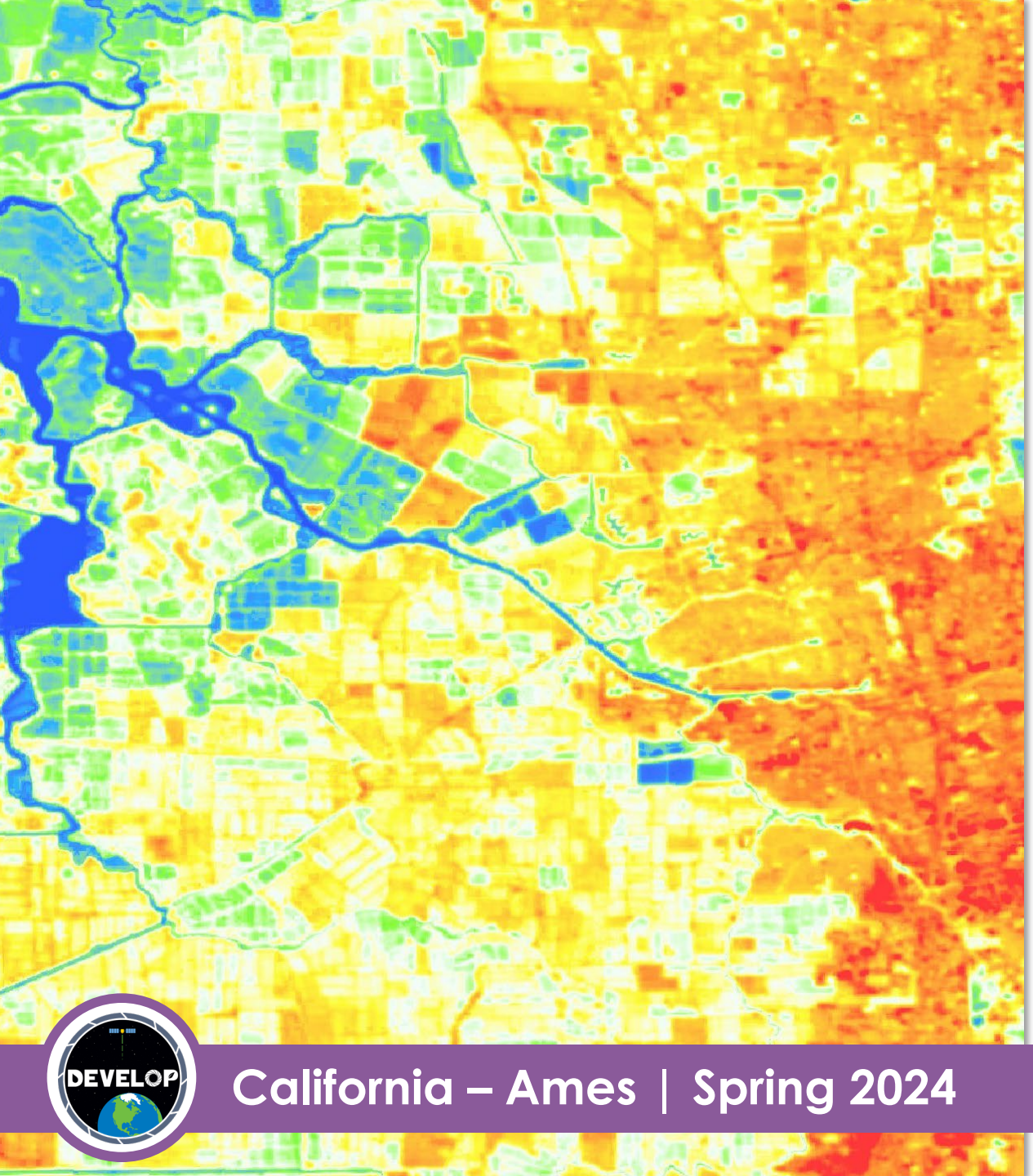


National Aeronautics and Space Administration

SAN JOAQUIN VALLEY HEALTH & AIR QUALITY

Assessing Urban Heat Island Distribution and its Intersections with Air Quality to Understand Converging Vulnerabilities

Shea Rousseau

Carlo Gomez

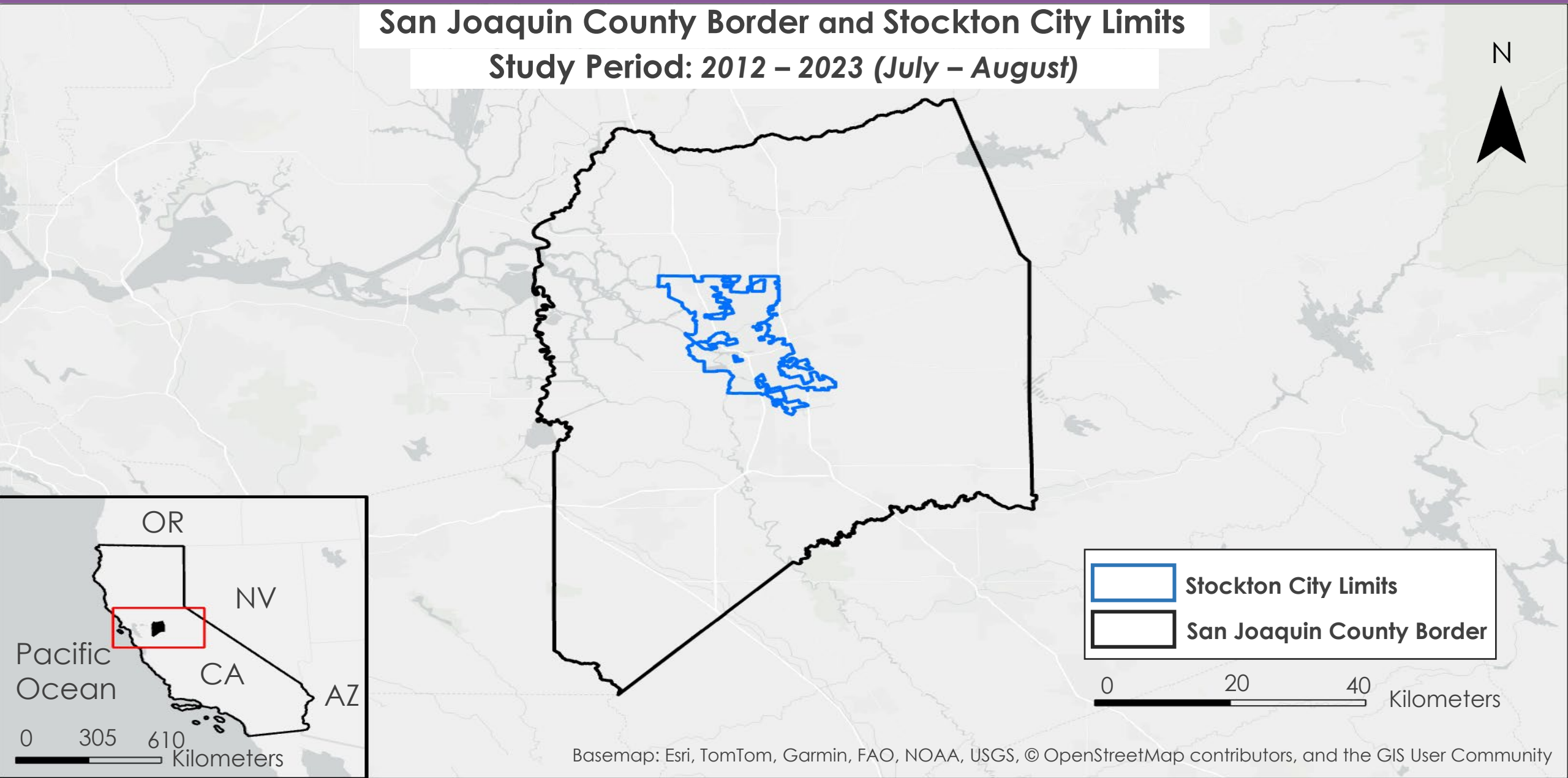
Gabi Colombo

Tyler Padua

DEVELOP

California – Ames | Spring 2024

Study Area & Study Period



Urban Heat Island (UHI) Effect

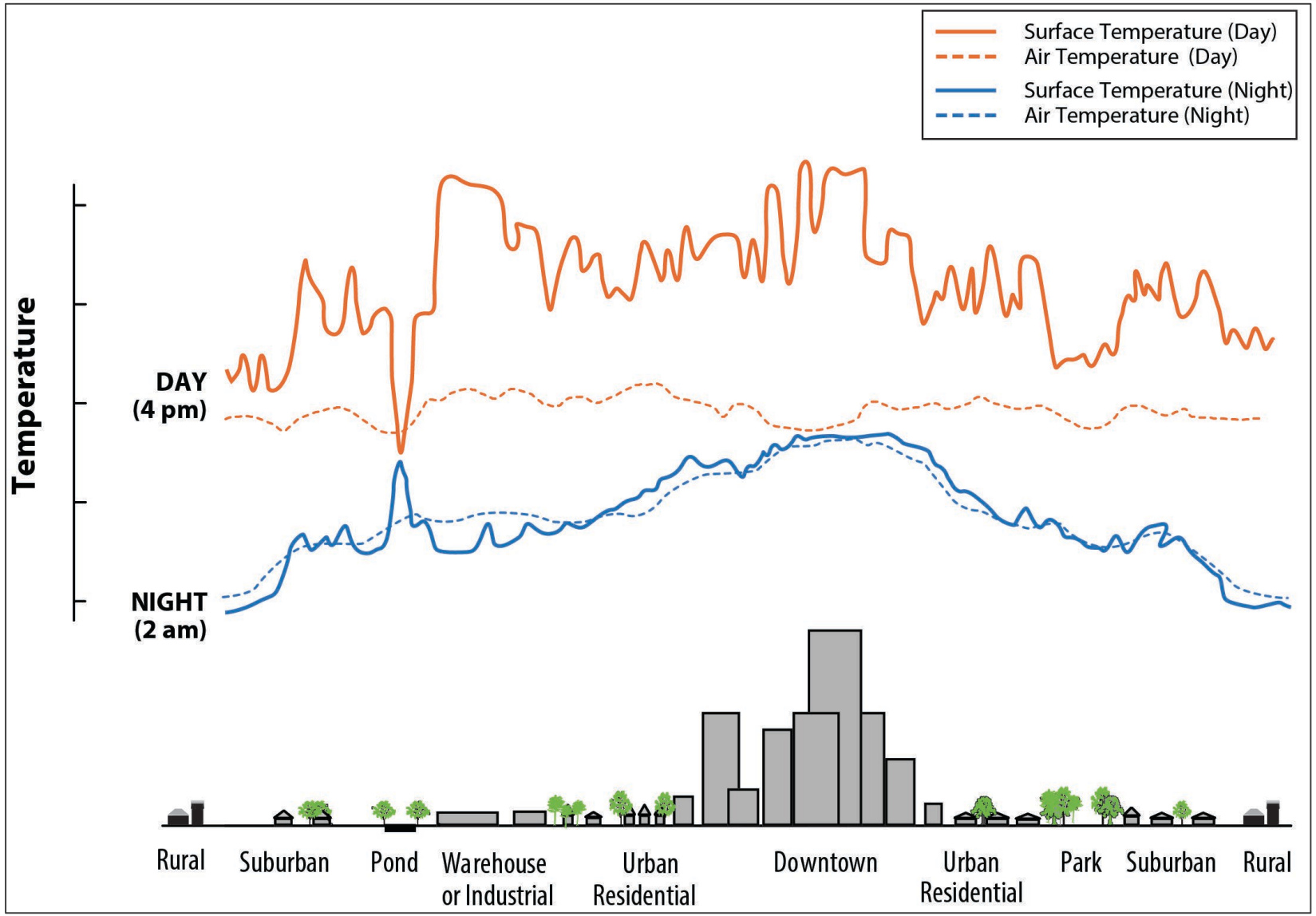


Image Credit: EPA

- Areas with dense infrastructure experience increased temperatures
- Tree canopy coverage provides a natural barrier against solar heat

Little Manila Rising (LMR)

