CLIMATE ADAPTATION
RESEARCH SYMPOSIUM

MEASURING & REDUCING SOCIETAL IMPACTS

Innovative Toolkits for Urban Heat Adaptation

Thanks for joining us!
The session will begin shortly.

UCLA Luskin Center for Innovation

Thank you to our event collaborators

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Widgets are resizable and movable

You can drag the presenter's video around your screen.

Have a question for presenters? Click the ? icon.

David Hondula
Arizona State University

Rui Shi
Johns Hopkins University

Max Wei
Lawrence Berkeley Laboratory

Taj Schottland
The Trust for Public Land

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UCLA Luskin Center for Innovation

David Hondula

Associate Professor, Arizona State University

@ASUHondula

Developing and Testing HeatReady Standards for Cities

Luskin Climate Adaptation Research Symposium | September 9, 2021

Developing and testing HeatReady Standards for Cities

David Hondula, ASU School of Geographical Sciences and Urban Planning

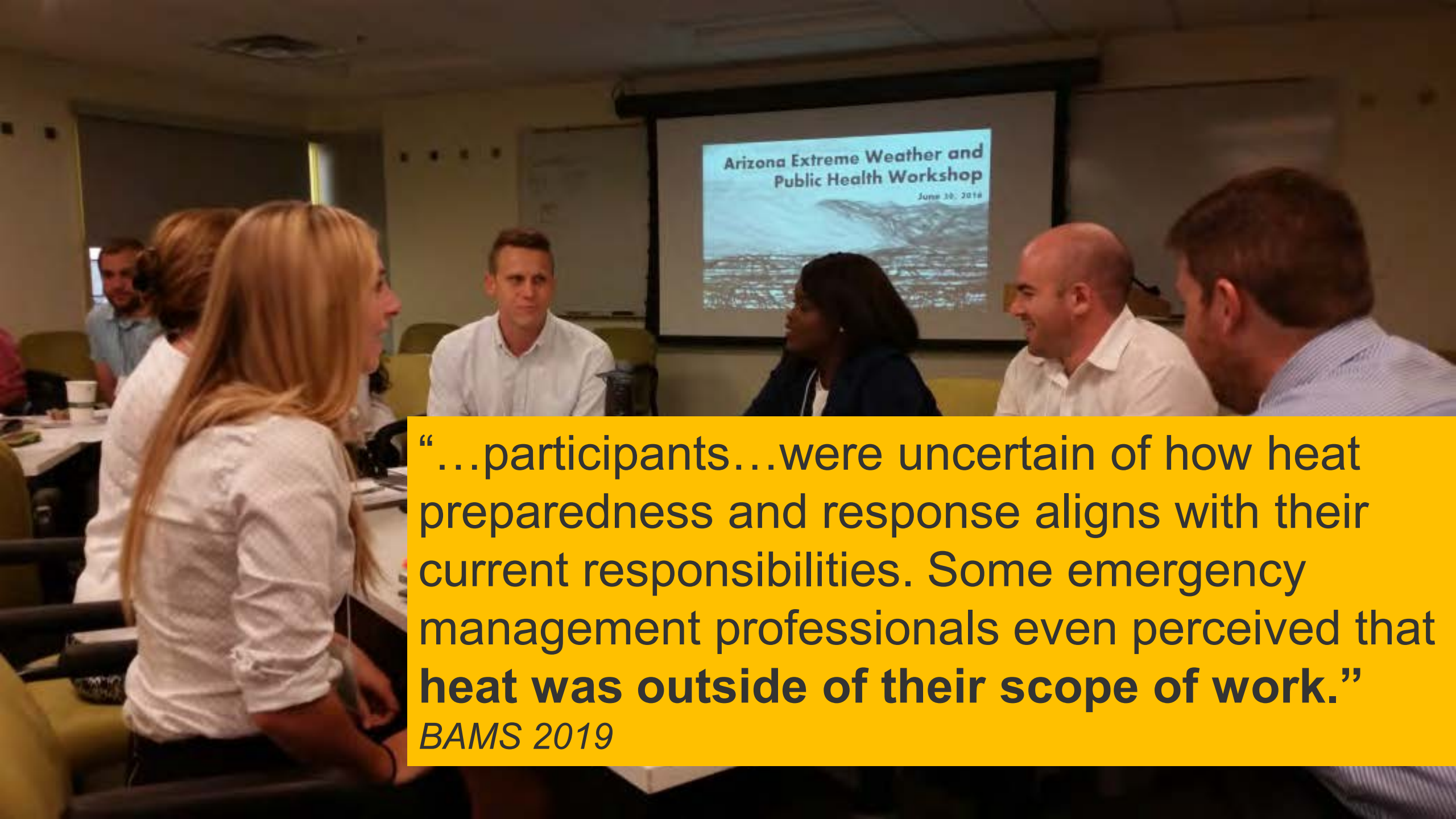
Liza Kurtz, ASU School of Human Evolution and Social Change

E-mail: David.Hondula@asu.edu Twitter: @ASUHondula

ASU Arizona State University

HeatReady Cities

“I think the biggest hurdle is that mitigating heat is nobody’s responsibility, yet it’s everybody’s concern”



"…participants…were uncertain of how heat preparedness and response aligns with their current responsibilities. Some emergency management professionals even perceived that **heat was outside of their scope of work.**"

BAMS 2019

History

City of Phoenix

"cities call all the time and ask what they should be doing about heat"

ASU Urban Climate Research Center Arizona State University

Multi-disciplinary applied research on urban climate and hazard management…
"heat doesn't seem to fit in"

+ growing and strengthening network of organizations working on heat (NWS, ADHS, MCDPH, TNC, etc.)

Mid 2010s → Today

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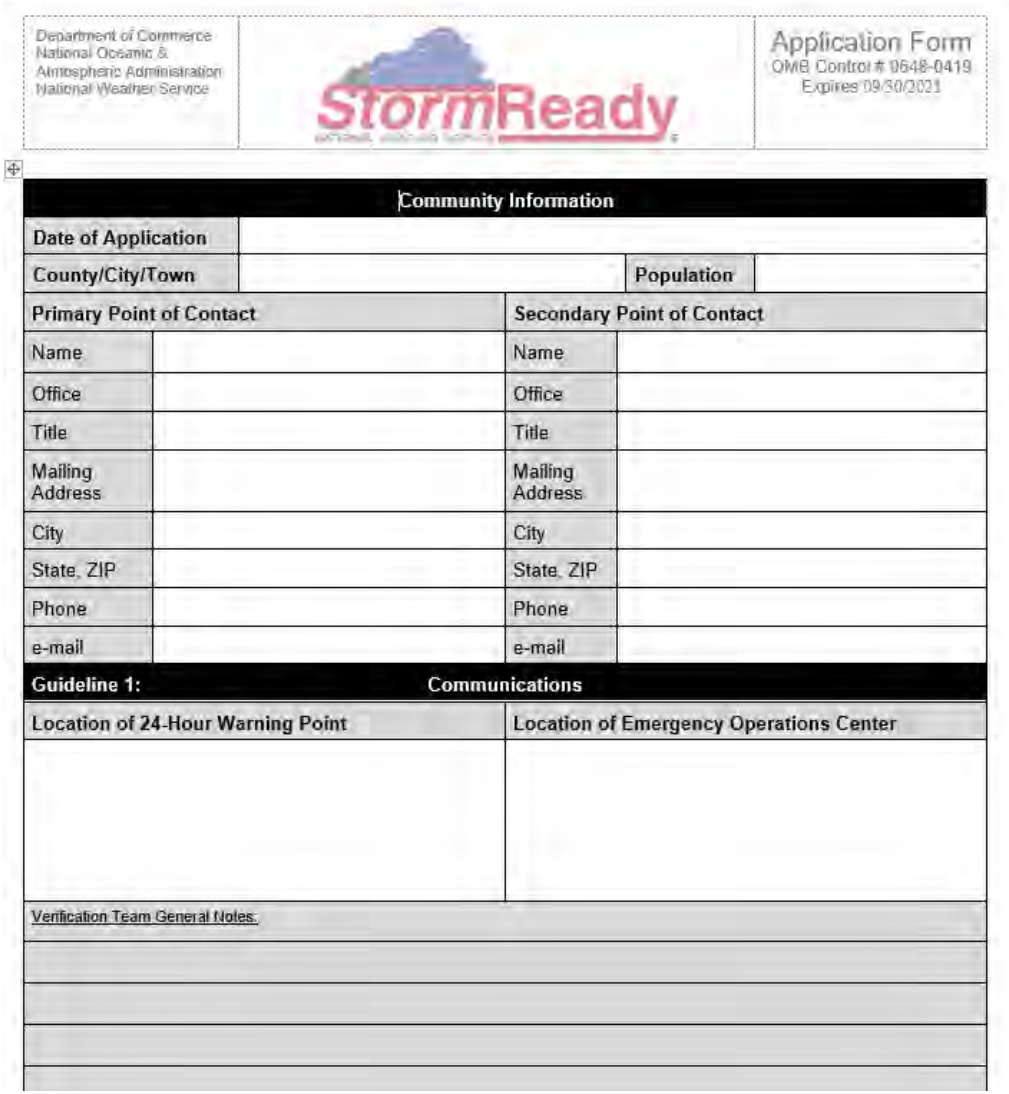
Mid 2010s → Today

- helps arm America's communities with the communication and safety skills needed to save lives and property--before, during and after the event

- helps community leaders and emergency managers strengthen local safety programs

NOAA/NWS StormReady

- 24-hour warning point and EOC
- Multiple communication channels to the public
- Local weather monitoring system
- Promote public readiness with community seminars
- Formal hazardous weather plan, including training and exercises



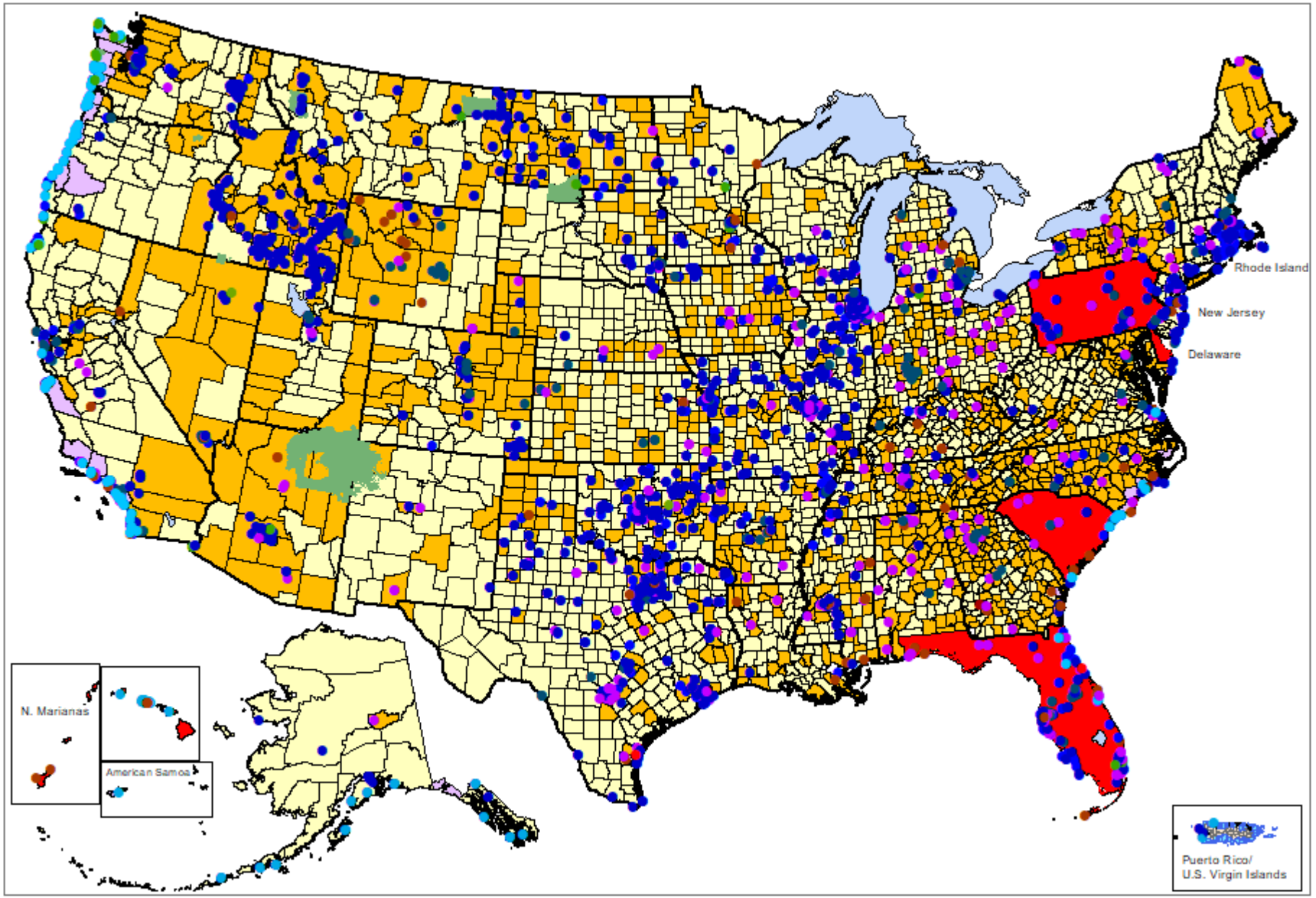
Department of Commerce
National Oceanic & Atmospheric Administration
National Weather Service

StormReady

Application Form
OMB Control # 0648-0419
Expires 09/30/2021

Community Information			
Date of Application			
County/City/Town		Population	
Primary Point of Contact		**Secondary Point of Contact**	
Name		Name	
Office		Office	
Title		Title	
Mailing Address		Mailing Address	
City		City	
State, ZIP		State, ZIP	
Phone		Phone	
e-mail		e-mail	
Guideline 1:	**Communications**		
Location of 24-Hour Warning Point		**Location of Emergency Operations Center**	
Verification Team General Notes:			

NOAA/NWS StormReady



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StormReady
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GLOBAL HEAT HEALTH INFORMATION NETWORK

2018: ASU participates in first global forum on heat and health

2019: Productive conversations with NIHHIS leadership

NIHHIS National Integrated Heat Health Information System

2019: Support from ASU Healthy Urban Environments initiative to continue concept development

Mid 2010s → Today

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2020-2021: Pilot testing with cities in the U.S. Southwest, conversations with potential partners, HeatReady Schools, HeatReady Neighborhoods

Mid 2010s → Today

Concept

HeatReady Cities

“demonstrate increasing capabilities to identify, prepare for, mitigate, track, and respond to urban heat dangers”

Certification Tiers

Tier 1 cities have demonstrated the **necessary foundations** to begin addressing heat and its impacts in a comprehensive manner. As such, the Tier 1 application questions are intended to assess a city's **preparedness to take action**.

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Tier 2 cities have demonstrated an **active and comprehensive approach** to respond to threats associated with heat. Tier 2 application questions assess the **breadth, maturity, and reach** of each city's heat mitigation and adaptation plans, policies, and actions.

Certification Tiers

Tier 1 cities have demonstrated the **necessary foundations** to begin addressing heat and its impacts in a comprehensive manner. As such, the Tier 1 application questions are intended to assess a city's **preparedness to take action**.

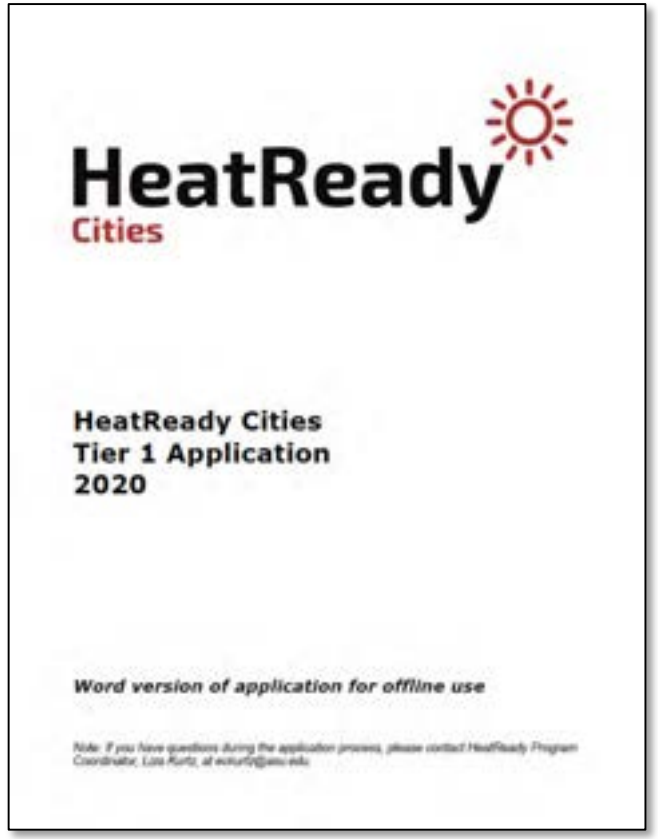
Tier 2 cities have demonstrated an **active and comprehensive approach** to respond to threats associated with heat. Tier 2 application questions assess the **breadth, maturity, and reach** of each city's heat mitigation and adaptation plans, policies, and actions.

Tier 3 cities are **evaluating and iterating** their approach to heat management and are demonstrating **progress toward measurable and desirable outcomes**. Tier 3 application questions assess the impact of each city's heat mitigation and adaptation efforts.

Tier 1 Application

“Expression of interest”
Check-boxes and short descriptive responses

1. Basic city information
2. Engagement with weather/climate data
3. Assessment of community impacts
4. Understanding of current heat management and collaboration
5. Understanding of current heat actions in city



Tier 2 HeatReady Standards

Mitigation Actions

(make the city cooler and more comfortable)

- Green infrastructure
- Materials and coatings
- Waste heat
- Shade structures
- Water features
- Building geometry
- Air movement

Adaptation Actions

(help people cope with heat)

- Messaging and education
- Cool public places
- Cool homes
- Cool workplaces+
- Reliable infrastructure
- Schedules and routes
- Social cohesion and support

Internal Actions

(support decision-making by city staff)

- Roles and responsibilities
- Visions and goals
- City plans
- External coordination
- Community input
- Data resources
- Capacity building

Equity, Sustainability, and Institutionalization

Tier 2 Evaluation Principles

HeatReady Cities

- Manageable reporting burden
- Recognize effort, reward institutionalization
- Flexibility and innovation
- Trust city staff judgment and expertise
- Progress is most important
- Not all actions are city led or managed

HeatReady Cities

- **Motivation and incentives**
  - Shared resource bank
  - Community of practice
  - Signal to funders
  - StormReady insurance
- **Systems and processes**
  - Technical knowledge
  - Capacity
- **Other HeatReady Communities**
  - Schools
  - Neighborhoods

HeatReady Cities

Heat Mitigation Actions in 2015 Plan (total of 23 across all hazards)

Table 6-8-24: Mitigation actions and projects and implementation strategy for Tempe

Mitigation Action/Project					Implementation Strategy				
ID No.	Description	Hazard(s) Mitigated	Community Assets Mitigated (Ex/New)	Estimated Cost	Priority Ranking	Planning Mechanism(s) for Implementation	Anticipated Completion Date	Primary Agency / Job Title Responsible for Implementation	Funding Source(s)
8	Participate with outside agencies to distribute bottled water and provide education about hazards associated with extreme heat.	Extreme Heat	Both	1000	Low	N/A	Ongoing	Fire Department	Grants
17	Utilization of Tempe Social Media platforms to educate the general public about the hazards of extreme heat, including Facebook and Twitter releases, and updates to the city website.	Extreme Heat	Both	Staff time	High	N/A	Ongoing / Seasonal	City manager's office / public Information Officer	General fund
7	Maintain CERT Program	All Hazards	Both	4000	Medium	N/A	Ongoing	Fire Department	Grants

HeatReady Cities

38 Heat Mitigation Actions in 2021 Plan

9	Transit shelters constructed in areas with high ridership, heat islands and/or higher poverty levels in order to address heat vulnerability.	Extreme Heat	Both	$22,000 per shelter	High	Capital Improvement Plan and Transportation Plan	Ongoing	Engineering and Transportation Equity and Inclusion Manager Sustainability	General Fund and HURF
10	Create regional cooling utility that pays for urban forestry, cool material and green infrastructure across Maricopa County	Extreme Heat	Both	$100,000,000 per year	High	Climate Action Plan Update	Ongoing	Sustainability Intergovernmental Officer	Regional tax (proposed)
11	Maintain a regional resilience collaborative to develop resilience to extreme heat solution	Extreme Heat	Both	$100,000 a year	High	Climate Action Plan Update	Ongoing	Sustainability Intergovernmental Officer	Grants
12	Create a regional extreme heat and racial equity task force to address the impacts of extreme heat on communities of color.	Extreme Heat	Both	$50,000 a year	High	Climate Action Plan Update	Ongoing	Sustainability Equity and Inclusion Manager Emergency Manager	Grants
13	IGCC adoption w/ shade and cool material additions that ensure new buildings are more resilient to extreme heat	Extreme Heat	New	$100,000 annually	High	Climate Action Plan	2025	Community Services	General Fund
14	Implementation of Urban Forestry Master Plan to support trees and shade in public and private landscapes	Extreme Heat	Both	$4,000,000	High	Urban Forestry Master Plan	Ongoing	Community Services-Parks and Recreation	General Fund
15	Adoption of Green infrastructure standards that promote widespread use of bioswales, curb cuts and other stormwater capture technologies in line with the City of Tucson, which also developed a Green Infrastructure Fund to support projects that follow their standards	Extreme Heat	Both	$100,000	High	Climate Action Plan	Ongoing	Engineering and Transportation Civil Engineer Community Development Sustainability	General Fund

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HeatReady Cities

Rui Shi

Ph.D. Candidate, Johns Hopkins University

@Dr_Sray

City-Heat Equity Adaptation Tool (City-HEAT) A Multi-Objective, Uncertainty-Based Decision Support Tool for Urban Heat Adaptation

City-HEAT (Heat Equity Adaptation Tool)

A multi-objective, uncertainty-based planning framework for urban heat adaptation & management

Rui Shi

Environmental Health and Engineering, Johns Hopkins University

Co-authors: Drs. Benjamin Hobbs, Julianne Quinn, Debra Knopman, Robert Lempert

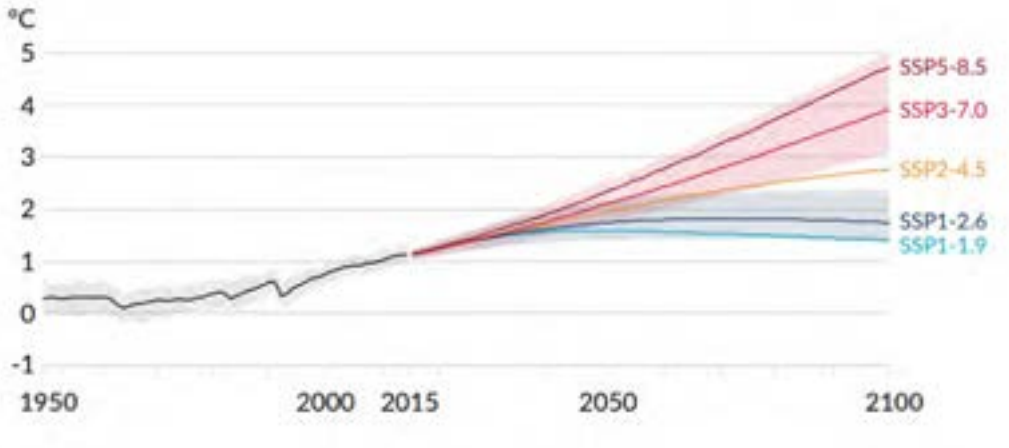
Climate Adaptation Research Symposium 2021

UCLA Luskin Center for Innovation

Sept 9, 2021

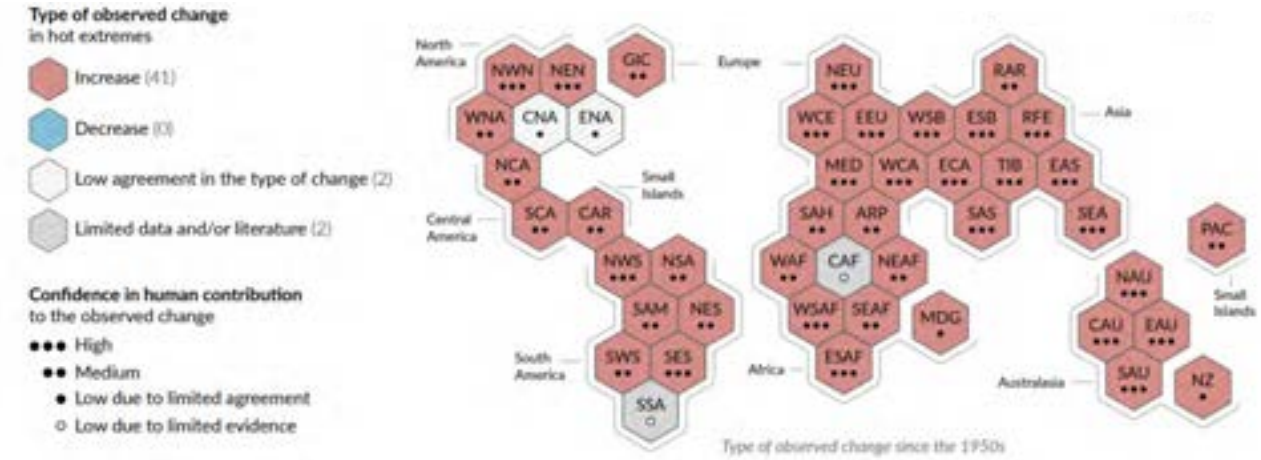
Warming climate leads to significant health concerns

