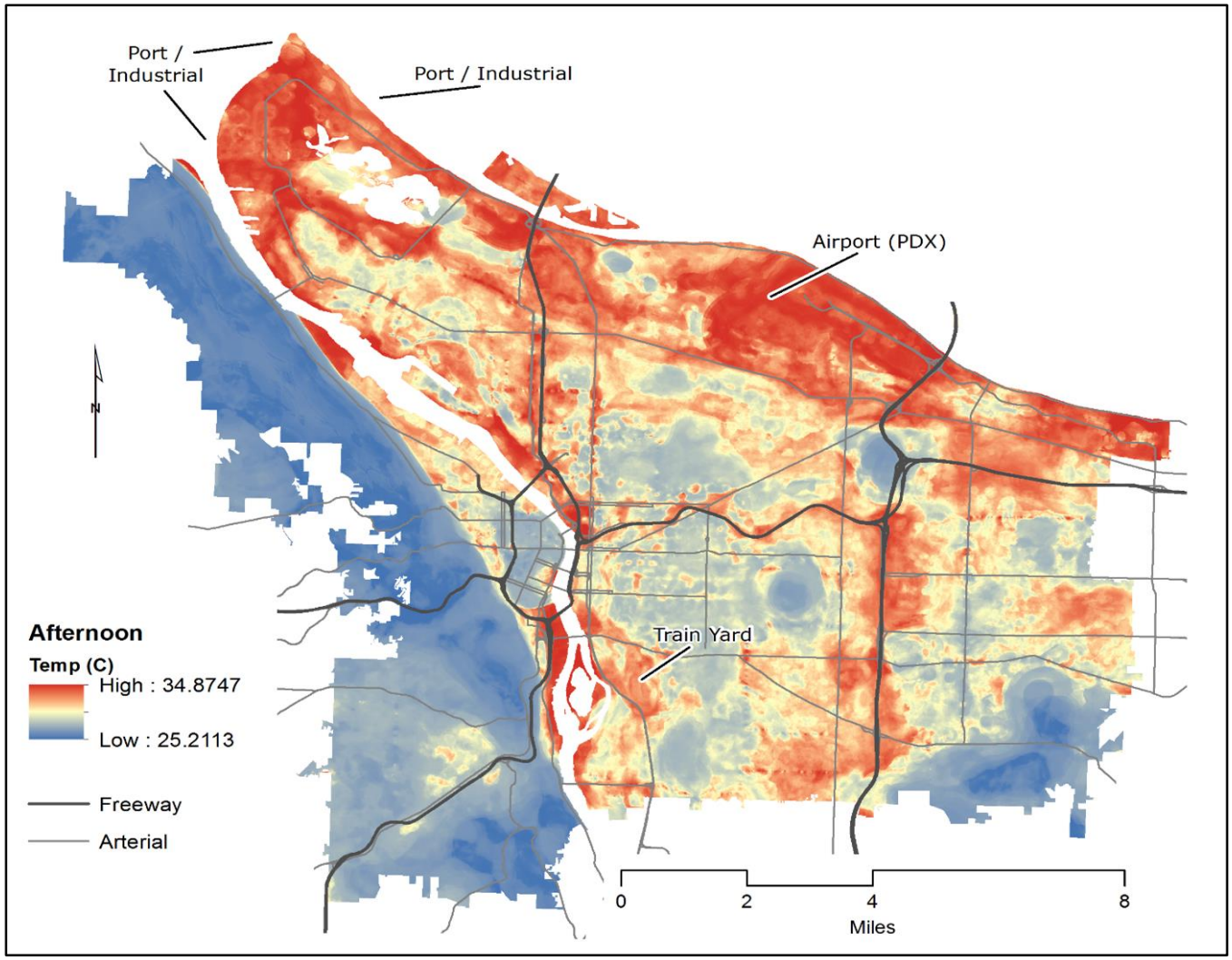




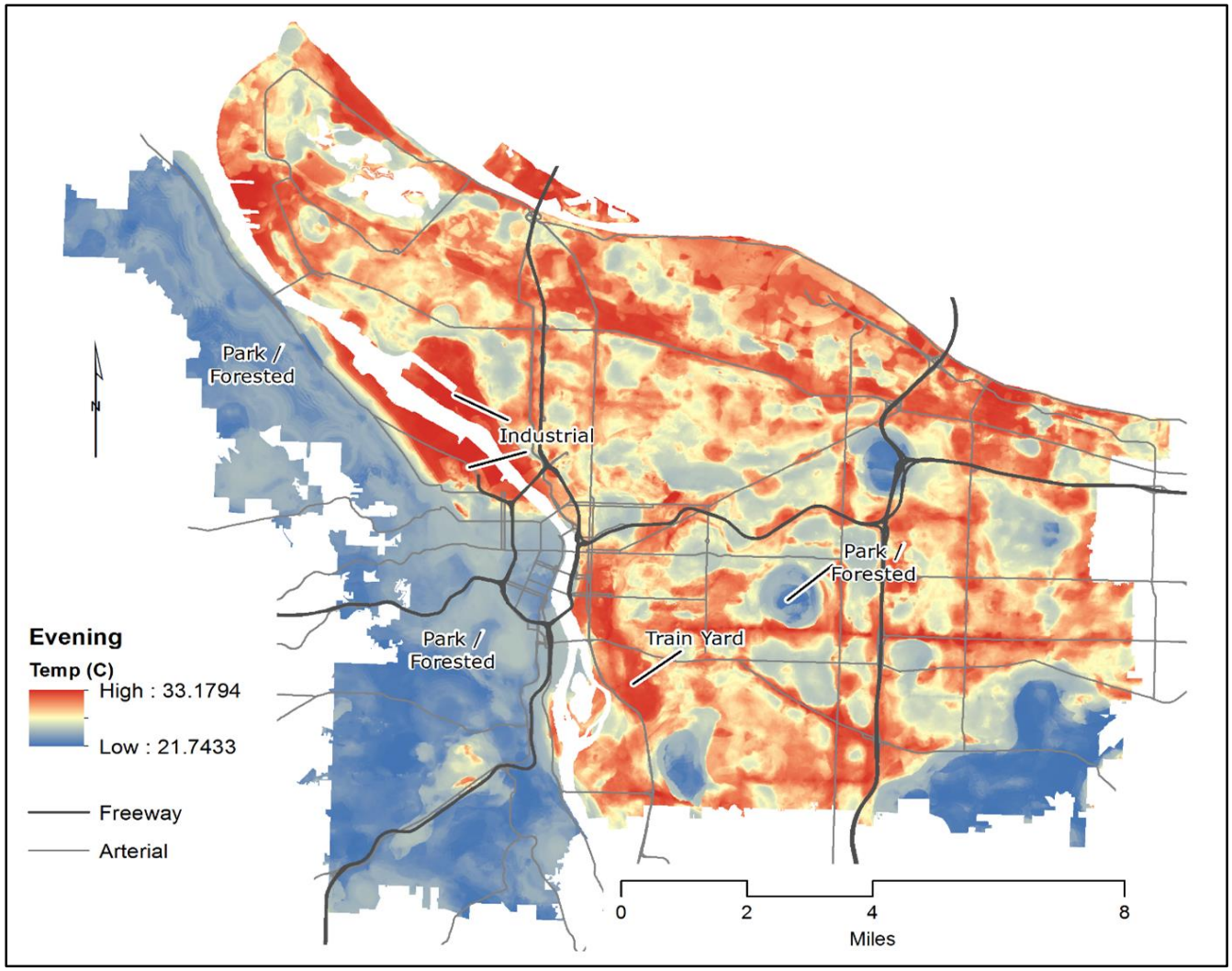
Temperatures: Morning (6am)



Temperatures: Afternoon (3pm)



Temperatures: Evening (7pm)



What Mediates Neighborhood Temperatures?