Partner Objectives

Community Development

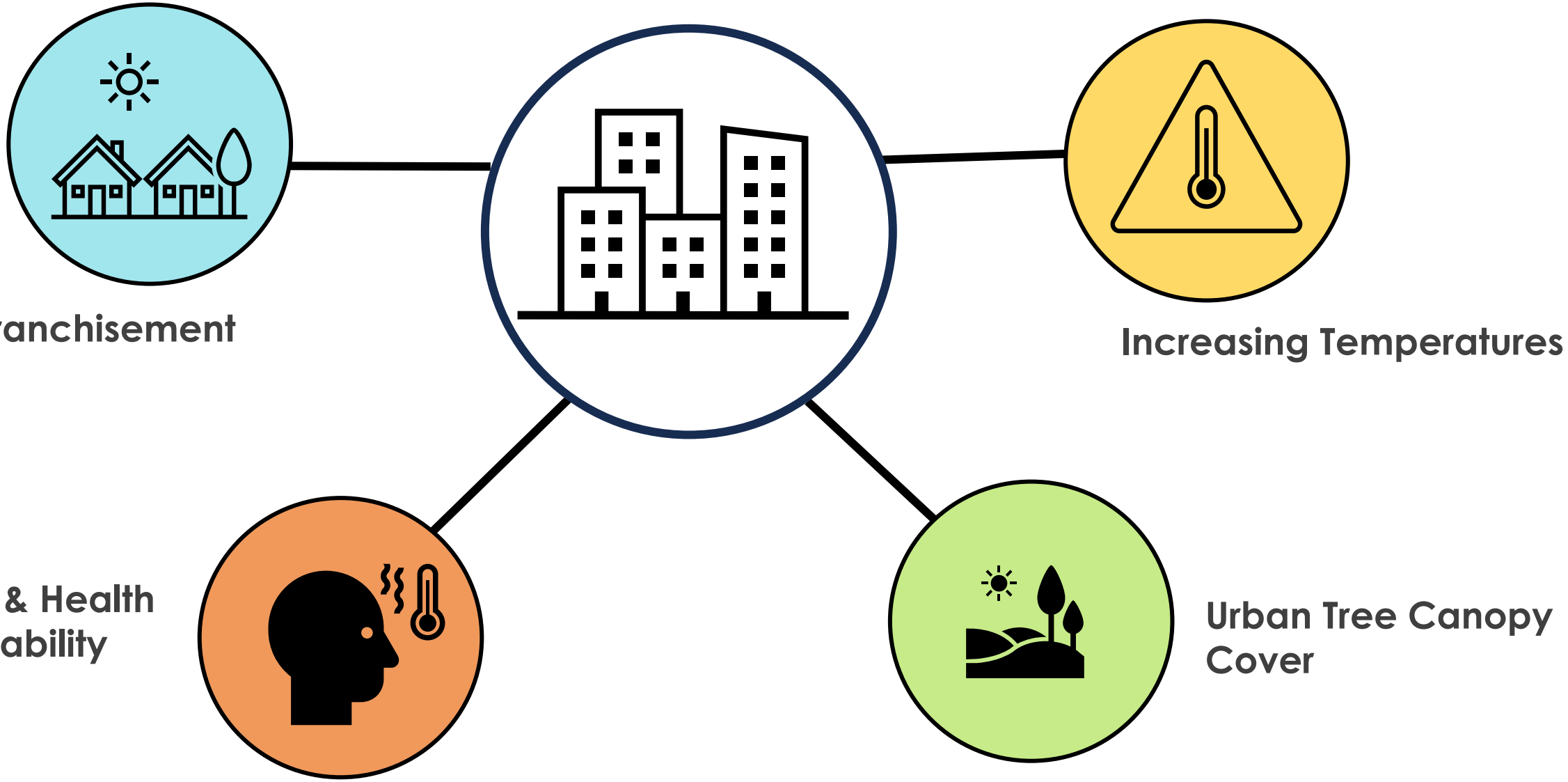
Air Quality

Urban Forestry

Environmental Justice

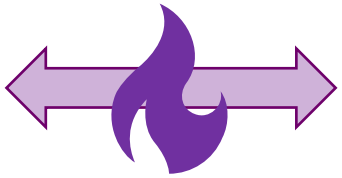
Image Credit: Kenny Chang

Community Concerns



Term I Summer 2023

Identified Converging Vulnerabilities Between Poor Air Quality and Regional Burning

PM2.5(AOD)  **Particulate pollutant**

Is a proxy for:

NO_2  **Exhaust emission**

Census tracts with greater social vulnerability are exposed to statistically higher concentrations of NO_2.

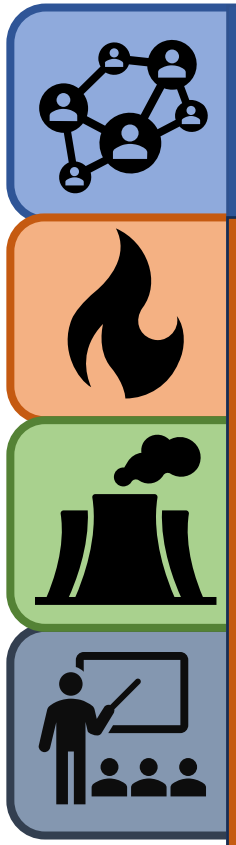
AOD = Aerosol optical depth

Project Objectives

Social Vulnerability Analysis

Produce a social vulnerability index (SVI) based on sociodemographic variables

Project Objectives



Social Vulnerability Analysis

Heat Analysis

Identify areas of extreme heat within San Joaquin County and map them against the socially vulnerable regions

Project Objectives

Social Vulnerability Analysis

Heat Analysis

Air Quality Analysis

Locate neighborhoods experiencing increased concentrations of NO2, taking note of overlap with our SVI

Project Objectives

Social Vulnerability Analysis

Heat Analysis

Air Quality Analysis

Community Outreach

Create a brochure with GIS products and descriptions to help inform the impacted community

Earth Observations

Image Credit: NASA, ESA

Landsat 8
OLI/TIRS

Sentinel-5 Tropomi

Methods: Social Vulnerability Map

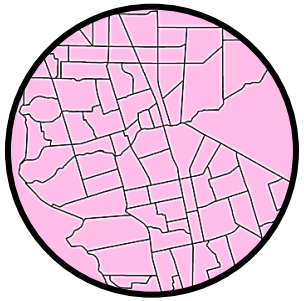
Data

EPA EJSCREEN
Variables

Excel

Data Processing

Census Tracts



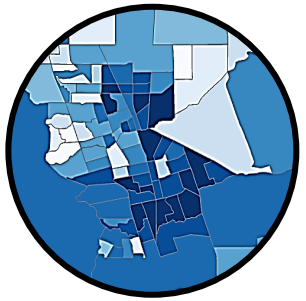
+

Social Vulnerability Index

ArcGIS Pro

Product

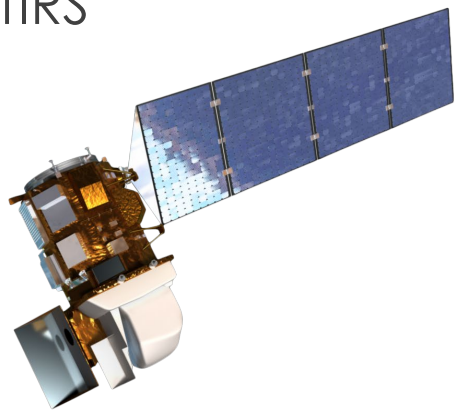
Social Vulnerability Map



Methods: Urban Heat Exposure

Data

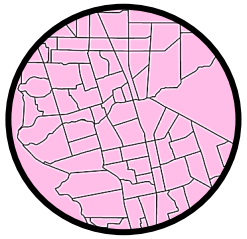
Landsat 8
TIRS



GEE

Data Processing

Census Tracts

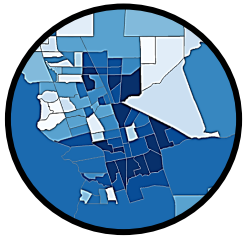


+

Average LST Map

+

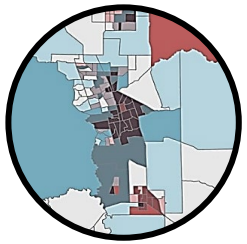
Social Vulnerability Map



ArcGIS Pro

Product

Heat Vulnerability Map



GEE = Google Earth Engine
NIR = Near Infared Wavelength

Image Credit: NASA

Methods: Air Quality Exposure

Data

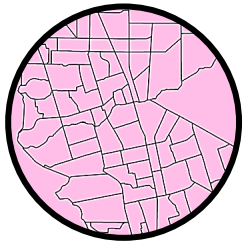
Sentinel-5
TROPOMI

Image Credit: ESA

ArcGIS Pro and QGIS

Data Processing

Census Tracts



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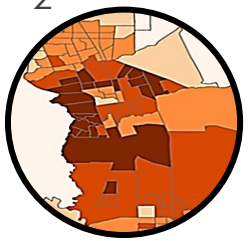
Average NO_2 Concentration Map



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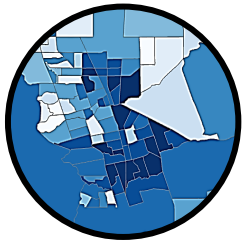
Social Vulnerability Map

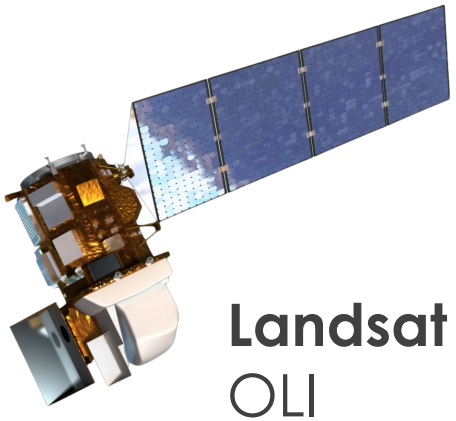


Product

Air Quality Vulnerability Map

Methods: Indicator of Green Vegetation (NDVI)

