EARTH SCIENCE
APPLIED SCIENCES

EARTH SCIENCE APPLICATIONS WEEK 2022

Day 1: Environmental Justice & Urban Development

August 9, 2022

EARTH SCIENCE APPLICATIONS WEEK 2022

WELCOME!

DAY 1 – AUGUST 9th: ENVIRONMENTAL JUSTICE & URBAN DEVELOPMENT

Event Attendance Guidelines

1. Please stay muted with cameras off
2. Post questions for speakers in the chat & they will be answered there

EARTH SCIENCE
APPLIED SCIENCES

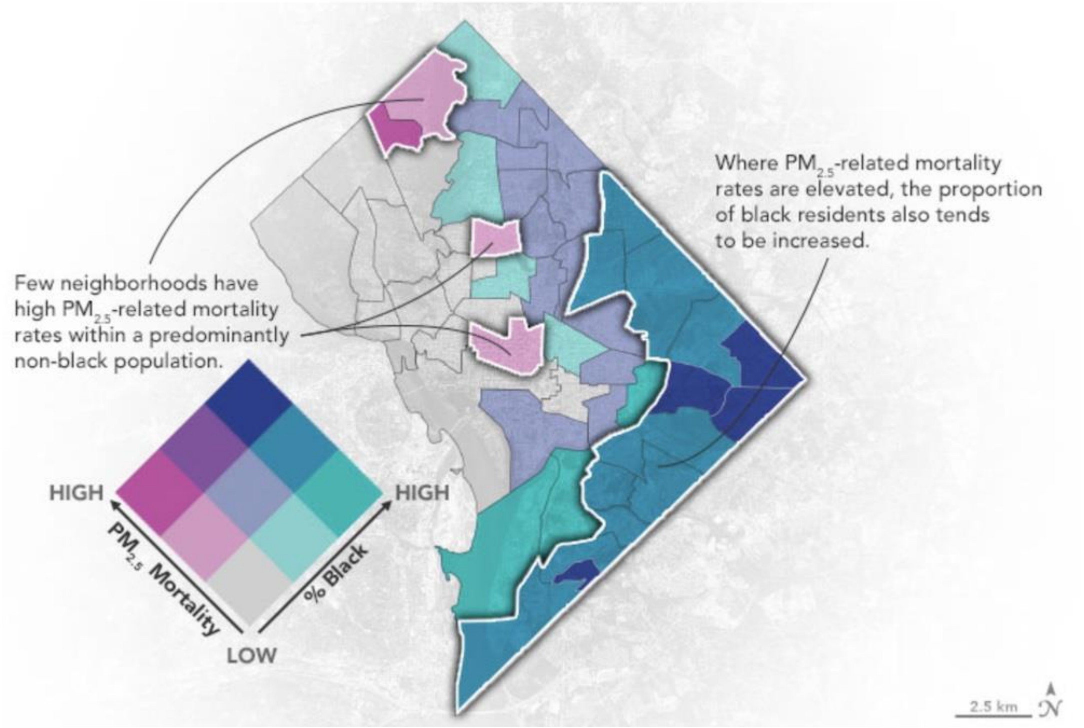
EARTH SCIENCE APPLICATIONS WEEK 2022

Equity and Environmental Justice

Nancy D. Searby, PhD

What is Environmental Justice?

Environmental Justice (EJ) is “the fair treatment and meaningful involvement of **all people** regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of **environmental laws**, regulations and policies.”



Map of Washington, D.C., showing areas that have higher rates of PM2.5-attributable mortality.

Elevated rates of PM2.5-attributed mortality correlate with areas that have a higher proportion of Black residents.

Credit: NASA Earth Observatory.

What can NASA do?

Satellite data can help us uncover environmental injustices

Monitor restoration of electricity in rural Puerto Rico following Hurricane Maria, which found that rural areas were disproportionately impacted by prolonged power outages.

Pair sea surface height with demographic data for Norfolk, Virginia to understand disparities seen by communities of color and lower economic status in negative impacts of **sea level rise.**

Create an application that provides the Navajo Nation with info about water resources to support **increased water accessibility.**

Identify drivers of **extreme urban heat** and generate of a vulnerability index for urban planning in San Diego, California.

Capacity Building for Community Action

Equity and Environmental Justice

Builds connections with communities to advance equity and environmental justice

✓ Emphasis on co-development and equitable engagement

✓ Combines Earth and social sciences

Health & Air Quality

Energy

Urban Canopy & Development

Disasters

Greenspace

Climate and Weather

Food Security

Water Resources and Access

Wildfires

Want to learn more?

Check out these resources!

[Environmental Justice Data Backgrounder]

[Earth Observing Dashboard]

[UNBOUND for EJ]

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EARTH SCIENCE APPLICATIONS FOR SUSTAINABLE DEVELOPMENT GOALS

Argyro Kavvada, Ph.D.

August 9, 2022 @EO4SDG

TOWARDS INTEGRATED MONITORING FRAMEWORKS

5 Main Areas

17 Goals

169 Targets

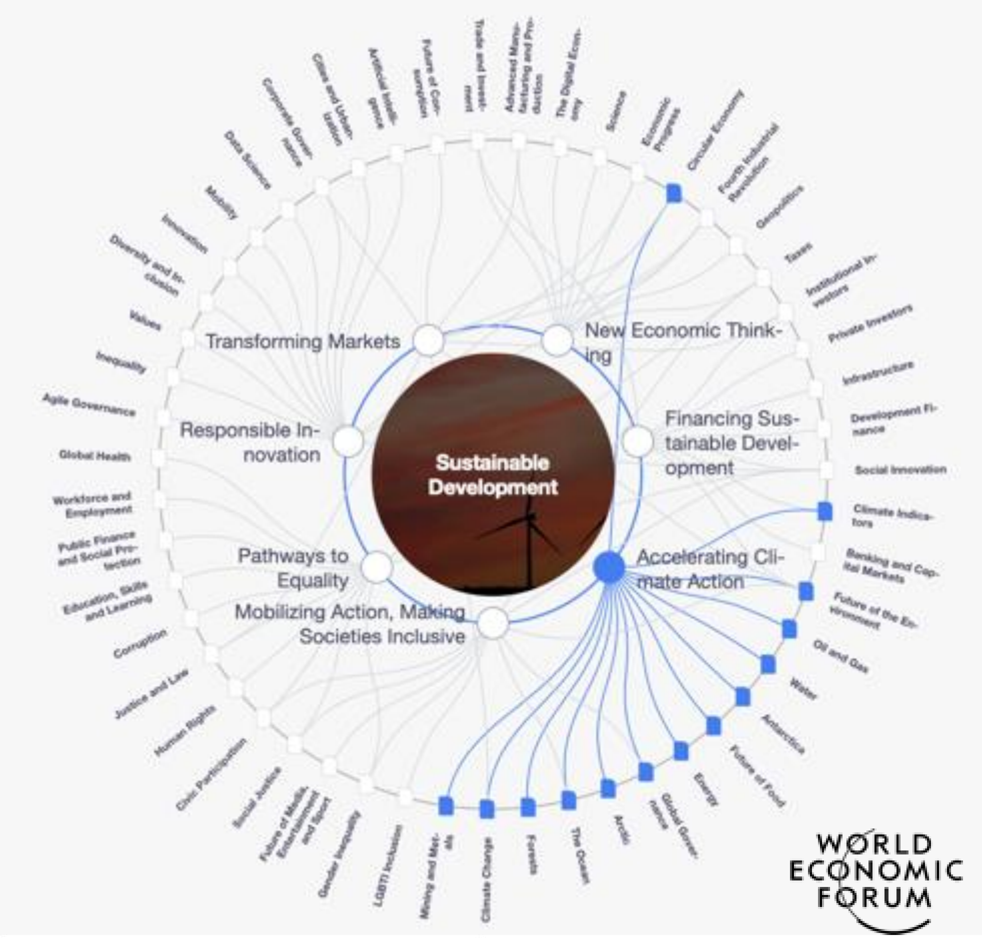
231 Indicators

https://sdgs.un.org/goals

https://unstats.un.org/sdgs/indicators/indicators-list/

NUA

UNITED NATIONS PARIS CLIMATE AGREEMENT SIGNING CEREMONY 22 APRIL 2016



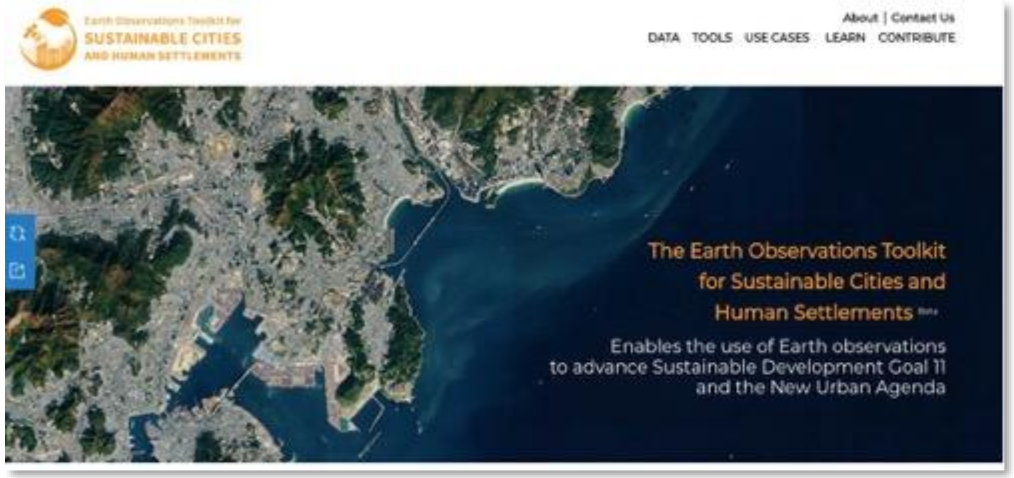
WORLD ECONOMIC FORUM

UN World Conference on Disaster Risk Reduction
2015 Sendai Japan

Convention on Biological Diversity

Earth Observations Informing Human Settlements Monitoring and Resilience Planning

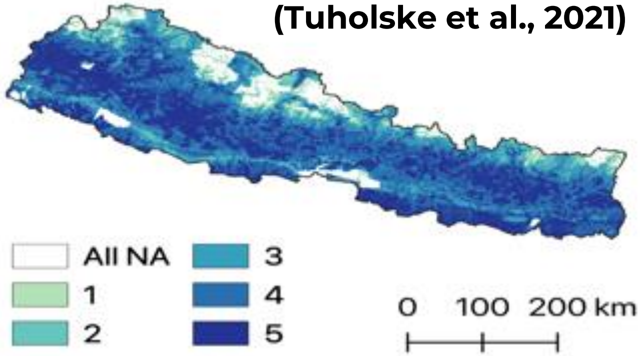
Cities and communities around the world face numerous environmental hazards— e.g., extreme heat events, landslides, pollution, flooding— that they must monitor and address to enhance resilience of their residents to pressing challenges including climate change impacts. Earth observations provide significant cost and time saving in policy areas that are important to delivering successful and sustainable cities.



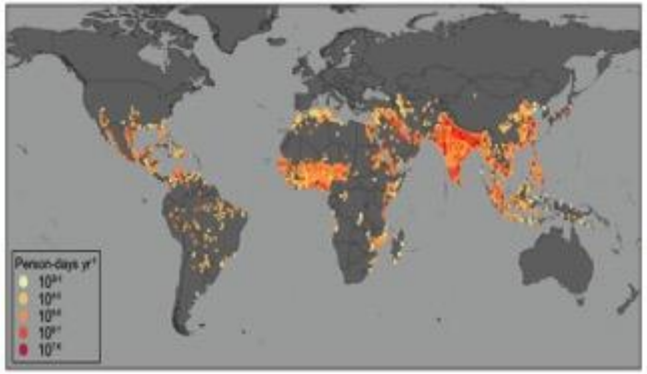
Land use and urban planning • Access to Transportation • Adequate Housing• Open Public Spaces • Disaster Risk Management • Air Quality • Sustainable resource management • Intern. frameworks for development and sustainability

https://eotoolkit.unhabitat.org

PopGrid-Compare (Tuholske et al., 2021)



Urban Heat Exposure (Daily), 1983-2016

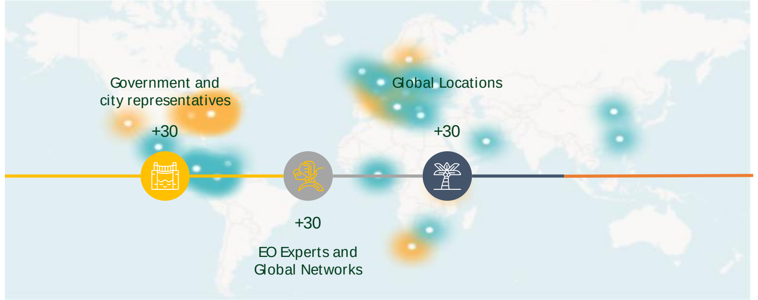


<u>Example data set:</u> POPGRID-Compare allows users to produce range estimates of population exposure to hazards.

Earth observations toolkit for sustainable cities and human settlements

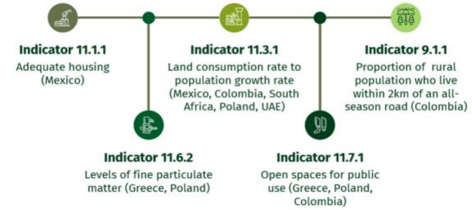
- **Builds on SDG 11 but** addresses a wider range of urbanization and human settlements issues.
- **Places emphasis on the need to develop capacity of local authorities** and other local actors for NUA and SDG implementation at the urban local level.
- **Promotes FAIR-ness, contextualization and re-usability of EO resources** and links to the GEO Knowledge Hub.
- **Shares guidance on EO data and tools** (national, subnational and city experiences)
- **Aims to become a global reference point** and "go to" place for city to city and country to country learning.

