

#### National Aeronautics and Space Administration



### **BALTIMORE ENERGY & INFRASTRUCTURE**

Assessing Urban Heat Vulnerability in Baltimore Neighborhoods to Inform Transportation Resiliency Planning Efforts

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### **Outline**



### Meet the Team!



Image Credit: Brian Arruda

# **Project Partner**

### Maryland Transit Administration (MTA)

- Division of the Maryland Department of Transportation
- Operates Local Buses (CityLink and LocalLink), Commuter Buses, Light Rail, Metro Subway, Maryland Area Regional Commuter (MARC) Train Service, and MobilityLink system



## **Study Area**

Baltimore City and Baltimore County, Maryland: 2013 – 2023; June – October

#### **Baltimore City**

- Area: 92 mi sq
- Population: 569,931 (2021)

#### **Baltimore County**

- Area: 598.4 mi sq
- Population: 849,316 (2021)



# **Study Introduction**

### Urban Heat Island (UHI) Effect

 Urban environments experience more frequent extreme heat events compared to rural areas

- Urban heat is magnified by high concentrations of:
  - Impervious surfaces
  - $\circ~$  Local Emissions
  - Dark, low albedo surfaces

### Fundamentally, community challenges are spurred by...





SOCIAL VULNERABILITY





# Objectives

### **HEAT MAPPING**

- Analyzing urban heat using Earth observations
- Identifying hot spots at neighborhood level

### HEAT VULNERABILITY INDEX (HVI)

- Incorporate
  socioeconomic factors
  such as:
  - o Age
  - Household income
  - o Ethnicity

### HEAT MITIGATION STRATEGIES

- Expand the MTA's Adaptation and Resiliency Toolbox (ART)
- Assess bus corridor heat coping capacity

# EARTH OBSERVATIONS

### Aqua MODIS

### Landsat 8 OLI/TIRS

### Terra MODIS

Image Credit: NASA GSFC

# **Methods**

### **HEAT ISLAND ASSESSMENT**

#### <u>Calculate</u> natural and built environment indices via NASA satellite derived data

### HEAT VULNERABILITY INDEX (HVI)

 <u>Combining</u>: socioeconomic and environmental variables through a Principal Component Analysis in R

### OUTDOOR THERMAL COMFORT ASSESSMENT

 Inputting: DSM's, Ground Cover, & Ancillary Data into SOLWEIG Model using QGIS

# Maximum Land Surface Temperature (LST)



# Mean Land Surface Temperature (LST)



Baltimore County

June – September 2013 – 2023



# Land Cover

#### Normalized Difference Vegetation Index



# Land Cover

#### Normalized Difference Building Index



## **Heat Vulnerability Explained**

 Identify Sociodemographic and Environmental Variables

### • Conduct a Principal Component Analysis

### • Output Heat Vulnerability Indices

# Heat Vulnerability Index



### Heat Exposure Index



## Heat Priority Index



### **Bivariate Visualization:** Heat Vulnerability Score + Ethnic Minority



# **SOLWEIG Explained**



Image Credit: PowerPoint Icons

### Limitations







# Conclusion



**ACTION:** In Baltimore City, **32%** of blockgroups demonstrated a high to very high level of priority for MTA's **future mitigation strategies**.



**FEASIBILITY:** It is **feasible** to use NASA Earth Observations (EOs) to visualize + analyze urban heat distribution in Baltimore, despite resolution limitations.



**ENVIRONMENTAL JUSTICE:** Exposure to urban heat, and capacity to tolerate extreme heat, is unequal across **age**, **race**, **and income**.







Photo Credits: PowerPoint Icons

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- Sean McCartney, Science Advisor at GSFC
- Dr. Kent Ross, DEVELOP Program Manager

### **Outside Advisors**

- Blake Steiner, Former DEVELOP Participant
- Medhi Heris, Professor at Hunter College