- Six built environment factors
  - Percent Tree Canopy: vegetation 3m or taller
  - Percent Vegetation: 3m or below
  - Tree Canopy Density
  - Mean Building Height
  - Total Building Volume
  - Difference in Building Heights

Results Washington DC

EXPLORE | ATLAS

LOOKING FOR WAYS TO COOL HEAT ISLANDS

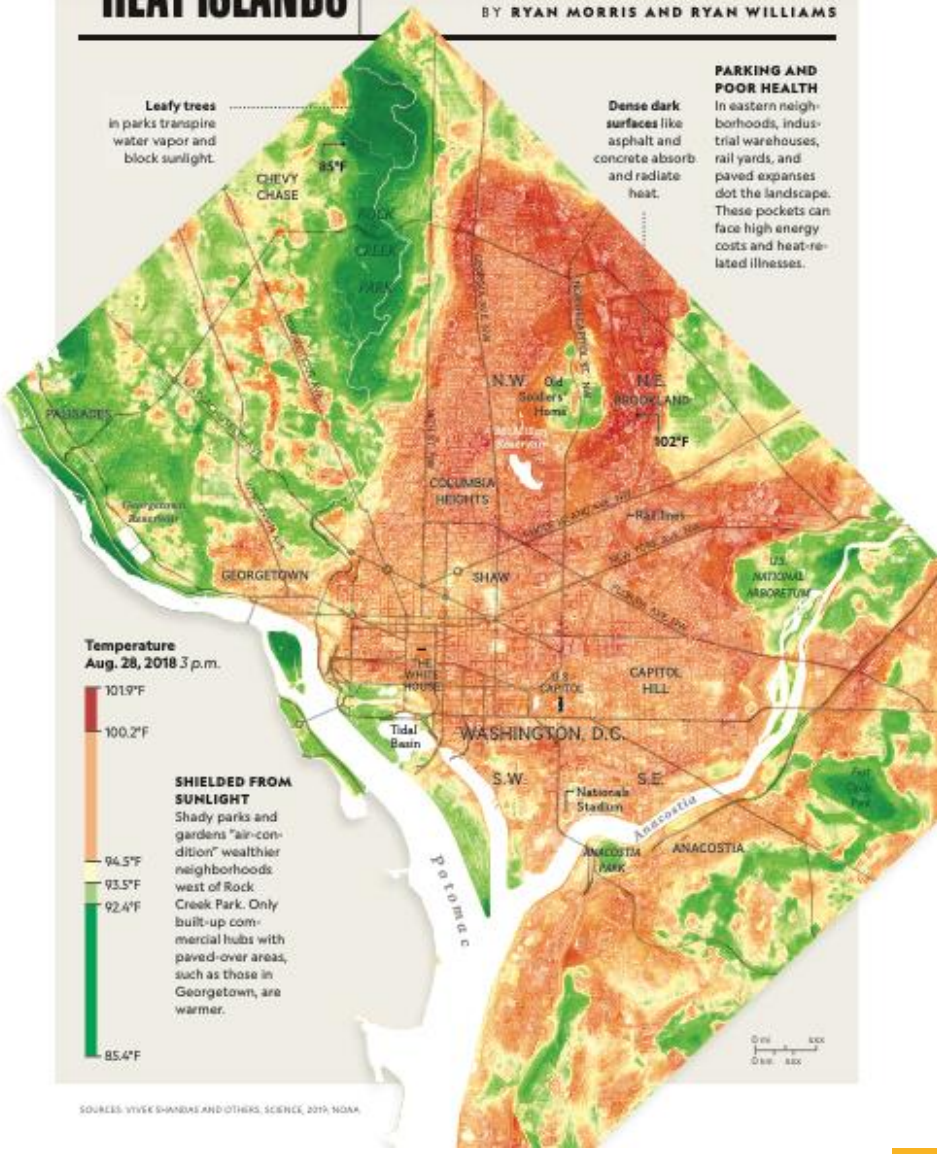
THERMOMETER-WIELDING VOLUNTEER DRIVERS are partnering with weather scientists to create detailed maps of urban heat islands, starting along the U.S. East Coast. On a hot day in Washington, D.C., for example, temperatures varied nearly 20 degrees (°F) between the warmest spot and the coolest. To cope with the heat, many cities are employing strategies such as tree-planting programs. And NOAA, which funded the study, plans to expand the research, to help cities figure out ways to keep their cool in a warming world.

BY RYAN MORRIS AND RYAN WILLIAMS

Leafy trees in parks transpire water vapor and block sunlight.

Dense dark surfaces like asphalt and concrete absorb and radiate heat.

PARKING AND POOR HEALTH
In eastern neighborhoods, industrial warehouses, rail yards, and paved expanses dot the landscape. These pockets can face high energy costs and heat-related illnesses.



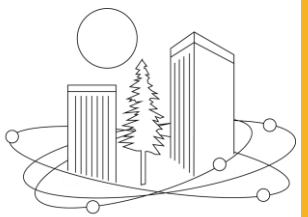
SOURCES: VIVEK SHANDAS AND OTHERS, SCIENCE, 2019; NOAA

Poll #3

- Do you expect to see similare differnces in temperatures in the area you live?
  - Yes
  - No

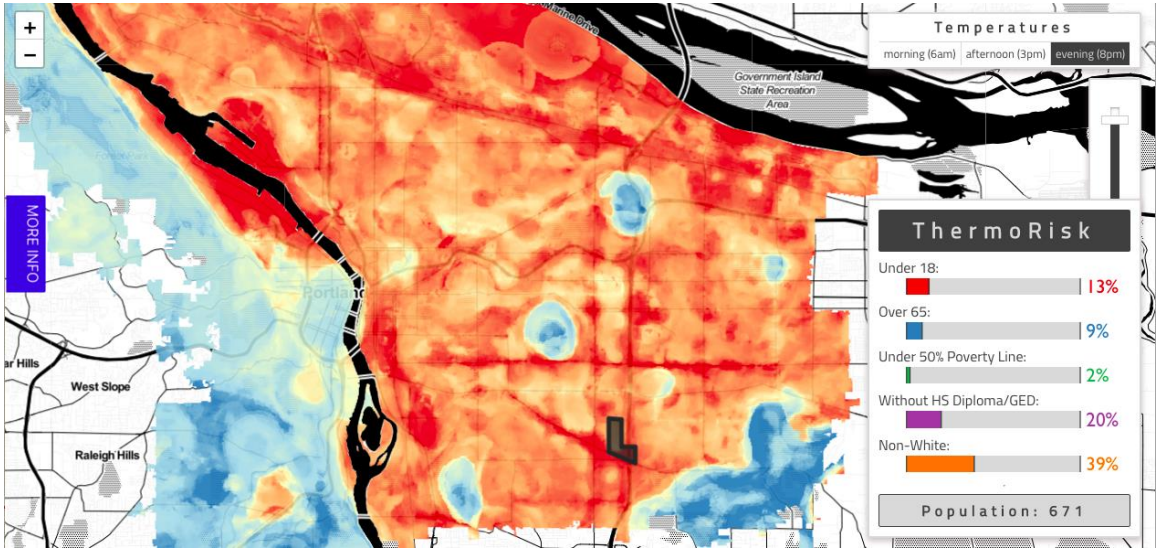
Poll #4

- Which stakeholder groups might consider participating in an urban heat field campaign in your region?
  - Local university researchers
  - Urban forestry groups
  - City staff at specific bureaus
  - High school students
  - Environmental justice groups



So What?