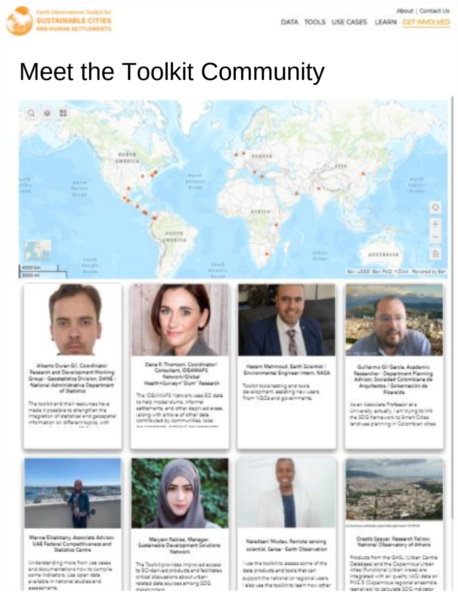
Urban Toolkit - Strengthening Capacity



4 Working Groups

Country & City-Level Use Cases

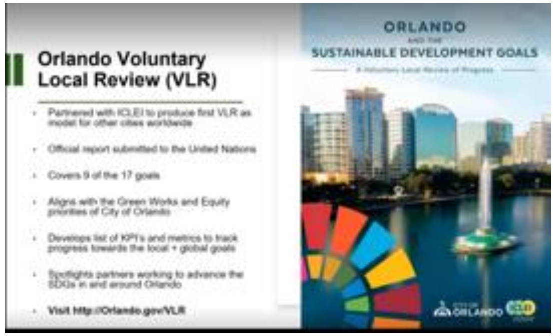




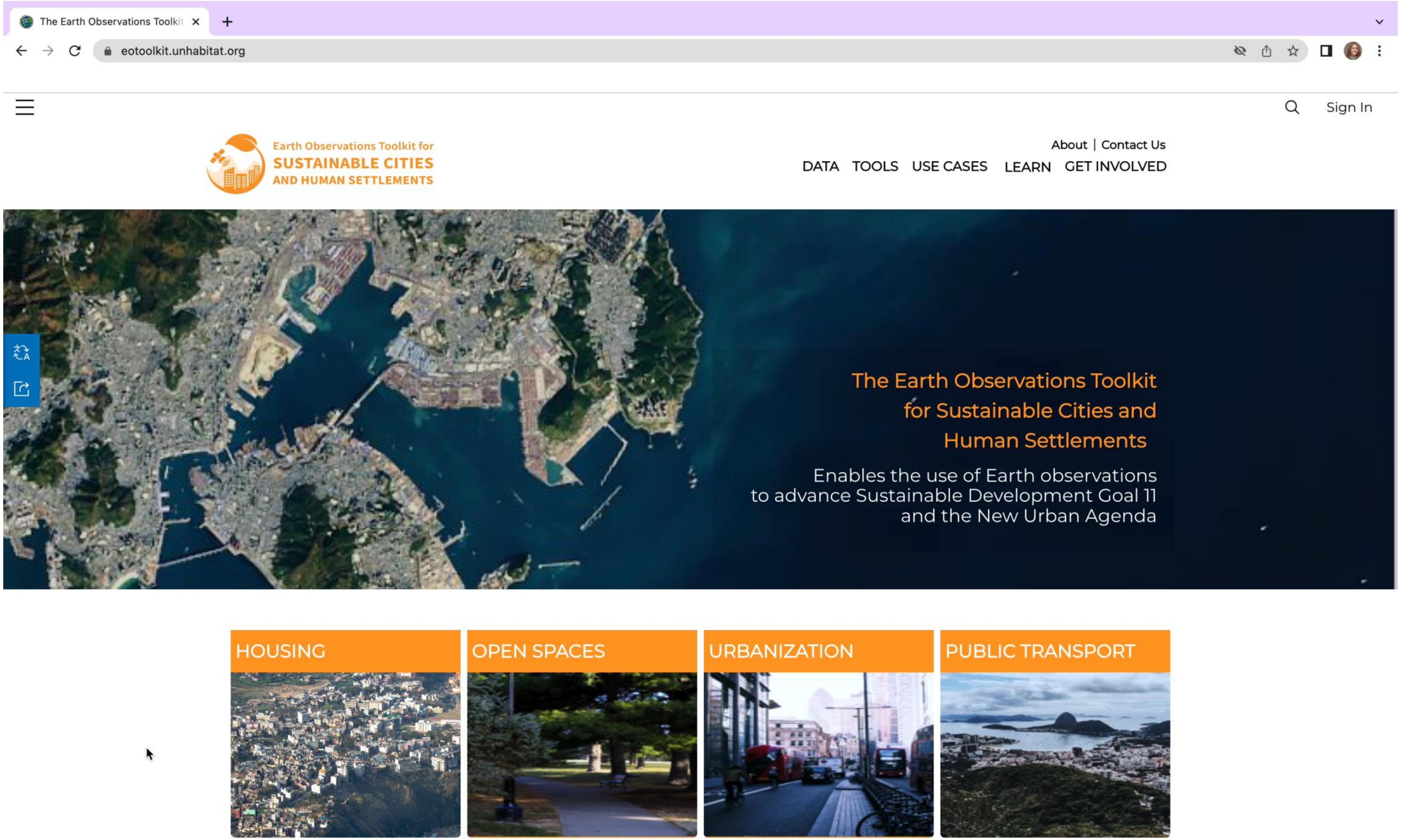
https://eotoolkit.unhabitat.org

- Hands-on Trainings
- Webinars
- Listening Sessions
- Earth Scientists<>Local Government Pairings

Individual links to download SDG 11 indicator one-pagers can be found here.

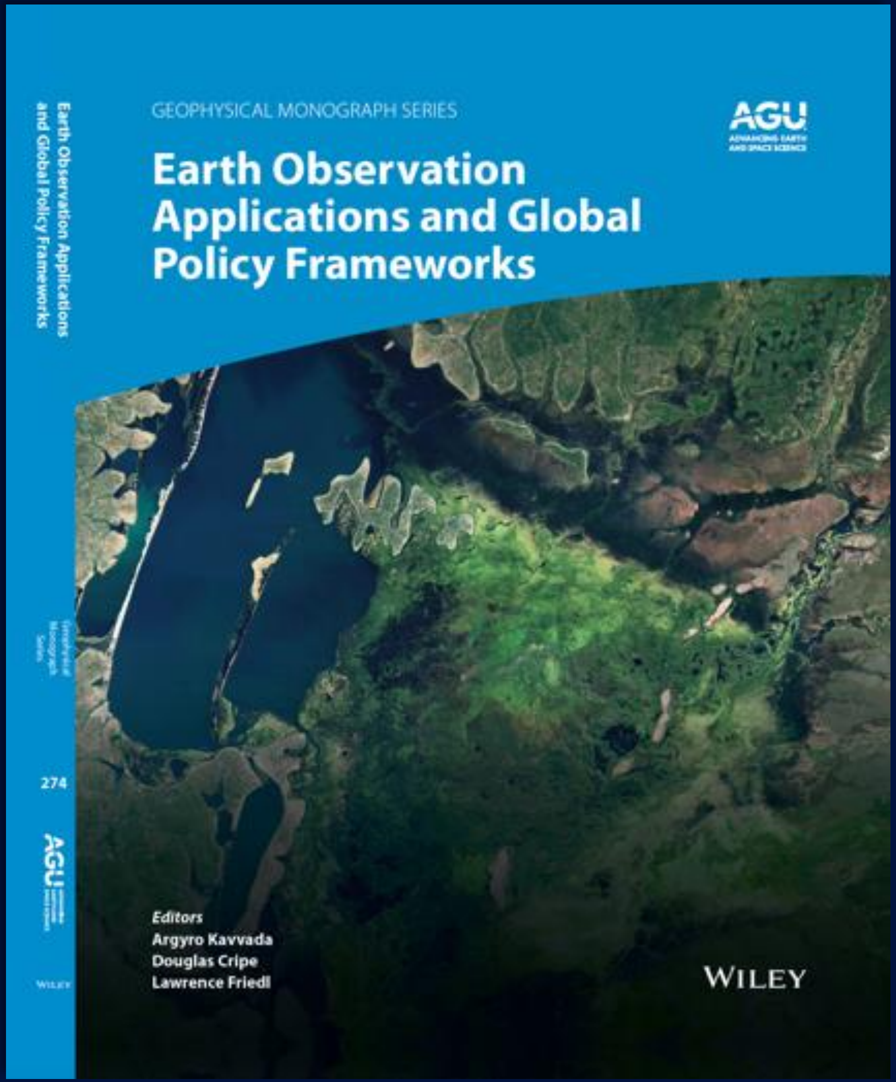


eotoolkit.unhabitat.org



NEW BOOK PUBLICATION

- ✓ Examples of internationally coordinated initiatives driving progress on UN Sustainability Agreements.
- ✓ Applications from diverse disciplines: wetland preservation, food security, water quality, marine conservation, disasters, urbanization, drought, land degradation, greenhouse gas monitoring.
- ✓ Case studies of projects engaging with a broad range of user communities, fostering their skills and capacity & co-designing practical applications to benefit the economy, society and the environment.
- ✓ Over 30 international contributors



https://www.wiley.com/en-us/Earth+Observation+Applications+and+Global+Policy+Frameworks-p-9781119536765

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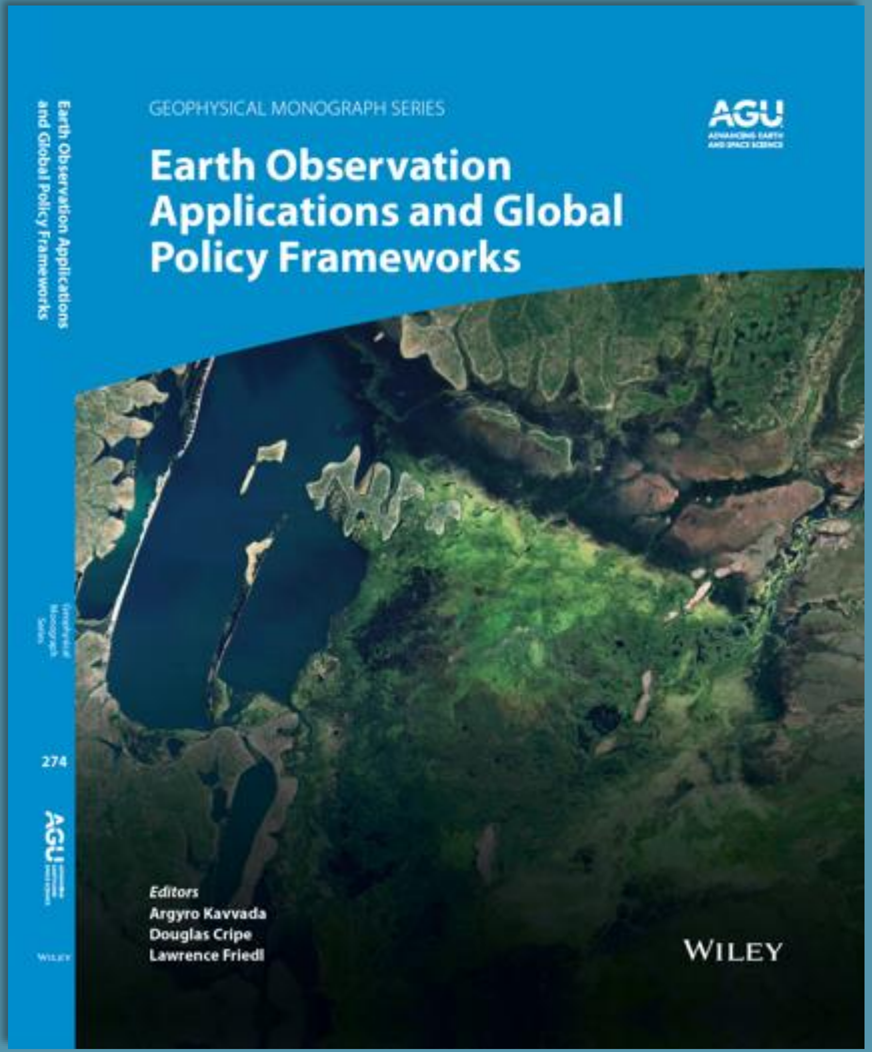

September 2022

Link

Thank you

Argyro.Kavvada@nasa.gov
August 9, 2022

@EO4SDG

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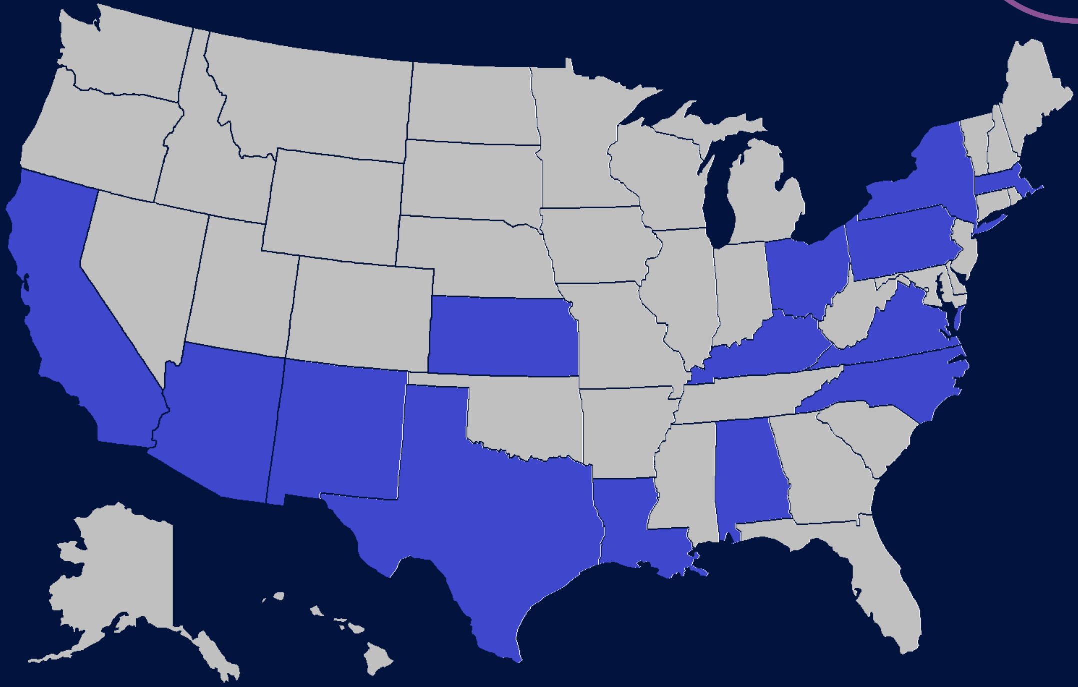
APPLICATIONS WEEK 2022

Environmental Justice @ DEVELOP

- 10-week feasibility studies that apply Earth observations to inform decision making
- Conducted 20+ projects in the past 5 years collaborating with non-profits and local governments
- Identify how Earth observations and socioeconomic data can be combined to better understand the inequities and injustices that some communities face and support informed decision making and action to address them
- **Project themes:** extreme heat & urban heat island effects, urban tree canopy coverage, urban flooding, and landslide risk



DEVELOP EJ Projects in 14 States

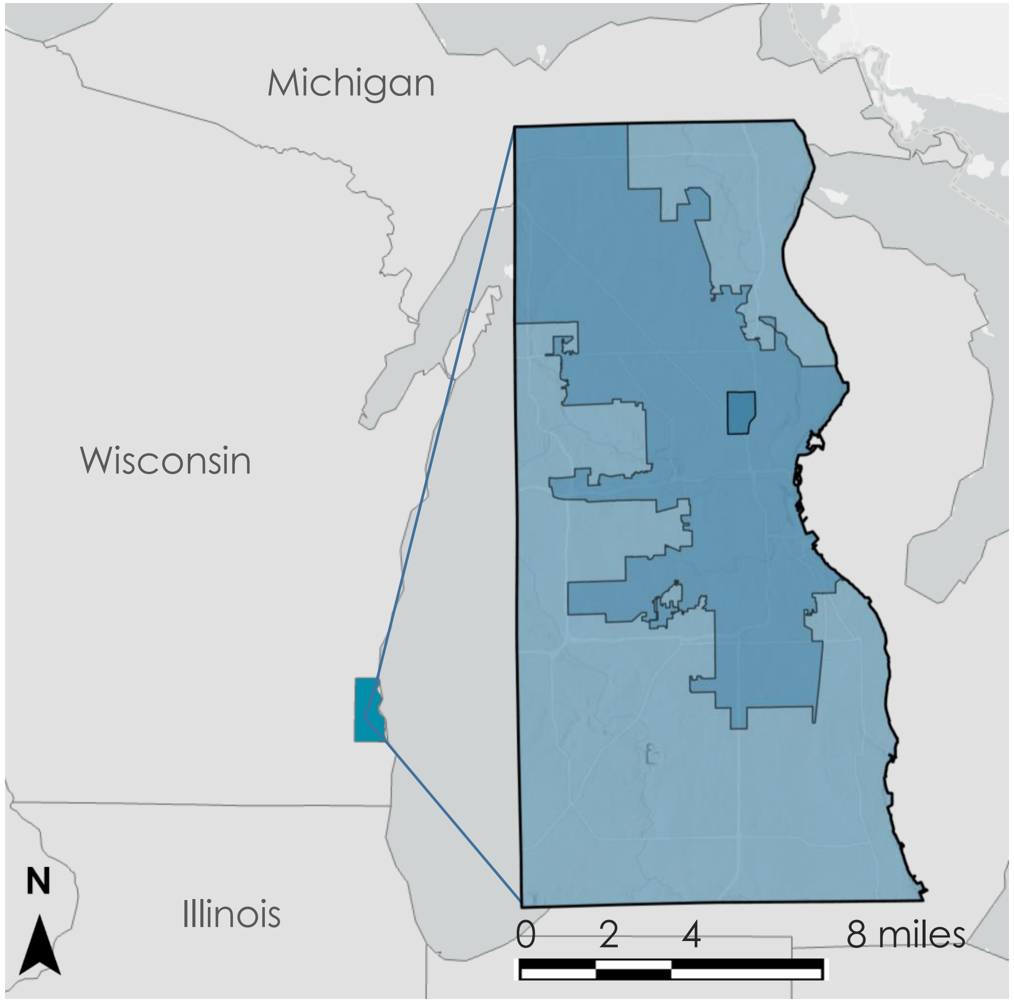
Milwaukee Urban Development

Assessing the Drivers of Urban Flood Vulnerability in Milwaukee using the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) Urban Flood Risk Mitigation Model

