EARTH SCIENCE
APPLIED SCIENCES

PROMOTING HEALTH & AIR QUALITY

EARTH SCIENCE APPLICATIONS WEEK 2021

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NASA Health & Air Quality Program Overview

John Haynes
Program Manager

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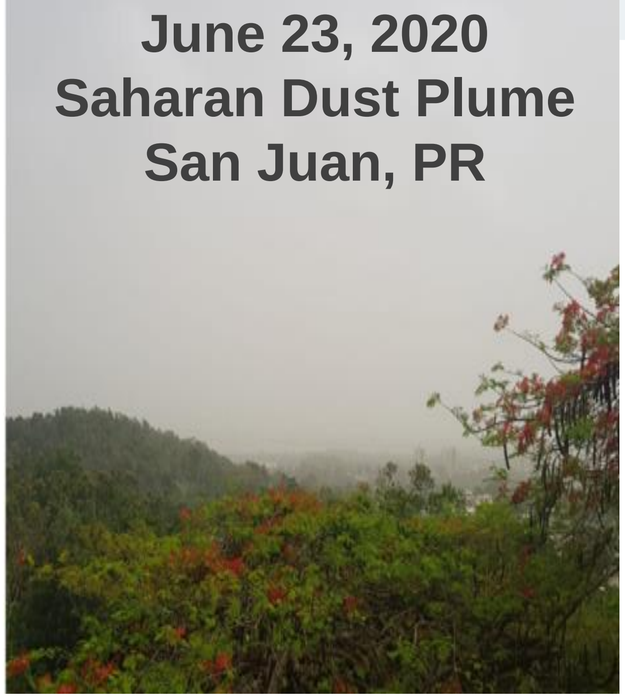
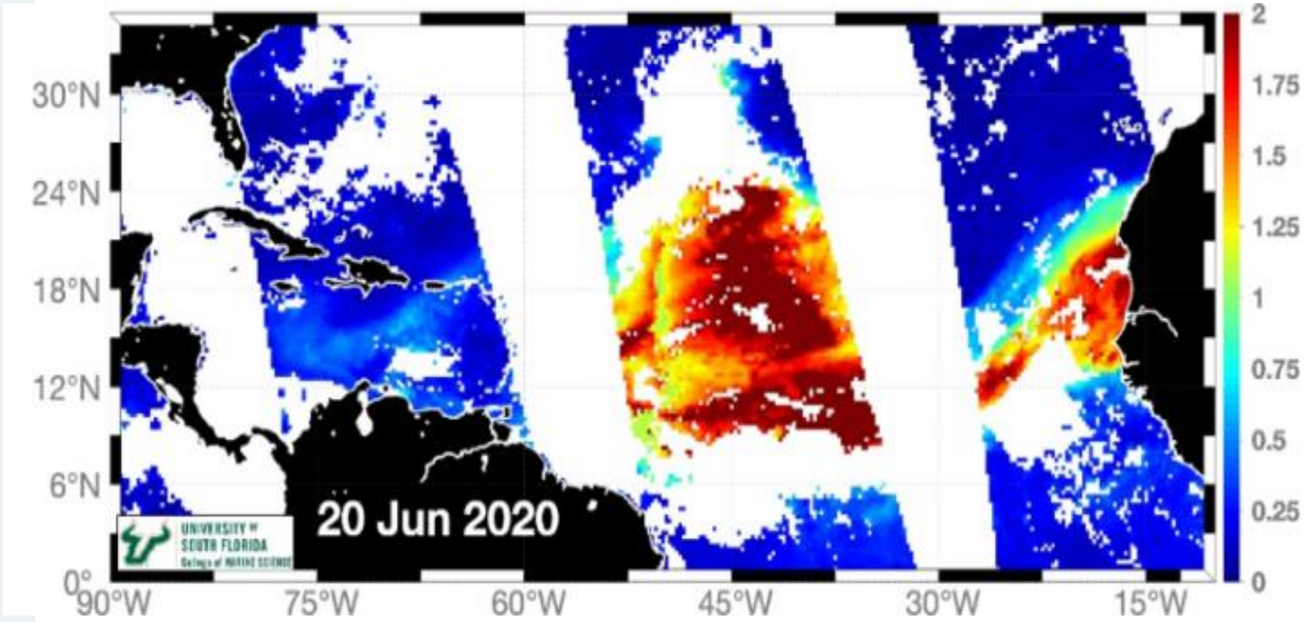
Health and Air Quality

Major Partners include International (e.g., GEO, WHO, UNICEF, PAHO), Federal (e.g., CDC, EPA, NIH, NOAA), State (e.g., South Dakota, California, Texas), and Private sectors (AER, Inc.).

- NASA's Health & Air Quality Applications Area supports the use of Earth observations in air quality management and public health, particularly regarding **infectious disease and environmental health** issues.
- The area promotes uses of Earth observing data and models regarding **implementation of air quality standards, policy, and regulations** for economic and human welfare.
- The area addresses issues of **toxic and pathogenic exposure and health-related hazards** and their effects for risk characterization and mitigation.
- The Health & Air Quality Applications Area also addresses **effects of climate change on public health and air quality** to support managers and policy makers in their planning and preparations.



Credits: NASA/Pablo Méndez-Lázaro



Forecasting Poor Air Quality Events in the Caribbean

Saharan dust storms crossing the Caribbean adversely impact air quality and human health. Robust applied research and community partnerships were developed in Puerto Rico to build an air quality forecasting tool that will inform policy decisions, educate the public on health risks related to dust storms, and safeguard population health.

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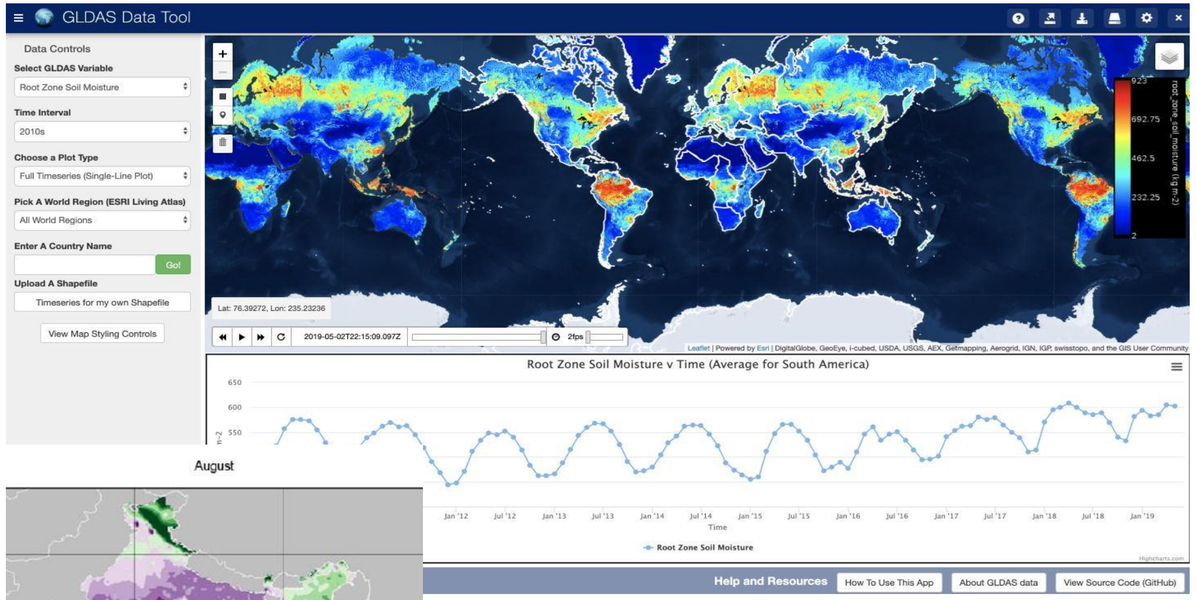
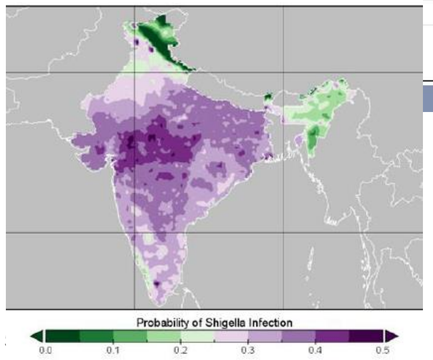
NASA Web Feature: https://www.nasa.gov/feature/nasa-helps-puerto-rico-prepare-for-saharan-dust-impacts

Environmental Determinants of Gastrointestinal Diseases

Satellite observations of temperature, soil moisture, and precipitation have been used to understand global rates of gastrointestinal illnesses. Similar data are now being used to investigate potential environmental factors that may influence COVID-19 transmission.





GLDAS Visualization of Root Soil Moisture and Shigella Risk Maps

GEO Health Community of Practice in Action

Using environmental observations to improve health decision-making

GEO HEALTH COMMUNITY OF PRACTICE

EO4Health Project on Hydroclimatic Factors and the COVID-19 Pandemic

European Commission Joint Research Centre
World Health Organization
World Meteorological Organization
Johns Hopkins University
EMPA
University of Maryland
CDC Centers for Disease Control and Prevention
NASA Goddard Space Flight Center
Global Modeling and Assimilation Office

Connection. Information. Collaboration.

http://www.geohealthcop.org

Thank You.

For further questions, please contact:
jhaynes@nasa.gov

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NASA Earth Observations and Model Data Supporting Disease Surveillance

Assaf Anyamba

NASA Goddard Space Flight Center
& Universities Space Research Association

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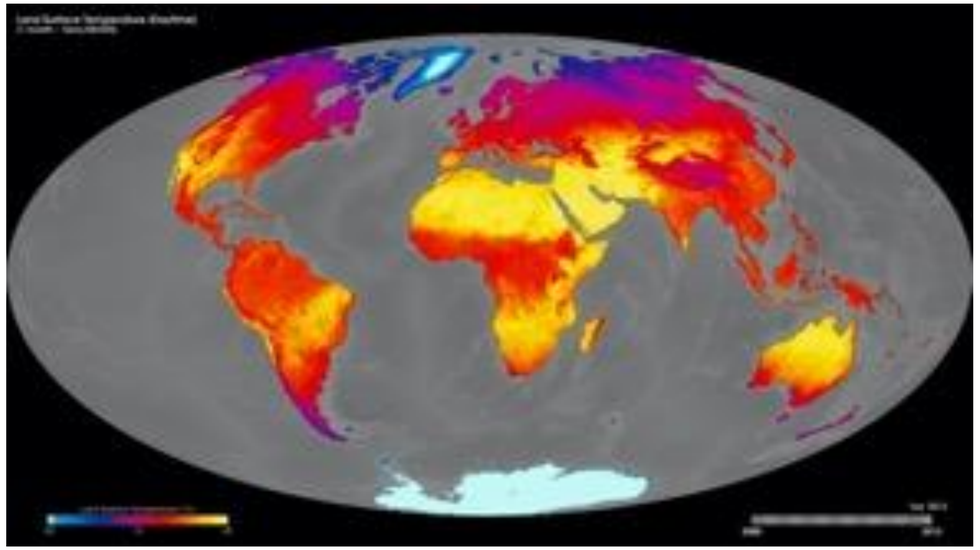
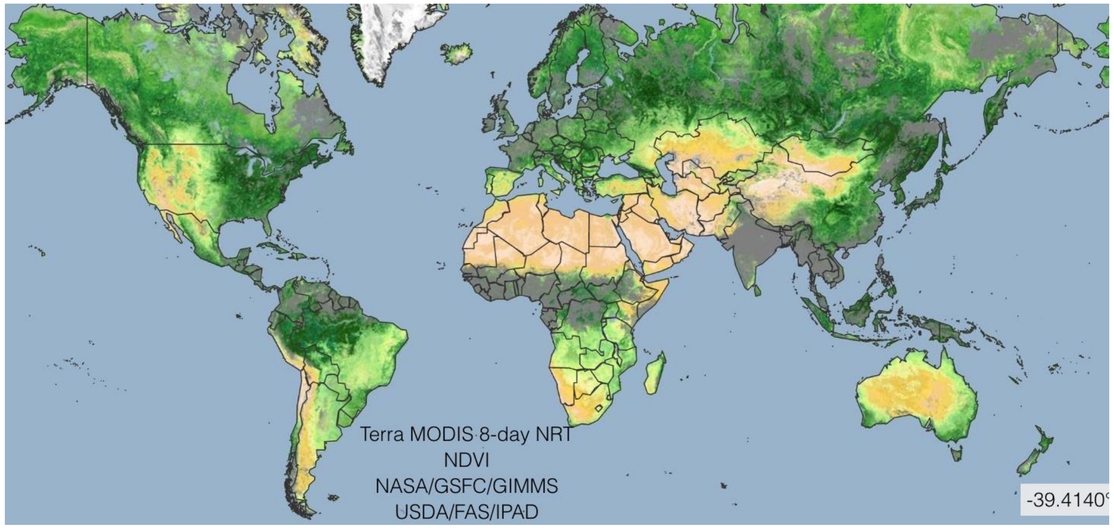
Promoting Health & Air Quality