URBAN INSIGHTS

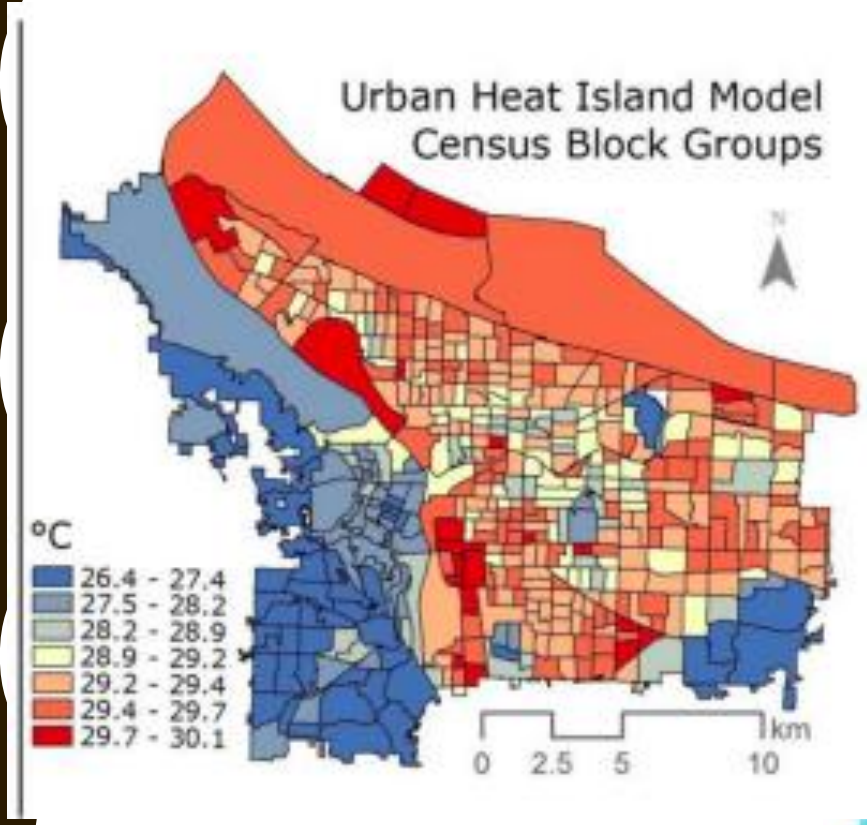


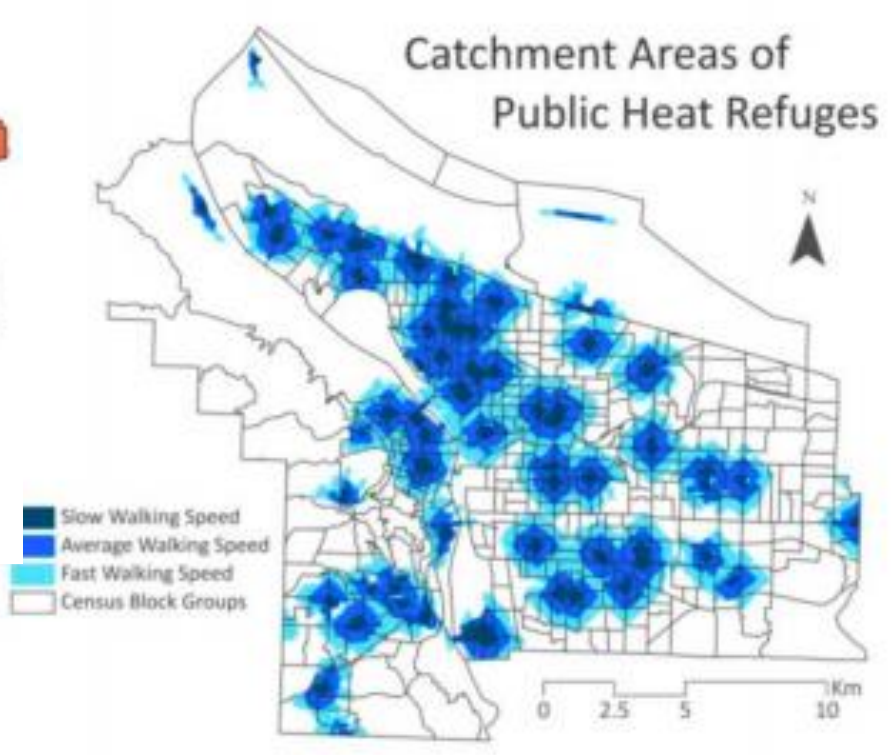
Communities living in the **hottest parts** of Portland include those with Less Formal Education 덥다! Limited English Proficiency and in neighbor-hoods that contain High Racial Diversity Extreme Poverty

White communities are **more** likely to have Central Air Conditioning, while communities with **children** are **less** likely.

Asian and Elderly Communities are less likely to have access to heat refuges.

Refuge from Urban Heat





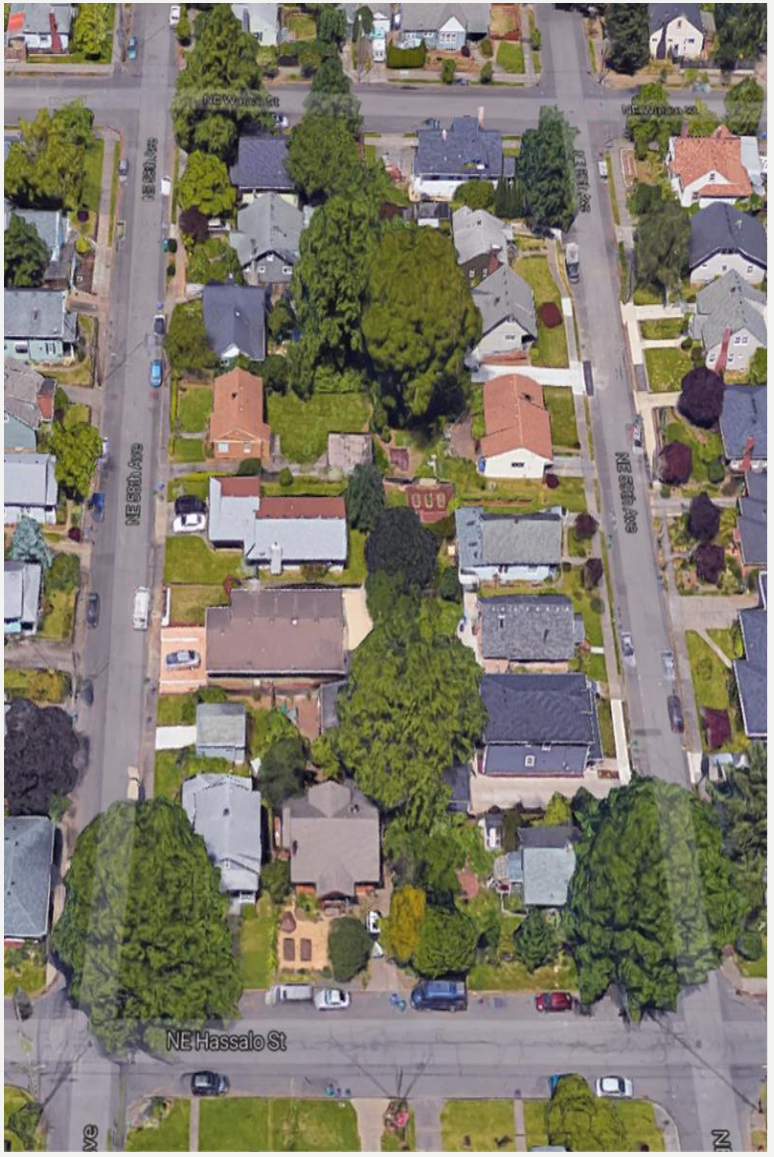
Voelkel, J., D Hellman, R Sakuma, and V Shandas, 2018. "Assessing Vulnerability to Urban Heat: A Study of Disproportionate Heat Exposure and Access to Refuge by Scio-Demographic Status in Portland (OR). International Journal of Environmental Research and Public Health 15(2): 640.