TEAM: Jack Acomb, Annika Harrington, Lisa Sun, Madeleine Tango

ADVISORS: Dr. Kenton Ross, Lauren Childs-Gleason

STUDY AREA AND PERIOD



Milwaukee County, WI

- Lindsay Heights
- City of Milwaukee
- Milwaukee County

January 1
2010

July 22, 2010
5.6 inches / 142 mm

April 9, 2015
3.2 inches / 81 mm

August 2, 2020
4.8 inches / 122 mm

December 31
2020

METHODOLOGY: InVEST MODEL

INPUTS

- Rainfall Depth *(IMERG & NWS)*
- Land Cover *(NLCD)*
- Hydrological Soil Type *(gNATSGO)*
- Area Polygons *(Census Block Groups)*
- Building Footprints *(County LiDAR)*
- Damage Loss Table *(FEMA HAZUS)*

MODEL

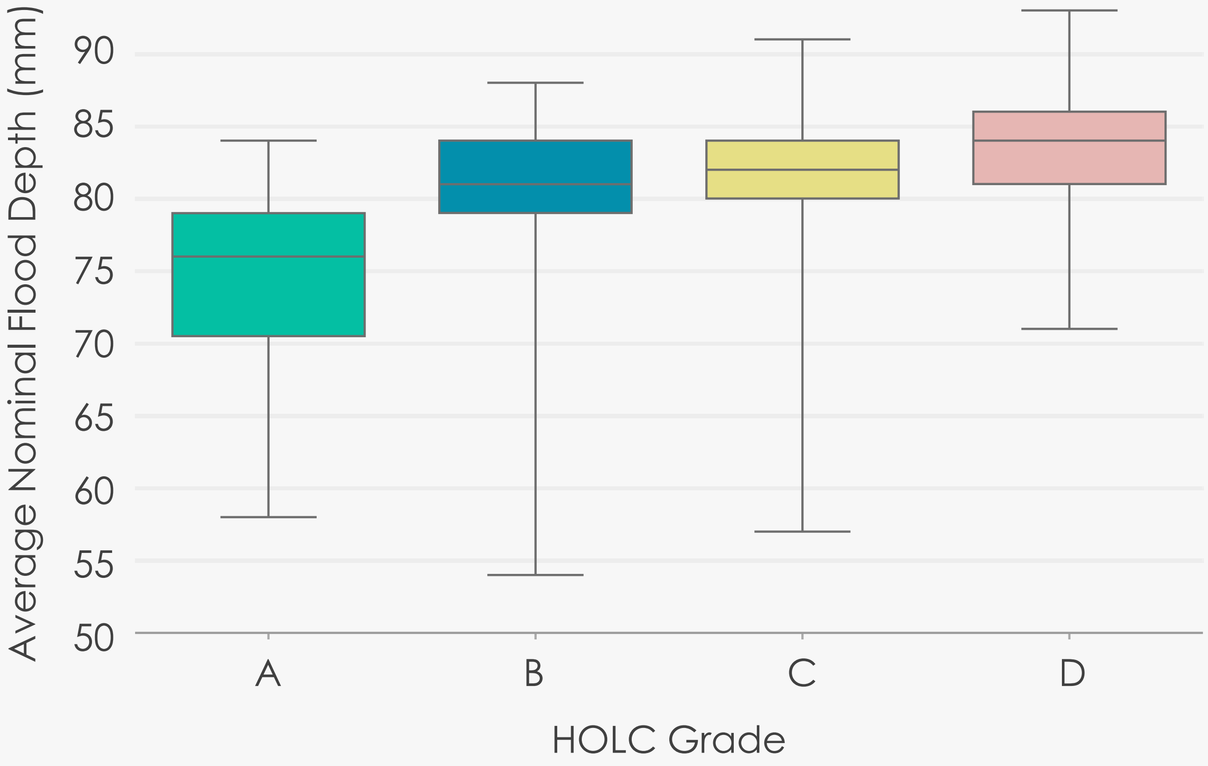
- *Physical*
- *Economic*

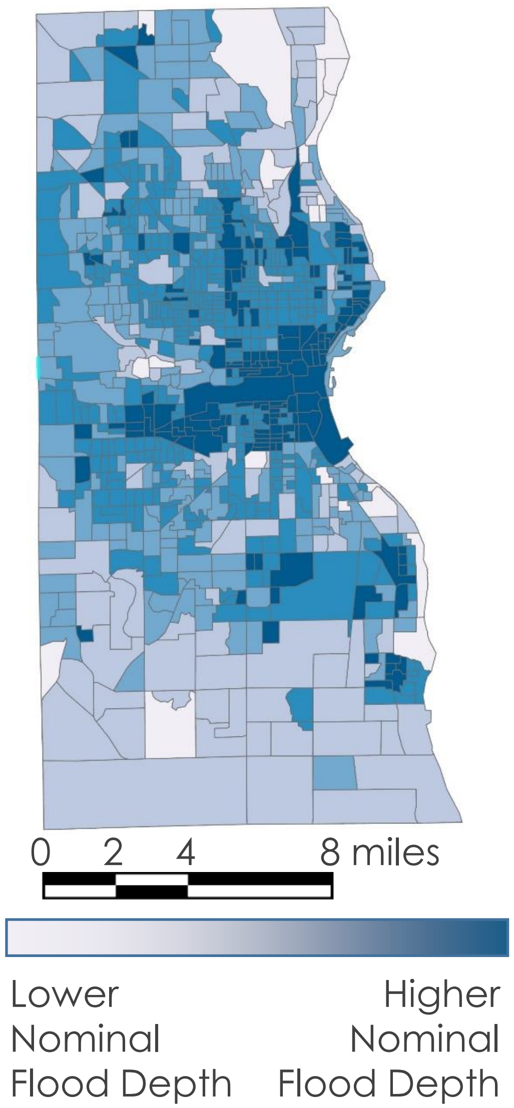
OUTPUTS

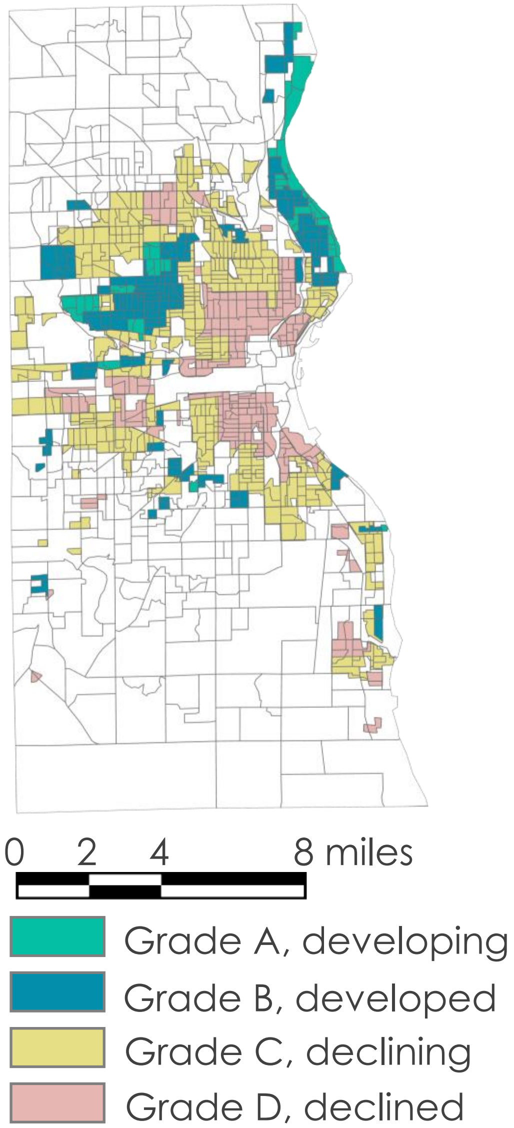
- Runoff Retention Percentage
- Nominal Flood Depth
- Potential Damage in Dollars
- Avoided Damage in Dollars

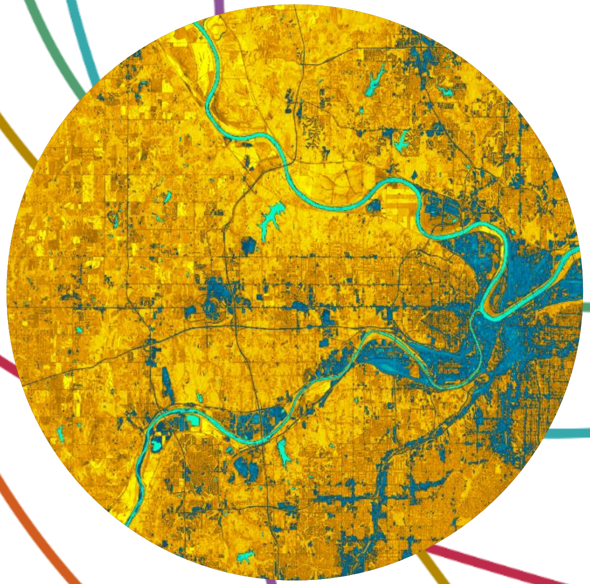
RESULTS: HISTORIC REDLINING

Historically redlined neighborhoods are associated with higher flood depths.









Kansas City Disasters

Assessing Environmental and Socioeconomic Factors of Urban Flood Vulnerability in Kansas City, Kansas

TEAM: Hadwynne Gross, M. René Castillo, Eric Sjöstedt, Raychell Velez

ADVISORS: Dr. Kenton Ross, Tyler Pantle (Fellow)

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COMMUNITY CONCERNS & PROJECT PARTNERS

Kansas City experiences exposure of raw sewage and excessive flooding due to **overwhelmed combined sewer systems**.

Neighborhoods affected by disinvestment and historical redlining face higher levels of **social vulnerability**.

Local communities lack access to resources needed to provide financial and temporal insight for urban flood mitigation.

Groundwork USA

Jalisa Gilmore
Lawrence Hoffman

Groundwork Northeast Revitalization Group

Ben Carpenter
Rev. Adrianne Showalter-Matlock

EARTH OBSERVATIONS & METHODOLOGY

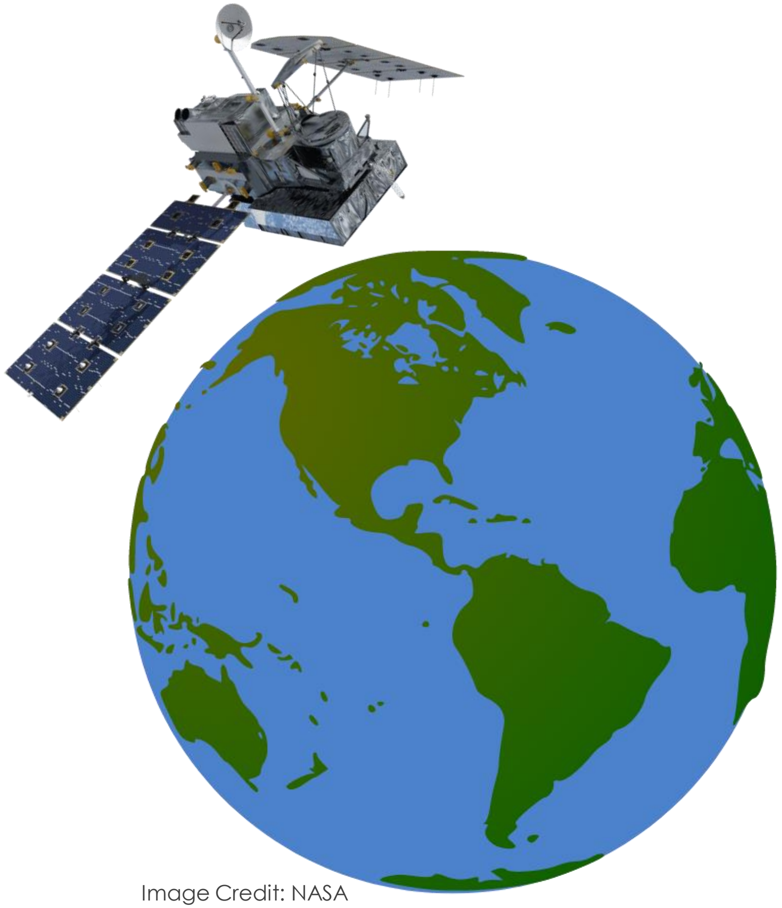


Image Credit: NASA

Global Precipitation Measurement
Integrated Multi-satellitE
Retrievals (GPM IMERG)

INPUTS

- Precipitation Data
- Land Use and Land Cover
- Soil Hydrologic Groups
- Ancillary Datasets

INVEST URBAN FLOOD RISK MITIGATION MODEL

- Surface Runoff (mm)
- Runoff Retention (m3)
- Potential Economic Damage

ENVIRONMENTAL JUSTICE ANALYSIS

- Low Income
- Minority
- No High School Diploma
- Over Age 65

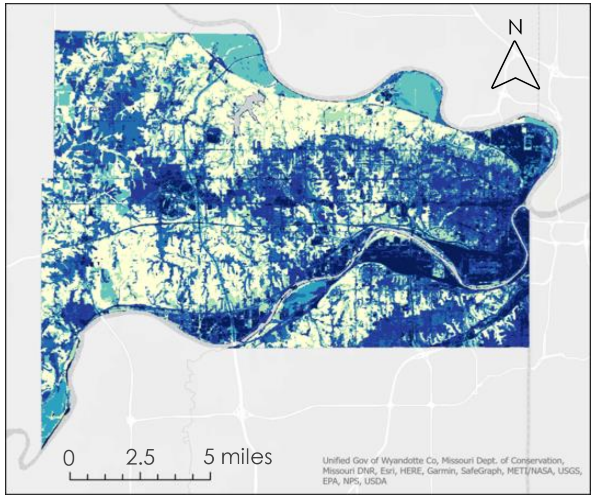
RESULTS

Special thanks to Tyler Pantle (Fellow), Celeste Gambino (Senior Fellow), and Dr. Kenton Ross (Science Advisor) for all their help with this project.

