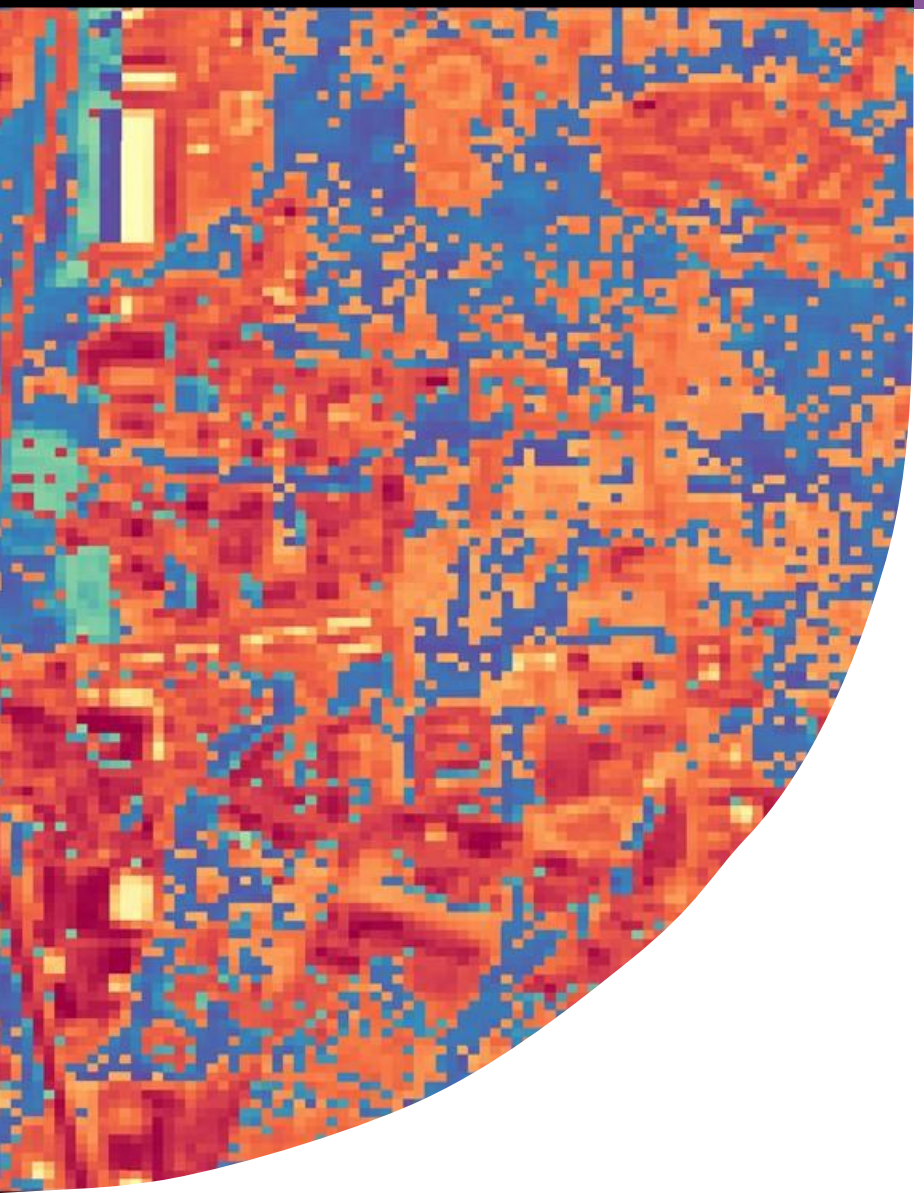
National Aeronautics and Space Administration



Davidson Health and Air Quality II

Assessing Urban Heat and Tree Canopy to Inform Urban Planning in Davidson, North Carolina

Jimmy Stephens, Julian Alcantara, Isaac Xie & Ava Johnson (Analytical Mechanics Associates)

Virginia – Langley | Summer 2025

Meet the Team

Jimmy Stephens

Julian Alcantara

Ava Johnson

Isaac Xie

Town of Davidson

Image Credit: Town of Davidson

The Town of Davidson is committed to sustainability, climate resilience, and public health.

They strive to set a precedent and act as a role model to other towns with their climate action plan.

The Town seeks to use map data to make informed decisions and take proactive, preventative measures.

Image Credit: Town of Davidson

Background

The Town is a rapidly expanding urban development

Dramatic population increase

Connected directly to interstate I-77

Located 20 miles North of Charlotte, North Carolina

Community Concerns

Image Credit: Kayla Kovach

The increase in urban development contributes to a rise in temperatures

Image Credit: Kayla Kovach

The public awareness to the dangers of heat

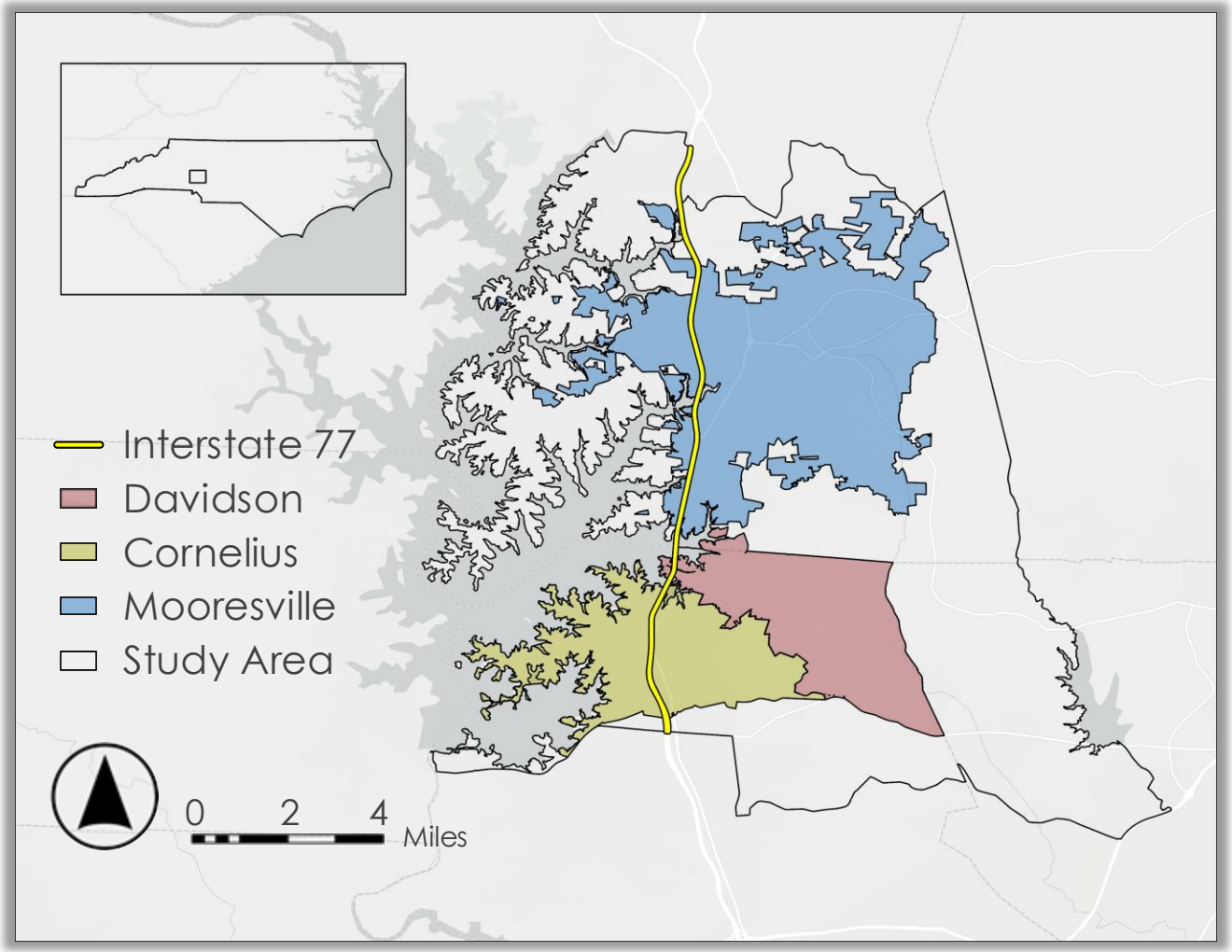
Project Objectives

Analyze surface reflectance and tree canopy coverage

Identify heat hot spots and urban heat islands

Inform the Town of Davidson on areas most vulnerable to heat

Study Area and Period

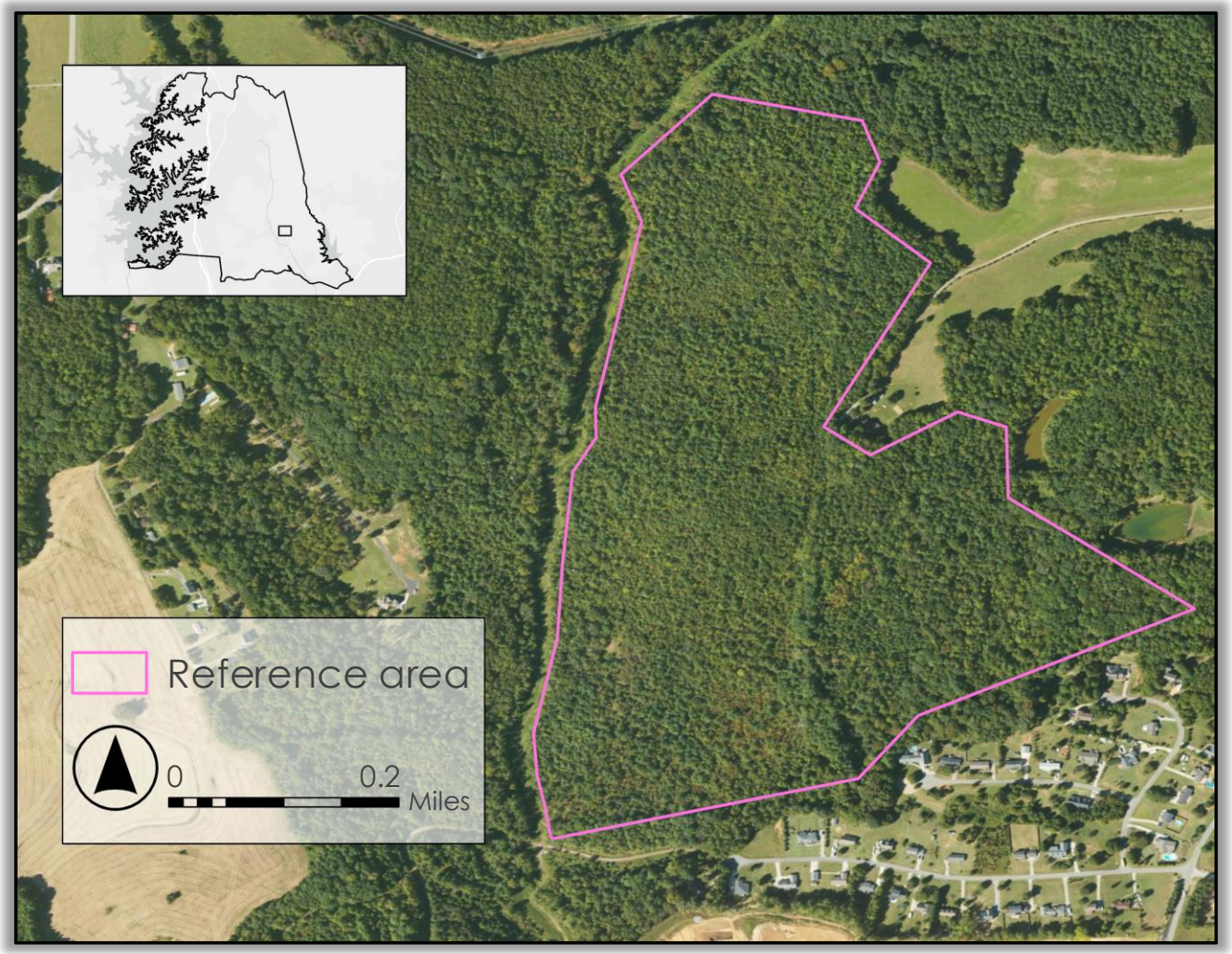


Basemap: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors and the GIS User Community

The area is focused on the Town of Davidson and includes the towns of Cornelius and Mooresville.

