



# ASHEVILLE URBAN DEVELOPMENT II

Mapping Urban Heat to Support Cooling  
Initiatives and Climate Resilience Planning  
in the Greater Asheville Area

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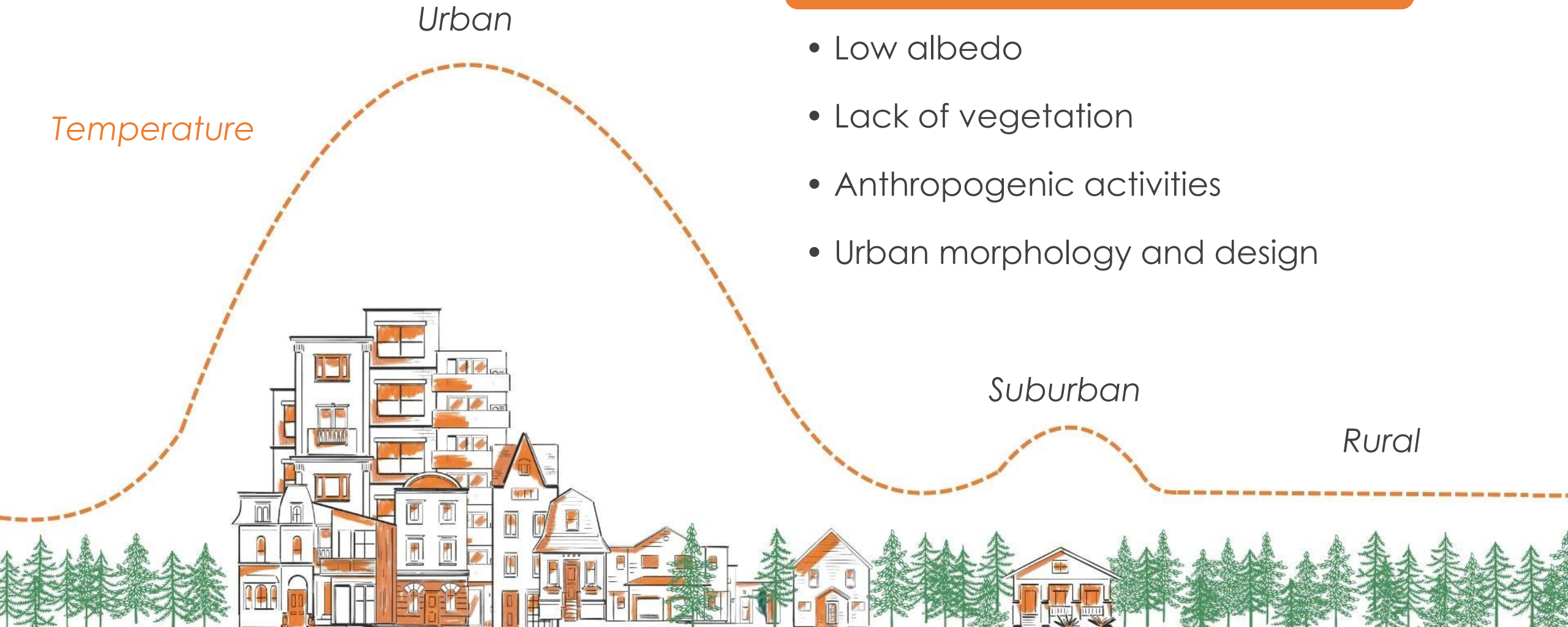
North Carolina – NCEI Summer 2024



# Background – Urban Heat Islands (UHI)

## Causes for UHIs

- Low albedo
- Lack of vegetation
- Anthropogenic activities
- Urban morphology and design



# Background – Effects of UHIs

Environmental  
and human health  
implications

Implications are  
uneven: hotspots

Spatial environmental  
injustice


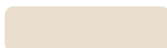



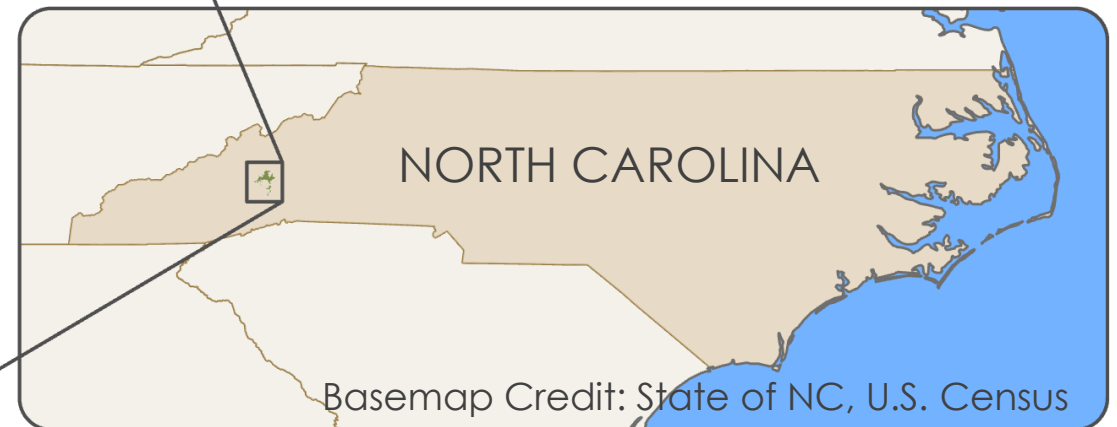
Visualization of Land Surface Temperature in Asheville, NC  
Image Credit: Darcy Gray, Amiya Kalra, and Amy Kennedy

# Study Area and Period



**Study Area** Asheville, NC  
**Study Period** 2019 - 2023

-  Asheville - Study Area
-  North Carolina
-  Bodies of Water



# Asheville Community Concerns

## Asheville UHI Influences

- Population Increase
- Tree cover decline
- Infrastructure expansion
- Climate change intensification

## Asheville UHI Consequences

- Environmental degradation
- Social vulnerability to heat



Image of Asheville, NC  
Image Credit: Ken Lane

# Partners

## Asheville GreenWorks



Image of Asheville GreenWorks  
Image Credit: Sarah McMullen

## City of Asheville Sustainability Department



Image of Asheville City Hall  
Image Credit: Dan Phairas

# Project Objectives

*Expand on and update the 2019 NASA DEVELOP Asheville Urban Development I project, to support cooling initiatives and climate-resilient urban planning.*

Identify hot spot areas

Identify heat-vulnerable areas

UHI Hot Spots

Social Vulnerability

Heat Vulnerability

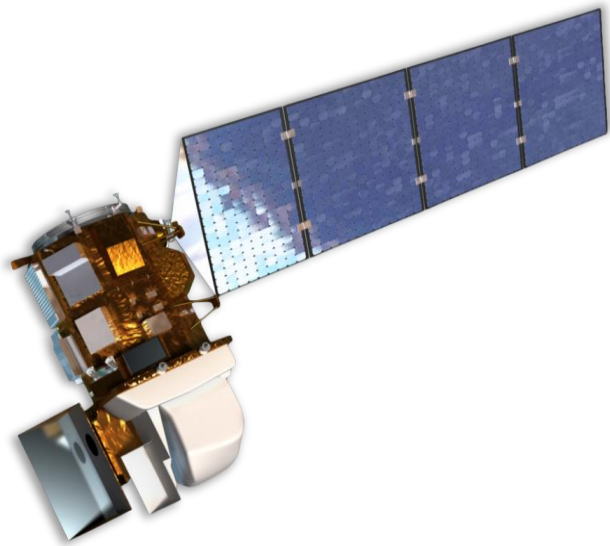
UHI Mitigation and  
Adaption

Identify socially vulnerable areas

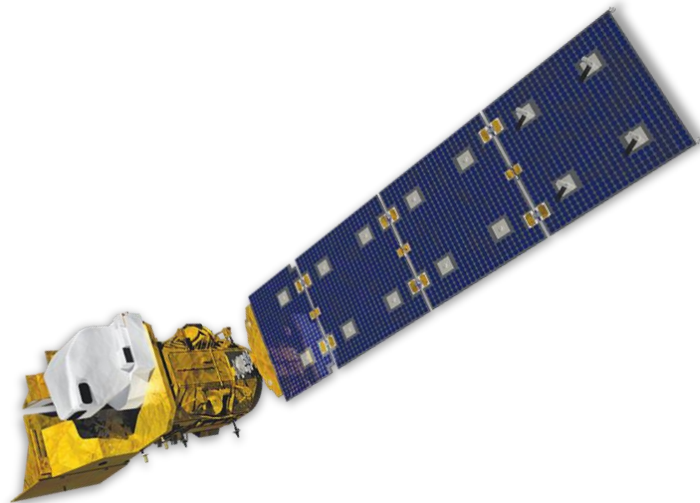
Assess the spatial suitability  
of mitigation and adaption measures  
based on cooling capacity