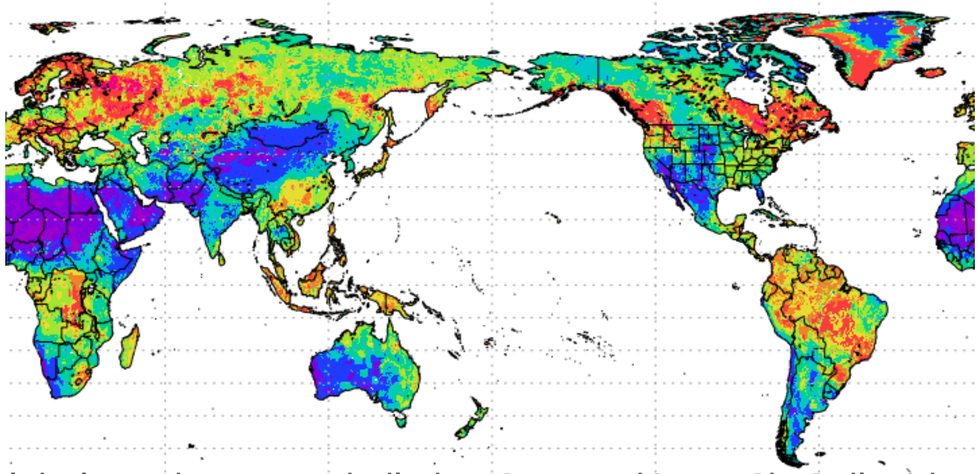
NASA Earth Observations and Model Data



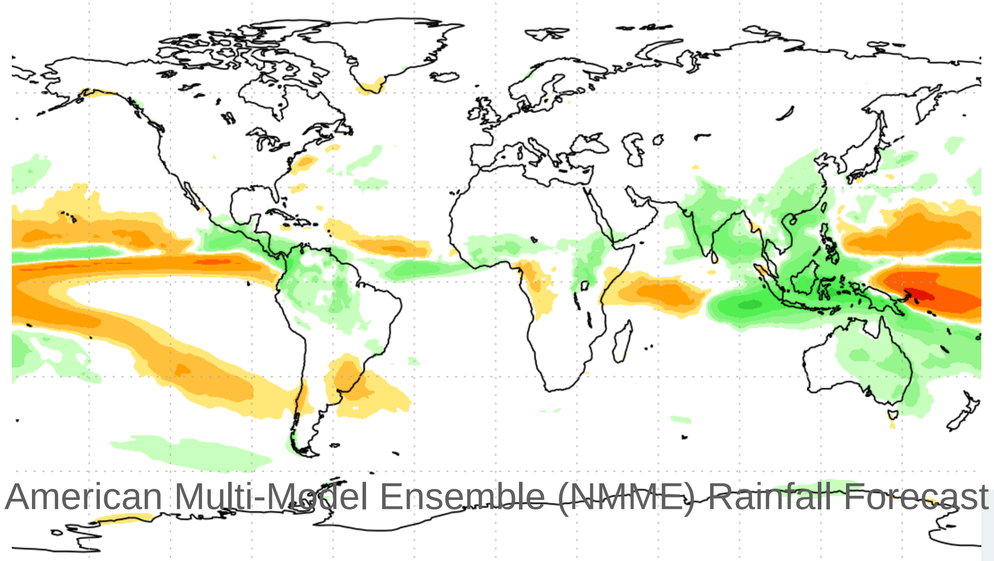
MODIS Land Surface Temperature



MODIS Vegetation Index

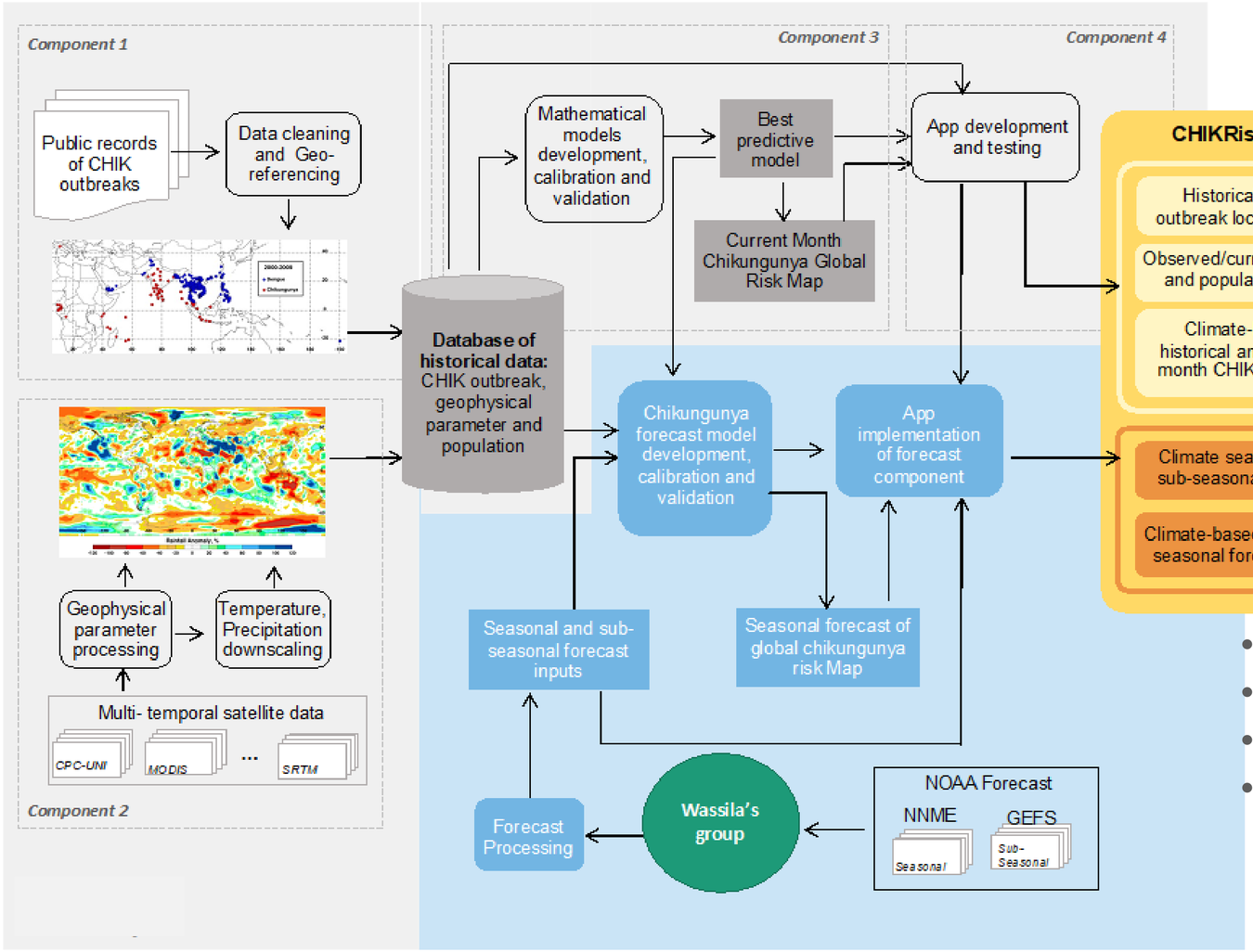


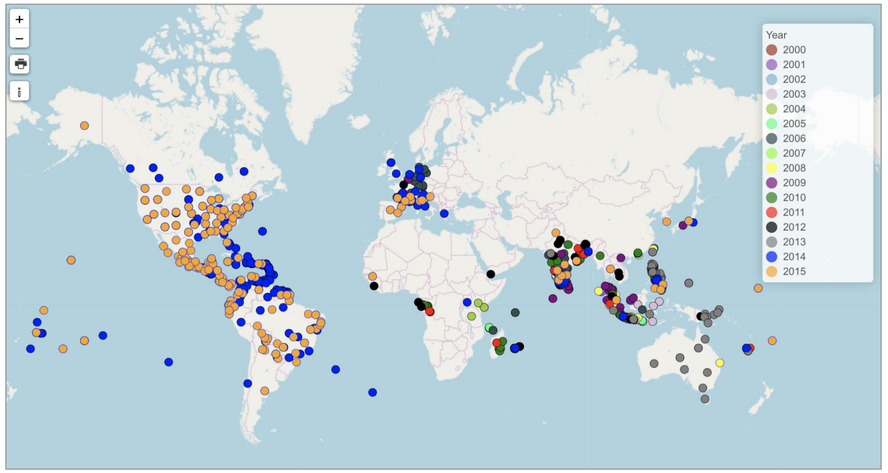
Global Land Data Assimilation System (GLDAS): Soil Moisture



North American Multi-Model Ensemble (NMME) Rainfall Forecast

Building Integrated Disease Models: Chikungunya

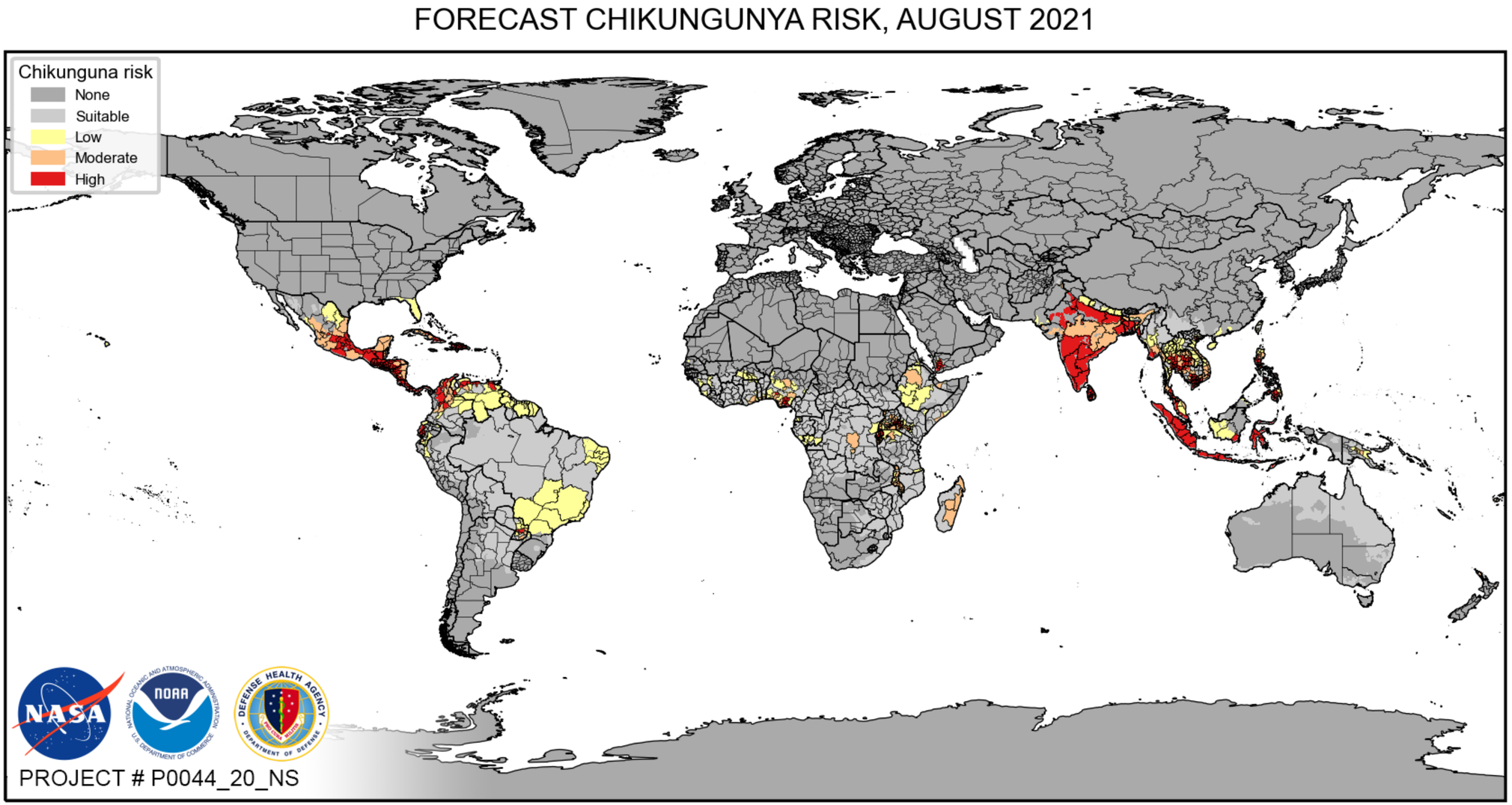




- Mosquito vector distributions
- Human Population Density + Machine Learning (ML)
- Satellite Observations
- Climate Model Outputs

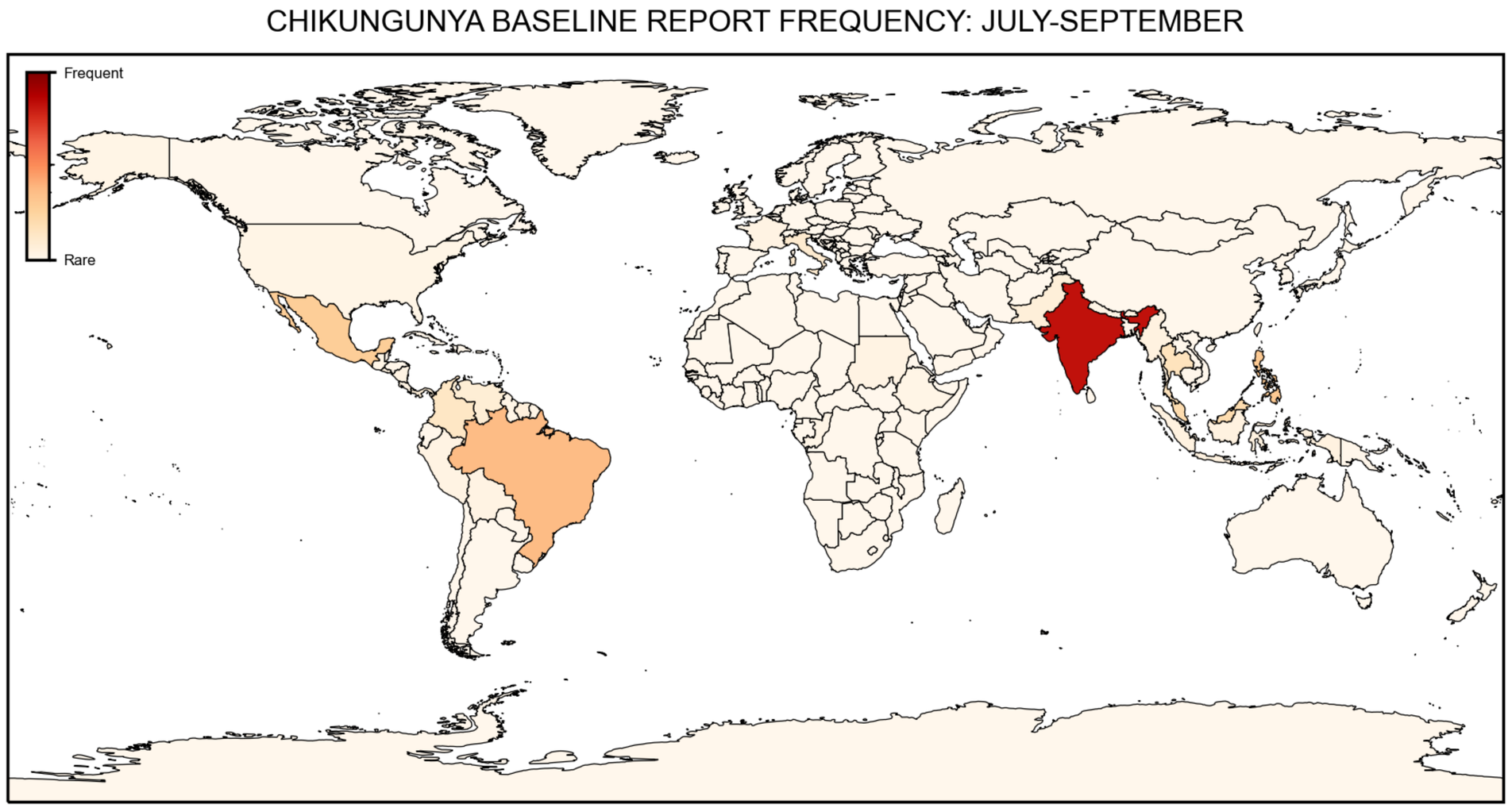
= Disease Risk Maps

Early Warning Capability

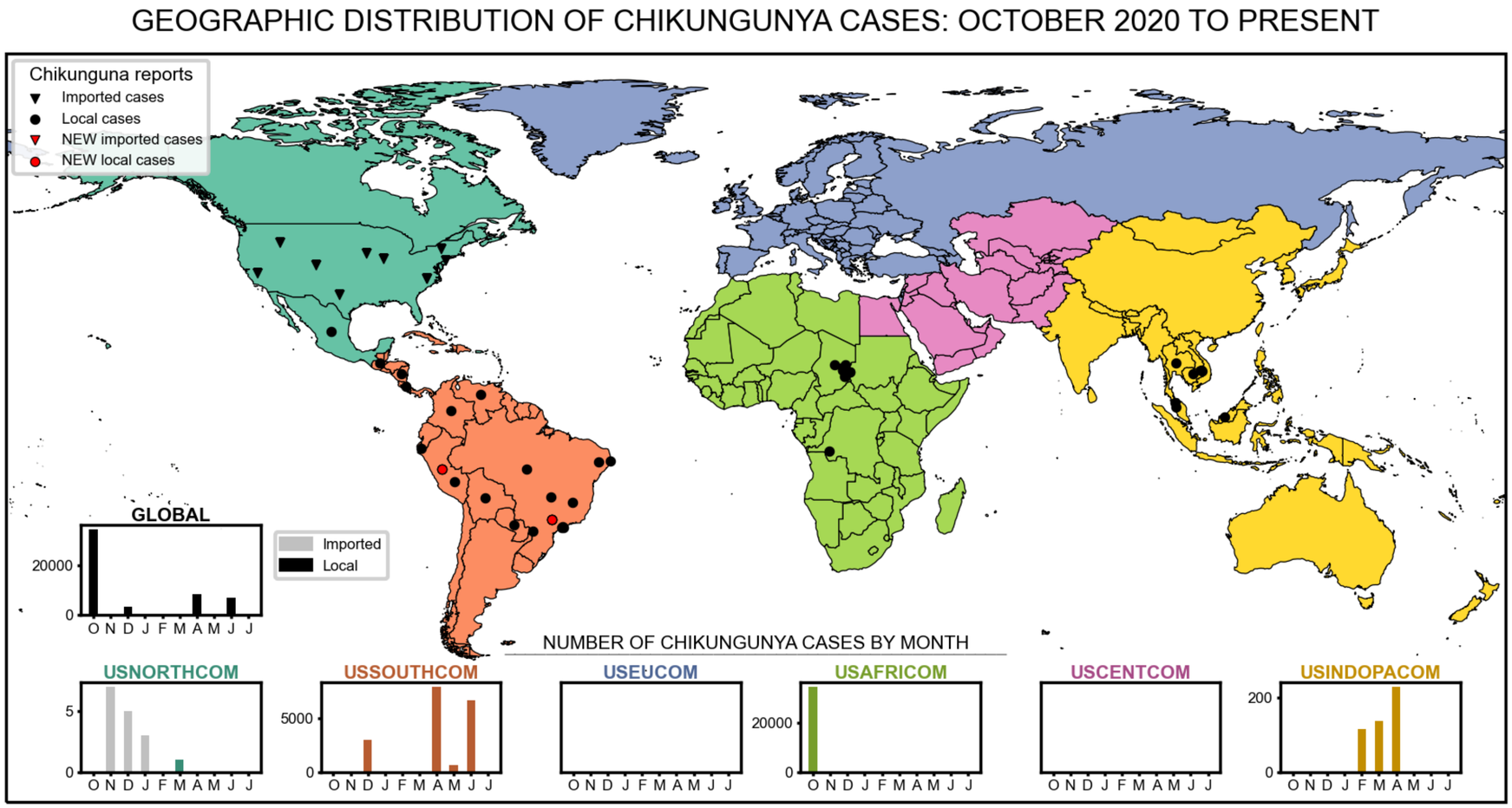


- Defense Health Agency/ Armed Forces Health Surveillance Branch - Global Emerging Infections Surveillance (AFHSB-GEIS)
- Pan-American Health Organization (PAHO)

