

National Aeronautics and
Space Administration



Monitoring the Urban Heat Island Effects on the Health of Residents in New Orleans, Louisiana Metropolitan Area with Landsat Land Surface Temperature Products

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Overview

Study Area: New Orleans metropolitan area

Study Period: June – September (2000 – 2018)

Partner: Louisiana Public Health Institute (LPHI)

Community Concerns:

- ▶ Urban sprawl
- ▶ High density of impervious surfaces
- ▶ Lack of green infrastructure
- ▶ Extreme urban heat

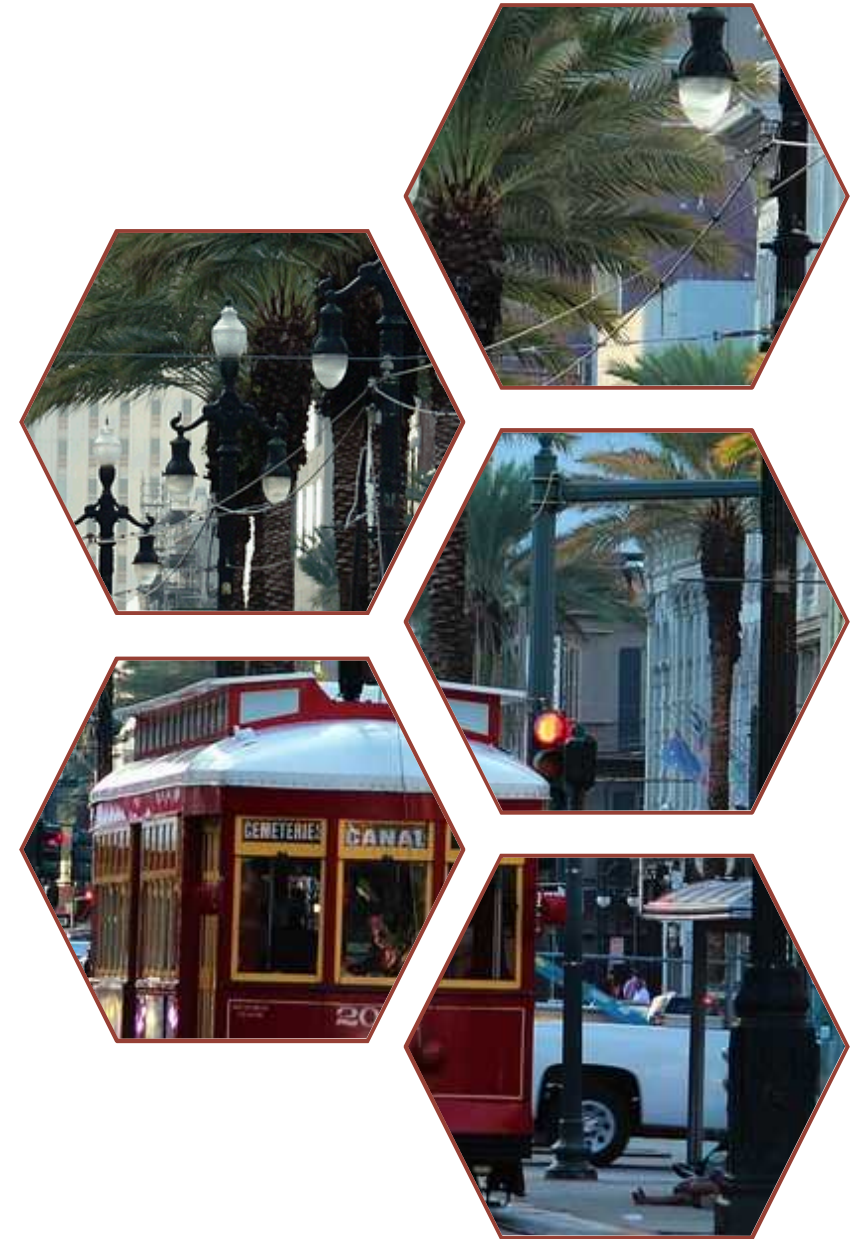


Image Credit:
Oliver Weidmann

Community Concerns



Urban Heat Island (noun) /'ərbən hēt 'ɪlənd/ :

an urban or metropolitan area that is significantly warmer than surrounding rural areas due to the presence of impervious surfaces, industry, and human activities that can contribute to heat-related health crises



Community Concerns

More frequent heat wave events can lead to **higher rates of hospitalizations and heat-related mortality**

Urban Heat Islands = higher surface temperatures in the daytime, less night time cooling, and higher air pollution levels

Populations most vulnerable:

- ▶ children (<5 years)
- ▶ elderly (>65 years)
- ▶ people with pre-existing chronic conditions
- ▶ disabled persons



Image Credit: Pixabay



Community Concerns: Human Health

Apparent Temperature	Heat-stress risk with physical activity and/or prolonged exposure
90° - 104°	Heat cramps or heat exhaustion possible
105° - 129°	Heat cramps or heat exhaustion likely. Heatstroke possible
130° +	Heatstroke very likely

Prolonged exposure to temperatures **90°F or above** impacts human health → we delegated these values as “**hot spots**”