Global surface temperature change relative to 1850-1900



Source: IPCC AR6

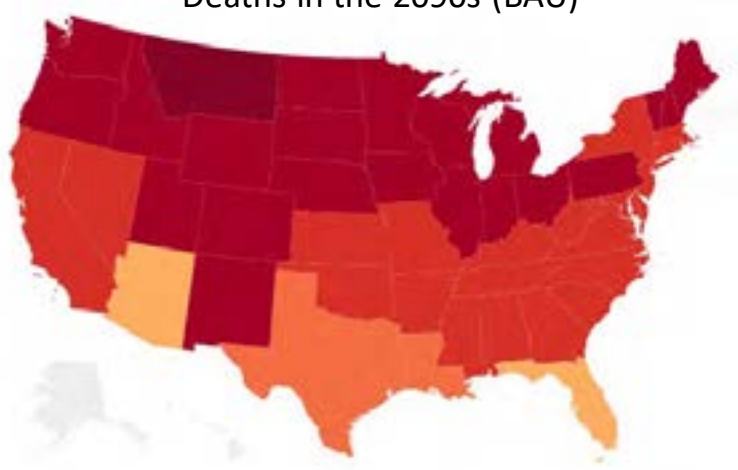
observed change in hot extremes



Source: IPCC AR6

Deaths in the 2010s

Deaths in the 2090s (BAU)

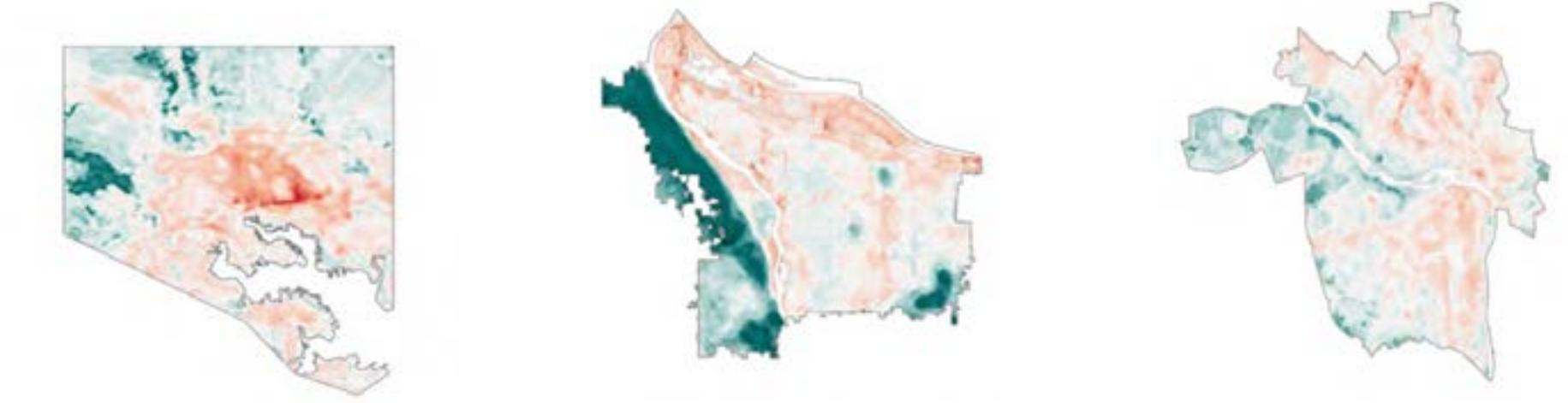


Source: Shindell D. et al., (2020). The effects of heat exposure on human mortality throughout the United States. *GeoHealth*

City is hot, but some neighborhoods suffer more…

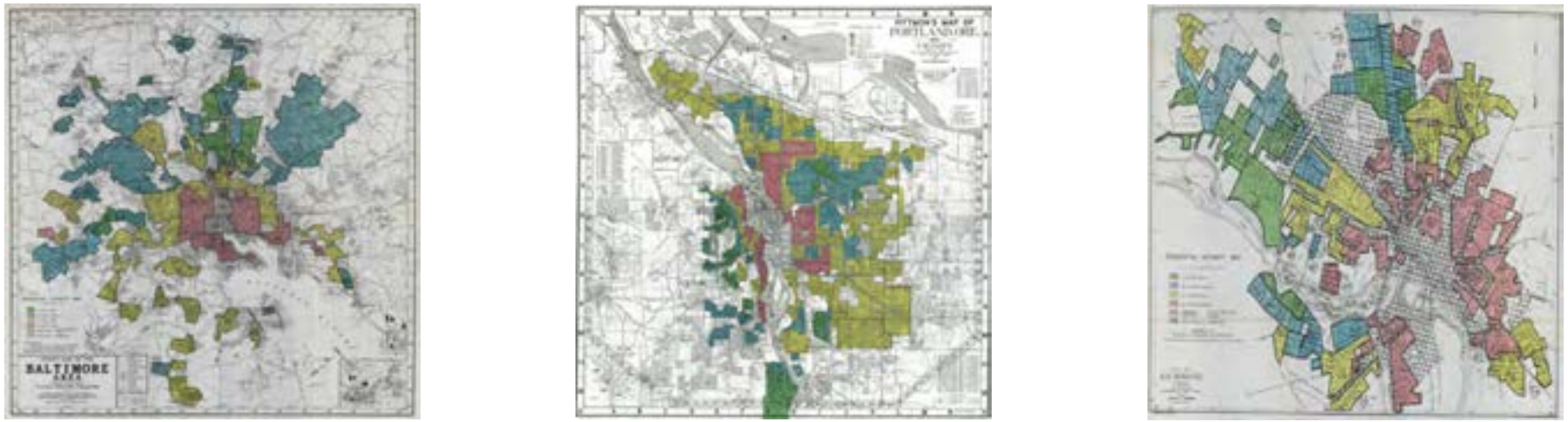
Baltimore, MD | Portland, OR | Richmond, VA

urban heat distribution



… due to past discriminatory urban planning practices

"Redlining" By HOLC



Source: Popovich N., & Flavelle C, (Aug 9, 2019). Summer in the City Is Hot, but Some Neighborhoods Suffer More. *New York Times*
Robert K. Nelson, LaDale Winling, Richard Marciano, Nathan Connolly, et al., "Mapping Inequality," American Panorama, ed.

Urban heat adaptation is an IMPORTANT but TOUGH problem!

Important

Size of health impacts

Concerns with equity

Size of expenditures

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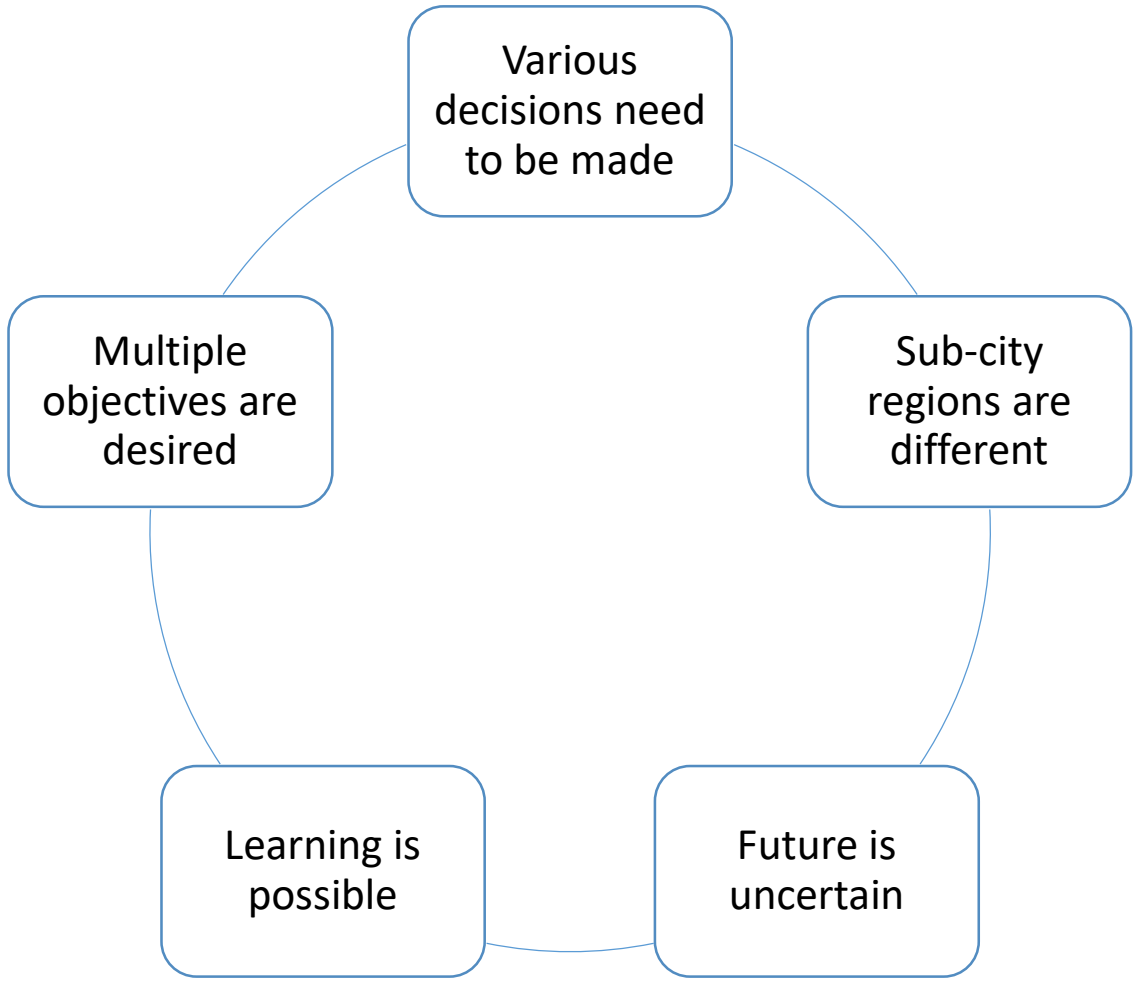

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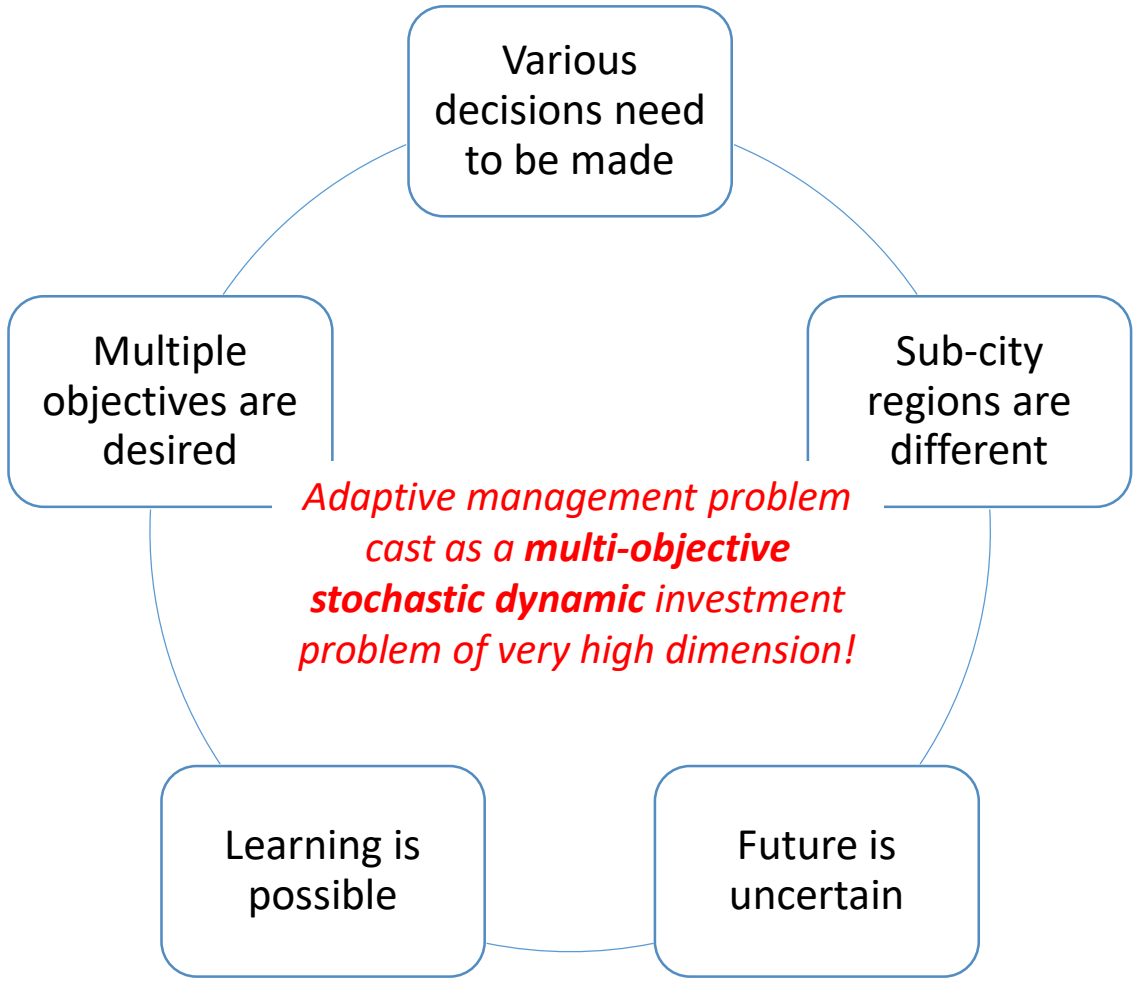

City-HEAT (Heat Equity Adaptation Tool)

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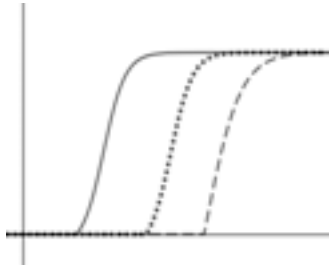
Decisions

when,
where,
which,
how much,
to invest?



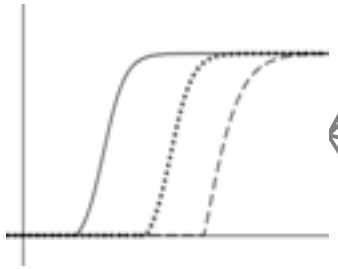
Sub-city level
policy functions

City-HEAT (Heat Equity Adaptation Tool)

Decisions

Scenarios that are realizations of uncertain parameters

when,
where,
which,
how much,
to invest?



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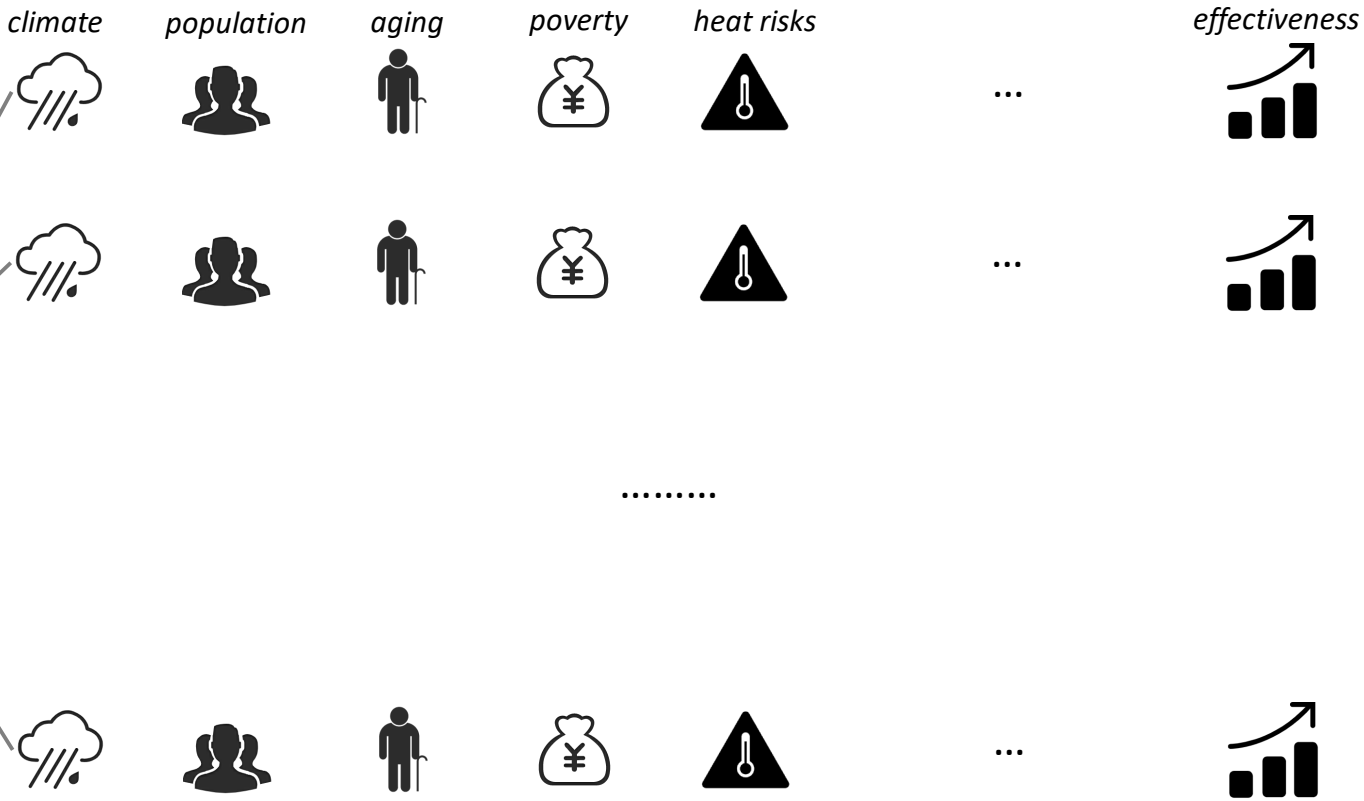
policy functions



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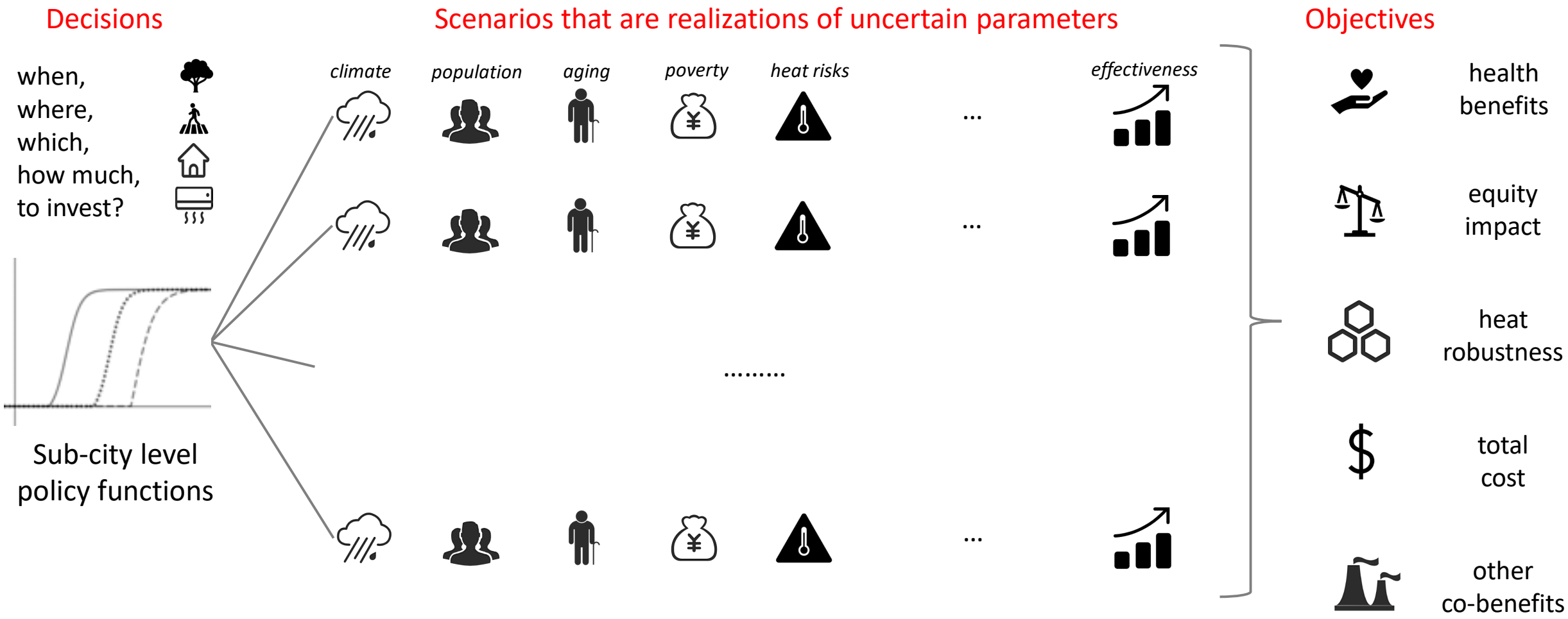

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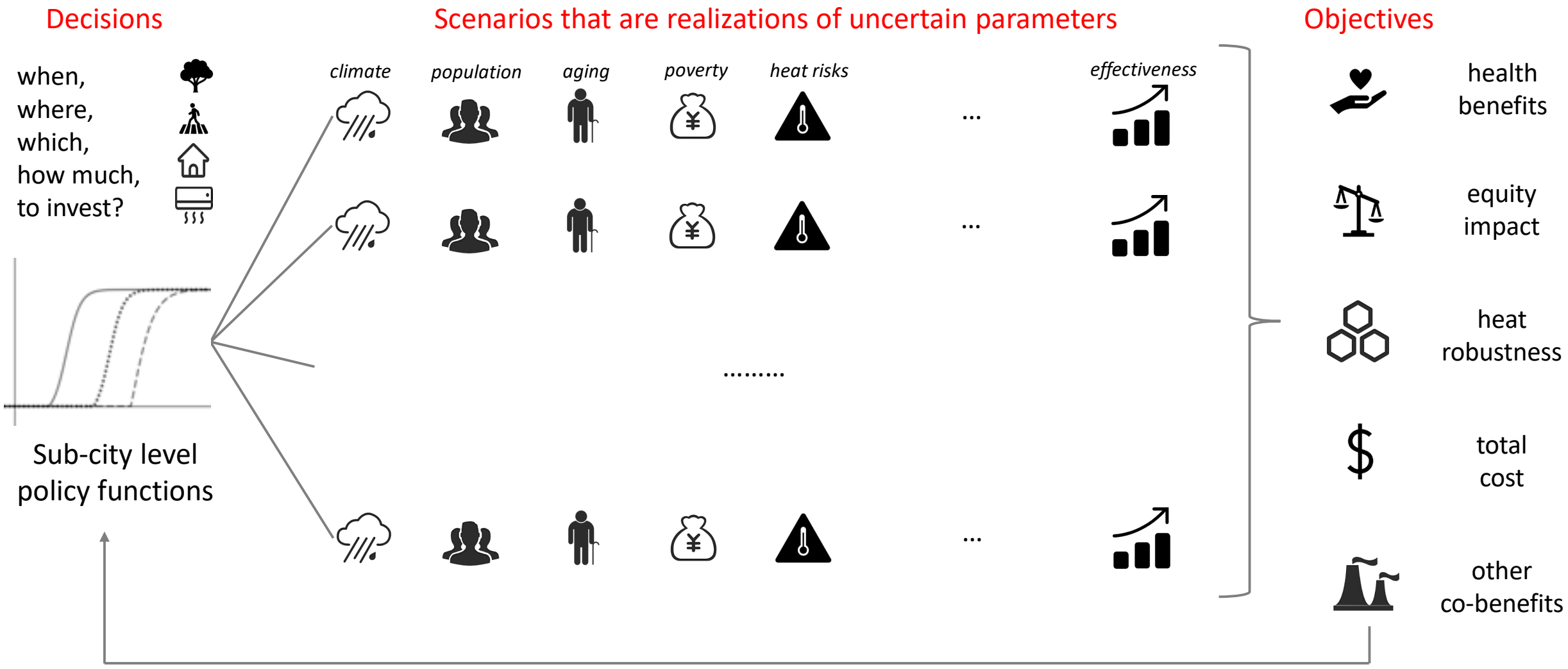
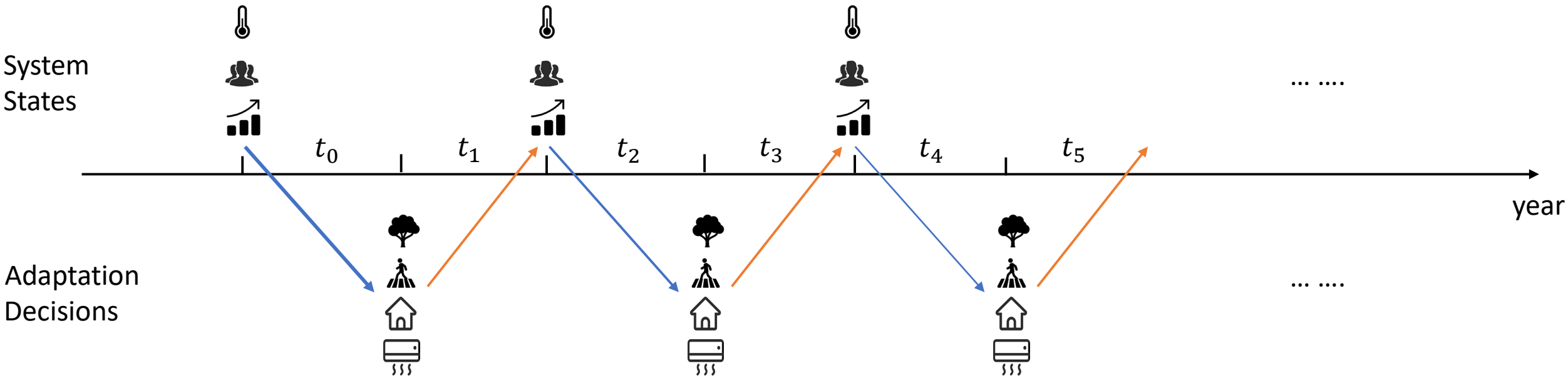