Data



Landsat 8
OLI

GEE

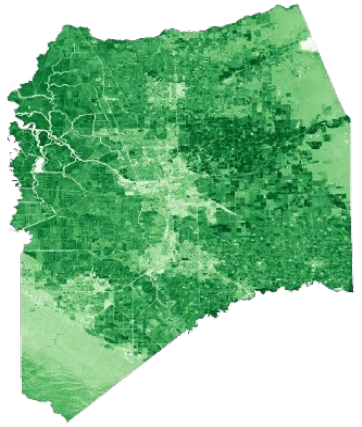
Data Processing

Filters:
Date Range
Cloud Mask

+

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

Product



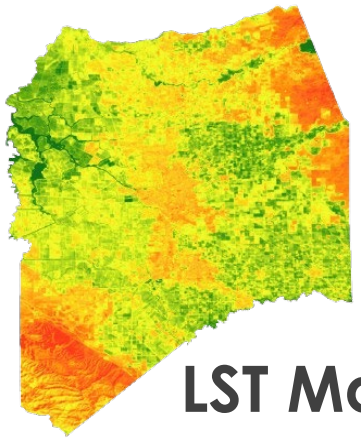
Normalized Difference Vegetation Index

GEE = Google Earth Engine
NIR = Near Infared Wavelength

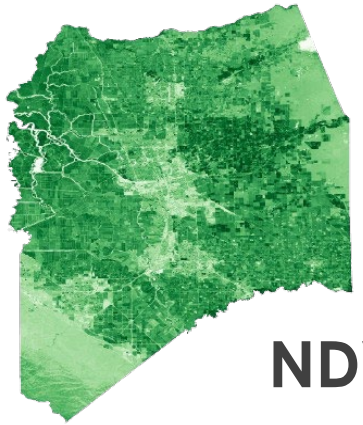
Image Credit: NASA

Methods: Correlation Analysis

Data

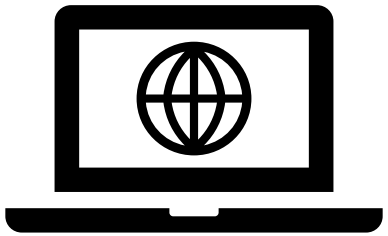


LST Map



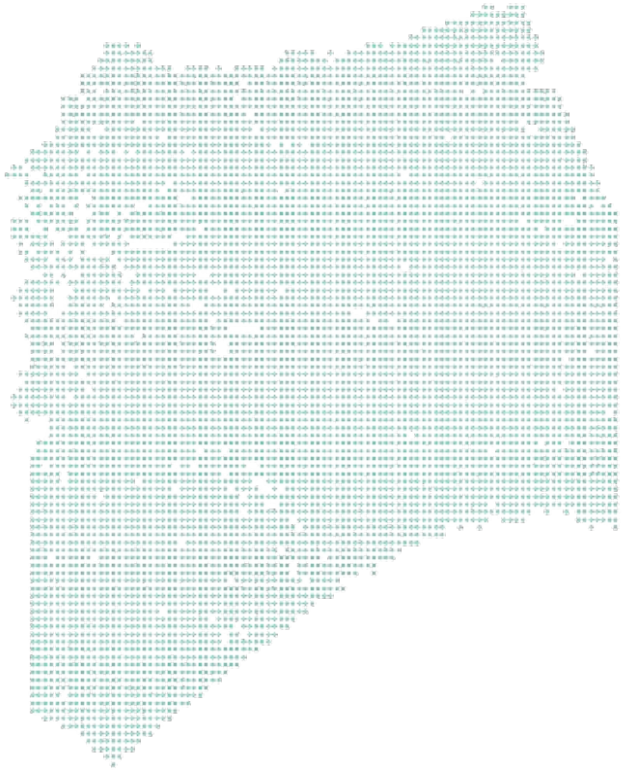
NDVI Map

Data Processing



ArcGIS 2.4.2

Product



Discrete Data Point Map

NDVI = Normalized Difference Vegetation Index
LST = Land Surface Temperature

Methods: Land Cover