InVEST Outputs

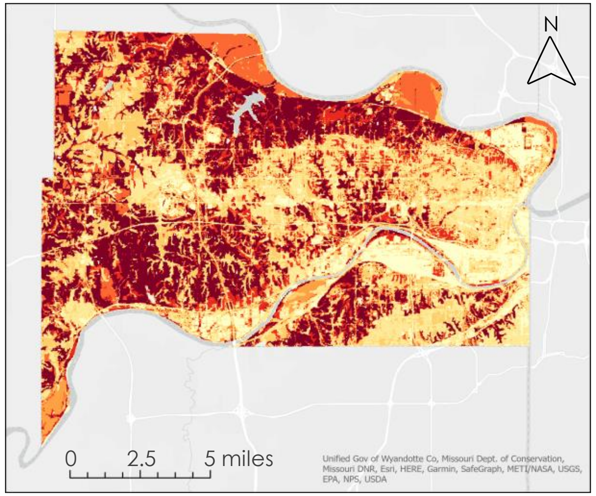
Surface Runoff (mm)

- 0 – 14
- 14 – 29
- 29 – 44
- 44 – 58
- 58 – 73
- 73 – 88
- 88 – 102
- 102 – 117

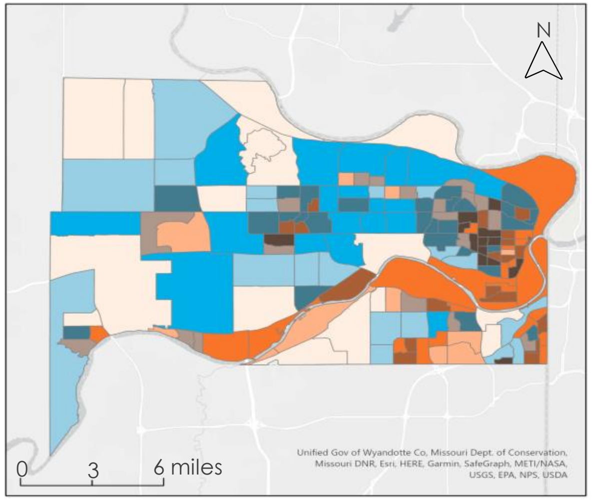


Runoff Retention (m^3)

- 0 – 13
- 13 – 26
- 26 – 39
- 39 – 52
- 52 – 65
- 65 – 79
- 79 – 92
- 92 – 105

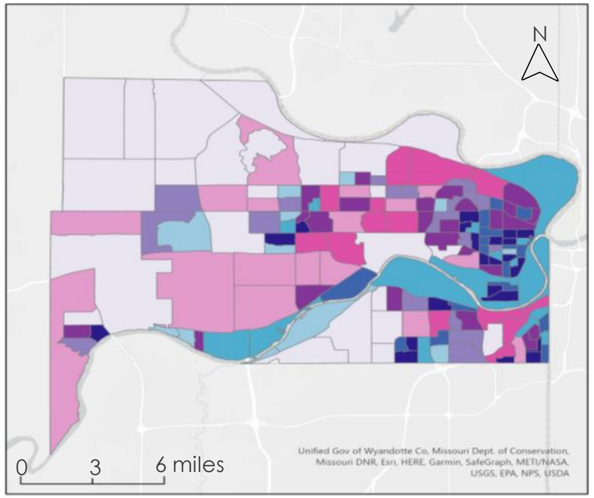


Environmental Justice



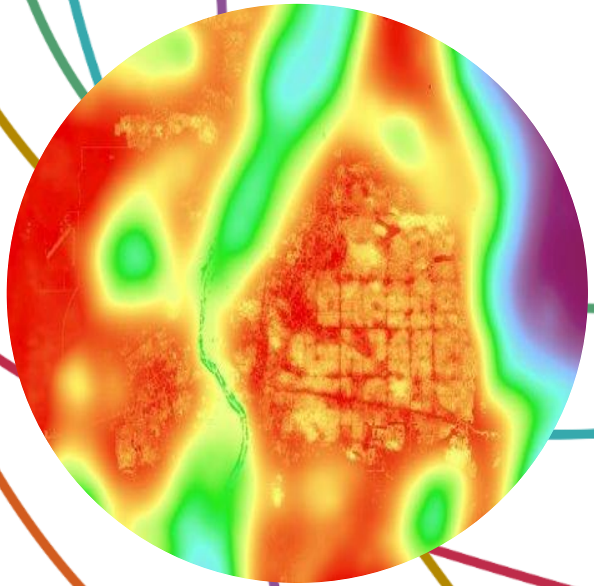
Minority

High
Non-White Population
Low
High
Runoff Value



Low Income

High
Population with Income Below $50,000
Low
High
Runoff Value



Albuquerque Urban Development

Enhancing Urban Cooling Interventions by Modeling Urban Forestry through NASA Earth Observations in Albuquerque, New Mexico

TEAM: Ritisha Ghosh, Robert Stewart, Christina Dennis, Richard Kirschner, Steven Nystrom

ADVISORS: Dr. David Hondula, Dr. Kenton Ross, Ryan Hammock

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Background: Urban Heat Islands & Green Infrastructure

Project Partners:

City of Albuquerque
Dept. of Parks and Recreation

City of Albuquerque
Dept. of Environmental Health

Let's Plant Albuquerque

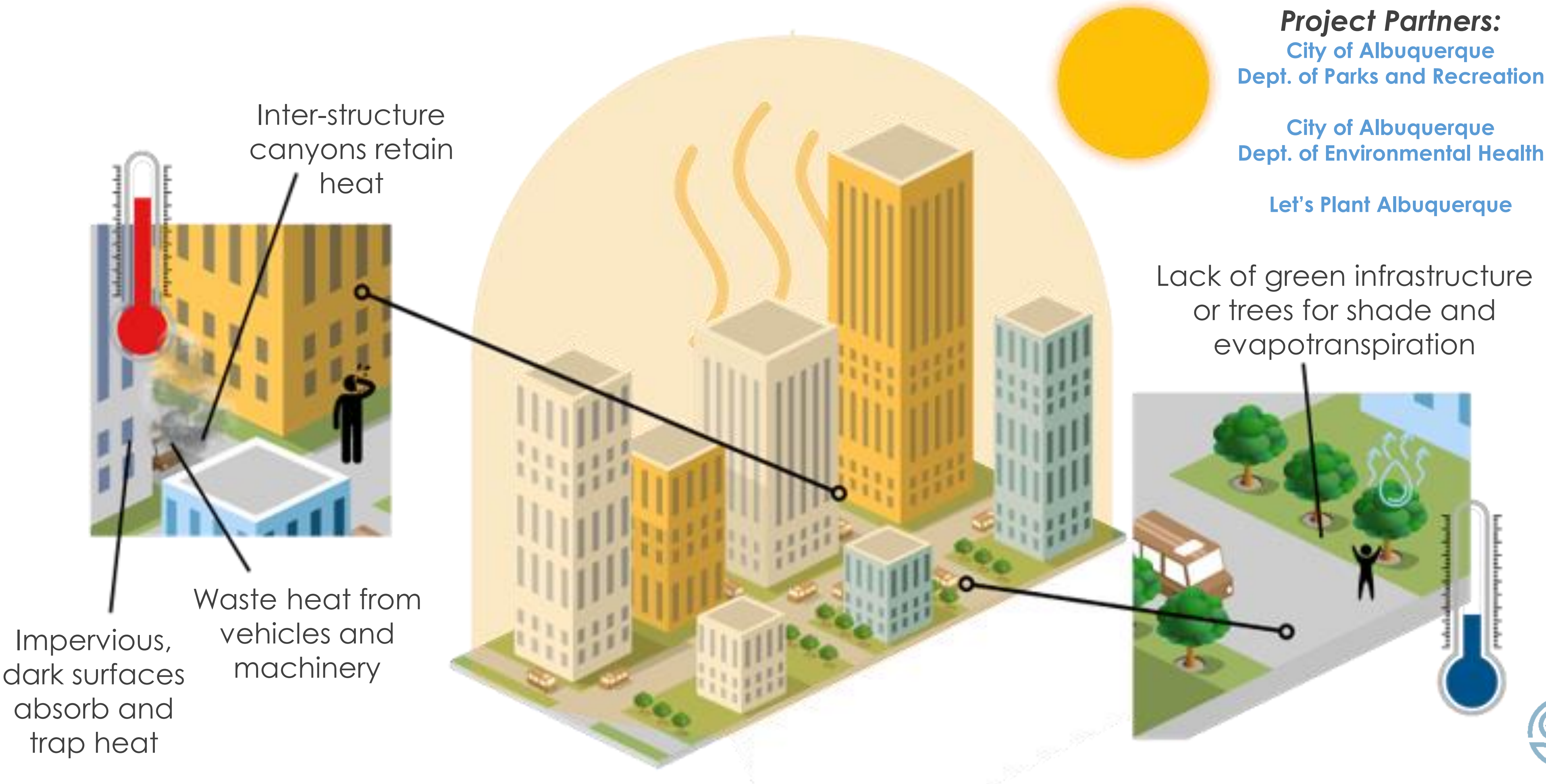
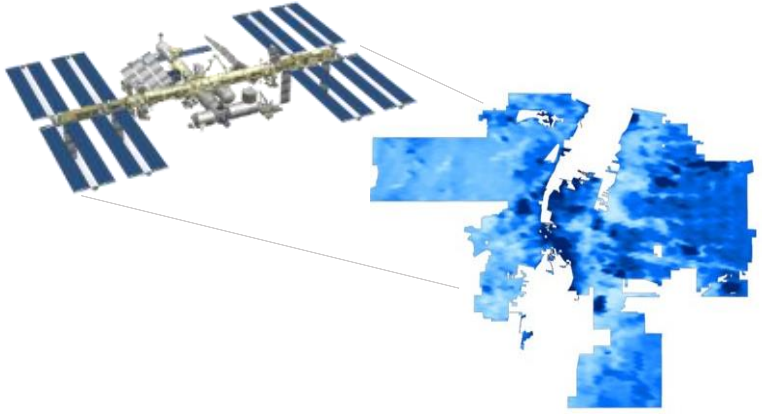
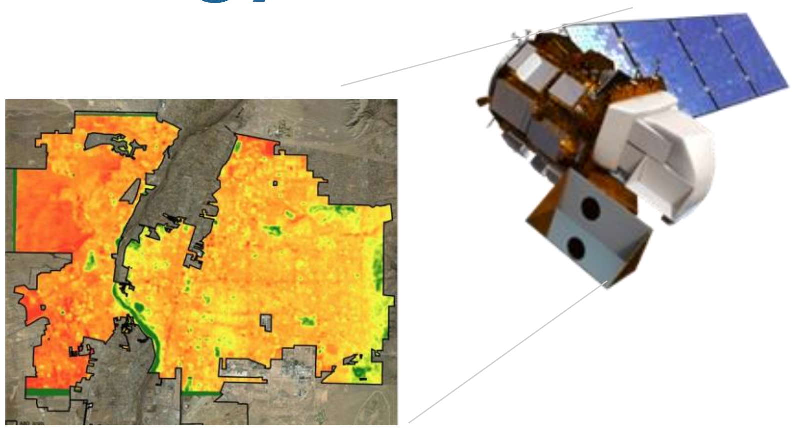


Image Credit: Created on © Canva, Elements from Skechtify, Alexel, Pesky, Viktor Morozuk, Leremy Gan, gstudioimagen, and vectorwin

Methodology

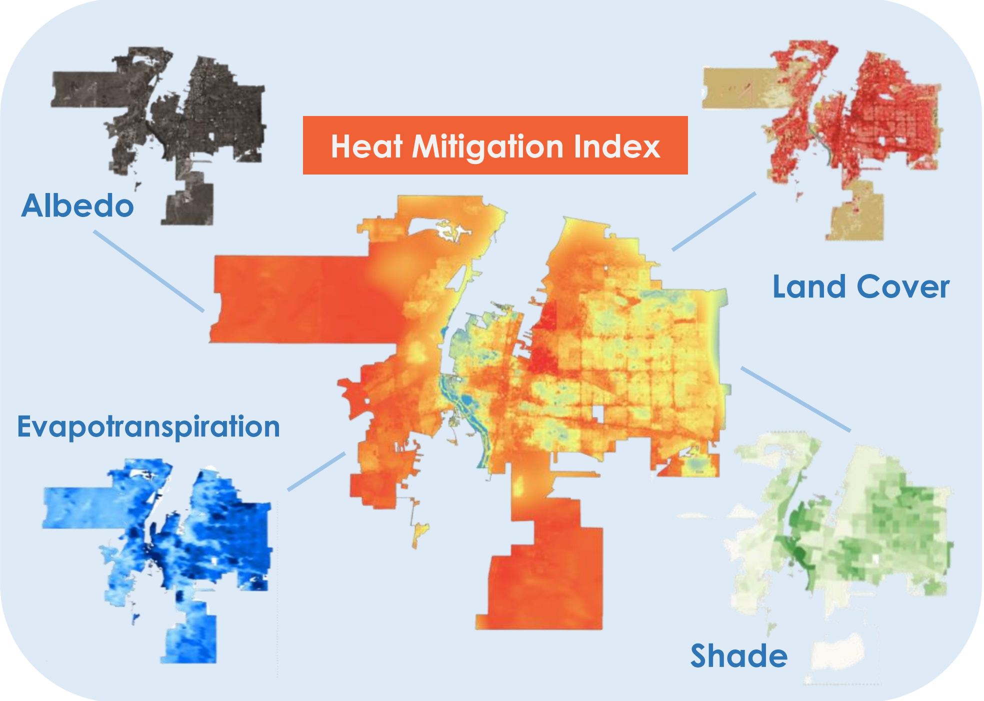


ISS: ECOSTRESS
70 meter resolution, temporal revisitation 1-7 days

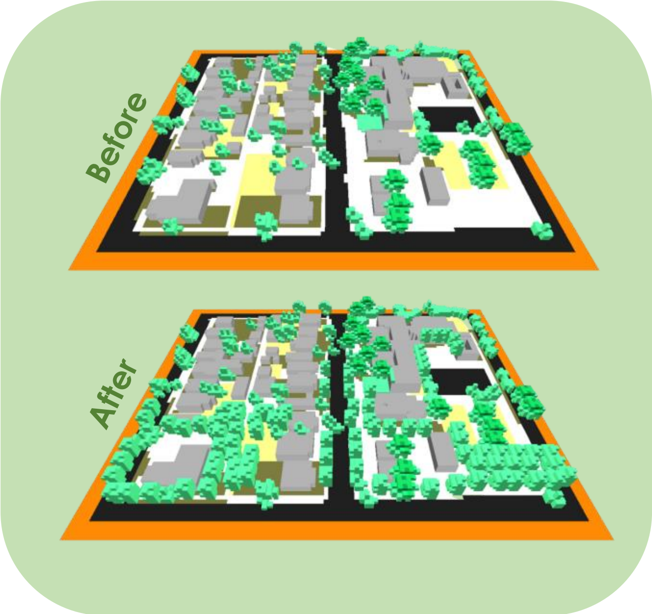


Landsat 8 TIRS
100 meter resolution, (LST product gridded at 30 meters), temporal revisitation 16 days