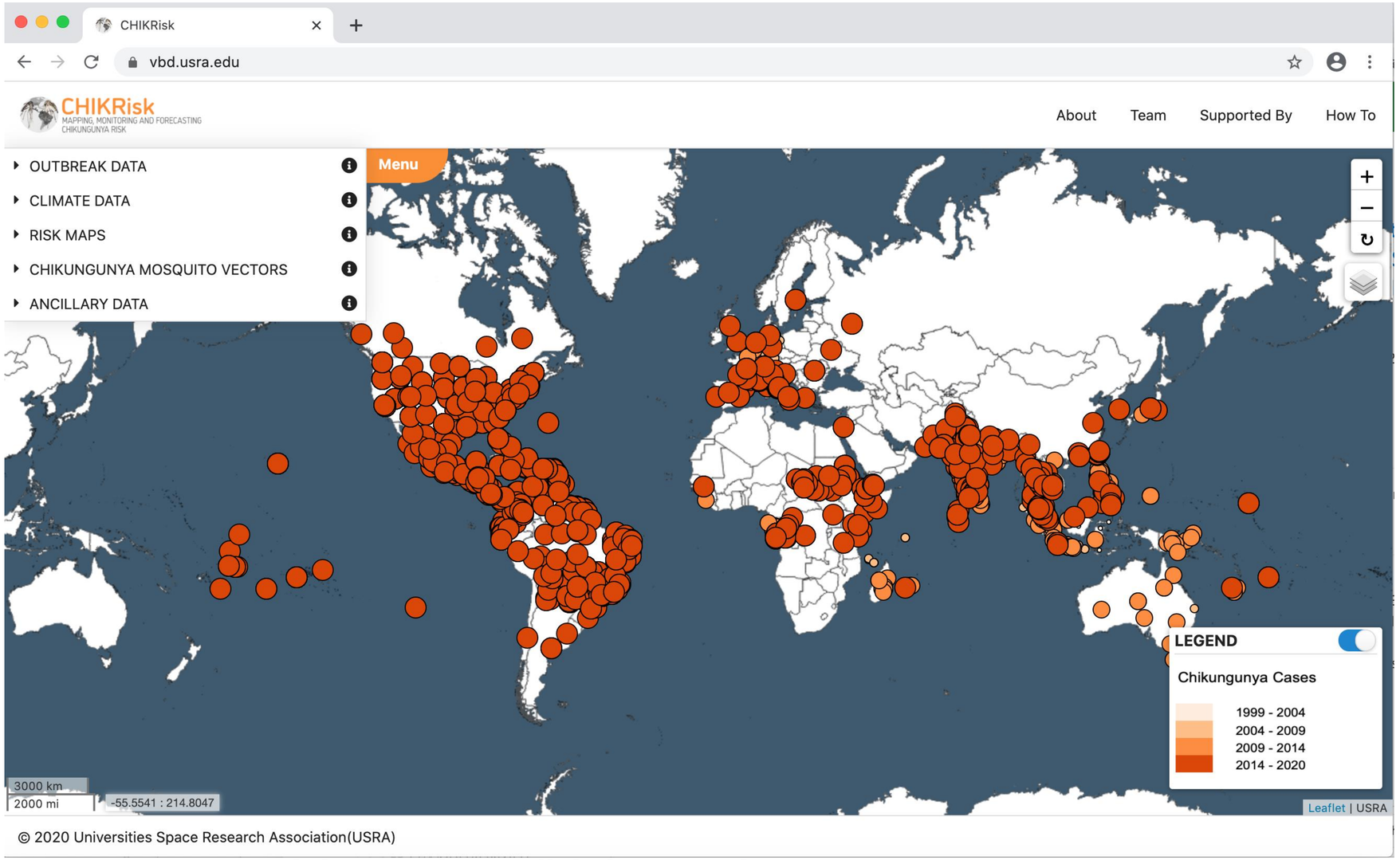
Turning Data into Information Products



Real Time Tracking for Situational Awareness

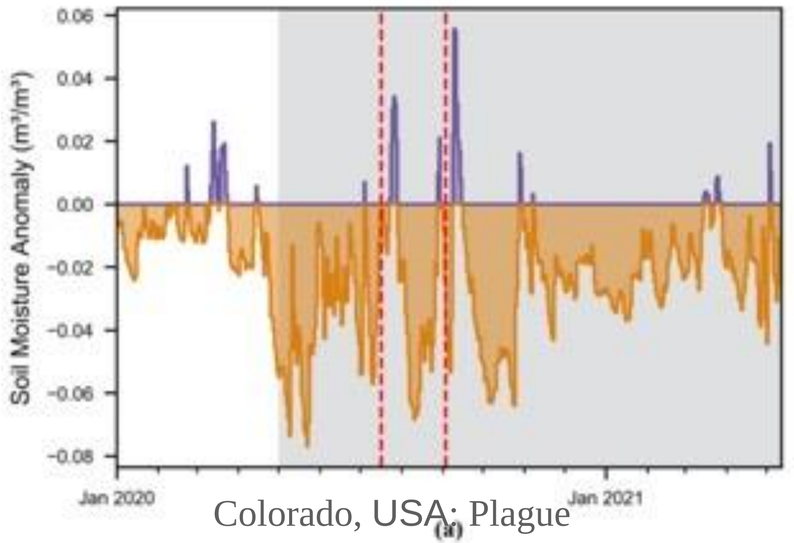


Building Publicly Accessible Applications

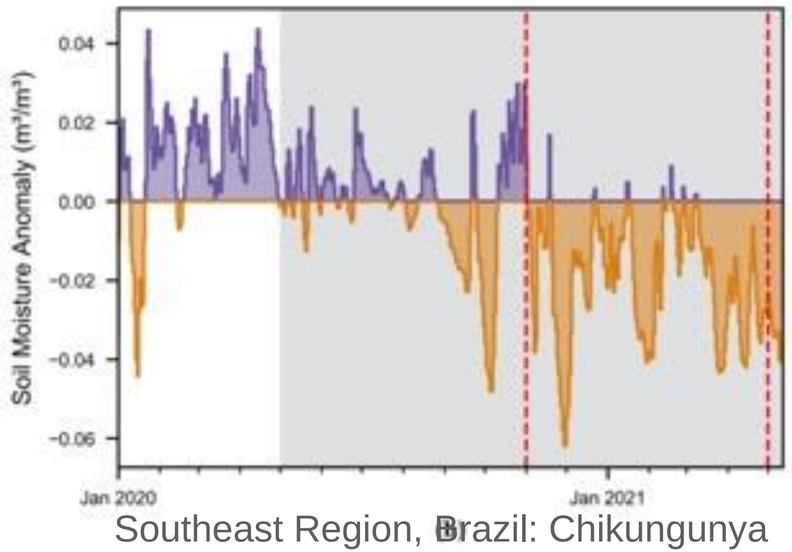


CHIKRisk App: https://vbd.usra.edu

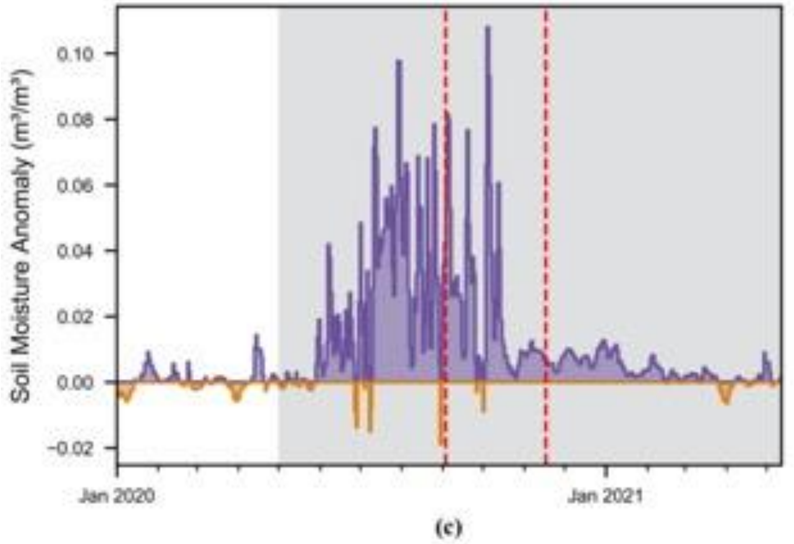
Soil Moisture Anomalies and Disease Outbreaks



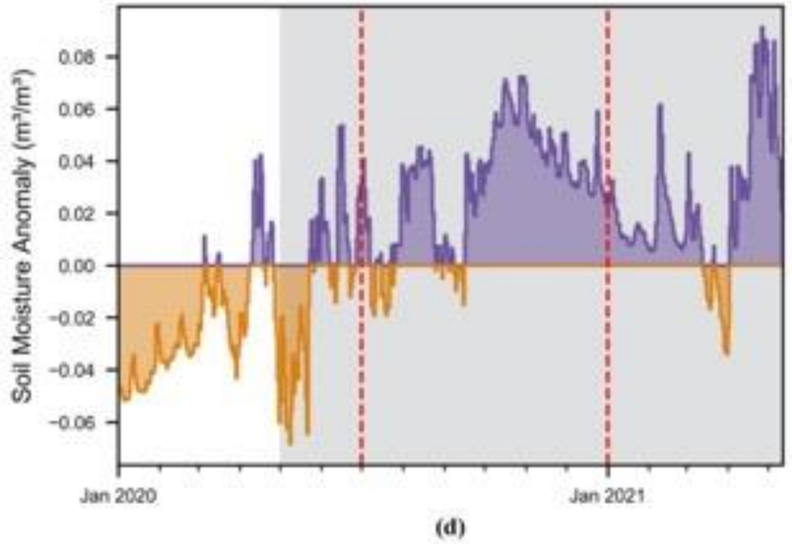
Colorado, USA: Plague



Southeast Region, Brazil: Chikungunya

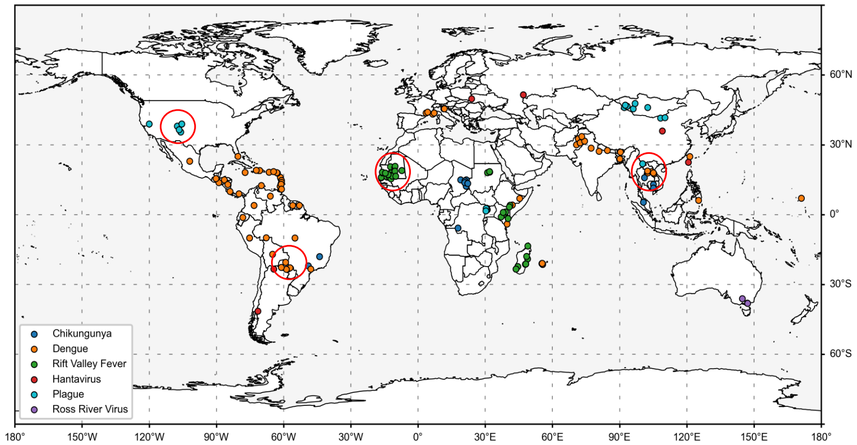


Mauritania: Rift Valley fever



Cambodia, Southeast Asia: Dengue.

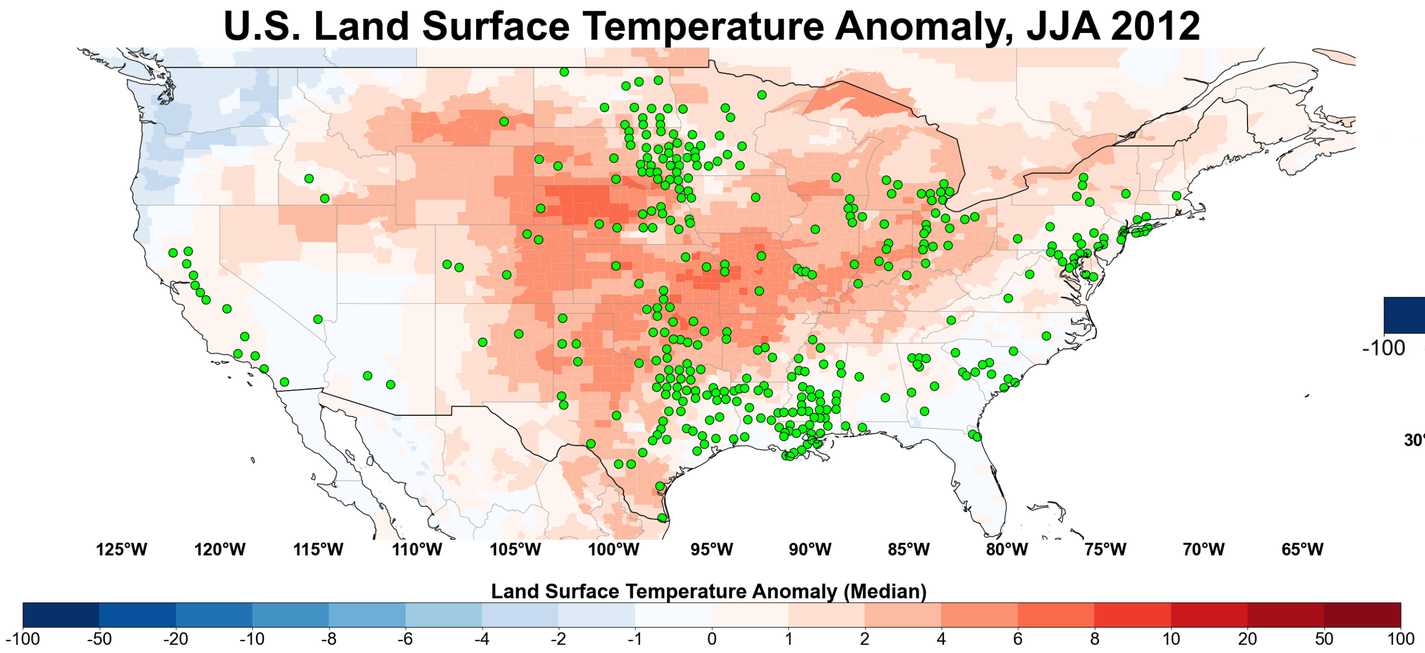
VBD Outbreaks May 2020 – April 2021

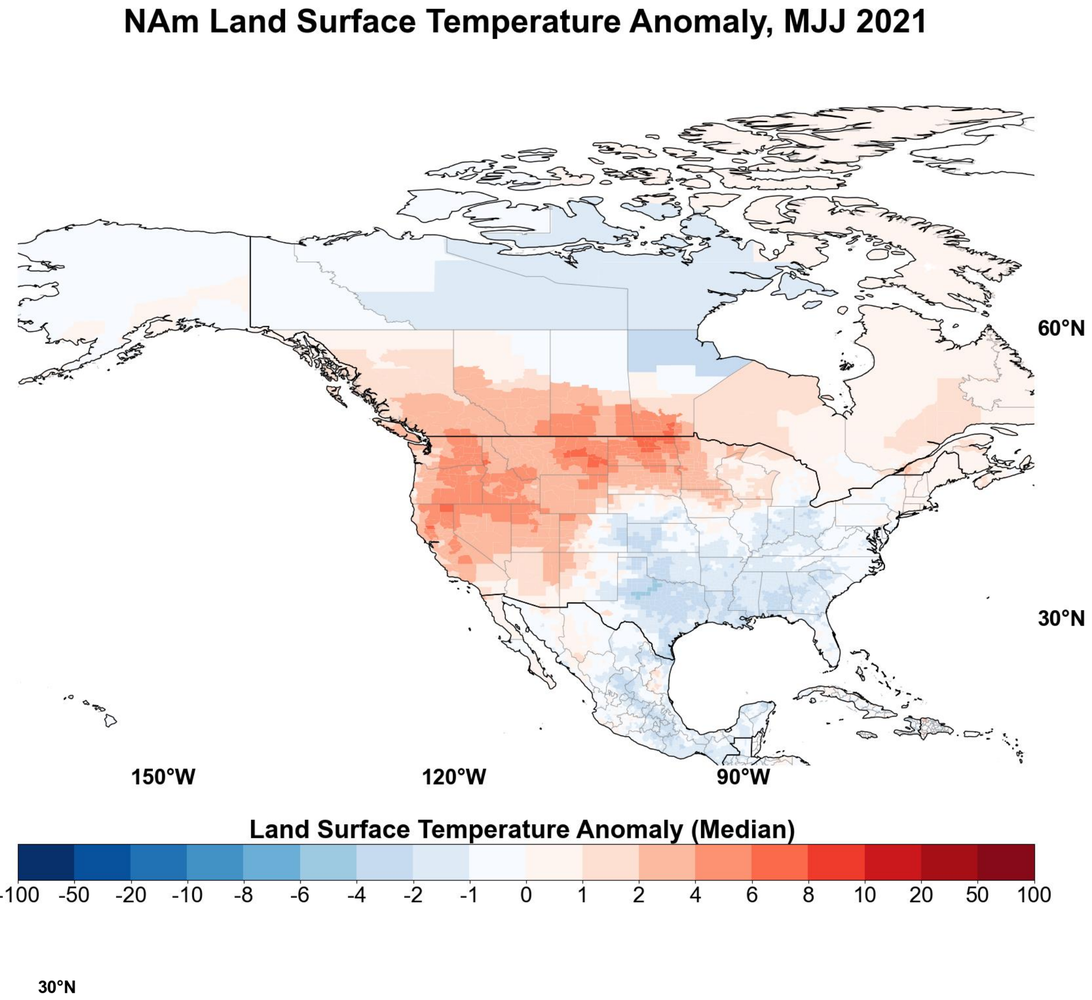


Soil Moisture Active Passive (SMAP)

Hot Summer 2021

Impact of increased temperatures on disease emergence
2012 – WNV Epidemic





Partnerships + Resources + Teamwork

GIMMS VBD Team

Dr. Assaf Anyamba, Jennifer Small, Bhaskar Bishnoi, Heidi Tubbs, Dr. Richard Damoah, Dr. Natalie Thomas
Dr. Compton J. Tucker

Collaborators

USDA/ARS-CMAVE
Dr. Kenneth J. Linthicum
Dr. Seth C.Britch

NOAA/CPC
Dr. Wassila Thiaw

PAHO
Dr. Ana Rivière Cinnamond

Dr. Stephanie Scholler Uz,
Applied Sciences Manager | Earth Sciences
NASA Goddard Space Flight Center

- **NASA Applied Sciences Program – Health and Air Quality (17-HAQ17-0065)**
- **NASA, Soil Moisture Active-Passive (SMAP) Mission Science Team (80NSSC21K0777)**

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APPLIED SCIENCES

Connecting Earth Observations to Emergency Department Visits following flooding

J Gohlke, B Ramesh,
S Swarup, B Zaitchik

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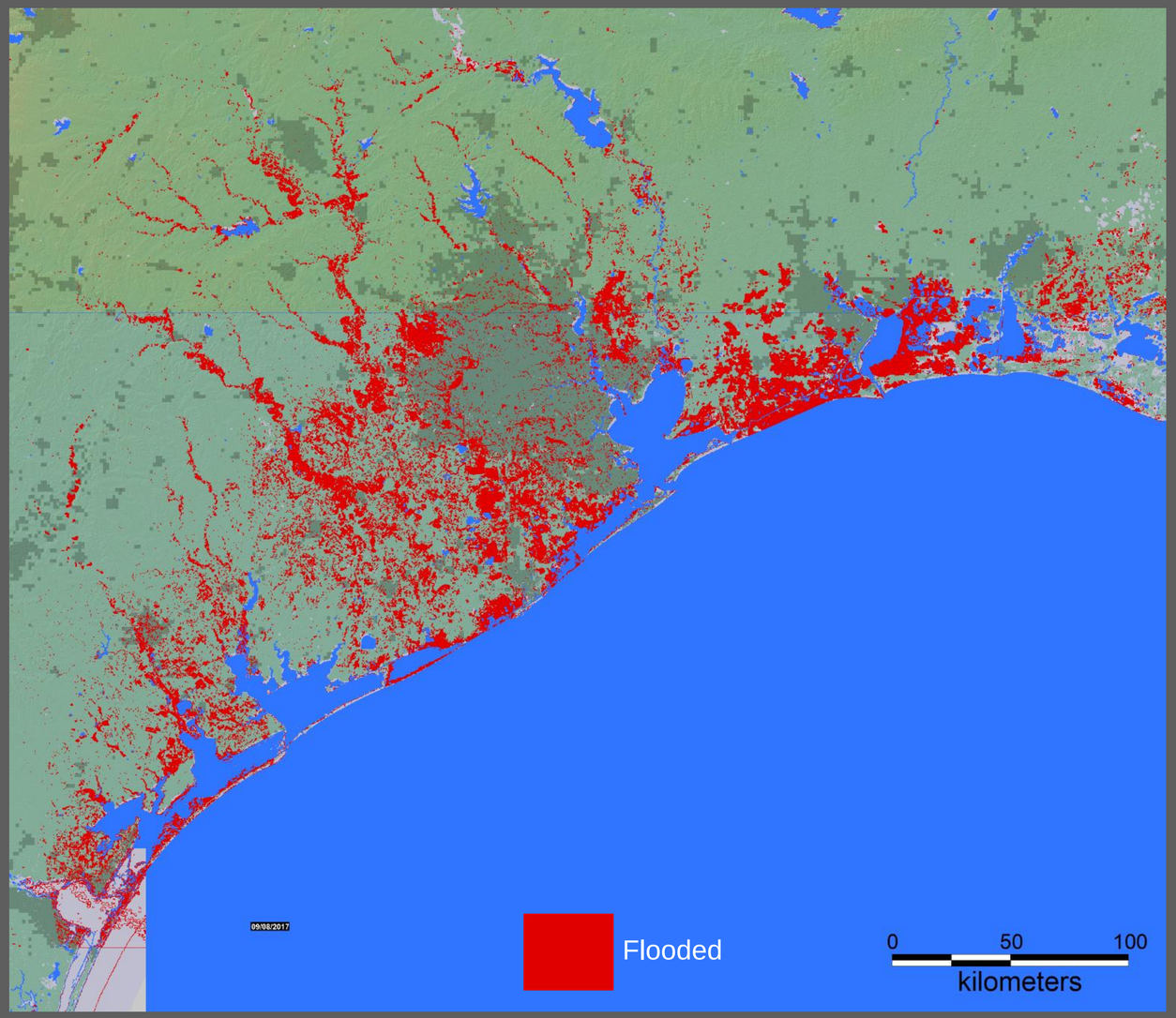
Health and Air Quality