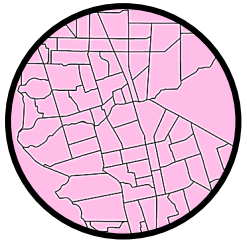
Data

NAIP

ArcGIS Pro

Data Processing

Census Tracts



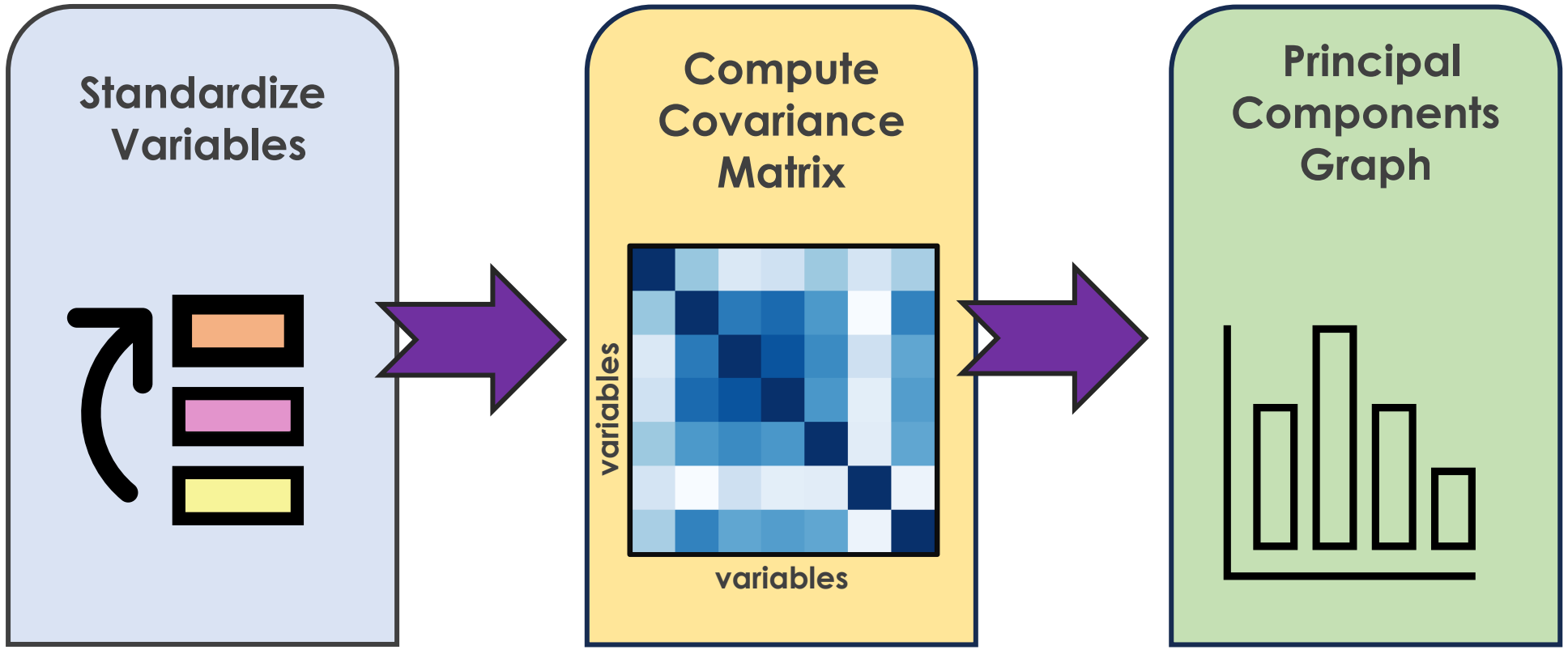
+

Extracted NAIP Mosaic

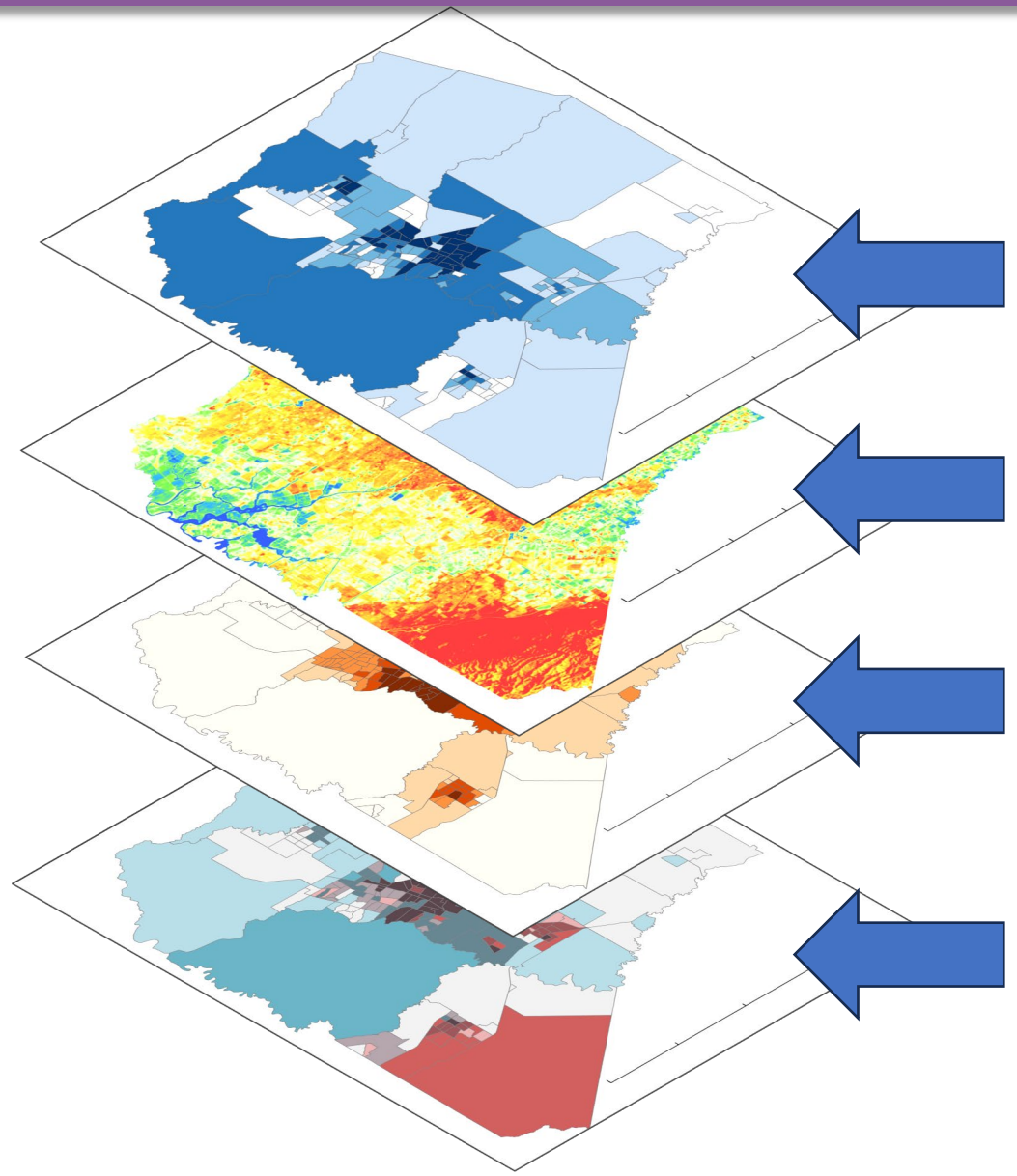
Product

Land Cover Classification Maps

Methods: Principal Component Analysis



Methods: Heat and Air Quality Analysis



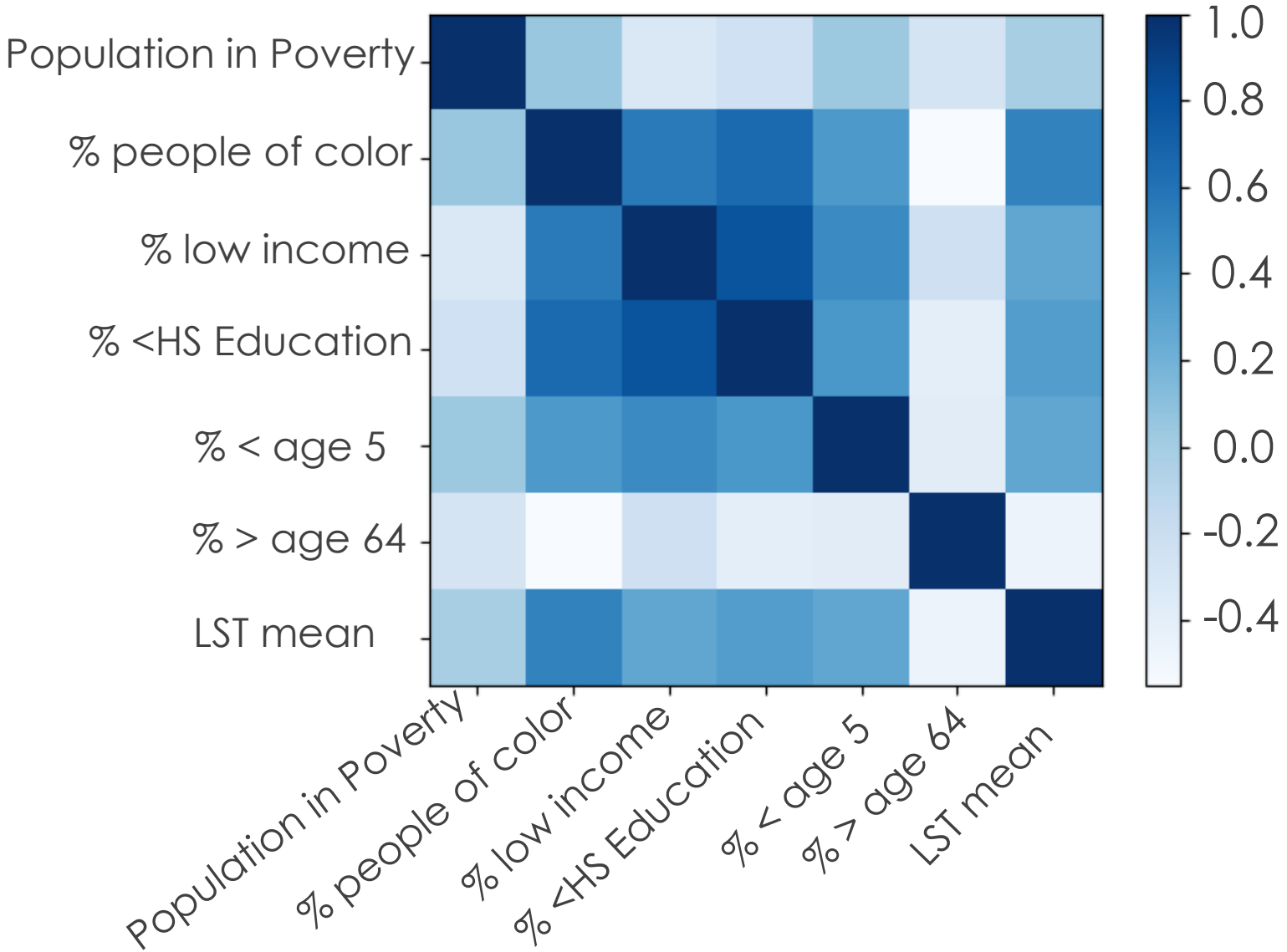
Social Vulnerability Map

Land Surface Temperature Map

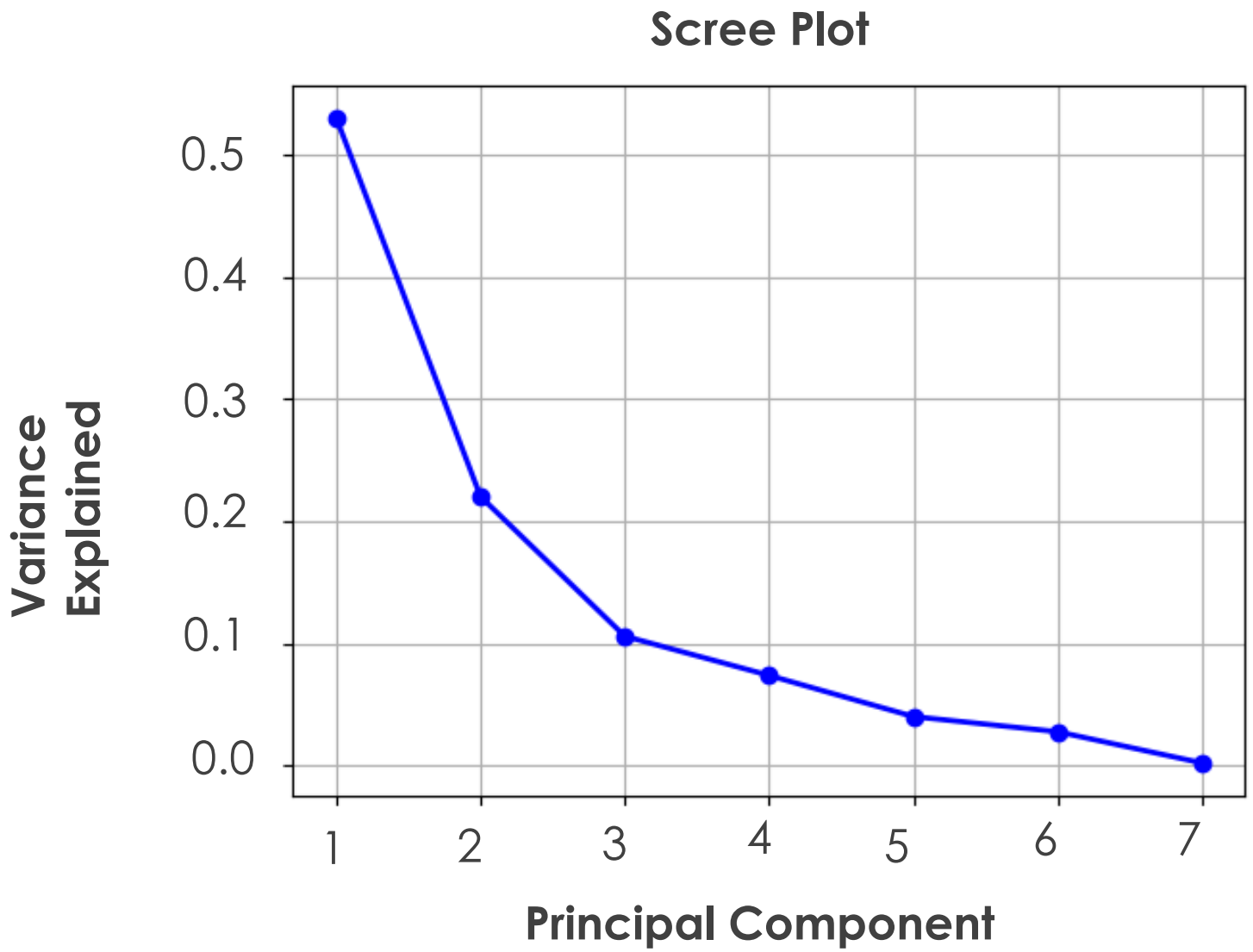
Air Quality Map

Heat and Air Quality Vulnerability Map

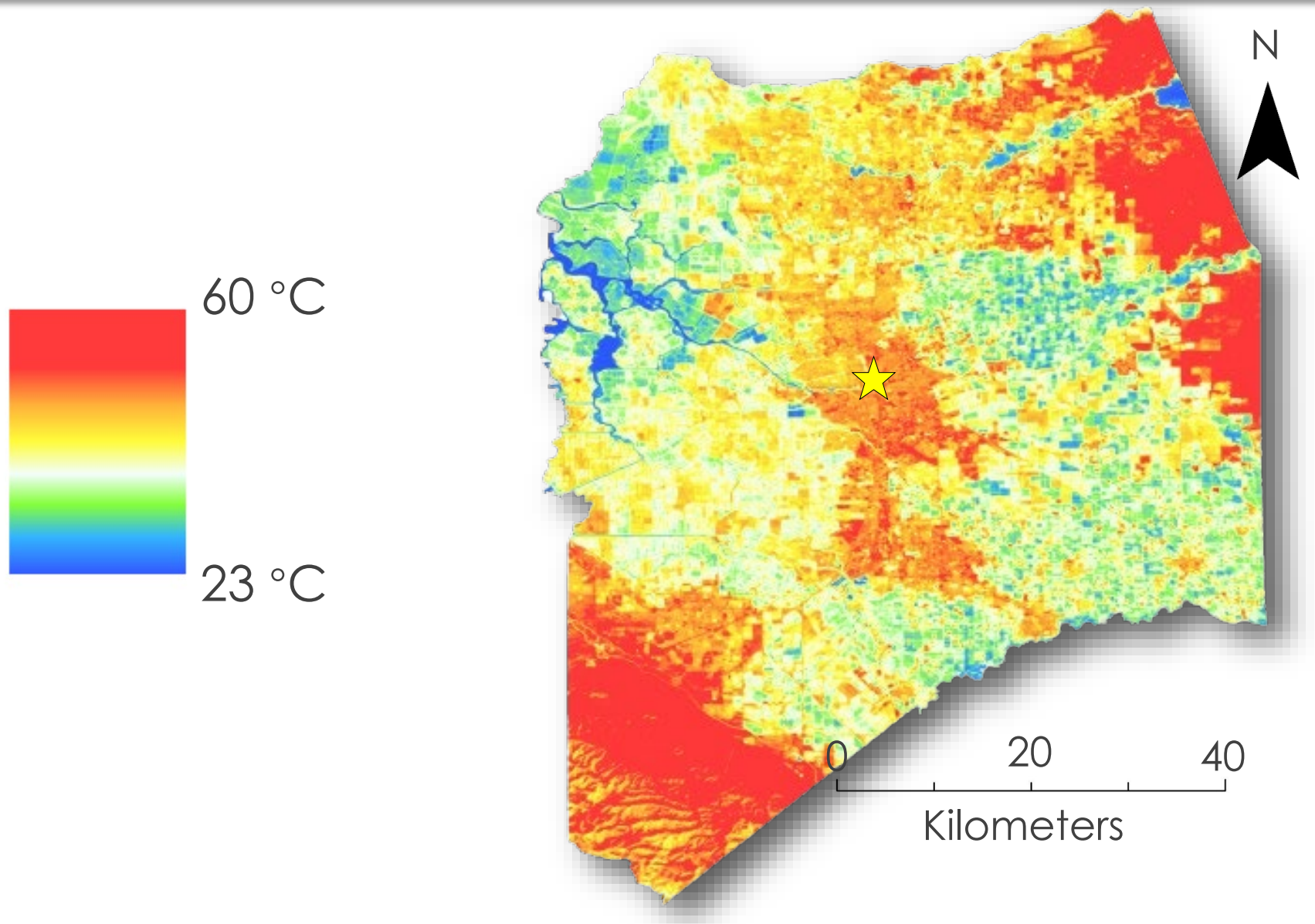
Results: Principal Component Analysis: Part 1



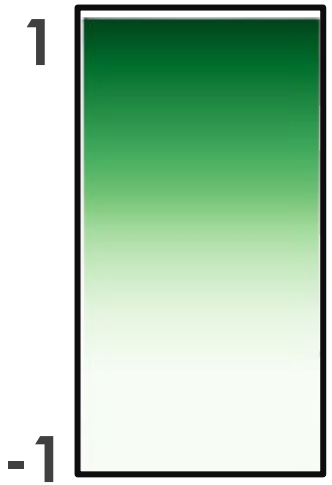
Results: Principal Component Analysis: Part 2