# Earth Observations

**Landsat 8**  
OLI and TIRS



**Landsat 9**  
OLI-2 and TIRS-2



**ECOSTRESS**  
PHyTIR



Image Credit: NASA, Northrop Grumman

# Earth Observations

**Sentinel-1**  
C-SAR

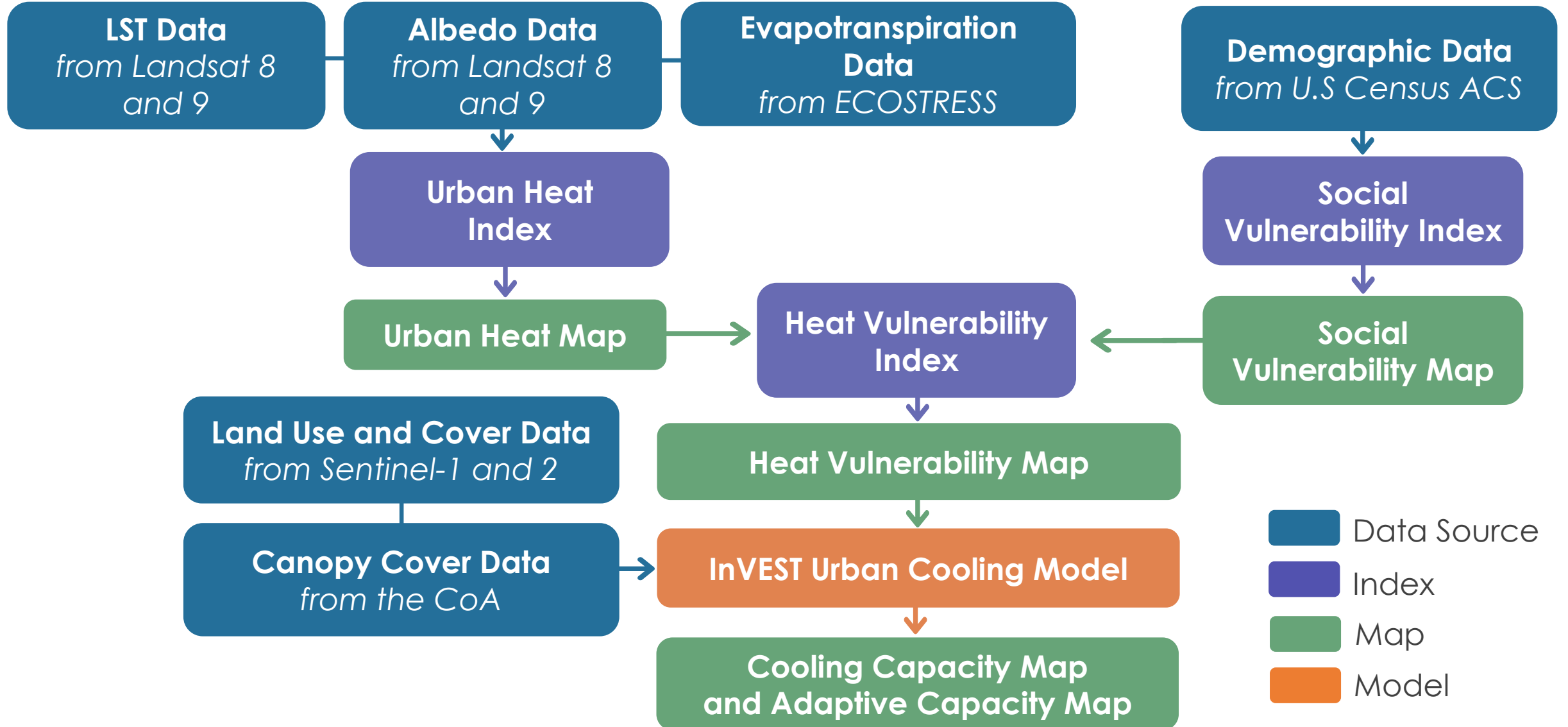


**Sentinel-2**  
MSI