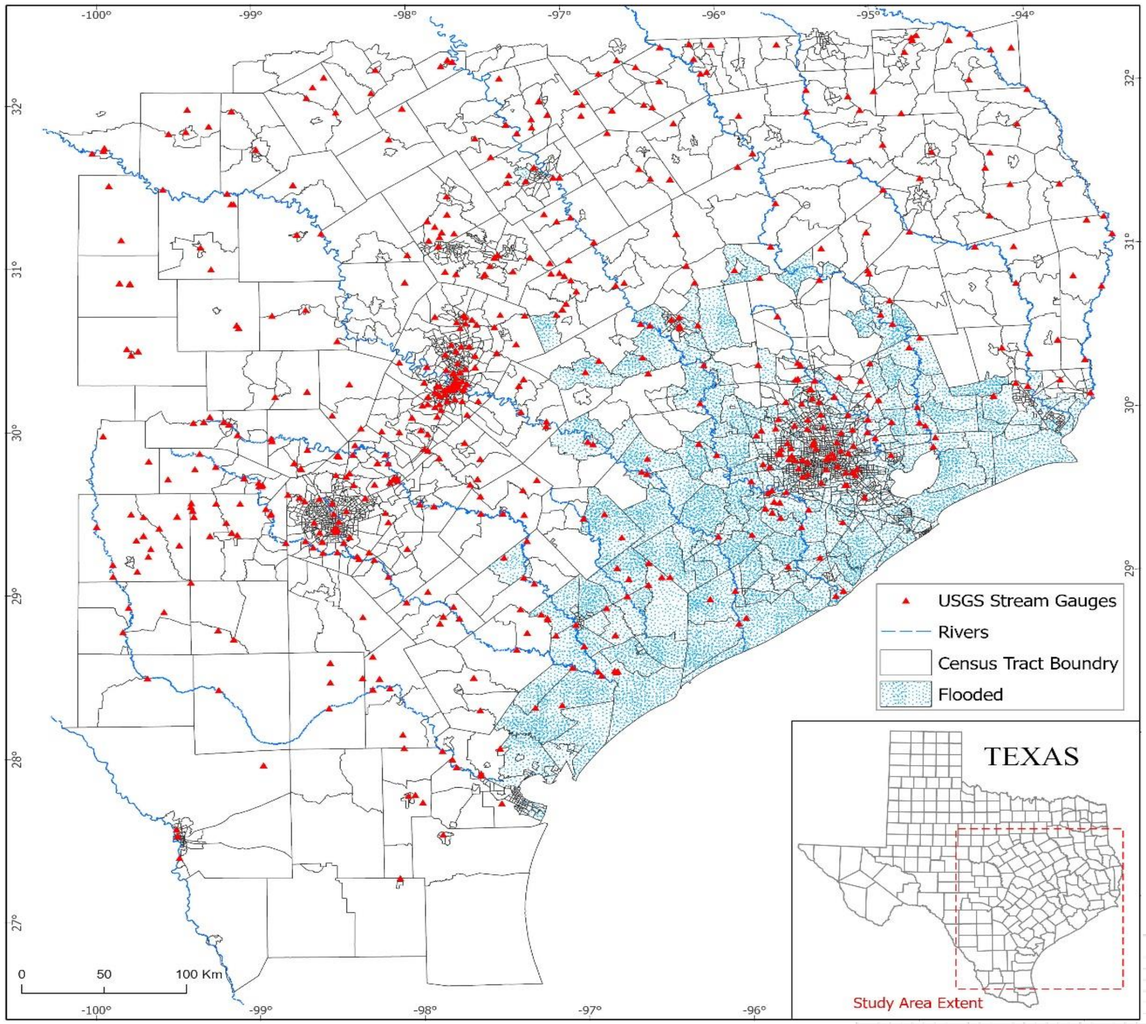
Inundation Data from Dartmouth Flood Observatory

Can EO data improve health related responses during flooding events?

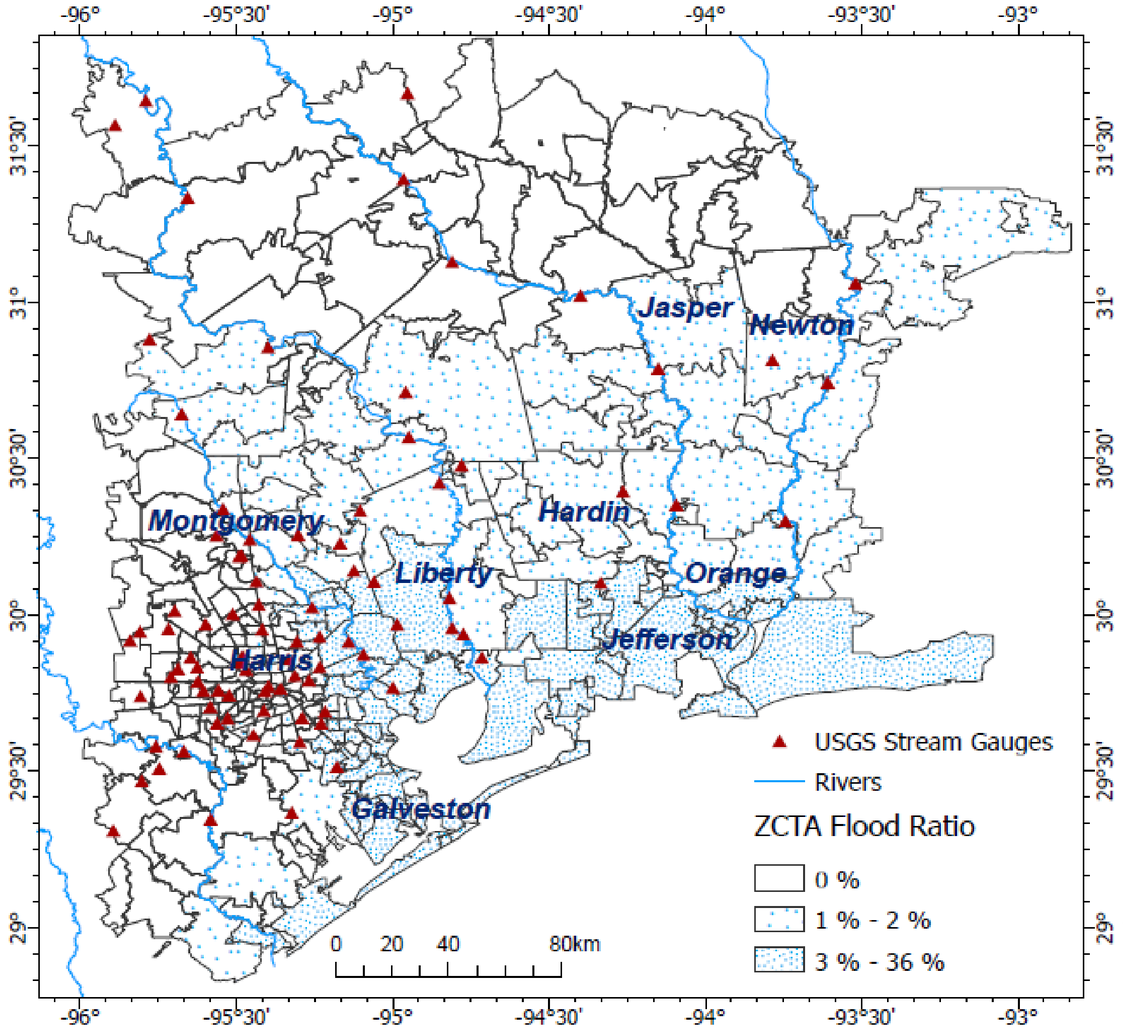
- Inundation and stream gauge data
- ED visit and syndromic surveillance during Harvey and Imelda
- CDC Social Vulnerability Index

Using EO to define spatiotemporal flooding extents during Hurricane Harvey (census tract) and Tropical Storm Imelda (ZCTA)

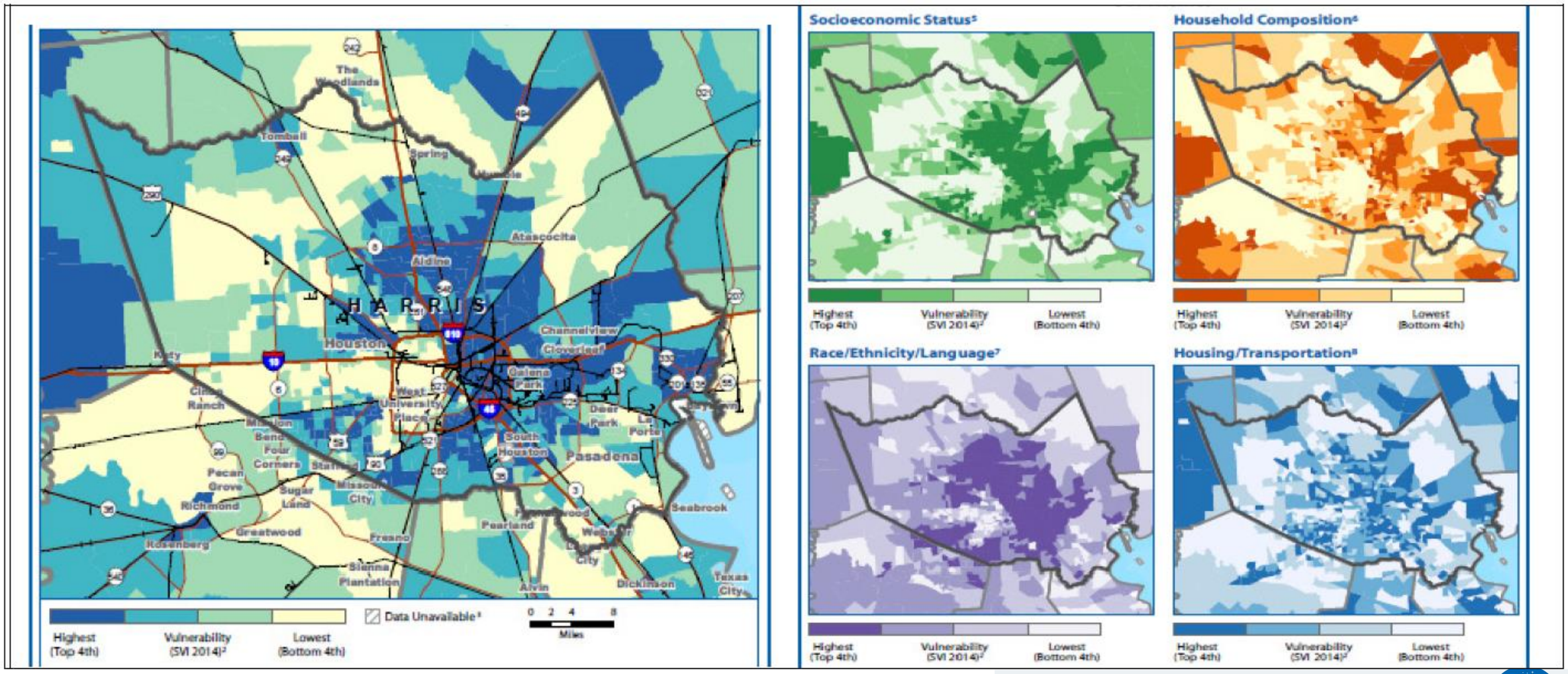
Hurricane Harvey (August 2017)



Tropical Storm Imelda (September 2019)

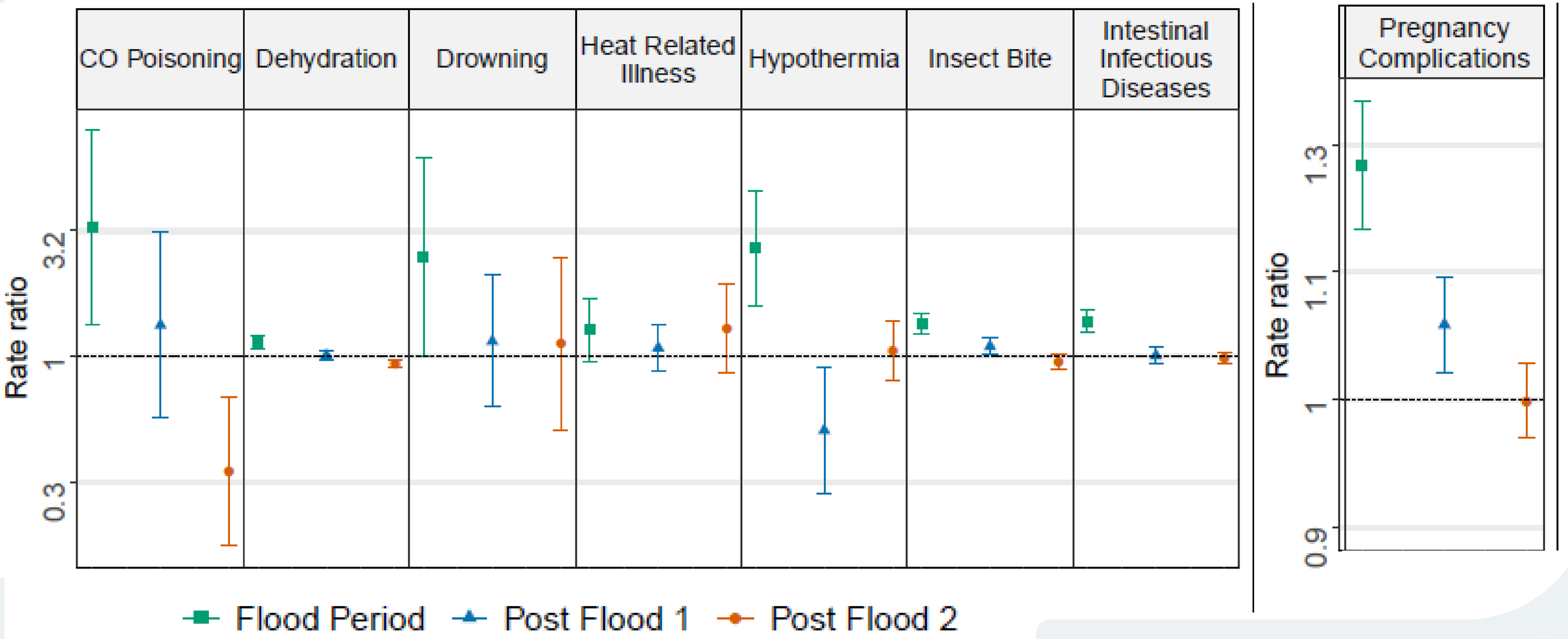


The CDC SVI is used to estimate the amount of needed supplies, locations of emergency shelters, assisted evacuations, and support response



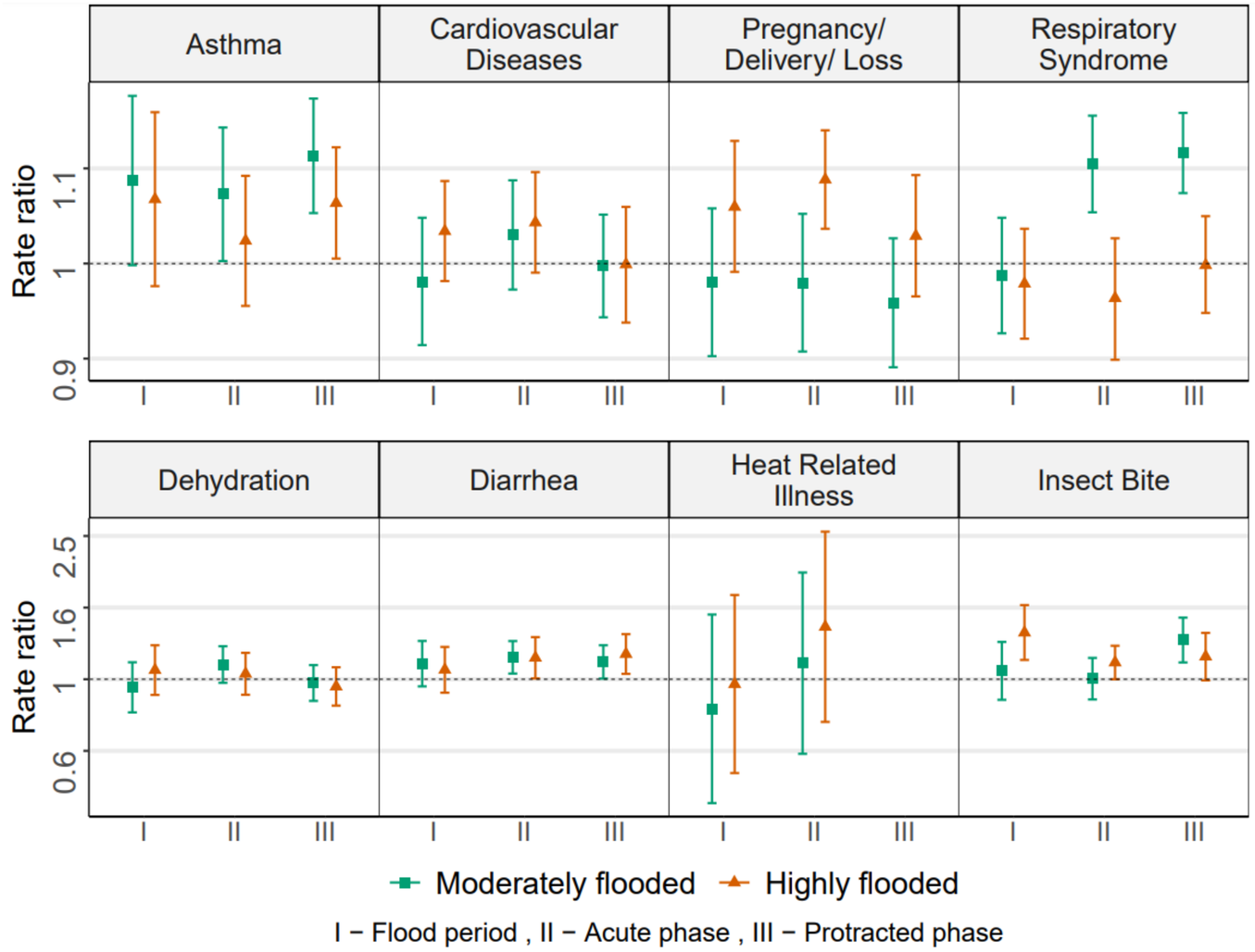
https://svi.cdc.gov/

ED visits for pregnancy complications, intestinal infections, insect bites were elevated following Hurricane Harvey