The period takes place between the years 2015-2025.

Vegetated Reference Area

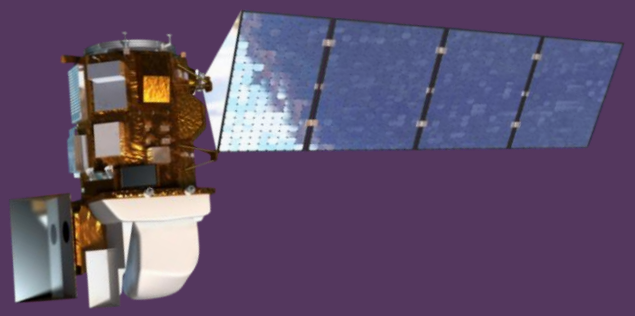


Basemap: Esri, Maxar, Earthstar Geographics, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors and the GIS User Community

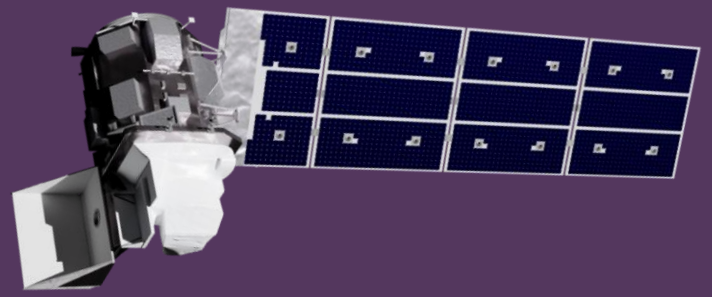
Desired Qualities:

- Analogous to pre-urbanized conditions
- Dense with healthy trees
- Surrounded by less urban setting

Earth Observations & Ancillary Data



Landsat 8 OLI & TIRS



Landsat 9 OLI-2 & TIRS-2

Operational **L**and **I**mager & **T**hermal **I**nfra**R**ed **S**ensor

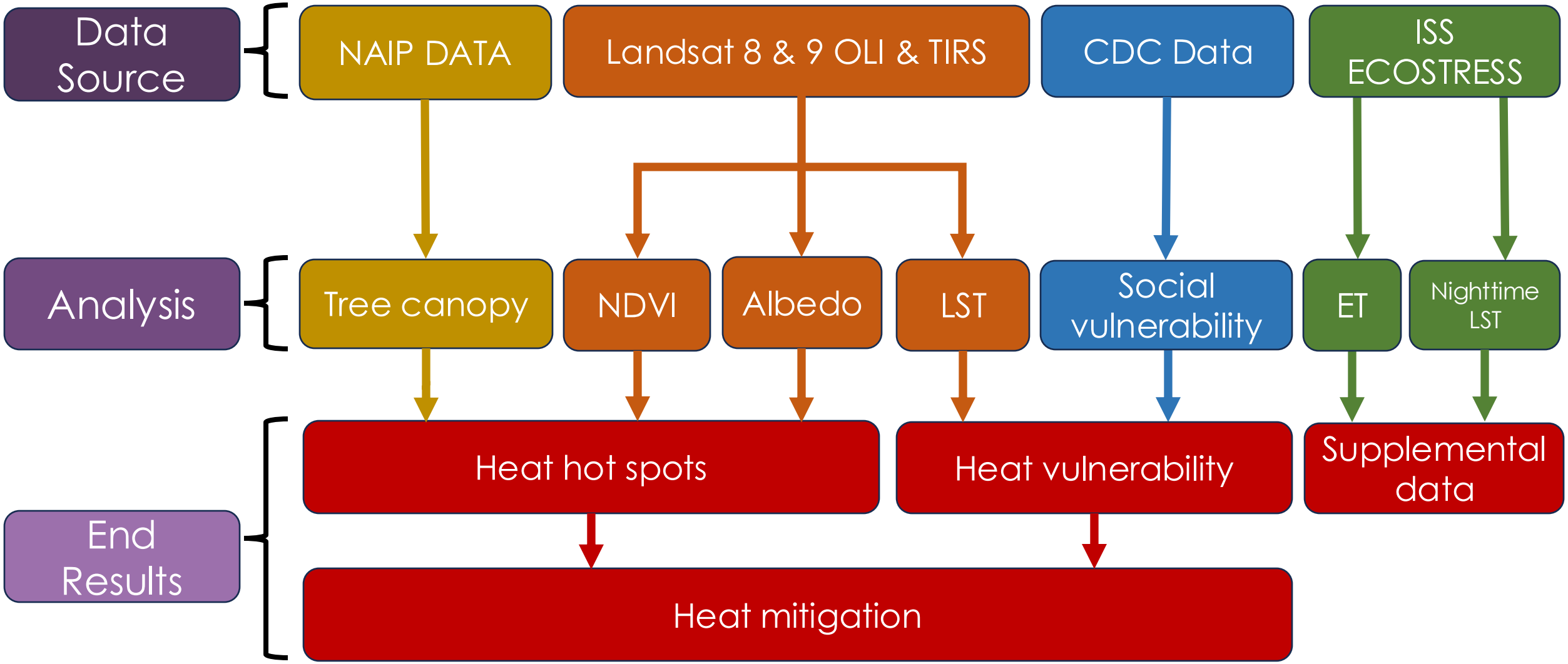
International Space Station

ECOsystem **S**paceborne **T**hermal **R**adiometer on **S**pace **S**tation

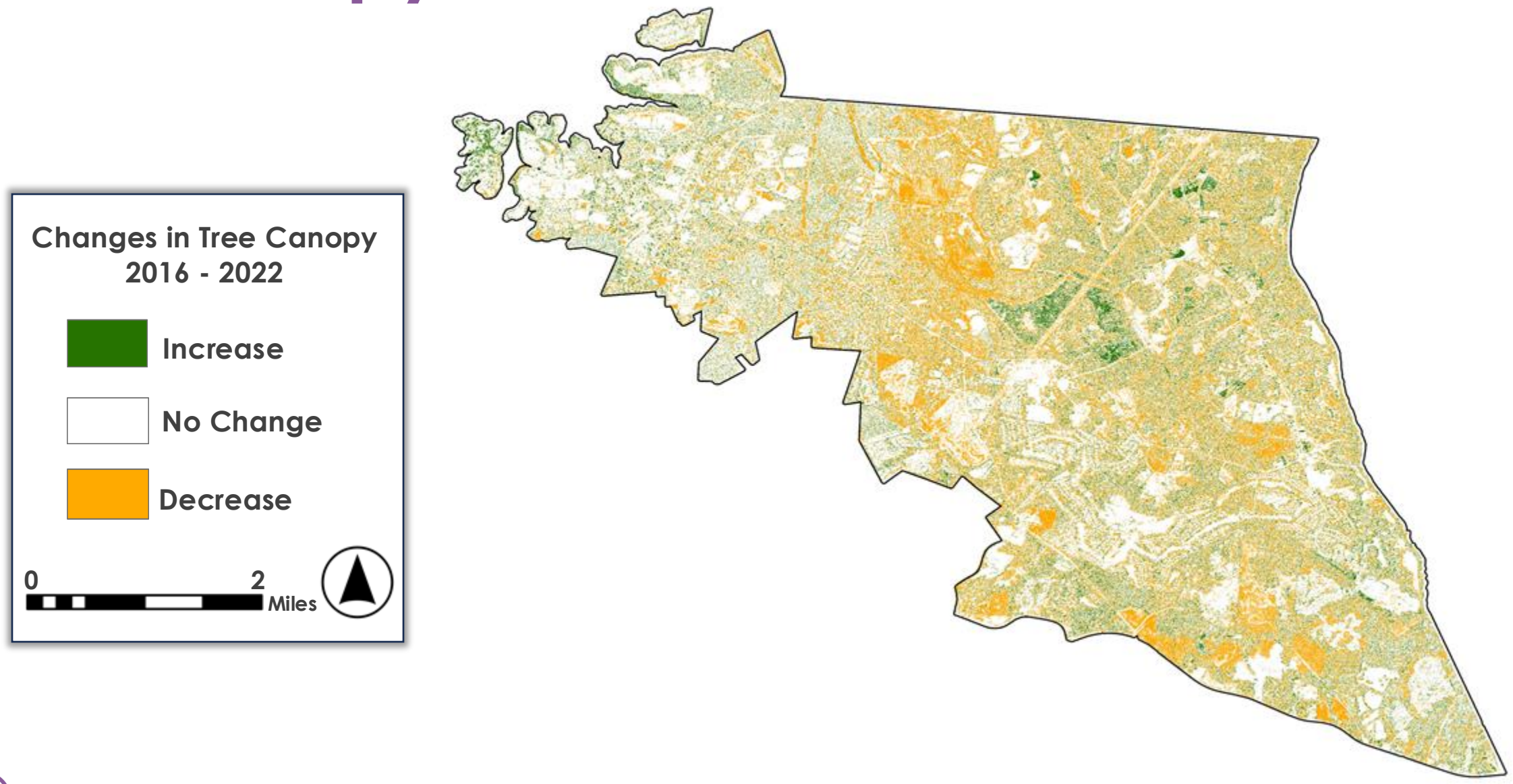
National Agricultural Imagery Program (NAIP)

Center for Disease Control and Prevention (CDC)