City-HEAT employs adaptive decision-making schemes

Decisions depend on what's observed



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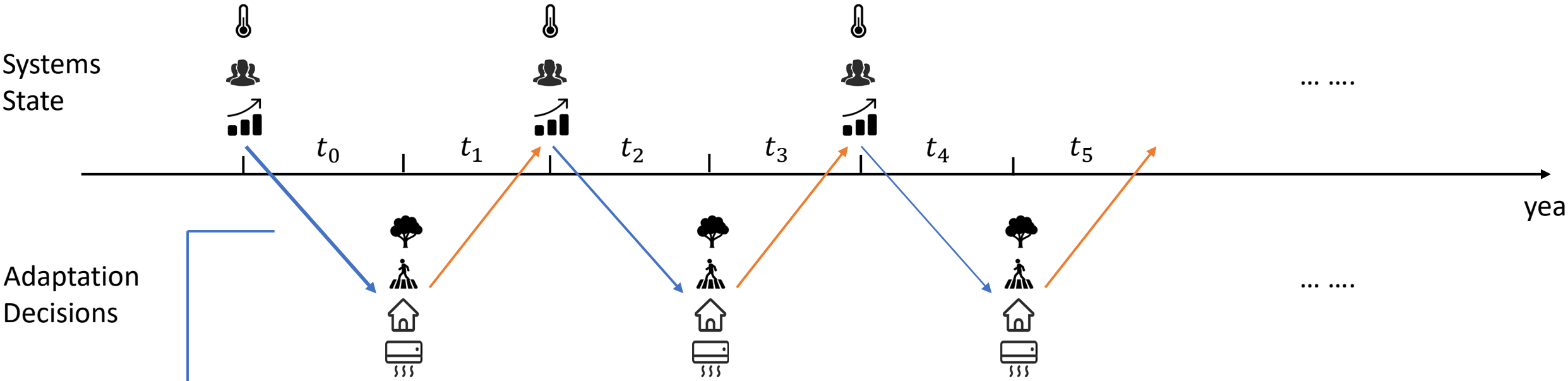
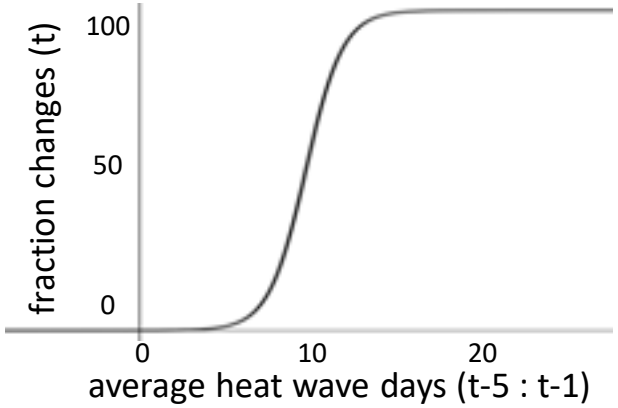




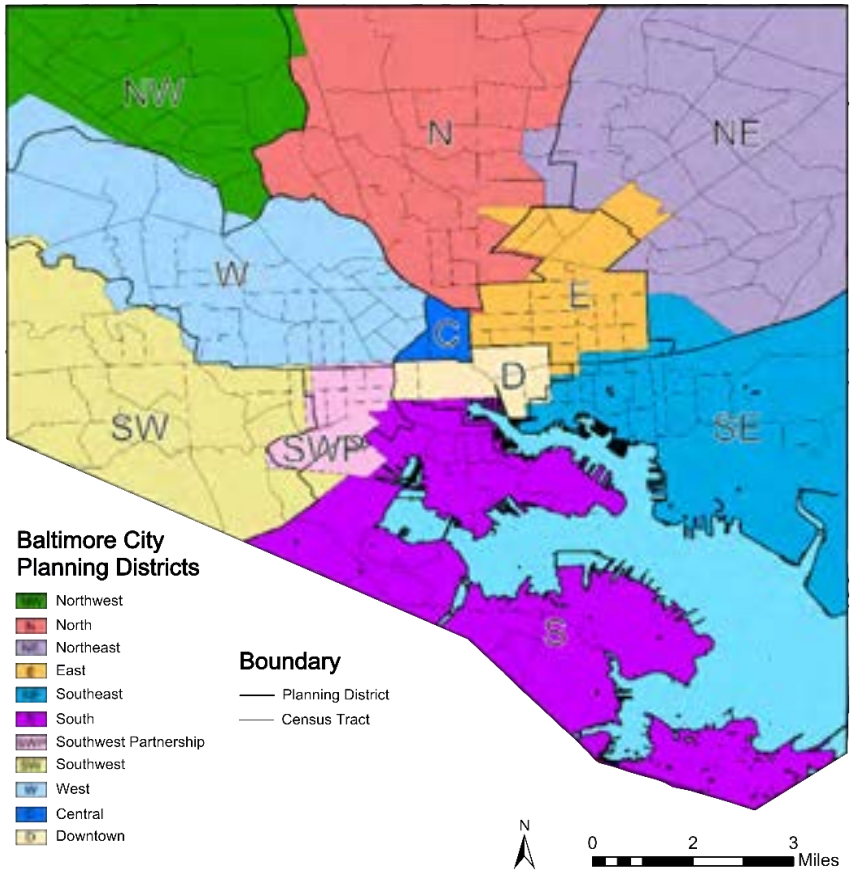
Direct Policy Search

- reduce dimensionality in decision space

- adjust decisions with state of the system

- find rules that are robust against uncertainty

Case study – Baltimore City



Background and motivation

- Baltimore has **10%** of MD Population, but **28%** of heat-related death
- shrinking and aging population with 21.8% poverty rate
- "heat" inequity (Wilson, 2020; NYT, 2020)

City-HEAT application

- 11 districts, 4 actions, and 110 decision variables
- 2020-2039 (20 years), 1,500 scenarios (16 uncertain factors)
- 5 objectives

Source: Plumer B., & Popovich N. (Aug 24, 2020). How Decades of Racist Housing Policy Left Neighborhoods Sweltering. *New York Times*
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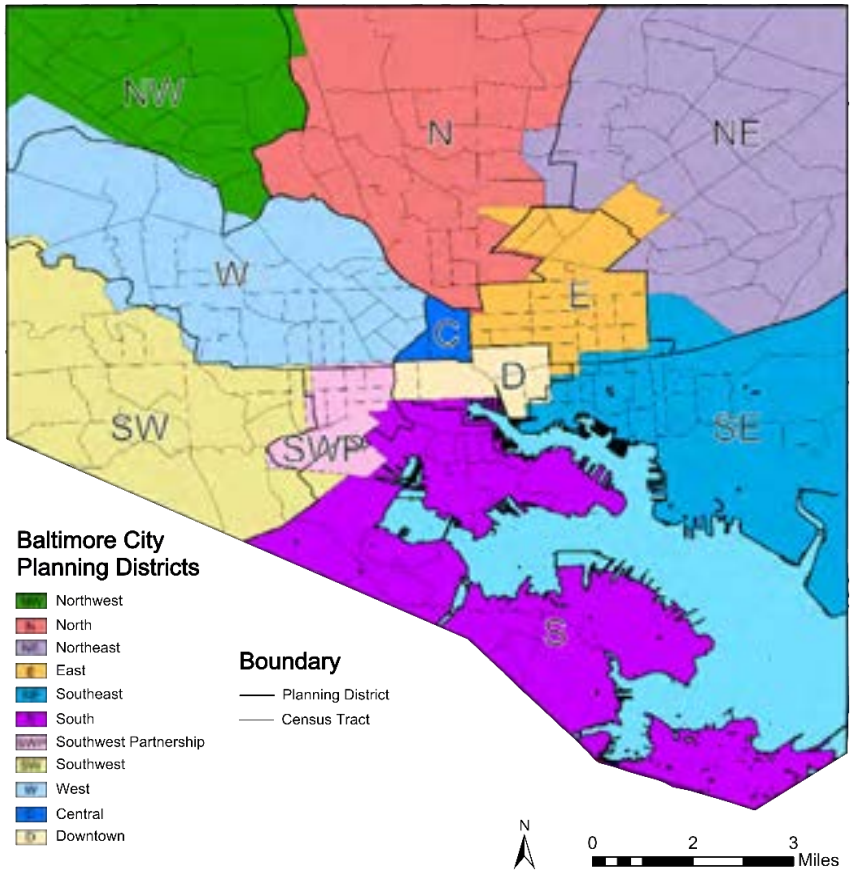

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- 5 objectives

Data source
- 32 temperature projections (NA-Cordex & LOCA datasets)
- sub-city temperature distributions (ground-based sensors)
- demographic data (American Community Survey)
- range of uncertain parameters

Source: Plumer B., & Popovich N. (Aug 24, 2020). How Decades of Racist Housing Policy Left Neighborhoods Sweltering. *New York Times*
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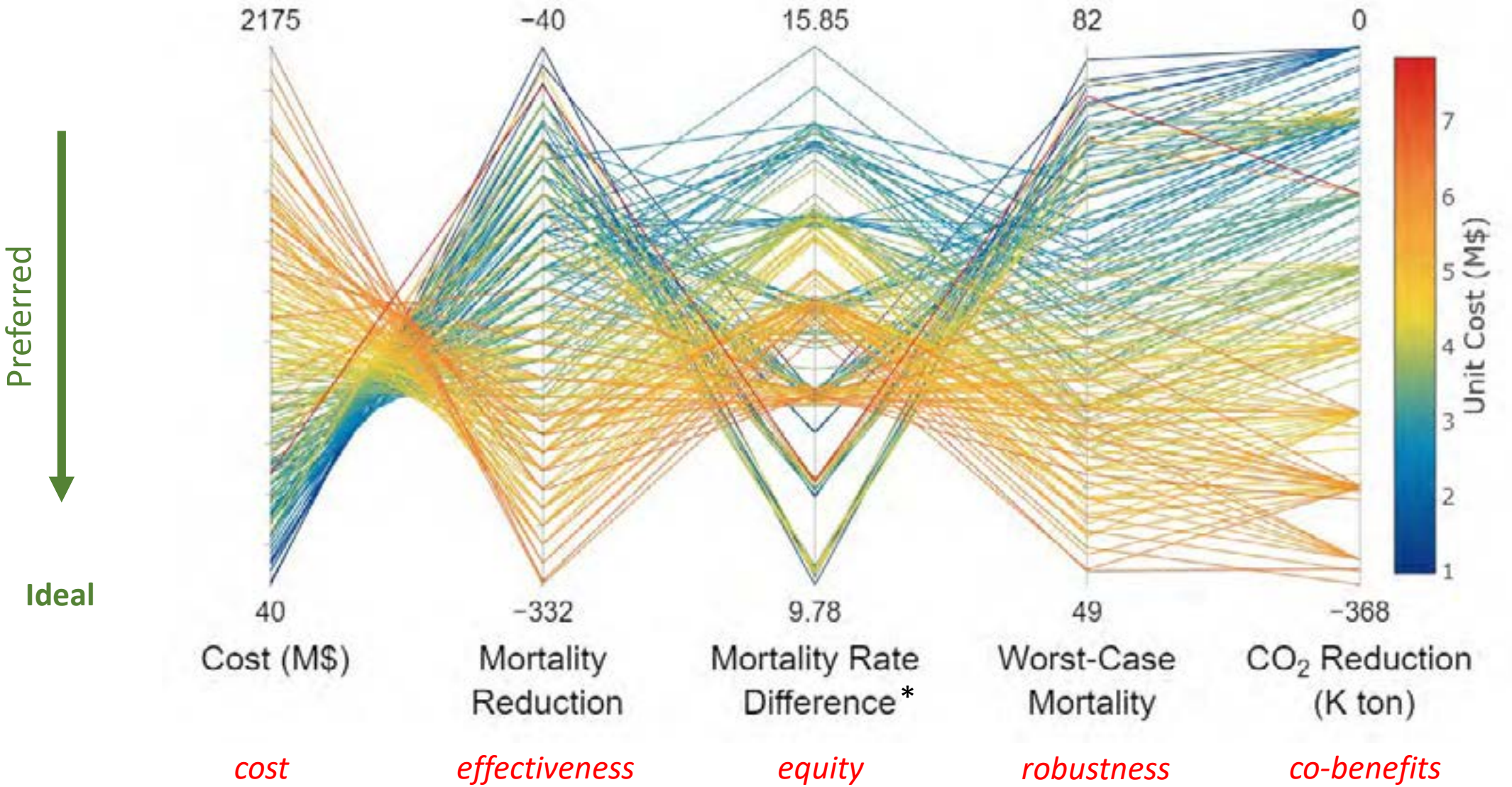
City-HEAT generates optimal adaptation policies

City-HEAT generates 170 optimal adaptation polices for Baltimore City
-- using Borg Many Objective Evolutionary Algorithm (200,000 iterations and 10 seeds)



*: per 100,000 people

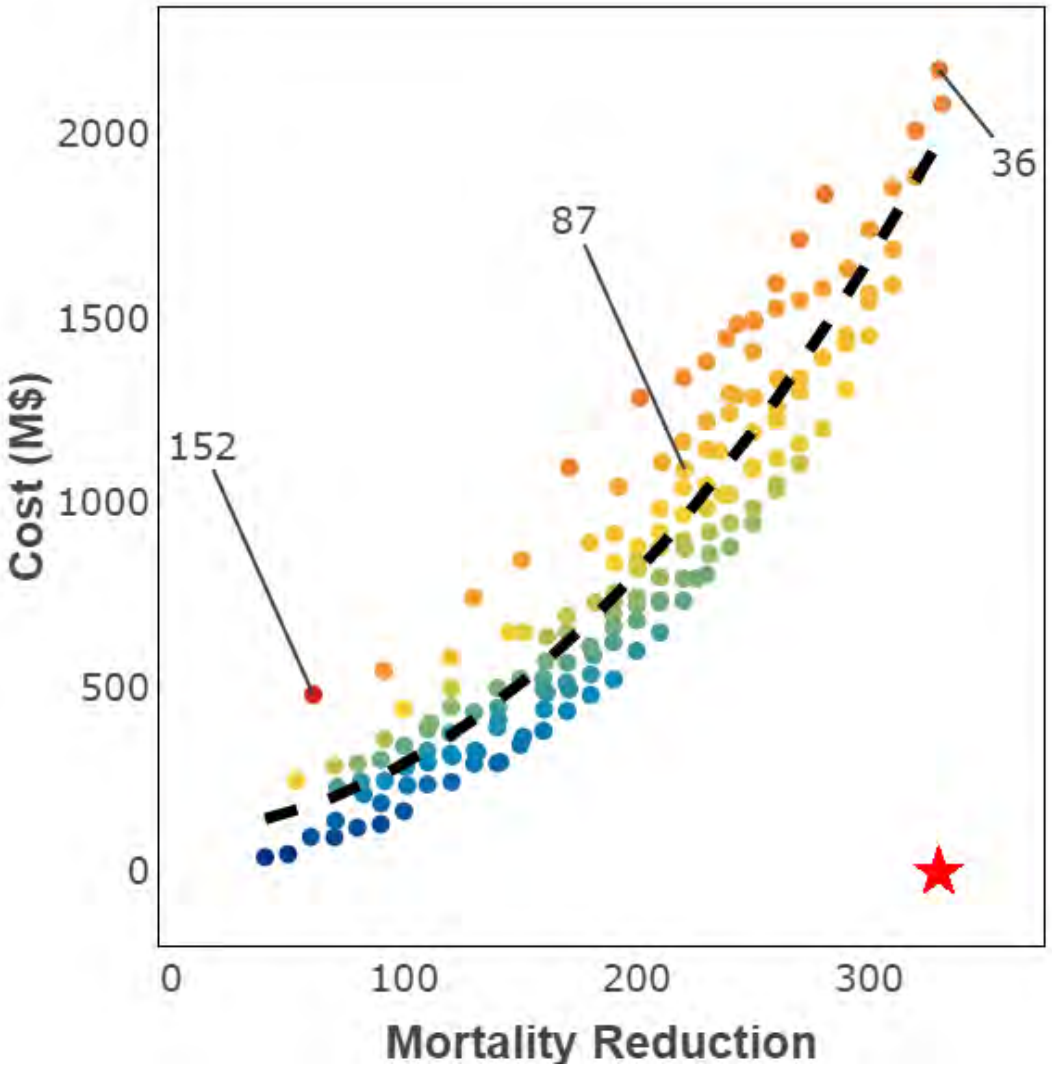
City-HEAT generates Pareto-efficient adaptation policies

City-HEAT generates 170 Pareto-efficient adaptation polices for Baltimore City

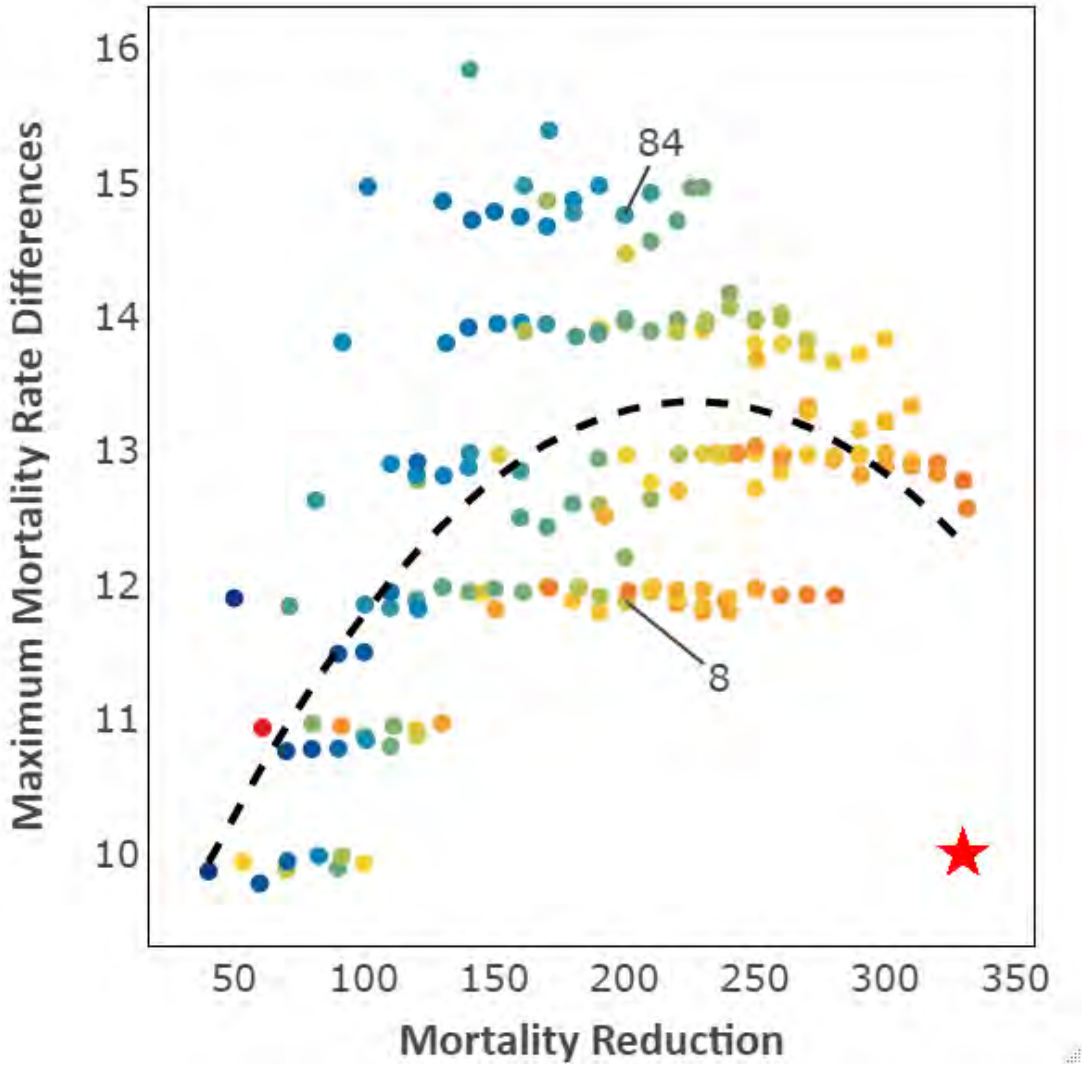
*: per 100,000 people

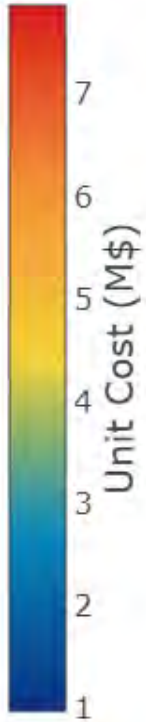
City-HEAT illustrates trade-offs among objectives

Effectiveness vs. Cost



Effectiveness vs. Equity





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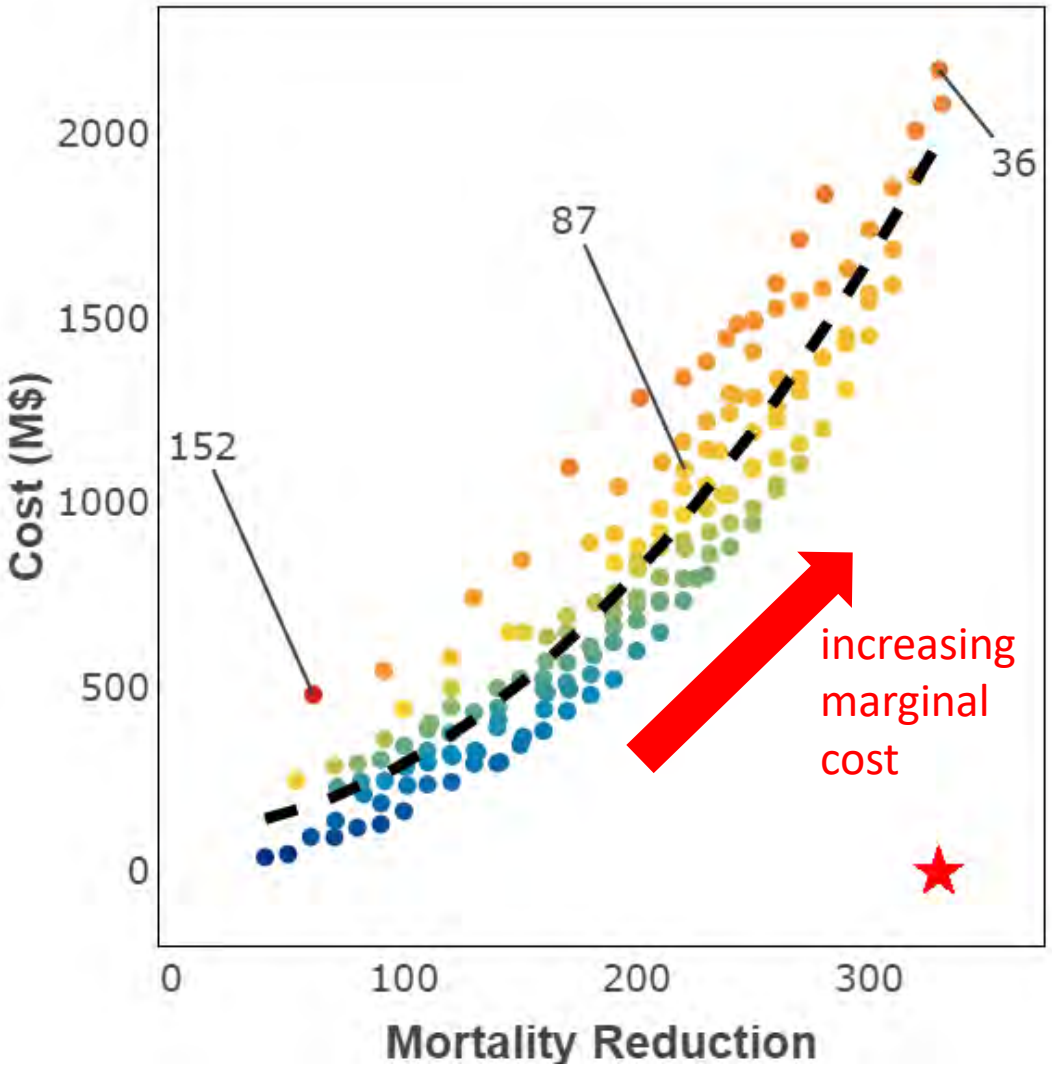
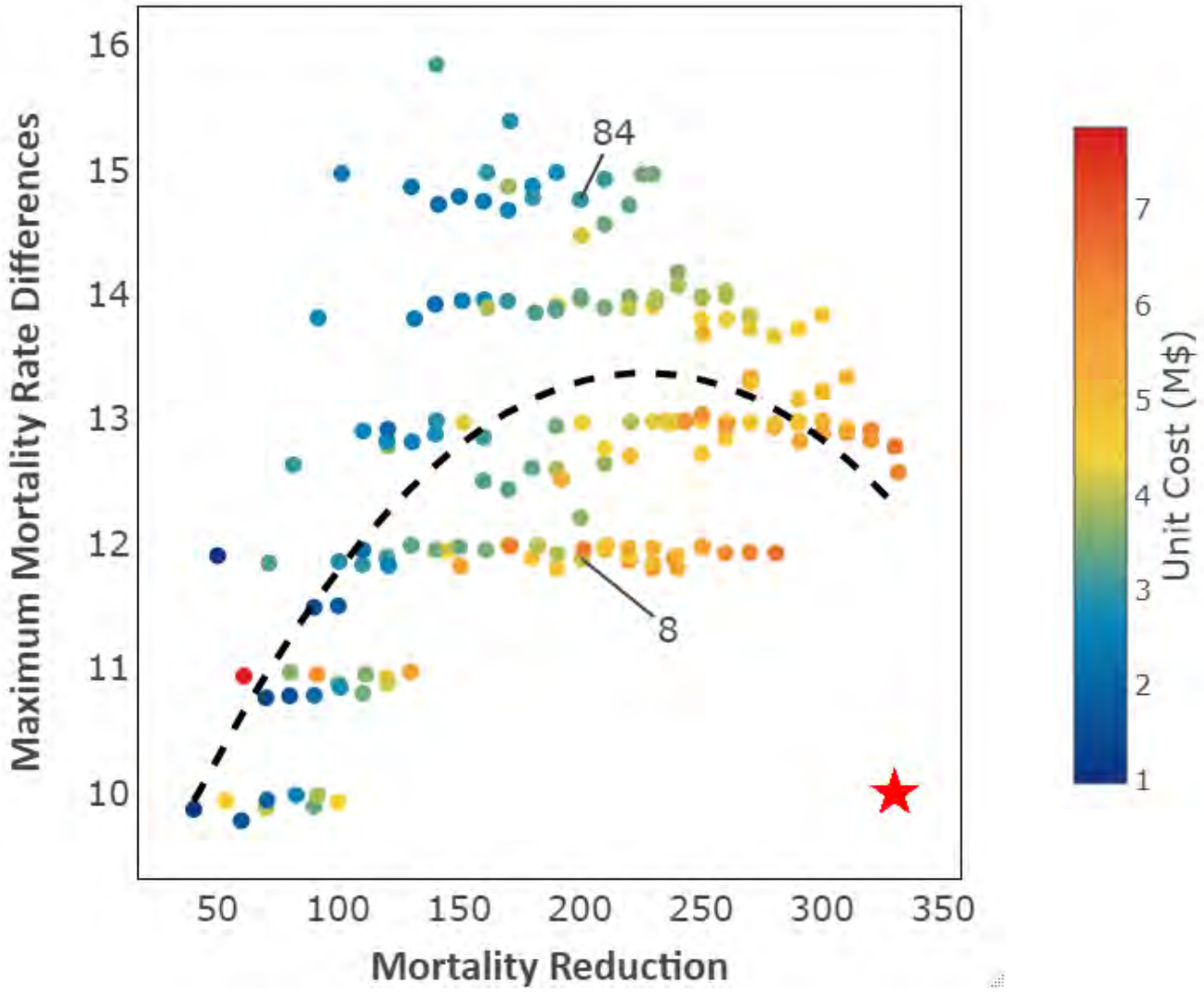
Effectiveness vs. Cost