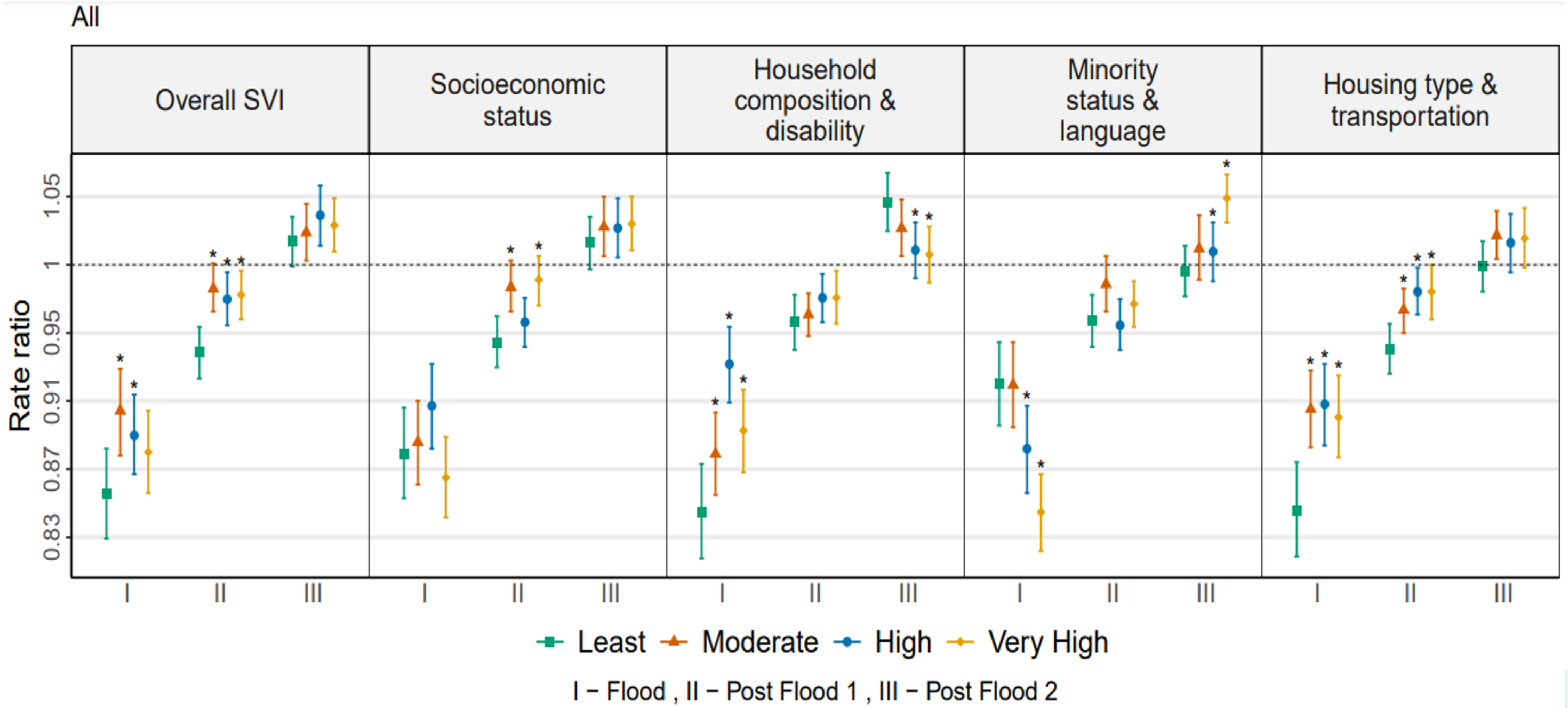


Ramesh et al. (2021) *JESEE*

Tropical Storm Imelda: similar increases in cause-specific ED visits, particularly in highly flooded ZCTAs

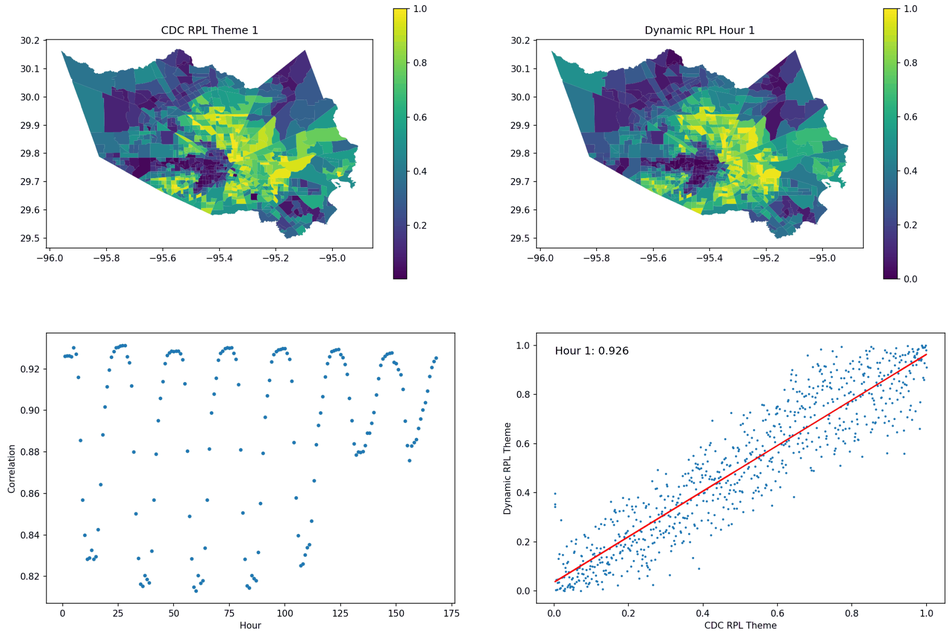


Census tract CDC SVI modifies the effect between flooding and ED visits



Conclusions and Next Steps

Synthetic population of Harris County, TX compared to CDC SVI



EO data can be used to improve characterization of flood-related health outcomes when combined with healthcare visit data

Next steps

- Exposures beyond the home census tract or ZCTA can be modeled via a synthetic population to further refine exposures.
- Inundation data could be incorporated into real-time syndromic surveillance systems to improve situational awareness at health departments.

EARTH SCIENCE
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Yonkers Urban Development

Utilizing NASA Earth Observations to Identify Environmental and Social Drivers of Urban Heat Vulnerability and Model Urban Cooling Interventions in Yonkers, NY

Jillian Walechka*, Oded Holzinger* (Groundwork USA), Tanya Bils, Kathryn Greenler, Samain Sabrin, & Joseph Scarmuzza

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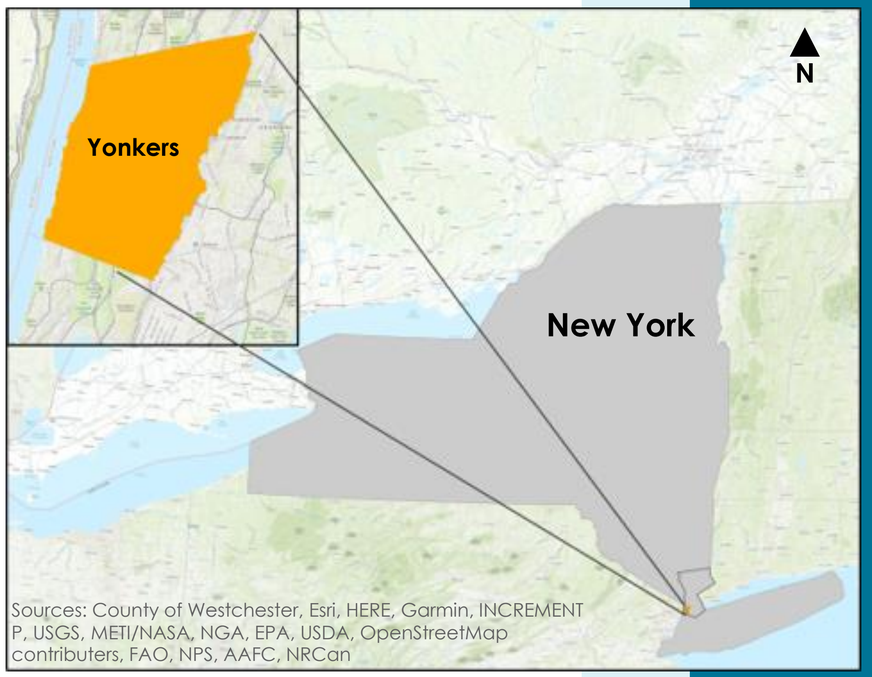
GROUNDWORK Hudson Valley

CHANGING PLACES CHANGING LIVES

Groundwork Hudson Valley creates sustainable environmental change in urban neighborhoods through community-based partnerships that promote equity, youth leadership, and economic opportunity.

Sustainability Education

Youth Leadership



City of Yonkers, New York

- Population: 201K
- Climate: Humid continental hot summers
- 35% Hispanic/Latino
- Founded in 1646, grew from farming village around Saw Mill River

Climate Resilience

YONKERS GREENWAY

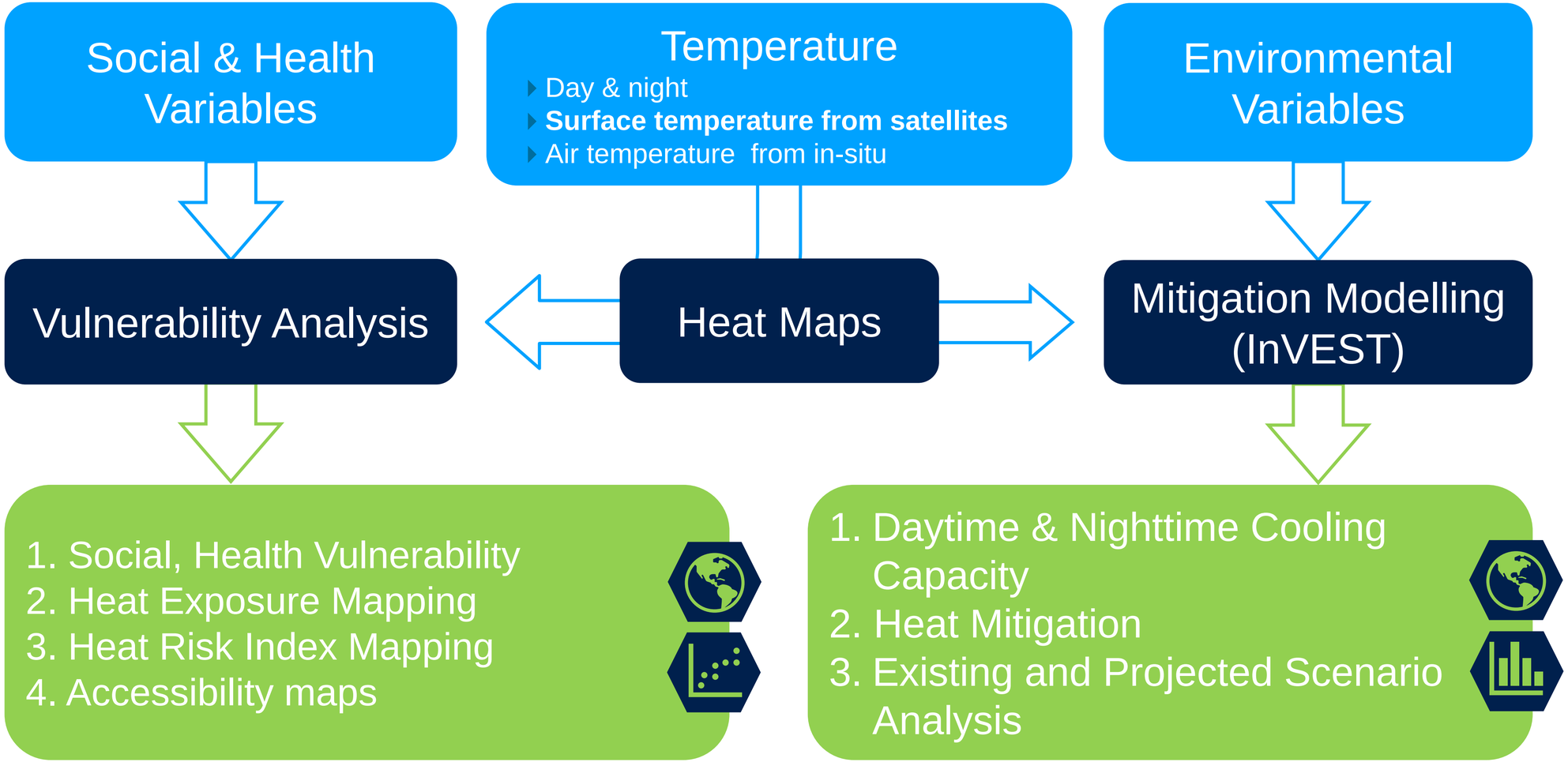
Saw Mill River COALITION

CLIMATE SAFE NEIGHBORHOODS

GROUNDWORK Hudson Valley

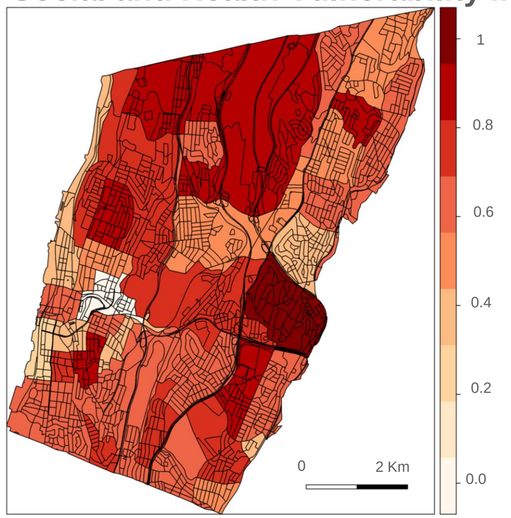
CHANGING PLACES CHANGING LIVES

Methodology: Overview



Results: Heat Vulnerability Index + Proximity Analysis

Social and Health Vulnerability in Yonkers, NY



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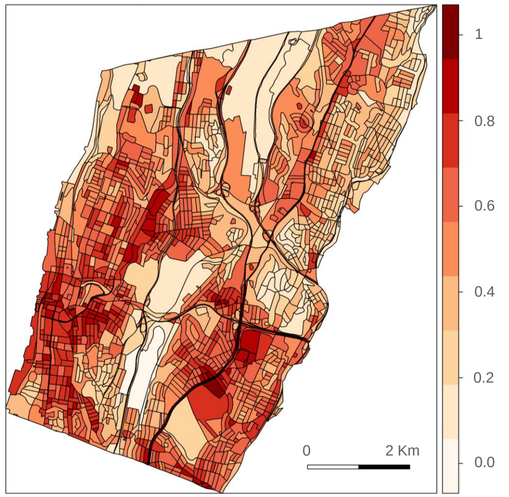
Heat Exposure in Yonkers, NY



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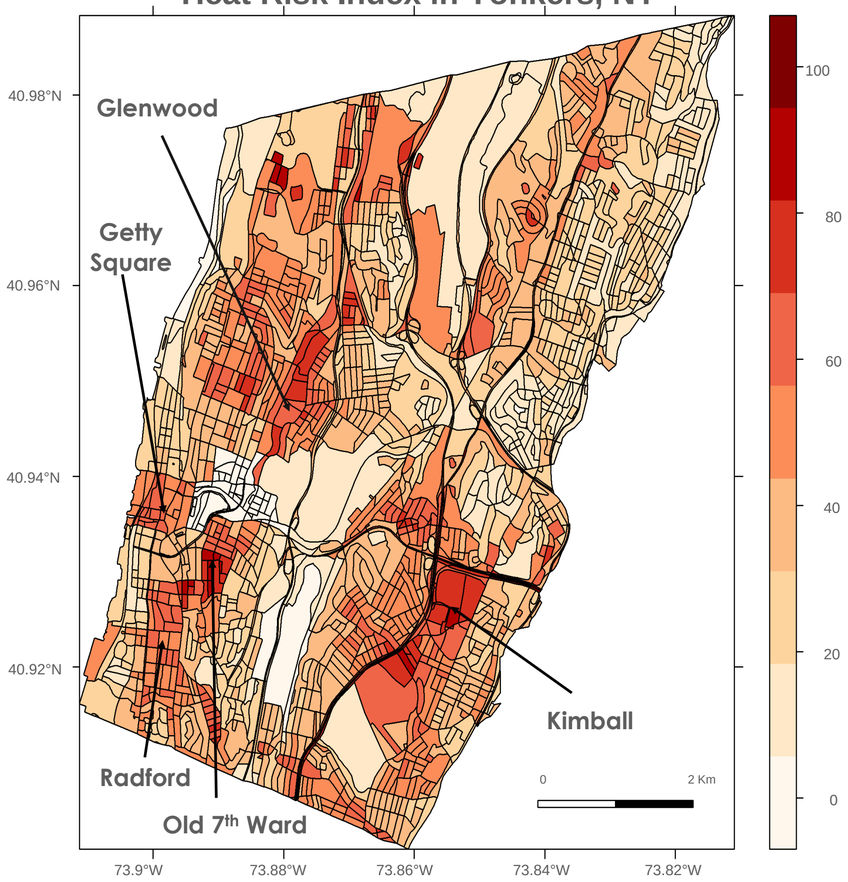
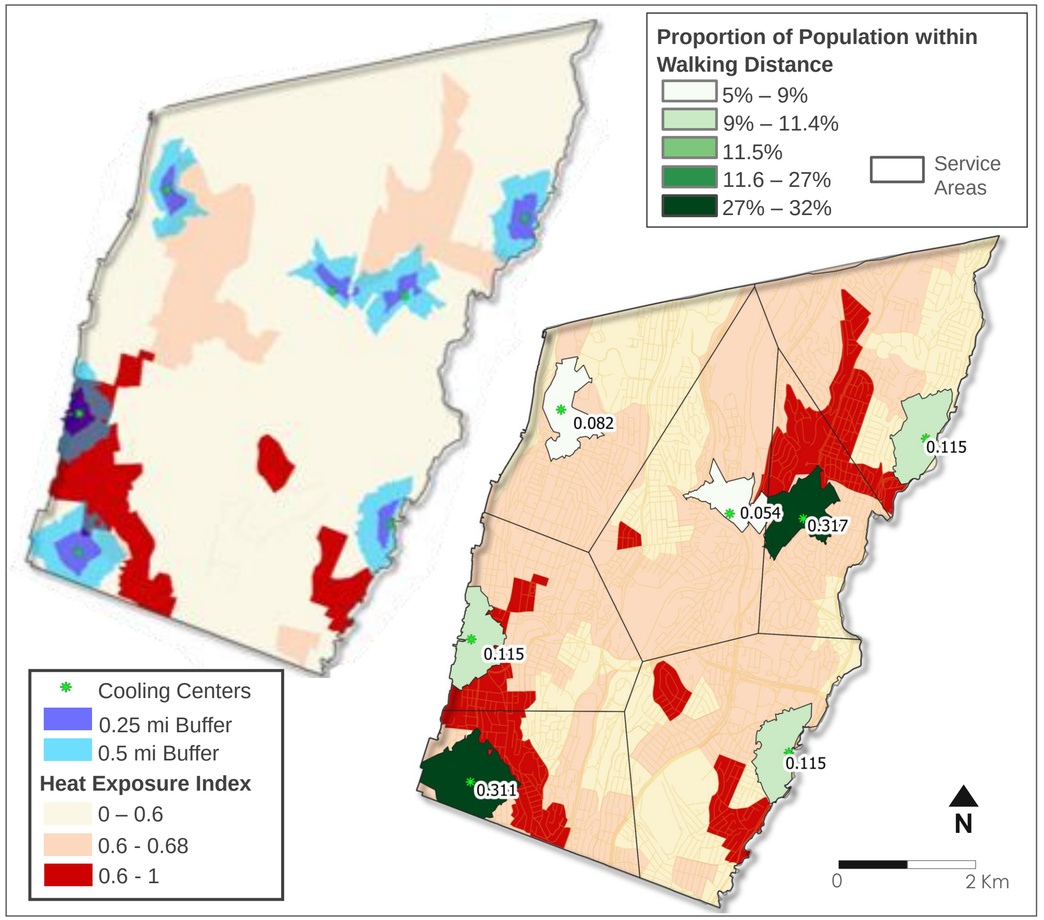
Heat Risk Index in Yonkers, NY