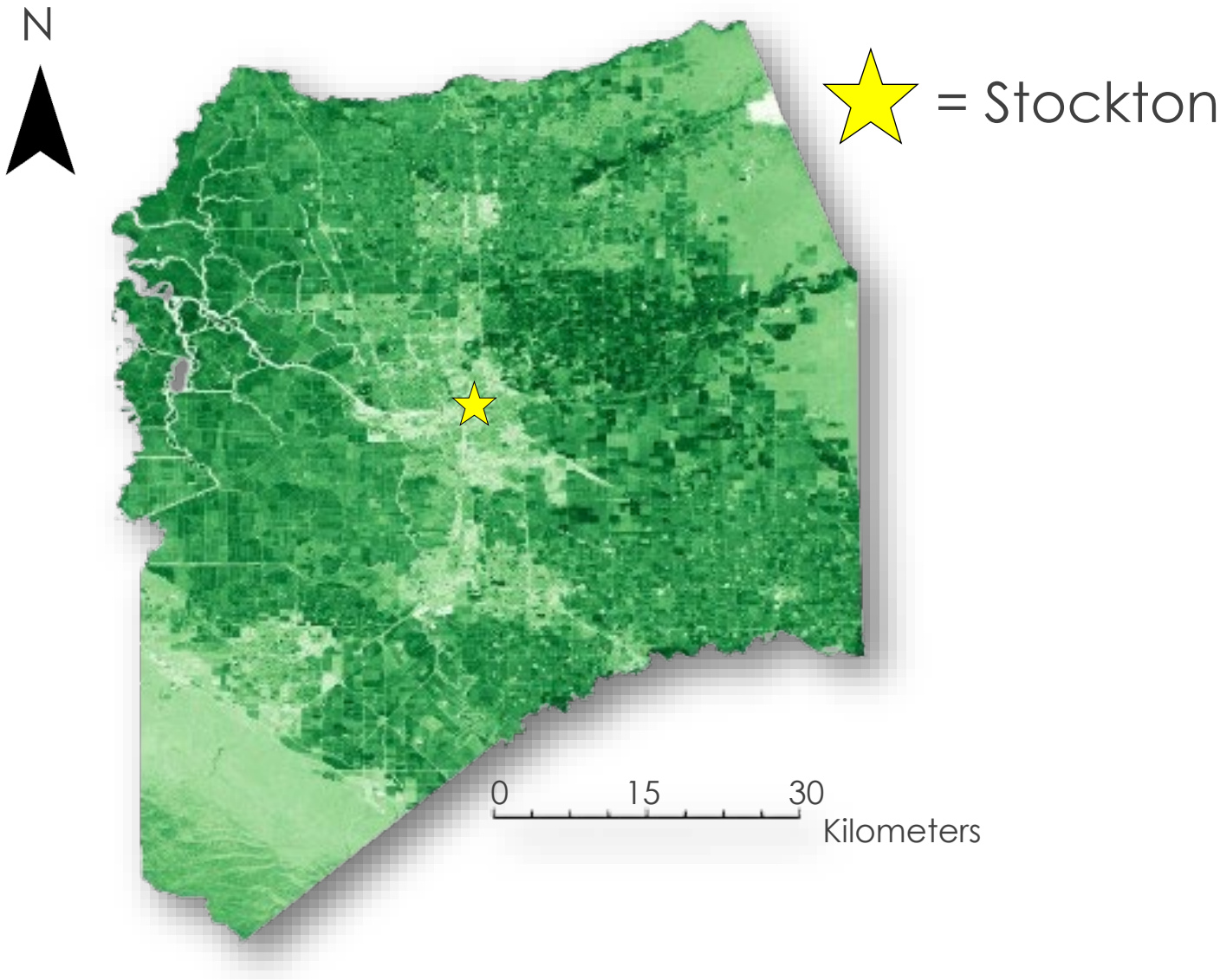


Results: Raw Land Surface Temperature Map

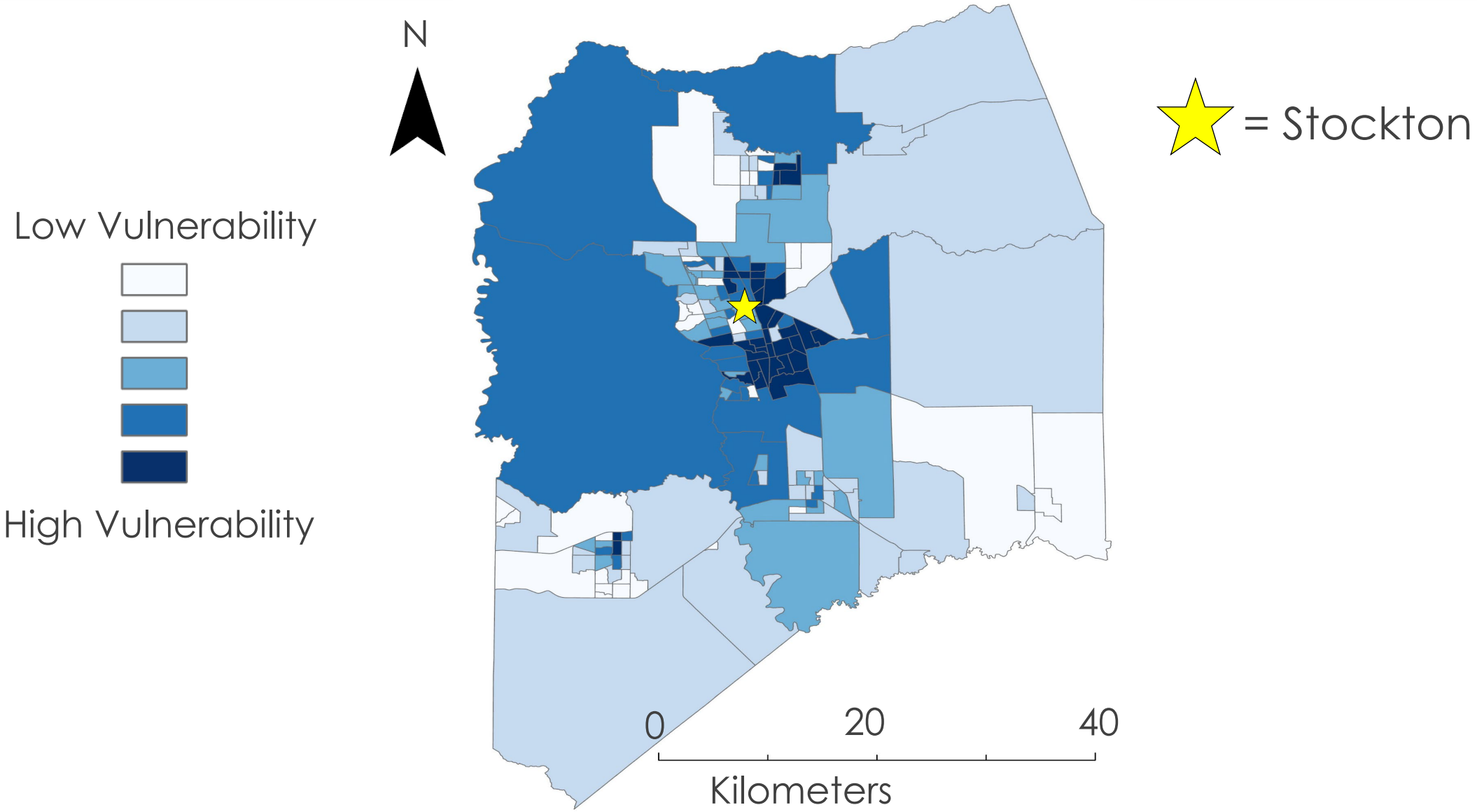


Results: Indicator of Green Vegetation (NDVI)