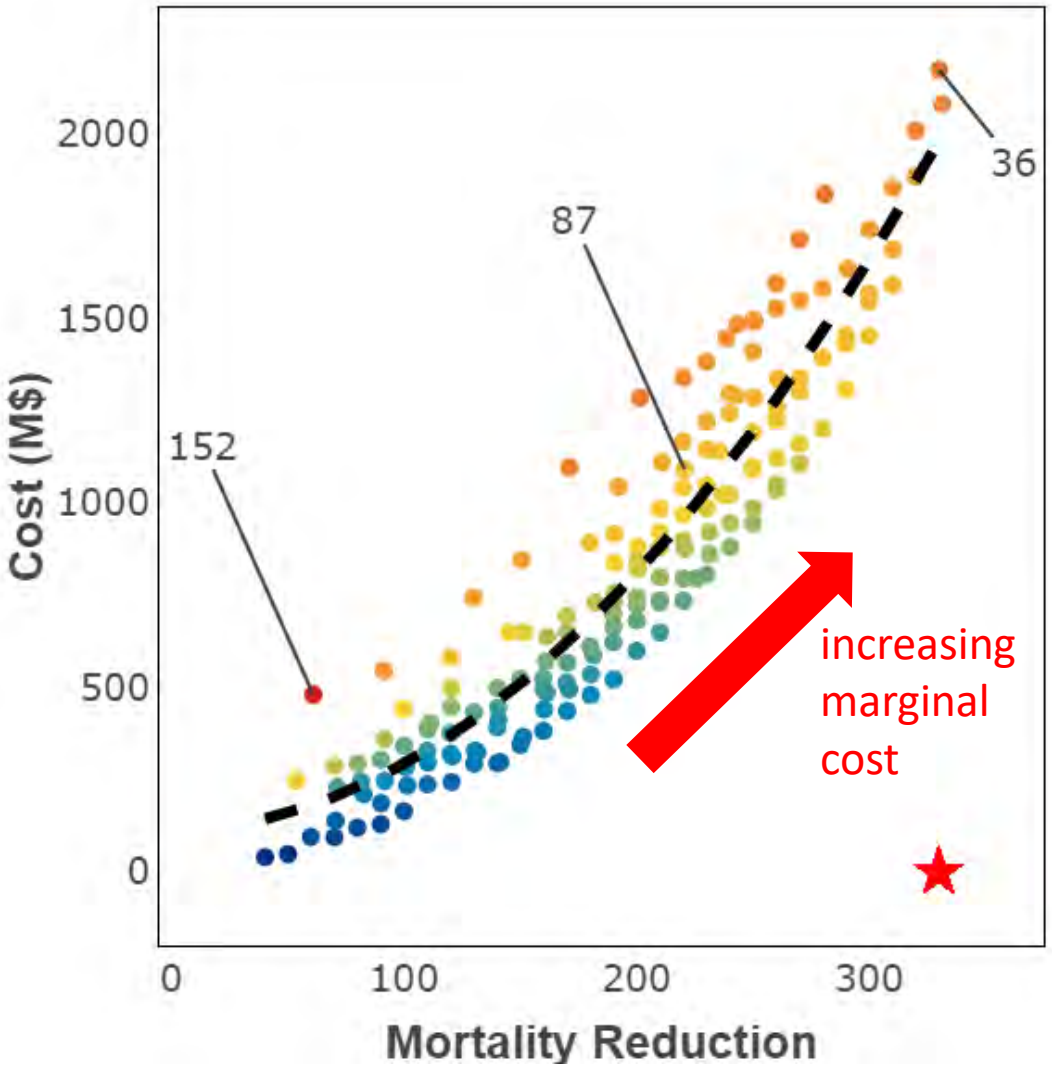


Effectiveness vs. Equity

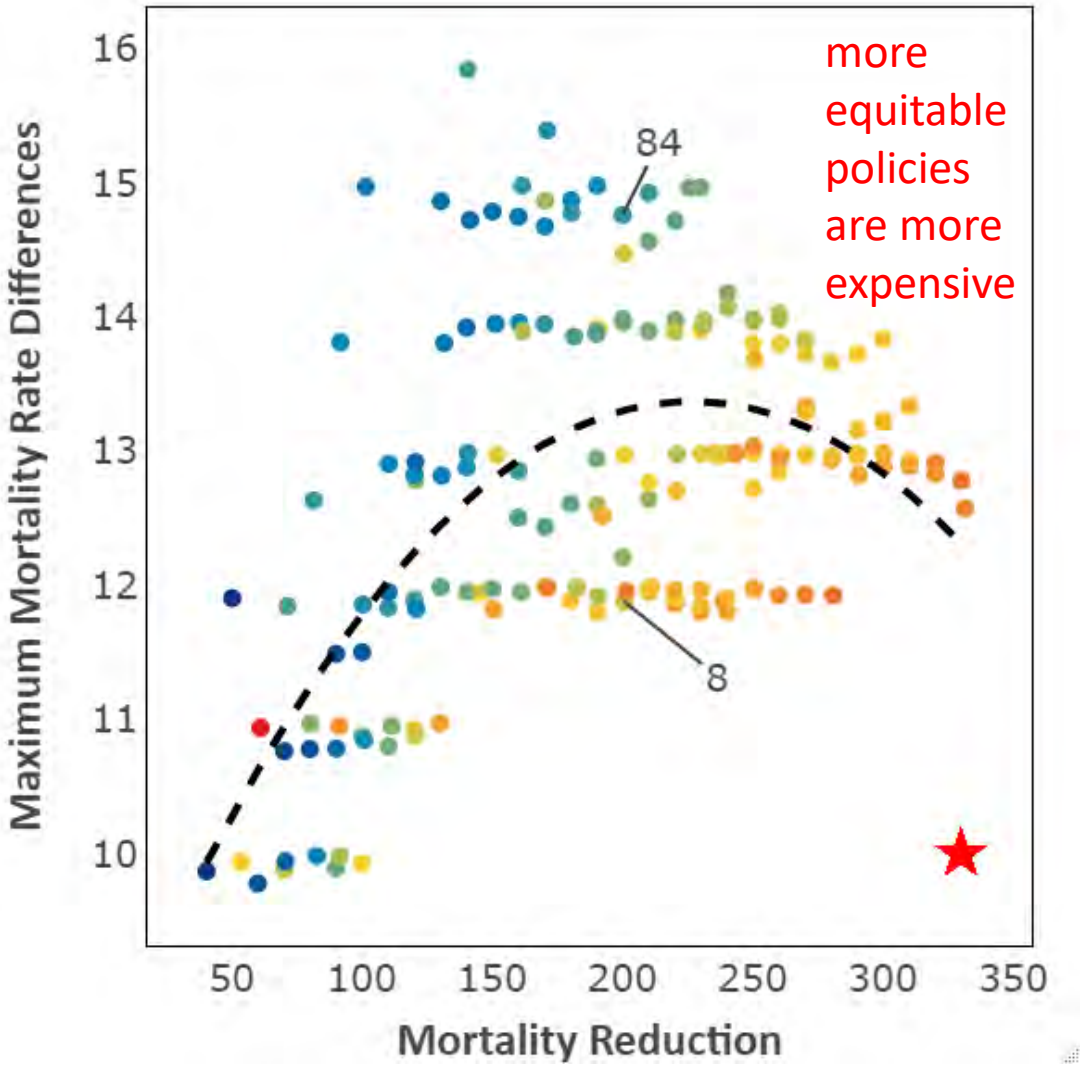


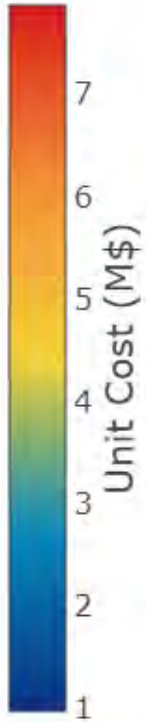
City-HEAT illustrates trade-offs among objectives

Effectiveness vs. Cost



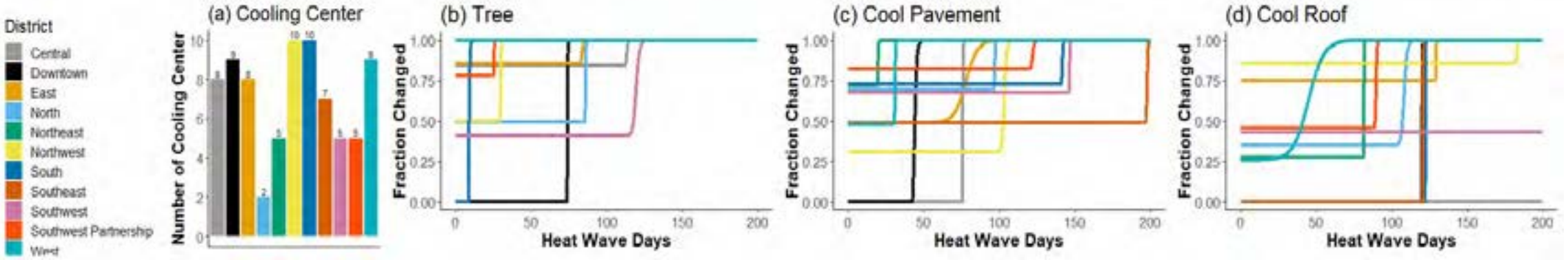
Effectiveness vs. Equity





City-HEAT provides details for individual policy

Avg Mortality Reduction	Avg Total Cost (M$)	Mortality Rate Difference	Worst-year Mortality	Cumulative CO2 Reduction (K ton)	Unit Cost of Saving Life (M$)
330	2175	13	50	357	6.59



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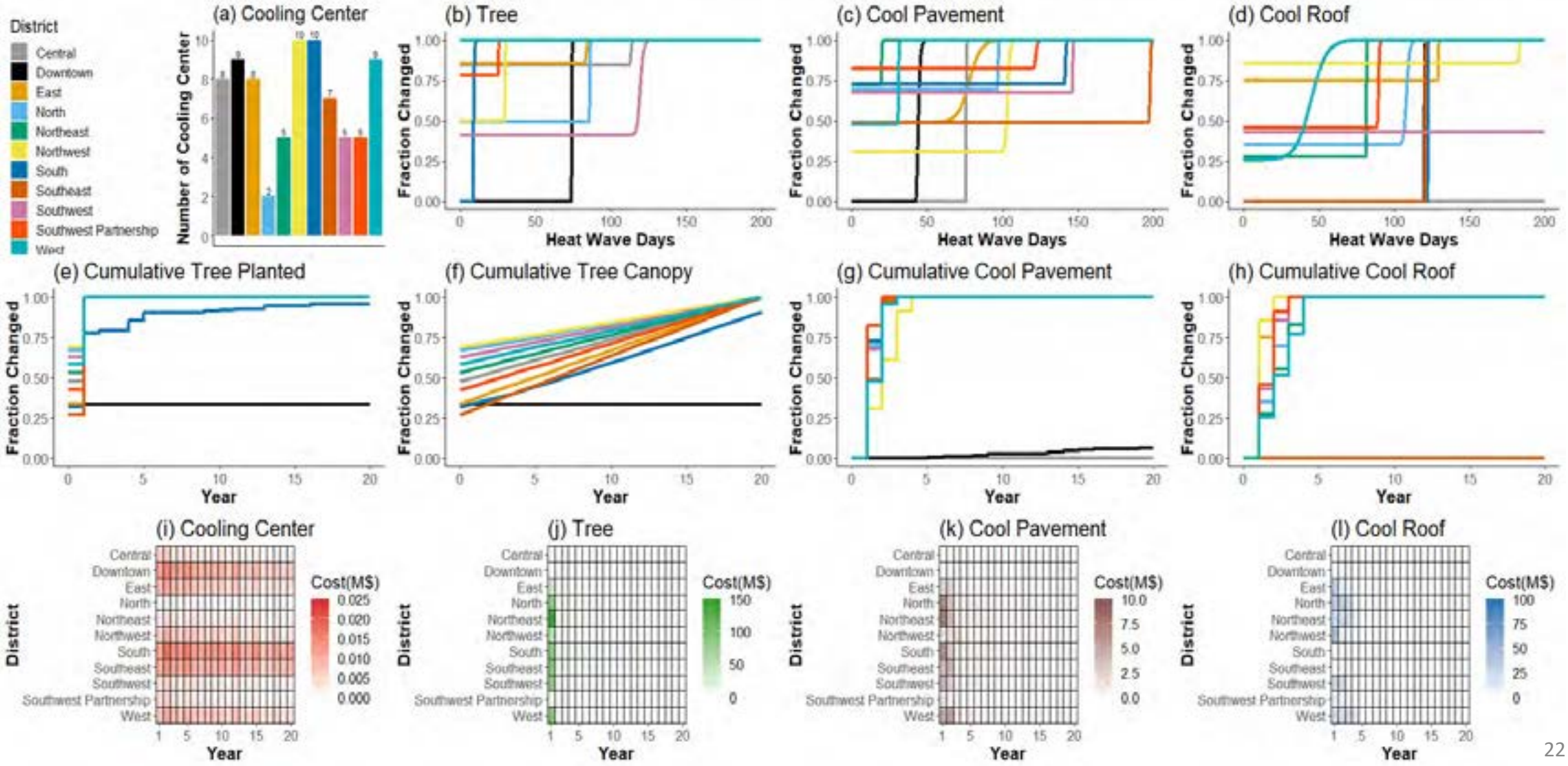
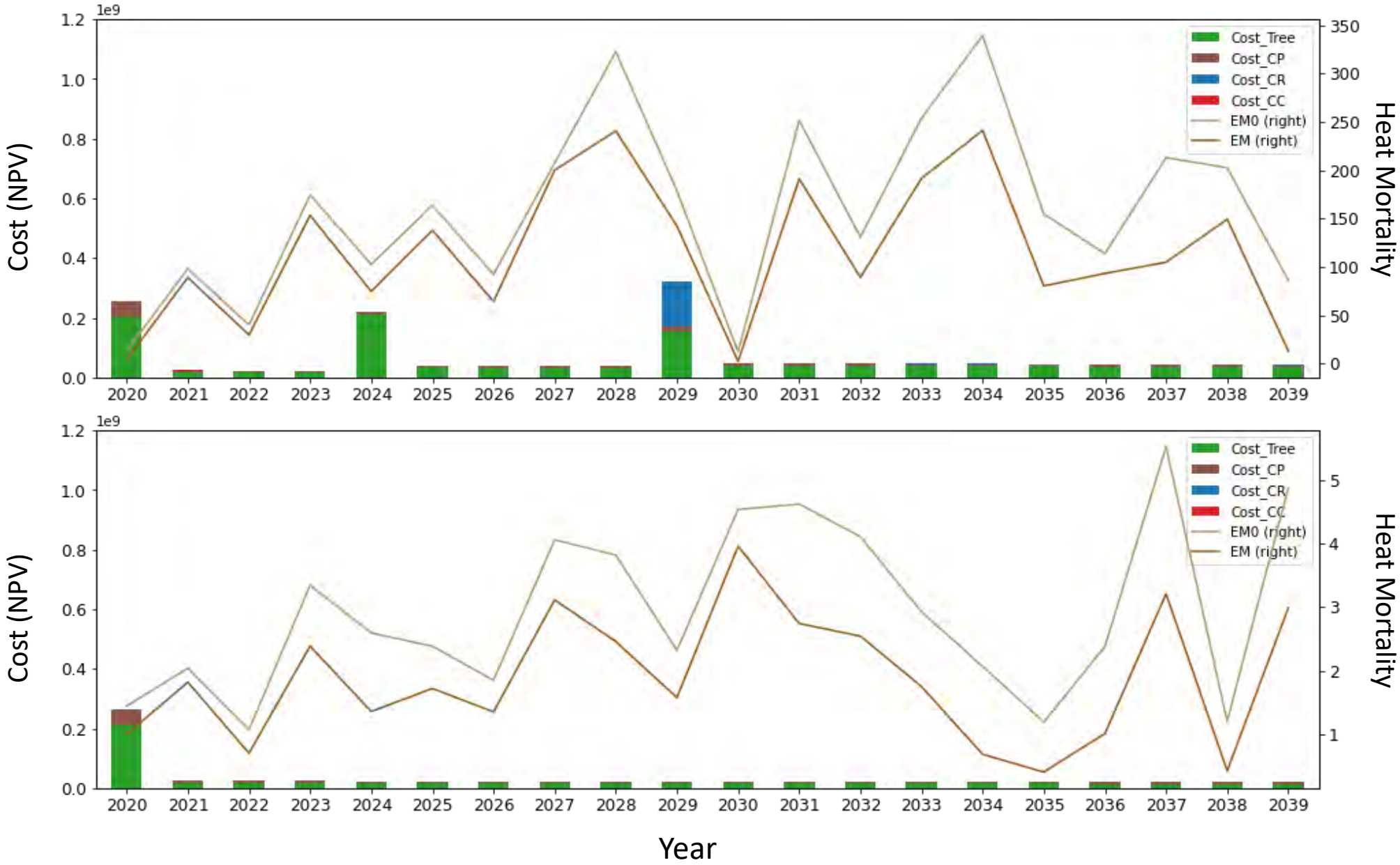


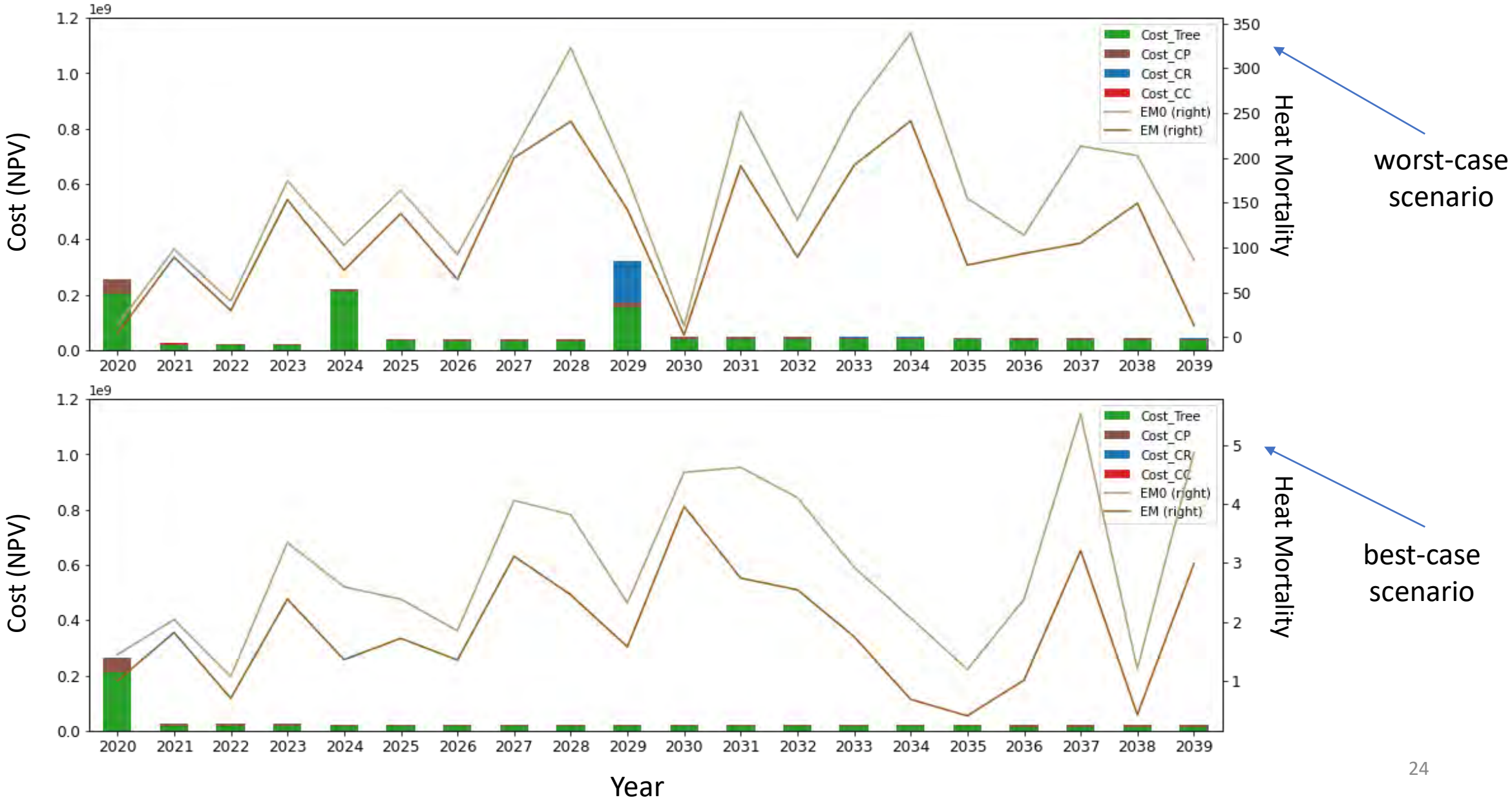
Same policy results in different decisions in two scenarios