Image Credit: Bonnie Ferrante

Project Objectives

1. **Perform** temporal and spatial analysis to identify heating patterns in New Orleans
2. **Identify** regions experiencing anomalous temperatures ($\leq 70^{\circ}\text{F}$ or $\geq 90^{\circ}\text{F}$)
3. **Classify** land cover to quantify density of gray infrastructure and vegetated space
4. **Create** Heat Vulnerability Assessment by calculating combined influence of:
 - ▶ Land surface temperature
 - ▶ Land cover classifications (% urban land)
 - ▶ Census demographic data



Earth Observations



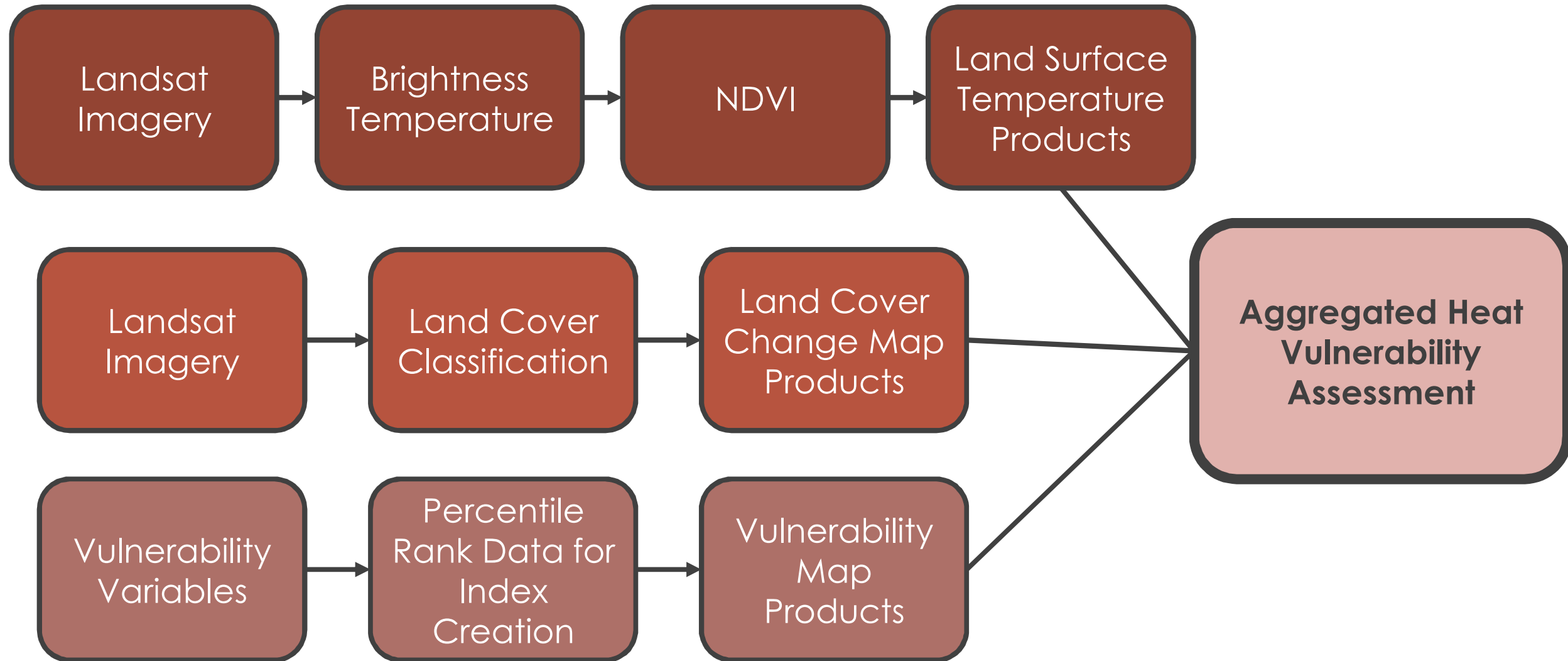
Landsat 5 TM
2000 - 2011

Landsat 7 ETM+
2012

Landsat 8 OLI/TIRS
2013 - 2018

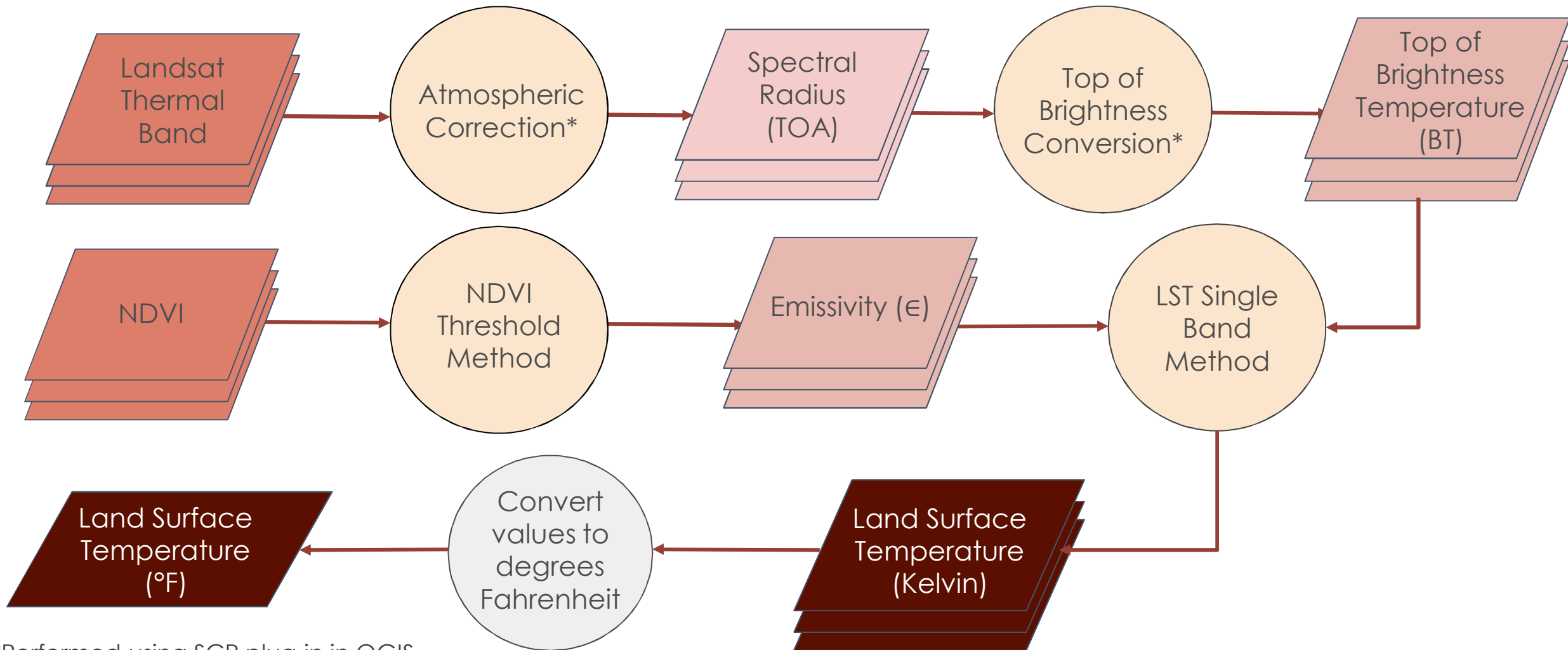


Methodology





Land Surface Temperature

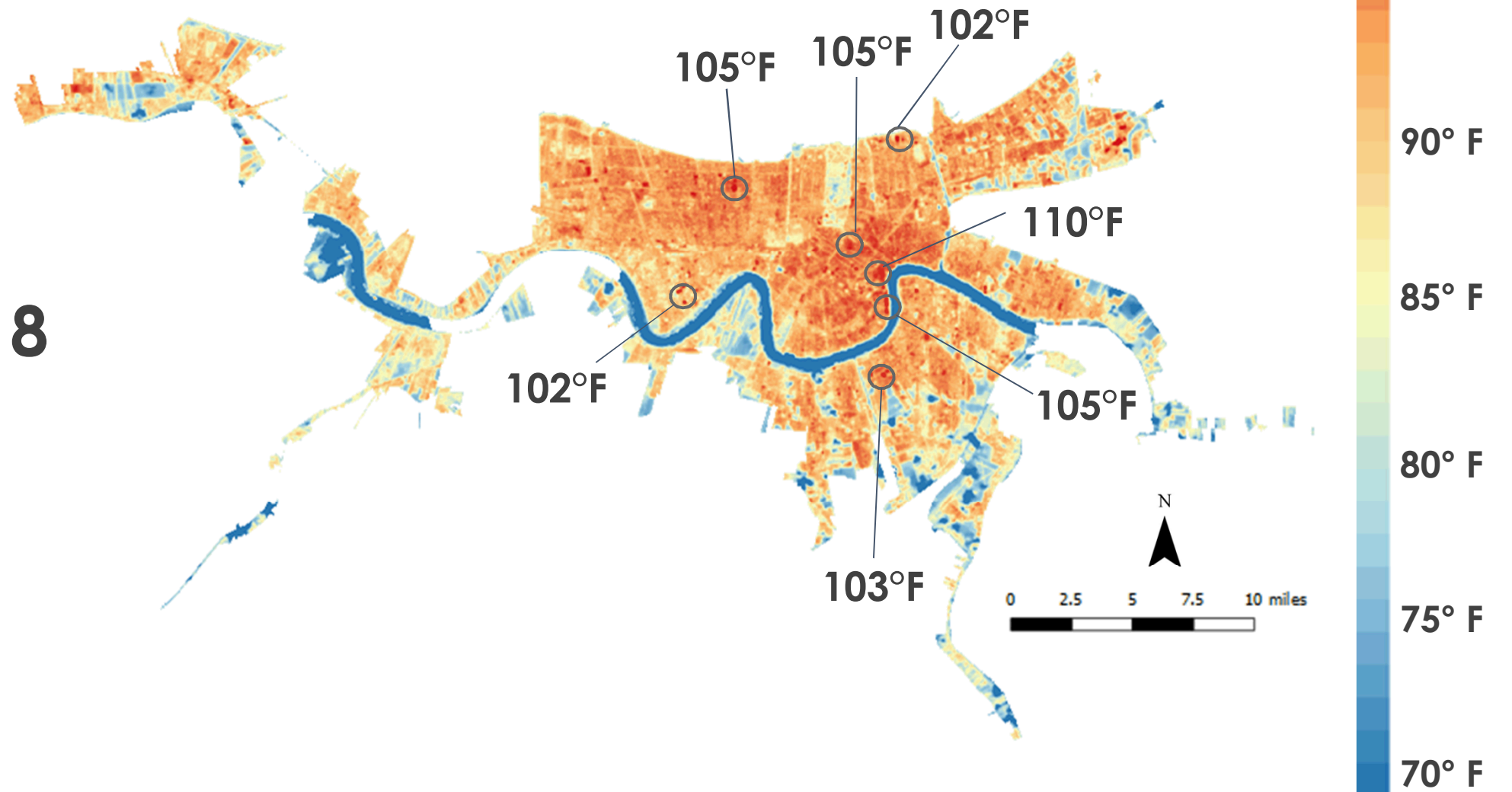


*Performed using SCP plug-in in QGIS



Land Surface Temperature