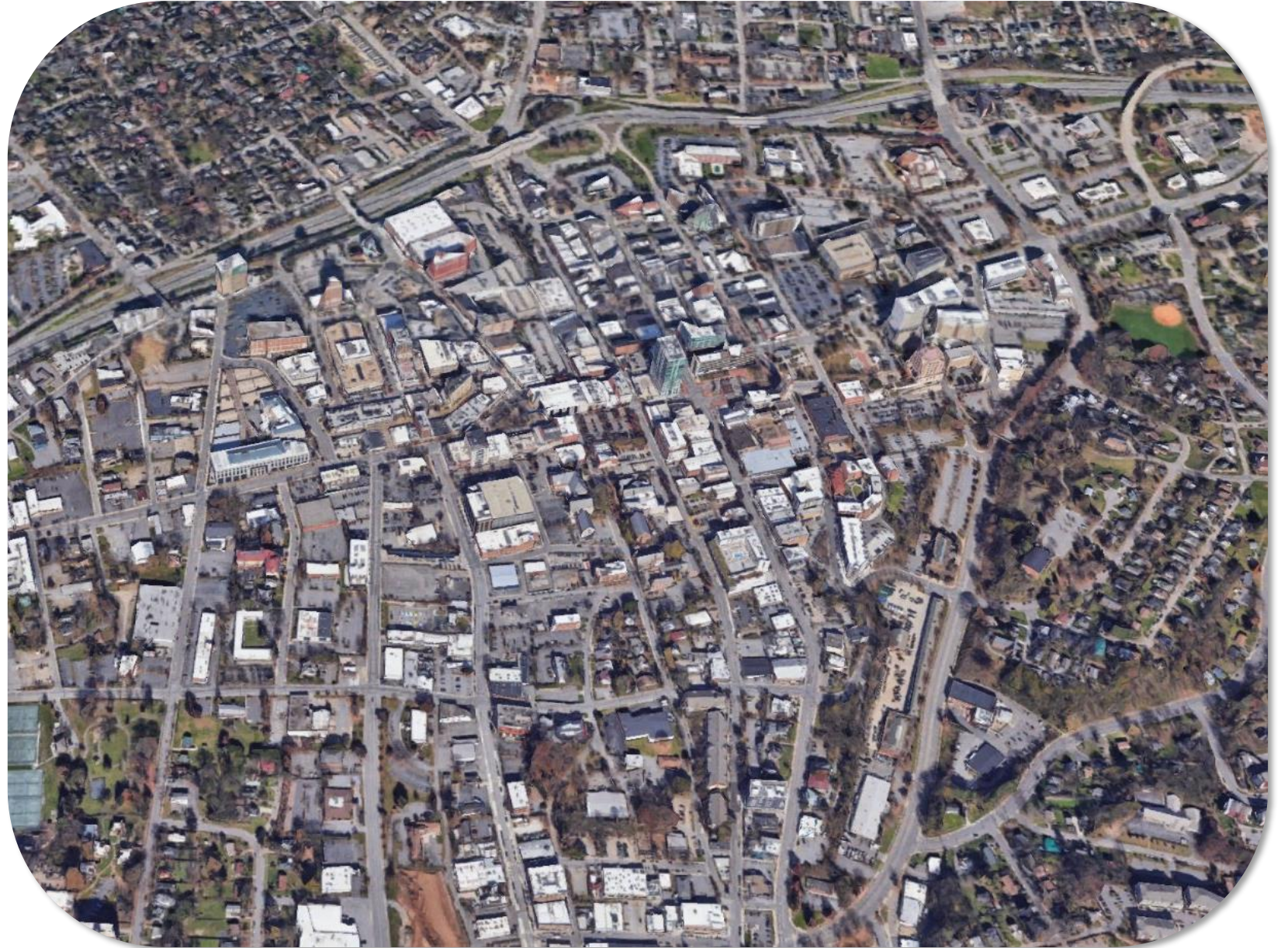


Image Credit: European Space Agency

# Methodology

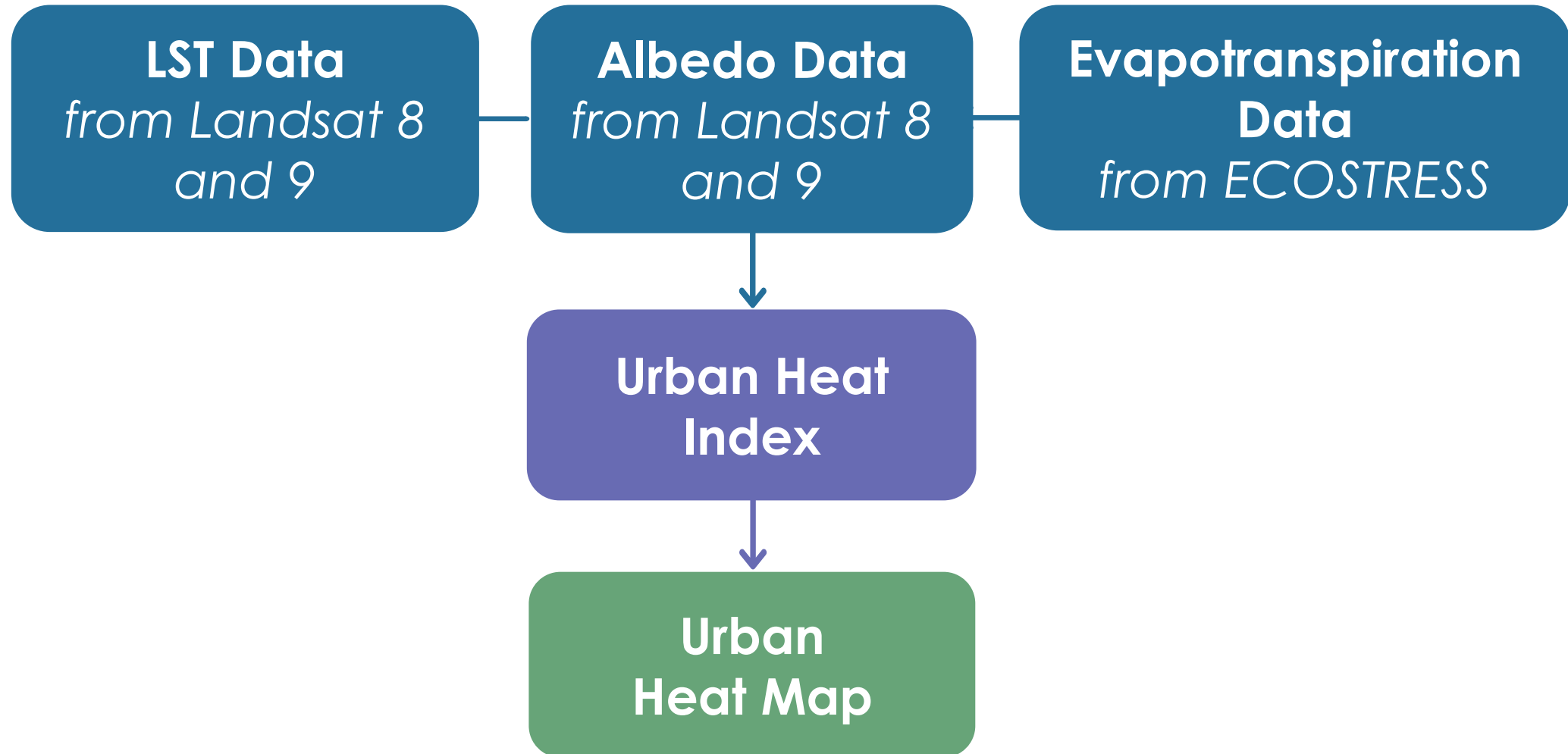


# Urban Heat

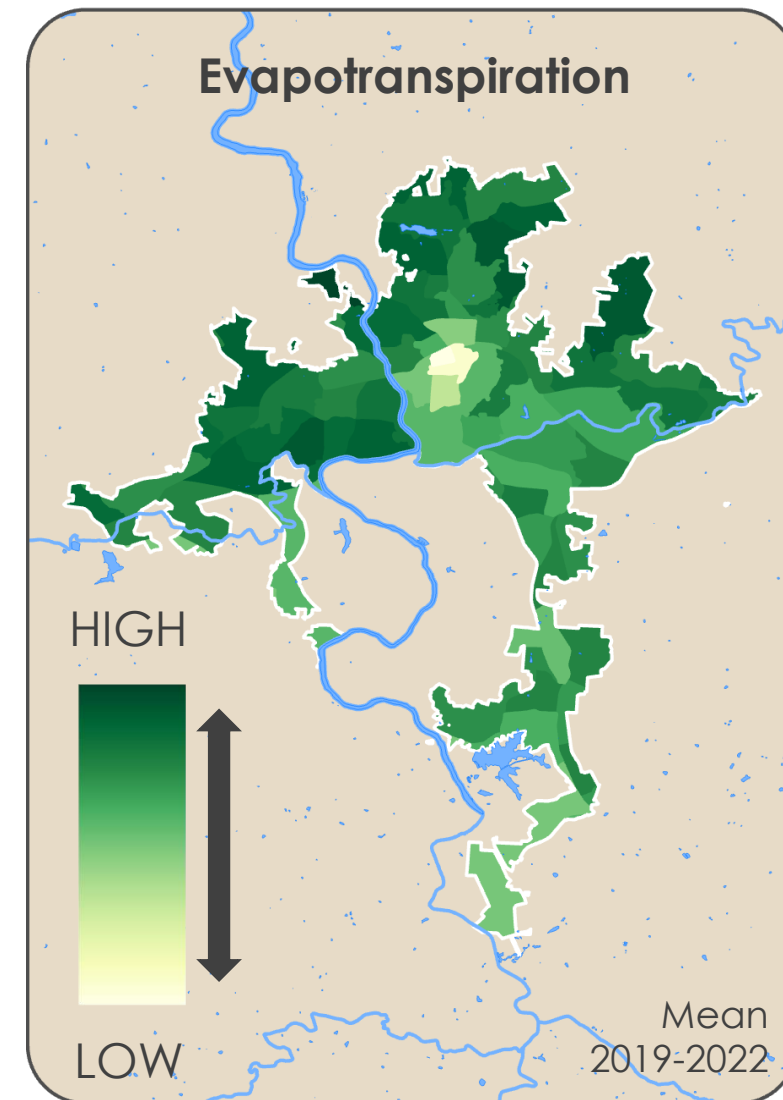
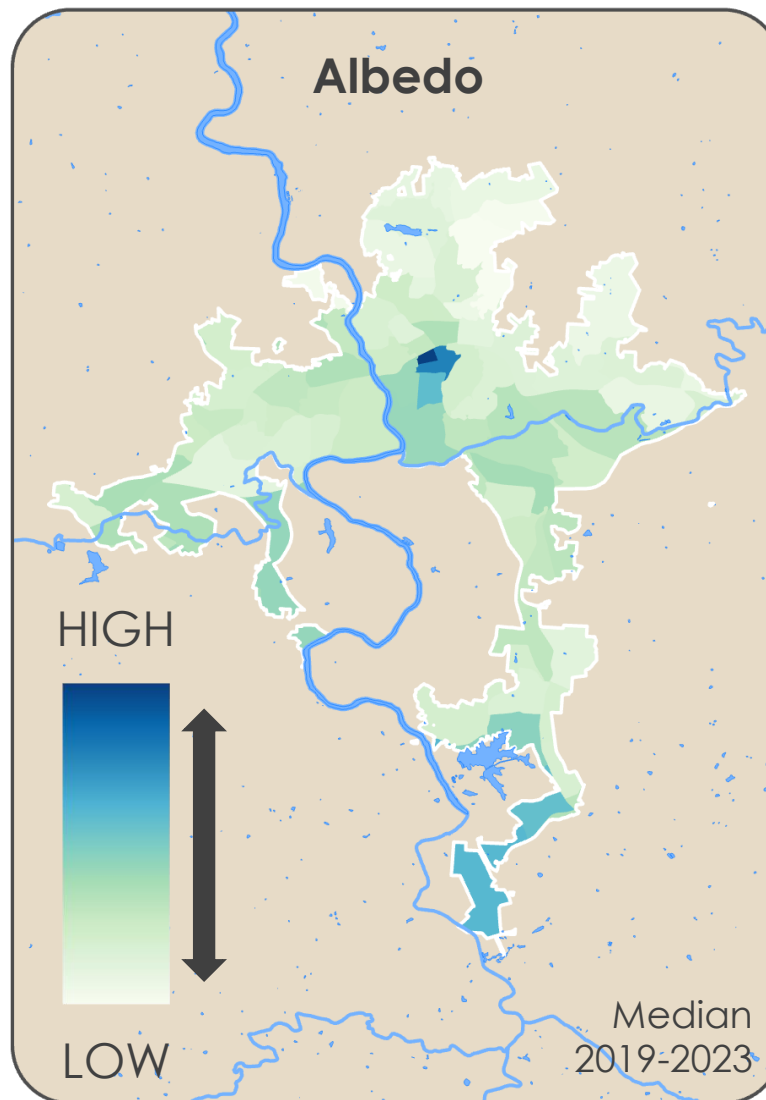
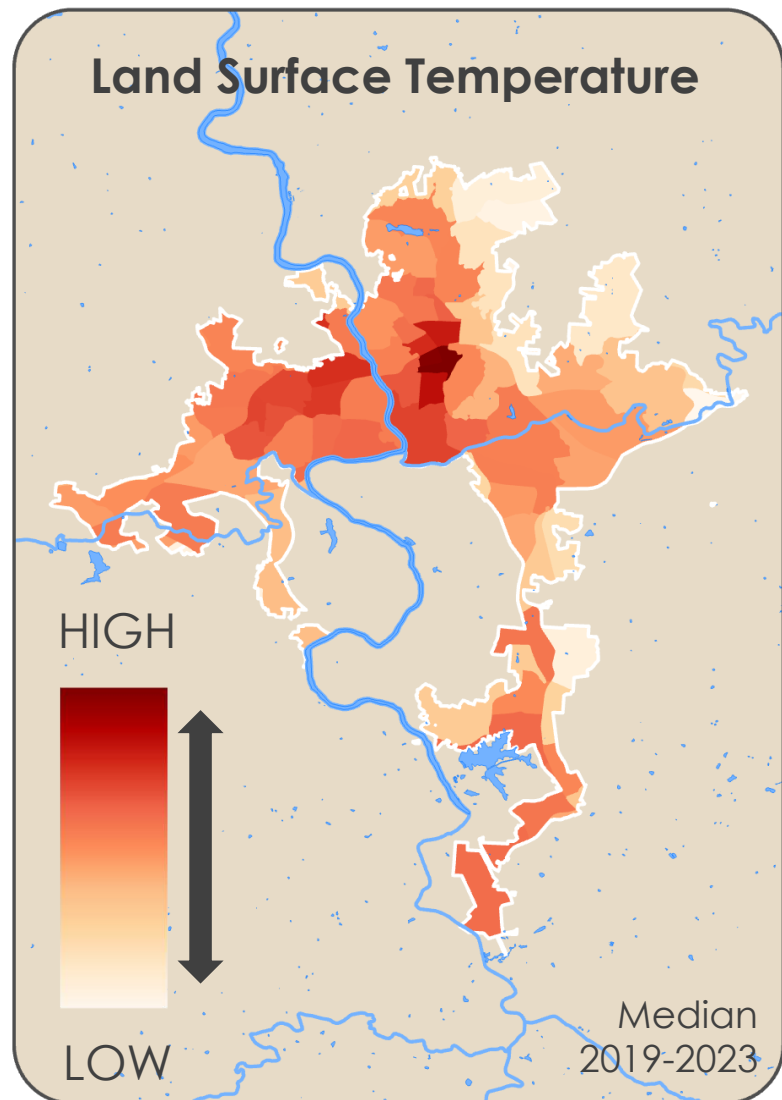