Methodology



Tree Canopy


Changes in Tree Canopy
2016 - 2022
Increase
No Change
Decrease
0
2
Miles

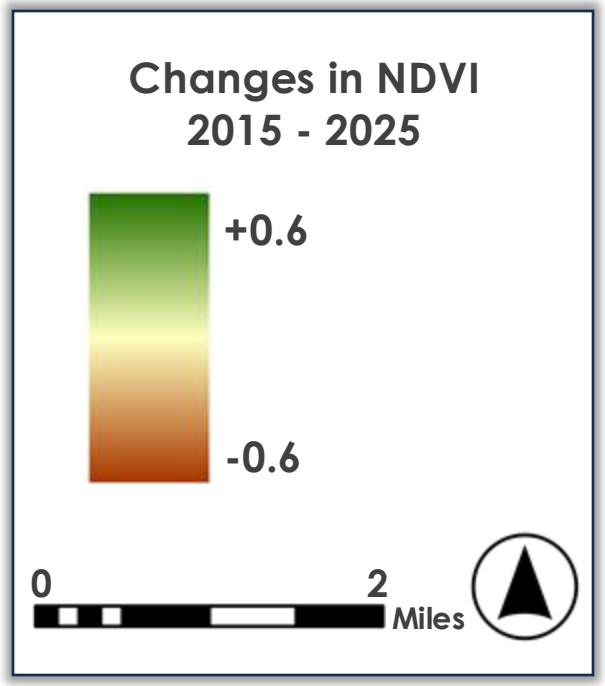
Confusion Matrices

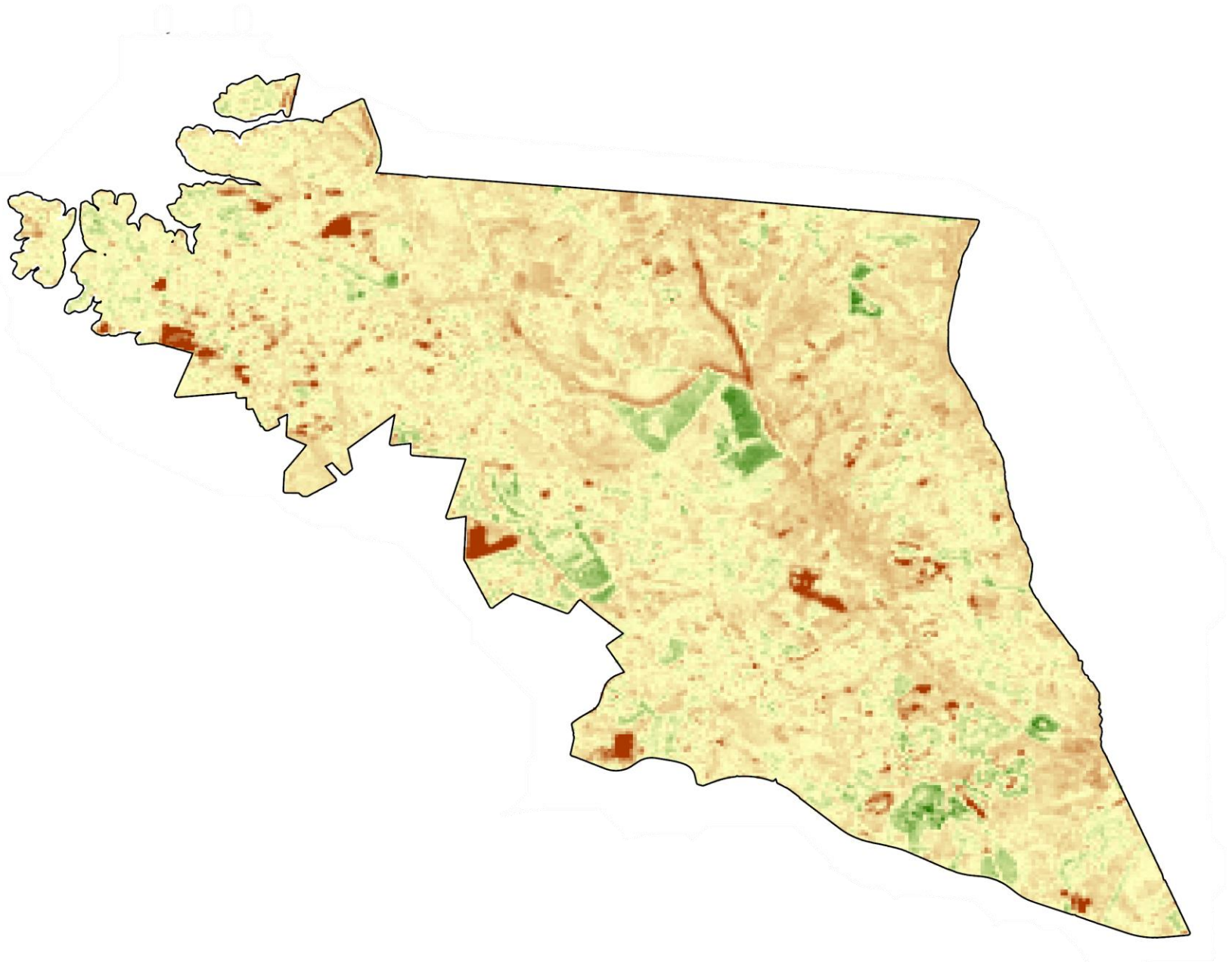
2016 Tree Classification				
	Tree	**Not Tree**	**Total**	**User's Accuracy**
Pixel Tree	74	10 (false positive)	84	.881
Pixel Not Tree	28 (false negative)	88	116	.759
Total	102	98	200	
Producer's Accuracy	.725	.898		.81

2022 Tree Classification				
	Tree	**Not Tree**	**Total**	**User's Accuracy**
Pixel Tree	64	3 (false positive)	67	.955
Pixel Not Tree	25 (false negative)	108	133	.812
Total	89	111	200	
Producer's Accuracy	.719	.972		.86

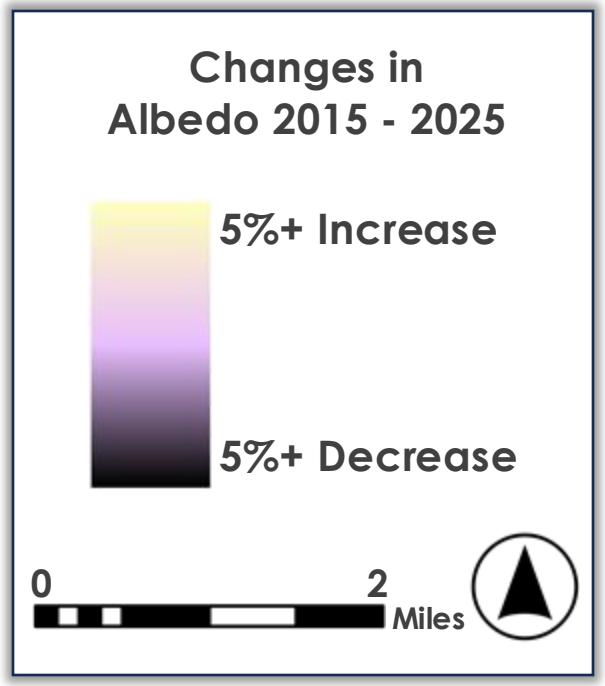
*For entire study area including towns adjacent to Davidson: Mooresville and Cornelius