July 2018





Land Surface Temperature

Zonal statistics for LST 2018:
mean temperature per
Census tract

Zonal statistics were calculated
using mean temperature per
Census tract:

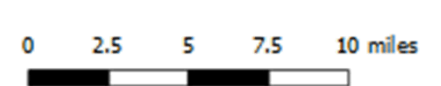
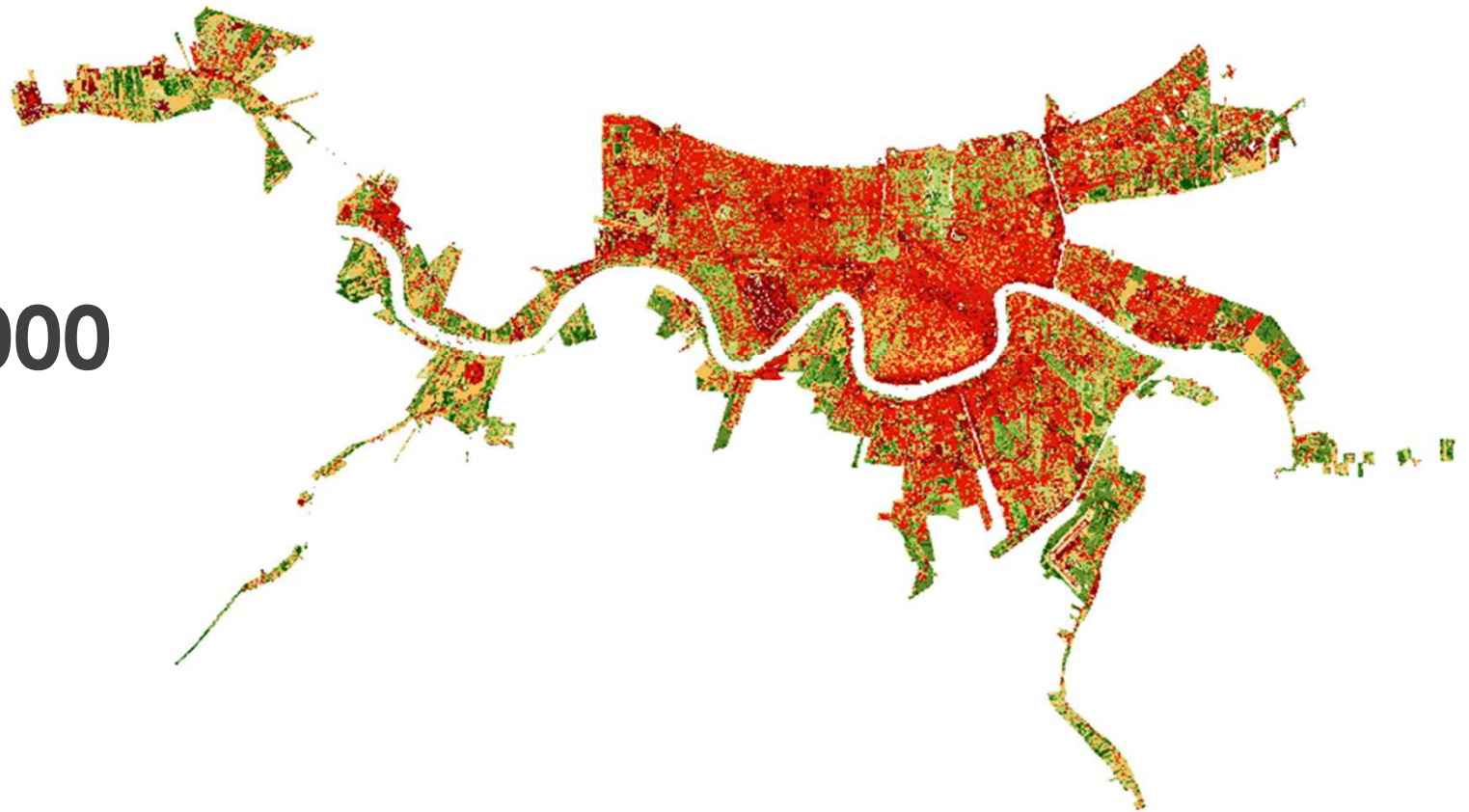
- ▶ $75^{\circ} - 80^{\circ} = 1$
- ▶ $80^{\circ} - 85^{\circ} = 2$
- ▶ $85^{\circ} - 90^{\circ} = 3$
- ▶ $90^{\circ} - 95^{\circ} = 4$
- ▶ $95^{\circ} - 100^{\circ} = 5$