Aerial Image of Downtown Asheville, NC  
Image Credit: Google Earth

# Urban Heat



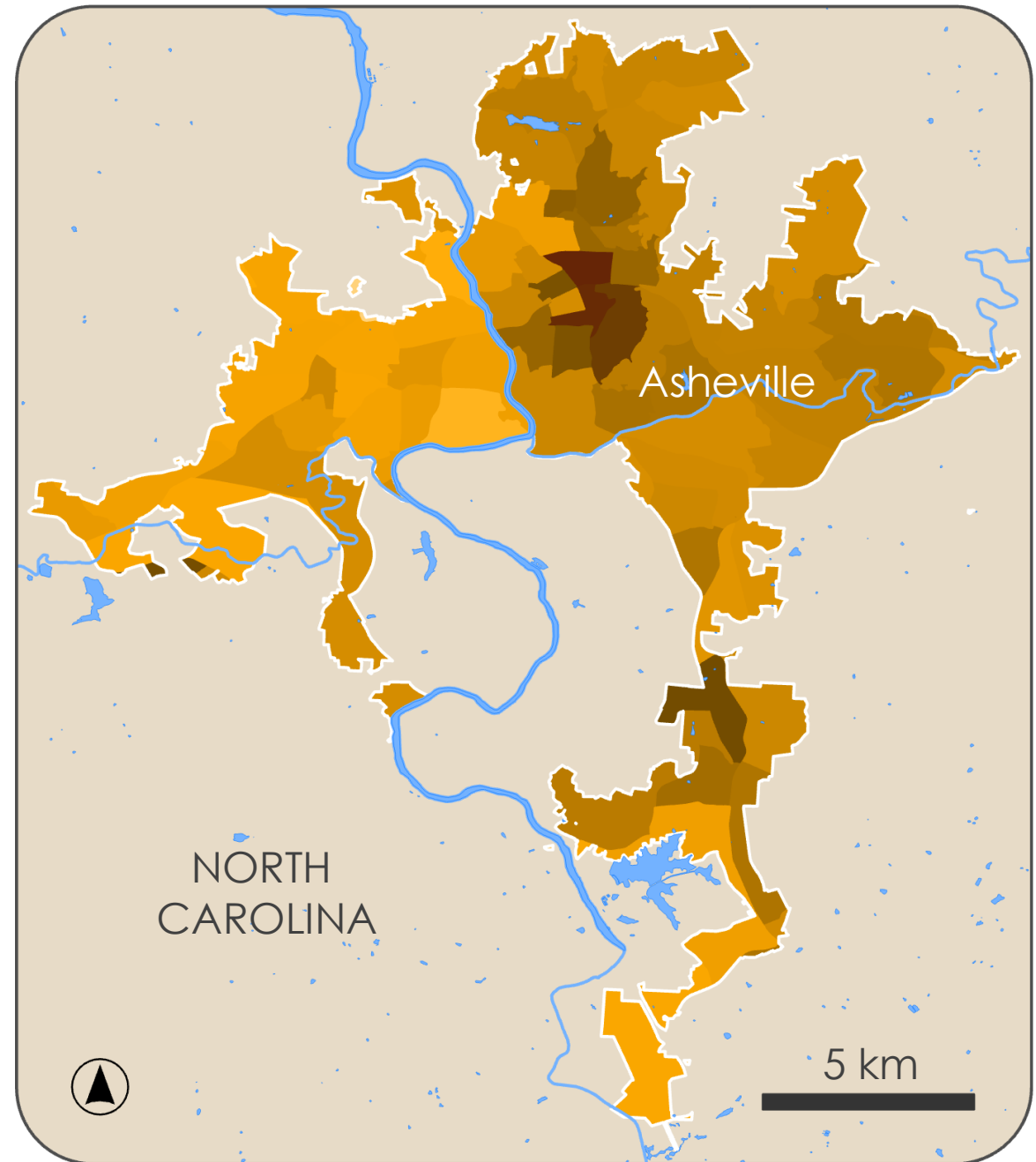
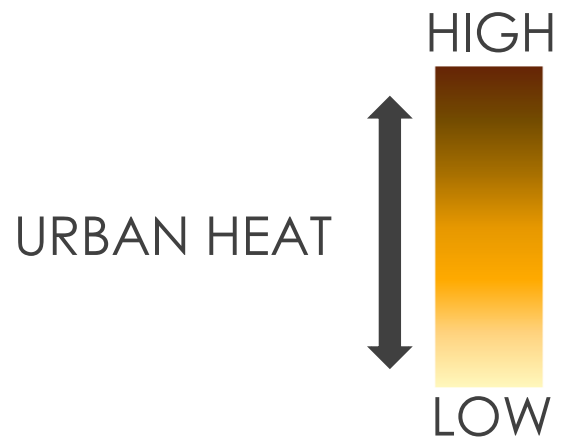
# Urban Heat