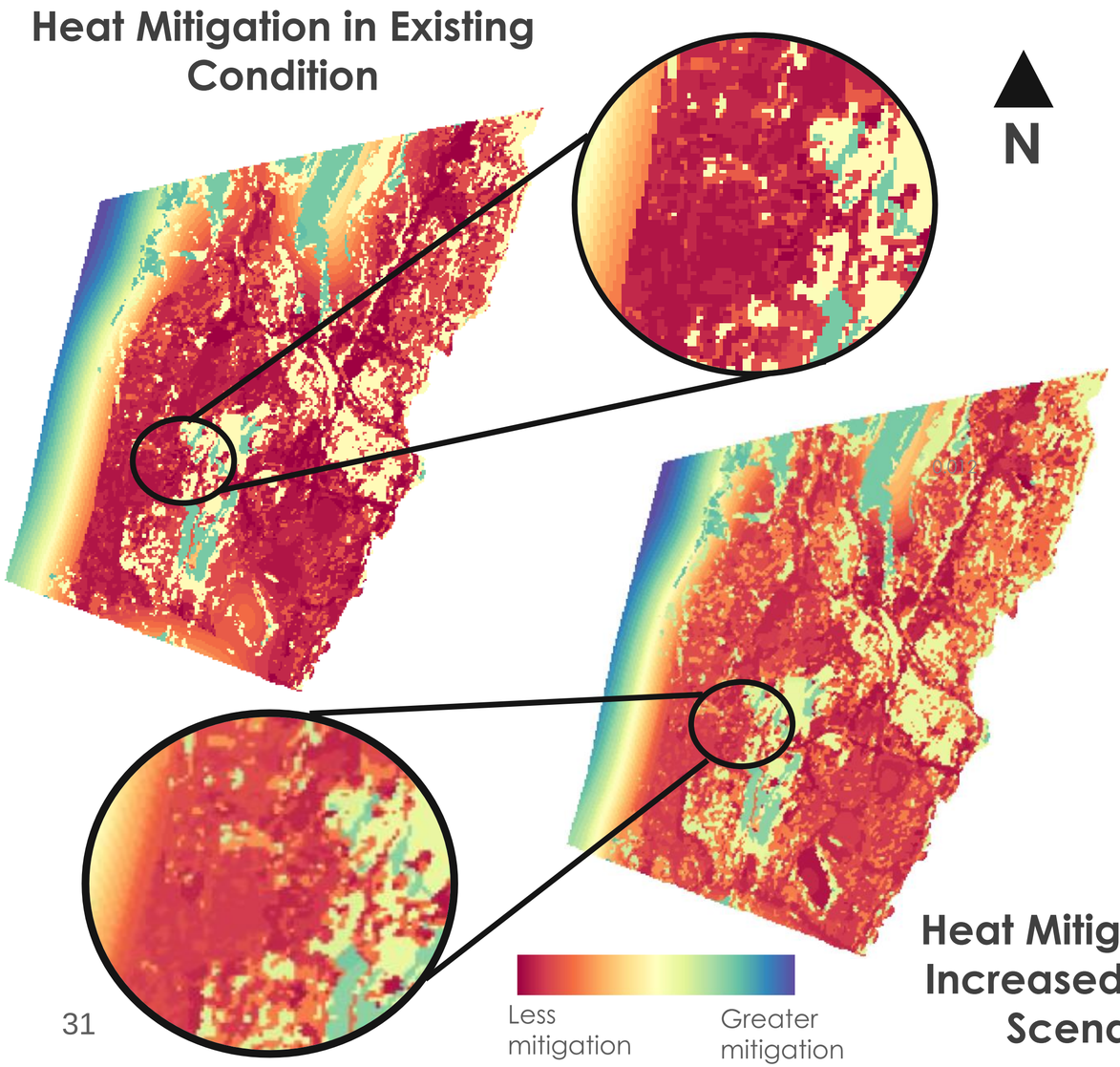


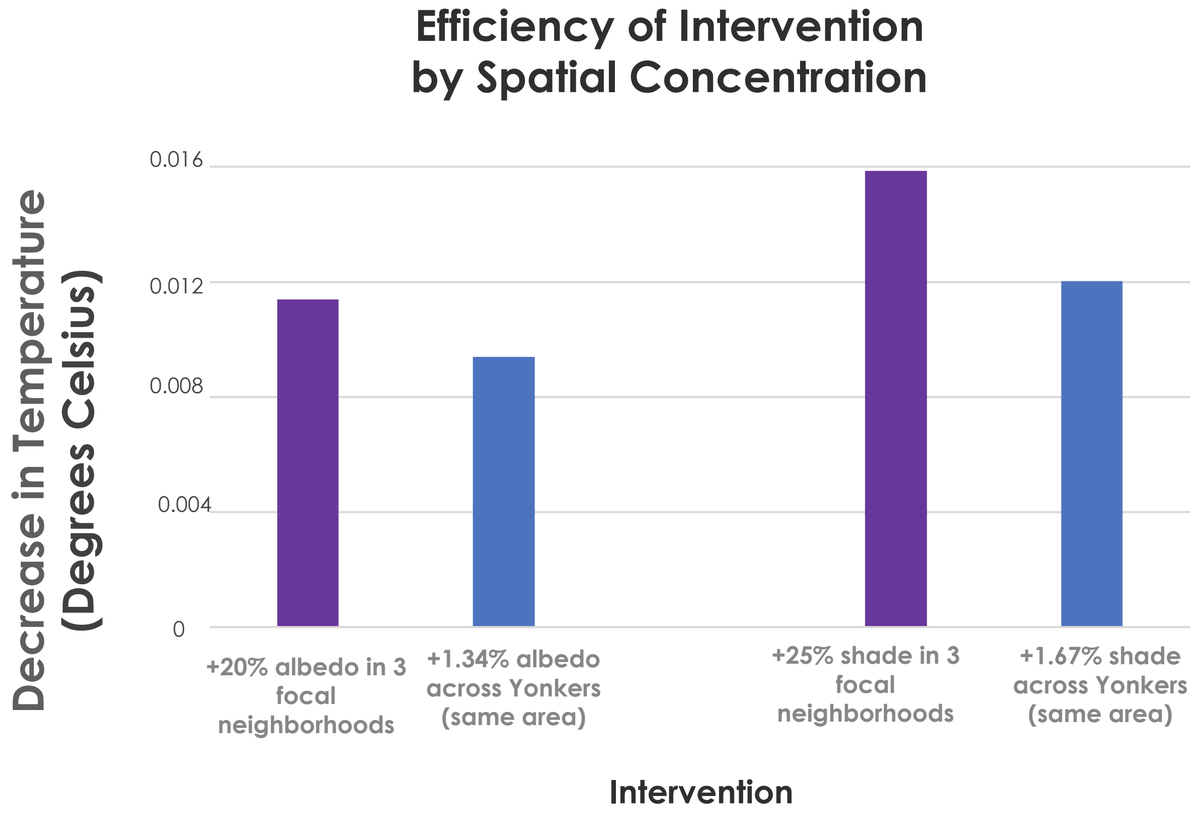


Neighborhood Characteristics

- High population densities
- High rates of renters
- Over 50% no college
- Over 35% not U.S.-born

Results: InVEST Model Heat Mitigation

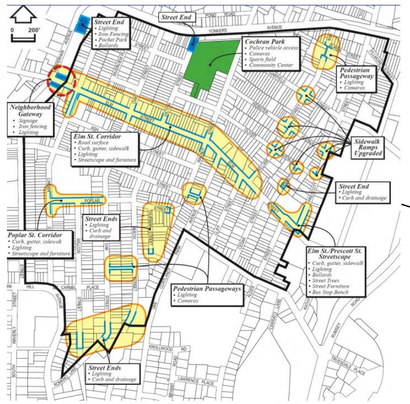


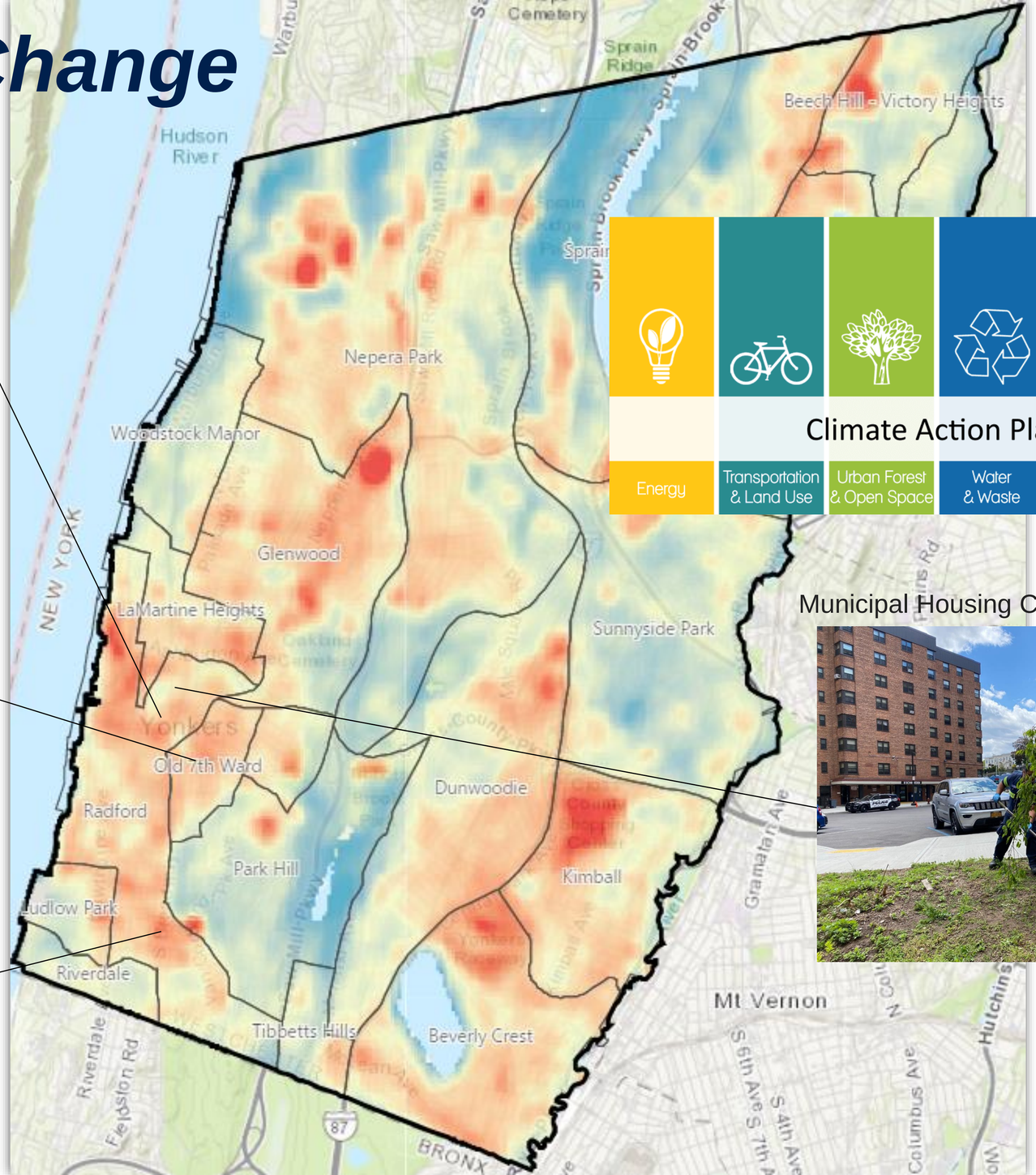


Vehicles of Change

Downtown Redevelopment

Neighborhood Master Plan





Climate Action Plan

Energy	Transportation & Land Use	Urban Forest & Open Space	Water & Waste	Public Involvement	Municipal Operations

Municipal Housing Construction Projects

YONKERS GREENWAY

GROUNDWORK Hudson Valley
CHANGING PLACES CHANGING LIVES

Acknowledgements

A special thank you to our Science Advisors, Mentors and Fellow for their direction and support:

- Dr. David Hondula (Arizona State University, Associate Professor)
- Dr. Kenton Ross (NASA Langley Research Center)
- Lauren Childs-Gleason (NASA Langley Research Center)
- Ryan Hammock (NASA DEVELOP, Fellow/Lead)

We would also like to thank our wonderful project partner and collaborator at Groundwork USA, Groundwork Hudson Valley:

- Oded Holzinger, Climate Resilience Manager of Groundwork Hudson Valley

EARTH SCIENCE
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Air Quality Monitoring & Forecasting in Thailand

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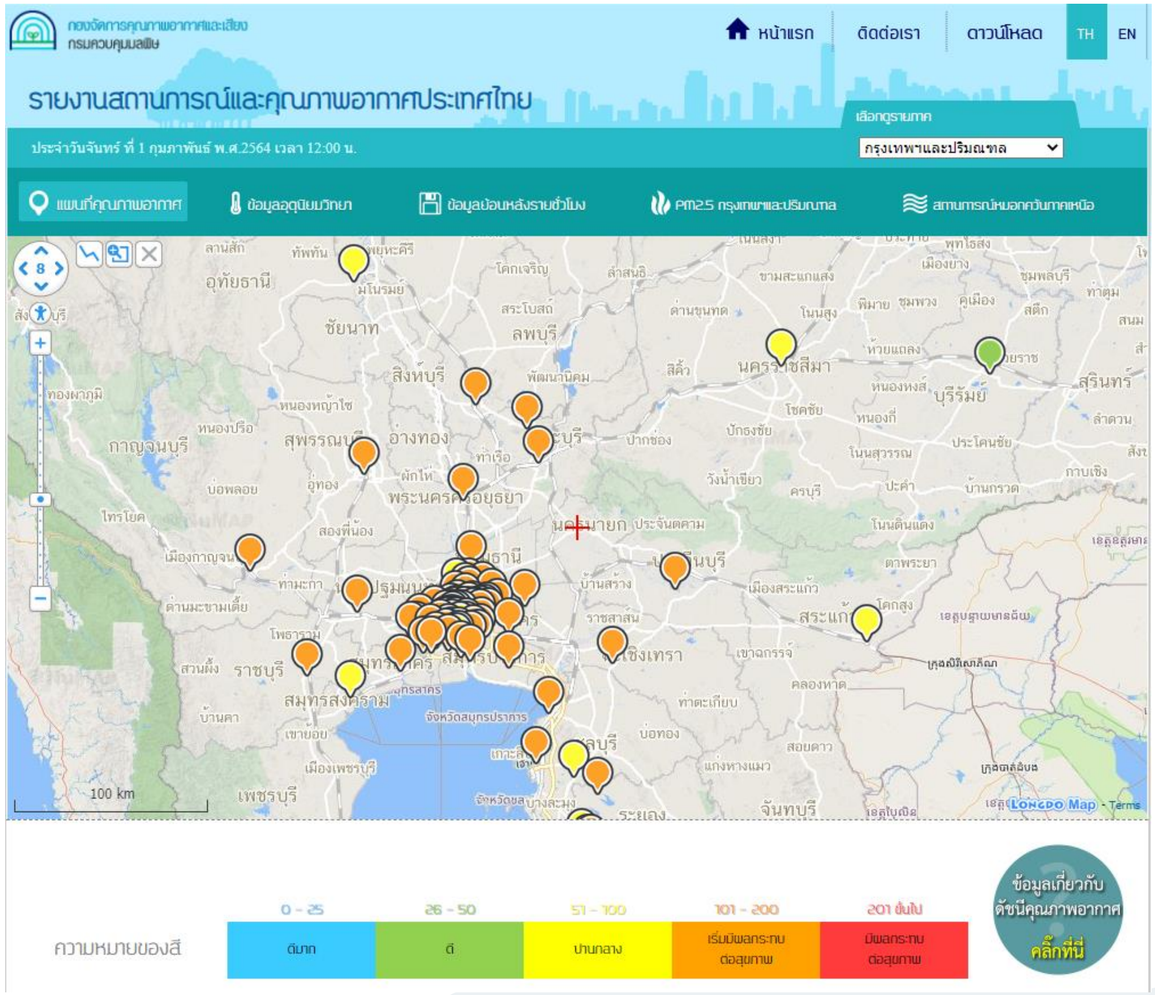
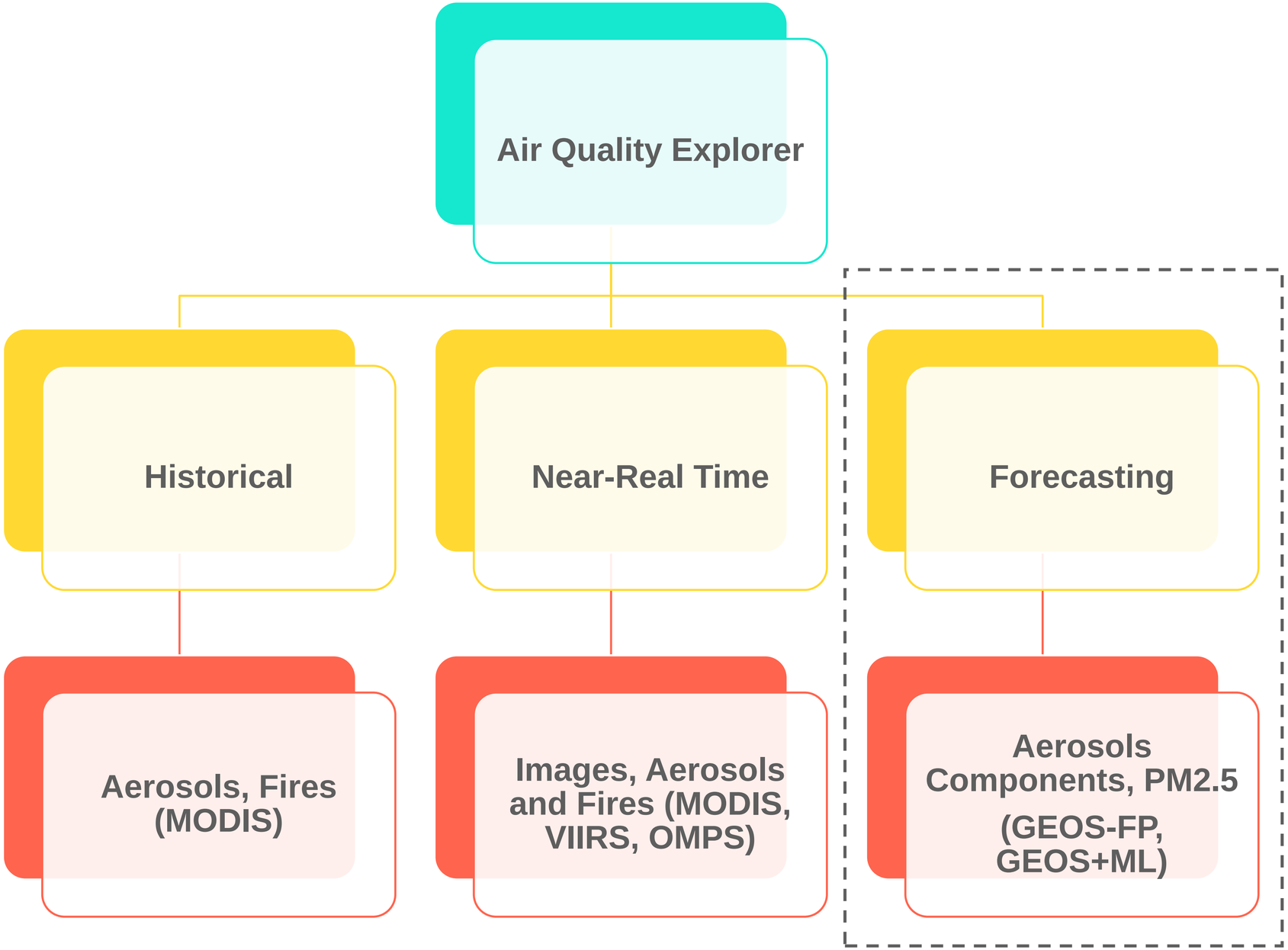
SERVIR focuses on countries in Asia, Africa, & the Americas