Land Cover Classification

July 2000





Land Cover Classification

Zonal statistics for Land Cover:

% Urban density per Census Tract

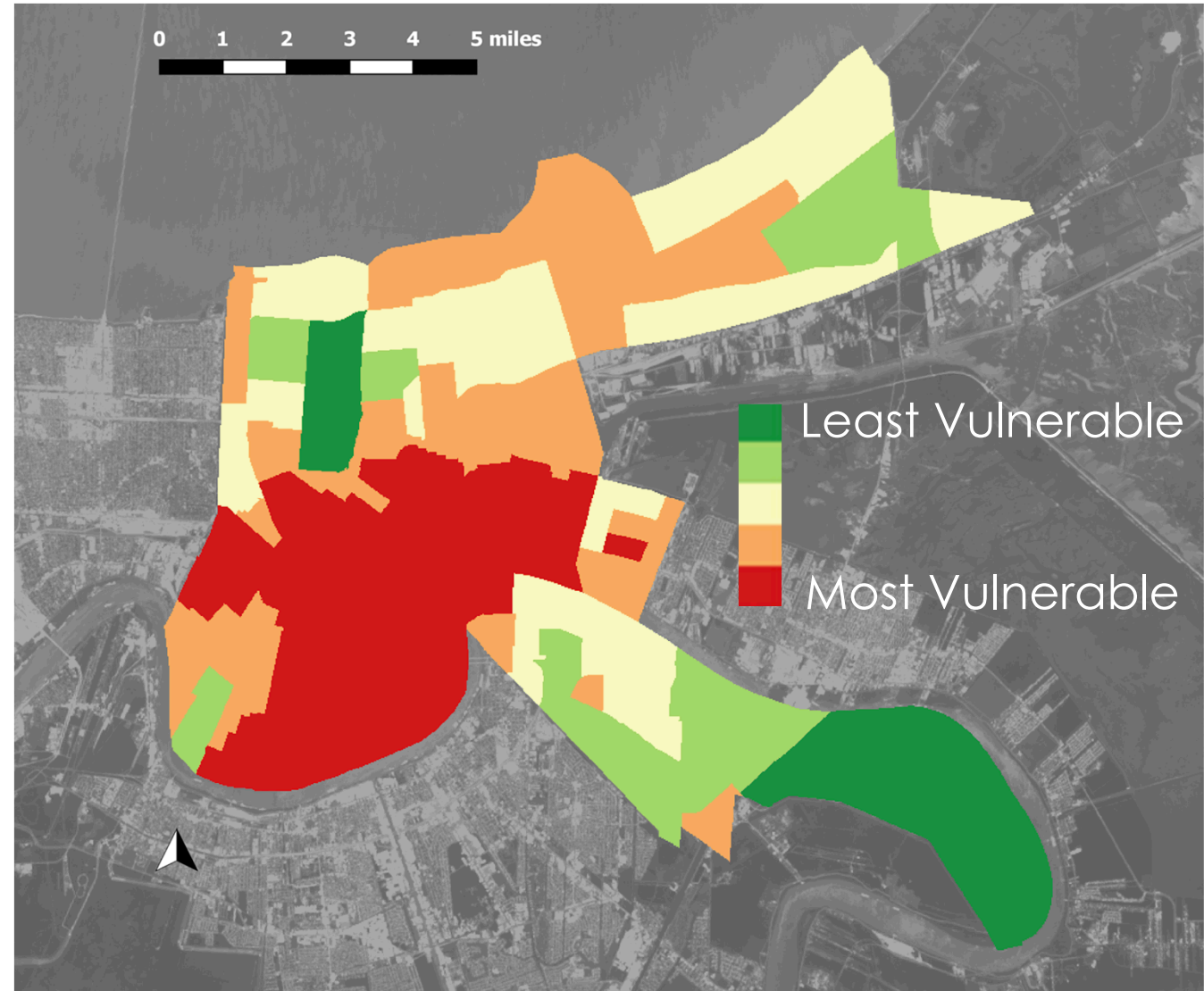
Land Cover was reclassified:

0 = Vegetation

1 = Urban

Zonal statistics were calculated to find mean per census tract, and the score was ranked:

- ▶ 0 - .2 = **1**
- ▶ .2 - .4 = **2**
- ▶ .4 - .6 = **3**
- ▶ .6 - .8 = **4**
- ▶ .8 - 1 = **5**