# Urban Heat

**Data** LST | Albedo | Evapotranspiration

**Geometry** U.S. Census Block Groups

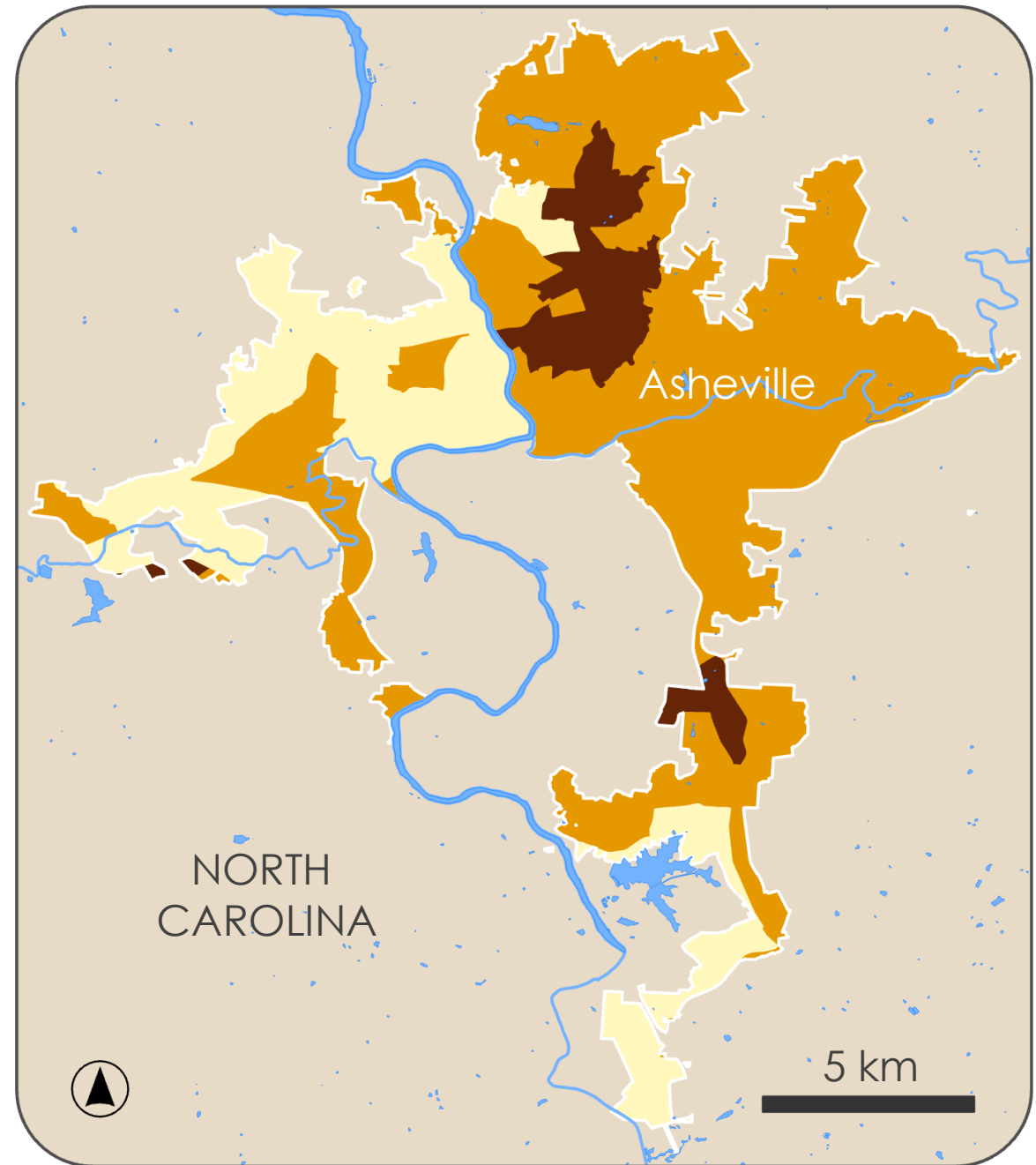


Basemap Credit: State of NC

# Urban Heat

**Data** LST | Albedo | Evapotranspiration

**Geometry** U.S. Census Block Groups



Basemap Credit: State of NC

# Social Vulnerability



Image of Asheville Citizens  
Image Credit: Will Thomas

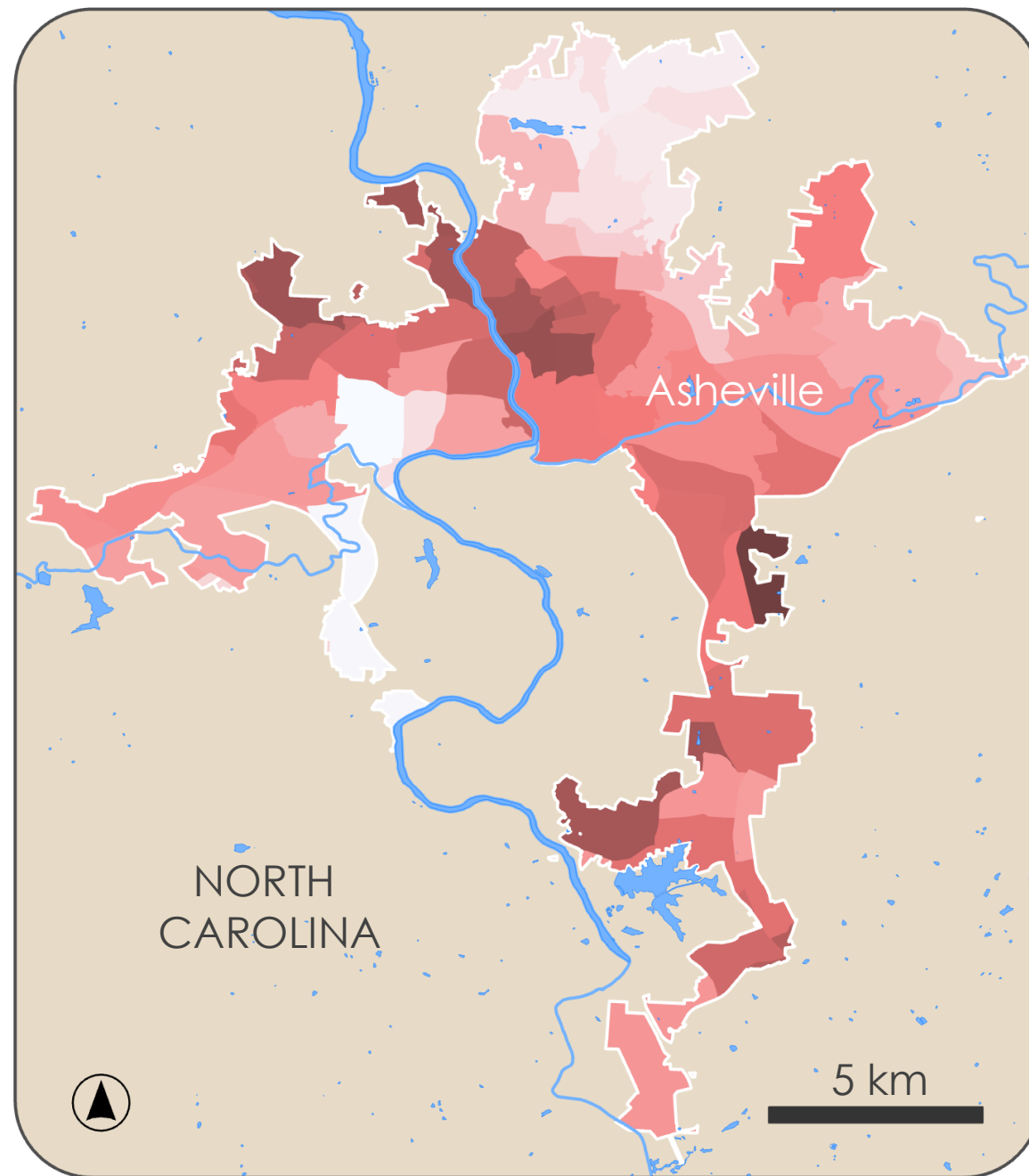
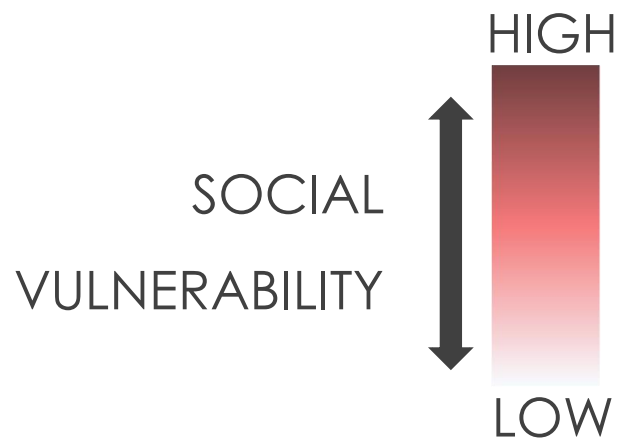
# Social Vulnerability