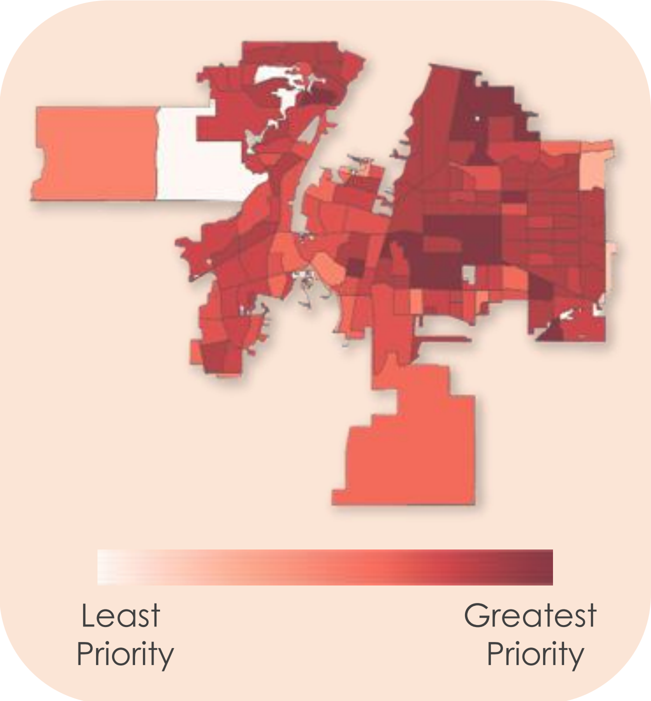
InVEST Urban Cooling Model



ENVI-Met Microclimate Simulation: Human Thermal Comfort



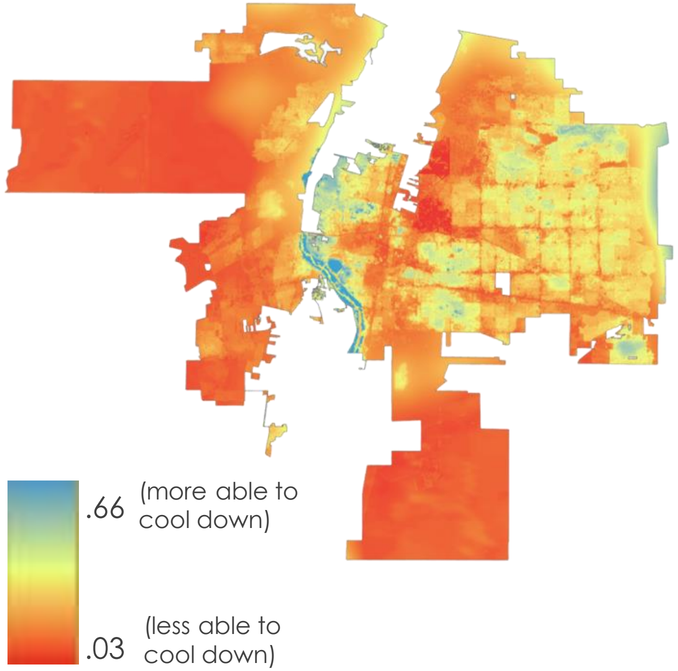
UHEAT 2.0 Heat Vulnerability



Results

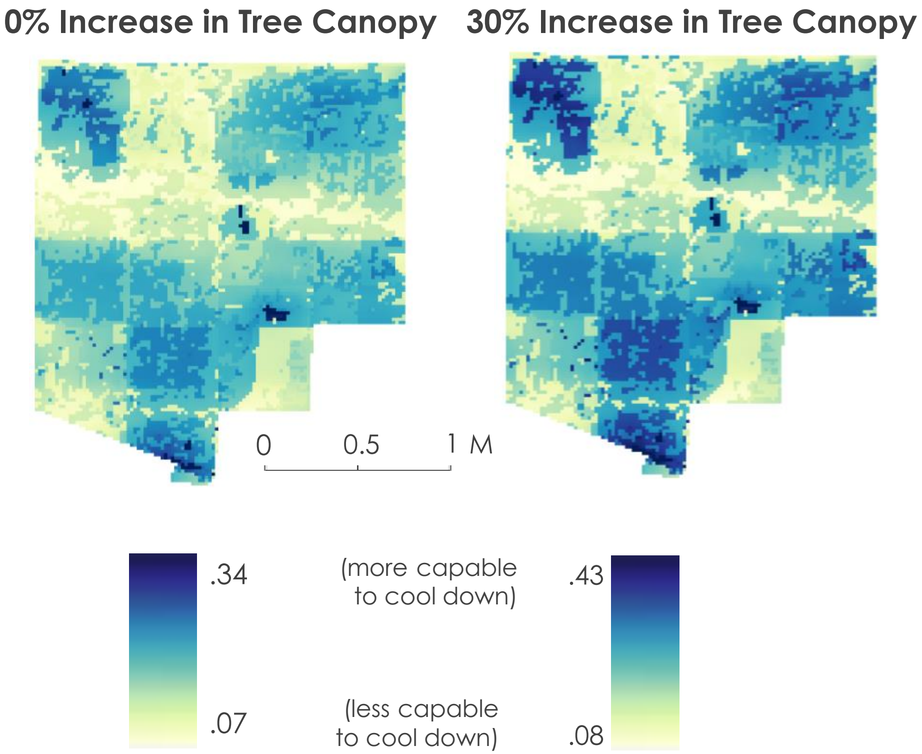
Heat Mitigation Index:

With the current green spaces available, how well can different areas in Albuquerque reduce excess heat?



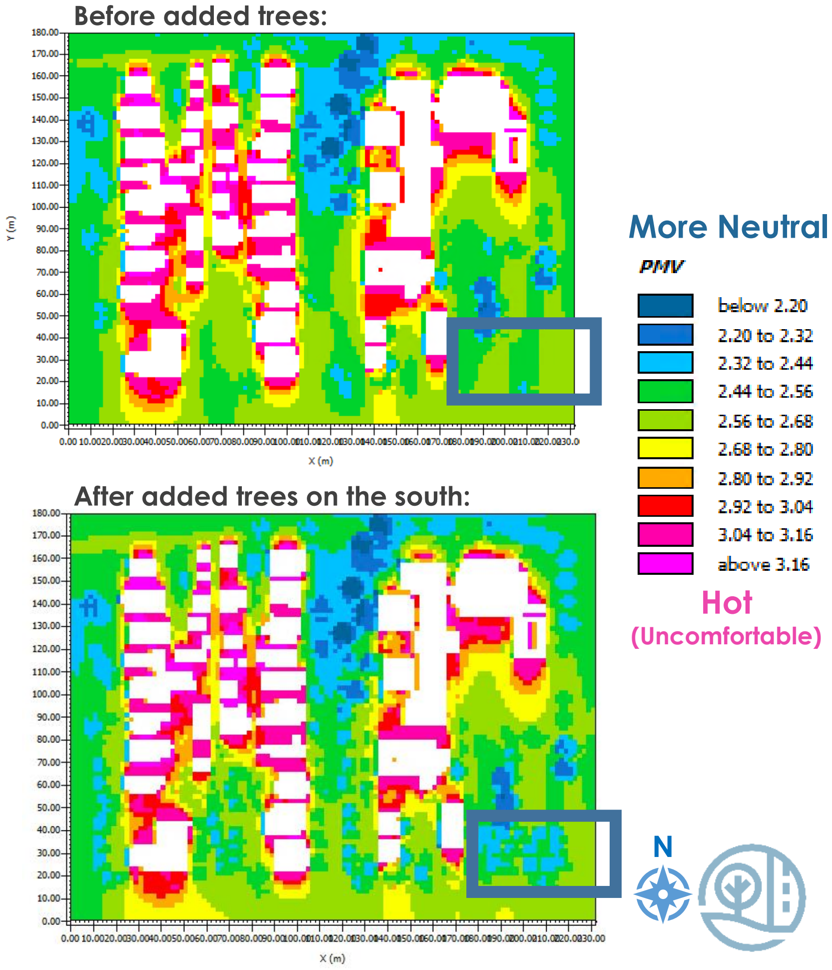
Cooling Capacity:

What happens to the capacity of an area to cool down if we add trees?



Thermal Comfort Index:

How comfortable does the average human feel in this area? How does this change if we add trees?



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FROM SPACE TO THE STREETS:

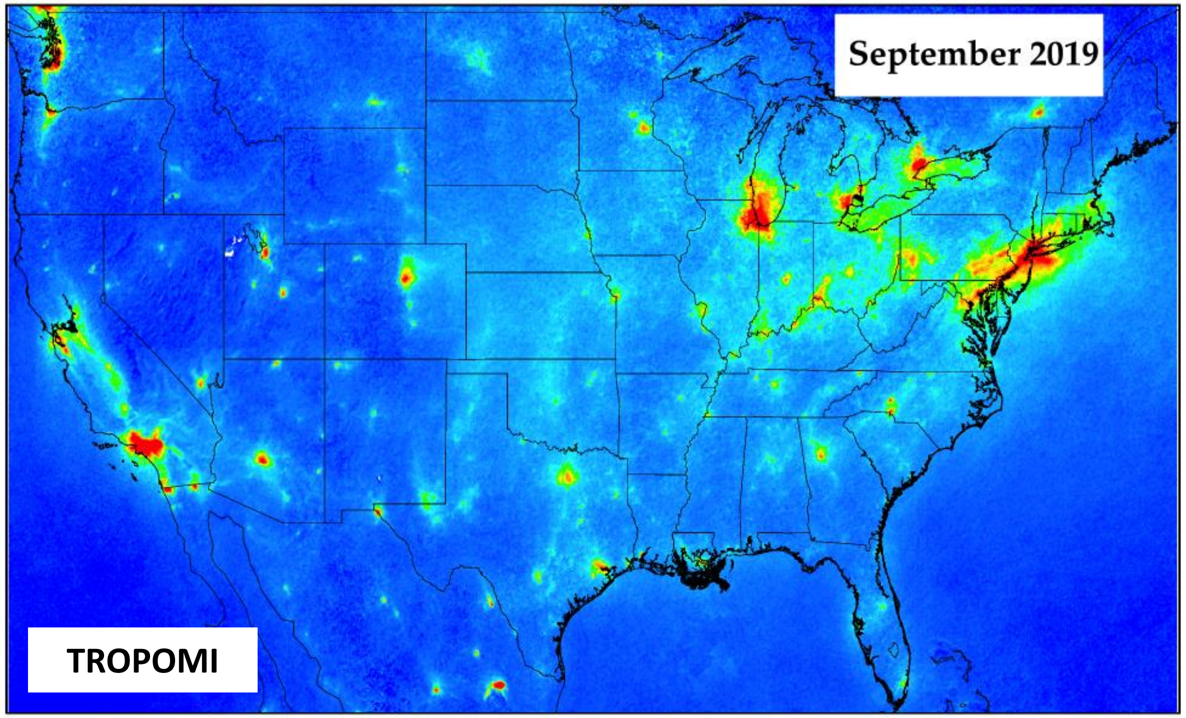
USING SATELLITE DATA TO TRACK NEIGHBORHOOD-SCALE AIR INEQUALITY

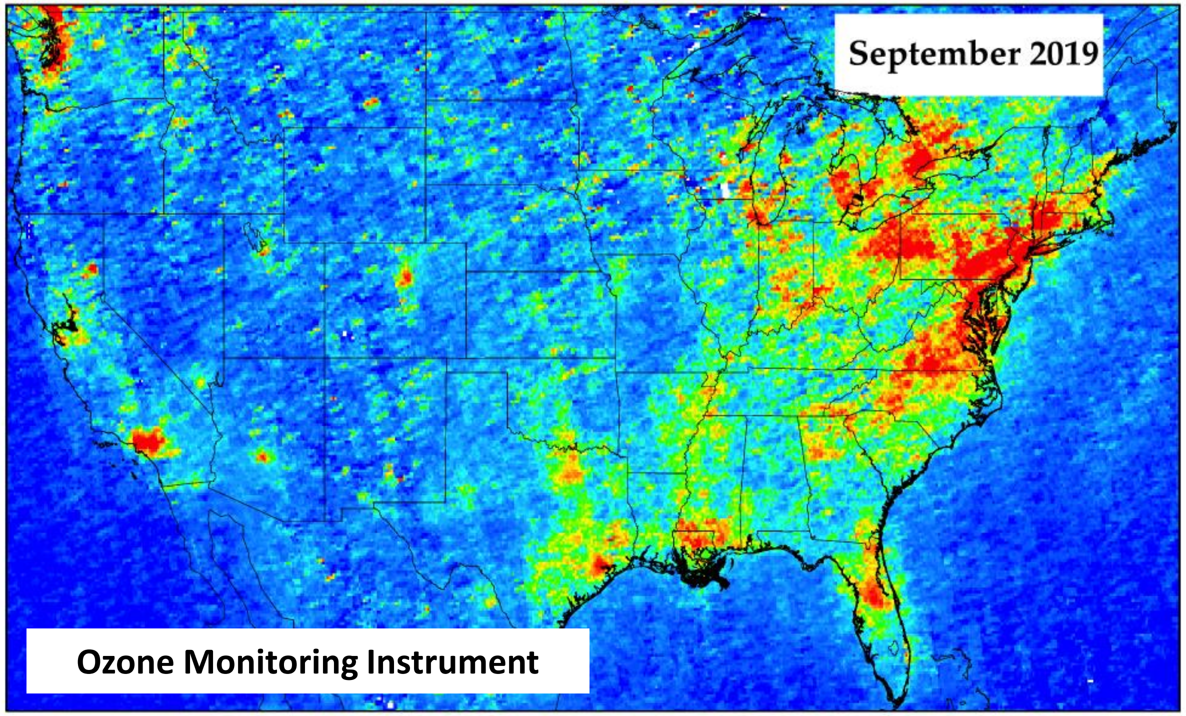
Gaige Kerr, George Washington University

Special thanks to Susan Anenberg, Daniel Goldberg, Natalie Youssef, Lauren Johnson, Qian Xiao, and Colleen Heck

Recently-launched satellites provide increasingly high resolution NO_2 estimates

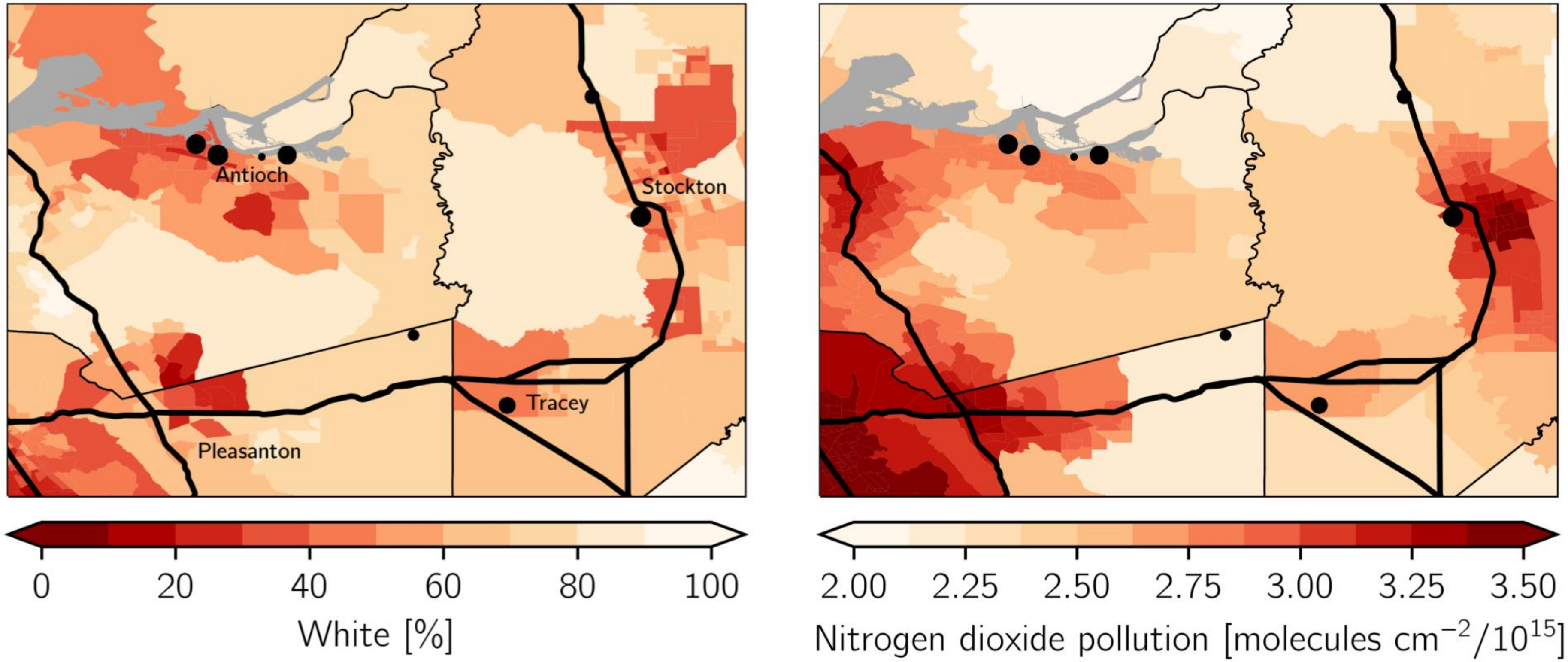
Nitrogen dioxide (NO_2) measured by the TROPospheric Monitoring Instrument (TROPOMI) represents important advancements over predecessor instruments.