What Can we Do?

- Question: Can we increase housing density, while maintaining (or reducing) pre-development temperatures?

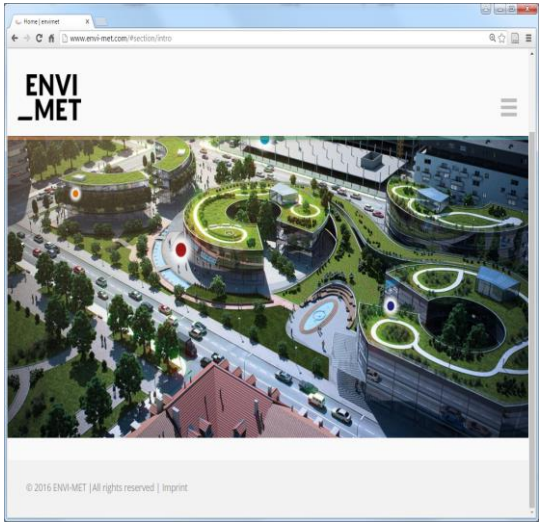
Cool Neighborhoods

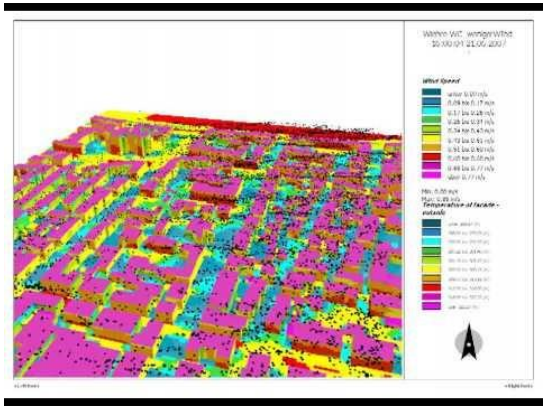
- Selected ‘Large Lot Neighborhood’ that will increase in density
  - Increase the numbers of housing units from 16 to 64
  - Varying open parking spaces (asphalt)



Neighborhood Scale Adaptation

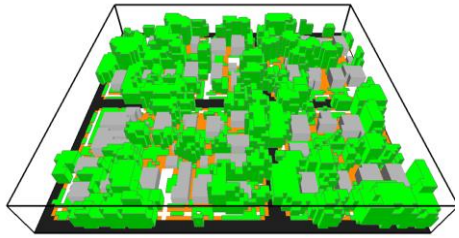
- ENVI-Met: High-resolution microclimate modelling system
  - A computational fluid dynamics model based several principles of
    - Fluid mechanics
    - Thermodynamics
    - Atmospheric physics



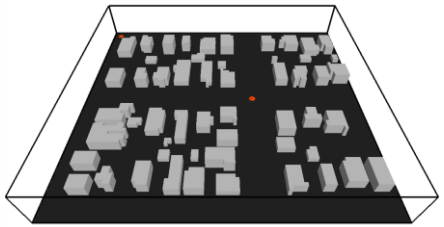


High Canopy Neighborhood

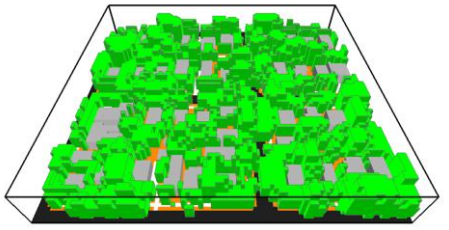
The role of trees in cooling the neighborhood