NDVI

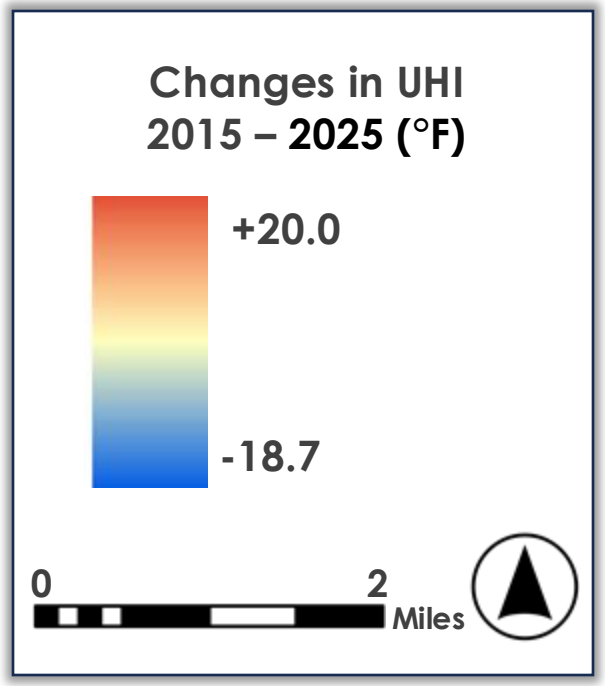


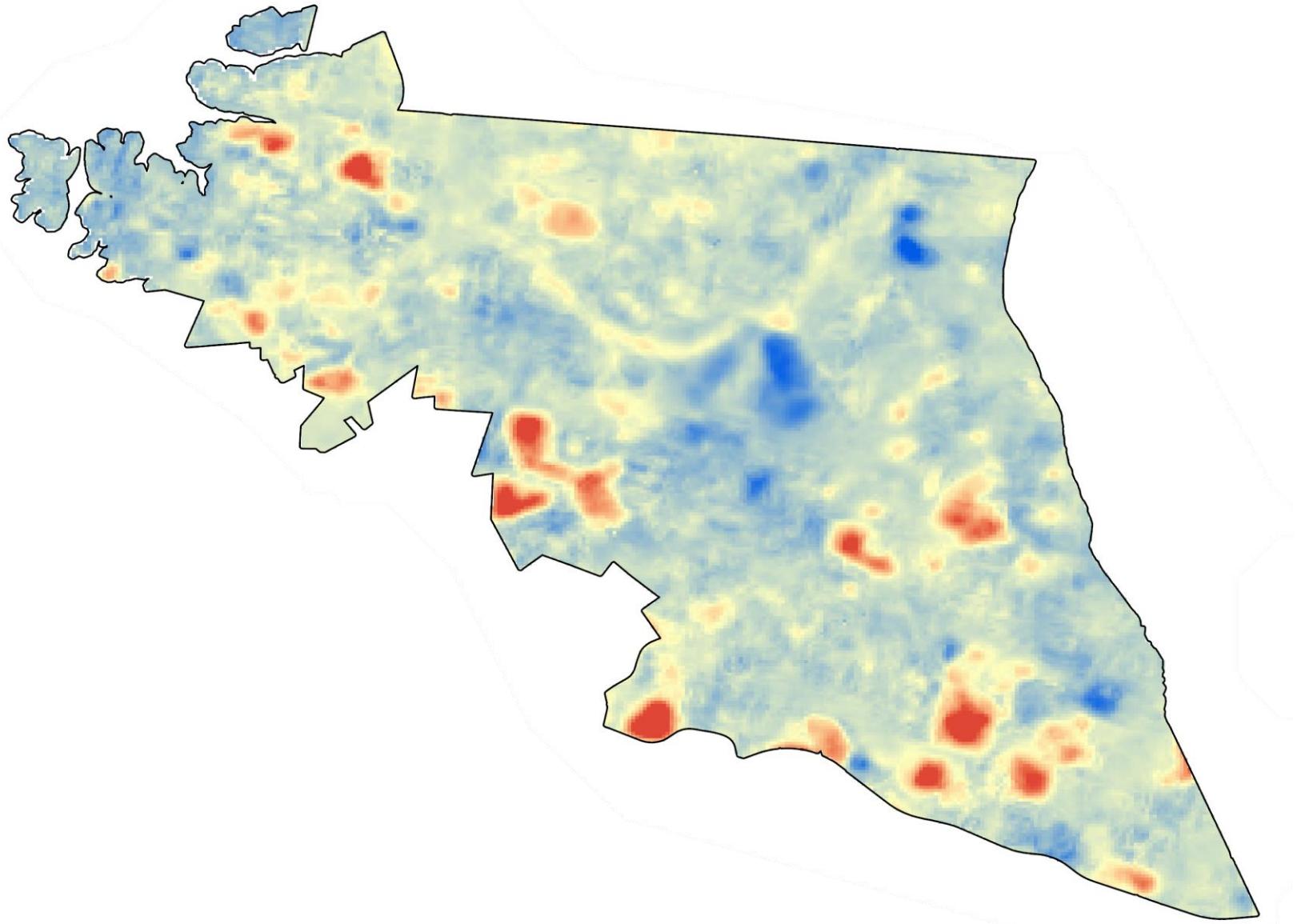


Albedo

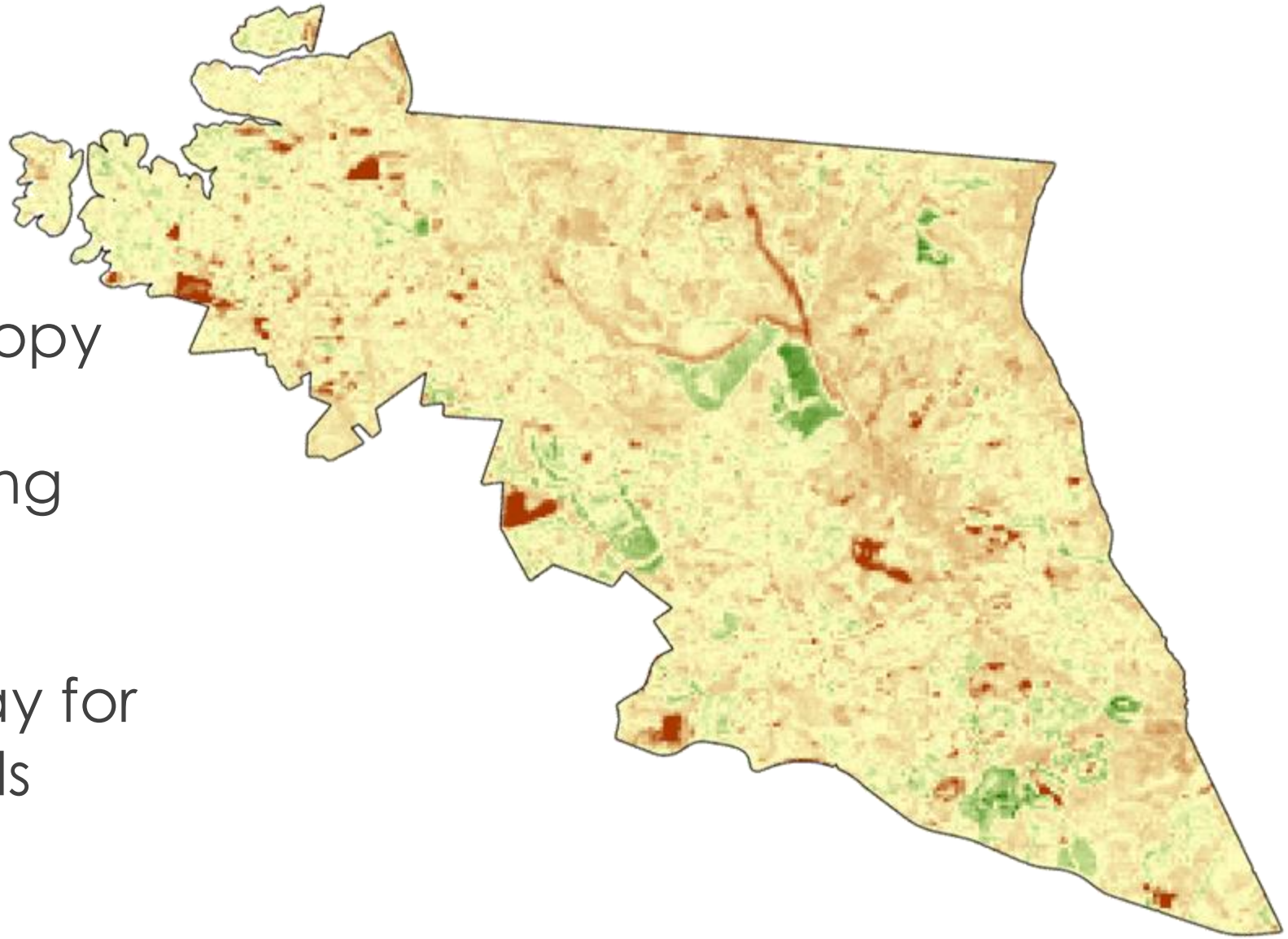


Urban Heat Index





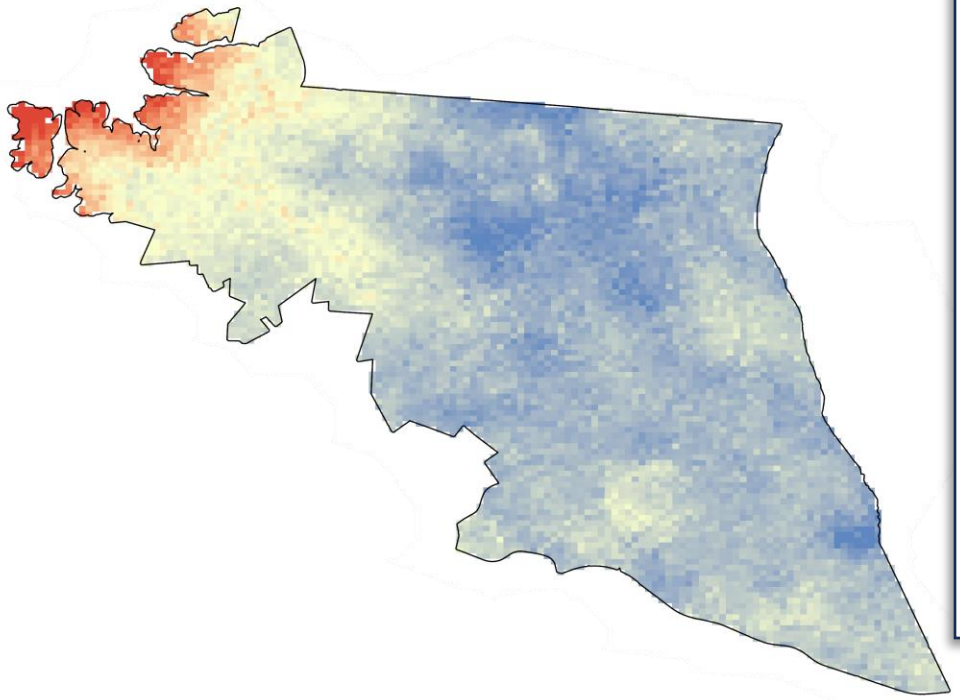
Impacts on Heat

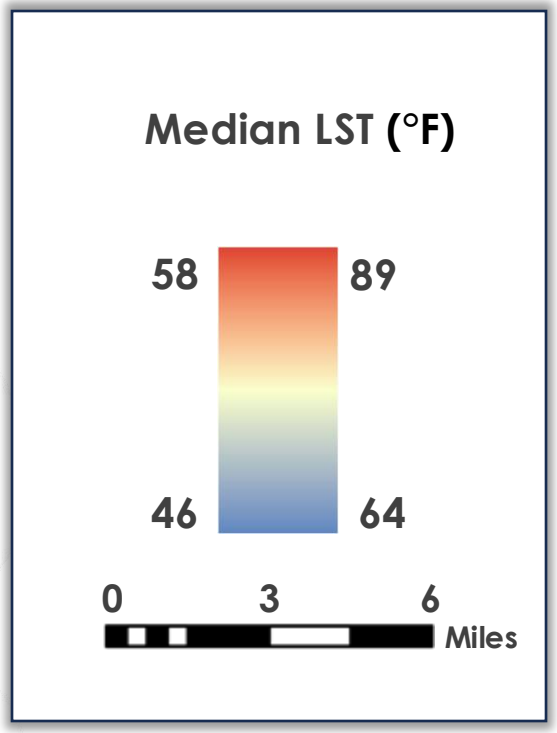


- Altering tree canopy and albedo can impact surrounding communities
- This paves the way for urban heat islands