Air Quality Monitoring in Thailand

- The Royal Thai Pollution Control Department monitor air quality in Thailand from over 60+ stations.
- The major sources include fossil fuel burning, roadside dust, seasonal biomass burning and transboundary pollution
- PCD have limited or no forecasting capabilities for the region.
- NASA SERVIR in partnership with PCD and GISTDA started air quality research and co-development in 2019.



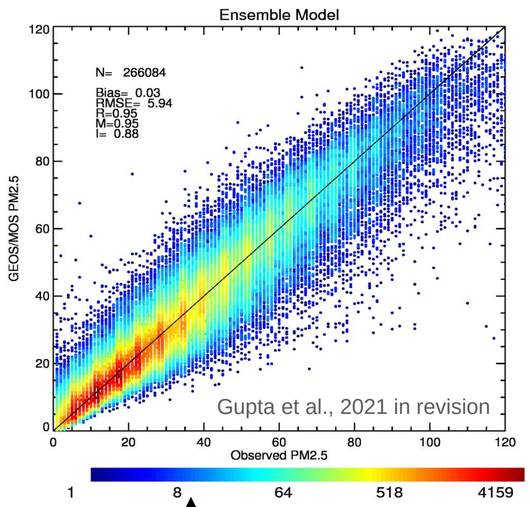
Air Quality Explorer (Service) For Thailand



37

Forecasting Framework

https://aqatmekong-servir.adpc.net/en/



Surface

Satellite

Model

Input Data

MOS-ML

Data

Data

Data

Estimated PM2.5 (μgm^{-3})

Real Time Validation (PCD)

AQI AIR QUALITY INDEX 200 150 100 50

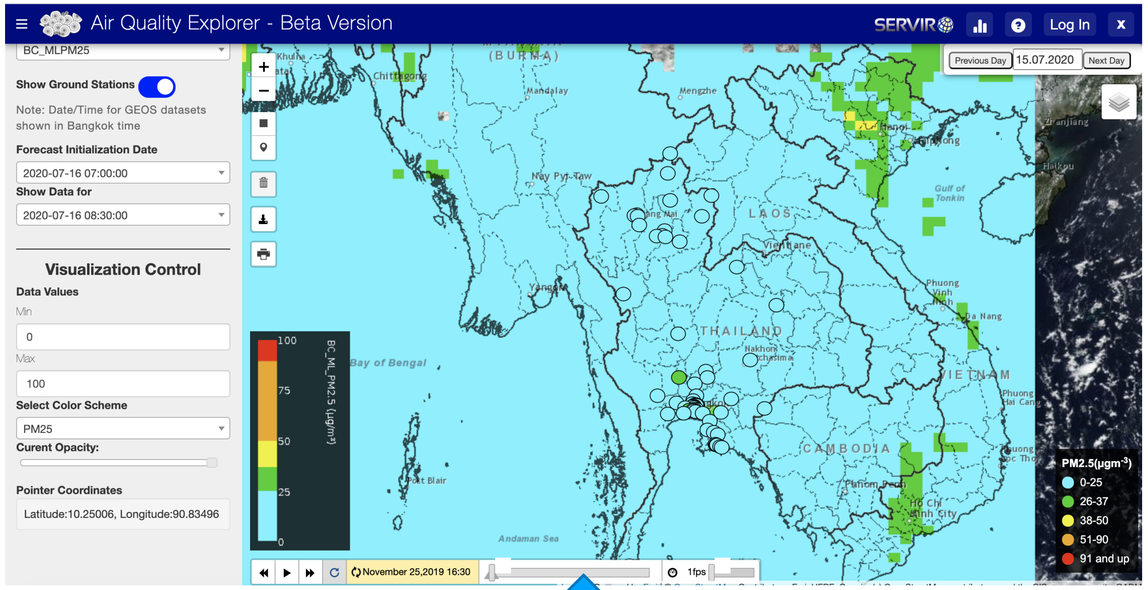
Good

Moderate

Unhealthy for Sensitive Groups

Generally Unhealthy

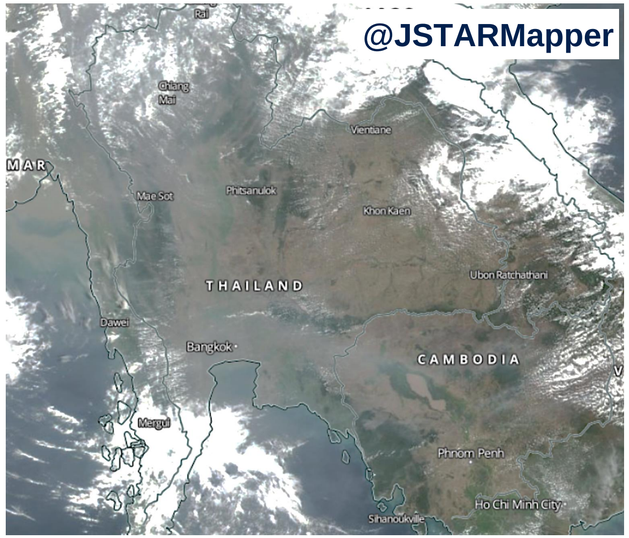
Very Unhealthy



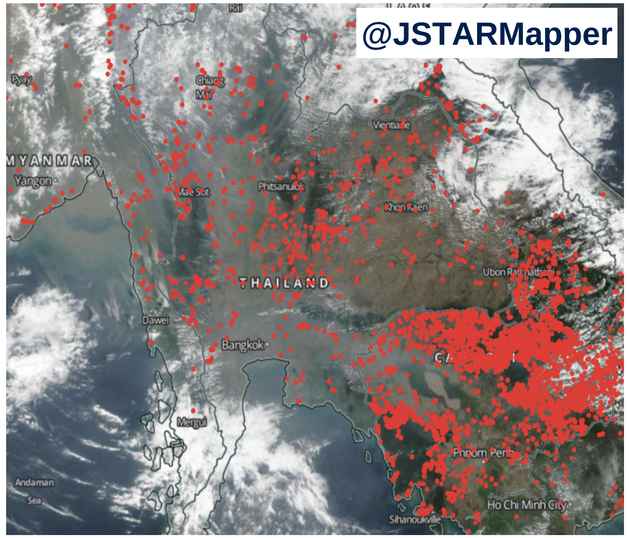
API & Phone Apps

Online Visualization Tools and Web based Data Archives

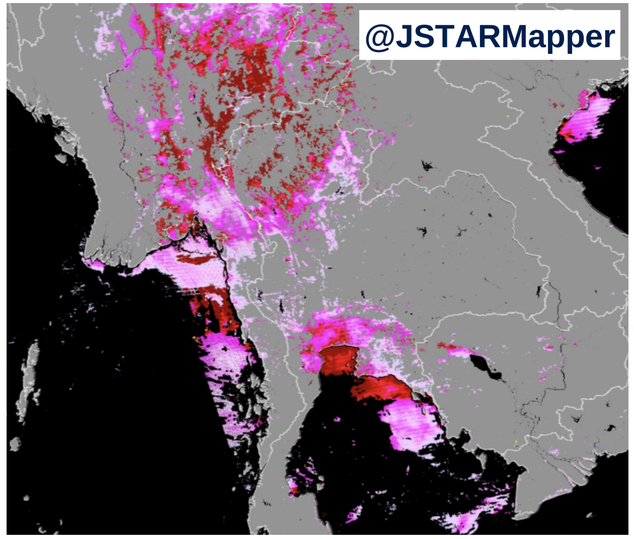
Air Quality Event Example (Feb 18, 2021)



Suomi-NPP VIIRS, RGB

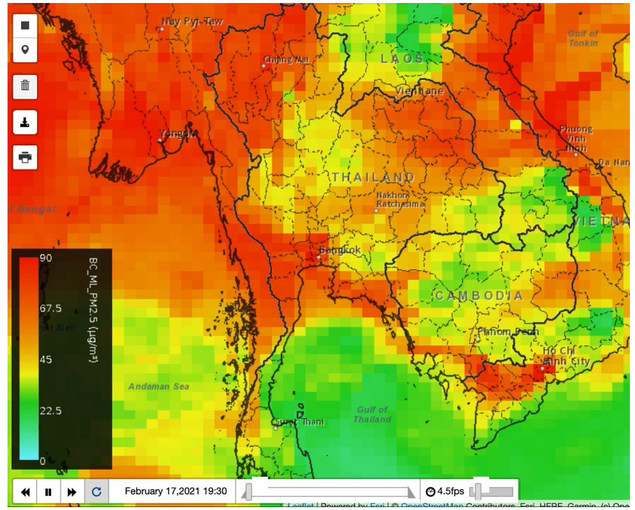


Suomi-NPP VIIRS, Fires



Suomi-NPP VIIRS, Smoke Mask

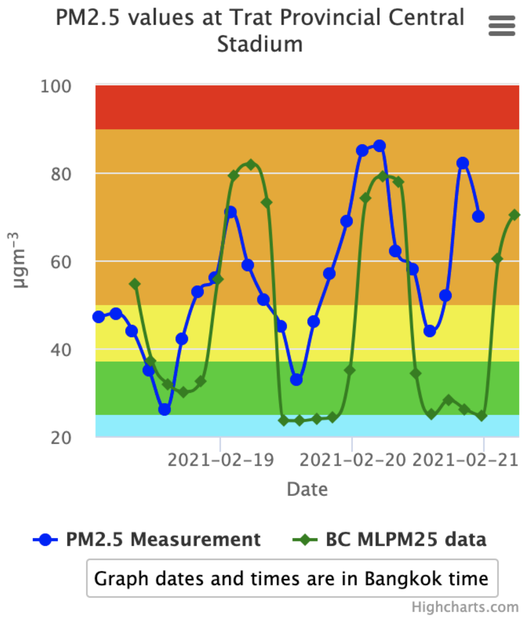
Air Quality Explorer

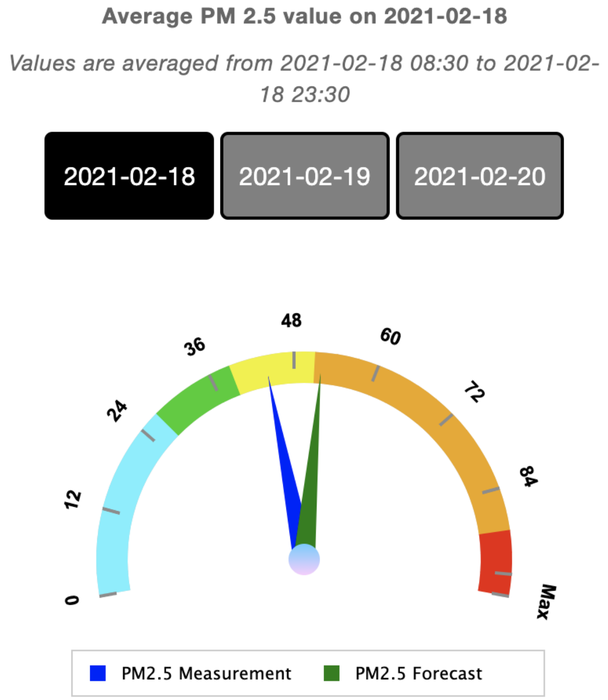


GEOS-FP + MLA – PM2.5

Real Time Validation and Other Applications

Forecast is initiated on Feb 18th



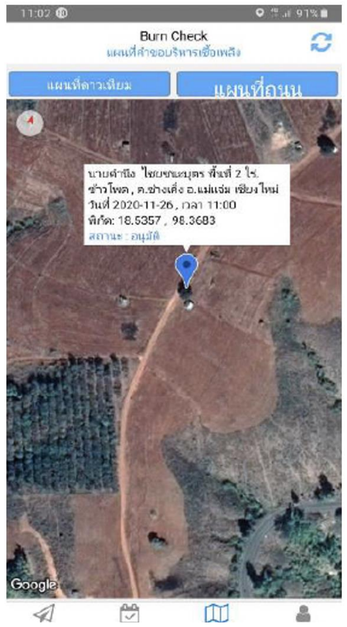


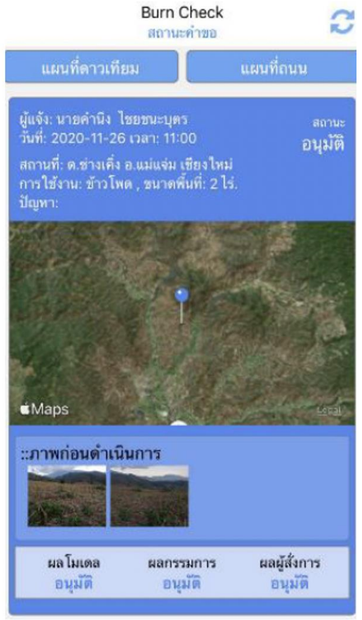
PM2.5 index is based on Thai Pollution Control Department standard

Air quality is very good	Good air quality	Moderate air quality	Air quality began to affect health	Affecting health