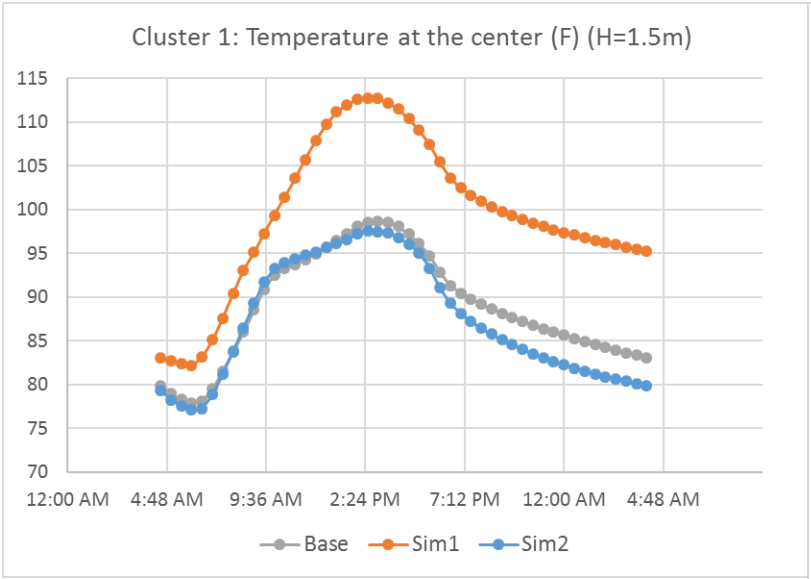
Base

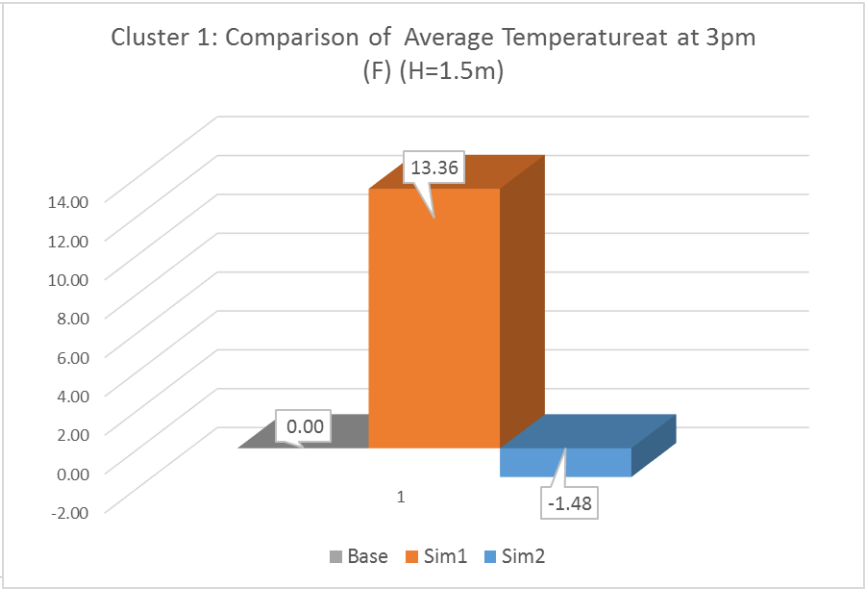


Sim1

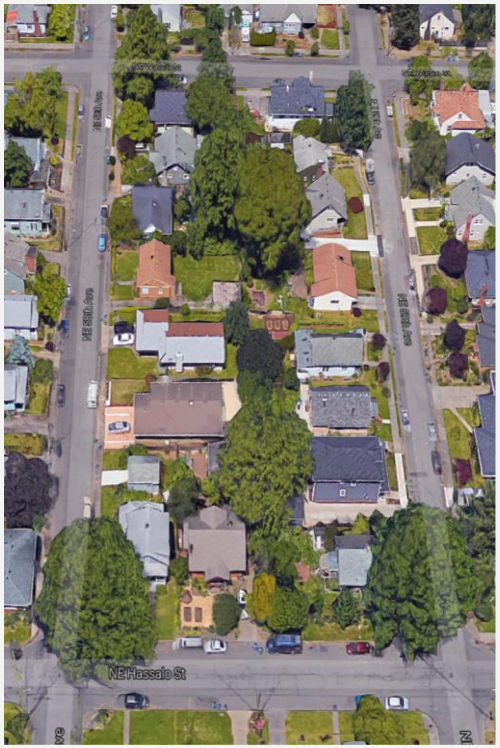


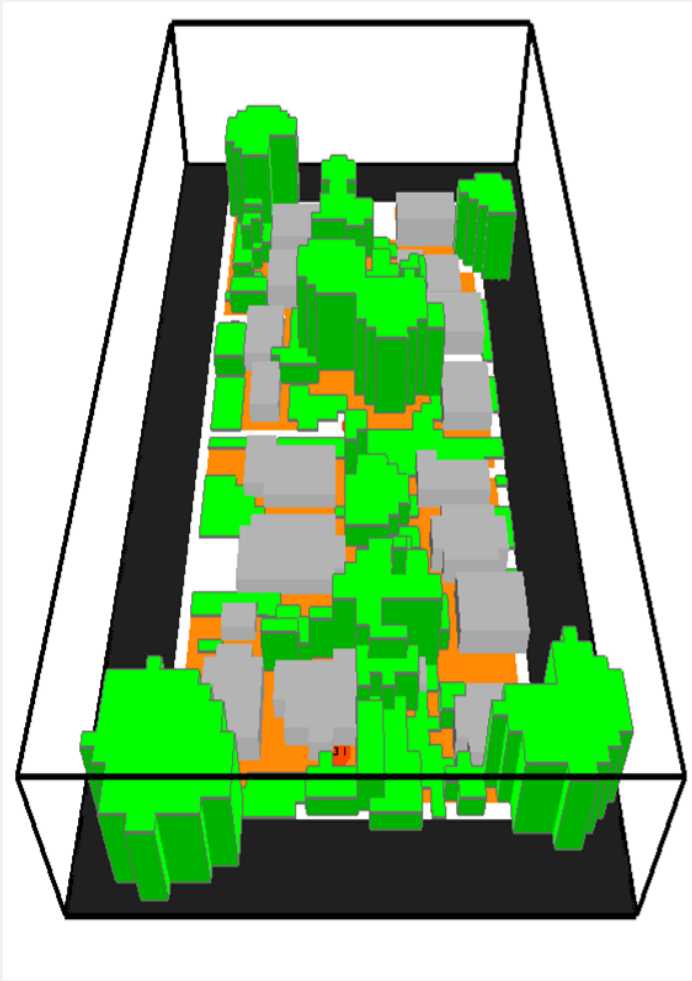
Sim2



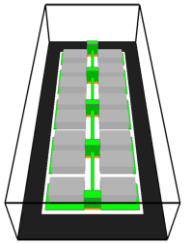


Rezoning to Higher Density

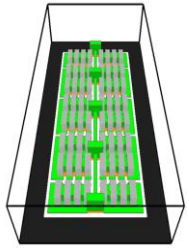




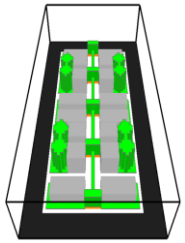
Plan 2



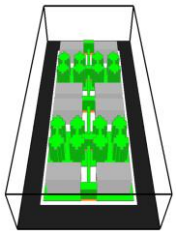
Plan 3