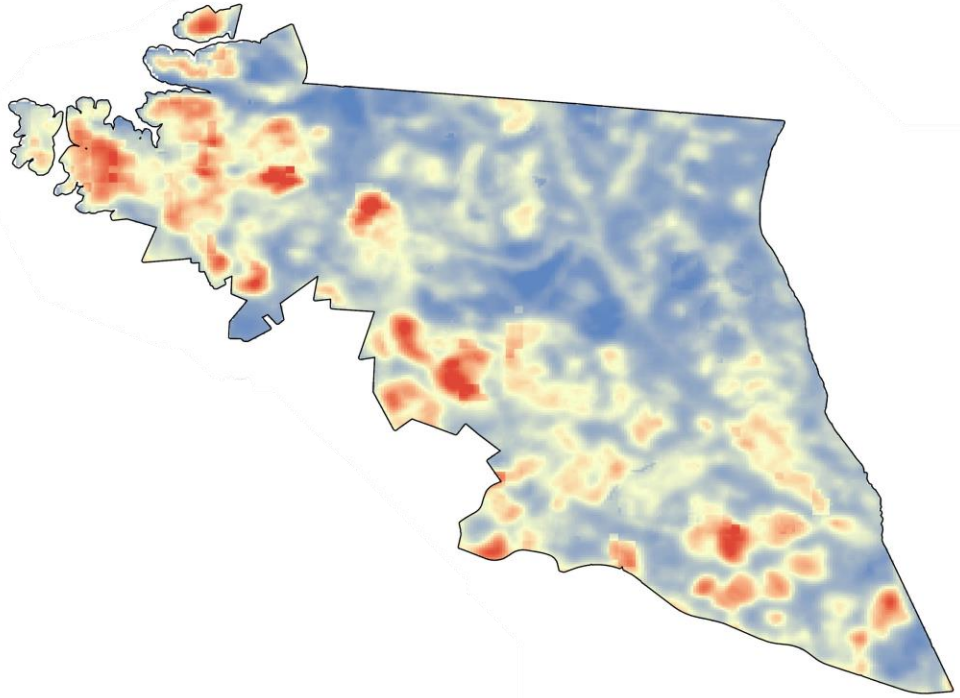
2022 – 2025 LST

Nighttime

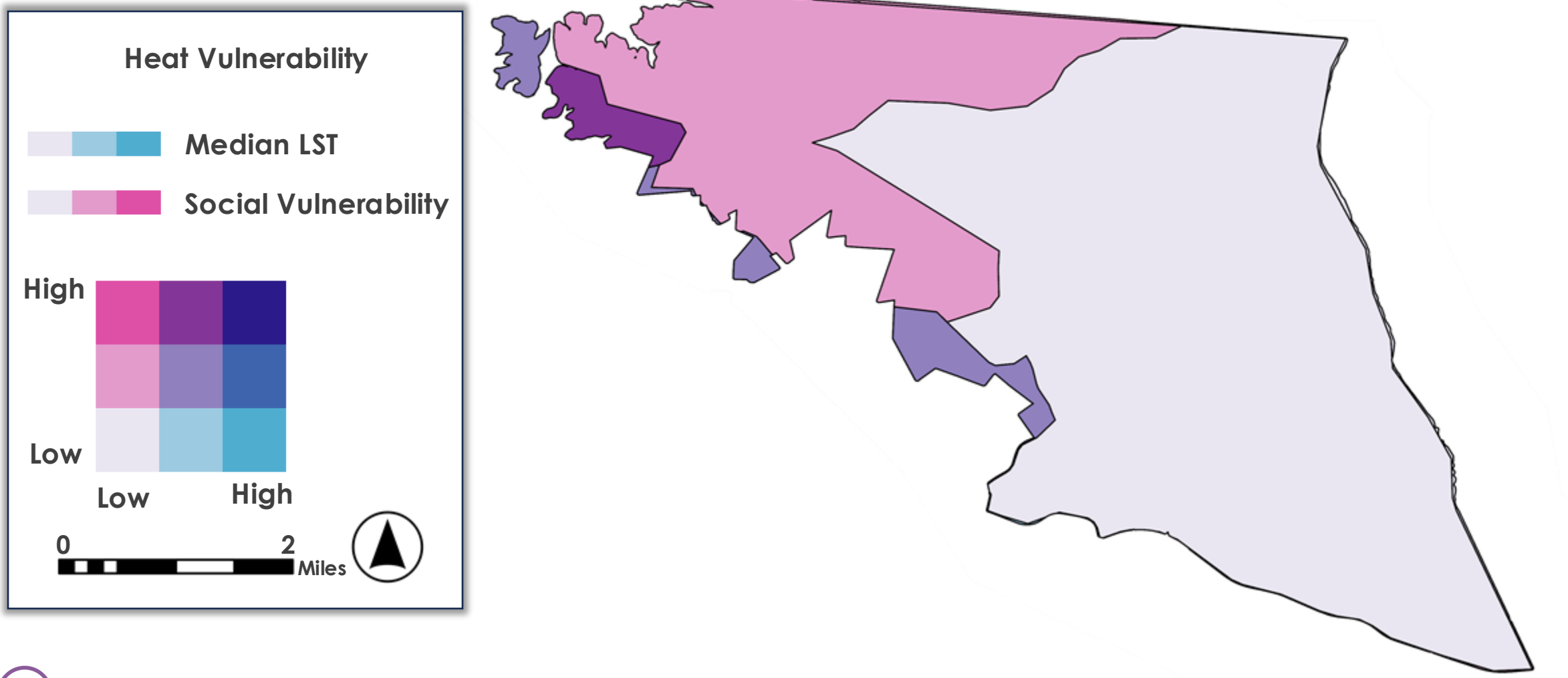




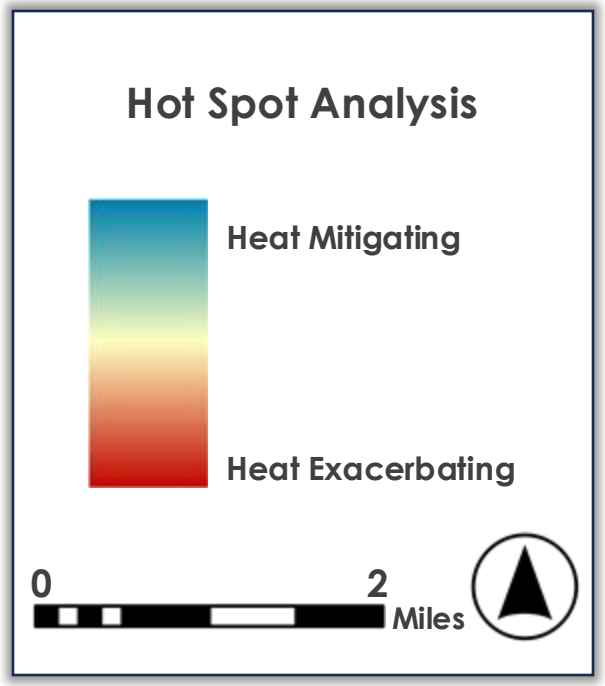
Daytime



Heat Vulnerability



Hot Spot Analysis



Feasibility & Partner Implementation

Efficient and cost-effective analysis

Image Credit: Town of Davidson

Image Credit: Kayla Kovach

More informed Climate Action Plan

Focused heat mitigation efforts

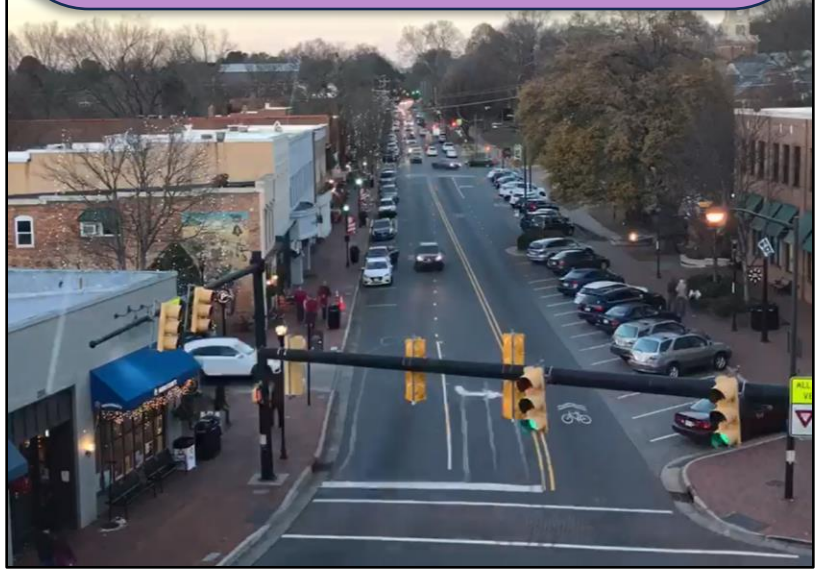
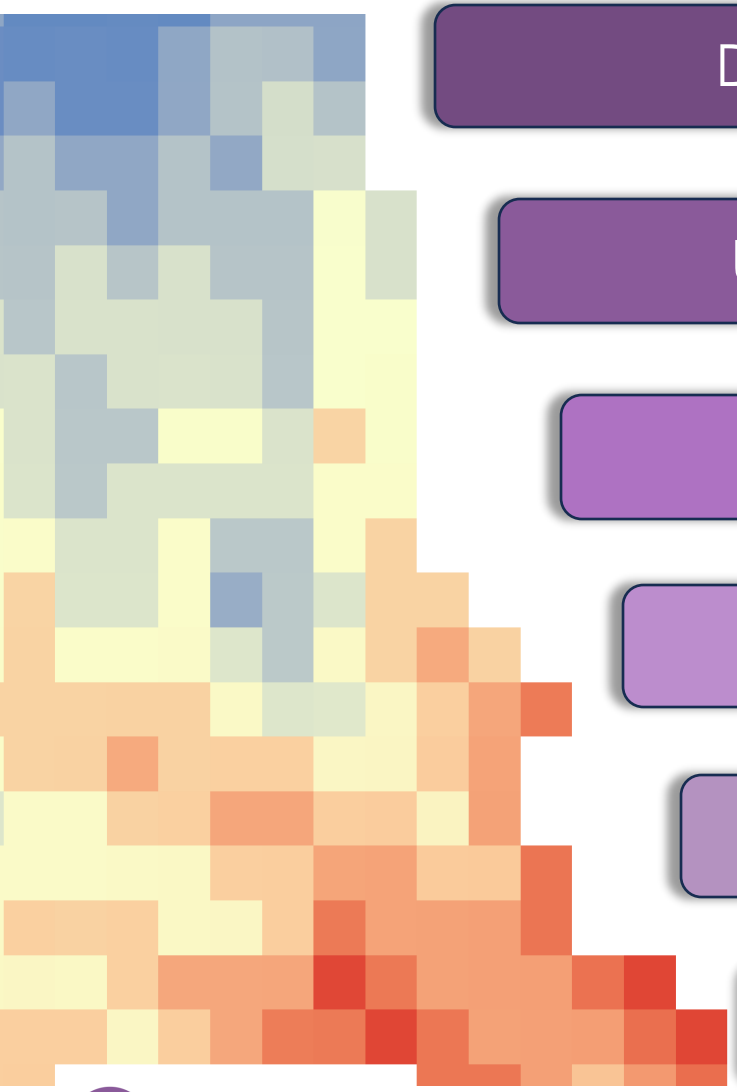


Image Credit: Town of Davidson

Errors and Uncertainties



- Different spatial resolutions
- Uneven distribution of seasons
- Different satellite launch dates
- Skewed data due to water from lakes
- Lack of ECOSTRESS data in 2022
- Inaccuracy in Land Classification

Image Credit: Kayla Kovach

Conclusion

7.7% canopy change decrease between 2016 and 2022

Tree canopy is more effective in mitigating heat than reflective surfaces

Overlap between changes in NDVI, Albedo, and UHI are consistent with urbanization

Potential mitigation areas: Davidson, Mooresville, and Cornelius near I-77

Acknowledgements

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Kayla Kovach - Sustainability Manager
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Andrew Golden - Transportation Planner
Veronica Westendorff - Sustainability Board Member
Tim Belitz - Sustainability Board Member

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Dr. Xia Cai – NASA Langley Research Center
David Young – NASA Langley Research Center

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Briana Johnson - DEVELOP Participant
Drew Emerine- DEVELOP Participant
Tanya Kasyanchuk- DEVELOP Participant