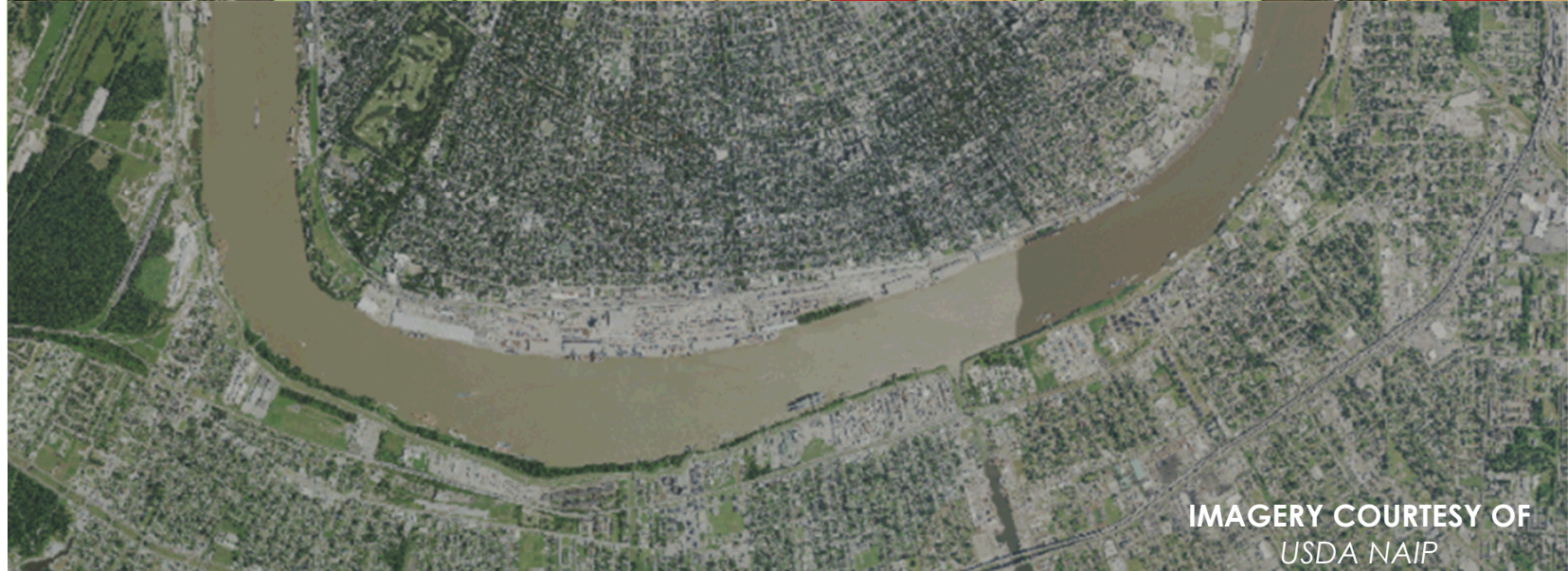
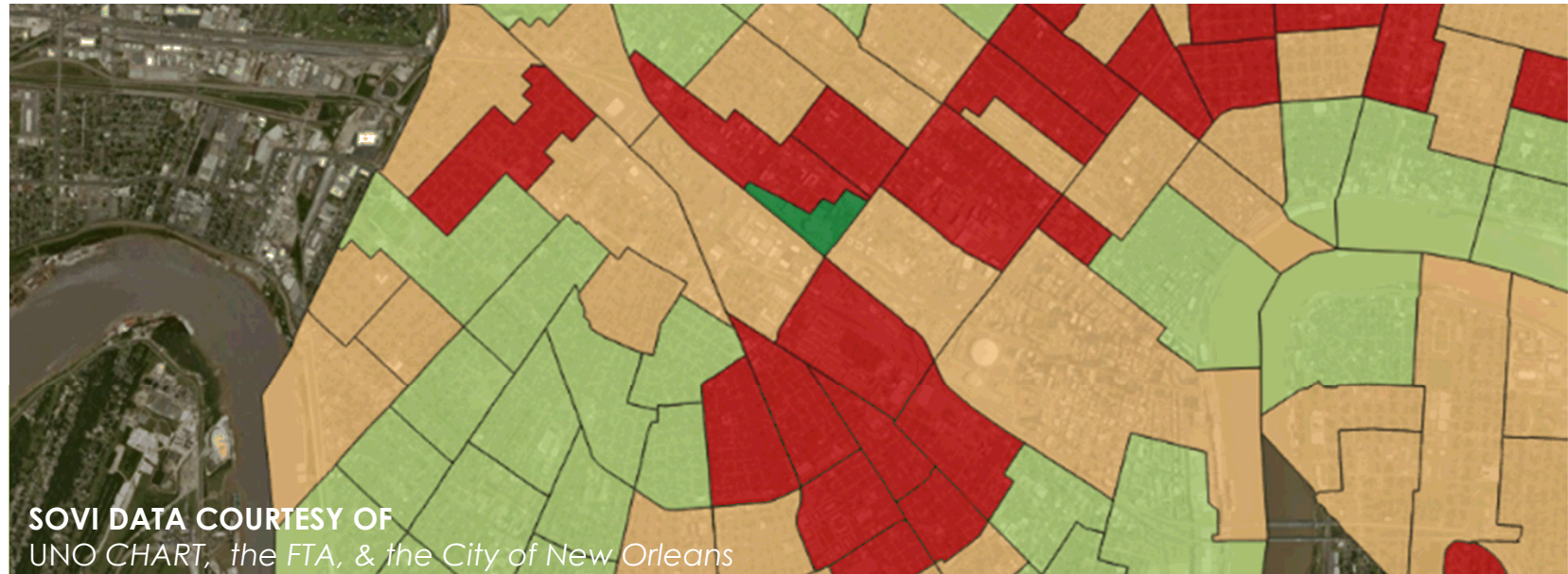
Social Vulnerability Index