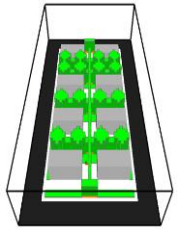
Plan 4



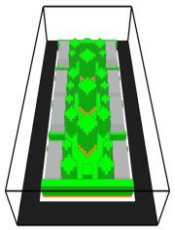
Plan 5



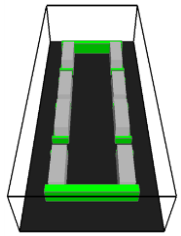
Plan 5b

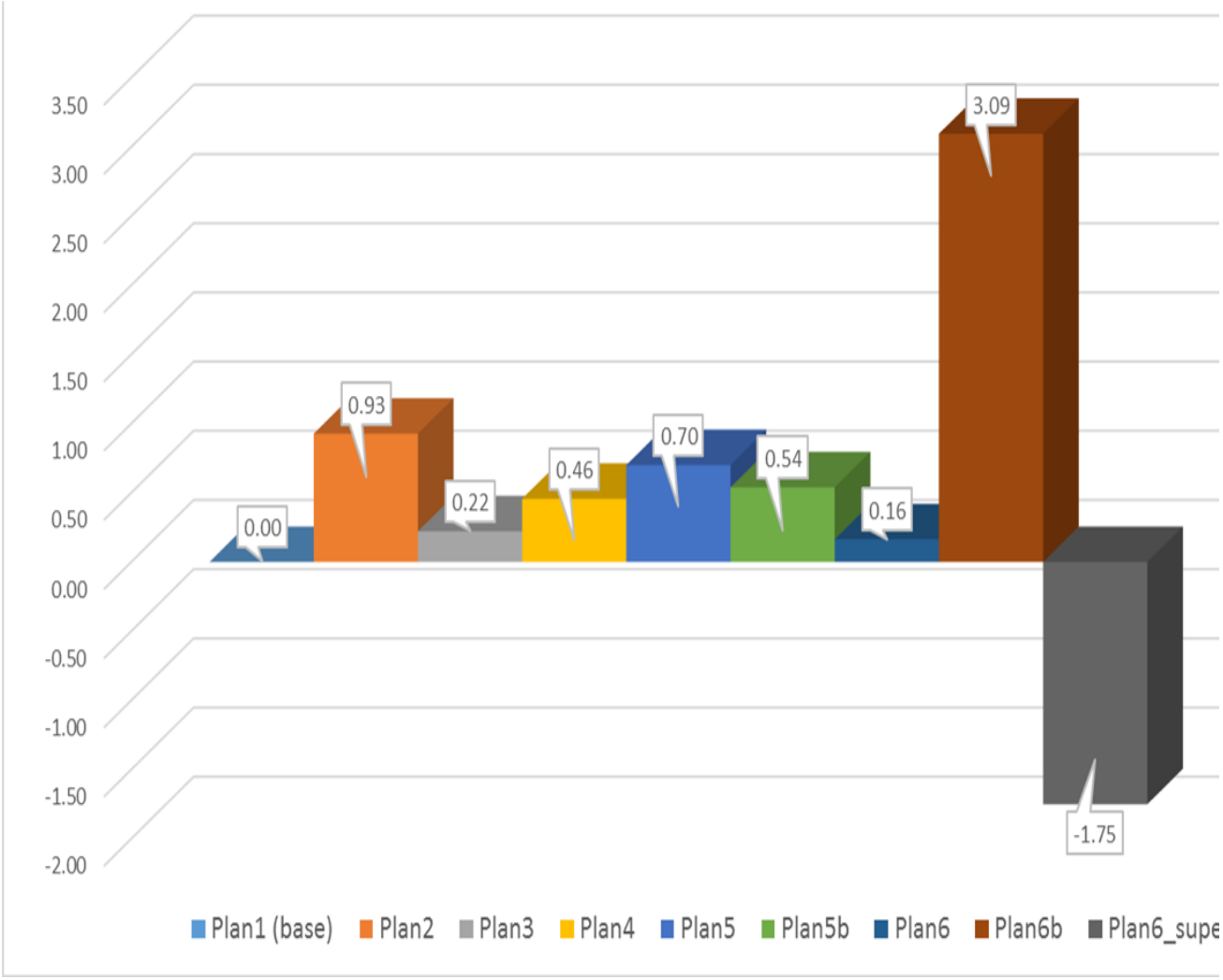


Plan 6

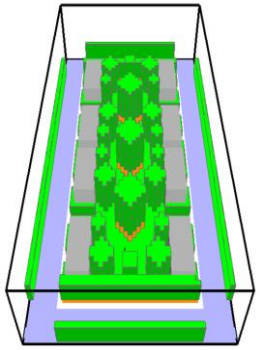


Plan 6b

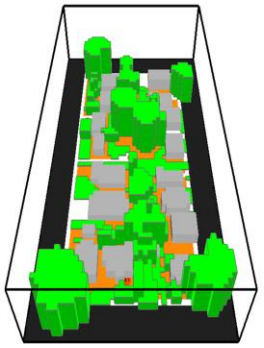




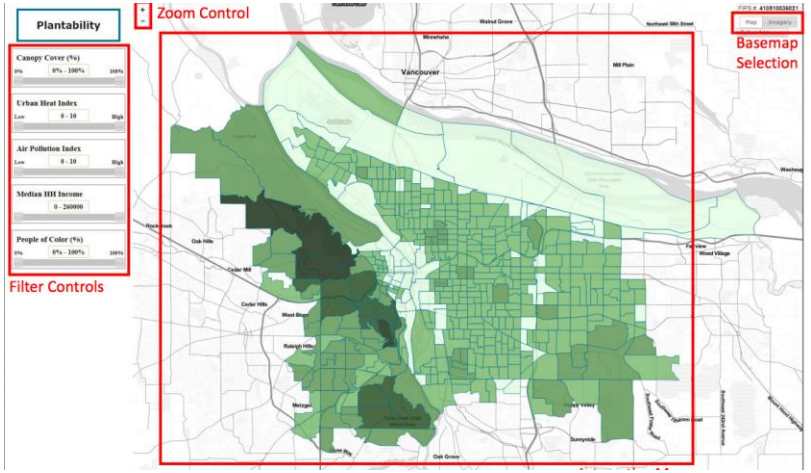
Plan 6S



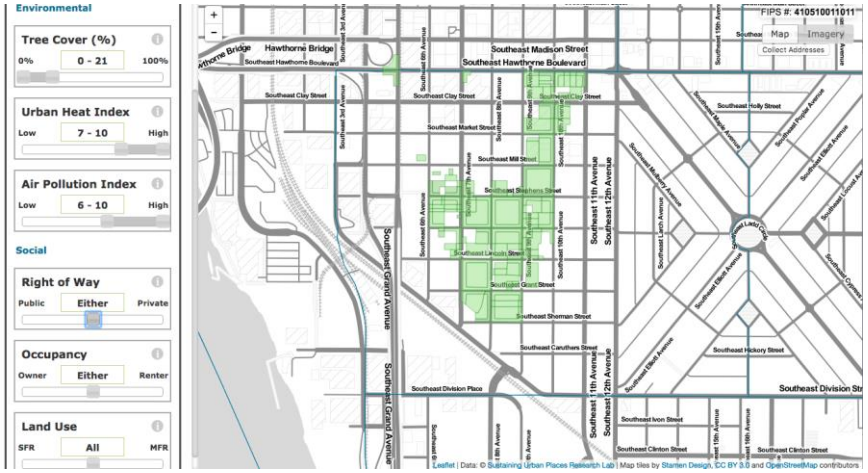
Plan 1(base)