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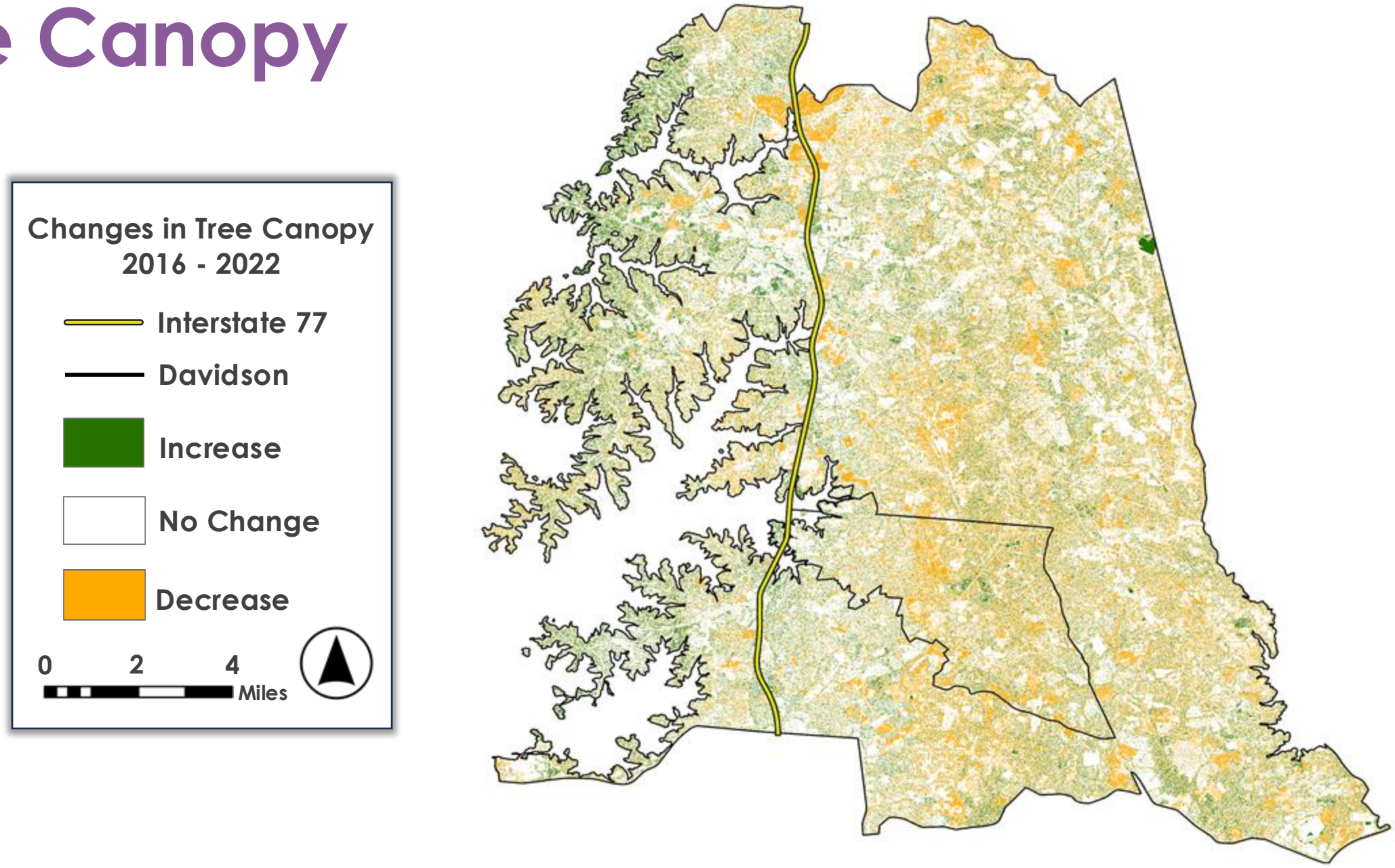
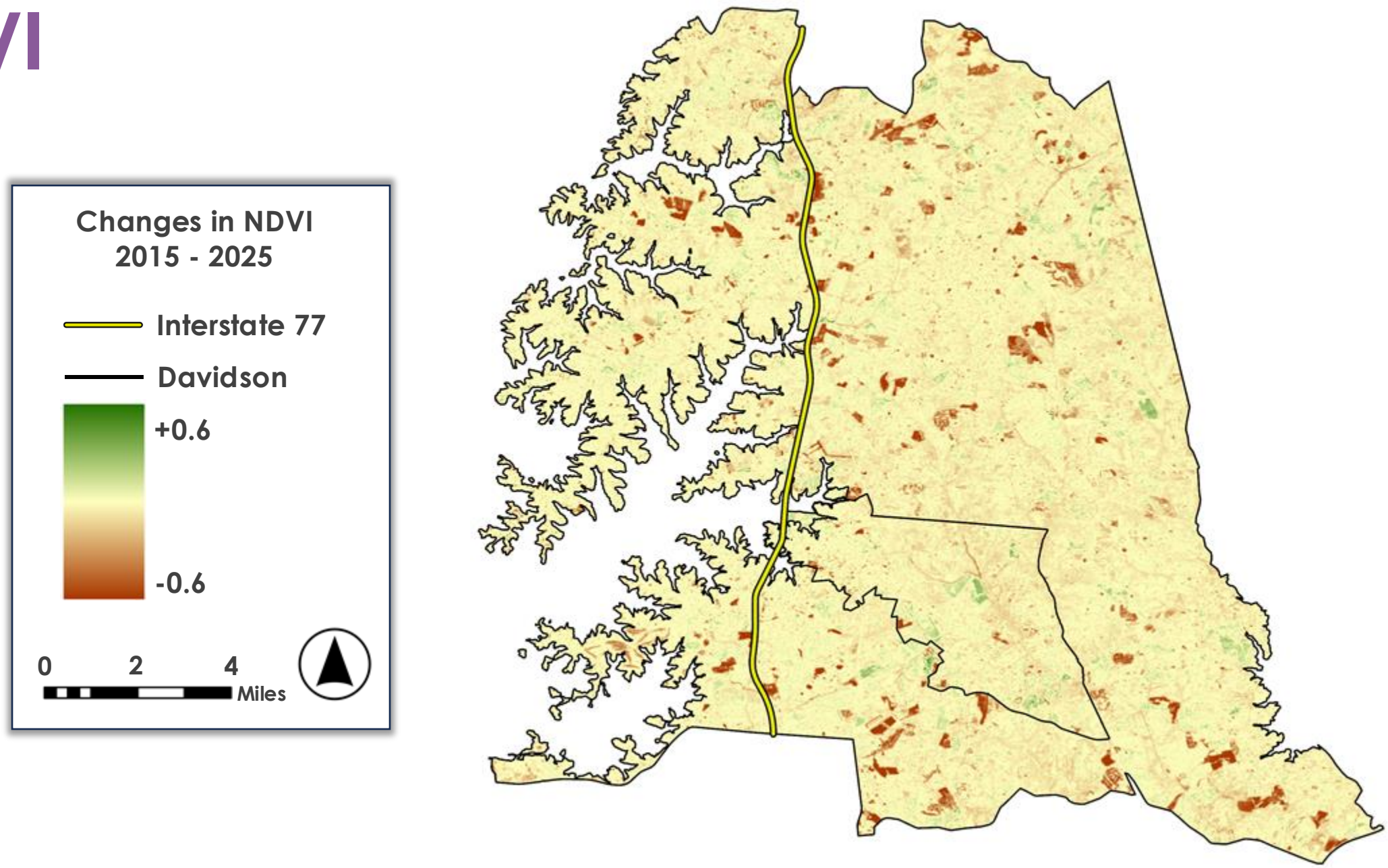
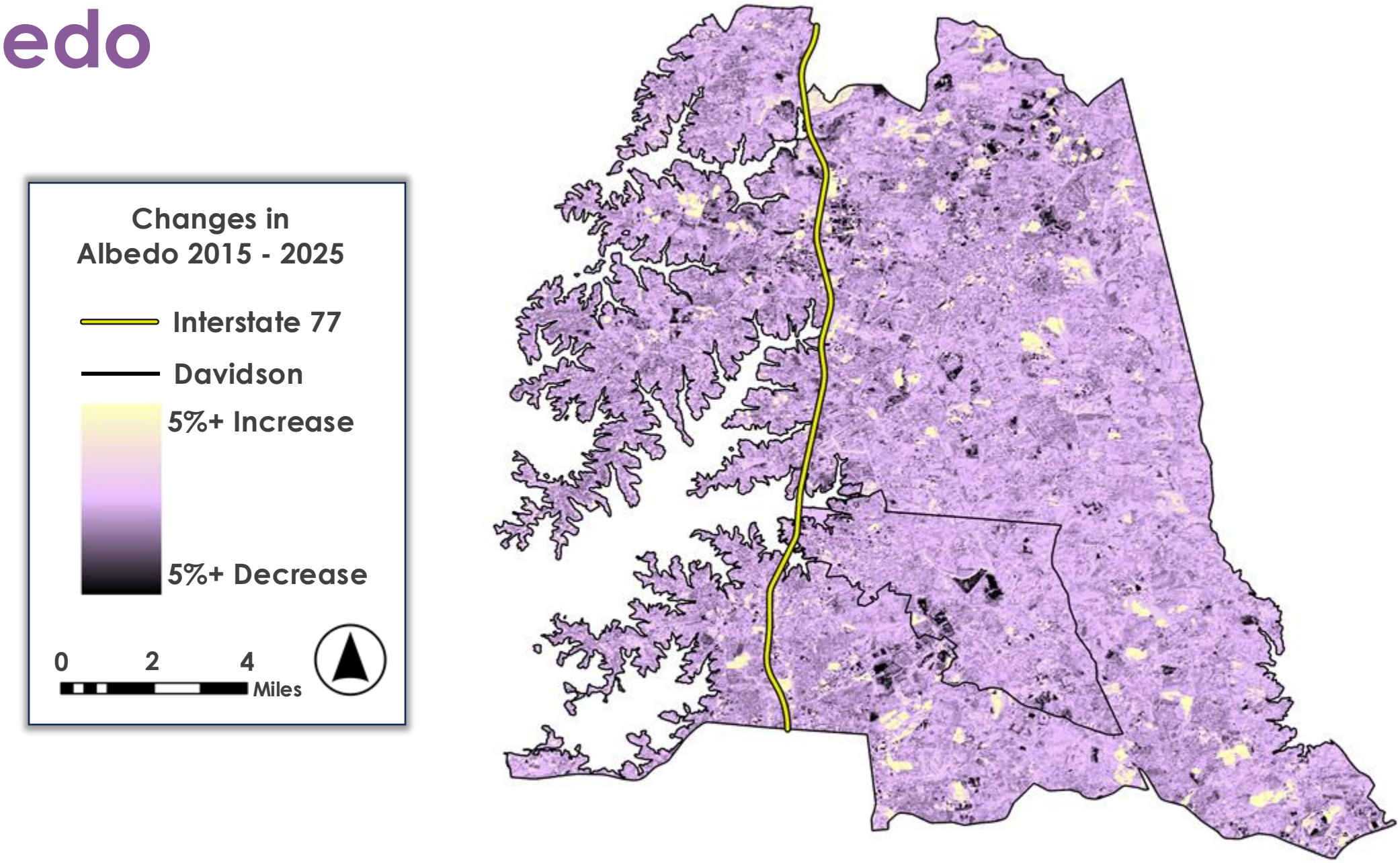
Tree Canopy


Changes in Tree Canopy
2016 - 2022
Interstate 77
Davidson
Increase
No Change
Decrease
0
2
4
Miles