SOVI

- ▶ Based on 2015 U.S. Census data
- ▶ Social Vulnerability score: **0 - 52**
- ▶ High scoring tracts had large populations that were:
 - ▶ Under 5 or over 65 years old
 - ▶ Without a higher education degree
 - ▶ Low income / below poverty line
 - ▶ Linguistically isolated

USDA National Agricultural Imagery Program (NAIP)

- ▶ 1-meter resolution imagery
- ▶ Used to confirm the results of land cover classification from 30-meter Landsat imagery





Social Vulnerability Index

Social Vulnerability Index: Ranked

Raw social vulnerability scores were reclassified into 5 groups via QGIS natural breaks:

- ▶ 0 - 25 = **1**
- ▶ 25 - 32 = **2**
- ▶ 32 - 38 = **3**
- ▶ 38 - 45 = **4**
- ▶ 45 - 52 = **5**



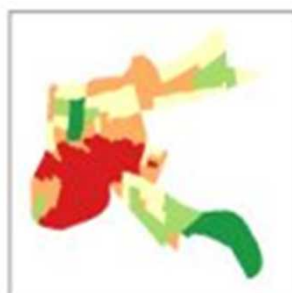
Aggregated Heat Vulnerability Analysis



+



+

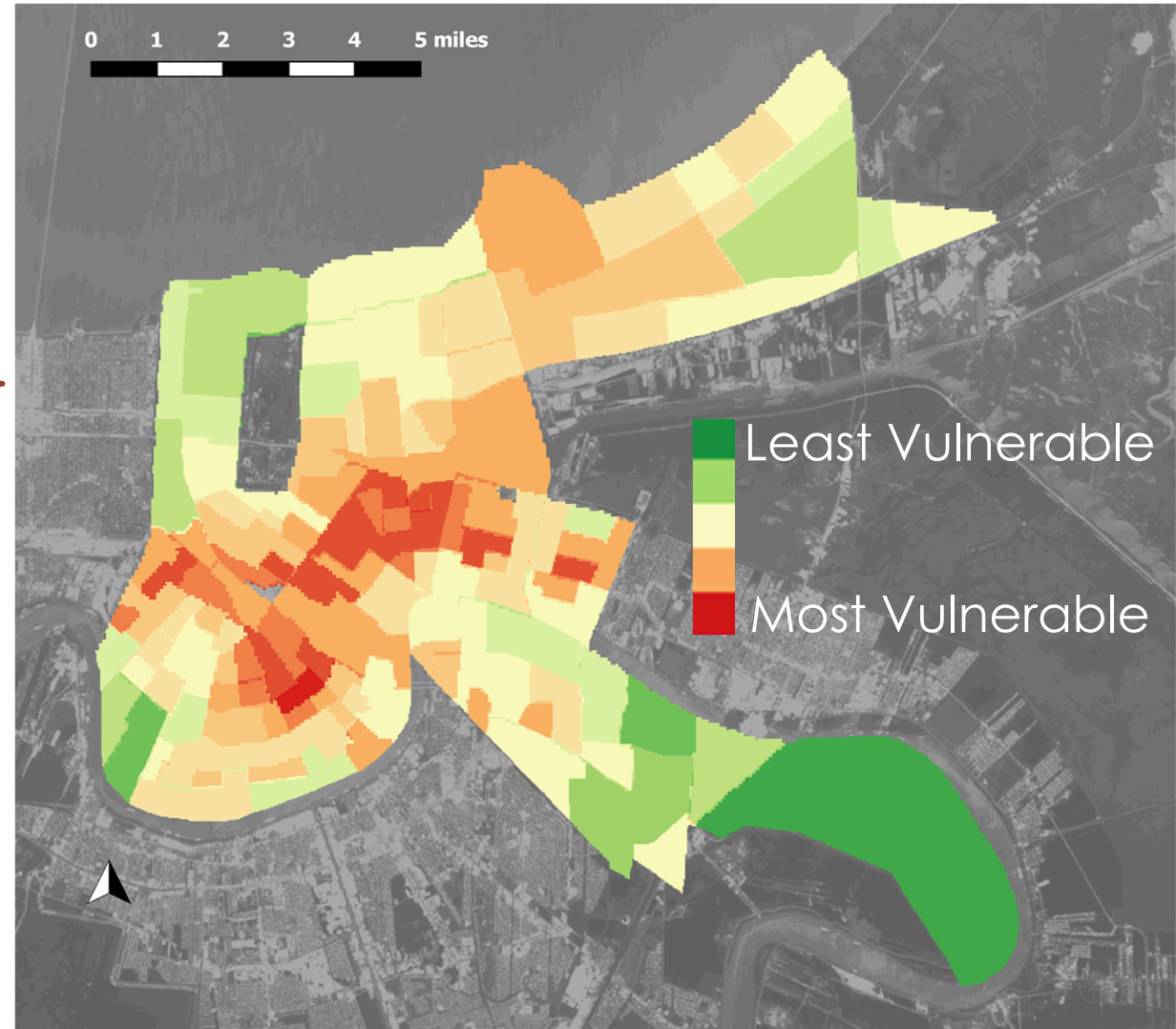


LST Map +

**Social
Vulnerability
Map** +

**Land Cover
Classification
Map**

- ▶ Each tract from each input assigned a scale and ranked from 1 to 5 based on unique values.
- ▶ Each input was given weight of .33 and aggregated to assign each overall vulnerability score between 5 (most vulnerable) and 1 (least vulnerable).