worst-case scenario

best-case scenario

Same policy results in different decisions in two scenarios



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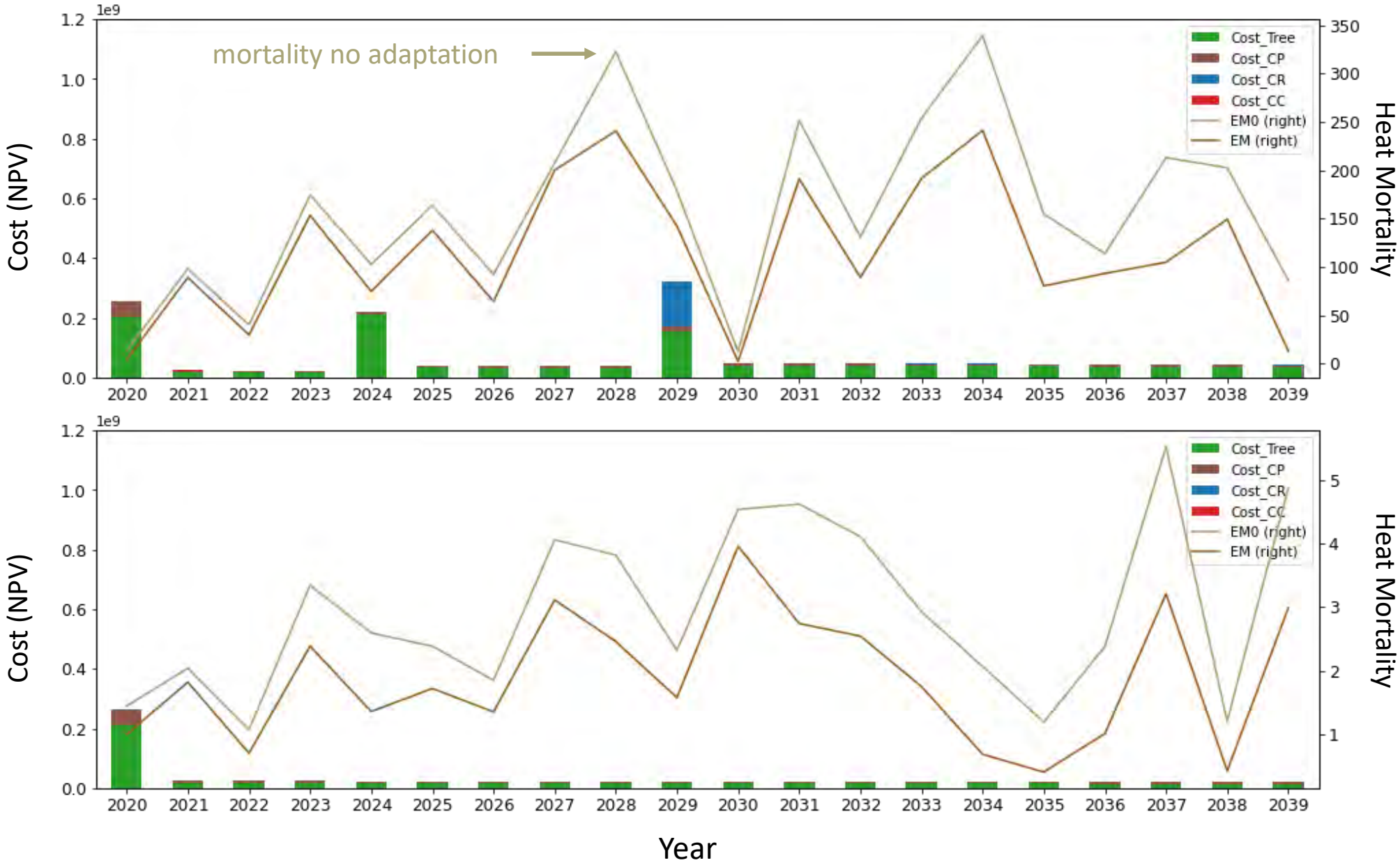
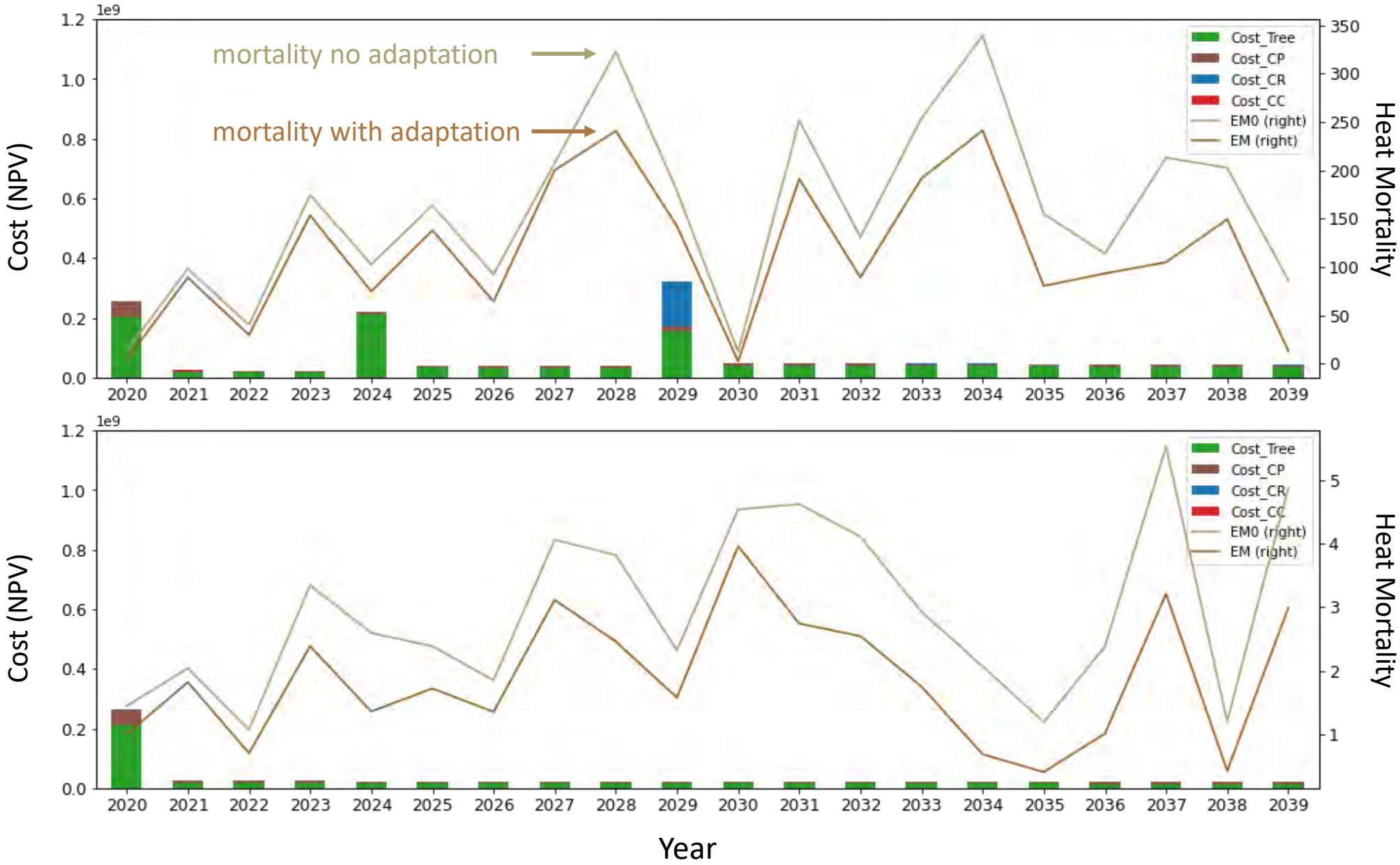


worst-case scenario

best-case scenario

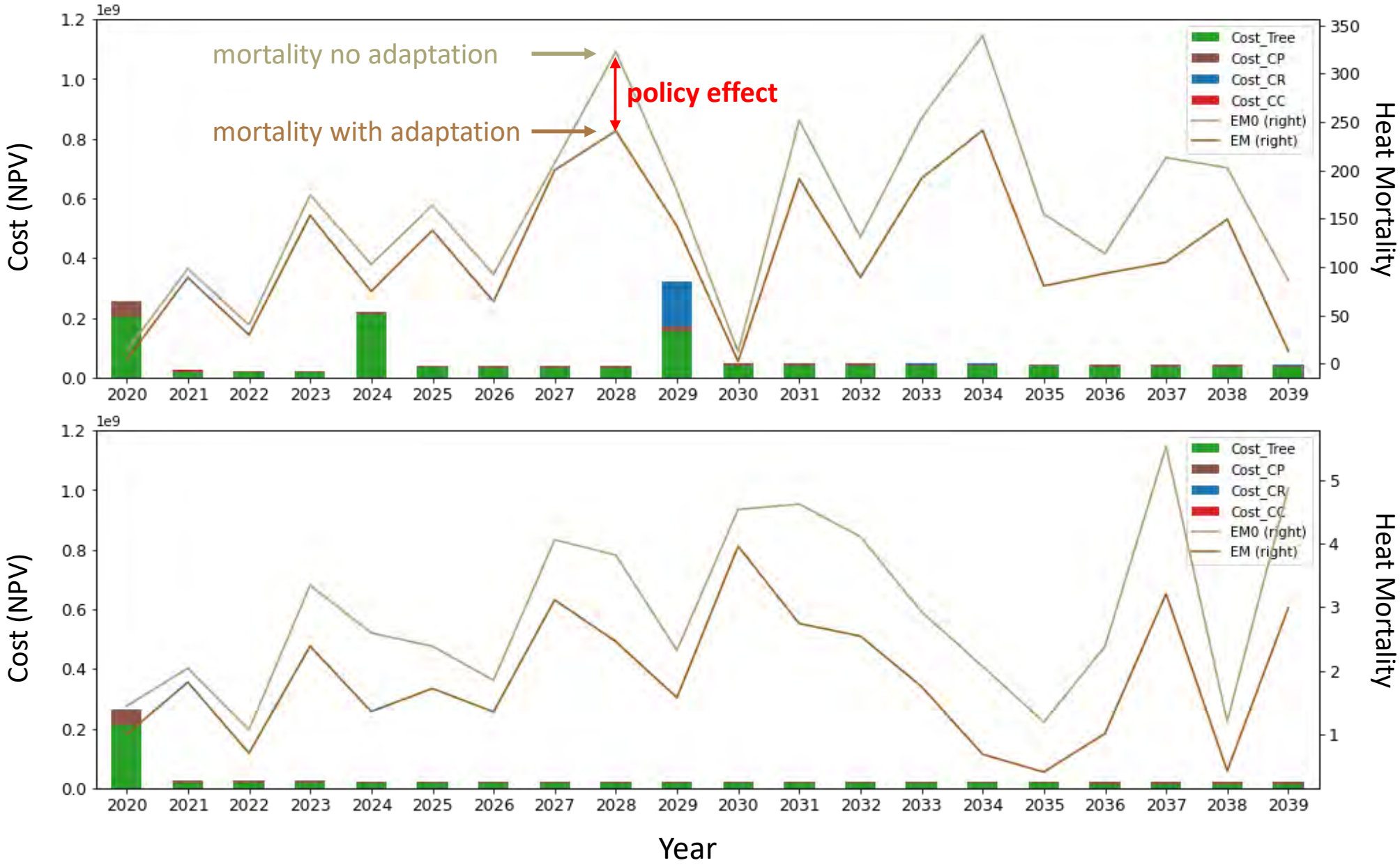
Same policy results in different decisions in two scenarios



worst-case scenario

best-case scenario

Same policy results in different decisions in two scenarios



worst-case scenario

best-case scenario

Summary

In general,

- Urban heat adaptation is a tough adaptive management problem
  -- lots of objectives, decisions, uncertainties over decades

- City-HEAT can generate Pareto-efficient policies based on multiple objectives across scenarios
  -- a reference set for decision makers
  -- detailed decision rules for each sub-city region and adaptation pathways in different scenarios

- City-HEAT can be generalized to other cities
  -- most input data required are public available
  -- code is open source with a user manual (will be on GitHub)

Summary

In general,

- Urban heat adaptation is a tough adaptive management problem
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For Baltimore, we find that

- Marginal cost of saving lives from extreme heat increases

- Equitable polices can be much more expensive (*Effectiveness-Efficiency-Equity* trade-offs)

Thank You!

Email: rshi8@jhu.edu
Twitter: @DrSray

Max Wei

Research Scientist, Lawrence Berkeley National Lab

CAL-THRIVES – A California Toolkit for Heat Resilience in Underserved Environments

CAL-THRIVES

A California Toolkit for Heat Resiliency in Underserved Populations

UCLA Climate Adaptation Research Symposium
September 9, 2021

Max Wei
Lawrence Berkeley National Lab

CALIFORNIA STRATEGIC GROWTH COUNCIL

CALIFORNIA CLIMATE INVESTMENTS
Cap and Trade Dollars at Work

BERKELEY LAB

INDICIA Consulting

USC

West Fresno family resource center

Research team

CAL THRIVES - A California Toolkit for Heat Resiliency in Underserved Populations

Max Wei(1), Ronnen Levinson (1), Tianzhen Hong(1), Kai-yu Sun(1), Zhao-yun Zeng(1), Wanni Zhang(1), Yu-jie Xu(1), Henry Willem(1), Susan Mazur-Stommen(2), Haley Gilbert(2), George Ban-Weiss(3), Alexandra Bruce(3), Yuxi Liu(3), Kayley Butler(3), Janice Mathurin(4), Yolanda Sue Randles(4)

(1) Lawrence Berkeley National Lab; (2) Indicia Consulting; (3) University of Southern California; (4) West Fresno Family Resource Center

EXTREME HEAT: "**Heat now causes more deaths** than hurricanes, tornadoes or floods in most years" *The Guardian* 6/20

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Deadly heat is killing Americans: A decade of inaction on climate puts lives at risk

Dean Russell, Elisabeth Gawthrop, Veronica Penney, Ali Raj and Bridget Hickey, Columbia Journalism Investigations

1615

Heat now causes more deaths than hurricanes, tornadoes or floods in most years, creating a new public health threat. An investigation reveals why the CDC's prevention efforts have faltered

This story is co-published with Columbia Journalism Investigations, the Center for Public Integrity and Covering Climate Now. Read the full investigation here.

CALIFORNIA

California has first rolling blackouts in 19 years — and everyone faces blame

While California braved for another round of rolling blackouts Monday night, the state's grid operator held off for a second straight night.

PUBLIC SAFETY POWER SHUTOFF

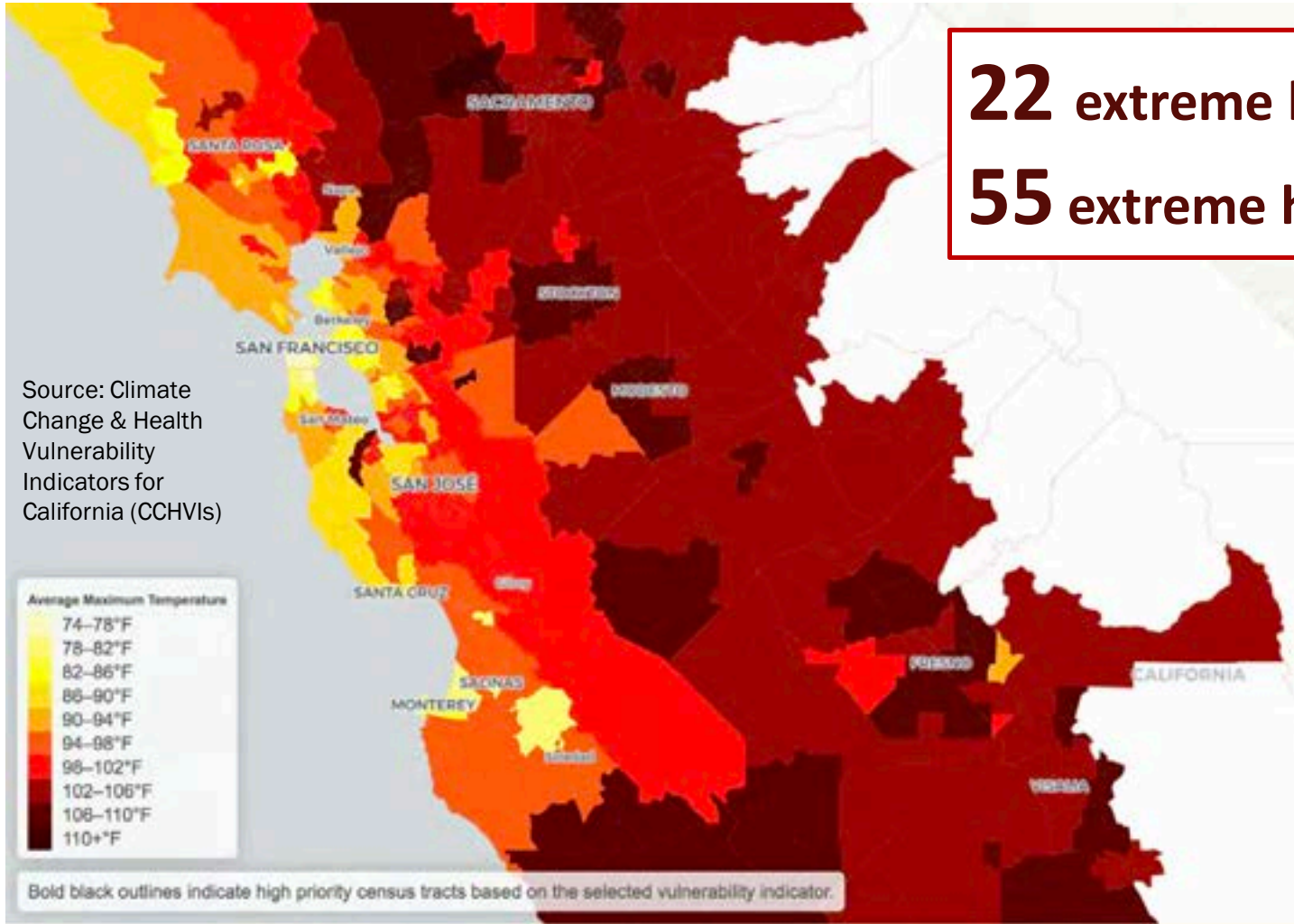
In order to keep communities safe, PG&E may need to turn off power when extreme weather or wildfire conditions are forecast.

This statewide initiative is called Public Safety Power Shutoff.

Heat is increasingly brutal in California's Central Valley, where low incomes, poor air quality, old homes, and high utility bills disadvantage many residents

California and Fresno are hot

…and getting hotter



Source: Climate Change & Health Vulnerability Indicators for California (CCHVIs)

22 extreme heat days/year by 2040 - 2060

55 extreme heat days/year by 2080 - 2099


Climate change

In California's interior, there's no escape from the desperate heat: 'Why are we even here?'

Soaring temperatures are a way of life in the Central Valley, but racial disparities mean many have no access to relief

Maanvi Singh in Fresno

https://www.theguardian.com/us-news/2021/jul/10/california-central-valley-extreme-heat-race

The good news is that we can act now on preventative strategies to mitigate heat health impacts

CAL-THRIVES project developing a toolkit for local and state stakeholders

SHORT TERM

- Increase awareness of heat-related vulnerability
- Identify areas that are vulnerable to extreme heat events

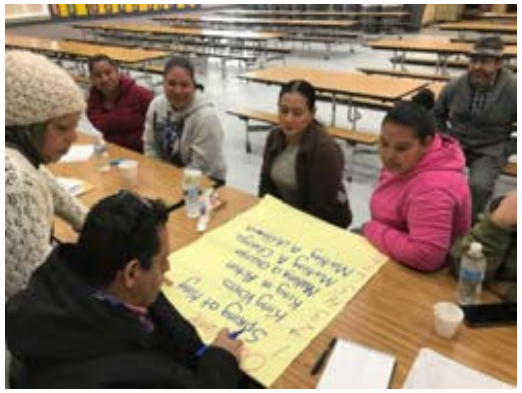
LONG TERM

- Remedy the built environment, such as building retrofits & increases to tree canopy
- Enhance community and home cooling programs
- Improve social capital and connectivity at the neighborhood level

Source: Cal-heat.org

Our heat-resiliency recommendations incorporate both **community input and science**

Community engagement



Neighborhood-scale building modeling

Cooling center optimization

Outdoor measure modeling

Heat Resilience Toolkit

Fact sheets
Modeling outputs
Heat vulnerability index tool
Online tools (videos, webinars)
Policy/program recommendations

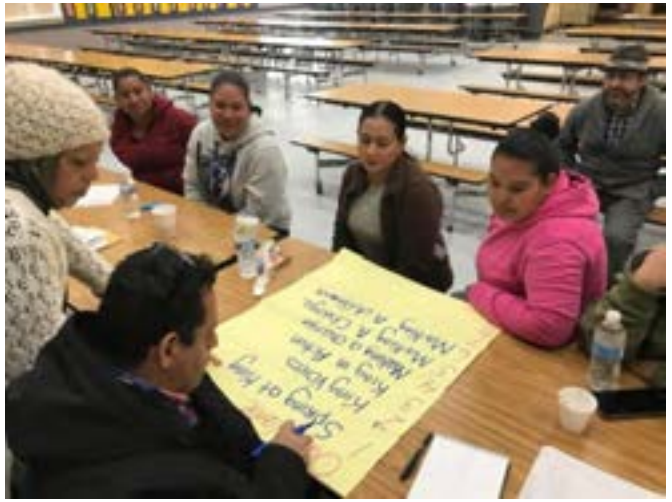
Community engagement and feedback are a key part of the project

Collecting and responding to community feedback a key part of project

- *To help understand how residents cope with extreme heat*
- *To better understand resident needs, preferences, barriers to proposed cooling strategies & how they view community cooling centers*
- *To inform our modeling assumptions*

Outreach methods

- Community meetings (2)
- Focus groups (4)
- In-home interviews (11)
- Phone interviews (90)



We're modeling **nine passive indoor cooling measures** in a worst-case heat wave, with and without grid power available

Window blinds

Window overhangs

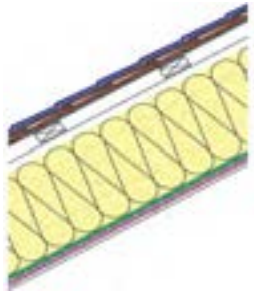
Cool roof

Cool walls

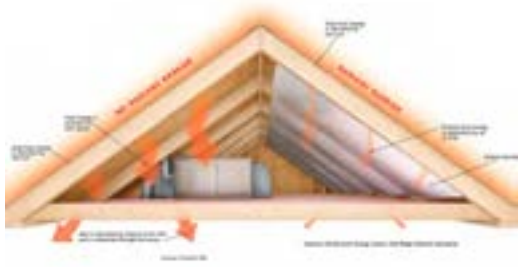
Storm windows

Solar-control window films

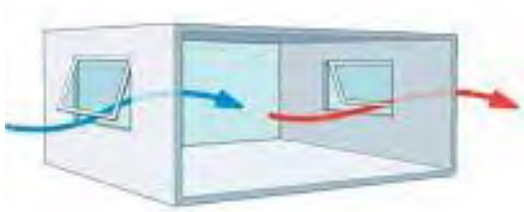
Roof insulation



Radiant barrier



Natural ventilation



We're also evaluating **eight active indoor cooling measures** and **four passive outdoor cooling measures**

ACTIVE INDOOR

Ceiling fans

Attic fan

Portable fans

Evaporative cooler

Central AC

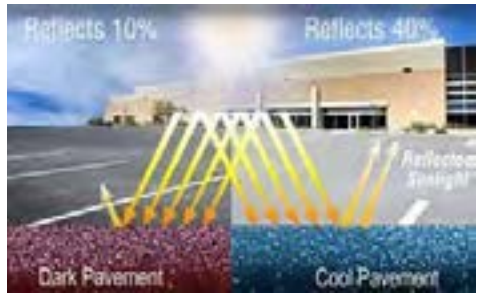
Mini-split AC

Window AC

Portable AC

PASSIVE OUTDOOR

Cool pavements

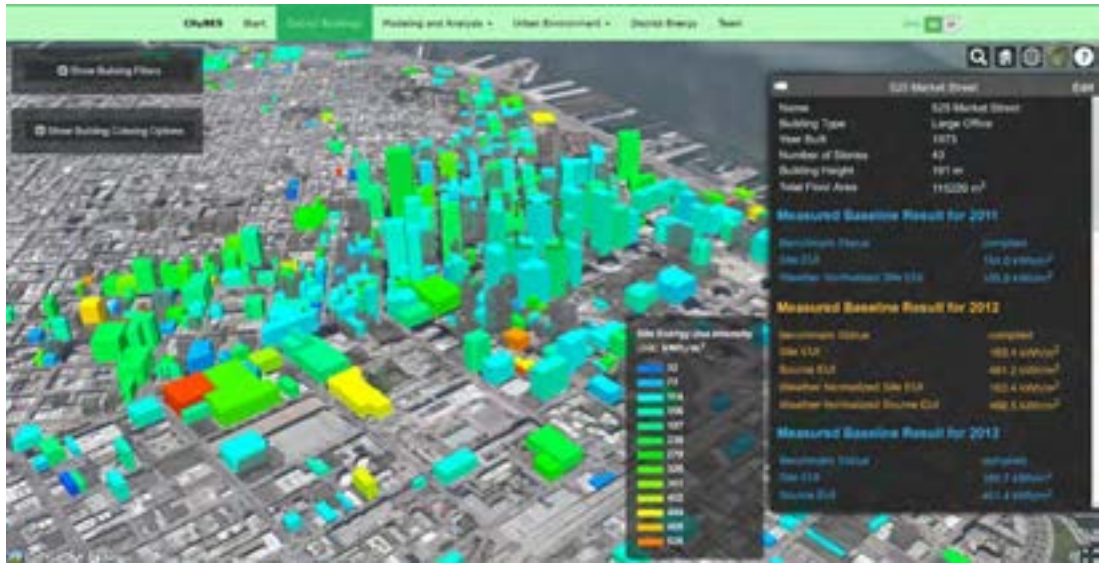


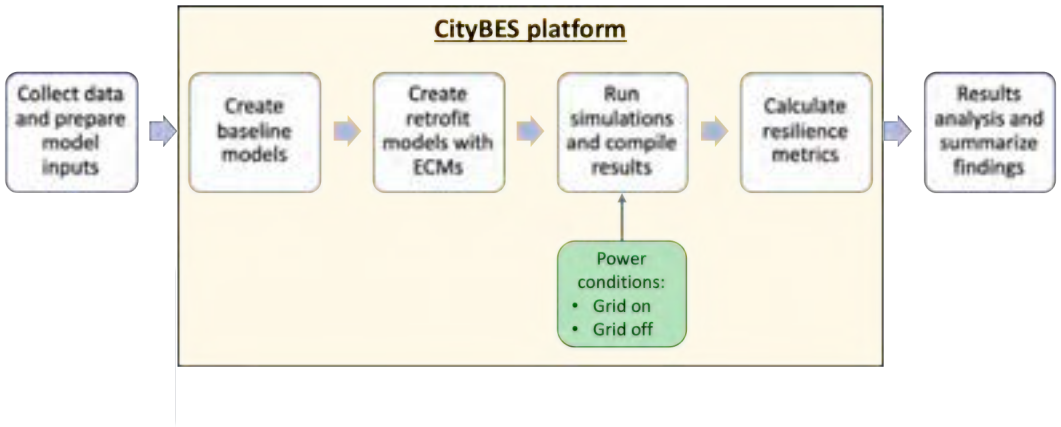
Cool walls

Trees

Canvas canopies

Neighborhood-scale building modeling with CityBES

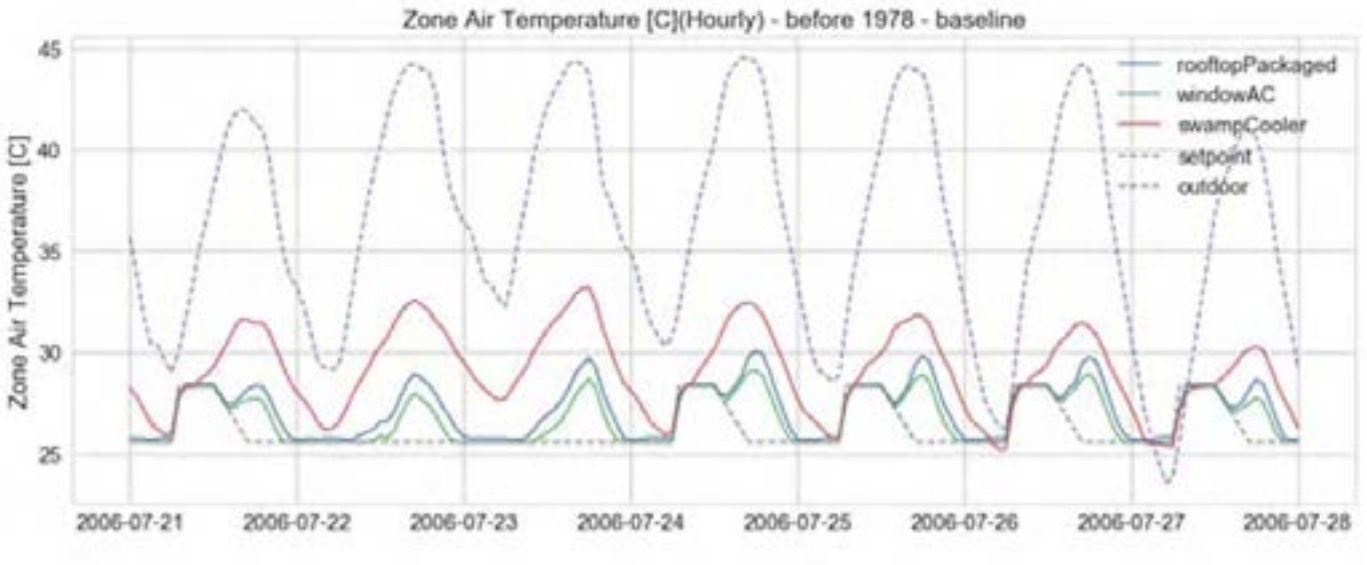




- CityBES is an open tool for neighborhood- to urban-scale building modeling
- The team has developed a residential building dataset for several neighborhoods in southwest Fresno
- The CityBES tool can model energy savings for one building or for a group of buildings