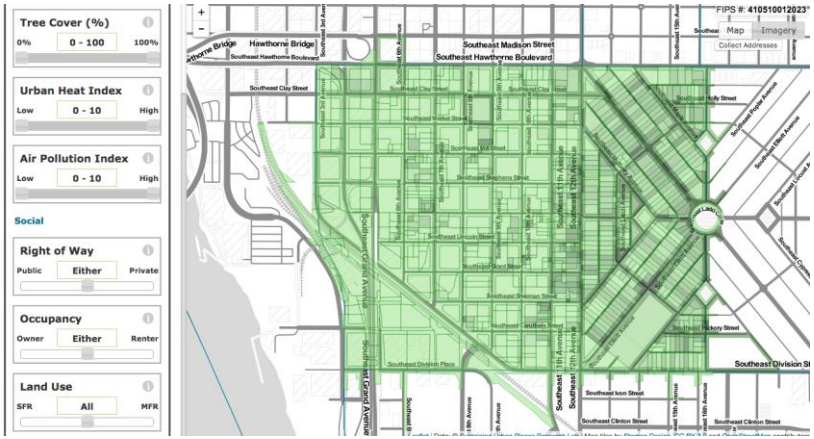


Areas for Expanding Green Infrastructure



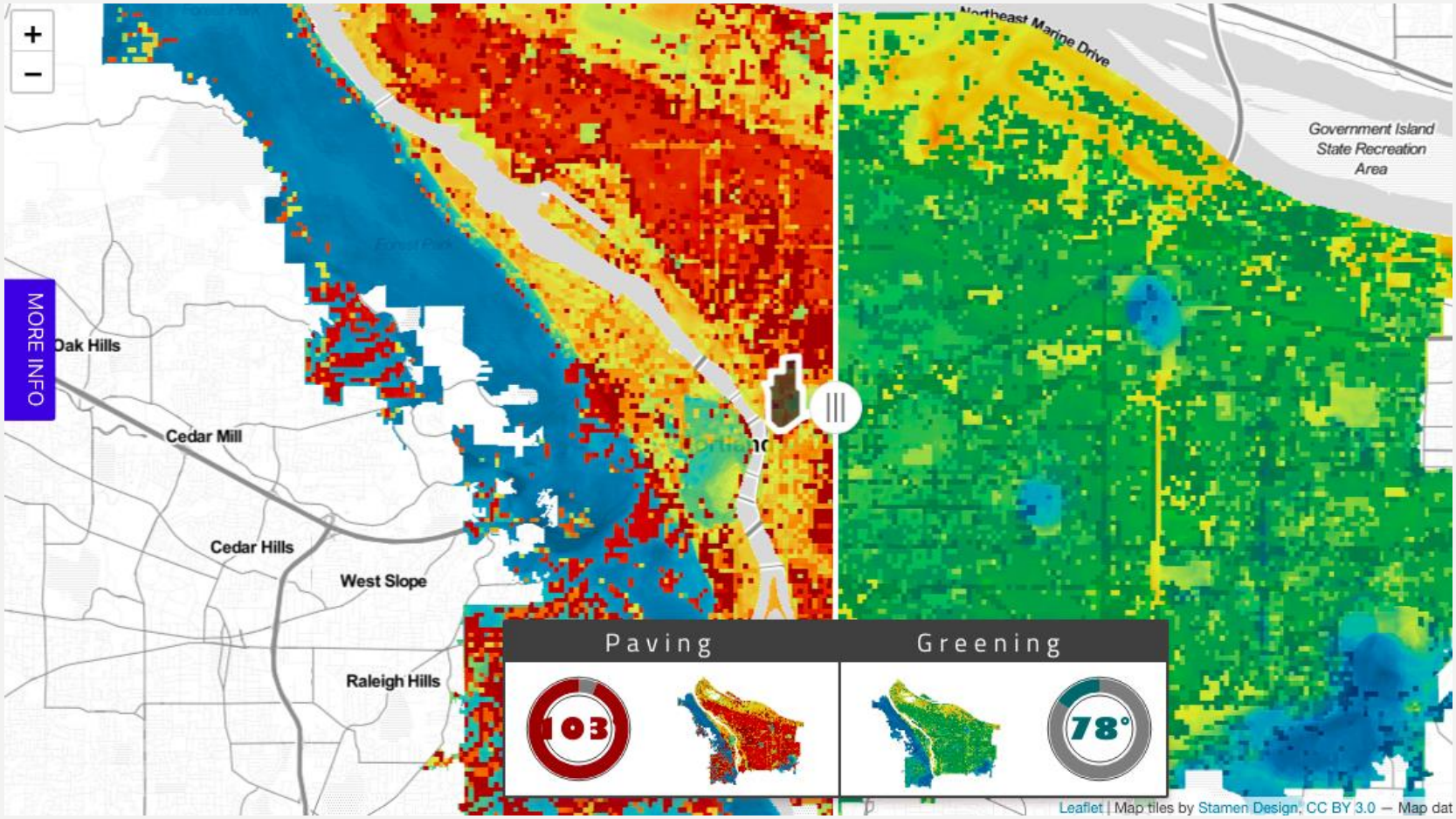
Finding locations to plant trees as a next step for engaging communities





www.branchoutpdx.org

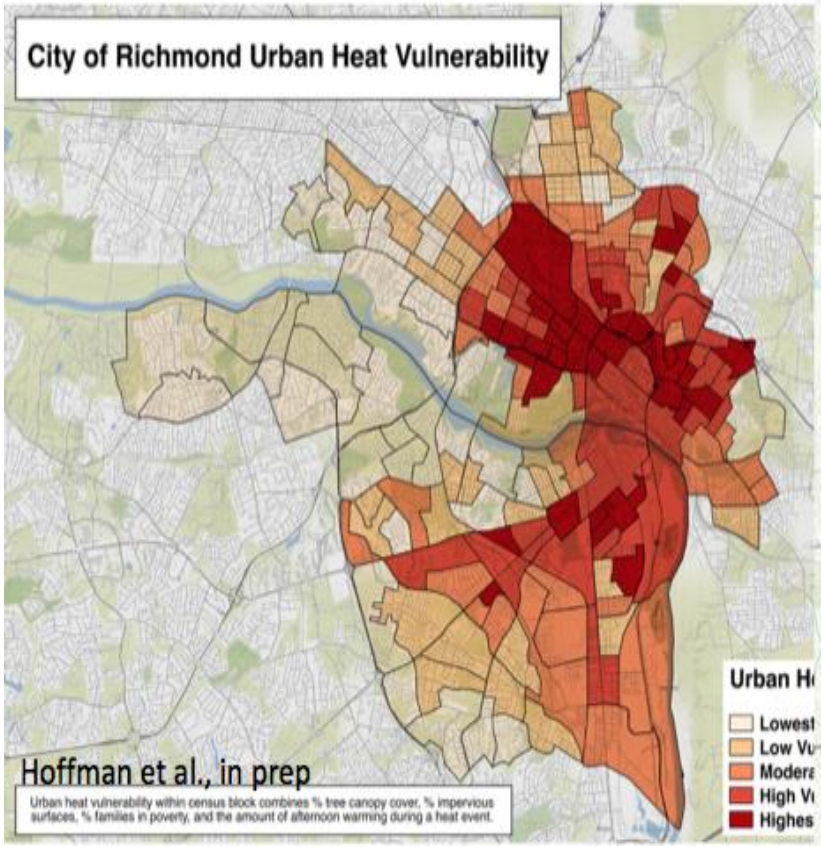
CAPA INSIGHTS: Decision Support



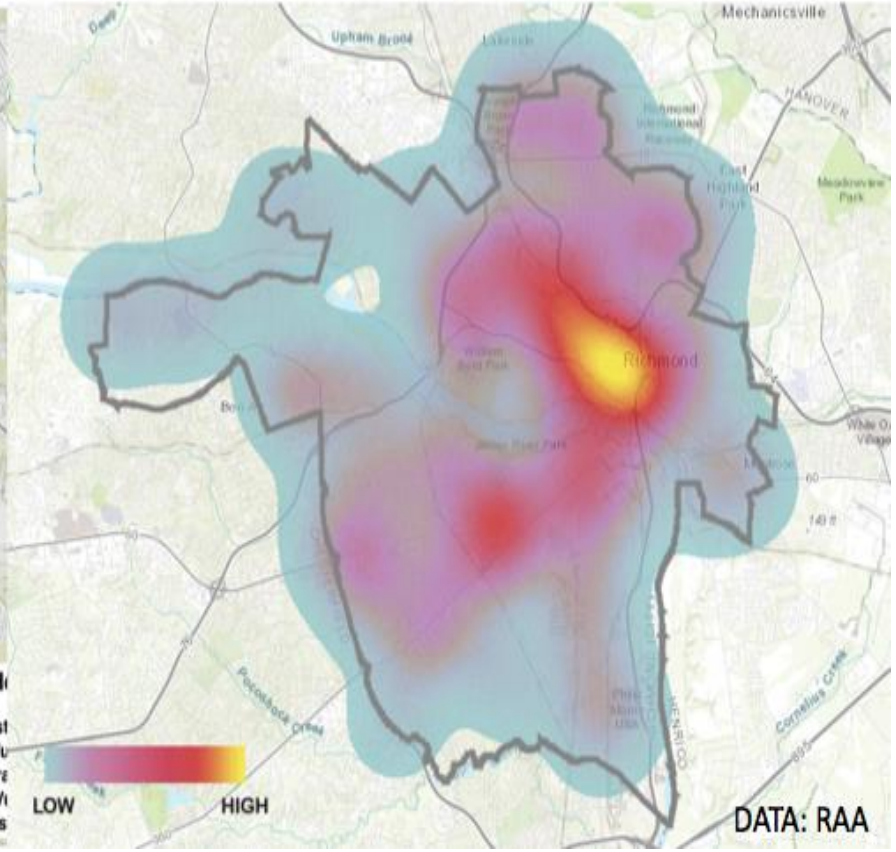
Makido, Y, D Hellman, and V Shandas, 2019. "Nature-Based Designs to Mitigate Urban Heat: The Efficacy of Green Infrastructure Treatments in Portland (OR)." Atmospheres 10(5) 282.