NDVI

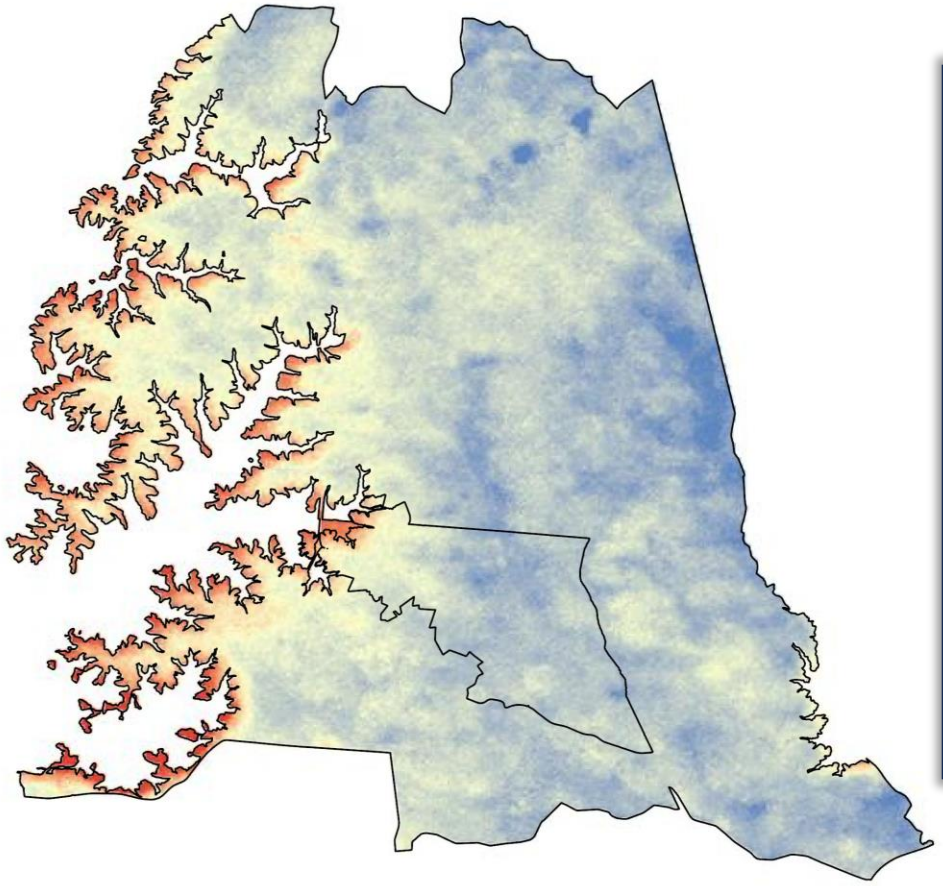

Changes in NDVI
2015 - 2025
Interstate 77
Davidson
+0.6
-0.6
0
2
4
Miles

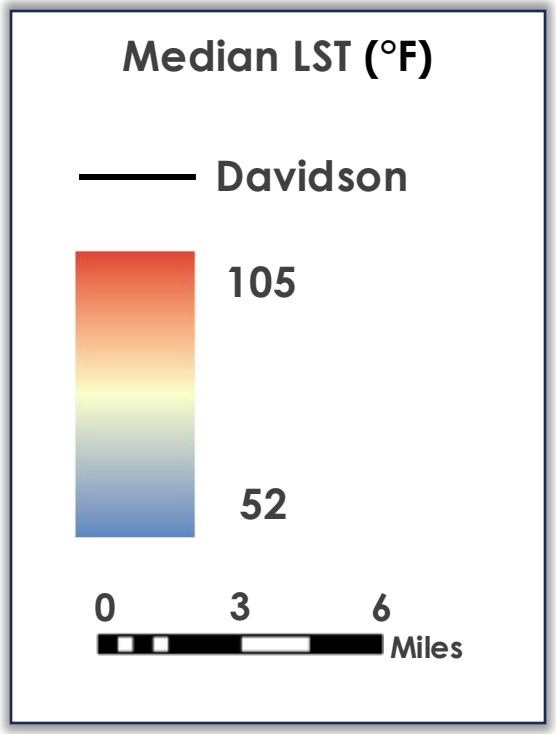
Albedo


Changes in
Albedo 2015 - 2025
Interstate 77
Davidson
5%+ Increase
5%+ Decrease
0
2
4
Miles

2022 – 2025 LST

Nighttime





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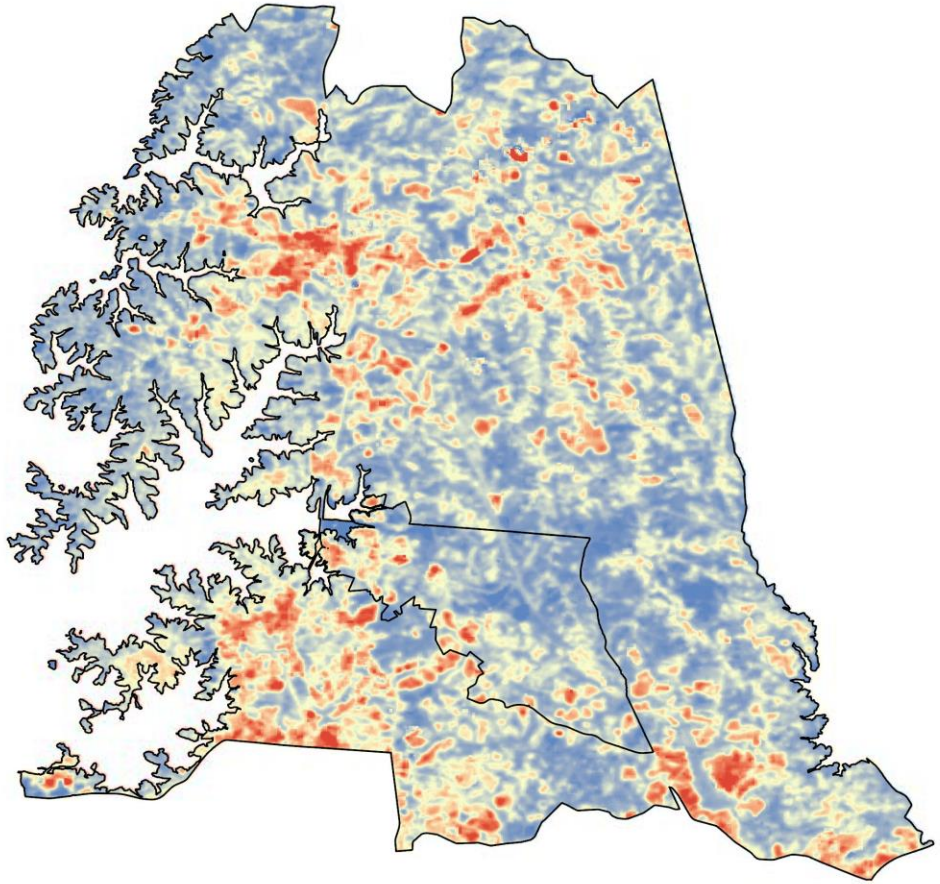

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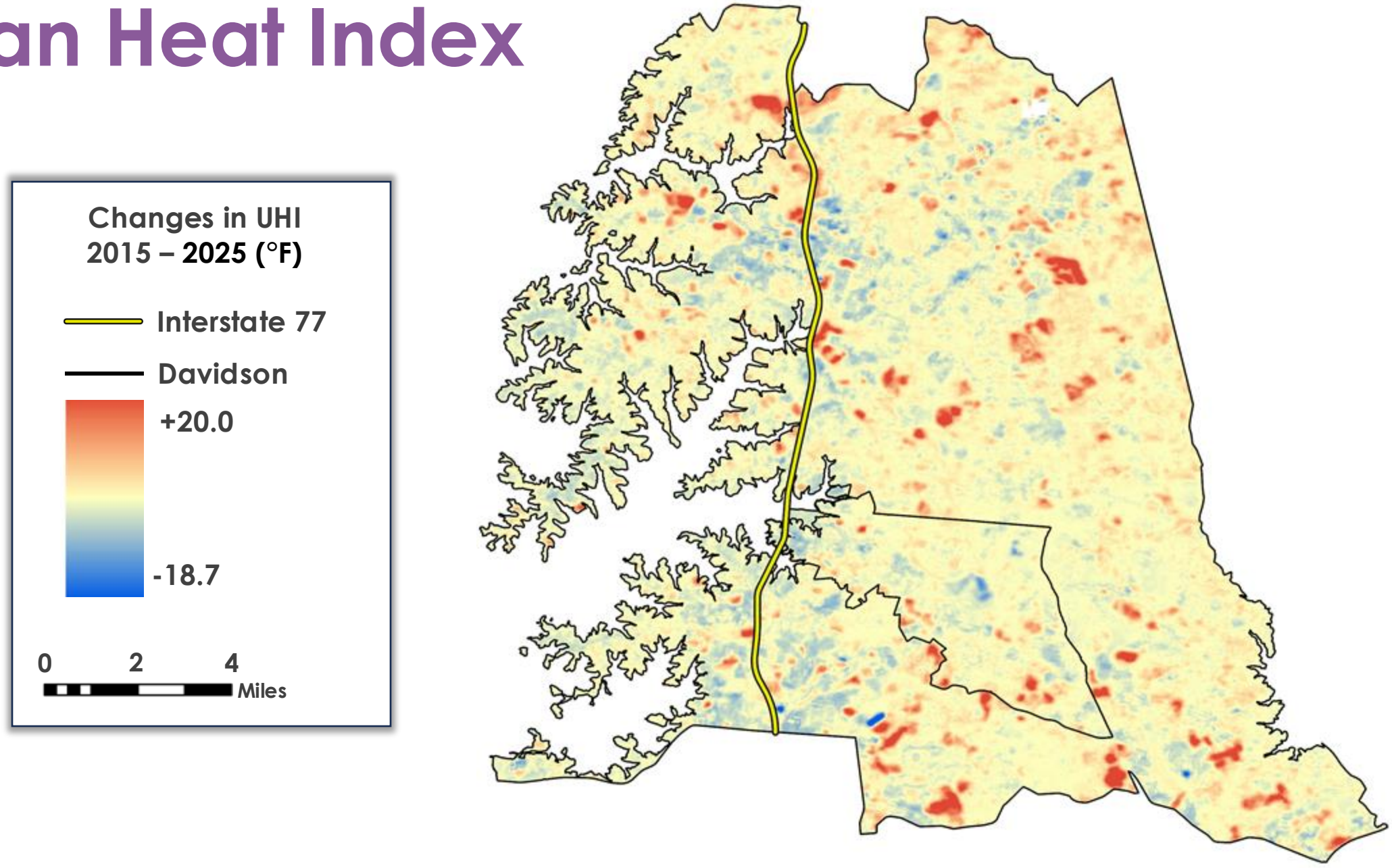