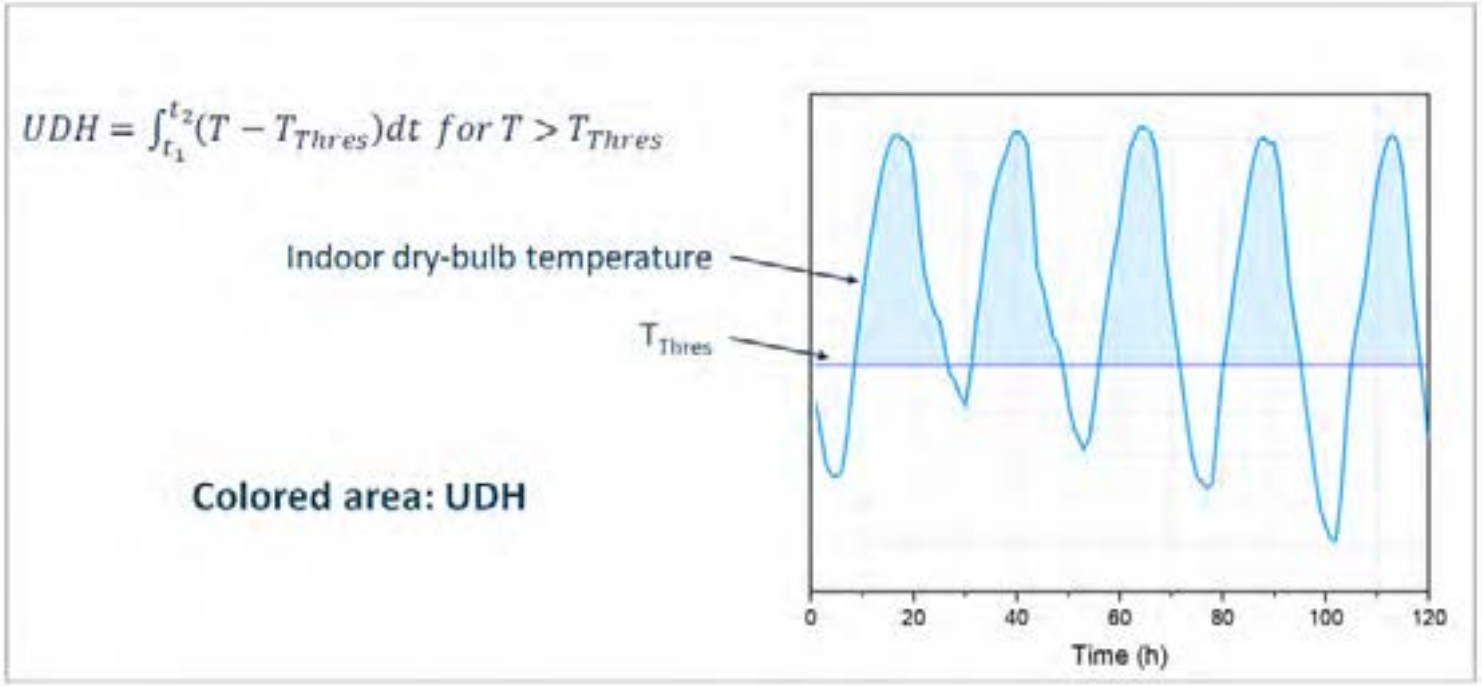
(https://citybes.lbl.gov/)

We model **worst-case heat wave** (7 days between 108 and 111° F), with grid power-on and grid-power off, and consider **several resilience metrics**



Resilience Metric	Parameters in metric
UDH (unmet degree hours)	• Air temperature
HICH (heat index caution hours)	• Air temperature • Relative humidity
SETUDH (standard effective temperature unmet degree-hours)	• Air temperature • Relative humidity • Mean radiant temperature • Air velocity • Metabolic rate • Clothing insulation
PMVEH (predicted mean vote exceedance hours)	

Example heat resilience metric : Unmet degree hours



- "Unmet degree hours" (UDH) is defined as the total area under the curve for an indoor temperature vs. time plot that is above a threshold temperature, T(Thresh).
- The colored area above represents the UDH.

Some community findings from focus groups and individual interviews

Kinship networks

- A surprisingly large number of renters rent from family members
- Importance of kinship networks in securing housing, and the existence of ‘supra-household’ decision-making units

Multi-generational households

- Many respondents for the IDIs are heading up multi-generational households, often transient/transitory household sizes
- Such informal arrangements often not formally recognized by authorities; difficult for older residents to acquire support from city/state

Local Experts

- Each Focus Group contained a ‘local expert’, often long-term locals
- Expertise appears to be related to position along the lifecycle trajectory and/or social position within the community: e.g. young parents, seniors, business owners.

Some findings from community survey (n=90 respondents): people pay a lot and are hot!

- 92% have electricity costs of > $150 per month in summer
- 72% report feeling too hot at home very often during the summer
- 14% have evaporative (swamp) coolers
- 44% willing to plant trees, bushes, or shrubs in their yard
- 67% very comfortable opening doors or windows in the summer
- 8% have solar-control window films in their homes

Cooling center findings from community outreach

- The majority of residents queried prefer to balance mild discomfort from heat for the privacy and security of home.
- Several respondents voiced concerns attendees that were not in their shared demographic or lifecycle group.
- Most respondents do not report going to any common location during heat waves, e.g. they do not report heading to ‘the mall’ or ‘the movies.’
- There is no magic bullet for improving attendance at cooling centers.

Cooling center recommendations

- We recommend that money be used directly for either improving the cooling in homes for the most vulnerable, or for **extending and enhancing the services/hours/activities** of public spaces that supply cooling as an ancillary benefit (e.g. community centers, libraries).
- We also recommend that cooling centers **be expanded into emergency response centers or 'resilience hubs'** that could find a role in worst case events or in the confluence of acute events, such as wildfires causing extreme air pollution in conjunction with extreme heat events.
- Finally, we think there might be a role for city agencies to invest in/**take advantage of malls**, which already serve as transportation hubs, and typically have high-end, large scale HVAC installations.

Our toolkit elements target various stakeholders from local community to state-level agencies

Toolkit element	Toolkit element scope	CBO	Local NGO/ National NGOs	State-level Agency
1) Community info sheet	Staying cool in general, dangers, hydration, fans, cooling centers	x		
2) Summary matrix of output	Table of all modeled measures - results by resilience metric for each measure - costs, energy impacts for each measure		x	x
3) Measure Sheets	For each measure sheet: - benefits, costs, supplier contacts, watch items, tips, installation, lifetime, - pointers to other resources;		x	x
	Passive Measures e.g.: window films, cool walls		x	x
	Active measures e.g.: room air conditioners (window/ portable/ mini-split/ evap. coolers)		x	x
	Outdoor measures – e.g. cool walls, trees		x	x
4) Online tools	CityBES (for modeling the measures and HVI mapping)		x	x
	Training package(s)/ videos/ webinars (e.g. EPA Webinar)		x	x
5) Policy/program recommendations	Specific recommendations re: to advance CAL-THRIVEs findings			x

Toolkit examples

1. Community info sheet

HEALTH Facts

How to keep cool when it gets hot

Climate change is causing longer, more frequent spells of extreme heat across California, including in the Central Valley. Extreme heat puts us in danger of serious health risks, like dehydration, heat stroke, and other heat-related illnesses.

Cool to the touch

- **Cool the skin** by placing a wet bandana or washcloth around your neck and on other exposed skin. Resting with damp skin allows for evaporative cooling which is essential to cooling the body and regulating temperature. For longer lasting cooling, purchase an "evaporative cooling" bandana ($6+) which stays wet for hours.
- **Dampen your bed sheets** and place a fan at the bottom of your bed so it cools you throughout the night. Or slightly dampen your sheets by putting an iced water bottle in your bed, wrapped in a thin towel. Cotton sheets are best.
- **Postpone all heat-producing indoor activities** to the evening or nighttime hours. Cook meals ahead of time at night. Refrigerate, serve cool, or microwave briefly. Eat cool meals.
- **Hang a thin wet sheet or wet laundry** in front of a window or fan so the air blowing inwards is cooled.

Placing a box fan in a window at night can move hot air out of a room.

Get somewhere cool if you are hot. Cooling centers are local city resource providing air conditioning and water for everyone during heat events. Check www.fresno.gov/parks/cooling-centers/ for closest location to you.
Also, visit friends/family, libraries, community or senior centers, or shopping centers to keep cool if you are in need.

Ceiling fans can make you feel cooler and allow you to run your AC at a higher temperature.

Move the air to keep cool

- **Install ceiling fans.** Using a ceiling fan can make you feel up to 4° F cooler. Use while running your AC to double the cooling effect. The boost in air movement from the fan creates a wind chill that allows you to run the AC at a higher temperature while still keeping cool.
- **Position a box fan in a window at night** to move hot air out of one room and allow cool air inside. Purchase window locks ($1+) if you're concerned about leaving windows open.
- **Create a cross breeze** in your home/apartment by having a door or window open on one side of a room and another one open on the opposite side.
- **Turn on built-in exhaust fans** like those in the bathroom and kitchen when indoor air is hotter than outside.

HEALTH Facts

How to keep cool when it gets hot

Keep the heat out

- **Blackout curtains** ($25+) are extremely effective at keeping heat out during the day and keeping cool air in. Curtains that are neutral-colored with white backing are best. Close them in the early morning and open them up when the sun has set. $
- **Caulking and weatherstripping your doors and windows** to reduce the loss of cool or conditioned air. This is effective to regulate your home's temperature during both hot and cold months. $
- **Plant vegetation along the south and west** facing sides of your home. Vegetation keeps your home cooler in the summer and warmer in the winter. Plant deciduous trees on the south and west sides of your house to block sunlight in summer and let it through in winter. If your trees aren't yet big enough to cast much shade, put other types of tall plants, such as giant reeds or sunflowers, along the sunbaked sides of the house. Climbing plants, such as grapevines, can also provide a cool green screen over windows in summer but allow sunlight and heat through in winter. $ $$

A blackout curtain should have a white inner lining to be more effective at reduce heat from getting inside.

Resources

(need input from group on webpages to share and or phone #s)

A "cool" asphalt shingle image source: Owens Corning

Check on your neighbors & family, especially seniors, children, and people living alone. Make sure they have access to water, medications, and cooling. If someone needs attention, call **911** or the non-emergency dispatch number (559) 621-7000 for less urgent services.

- **Install heat reflecting film or awnings on windows** that face the sun. This will keep your house cooler and reduce glare and ultraviolet rays that damage furniture and floors. For hot climates, sun-control films are most effective, but be aware that they will also reduce the amount of light that comes in through the windows. $ $$
- **Install a "Cool Roof"** when it's time to replace your roofing. Light colored roofing reflects the sun's waves, reducing the heat transfer to the building. Now even darker-toned metal roofs can have reflective pigment added to boost their solar reflectance abilities. $$

Neighbors pick
Effective at cooling
DIY

$ up to $50
$$ $50 up to $500
$$$ $500 to $10,000

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2. Cooling Measure Fact Sheets

CAL-THRIVES | Window Retrofit Option: Window Films

Window Films

Description

Window films are designed to help decrease temperature increases from sunlight (solar heat gain) and protect against glare and ultraviolet (UV) exposure.

Window films with low-e coatings are preferred for keeping cool because they block the part of sunlight to reduce solar heat gain while maintaining visibility.

Keeping you cool & comfortable

- Reduce solar heat gain through windows to reduce overheating
- Lower indoor temperature by 0.7-3°C during power shutoff, and by 0.2-0.5°C with power available
- Reduce life-threatening overheating hours by up to 100% during power shutoff
- Reduce uncomfortable hours by 5-14% with power available

Other benefits for you

- Save energy cost by $0.44–1.3 per square footage of floor area
- No operation or maintenance

Window films help increase solar reflectivity, reject solar heat and reduce incoming ultraviolet light, resulting in a cooler indoor space.

When To Consider

- Solar gain through existing window results in overheating or uncomfortable glare.
- Resident does not want to block key views with awnings or other window attachments that interfere with view.

When to consider this retrofit—Ownership

x	Homeowner (Use check marks)
	Apartment Renter – Long Term
	Apartment Renter – Short Term
x	Live in a Condo/multi-family unit*
x	Live in a Historical District*

* Condominium regulations or historic building codes may require the use of films with higher visibility and lower-reflectance window films that maintain appearance from the outside.

When to consider this retrofit—Window conditions

x	Existing window single-glazed
x	Existing window double-glazed, no low-e*
x	Existing window double-glazed with low-e

* Applying a non-low-e surface film to a low-e window makes the most sense

Installation

Window films can be professionally applied by a skilled installer or are available for do-it-yourself projects at home improvement stores.

Window films are applied to the exterior surface of existing windows and typically cannot be adjusted or readily removed. Some films absorb, rather than reflect, solar radiation. This reduces their effectiveness because the absorbed energy will heat the glazing surface and a portion of that energy will be transferred into the room. This is more prominent if the film is applied to the interior side of the window.

Window films are most effective on east- and west-facing windows because of greater sun exposure and thus heat gain. South-facing windows may benefit during summer months but the warming during winter months could offset that benefit. North-facing windows won't benefit from applying window films because of limited direct sunlight.

SURFACE-APPLIED WINDOW FILMS

Tips/Cautions

- Look for a National Fenestration Rating Council (NFRC) rating label for solar heat gain coefficient (SHGC) and visible transmittance (VT), both numbers between 0 and 1.
  - The lower the SHGC, the better the film is at blocking heat gain.
  - The higher the VT, the more potential for daylighting.
- Warranties for window films vary from 2 – 15 years
- Having a professional install or remove film is recommended.
- High-VT films and some films with spectrally selective low-e coatings result in minimal change in transparency or appearance.
- Low-VT films can dim rooms and necessitate more indoor lighting and energy use.
- Silver, mirror-like films typically are more effective than the colored, more transparent ones but may be undesirable

x	Do it Yourself
	Carpenter
x	Manufacturer recommended installer
x	Weatherization/utility program

The window on the left has no film; the window on the right does. How much a film alters the appearance of the window (inside and out) depends on a number of variables and is difficult to generalize. Because there are currently so many different films

Considerations

	1	2	3	4	5
Ease of installation (1 = easier)			x	x (DIY)	
Availability (1 = more available)	x (DIY)		x		
Cost Details (1= lower cost)	x (DIY)	x			
Benefits (comfort & energy) (1 = more favorable)		x			

Average Total Cost for 30- by 60-inch window	
Do it Yourself	$10
Standard solar control	$80
Spectrally-selective	$125

Complementary Options

- Cool roofs & walls
- Fans (ceiling, standing)
- Natural ventilation

Operation

None

References

U.S. Department of Energy, Energy Saver, Energy Efficient Window Attachments, go to https://www.energy.gov/energysaver/energy-efficient-window-attachments

Efficient Window Coverings, Applied Films, go to https://efficientwindowcoverings.org/understanding-window-coverings/applied-film

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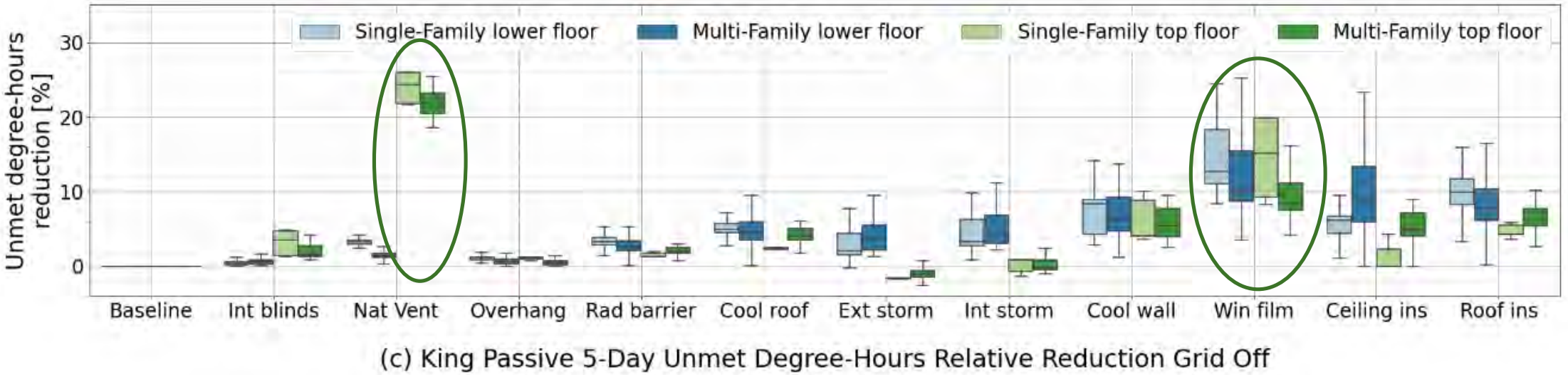
INDICIA Consulting

3. Matrix of resilience metric outputs

1100sqft single-family example model from the King neighborhood	Pre1978							
	Resilience							
	Grid-on scenario				Grid-off scenario			
	UDH	HICH	SETUDH	PMVEH	UDH	HICH	SETUDH	PMVEH
Baseline (absolute value)	173.0	66.0	115.9	61.0	1241.4	46.0	418.5	52.0
Measures (reduction percentage)								
Reroof and Add Roof Insulation	33.4	10.6	46.3	9.8	8.5	47.8	14.4	26.9
Apply Top Floor Ceiling Insulation	25.0	6.1	32.5	4.9	5.7	21.7	9.6	15.4
Increase Roof Solar Reflectance	13.6	4.5	17.6	3.3	4.6	15.2	7.3	11.5
Increase Wall Solar Reflectance	23.9	7.6	29.7	4.9	9.0	32.6	14.6	21.2
Use Window Blinds	-6.9	0.0	8.0	1.6	0.4	4.3	2.5	5.8
Add Exterior Overhang Shades	3.6	0.0	4.7	0.0	0.9	4.3	1.4	7.7
Add Exterior Storm Window Layer	14.4	4.5	17.1	3.3	1.1	8.7	1.7	7.7
Add Interior Storm Window Layer	16.8	4.5	20.4	3.3	2.2	10.9	3.5	7.7
Add Window Film	26.0	6.1	34.0	4.9	9.9	37.0	16.6	23.1
Enable Natural Ventilation for Rooms with Windows	3.8	1.5	3.7	-1.6	3.1	2.2	1.8	5.8
Add radiant barrier	11.8	3.0	15.3	1.6	2.9	13.0	4.6	11.5
Notes:								
UDH: unmet degree-hours								
HICH: heat index caution hours								
HIDH: heat index danger hours								
SETUDH: standard effective temperature unmet degree-hours								
PMVEH: predicted mean vote exceedance hours								
Baseline HVAC system type: central HVAC								

Simulation example for passive measures at neighborhood scale



(c) King Passive 5-Day Unmet Degree-Hours Relative Reduction Grid Off

Relative improvement from baseline in **unmet degree hours** as a function of passive cooling measures for **grid off** scenario, King Neighborhood

Natural ventilation and **window films** are the most effective measures

4. Online tools (videos / webinars)

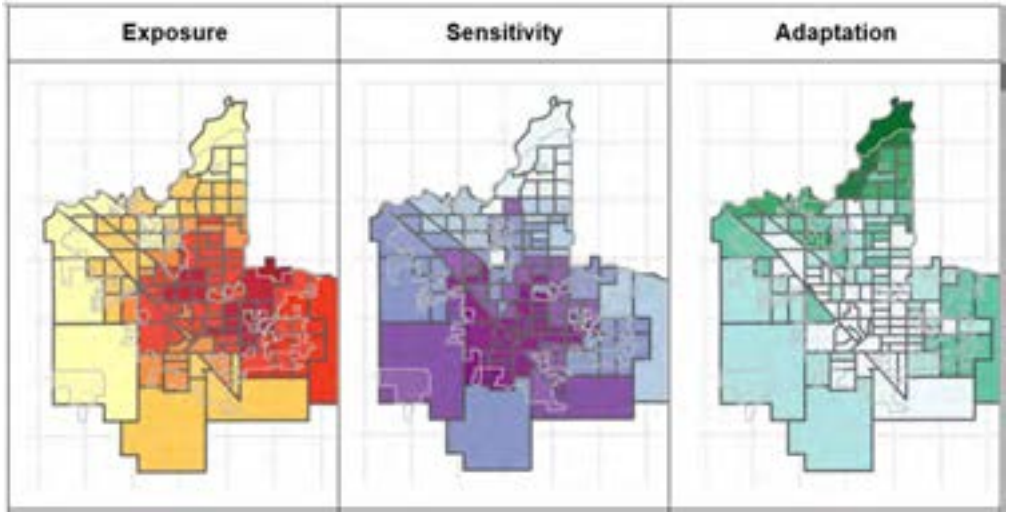
- Training package(s)/ videos/ webinars (e.g. EPA Webinar) e.g. for state climate collaboratives
  - CityBES.lbl.gov (for modeling the measures)
  - Heat vulnerability index (HVI) tool