SOURCE: GOLDBERG ET AL. (2021) *EARTHS FUTURE*

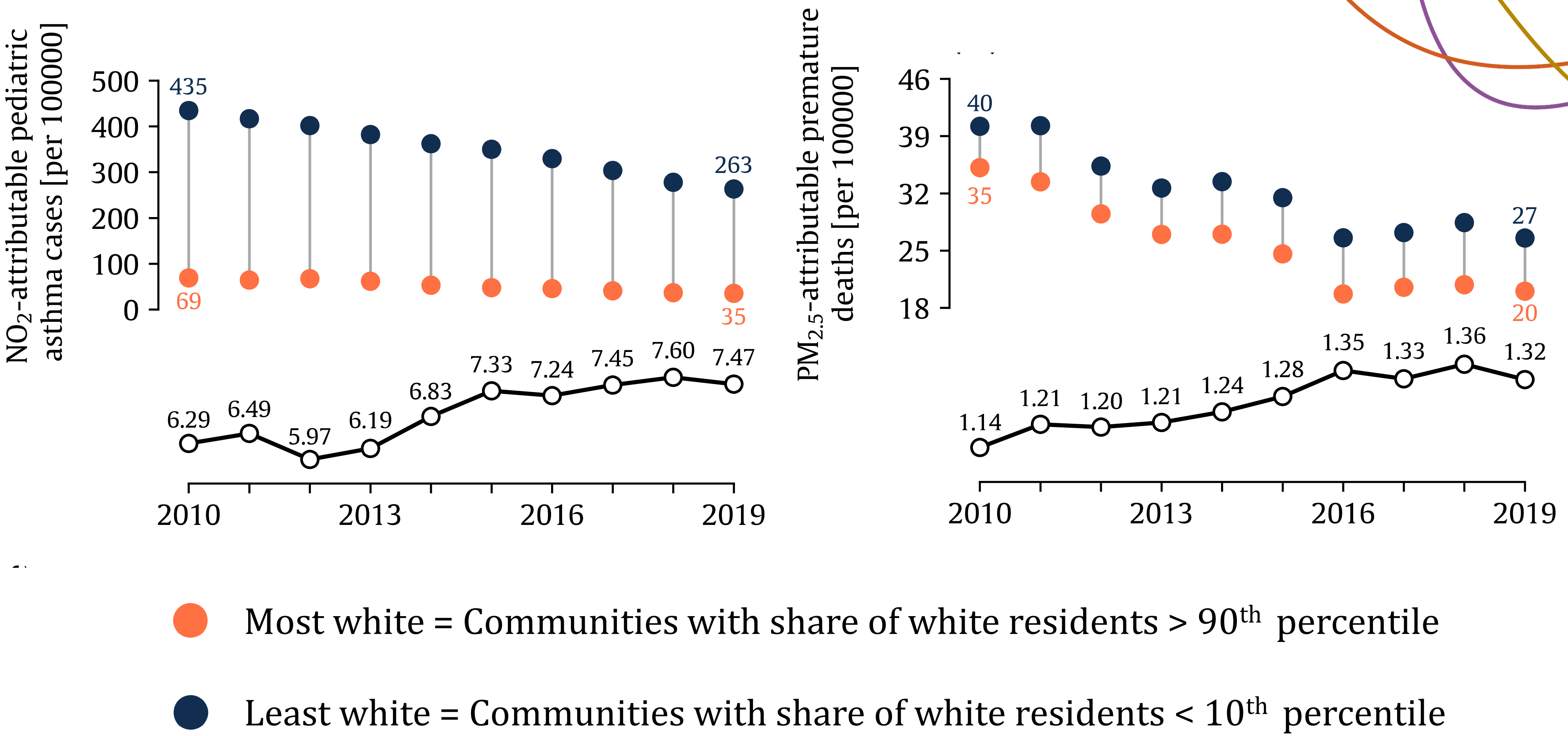
Satellite data paired with demographics provide neighborhood-level perspectives on environmental justice



In California's Central Valley, census tract-averaged NO_2 from TROPOMI was higher in communities of color in 2019.

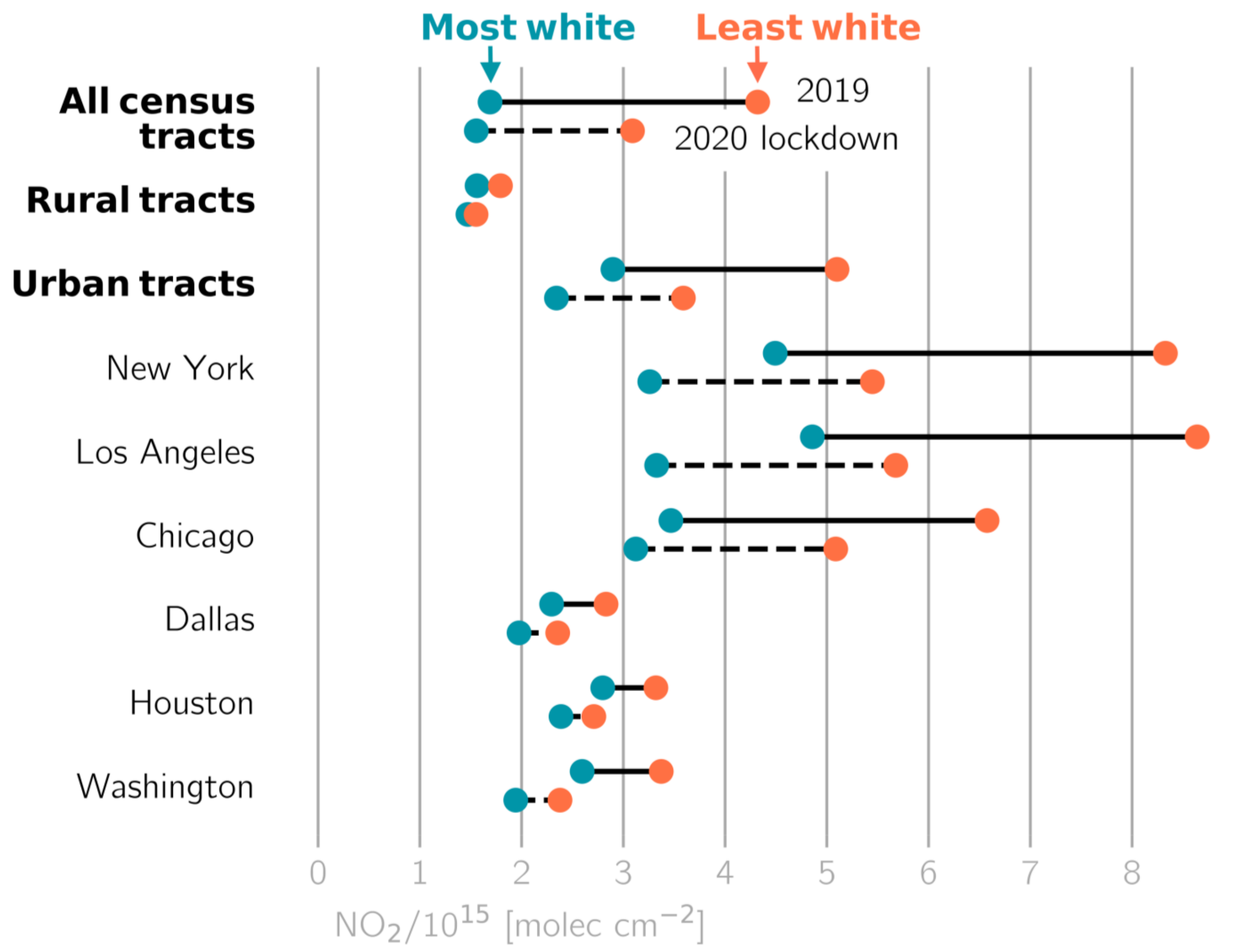
Racial relative disparities in pollution-attributable health burdens are widening

Successful regulatory measures have reduced the public health damages associated with air pollution, but uneven reductions have resulted in widening disparities.



SOURCE: KERR ET AL. (SUBMITTED) – *PRELIMINARY RESULTS, DO NOT QUOTE OR CITE*

Satellites can track changes in NO_2 and associated disparities in near-real time



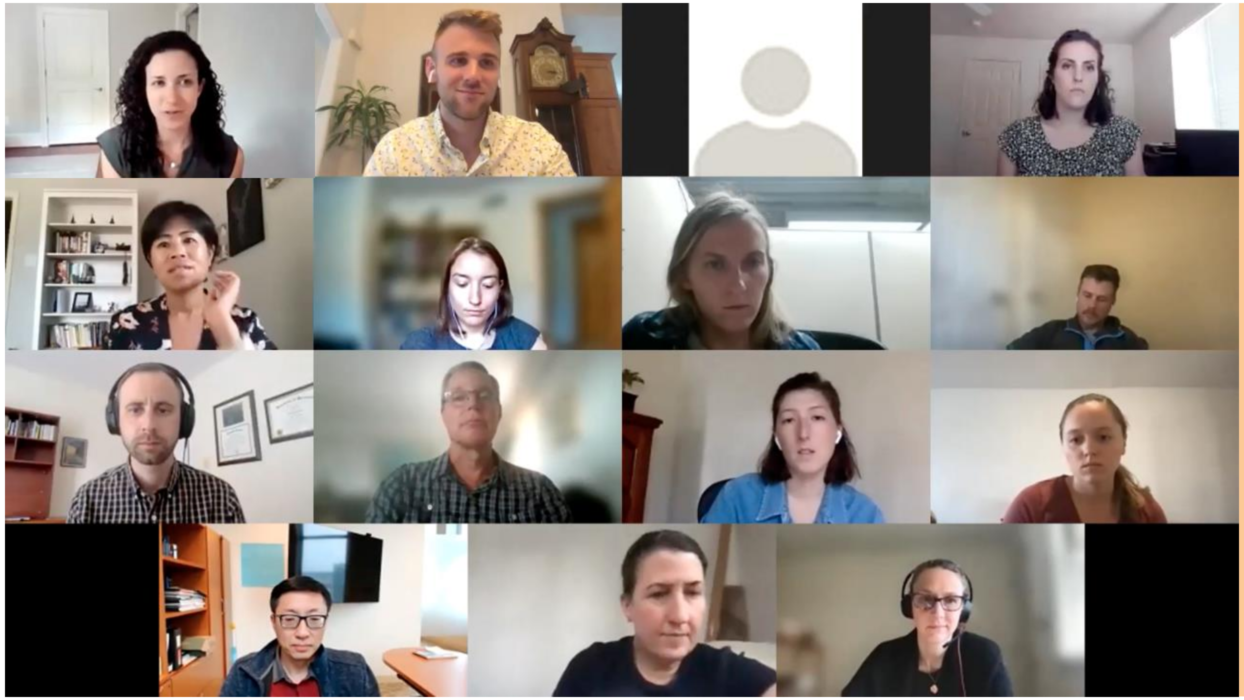
The COVID-19 pandemic reduced, but did not eliminate, NO_2 disparities in the U.S.

In many cities, the least white communities experienced higher NO_2 levels during the pandemic than the most white communities faced prior to the pandemic.

SOURCE: KERR ET AL. (2021) *PROC NATL ACAD SCI USA*

“Satellite Data for Environmental Justice:” A NASA-funded scientist-stakeholder partnership

We work with public health and air qualities agencies to assist in the use of NASA data and tools for the public benefits, specifically for environmental justice screening and mapping tools.



All are welcome to attend our **monthly team meetings** to exchange information and build a community of practice about using satellite data for EJapplications.

When: Every first Wednesday of the month

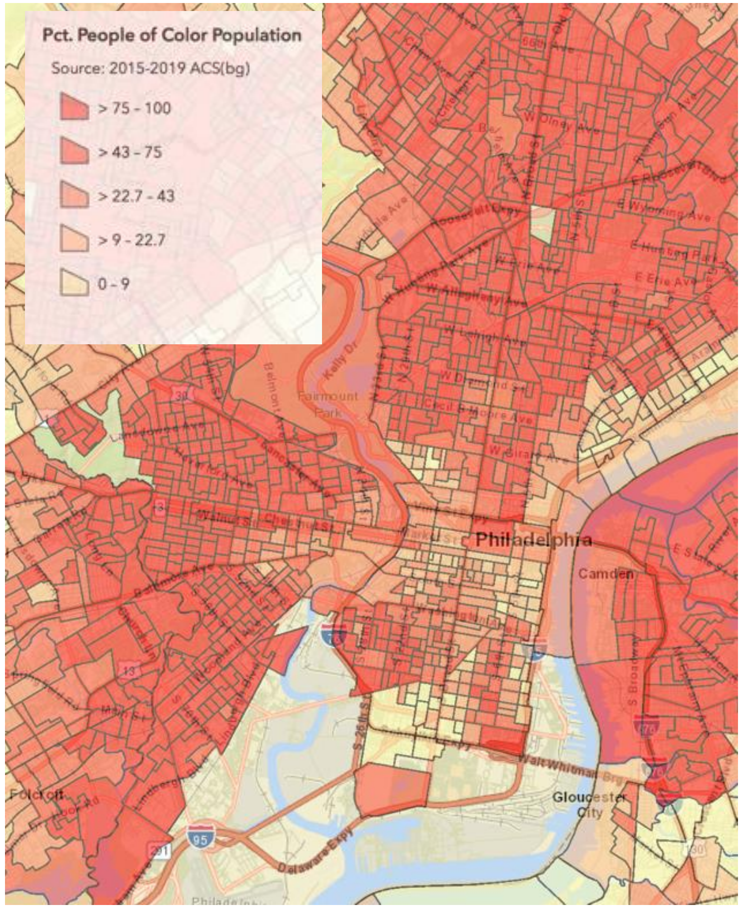
Time: 11am - 12:30pm EST

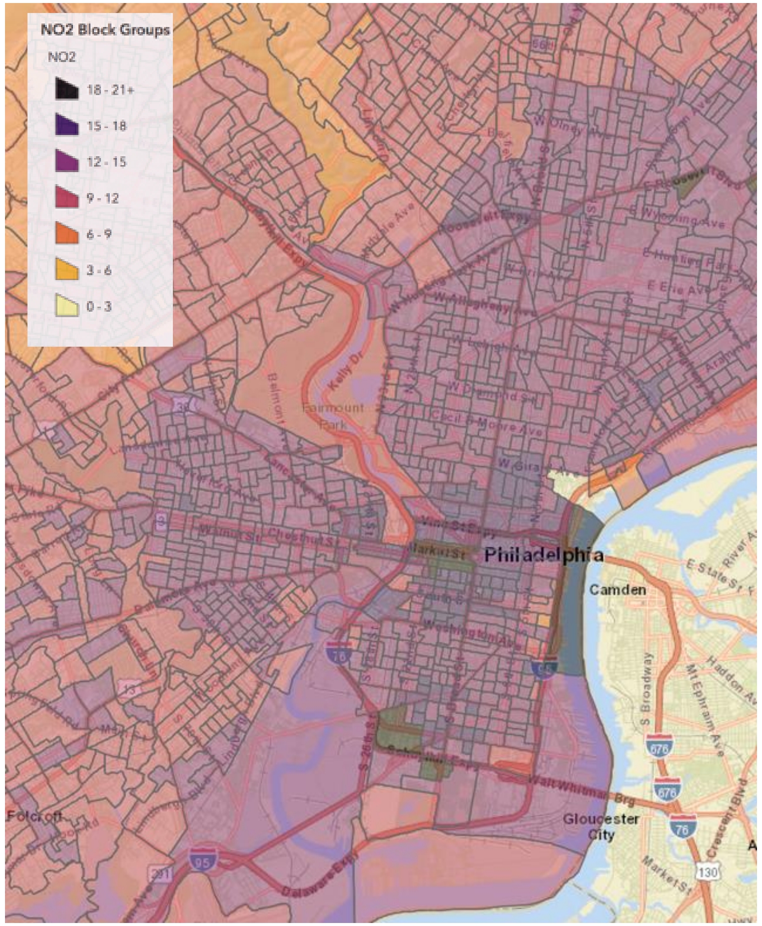
Where: Zoom

Contact us for more information/ how to get involved!

"Satellite Data for Environmental Justice:" Empowering a better understanding of NO_2 exposure

Datasets that incorporate satellite-derived NO_2 can help the general public and decision makers determine which communities may bear larger burdens from NO_2.