Urban Heat and Public Health

VULNERABILITY



RAA AMBULANCE RESPONSES



Sustainability and Resiliency Plans

Sustainability & Resiliency

Preparing and responding to a changing climate

Community Greenhouse Gas emissions have decreased by 15%.

From 2008 to 2015, community GHG emissions decreased by 15%. The City's goal is to decrease community-wide Greenhouse Gas (GHG) emissions by 80% by 2050 using 2008 as the baseline year. *RVAgreen 2050* is Richmond's planning process to develop a roadmap of actions to achieve Richmond's 80% reduction by 2050.

63% of GHG emissions are from the residential and commercial sectors.

In 2015, 40% of community GHG emissions were from commercial buildings, 24% from the transportation sector, 23% from residential buildings, and 11% from industrial facilities. 50% of community GHG emissions in 2015 resulted from the use of electricity, 24% from gasoline/diesel and 22% from natural gas. Overall energy consumption in Richmond decreased by 2% between 2008 and 2015.

Renewable energy is changing the Richmond landscape

In 2017, Richmond achieved SolSmart[1] Silver designation for its efforts to provide resources and reduce barriers to make it faster, easier and less expensive for the community to go solar. While only accounting for 0.08% of the total energy supply, the production of solar energy has increased by nearly 450 times between 2008 and 2015. Analysis by VCU's Center for Urban and Regional Analysis shows great potential for rooftop solar panels to produce up to 12% of the city's energy demand; however, the electricity distribution and energy storage infrastructure would need to be significantly upgraded to accommodate that much solar energy.

1 *SolSmart is a program of the Department of Energy and National League of Cities.*

There has been a slight increase in vehicle miles traveled since 2008.

Vehicle miles traveled (VMT) is an indicator that policy makers track to understand how much people are driving and estimate how many greenhouse gases are produced by vehicles. Total VMT increased from 2008 to 2015 by 0.2%.

The number of days over 95° is likely to increase by 30 days annually.

According to the Science Museum of Virginia, the city already experiences 9 more days above 90 degrees annually than surrounding rural areas. Climate models predict that Richmond could experience nearly 30 more days above 95 degrees annually. Per the Science Museum of Virginia, "As extreme summertime temperatures in the City of Richmond have been linked with urban heat vulnerability and visits to urgent care centers and emergency departments for heat-related illnesses in 2016, the urban heat island effect is not only an infrastructural challenge and an environmental equity issue, but also an important public health issue."

Major rain events are expected to increase by more than 25%.

According to the Science Museum of Virginia, from 1948 to 2011, "Virginia saw a 33% increase in the frequency of extreme rainfall events and an 11% increase in the amount of rain falling in its largest annual storms." The number of extreme rain events is expected to increase by two and a half times. Given the environmental constraints and large amount of paved surface in Richmond, planning for increased intensity and frequency of rain events is critical.

Richmonders are very vulnerable to urban heat.

Urban heat vulnerability is a term used to describe an area's conditions that make it more or less sensitive to heat. Currently, 21.5% of Richmonders live in Census tracts designated as "highest" in terms of urban heat vulnerability, while 19.6% live in Census tracts designated as "high". These areas correspond with some of the densest areas of the city.

Heat-related illness is highly concentrated.

Heat-related illness in the summer is highly concentrated in areas with "high" and "highest" urban heat vulnerability and areas that are poor.

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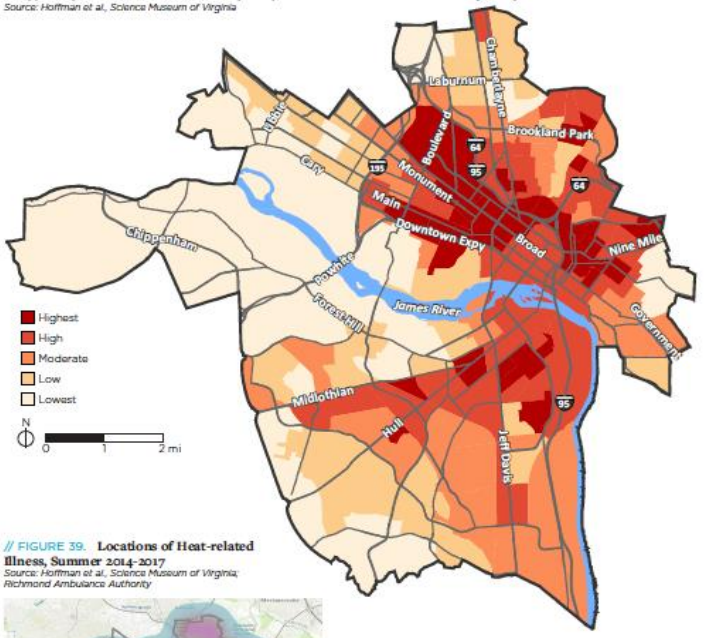
// FIGURE 38. **Urban Heat Vulnerability, 2017**

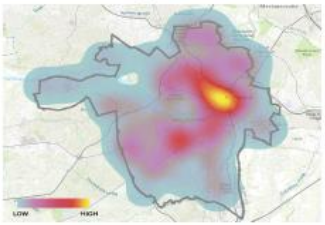
Urban heat vulnerability is a term used to describe an area's conditions that make it heat sensitive using a combination of % tree canopy, % impervious surfaces, % families in poverty, and the amount of afternoon warming during a heat event.

Source: Hoffman et al., Science Museum of Virginia



// FIGURE 39. **Locations of Heat-related Illness, Summer 2014-2017**

Source: Hoffman et al., Science Museum of Virginia; Richmond Ambulance Authority



Consider this:

- How can we prepare for the effects of climate change?
- How do we ensure the most vulnerable populations are included in creating solutions to mitigate the effects of climate change?

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Poll #5

- What additional considerations in the modeling exercise that would help you consider the role of trees in urban development?
  - Cost
  - Species of tree
  - Different scenarios
  - Impact on communities
  - Other

Poll #6

- Does your region currently have planning efforts underway that take into consideration the results from similar heat campaigns?
  - Yes
  - No

Next Steps

- Integrate findings to describe the implication of trees on social, financial, and human health
- Develop online tools for decision-makers to evaluate impacts of tree loss/gain
- Identify policy levers for advancing expansion of green infrastructure
- Apply CAPA Heat Watch and online tools to three California communities (2019) – ***Opportunities available for***

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