# Social Vulnerability

**Data** SVI from 2022

**Geometry** U.S. Census Block Groups

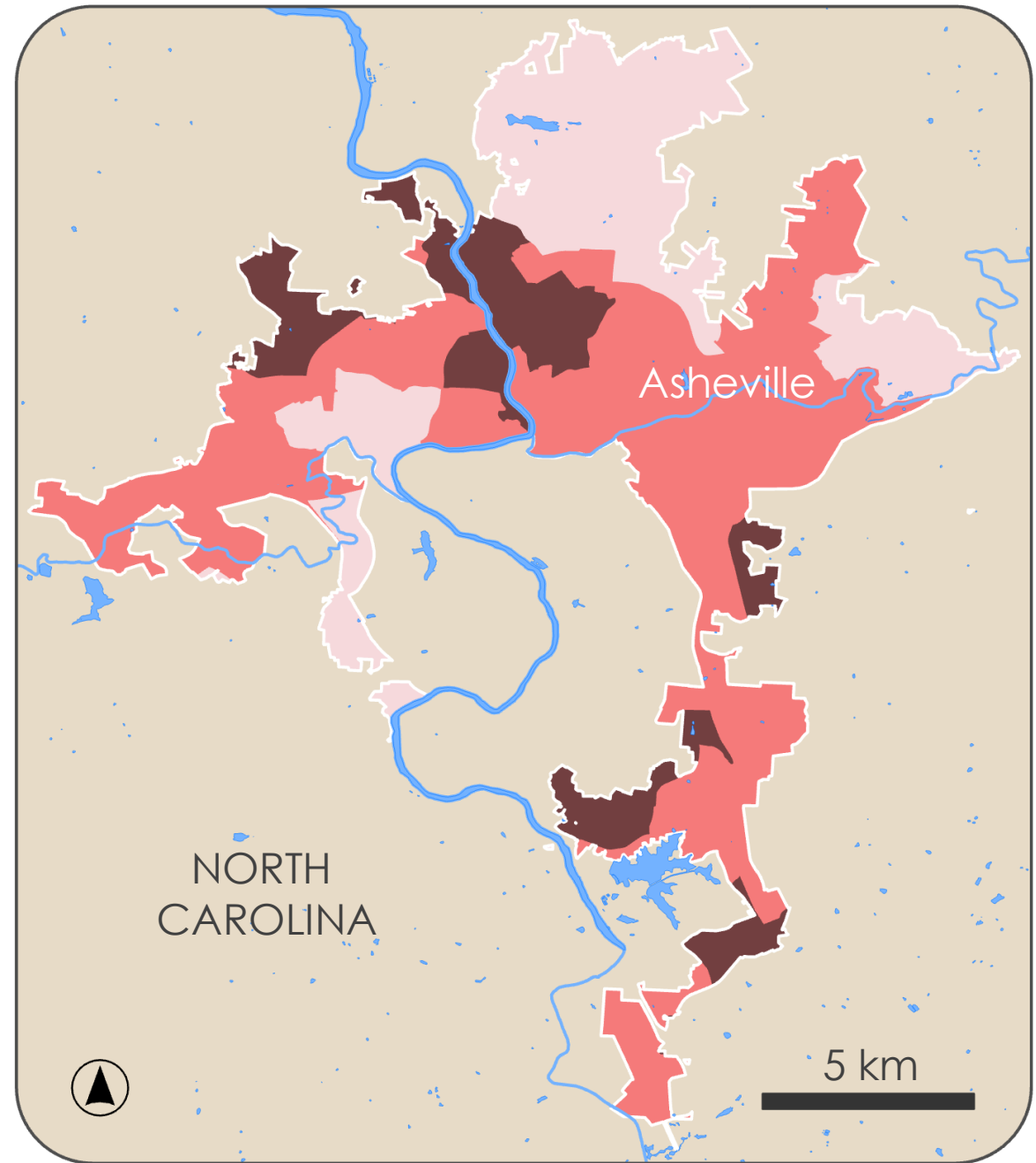


Basemap Credit: State of NC

# Social Vulnerability

**Data** SVI from 2022

**Geometry** U.S. Census Block Groups



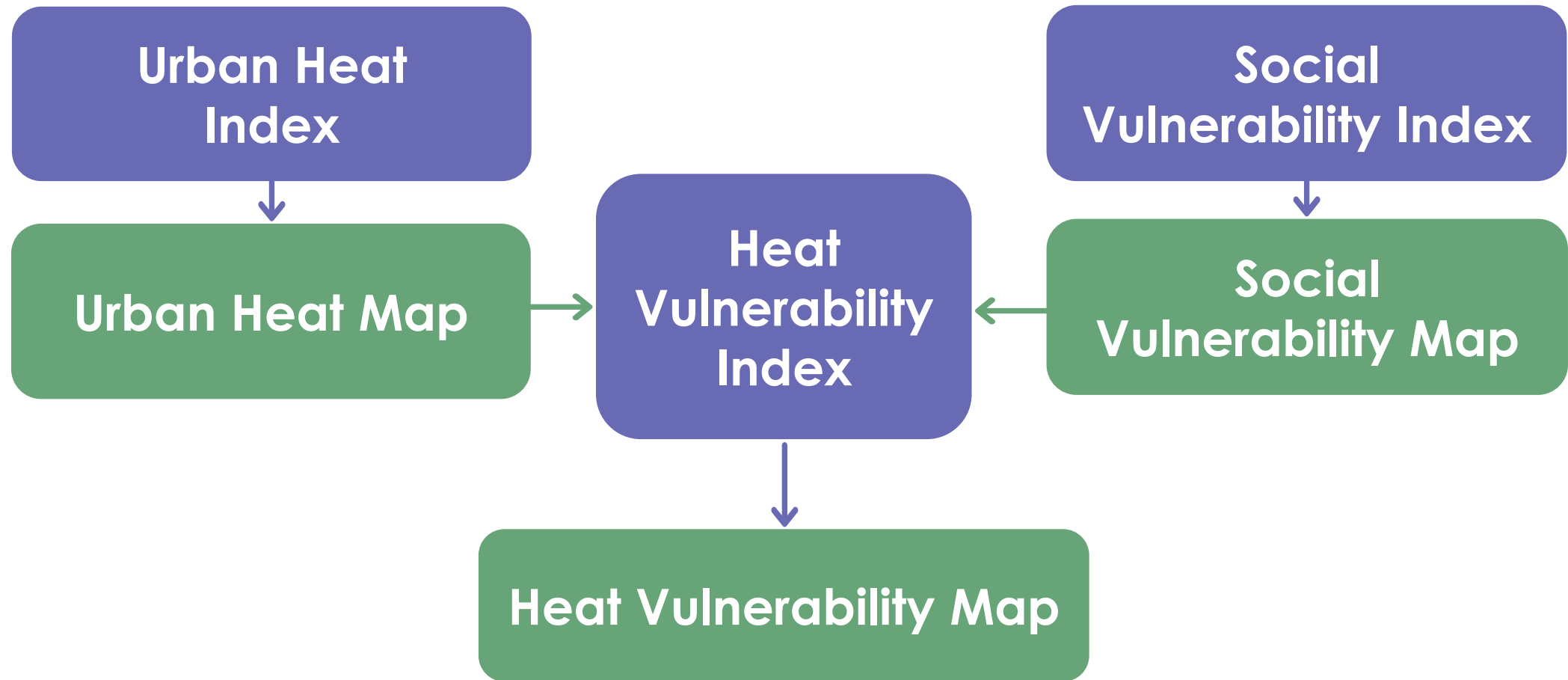
Basemap Credit: State of NC

# Heat Vulnerability



Aerial Image of Neighborhoods in North Asheville, NC  
Image Credit: Google Earth

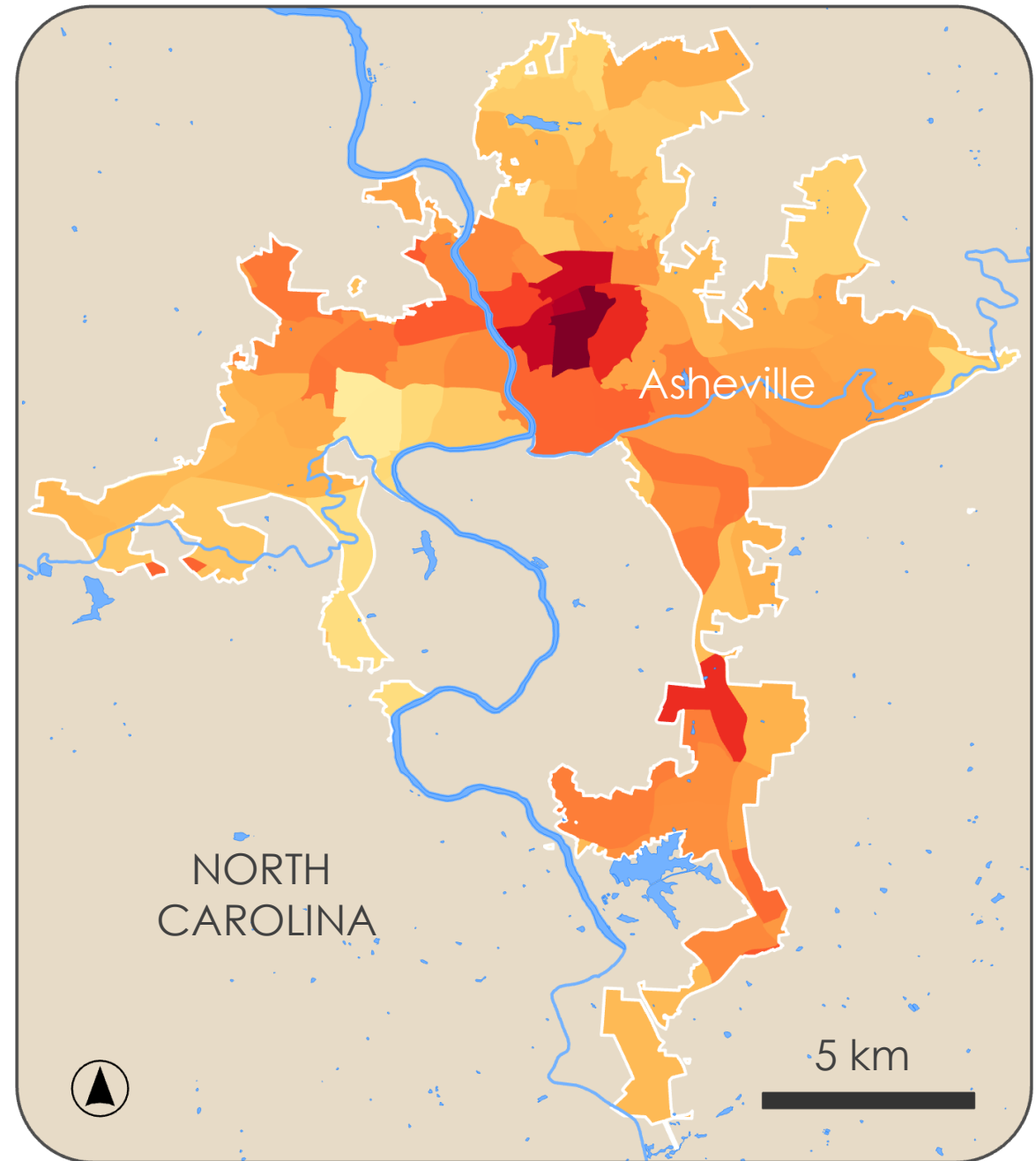
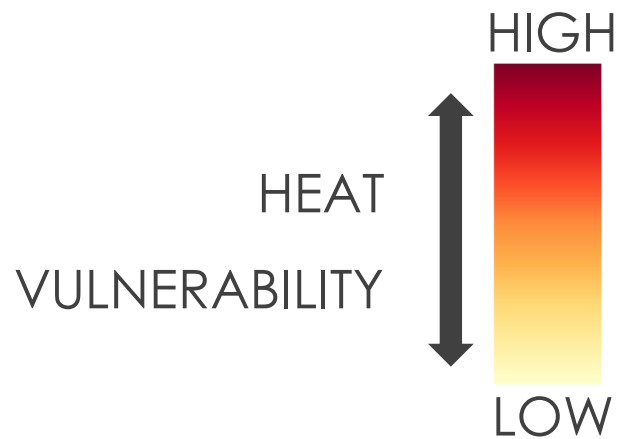
# Heat Vulnerability