Impacts on Heat

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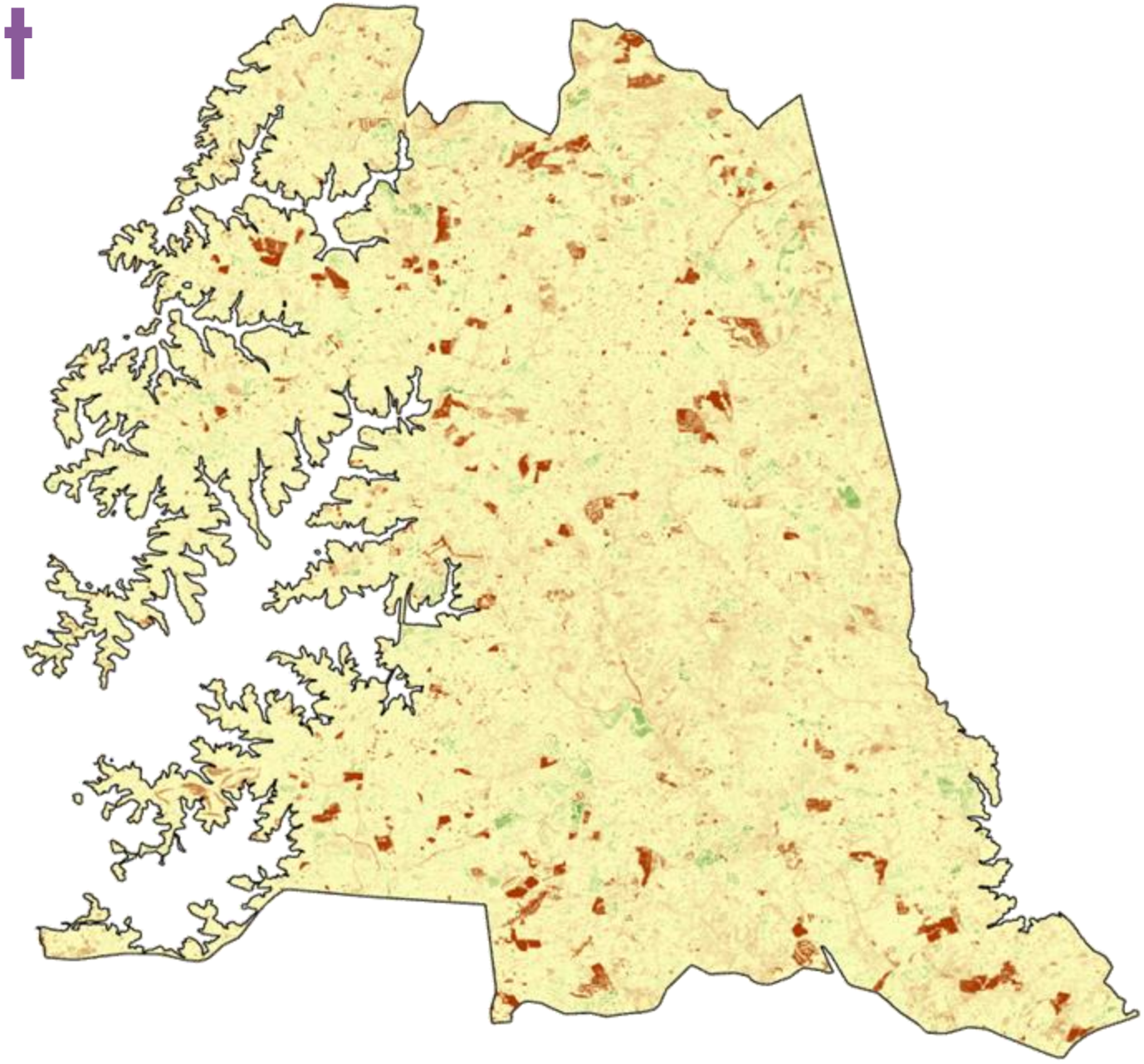
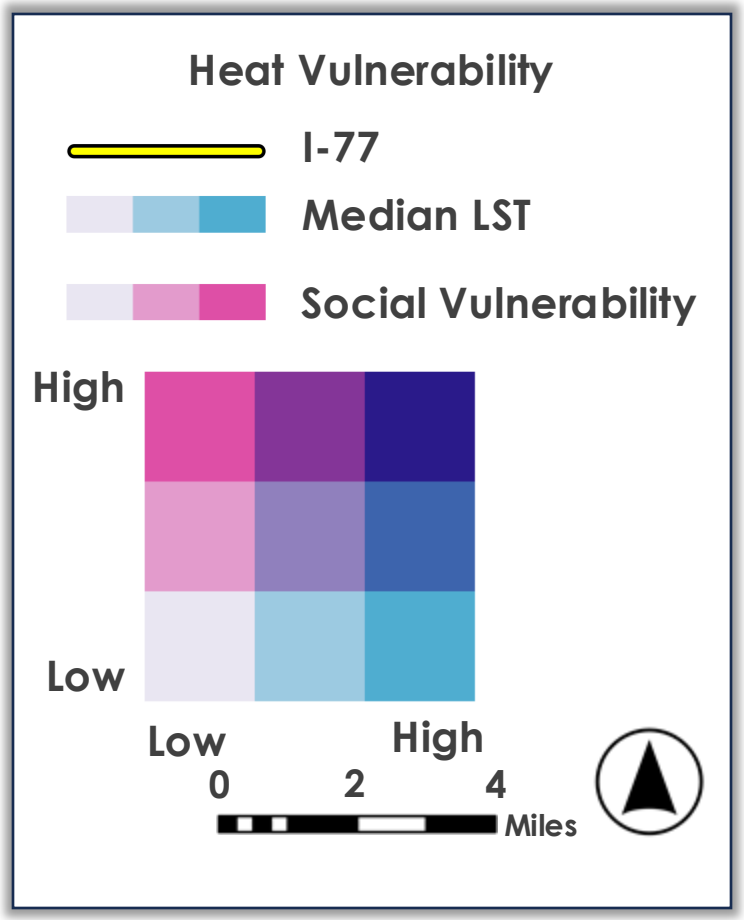
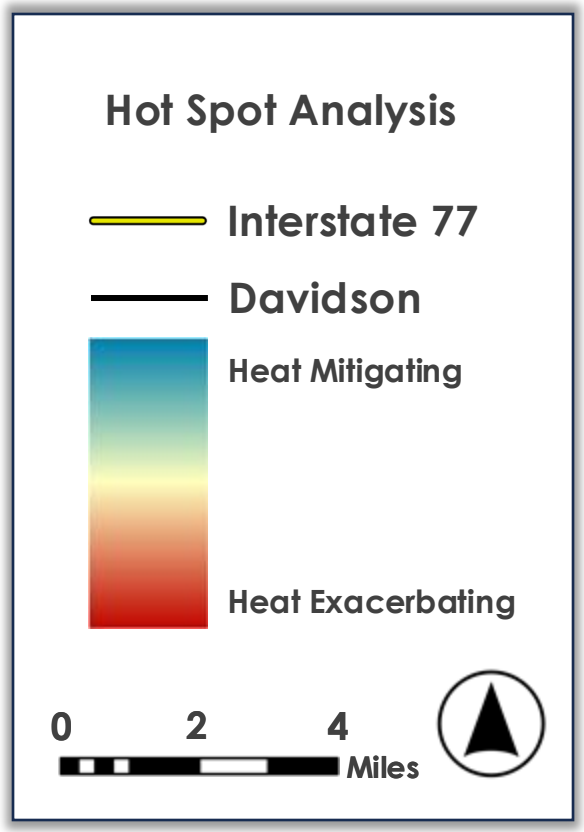
- This paves the way for urban heat islands

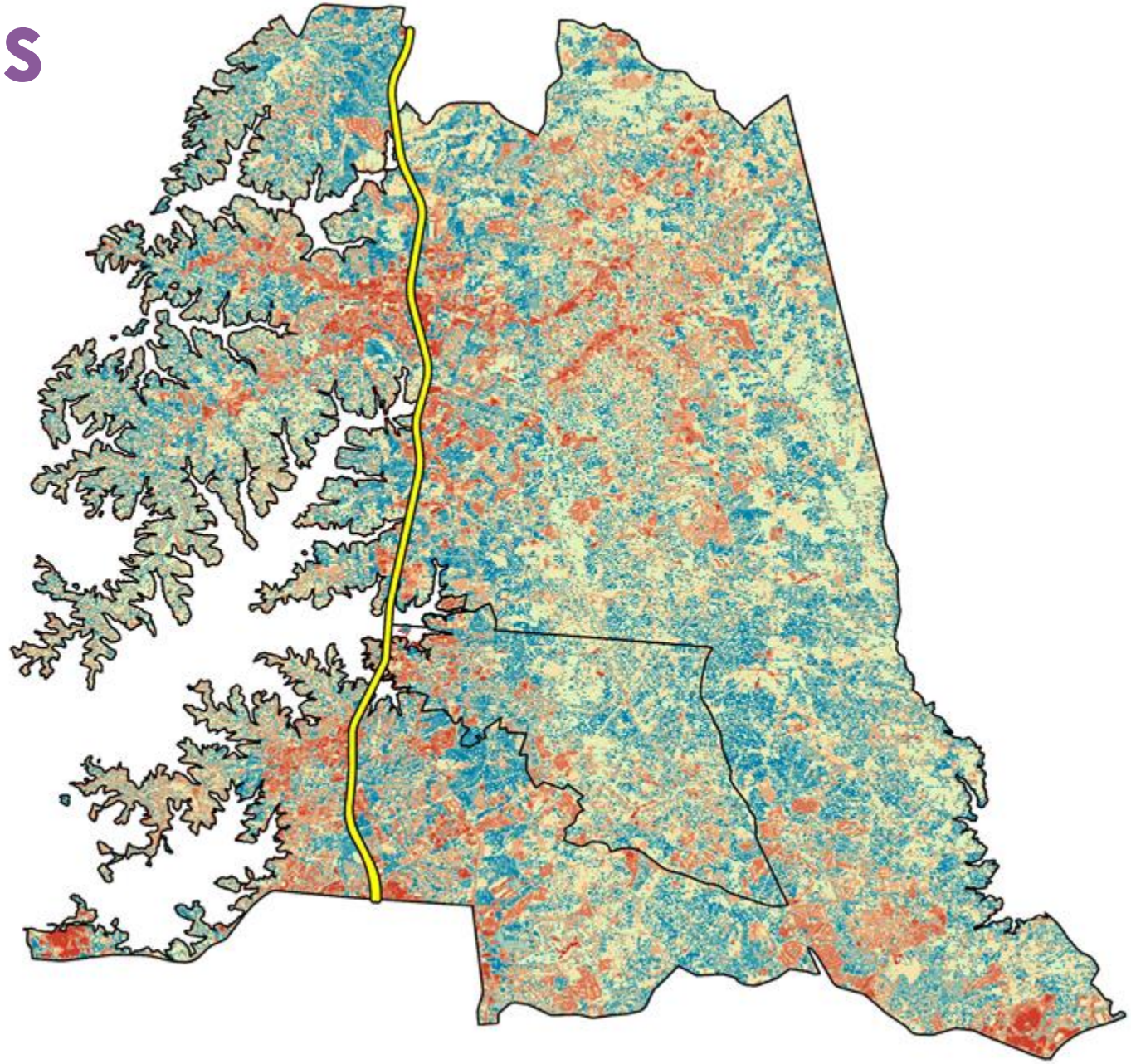


Heat Vulnerability



Hot Spot Analysis





Hot Spot Analysis

Overlap between areas of urban heat and hot spots validate our mitigation model