Real-time Validation with Ground Measurement

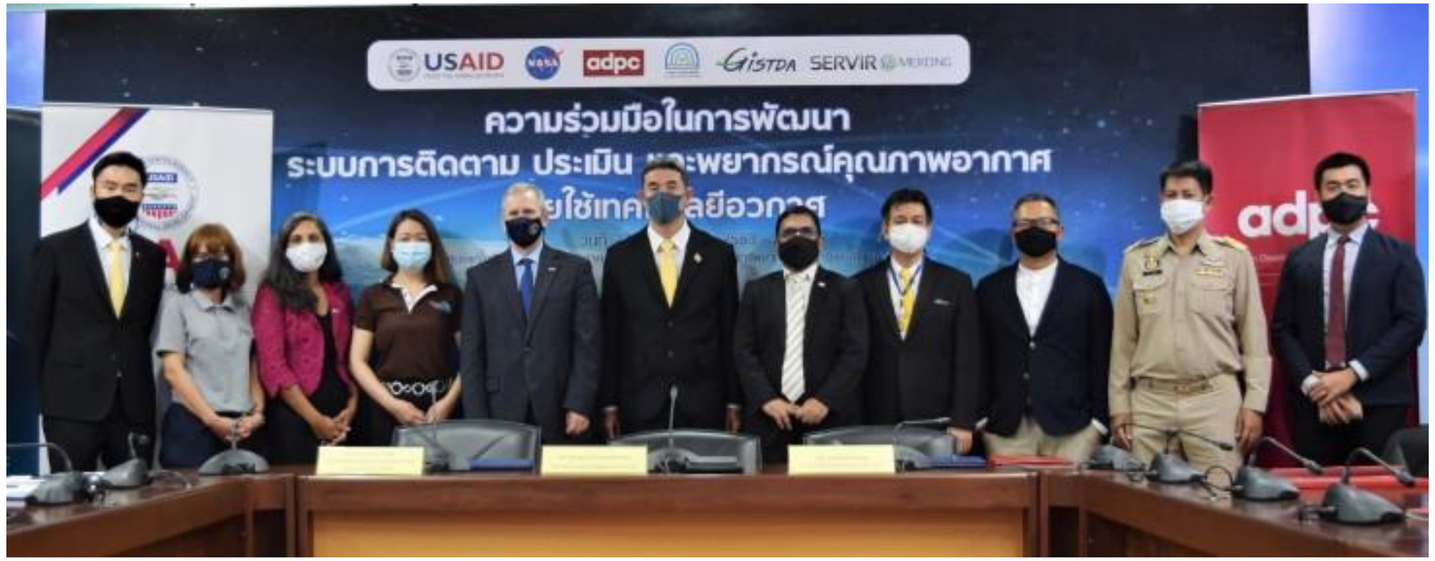
Burn Check Phone App



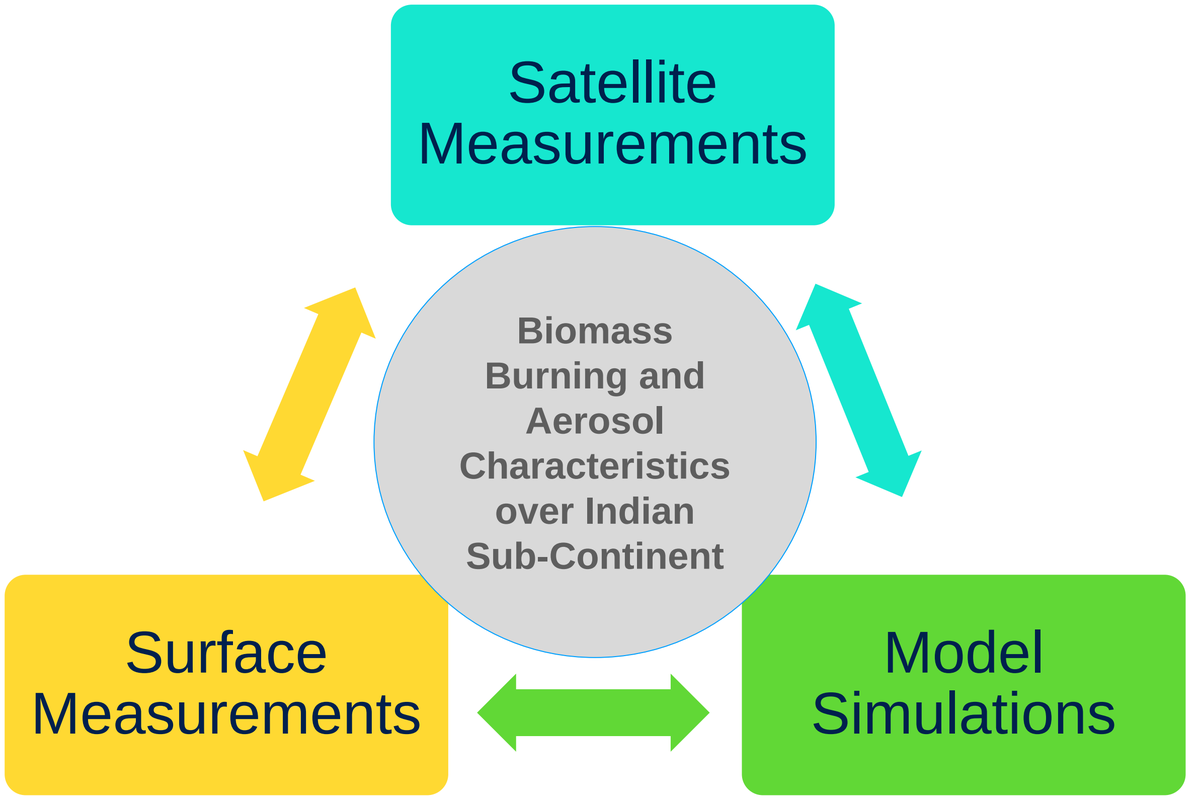


AQE Launch

- The air quality explorer tool is launched and adopted by Thai Pollution Control Department as their official air quality forecasting in November 2020.
- The event was widely covered by Thai and international media
- SERVIR SCO continue to work with partners to improve the application including spatial resolution, accuracy and expanding domain to track transboundary pollution.
- Regular capacity building and end-user engagement activities are held in the region



Research to Application



- ✓ **Research - This effort was funded (PI – Gupta) through NASA's Research Opportunities in Space and Earth Science (ROSES-2017) Program Element A.37: "The Science of NASA's Terra, Aqua, and Suomi NPP.**

- ✓ **Scaling - We took research and data developed under this project over India and scaled the approach over Thailand in partnership with NASA SERVIR and Thai Pollution Control Department**

Special thanks to SERVIR SCO Team (Githika Tondapu, Amanda Markert, Francisco Delgao), SERVIR Mekong, and PCD teams

EARTH SCIENCE
APPLIED SCIENCES

NASA HAQAST

Dr. Tracey Holloway

EARTH SCIENCE APPLICATIONS WEEK 2021

Overview of NASA HAQAST

The NASA Health and Air Quality Applied Sciences Team

3rd Generation; 2021-2025

Tracey Holloway, Team Lead, University of Wisconsin—Madison

What is “hay-kast”?

- Health and Air Quality Applied Sciences Team
- NASA-funded Applied Sciences Team
- 4 year initiative through 2025
- 14 Members and 70+ co-investigators
- Mission: Connect NASA science with air quality and health applications
- ~ $12+ Million Total Cost
- Three types of work:
  - Member projects
  - Tiger team projects (collaborative)
  - Outreach, engagement, rapid response

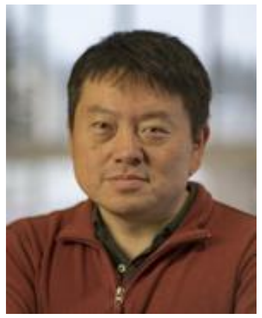
HAQAST1:
2011-2016

HAQAST2: *2016-2020*
HAQAST3: *2021-2025*

The team structure fundamentally changes outcomes.

- Increased visibility of work and resources to end-users
- Culture to support and promote collaborations and synergies
- Growth of two-way dialogue
- Increased collaborations to meet stakeholder needs
- Rapid spin-up of high-value activities

HAQAST Supports Two Types of Projects: Individual & Tiger Team



14 NASA Health and Air Quality Applied Sciences Team Members (HAQAST)

Tracey Holloway (Team Lead, UW-Madison)
Susan Anenberg (George Washington University)
Bryan Duncan (NASA GSFC)
Arlene Fiore (Columbia University)
Pawan Gupta (Universities Space Research Association)
Yang Liu (Emory University)
Jingqiu Mao (University of Alaska, Fairbanks)
Randall Martin (Washington University)
Ted Russell (Georgia Tech)
Jeffrey Pierce (Colorado State University)
Amber Soja (National Institute of Aerospace)
Daniel Tong (George Mason University)
Christopher Uejio (Florida State University)
Qian Xiao (University of Texas Health Science Center at Houston)

haqast.org

HAQAST

ehp Environmental Health Perspectives

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Vol. 129, No. 8 | Research Letter

The Association between Outdoor Artificial Light at Night and Breast Cancer Risk in Black and White Women in the Southern Community Cohort Study

Qian Xiao, Gretchen L. Gierach, Cici Bauer, William J. Blot, Peter James, and Rena R. Jones

Published: 11 August 2021 | CID: 087701 | https://doi.org/10.1289/EHP9381

Image: NASA Earth Observatory

*"Our findings extend prior work [attributing **breast cancer risk** to light at night] by characterizing this relationship among both Blacks and Whites in a large cohort of women recruited from disadvantaged communities."*

Image: USGS

Smoke from 900 miles away can still be harmful to human health

9NEWS

Air quality in Philly reaches unhealthy levels thanks to wildfires out west

WHYY PBS npr

GeoHealth

Research Article | Open Access

Differential Cardiopulmonary Health Impacts of Local and Long-Range Transport of Wildfire Smoke

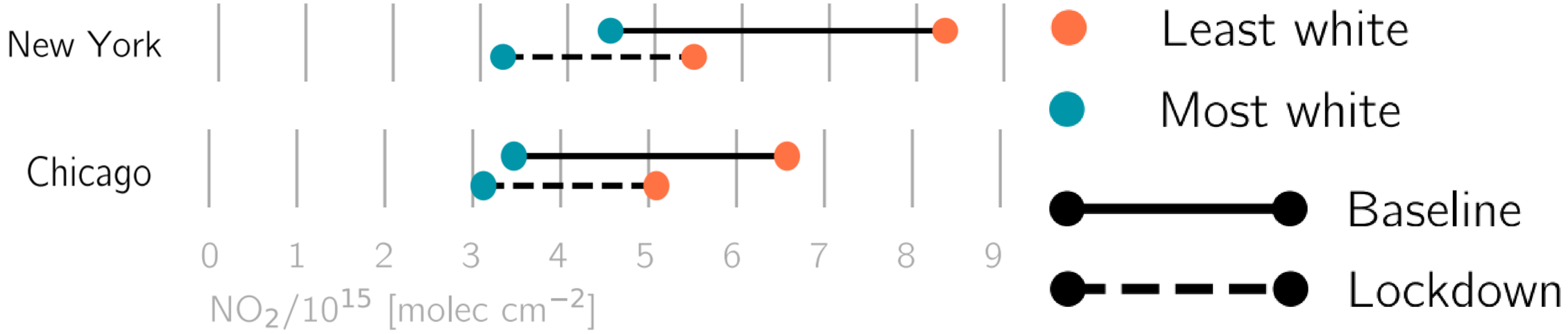
Sheryl Magzamen, Ryan W. Gan, Jingyang Liu, Katelyn O'Dell, Bonne Ford, Kevin Berg, Kirk Bol, Ander Wilson, Emily V. Fischer, Jeffrey R. Pierce

Research Article | Open Access

Associations Between Wildfire-Related $PM_{2.5}$ and Intensive Care Unit Admissions in the United States, 2006–2015

Cecilia Sorensen, John A. House, Katelyn O'Dell, Steven J. Brey, Bonne Ford, Jeffrey R. Pierce, Emily V. Fischer, Jay Lemery, James L. Crooks

"To our knowledge, this is the first paper to investigate health effects of both long-range transport and local [wildfire smoke], as well as the first to demonstrate a ***[wildfire smoke]-related mortality effect in the U.S."***



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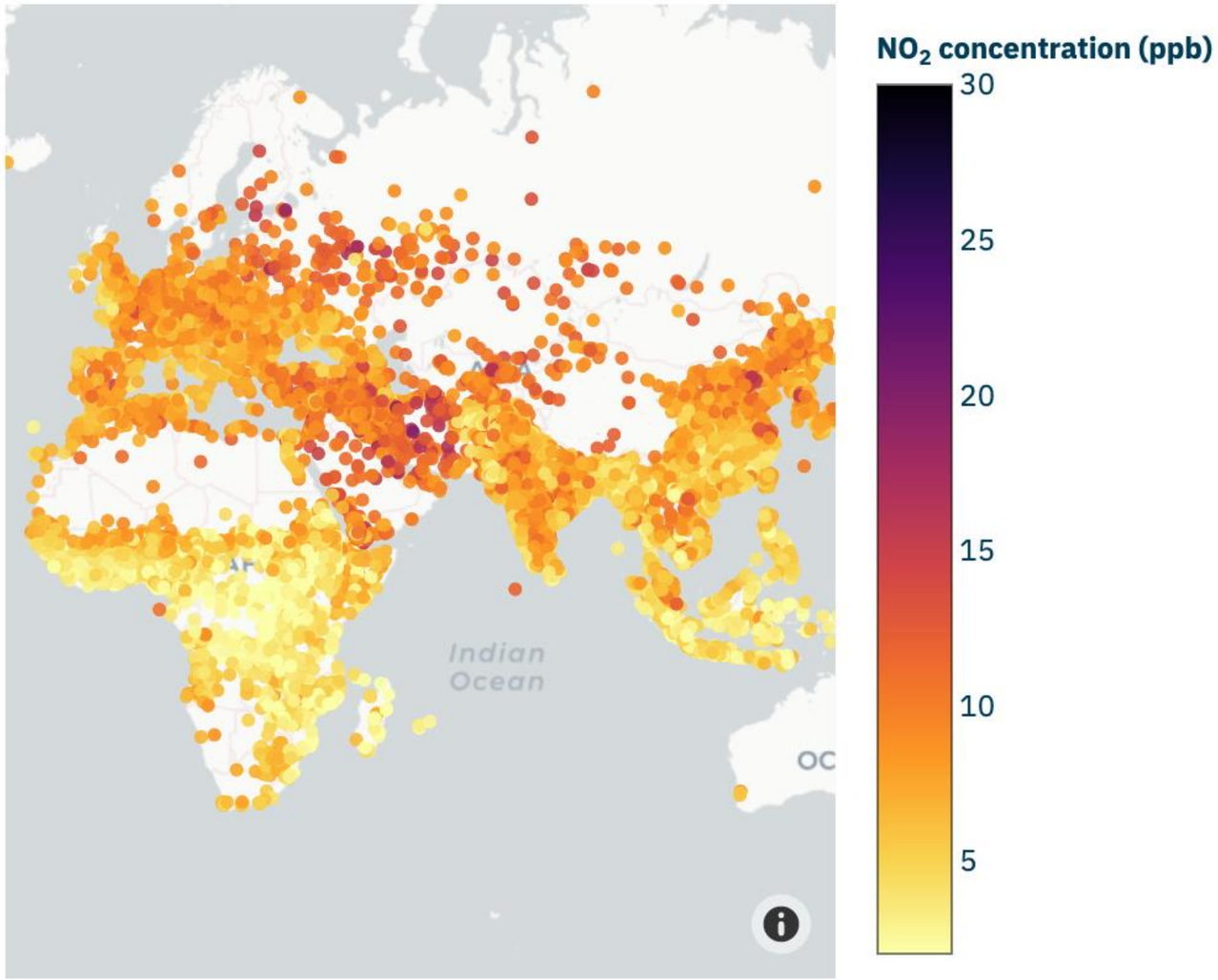
RESEARCH ARTICLE

COVID-19 pandemic reveals persistent disparities in nitrogen dioxide pollution

Gaige Hunter Kerr, Daniel L. Goldberg, and Susan C. Anenberg
+ See all authors and affiliations

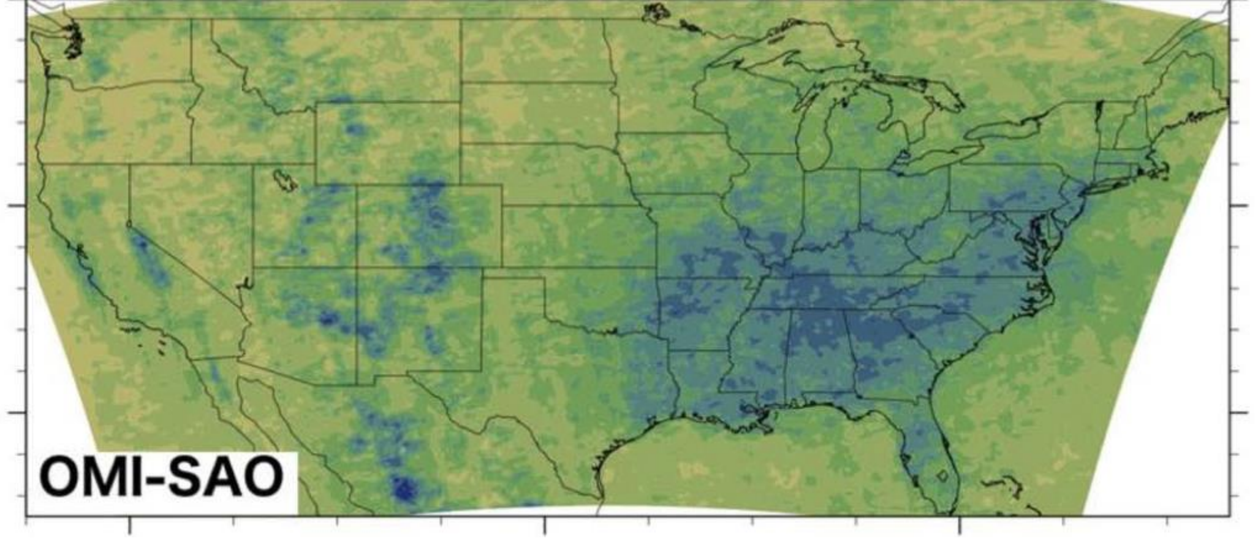
"marginalized communities continued to face higher levels of NO_2 *during the lockdowns than nonmarginalized communities experienced prior to the pandemic"*

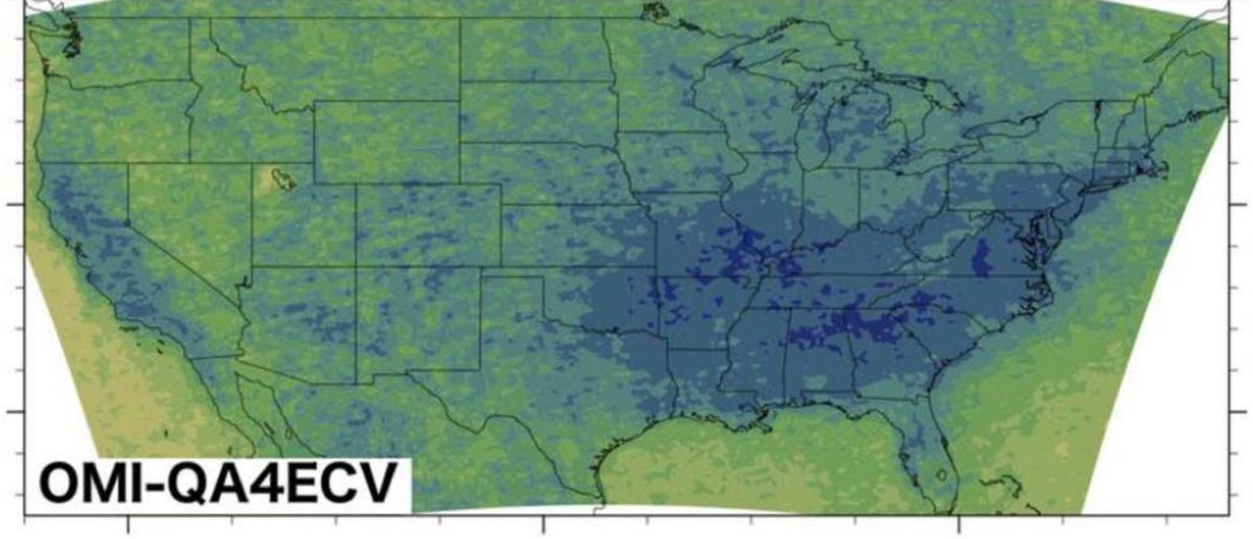
Annual Average NO_2 Concentration (ppb) (Year 2000 to 2019)



"[My group developed] a website for accessing air quality and disease burdens for ~13,000 cities worldwide, which ***I'm beta testing with a range of stakeholders*** *.. The PM and NO_2 estimates are derived from satellite observations"*

- Susan Anenberg





JGR Atmospheres

Satellite Formaldehyde to Support Model Evaluation

Monica Harkey[1], Tracey Holloway[1,2], Eliot J. Kim[1], Kirk R. Baker[3], and Barron Henderson[3]

"Formaldehyde (HCHO), a known carcinogen classified as a hazardous pollutant… This work highlights the potential for … ***modeling and satellite retrievals to support near-surface HCHO estimates*** *for the [EPA's National Air Toxics Assessment] and other applications.*

Image: NASA Earth Observatory

HAQAST

NASA HEALTH AND AIR QUALITY APPLIED SCIENCES TEAM

Connecting NASA Data and Tools with Health and Air Quality Stakeholders

EARTH SCIENCE
APPLIED SCIENCES

THANK YOU!

EARTH SCIENCE APPLICATIONS WEEK 2021