# Heat Vulnerability

**Data** LST | Albedo | Evapotranspiration | SVI

**Geometry** U.S. Census Block Groups

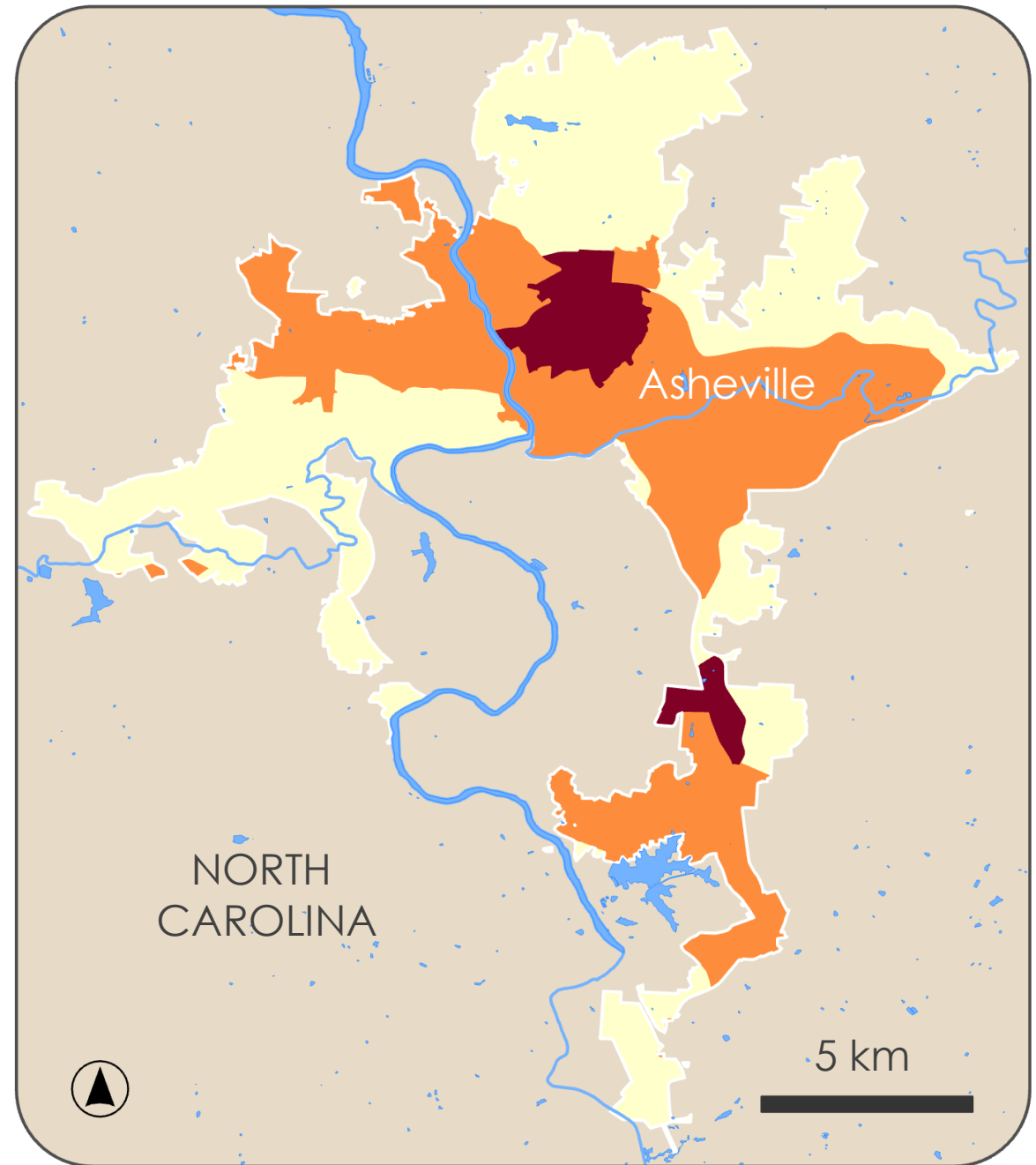
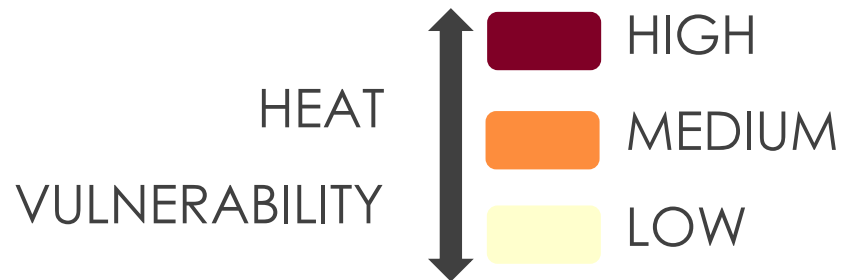


Basemap Credit: State of NC

# Heat Vulnerability

**Data** LST | Albedo | Evapotranspiration | SVI

**Geometry** U.S. Census Block Groups



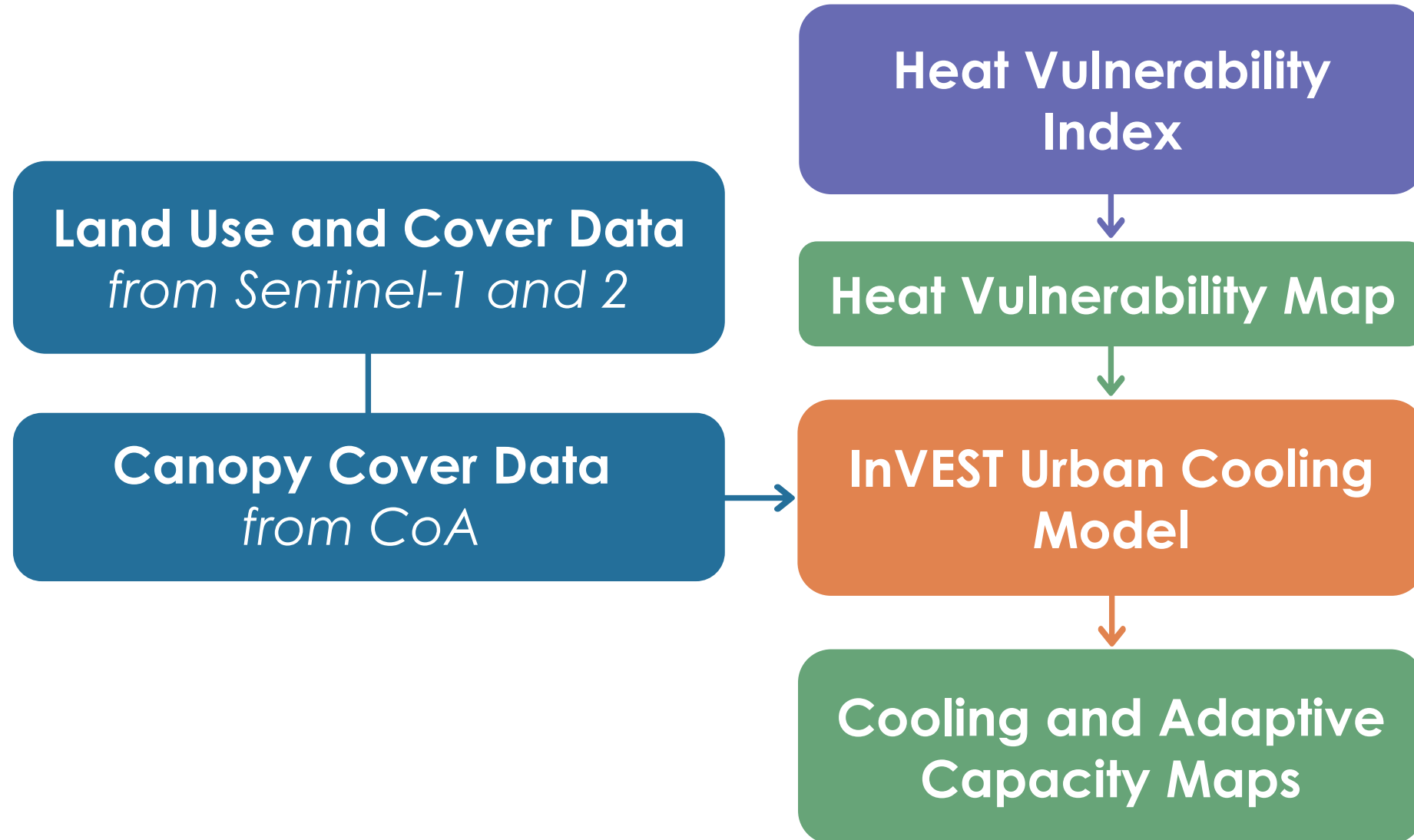
Basemap Credit: State of NC

# UHI Mitigation and Adaptation



Image of Asheville GreenWorks Volunteers  
Image Credit: Asheville GreenWorks

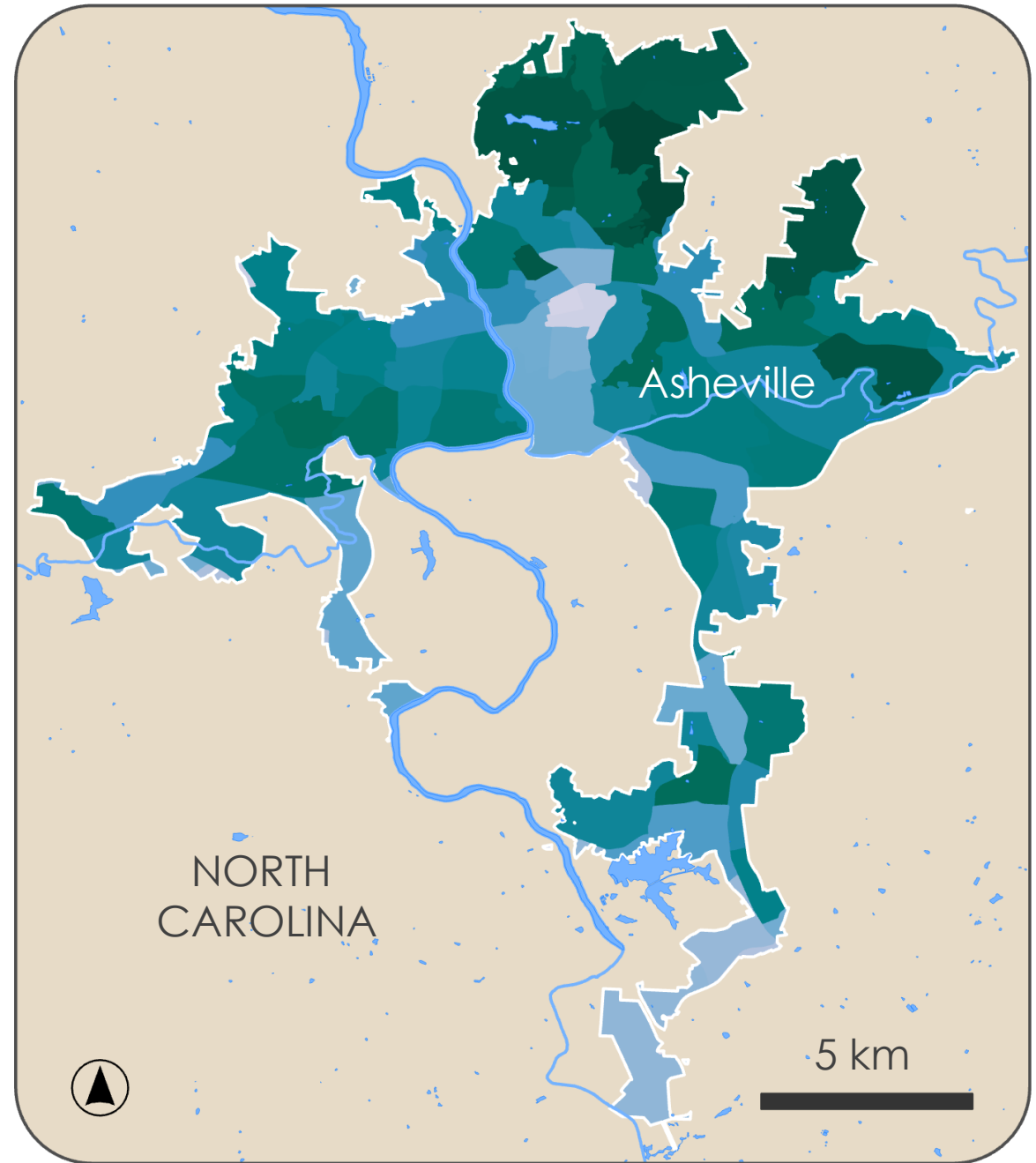
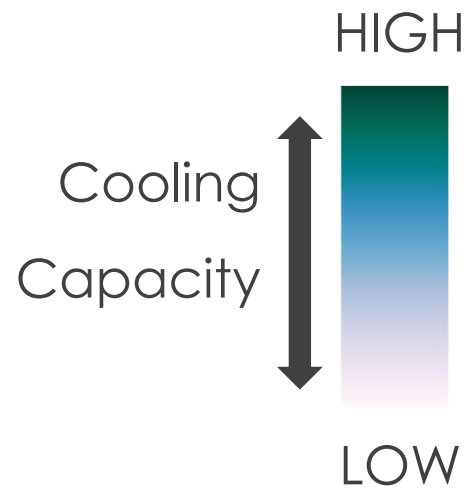
# Cooling and Adaptive Capacity