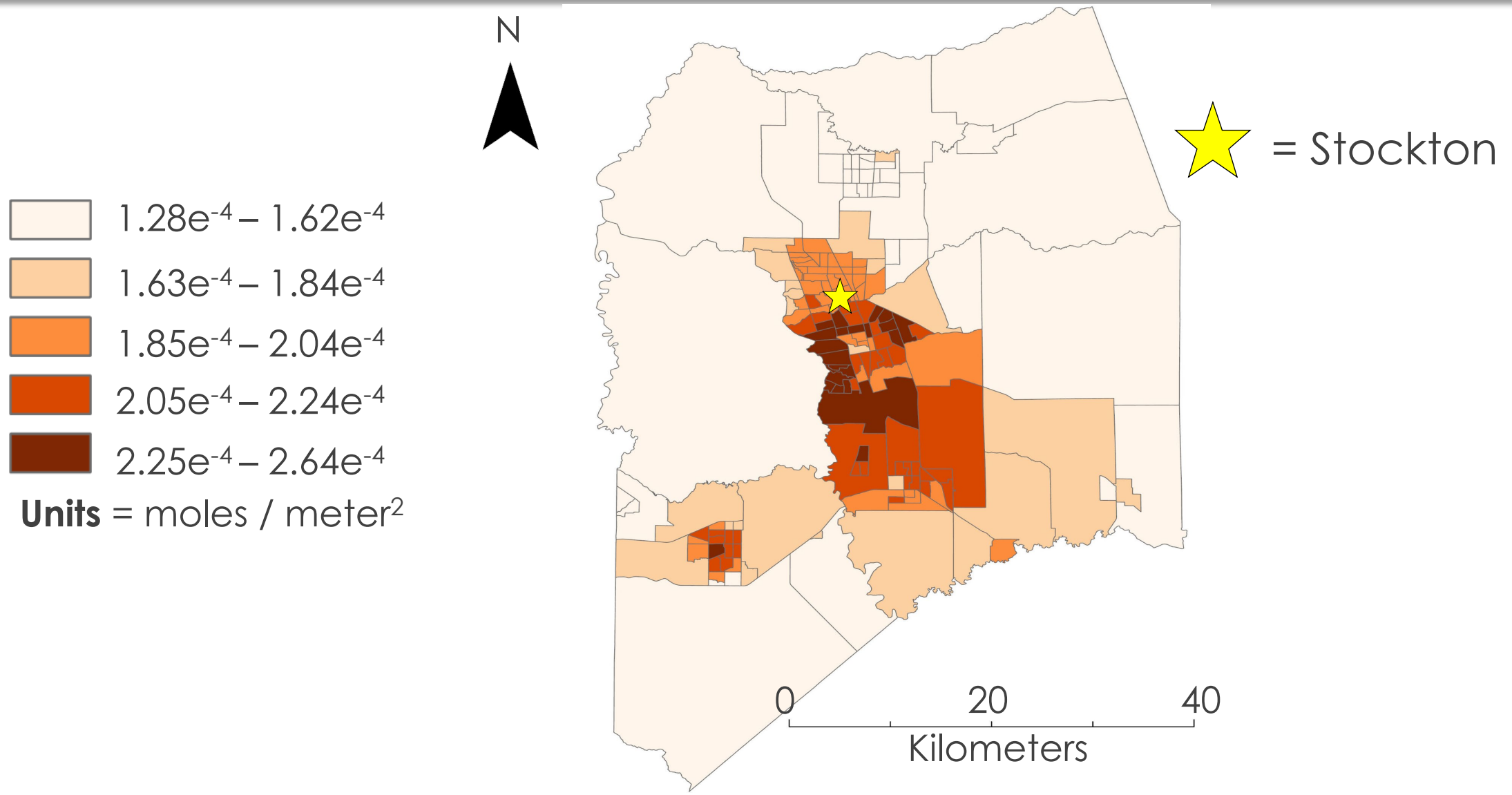




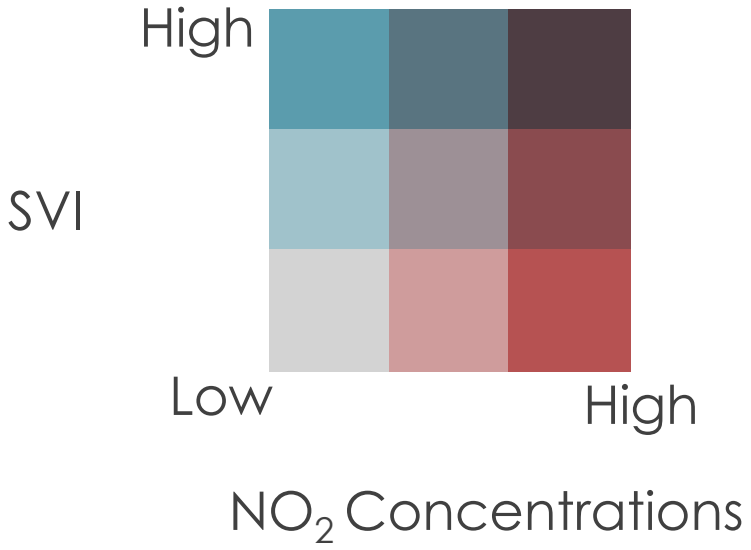
Results: Social Vulnerability Map

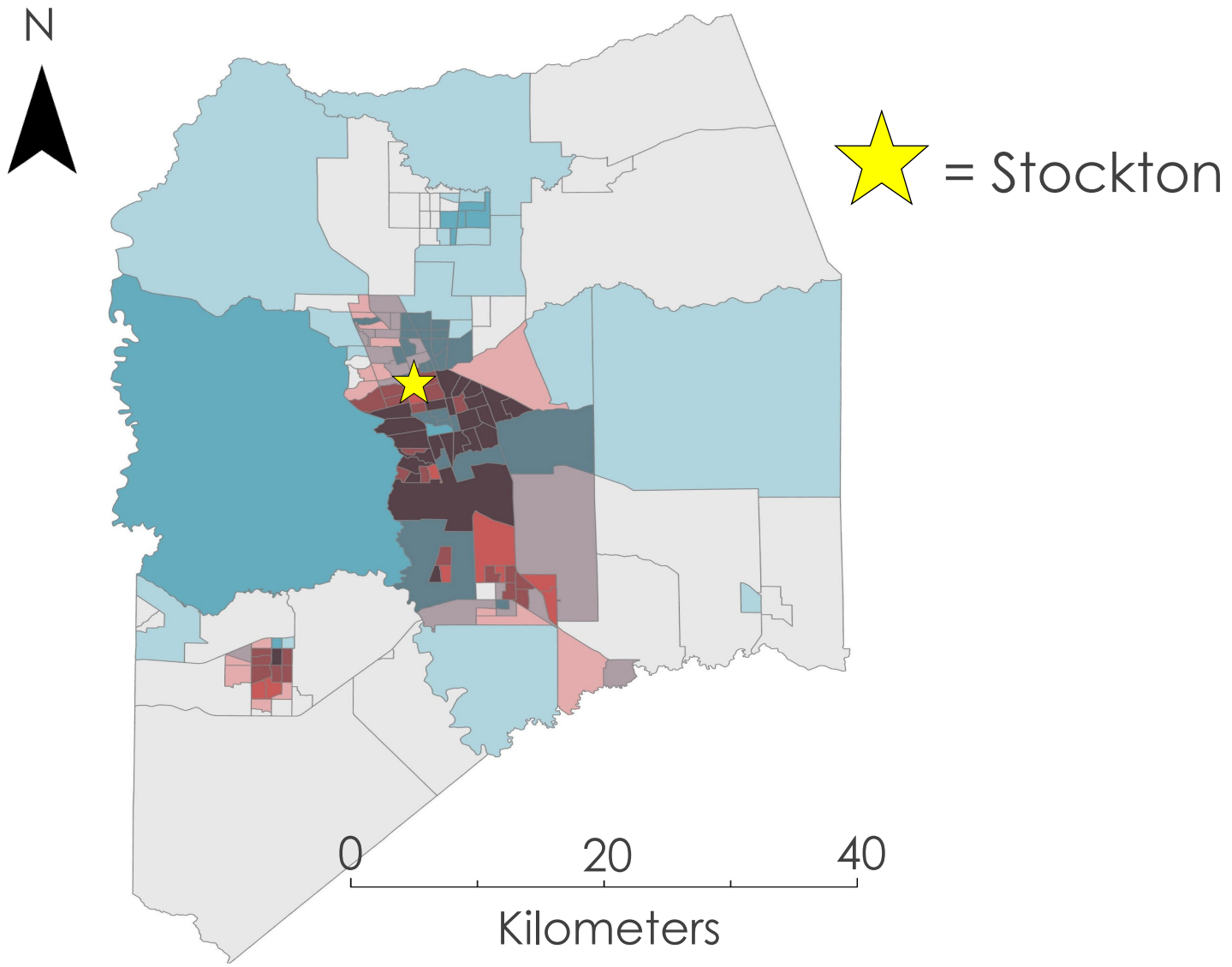


Results: NO_2 Concentrations

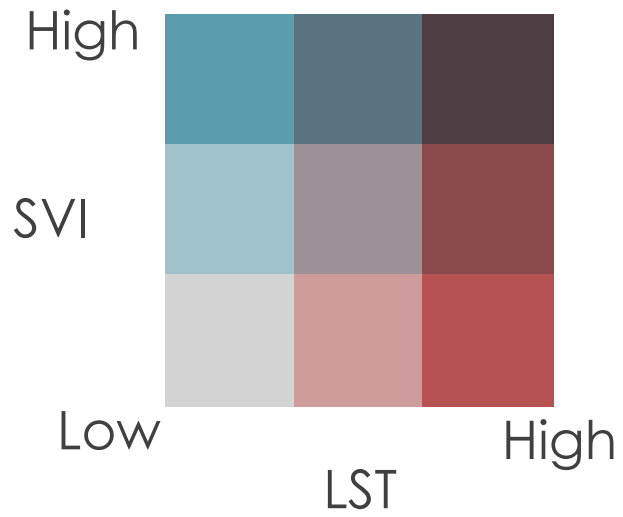


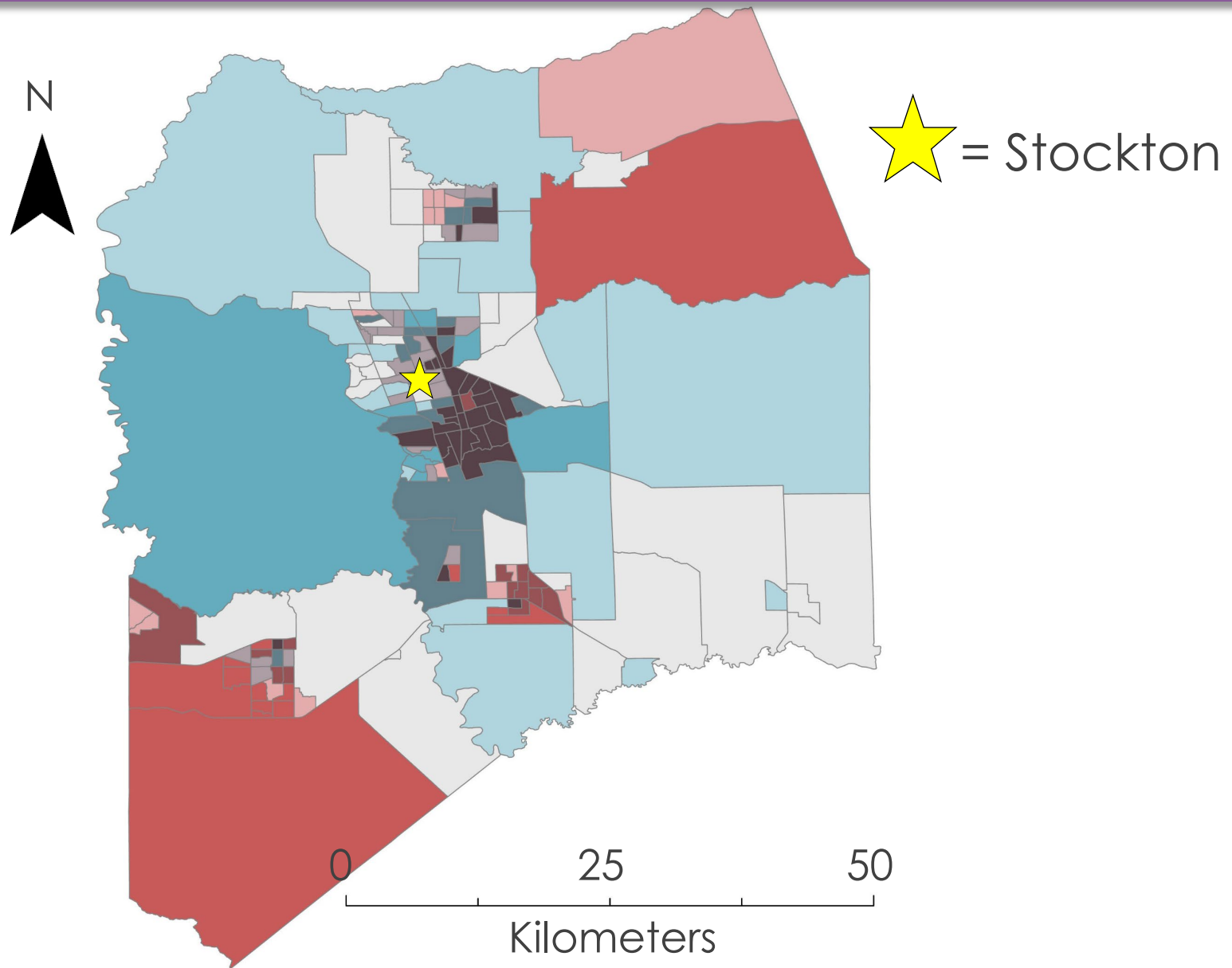
Results: Air Quality Vulnerability



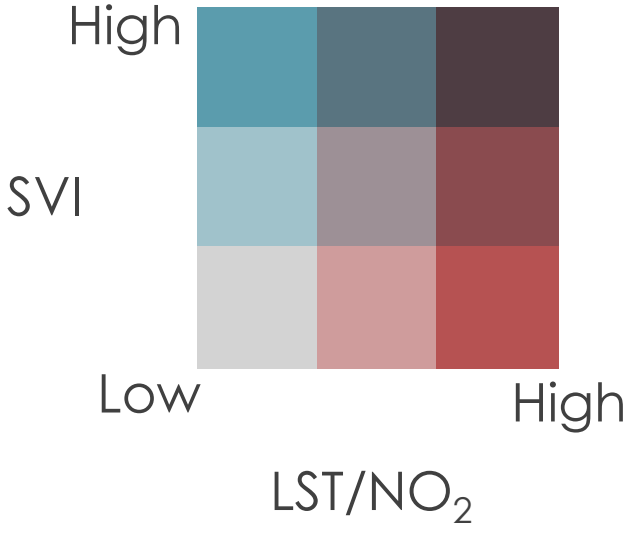


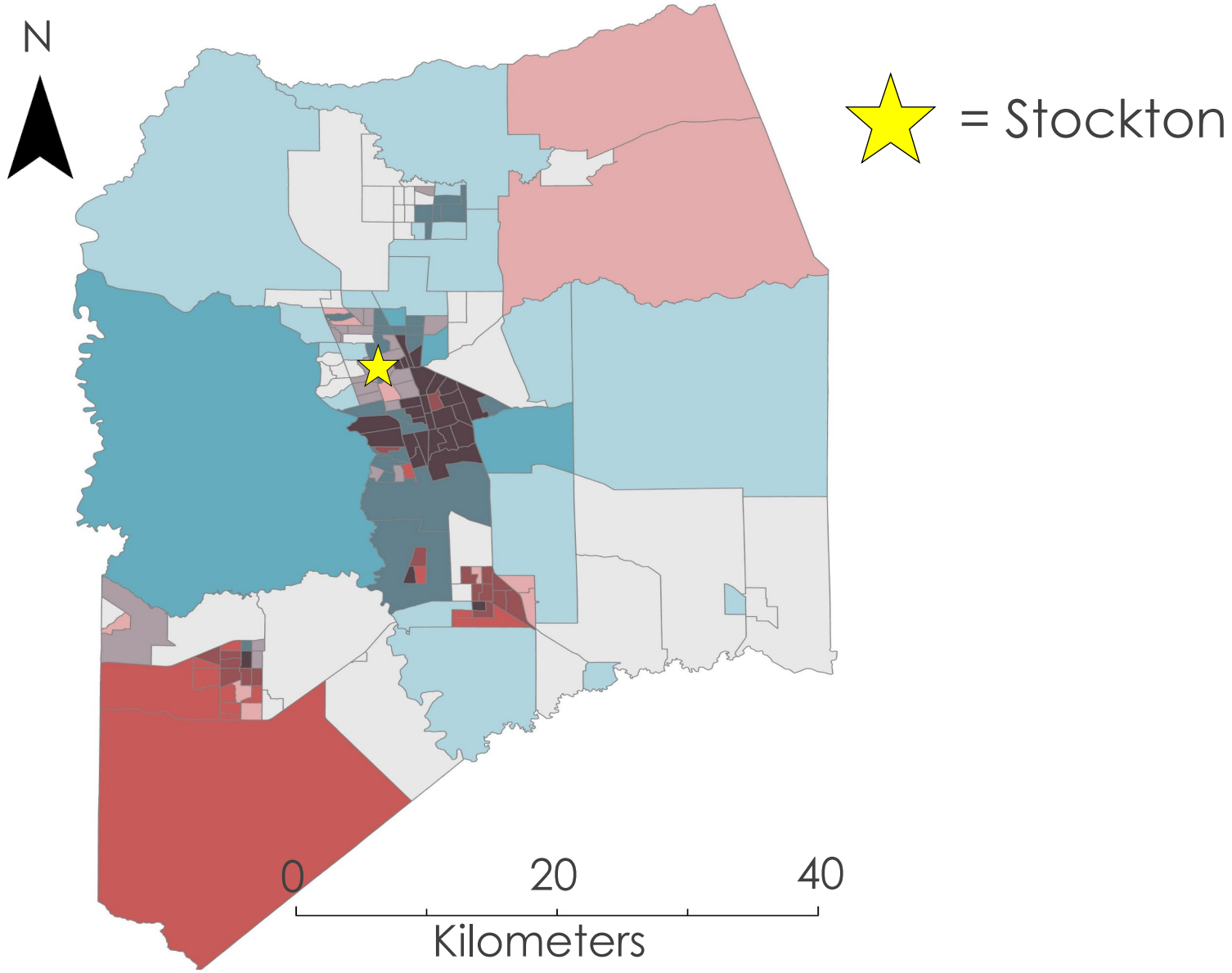
Results: Heat Vulnerability Map



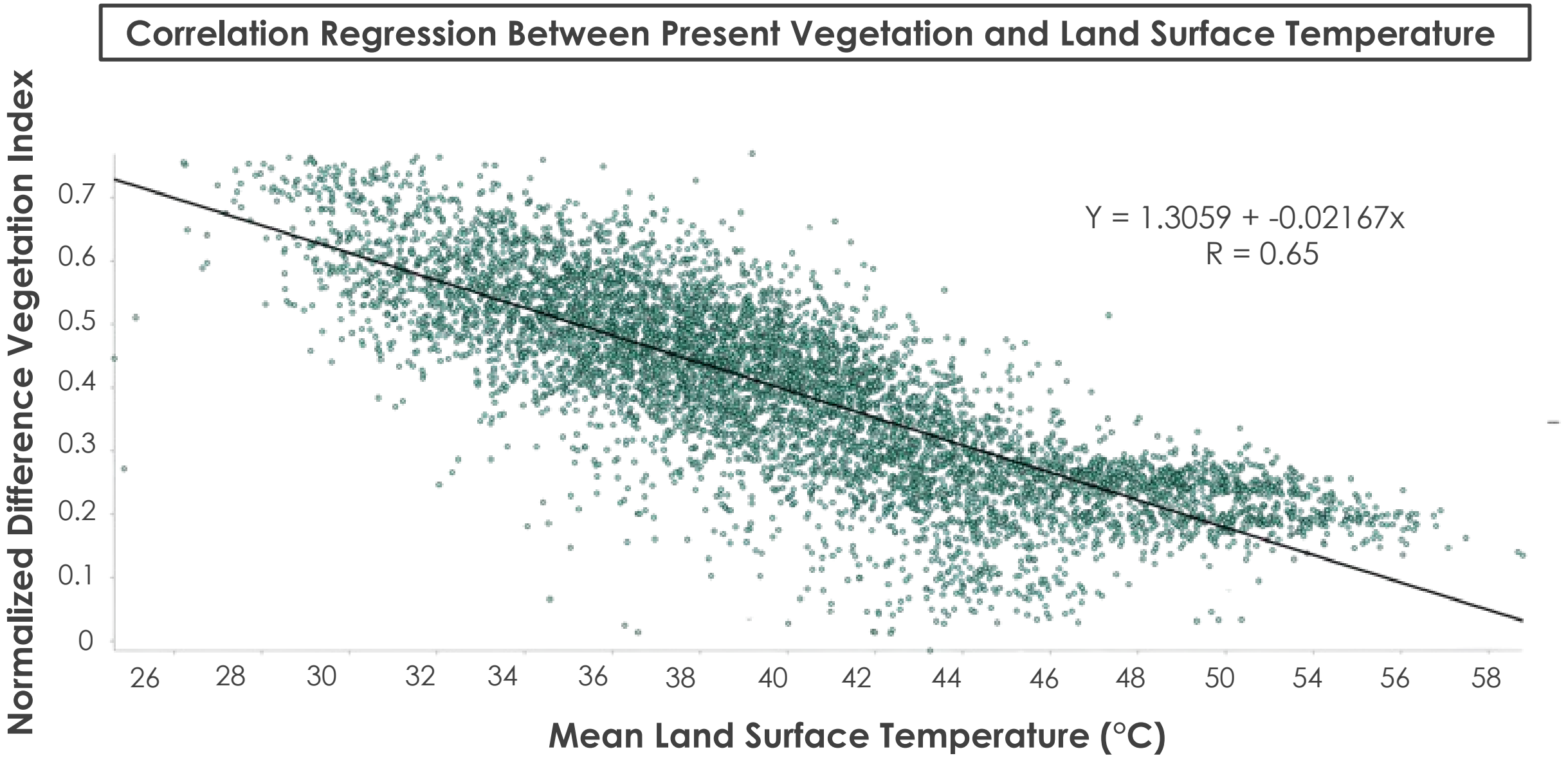


Results: Final Heat/Air Quality Analysis

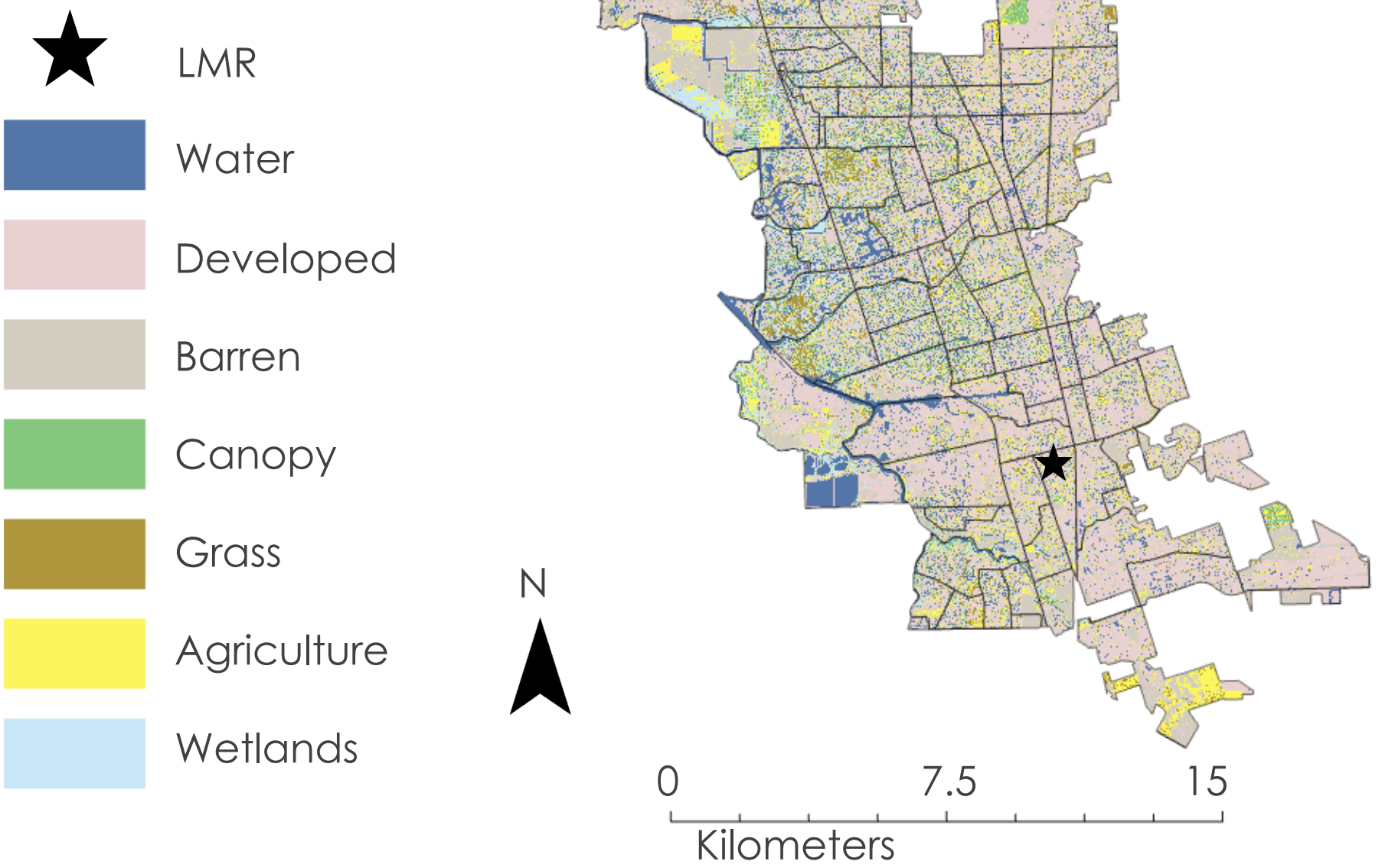




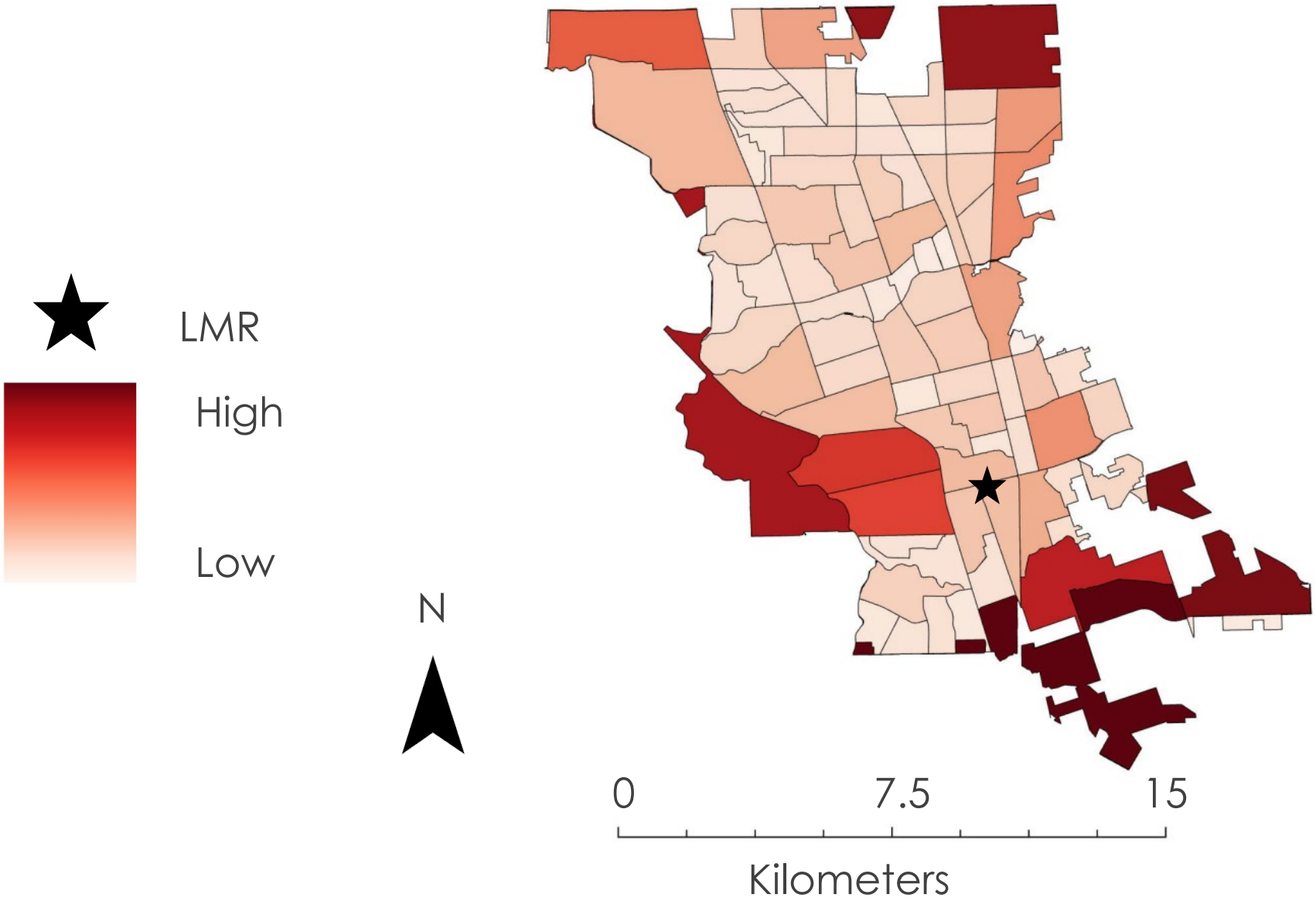
LST and NDVI Correlation Graph



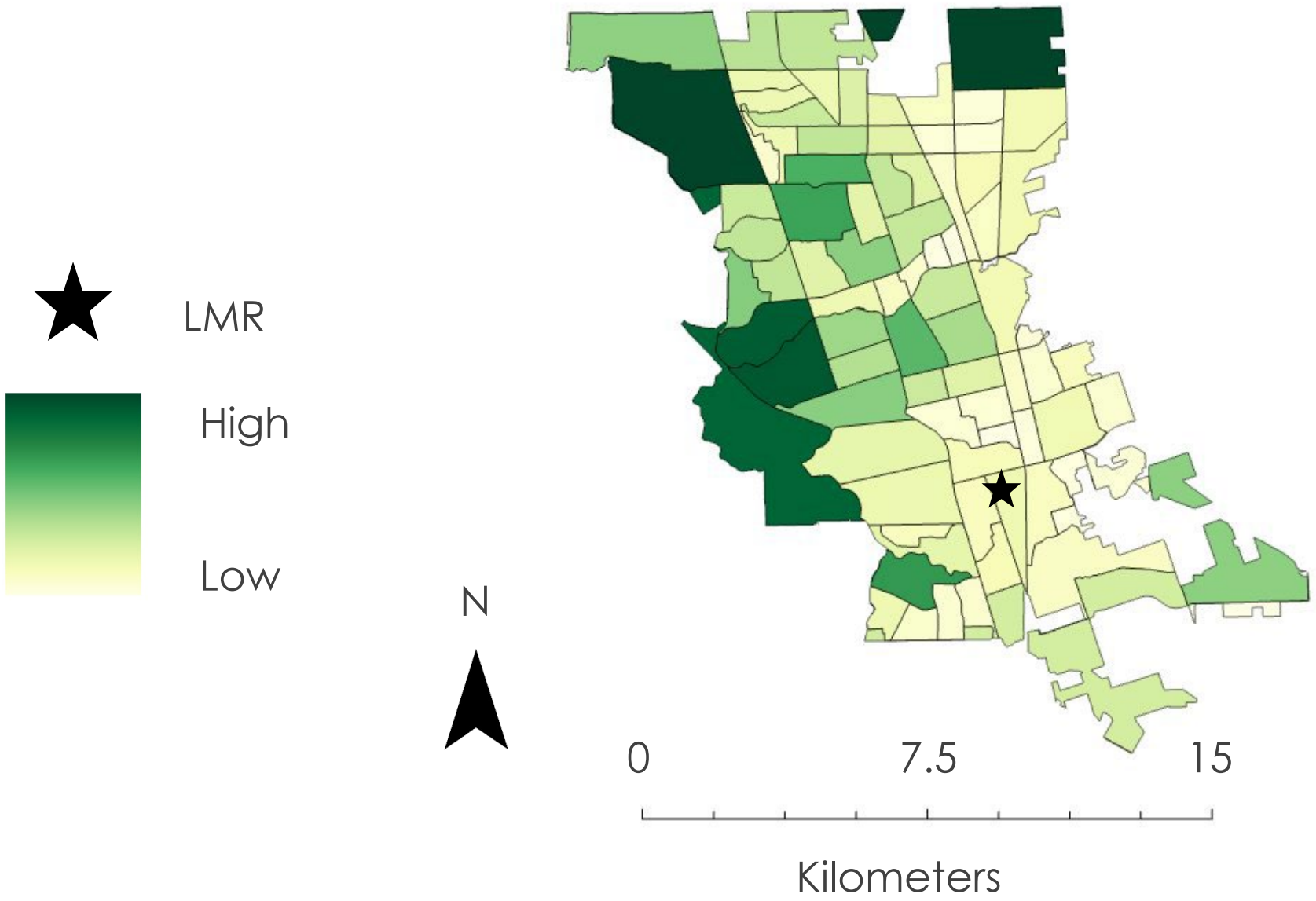
Land Cover


LMR
Water
Developed
Barren
Canopy
Grass
Agriculture
Wetlands
N
0
7.5
15
Kilometers

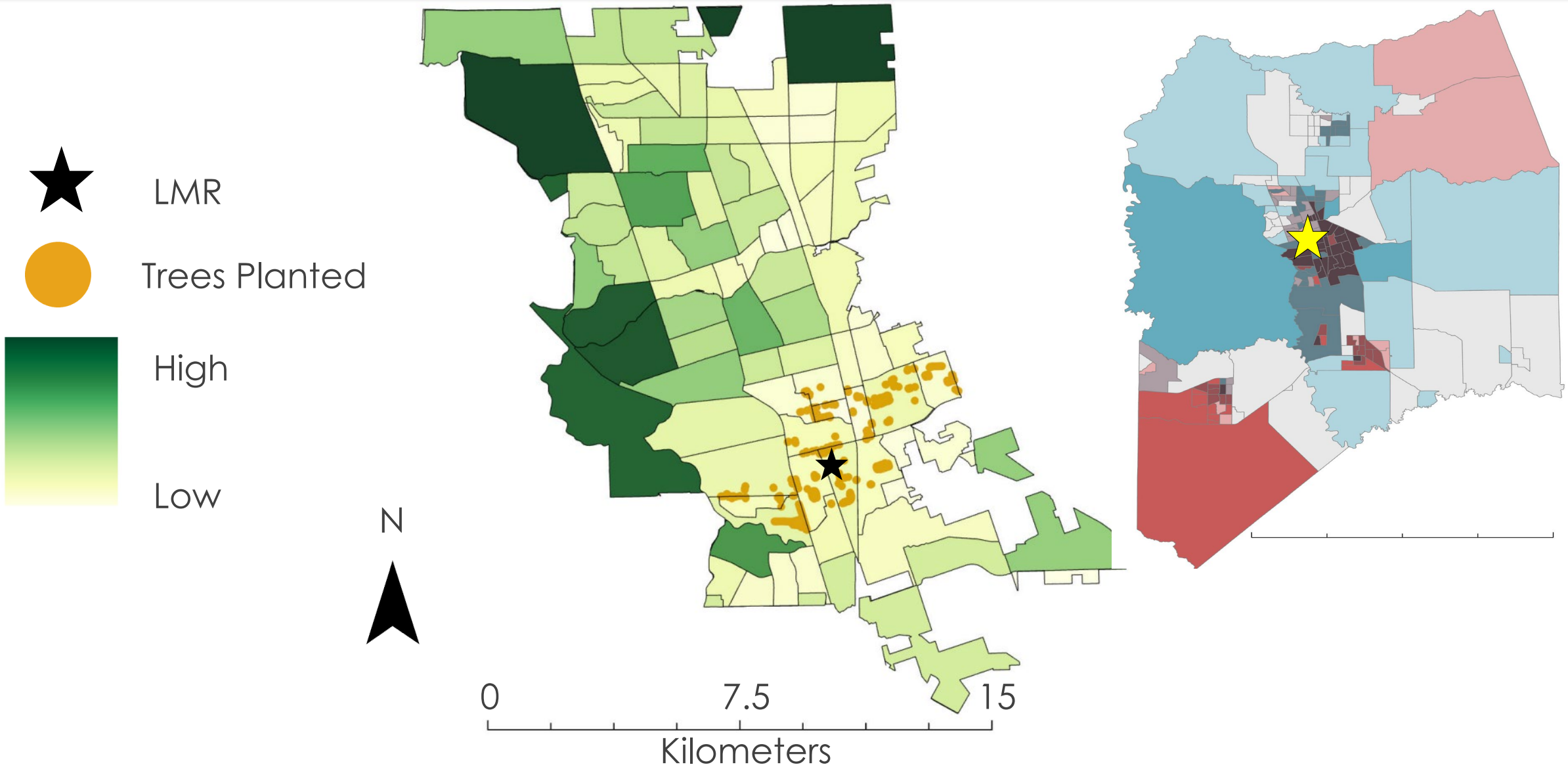
Developed Cover



Canopy Cover



LMR Urban Forestry



Urban Heat Island Intensity

Image Credit: NOAA Office for Coastal Management

Average LST in southern Stockton is 45.9 °C