SOURCE: EPA EJSCREEN

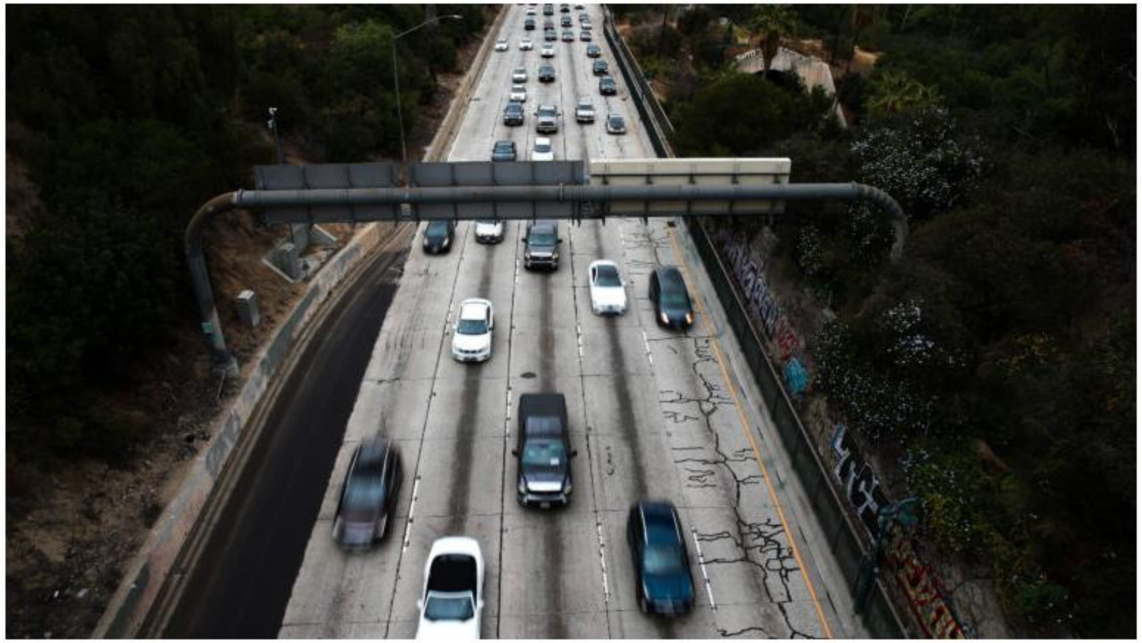
Research to action

FIRST OPINION

The pandemic made clear who doesn't get to breathe clean air. Now what?

By Gaige Kerr and Susan Anenberg Aug. 16, 2021

Reprints



In many urban areas, the most marginalized communities live and work disproportionately close to major highways and interstates.

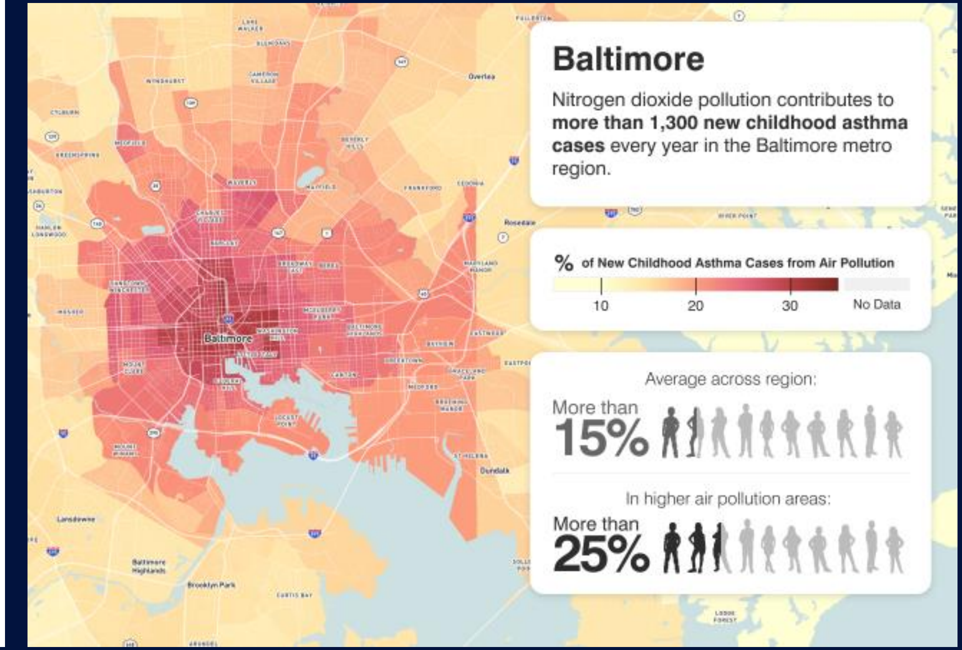
MARIO TAMA/GETTY IMAGES

May 16, 2022

Environmental Protection Agency
EPA Docket Center, OAR, Docket EPA–HQ–OAR–2019– 0055
Mail Code 28221T
1200 Pennsylvania Avenue NW
Washington, DC 20460

Re: Docket EPA–HQ–OAR–2019– 0055, Proposed Rule and Related Materials for Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards

On March 7, 2022, the EPA released proposed standards to reduce NOx emissions from heavy-duty vehicles (HDVs) and engines. We are researchers focused on understanding the health and environmental impacts of nitrogen dioxide (NO_2), fine particulate matter ($PM_{2.5}$), and ozone pollution, particularly stemming from vehicle tailpipe emissions. We have published dozens of peer-reviewed publications on these topics over the past 15 years. Thank you for considering these evidence-based comments on the proposed standards.



SOURCES: STAT NEWS, EPA, ENVIRONMENTAL DEFENSE FUND

Applied Remote Sensing Training (ARSET)

Satellite Remote Sensing for Measuring Urban Heat Islands and Constructing Heat Vulnerability Indices

EARTH SCIENCE APPLICATIONS WEEK 2022

Urban Heat Islands

- Urban areas experience higher temperatures than outlying areas. This difference in temperature is what constitutes an urban heat island (UHI).
- Difference in temperature has to do with changes in radiative and thermal properties of impervious surfaces i.e., heat-absorbing buildings and pavement.
- Temperatures vary within cities due to the spatial distribution of water, soil, vegetation, and impervious surfaces.

Monitoring Urban Heat Islands – SUHI

- Satellite thermal remote sensing measures SUHI and provides consistent and repeatable observations of the Earth’s surface at various spatial (from local to global) and temporal (diurnal, seasonal, and inter-annual) scales.

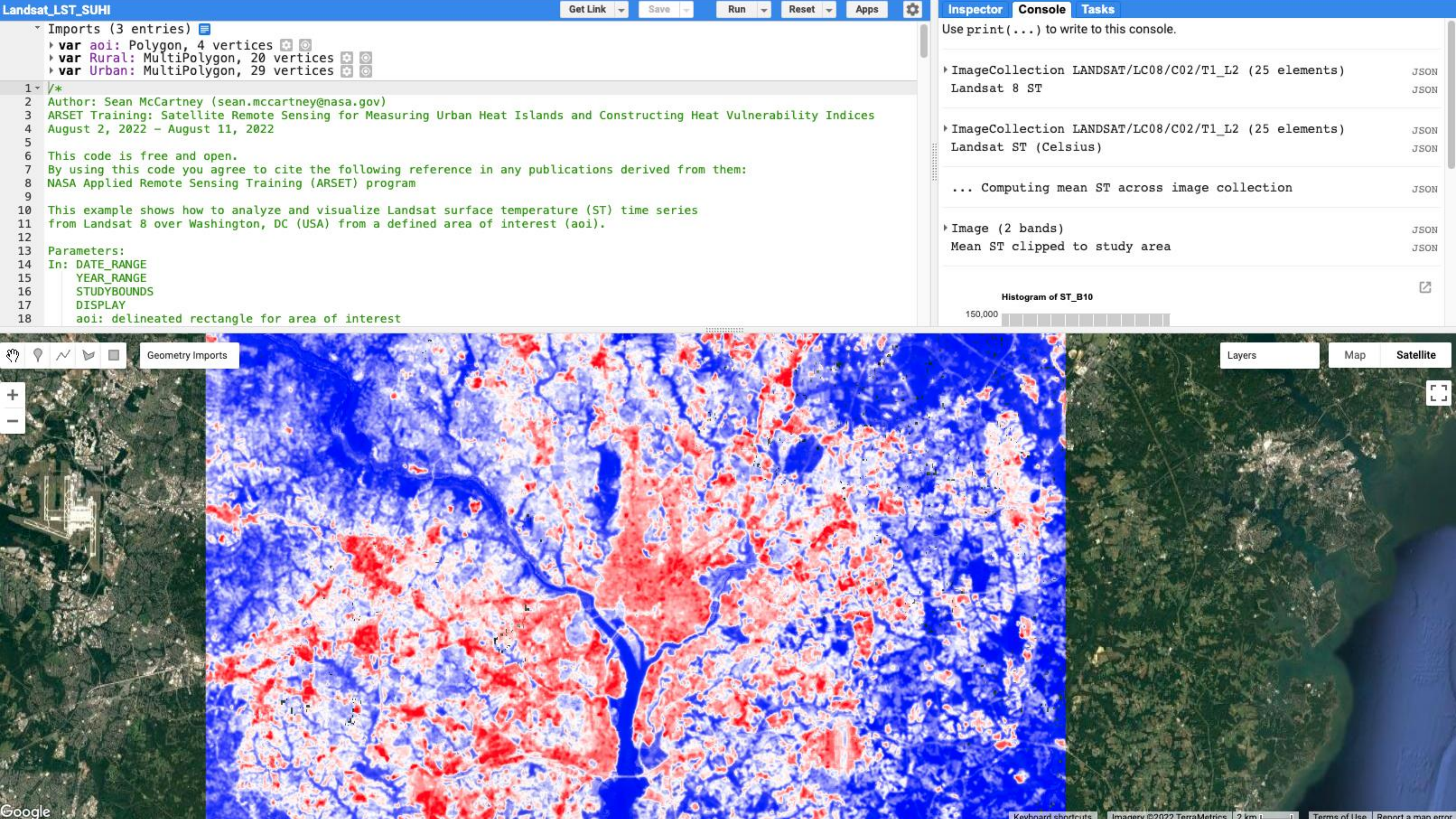
Monitoring Urban Heat Islands – SUHI

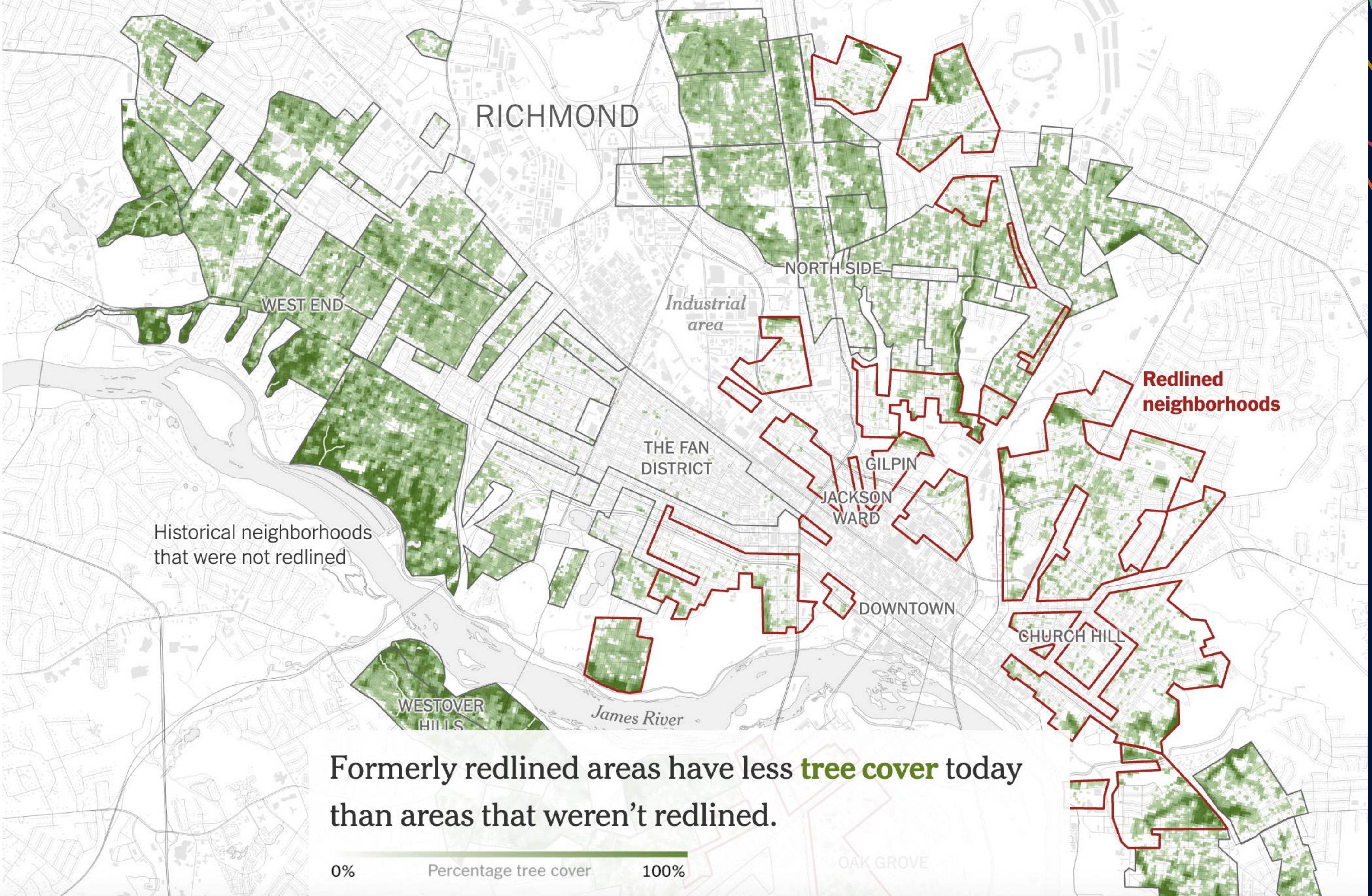
- Surface Urban Heat Islands (SUHI) represent the difference of land surface temperature (LST) in urban relative to non-urban areas, as well as “hot spots” within urban areas.