CityBES

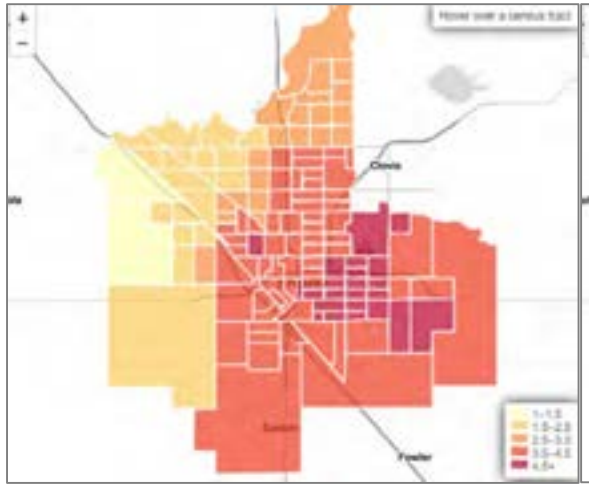
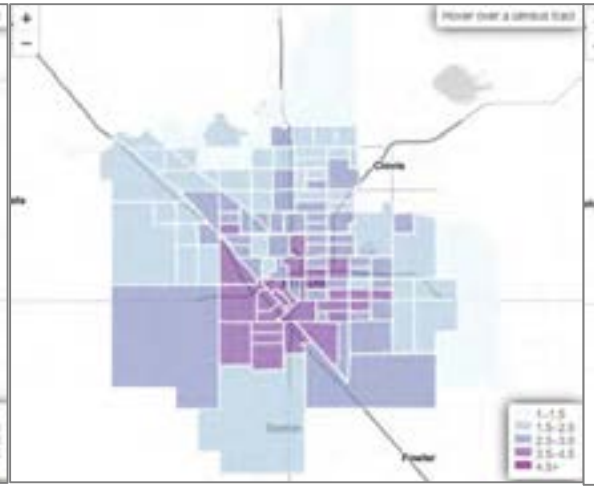
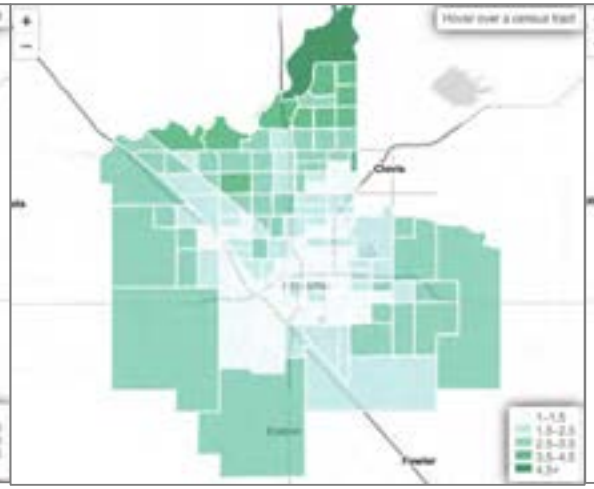
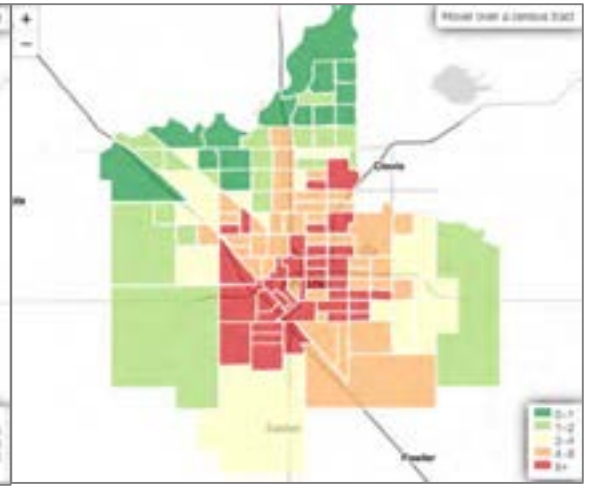
https://citybes.lbl.gov/

HVI tool

https://citybes.lbl.gov/?hvi=1



Our **Heat Vulnerability Index Tool** maps exposure, sensitivity, adaptation, and overall heat vulnerability

Exposure	Sensitivity	Adaptation	Heat Vulnerability Index
			
Number of hours with high heat index	Percent elderly and under 5	Median income	
Longest number of consecutive heat-wave days	Percent of pop. without high school degree	Percent of area covered in parks	
Number of heat-wave days	Percent of pop. below poverty level		
PM2.5 concentration	Percent non-white pop.		
Ozone concentration	Percent of pop. with ambulatory disability		
Building heat resistance indicator	Asthma hospitalization rate		
	Heart attack rate		
	Percent of pop. with a cognitive disability		

Highest vulnerability in south/central Fresno with high sensitivity and low adaptation

https://citybes.LBL.gov/?hvi=1

5. Policy/program recommendations – e.g.:

Policy needs and gaps:

- Development of **minimum cooling requirements** by climate zone, building type
- Policy to up-level **cool walls/ cool roofs on replacement**

Programmatic needs/opportunities:

- Testing/demo/pilots needed for **incorporation of passive/active measures** into existing program
- More data collection and baselining of housing stock e.g. **heat resilience audit/assessment**

Further research priorities:

- **Non-energy metrics development** and incorporation into codes/standards and cost effectiveness
- **Developing estimated health impacts** and costs as a function of metrics

CAL-THRIVES full modeling results and toolkit **will be available early next year**

- Estimated reductions in
  - Indoor air temperature
  - Unmet degree hours
  - Heat index danger hours
- Recommendations
  - Passive, active measures
  - Building code innovations

Thank You!

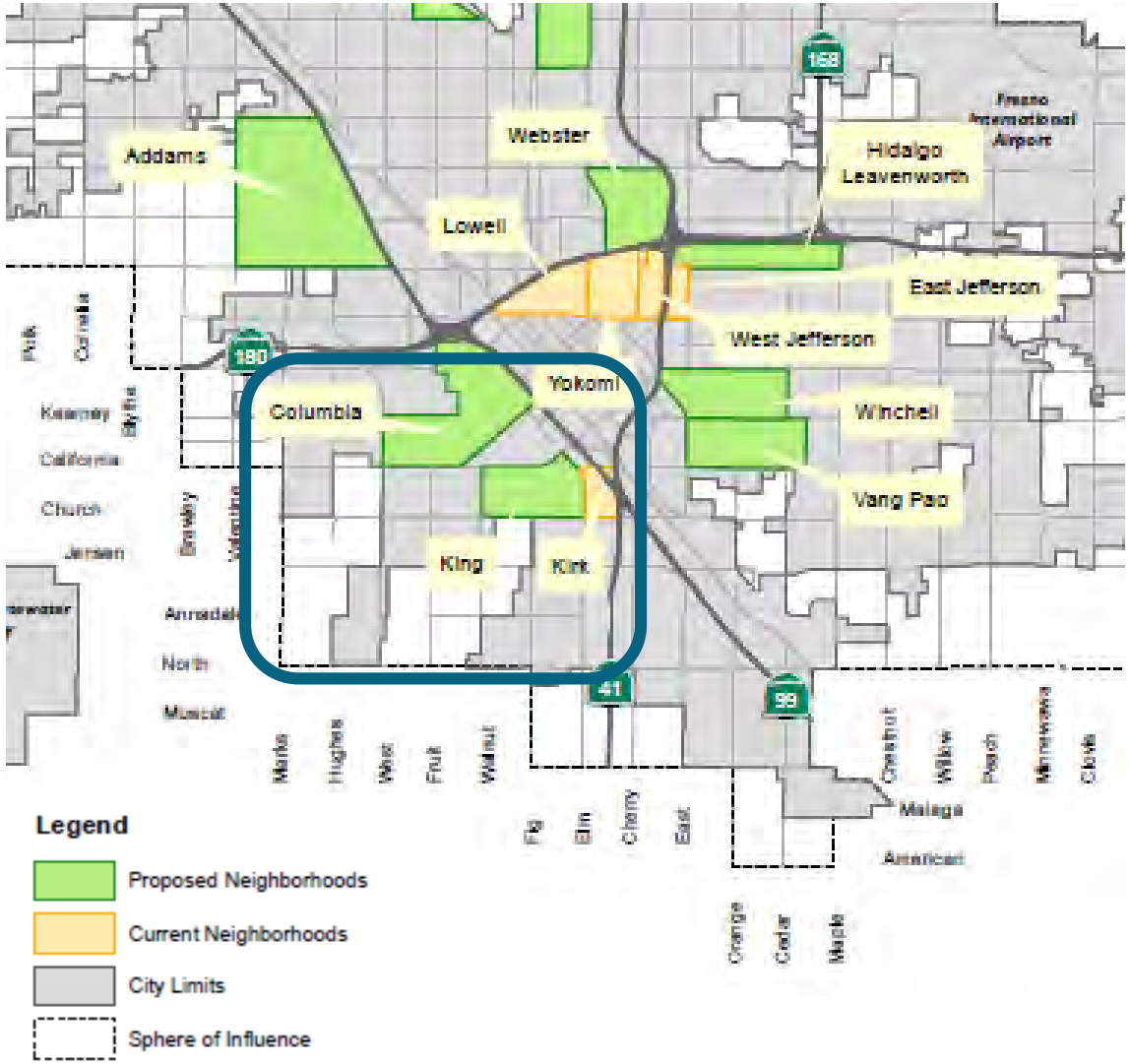
LBNL: Max Wei, Ronnen Levinson, Tianzhen Hong, Kaiyu Sun

mwei@lbl.gov

Indicia: Susan Mazur-Stommen

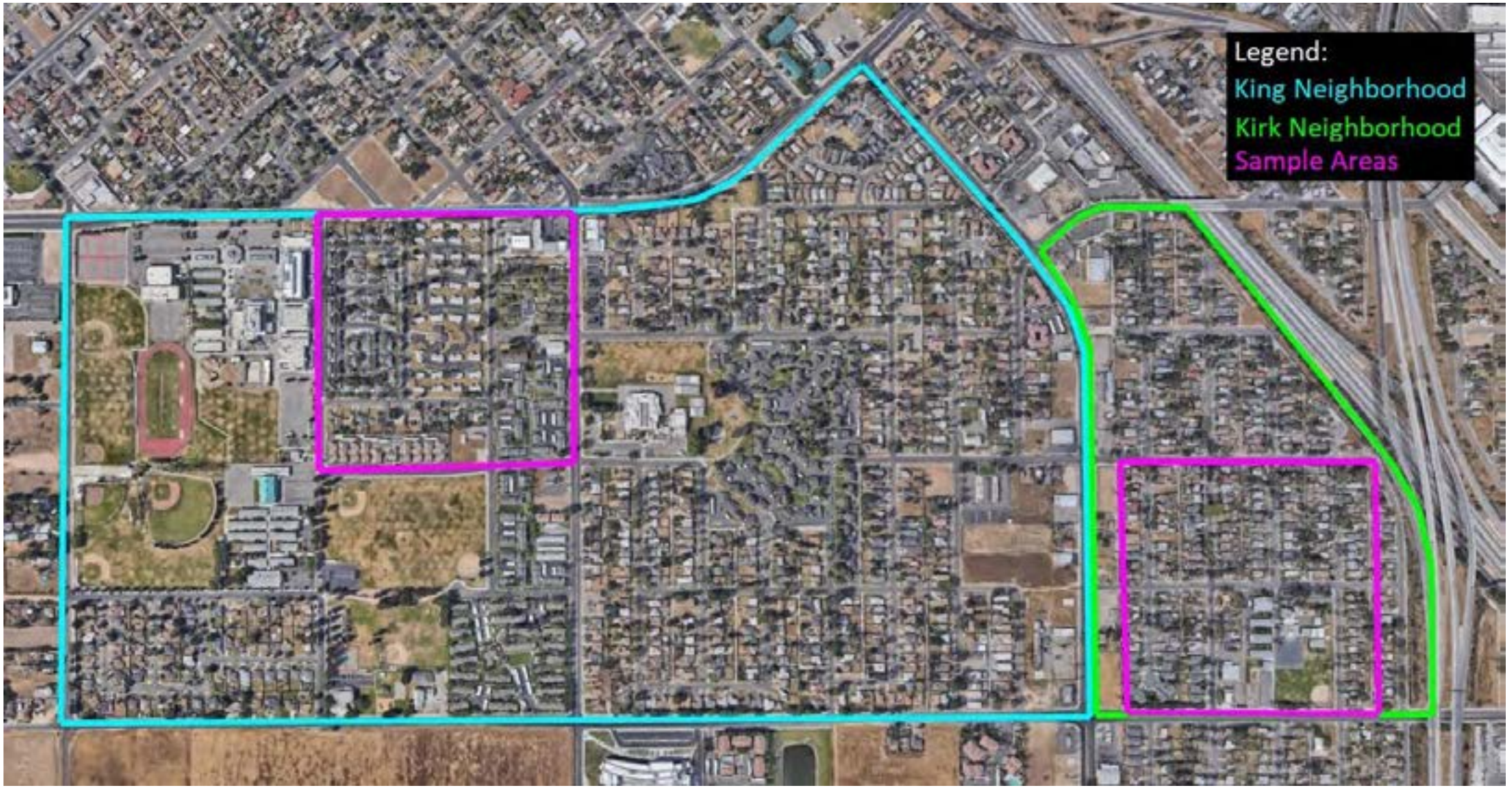
susanmazur@gmail.com

We are working in SW Fresno in King and Kirk neighborhoods



1. SW Fresno
   - Community meetings
   - Focus groups
   - Home walk throughs
   - Community building modeling
2. King and Kirk neighborhoods
   - In home interviews
   - Building modeling
3. Blocks in King & Kirk
   - Landscape-feature modeling (trees, lawns, etc.)

A close up of the SW Fresno neighborhoods and blocks



A variety of resilience metrics are characterized during a worst case heat wave

Resilience Metric	Parameters in metric	Limitations	Thresholds
UDH (unmet degree hours)	• Air temperature	• Neglects relative humidity, mean radiant temperature, air speed, clothing, and metabolic rate • Uses cooling setpoint as threshold, which could vary with different control strategies	• Cooling setpoint
HICH (heat index caution hours)	• Air temperature • Relative humidity	• Neglects mean radiant temperature of zone surfaces, indoor air speed, occupant clothing, and metabolic rate	• Caution: 27 °C • Extreme caution: 32 °C • Danger: 39 °C • Extreme danger: 52 °C
SETUDH (standard effective temperature unmet degree-hours)	• Air temperature • Relative humidity • Mean radiant temperature • Air velocity • Metabolic rate • Clothing insulation	• No comfort zone thresholds given by ISO or ASHRAE standards	• Grid-on: SET 28 °C • Grid-off: SET 30 °C
PMVEH (predicted mean vote exceedance hours)		• Fanger's PMV calculated in EnergyPlus may underestimate the cooling effect of increased air velocity	• Thermal comfort: 0.7 • Unbearable limit: 3

Taj Schottland

Senior Climate Program Manager,
The Trust for Public Land

@TajSchottland

Using the Climate Smart Cities Tool to Plan for Adaptation: Case Study of Two Cities

Climate Smart Cities

Case Studies From Los Angeles and Richmond

Taj Schottland, Sr. Climate Program Manager

UCLA Climate Adaptation Research Symposium

September 9th, 2021

THE TRUST FOR PUBLIC LAND

Thank you to my coauthors!

Robin Mark

LA Program Director

Sharon Sand

Grants Manager

Brendan Shane

Climate Director

Sadiya Muqueeth

Health Director

Kristen Weil

GIS Project Manager

THE TRUST FOR PUBLIC LAND

OUR MISSION

The Trust for Public Land creates parks and protects land for people, ensuring healthy, livable communities for generations to come.

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OUR COMMITMENT TO COMMUNITIES

PARKS

ARE ESSENTIAL TO OUR WELL-BEING

HEALTH

Humans are hardwired to thrive in nature, and research has shown that spending time outdoors boosts mental and physical health.

PARKS

LEVEL THE PLAYING FIELD

EQUITY

Great parks are welcoming to everyone, strengthening communities by improving quality of life for all–especially the most vulnerable.

PARKS

MAKE OUR COMMUNITIES MORE RESILIENT TO CHANGE

CLIMATE

Parks help protect us from extreme weather. For example, a shady green park on a hot day in Washington, DC, was 17 degrees cooler than surrounding neighborhoods.

Climate Smart Cities

Creating equitable & resilient communities

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Climate Smart Cities

Objectives

Climate Equity

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Climate Smart Cities
Objectives

Connect

Cool

Climate Equity

Absorb

Protect

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Existing Partnerships

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Our Integrated Approach

Partner

Research

Implement

Plan

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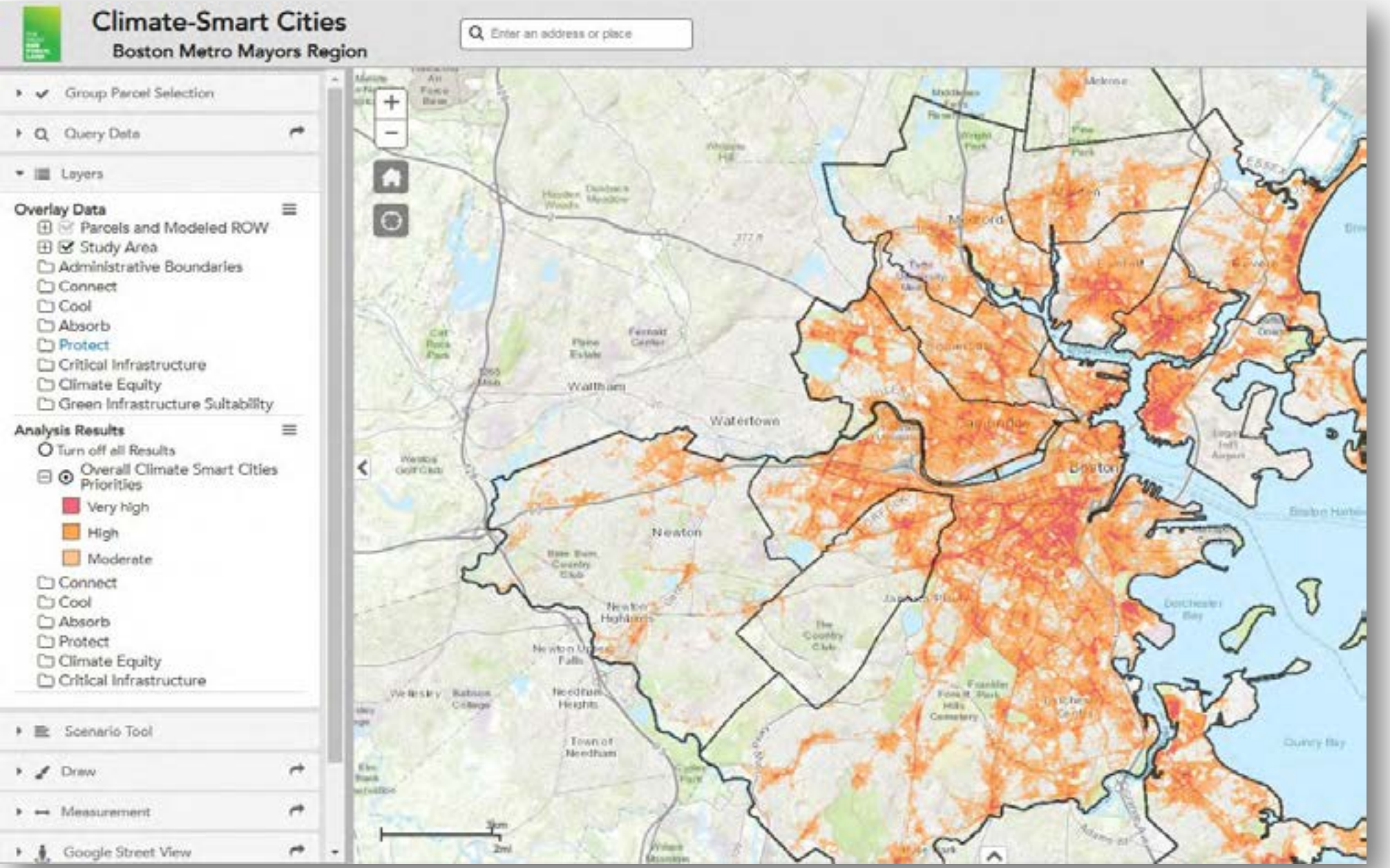

Overall Priorities

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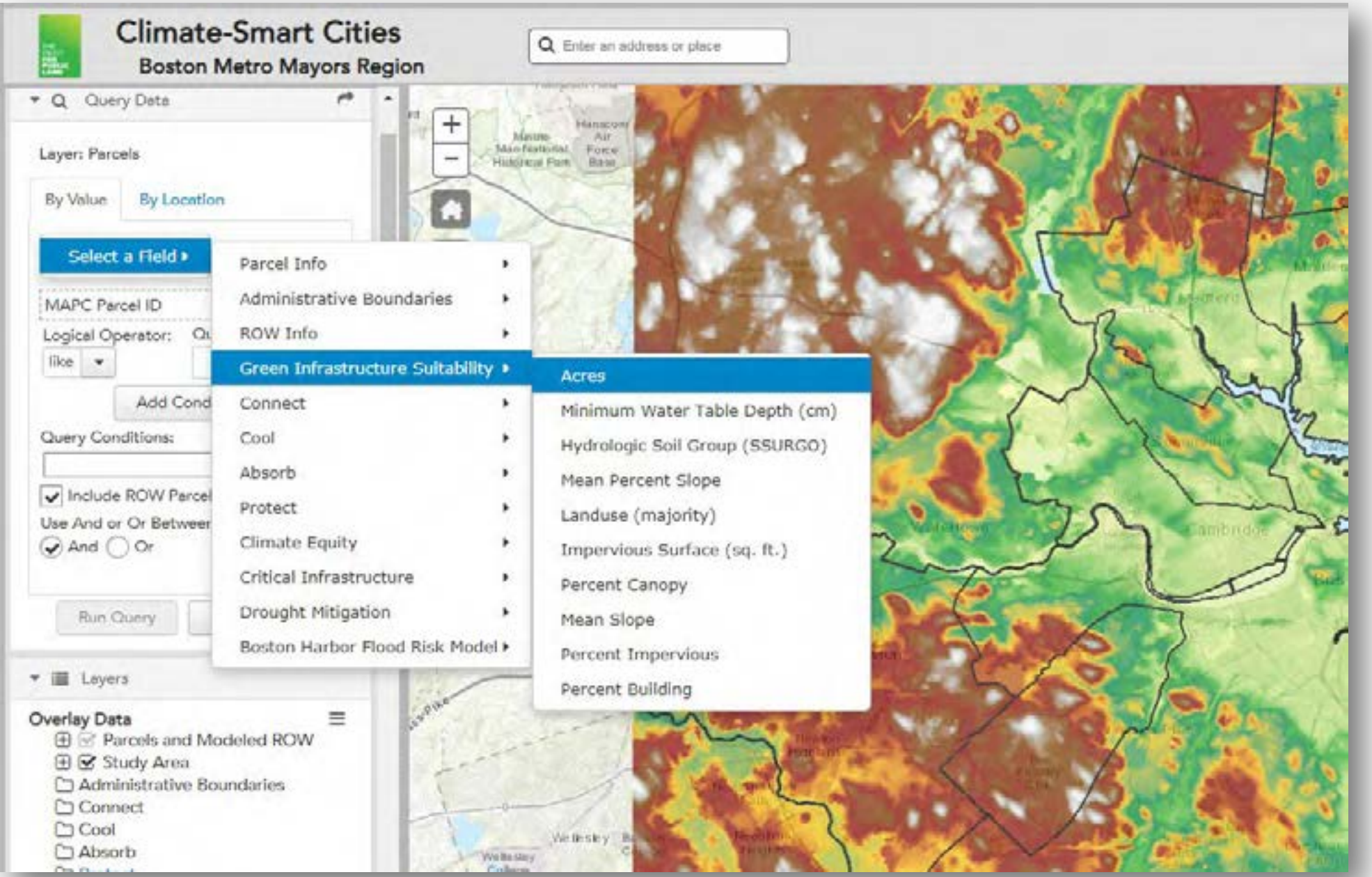

GSI Suitability

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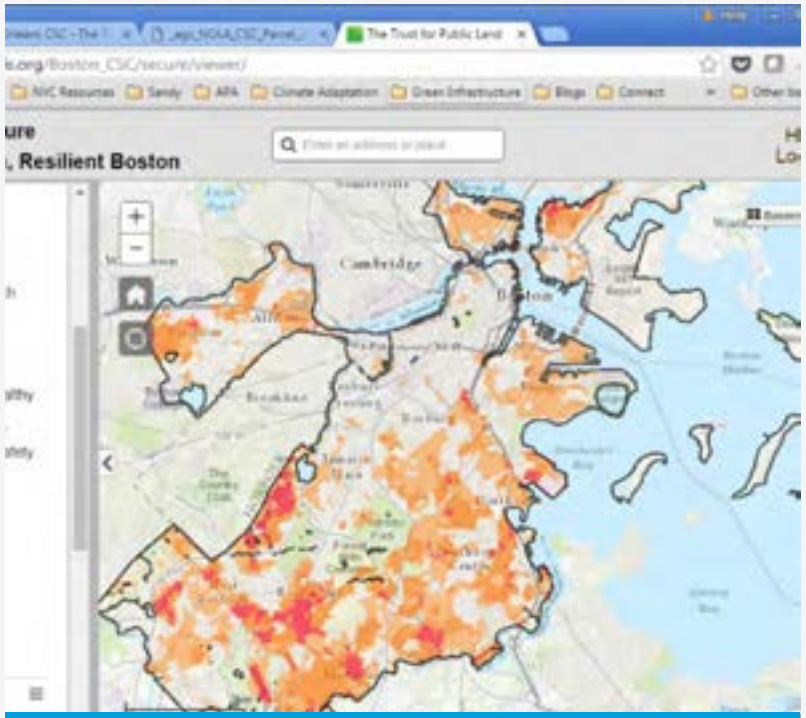
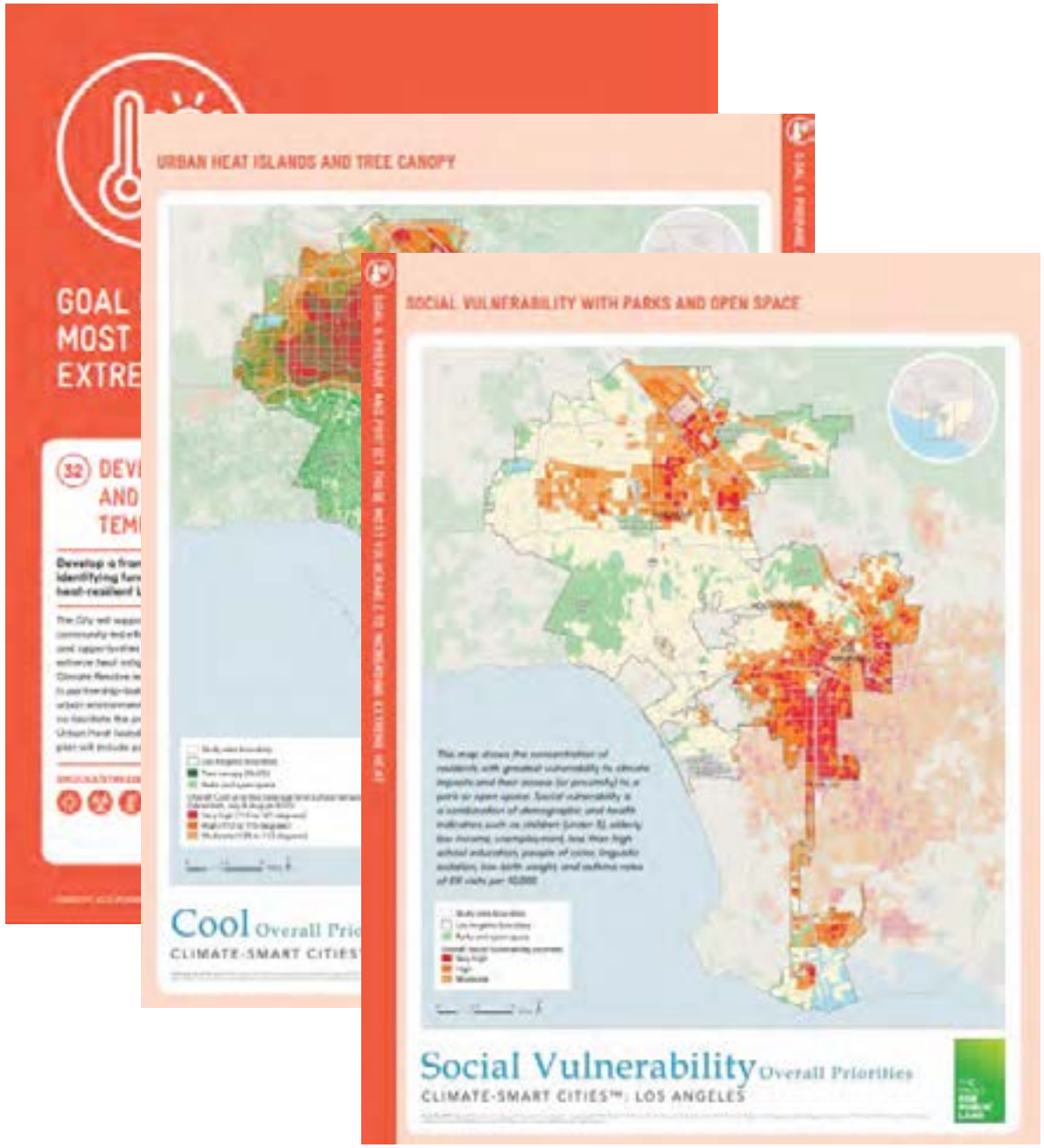
Implementation Case Studies