Image Credit: Ken Lund

Average LST in rural area next to Stockton is 37.5 °C

Urban Heat Intensity = 8.4 °C

Average LST in southern Stockton and rural area are different based on T hypothesis test ($p < 0.001$)

Neighborhood Temperature Differences

Image Credit: Thomas Vander Wal

Average LST in northern Stockton is 42.9°C

Image Credit: NOAA Office for Coastal Management

Average LST in southern Stockton is 45.9 °C

Temperature difference = 3°C

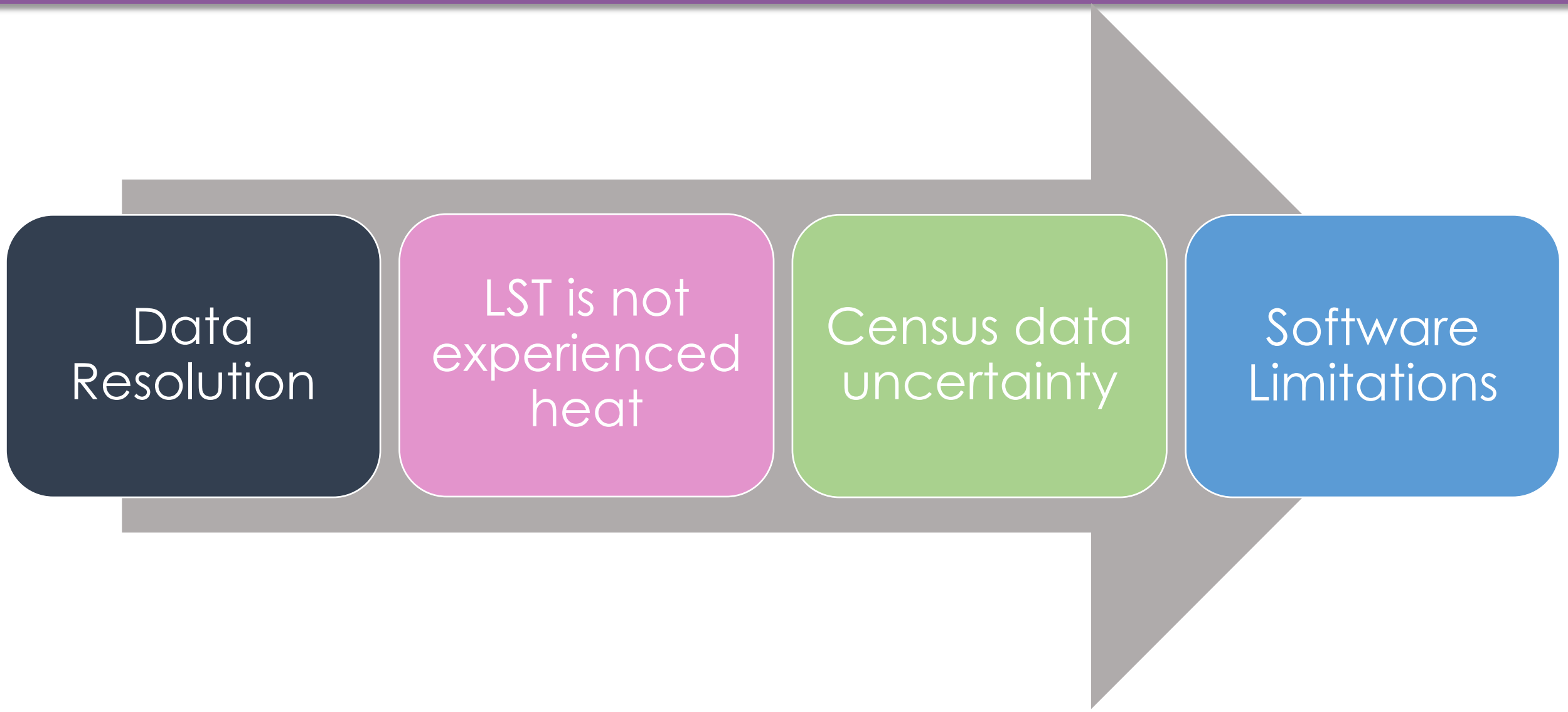
Average LST in northern and southern Stockton are different based on T hypothesis test ($p < 0.001$)

Conclusion

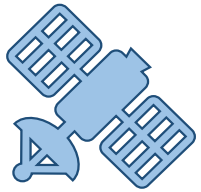
- In San Joaquin County, socio-demographics are linked to increased urban heat temperatures and poor air quality.
- NO2 concentrations are typically h igher along major roadways and urban areas.

- Remote Sensing techniques are useful methods for evaluating heat and air quality exposure.
- LMR's urban forestry efforts are promising for reducing urban heat.

Limitations and Uncertainties



Feasibility and Future Recommendations



NASA Earth observations can provide valuable information on urban heat and air quality to local communities such as LMR.

The analysis tools and end products developed from this project can help LMR make informed decision making.

Incorporating more social vulnerability indicators into a new social vulnerability index.

Adding major roads and highways to air quality maps to find relationships between air quality and distance to highways.

Acknowledgments

Advisors, Lead, and Fellow

- Dr. Morgan Gilmour (NASA Ames Research Center)
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- Dr. Xia Cai (NASA Langley Research Center)
- Dr. Kenton Ross (NASA Langley Research Center)
- Dr. Joshua Dimon (UC Berkeley)
- Lisa Tanh (ESRI)
- Lauren Webster (NASA DEVELOP Lead, California – Ames)
- Maya Hall (NASA DEVELOP Impact Analysis Fellow)

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