# Cooling Capacity

**Data** LULC | Albedo | Evapotranspiration | Canopy Cover

**Geometry** U.S. Census Block Groups

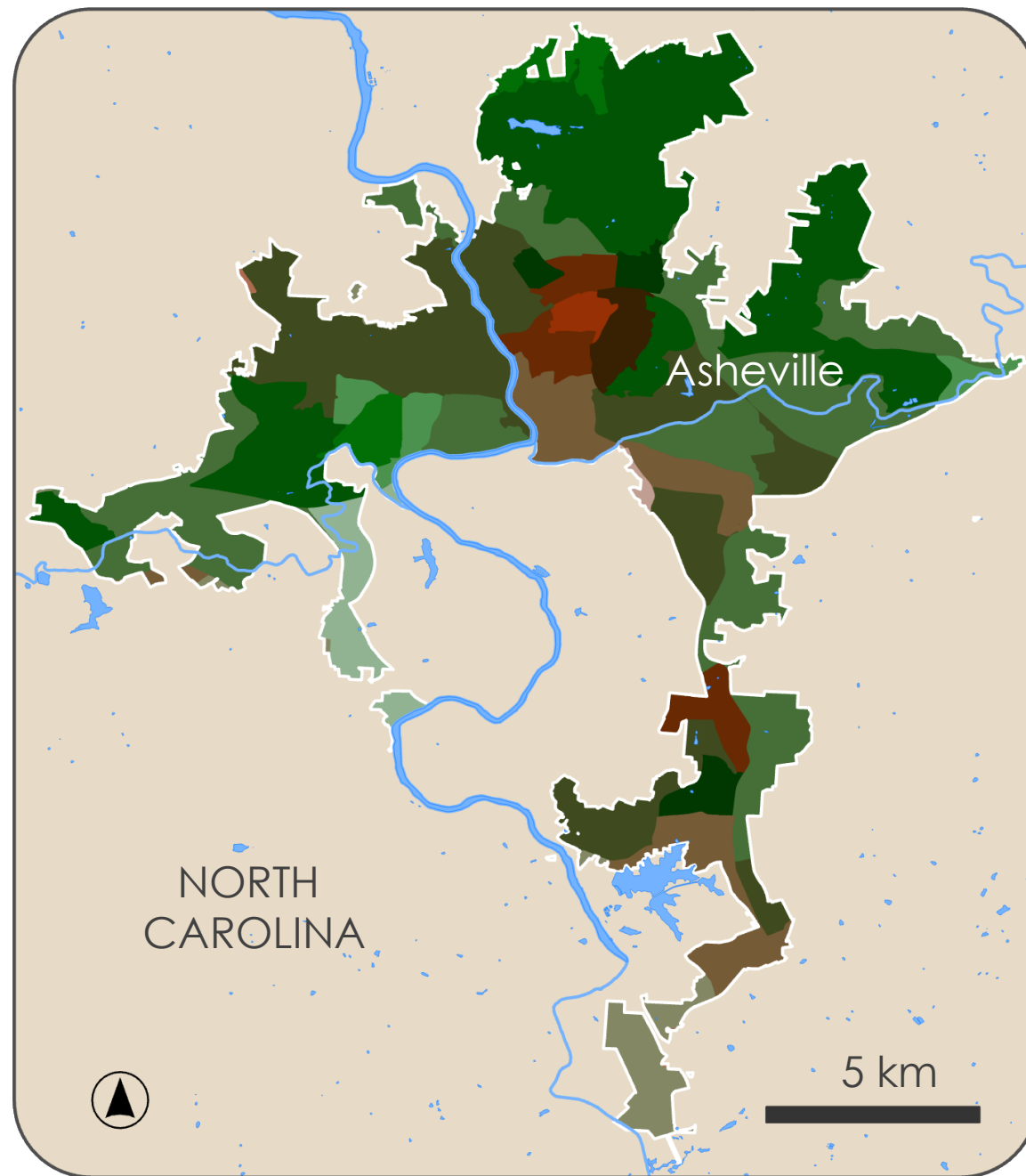
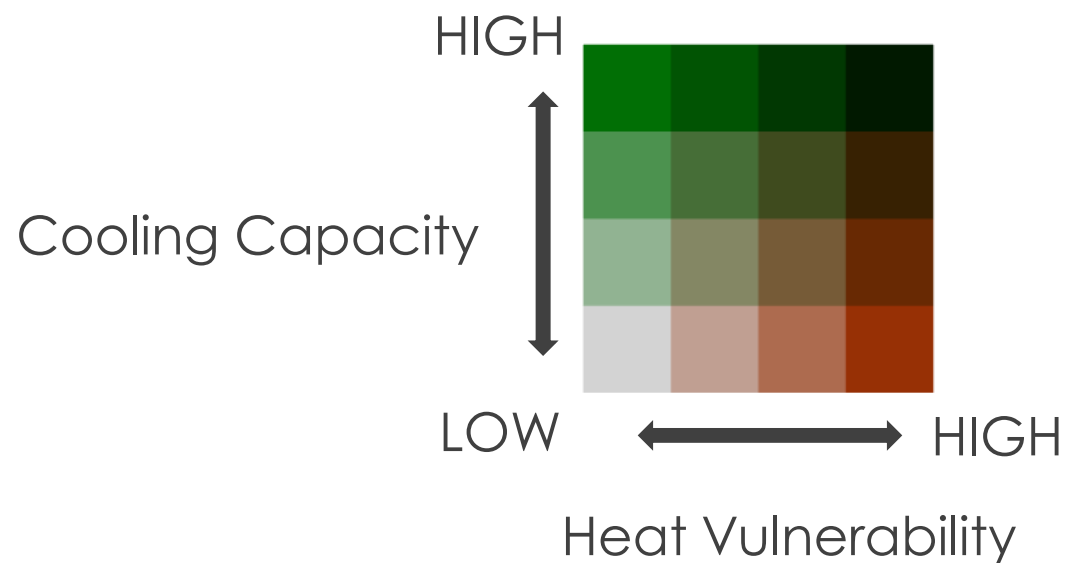


Basemap Credit: State of NC

# Adaptive Capacity

**Data** Cooling Capacity | Heat Vulnerability

**Geometry** U.S. Census Block Groups



Basemap Credit: State of NC

# Errors and Uncertainties

Scale and Data Sources

LST  $\neq$  Ambient Air Temperature



Image of Downtown Asheville, NC  
Image Credit: Nick Ledford



Image of Asheville, NC  
Image Credit: Michael Trace

Albedo Complexity

Evapotranspiration Parameters/Calculation

# Errors and Uncertainties

Social Vulnerability

Cloud Masking



Time and Aspect of Satellites

Data Processing and No Statistical Analysis

# Conclusion



Asheville's UHI was characterized by a radial pattern of decreasing urban heat from downtown to more rural areas



Socially vulnerable communities were disproportionately located in urban heat hotspots, indicating environmental inequity



Implementing cooling measures in hotspots can mitigate urban heat effects



Need for targeted interventions to reduce heat impacts, address environmental injustices, and enhance urban climate resilience

# Acknowledgments

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## **Project Partners**

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- Edward Macie – Asheville GreenWorks, City of Asheville Urban Forestry Commission
- Molly Woloszyn – NOAA National Integrated Drought Information System

## **Past Contributors**

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- Amiya Kalra
- Amy Kennedy

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