$\Delta T_{u-r} = T_u - T_r$

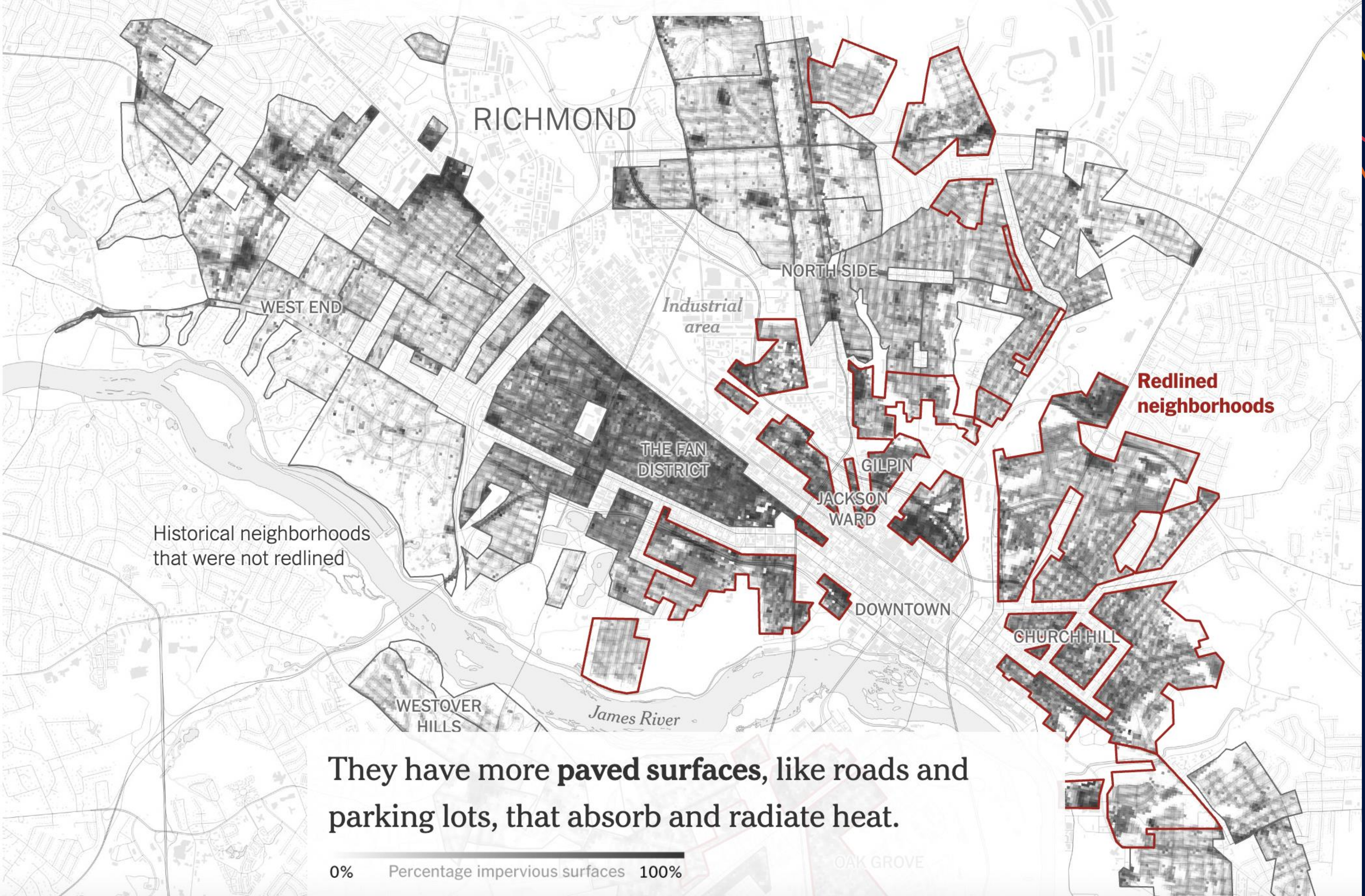
- where ΔT_{u-r} is UHI intensity, Tu is urban temperature and Tr is rural temperature.

- The intensity of the heat island is the simplest quantitative indicator of the thermal modification imposed by urban relative to non-urban areas.

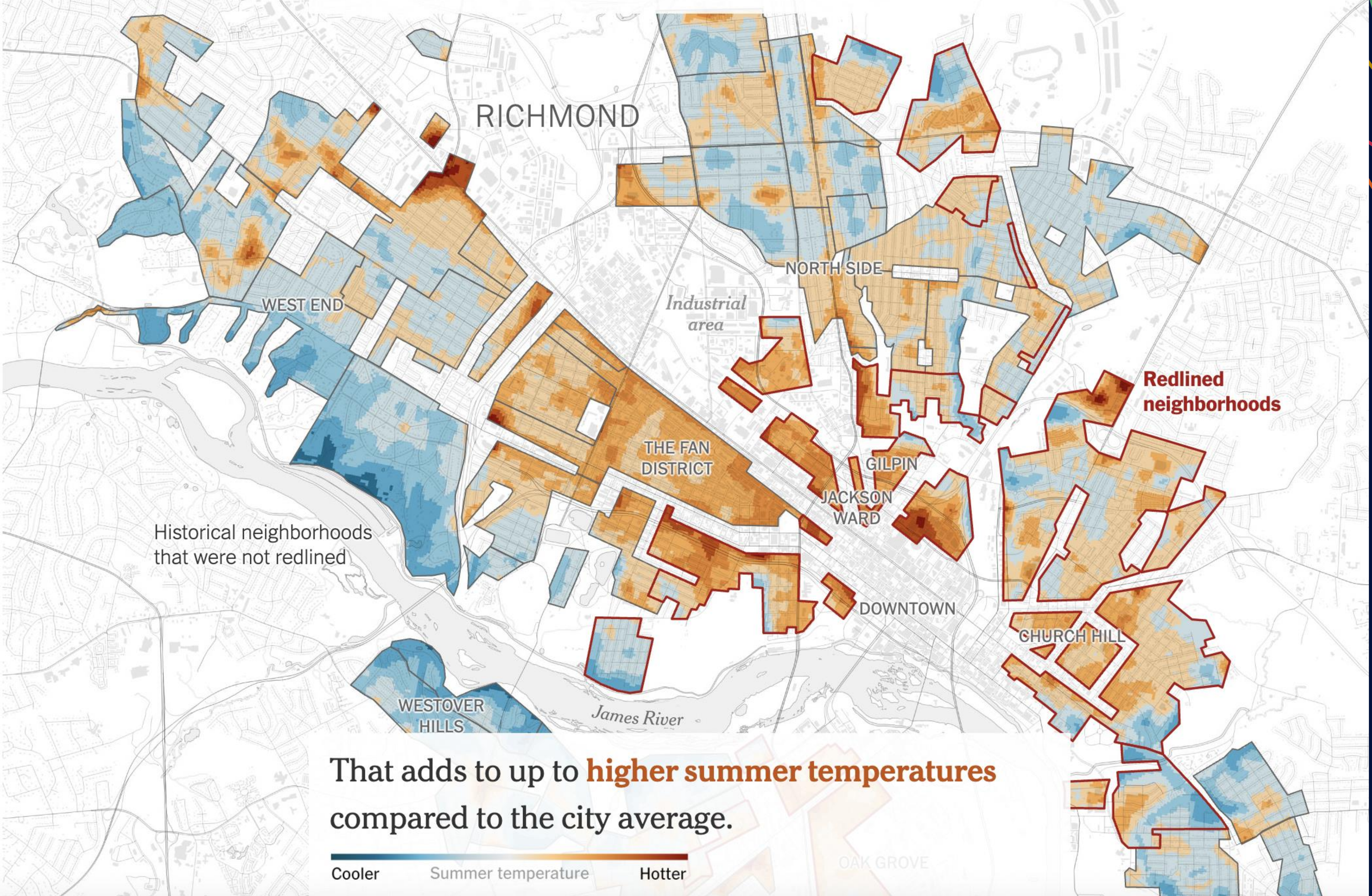

Landsat_LST_SUHI
Get Link
Save
Run
Reset
Apps
Inspector
Console
Tasks
Imports (3 entries)
var aoi: Polygon, 4 vertices
var Rural: MultiPolygon, 20 vertices
var Urban: MultiPolygon, 29 vertices
/*
Author: Sean McCartney (sean.mccartney@nasa.gov)
ARSET Training: Satellite Remote Sensing for Measuring Urban Heat Islands and Constructing Heat Vulnerability Indices
August 2, 2022 – August 11, 2022
This code is free and open.
By using this code you agree to cite the following reference in any publications derived from them:
NASA Applied Remote Sensing Training (ARSET) program
This example shows how to analyze and visualize Landsat surface temperature (ST) time series
from Landsat 8 over Washington, DC (USA) from a defined area of interest (aoi).
Parameters:
In: DATE_RANGE
YEAR_RANGE
STUDYBOUNDS
DISPLAY
aoi: delineated rectangle for area of interest
Use print(...) to write to this console.
ImageCollection LANDSAT/LC08/C02/T1_L2 (25 elements)
JSON
Landsat 8 ST
JSON
ImageCollection LANDSAT/LC08/C02/T1_L2 (25 elements)
JSON
Landsat ST (Celsius)
JSON
... Computing mean ST across image collection
JSON
Image (2 bands)
JSON
Mean ST clipped to study area
JSON
Histogram of ST_B10
150,000
Geometry Imports
Layers
Map
Satellite
Google
Keyboard shortcuts
Imagery ©2022 TerraMetrics
2 km
Terms of Use



Formerly redlined areas have less **tree cover** today than areas that weren't redlined.

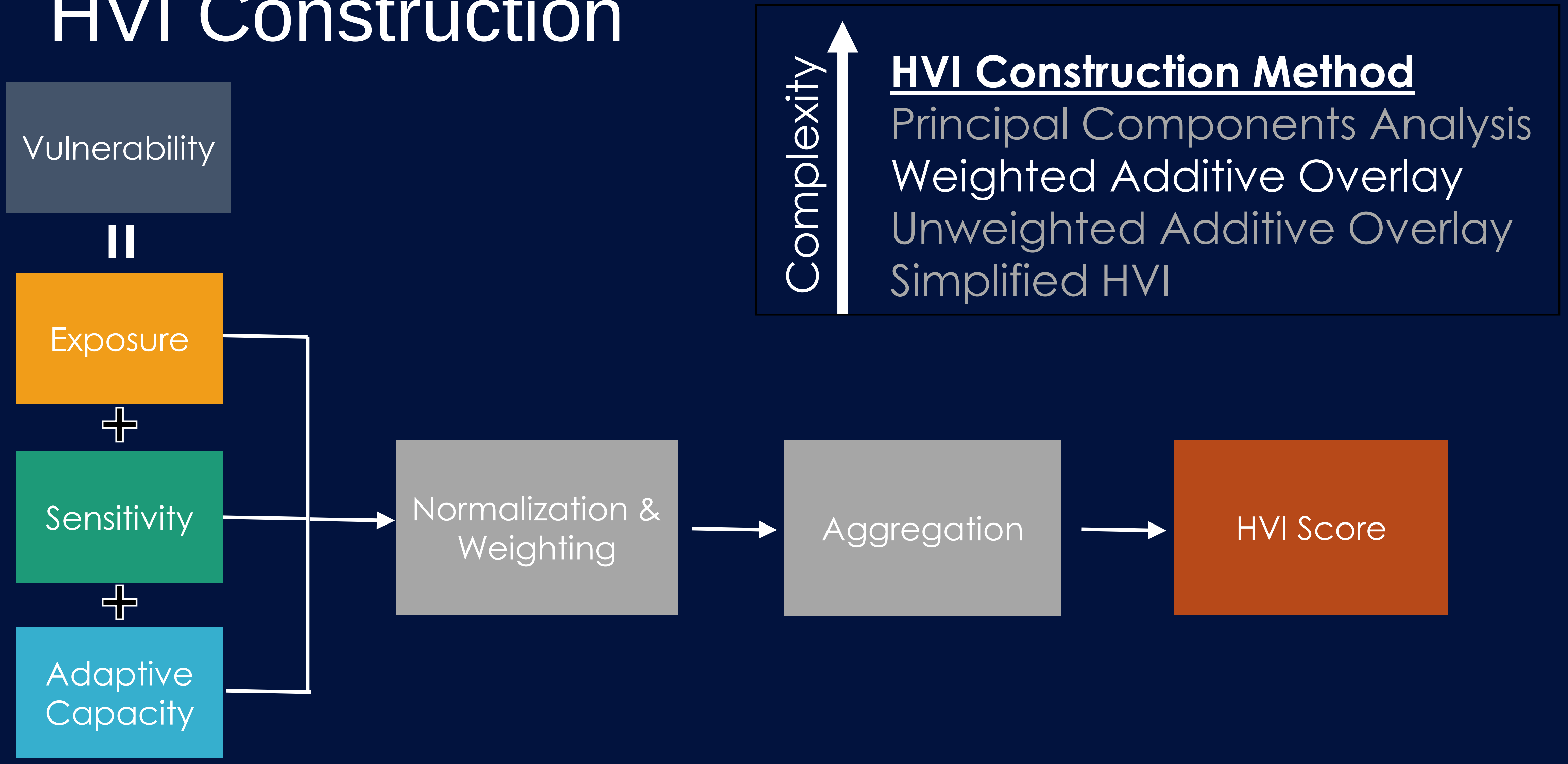


They have more **paved surfaces**, like roads and parking lots, that absorb and radiate heat.



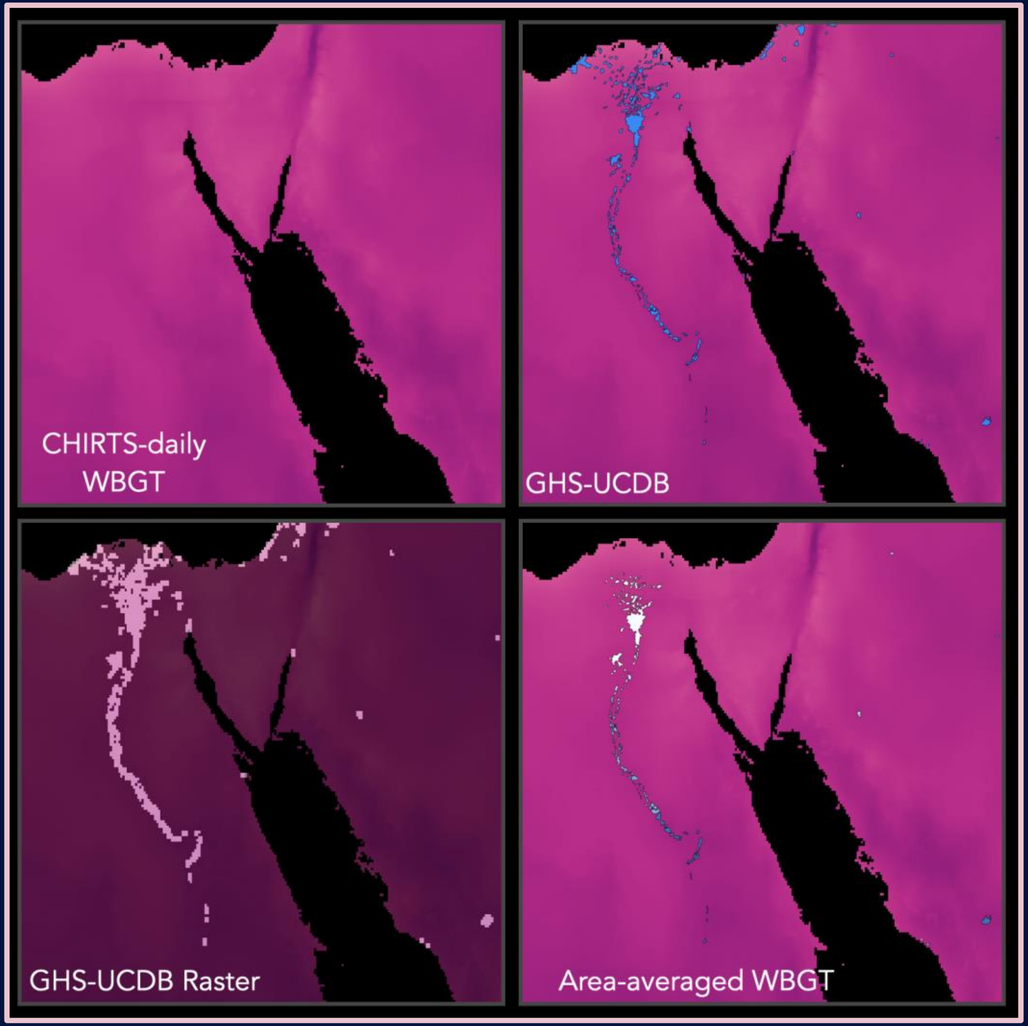
That adds to up to **higher summer temperatures** compared to the city average.

HVI Construction



Global High Resolution Daily Extreme Urban Heat Exposure (UHE-Daily), v1 (1983–2016)

- Combine CHIRTS-daily WBGTmax record with the Global Human Settlement Layer Urban Centre Data Base
- Create a record of WBGTmax for every urban settlement on the planet from 1983 – 2016 (150 million observations).
- Apply ISO threshold to identify dangerous hot-humid days (e.g., WBGTmax > 30°C) for each city on the planet, from 1983 – 2016 **to produce a record of all urban hot-humid heat waves**.



EARTH SCIENCE APPLICATIONS WEEK 2022

THANK YOU!

JOIN US TOMORROW 1-4PM EDT

SLIDES & RECORDINGS WILL BE POSTED BY AUG 31st