Limitations

- ▶ **Cloud cover** and **temporal resolution** limited available data.
- ▶ At the time, Landsat Provisional **Surface Temperature ARD** were not available.
- ▶ We utilized a user-friendly **semi-automated** classification plug-in for QGIS for preprocessing.





Conclusions



Image Credit: Pixabay

- ▶ Landsat LST and land cover data were used to assess severe heat impacts on the city's communities.
- ▶ The hotspots on the LST maps tended to be in areas with impervious surfaces.
- ▶ The proximity of vegetation appears to be associated with lower temperatures more than proximity to water.



Future Work

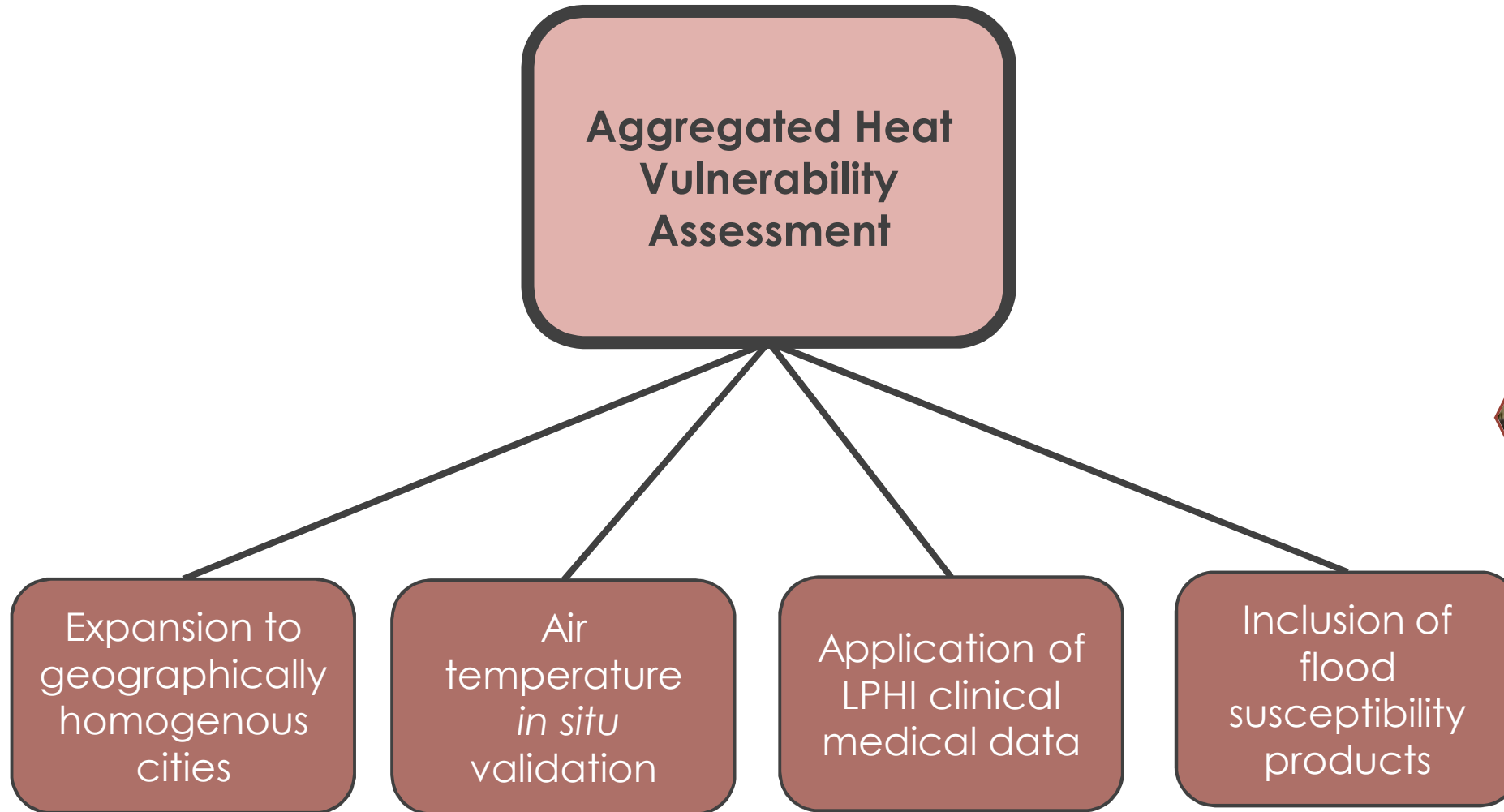


Image Credit: Arun Kuchibhotla



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