Exchange & Coalitions



Policy & Planning

Project Development



Resilient Los Angeles

Identifying cooling priorities through a multi-tiered climate equity analysis:

- Daytime hotspots
- Nighttime hotspots
- People of color
- Low-income population
- Asthma
- Population over 64 and under 5
- And more…

Cool Streets LA

Project selection

Courtesy of https://streetsla.lacity.org/cool-la-neighborhoods

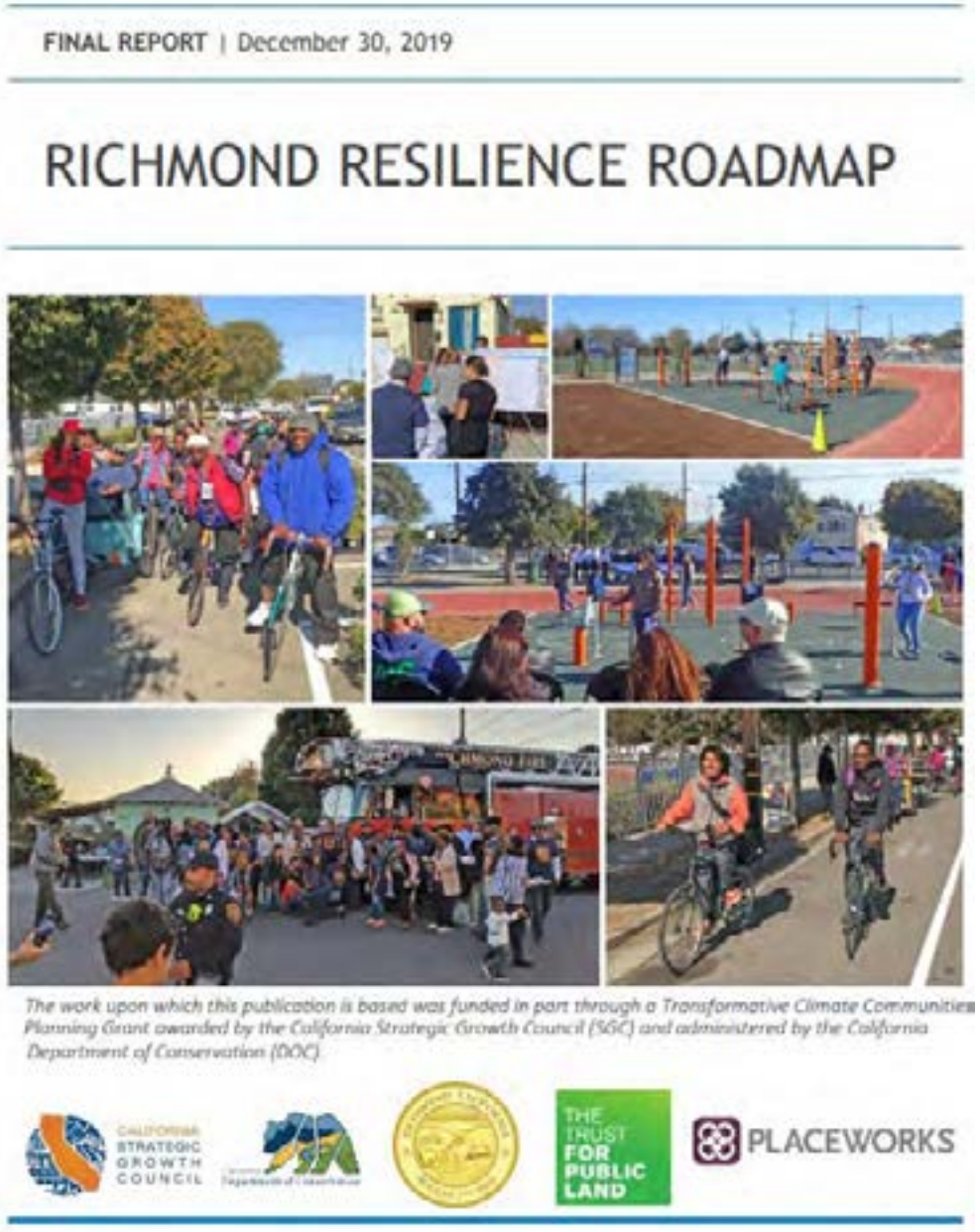
Identified first pilot project location using the Climate Smart Cities Equity and Cool analyses.

LA Metro

Guiding capital investments

Courtesy of WikiMedia Commons:
https://commons.wikimedia.org/wiki/File:LA_Metro_200_bus_stop_on_Alvarado_Street.jpg

Using heat island data combined with other transportation and equity metrics to prioritize cooling retrofits for bus stops.



Richmond, CA Resilience Roadmap

Identifying priority resilience projects through a multi-benefit framework:

- **Connect** neighborhoods
- **Cool** urban heat islands
- **Absorb** stormwater through GSI
- **Protect** against flooding

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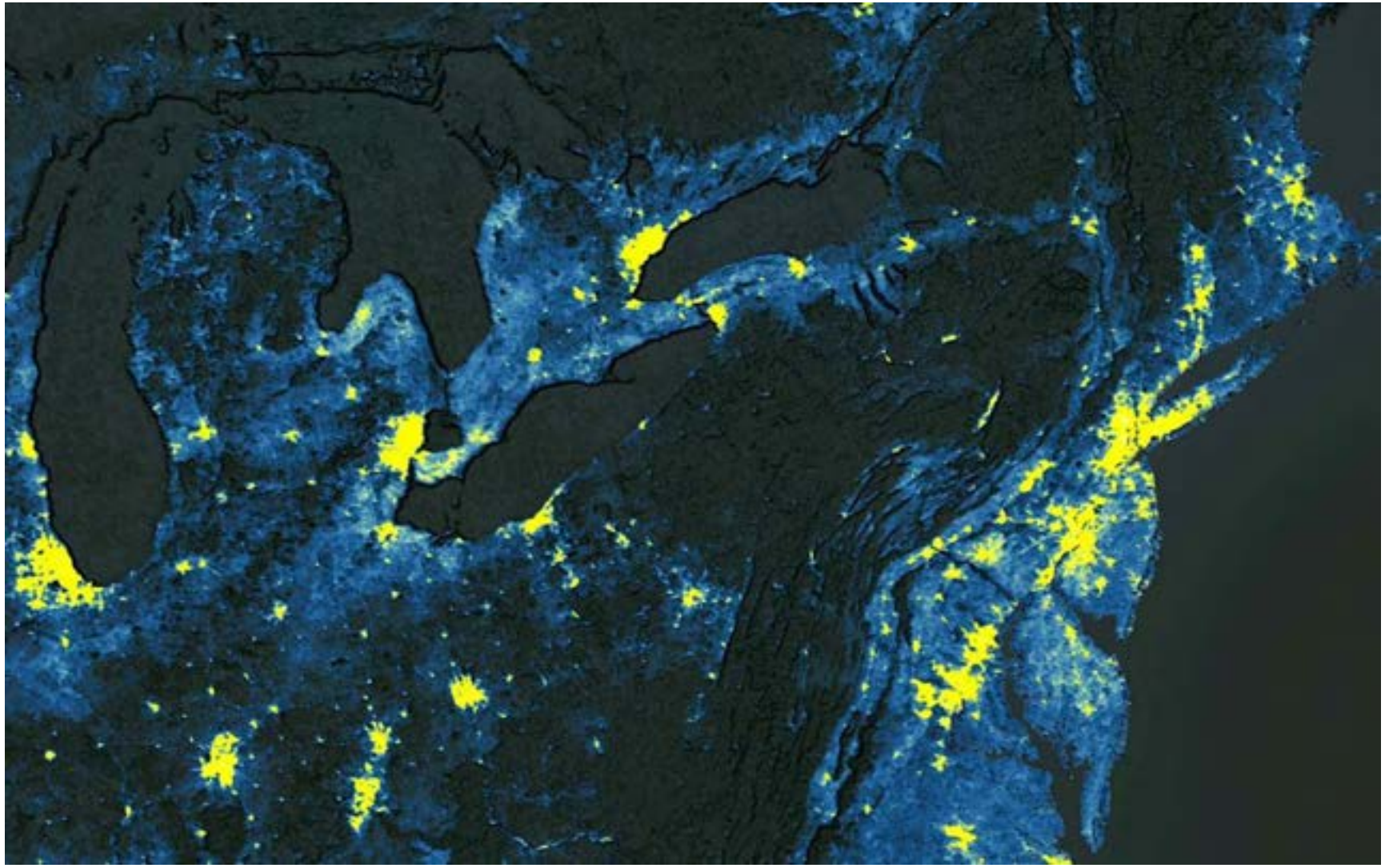
New High-Resolution Urban Heat Data



- 14,000 communities
- 30m resolution
- Now on ESRI Living Atlas
- Search for "*ESRI Urban heat island severity for U.S. cities*"

Descartes Labs

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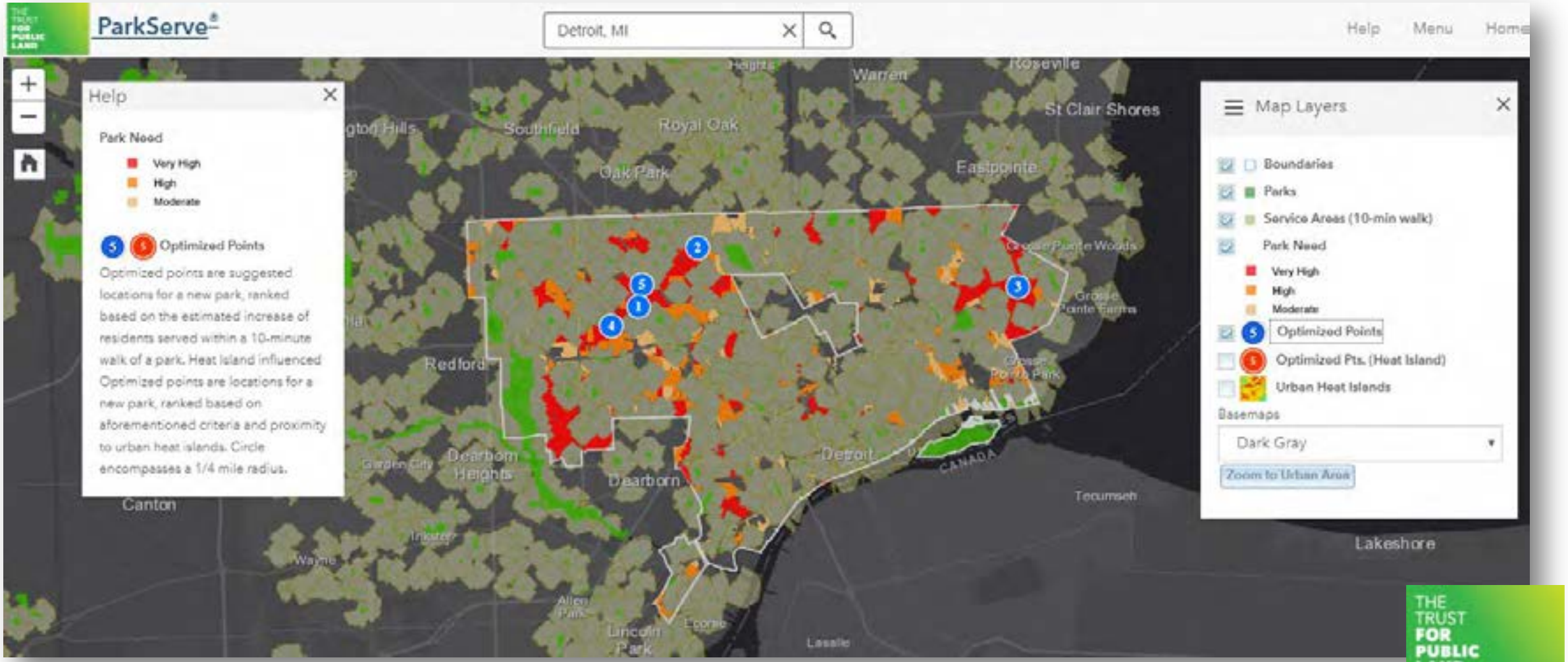
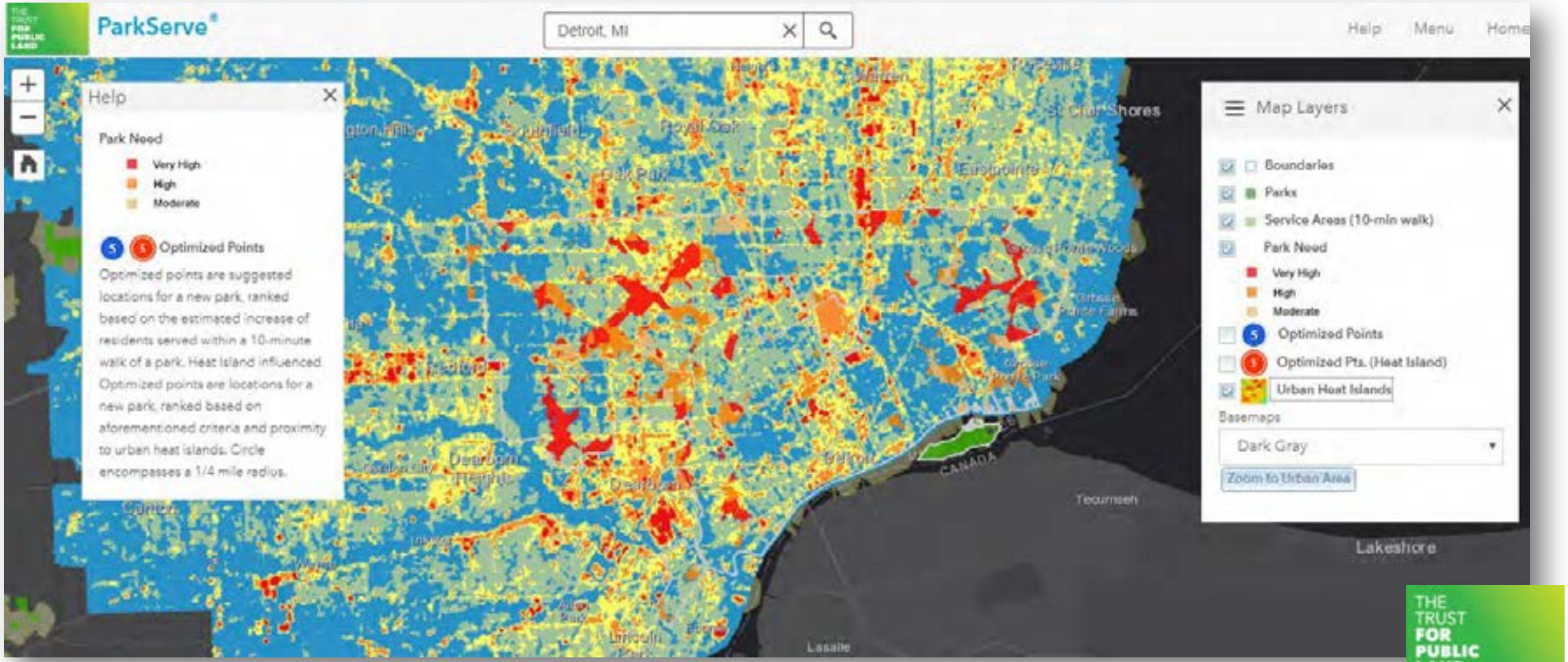
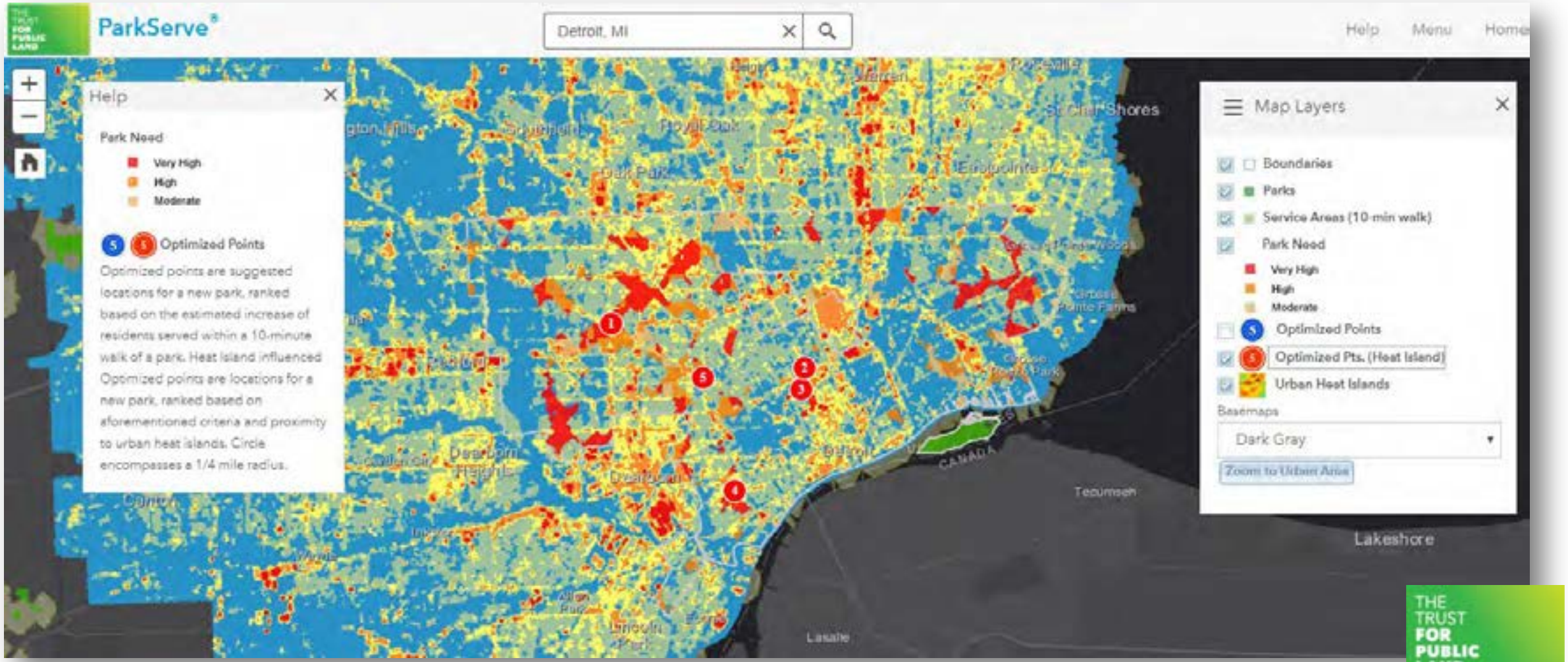
ParkServe platform links park need …



… with urban heat island risk

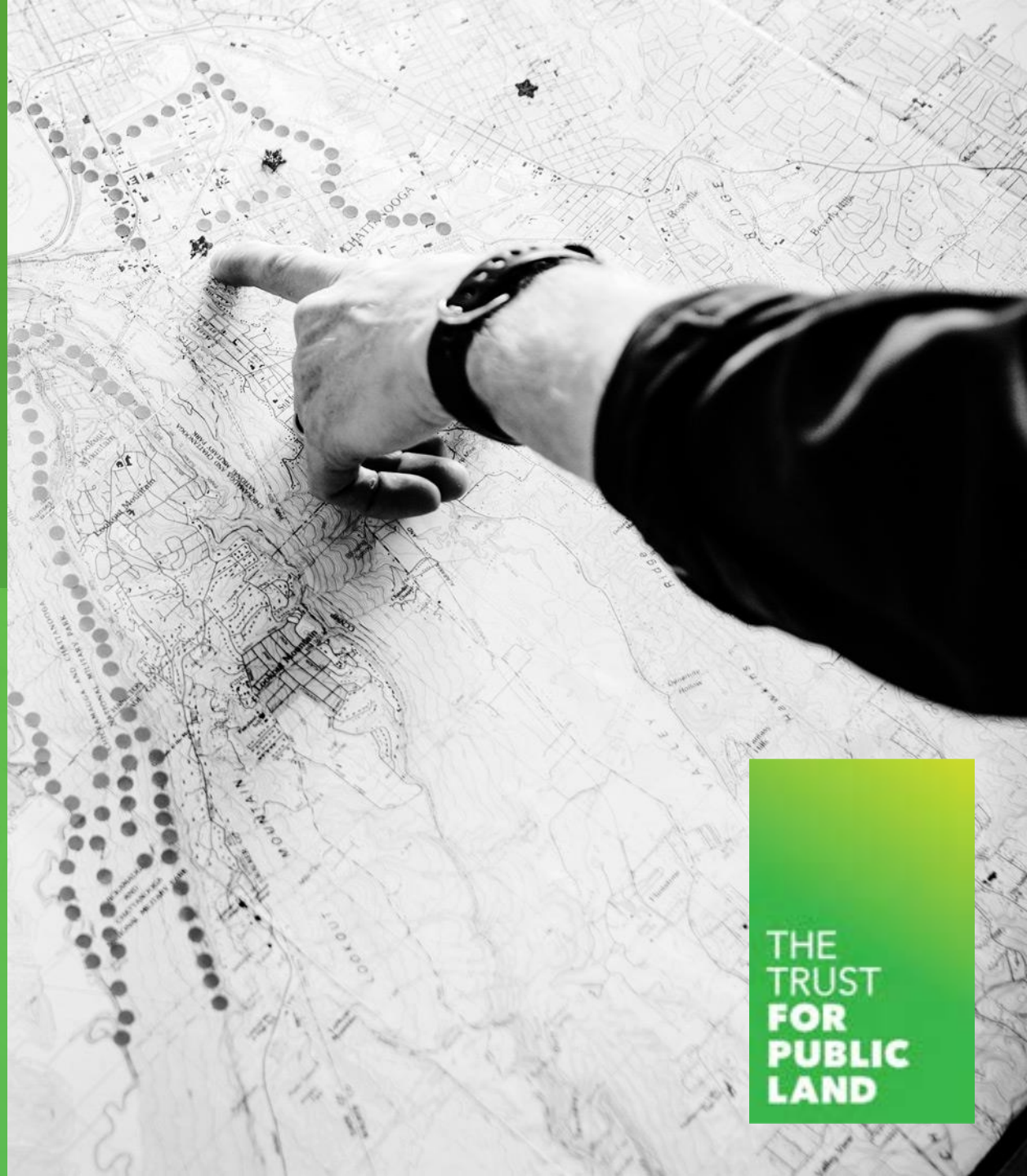


…to identify optimized points for greening



Thank You!

Taj Schottland
Sr. Climate Program Manager
Taj.Schottland@tpl.org



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Up next – 10:15-11:45am PT

SESSION 6.1

Emerging Research on Financial Adaptations to Climate Impacts

SESSION 6.2

Wading into the Economic Impacts of Climate Change on Water

SESSION 6.3

Equitable Adaptation to Climate-Related Flood Risks: Part 2

CLIMATE ADAPTATION
RESEARCH SYMPOSIUM

MEASURING & REDUCING SOCIETAL IMPACTS

Thanks for tuning in!

UCLA Luskin Center for Innovation