

Urban Heat Island measurements and sustainability maps to
help access vulnerability and potential mitigation techniques in
Birmingham and Auburn-Opelika, Alabama



Urban Sustainability Map - Pilot study for Auburn-Opelika, Alabama

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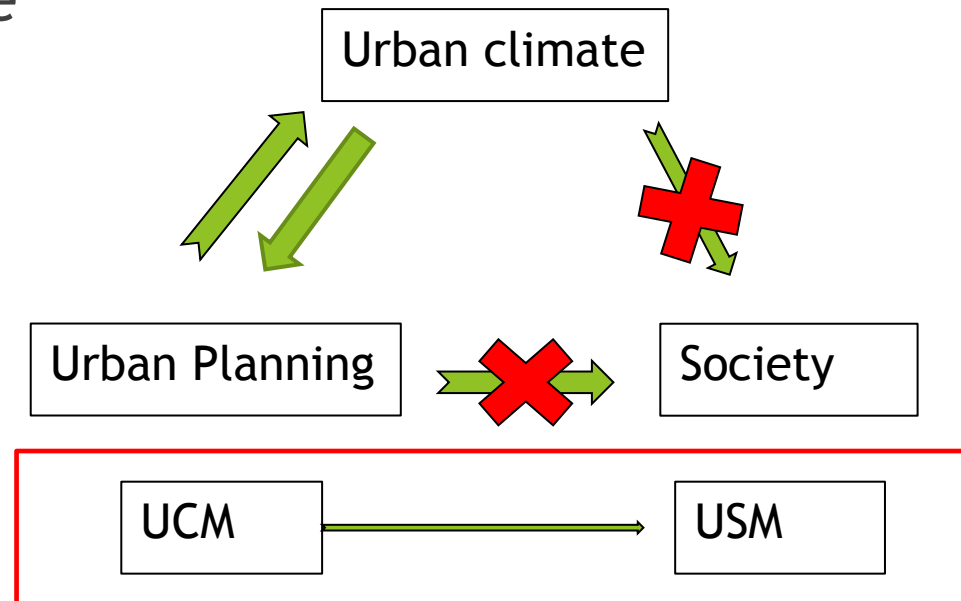
Motivation

- ▶ Motivation was Urban Climate Map (UCM) by Chao Ren and Edward Ng (Ren et al. 2011)
 - Urban climatic factors and town planning considerations
 - Two dimensional
- ▶ Auburn-Opelika average UHI intensity of 4.39°F for spring and summer 2014.
 - ▶ peaked during the day



Urban Sustainability Map (USM)

- ▶ Social aspect - disaster management, planning, energy efficiency
- ▶ GIScience intensive



Pilot Study Location

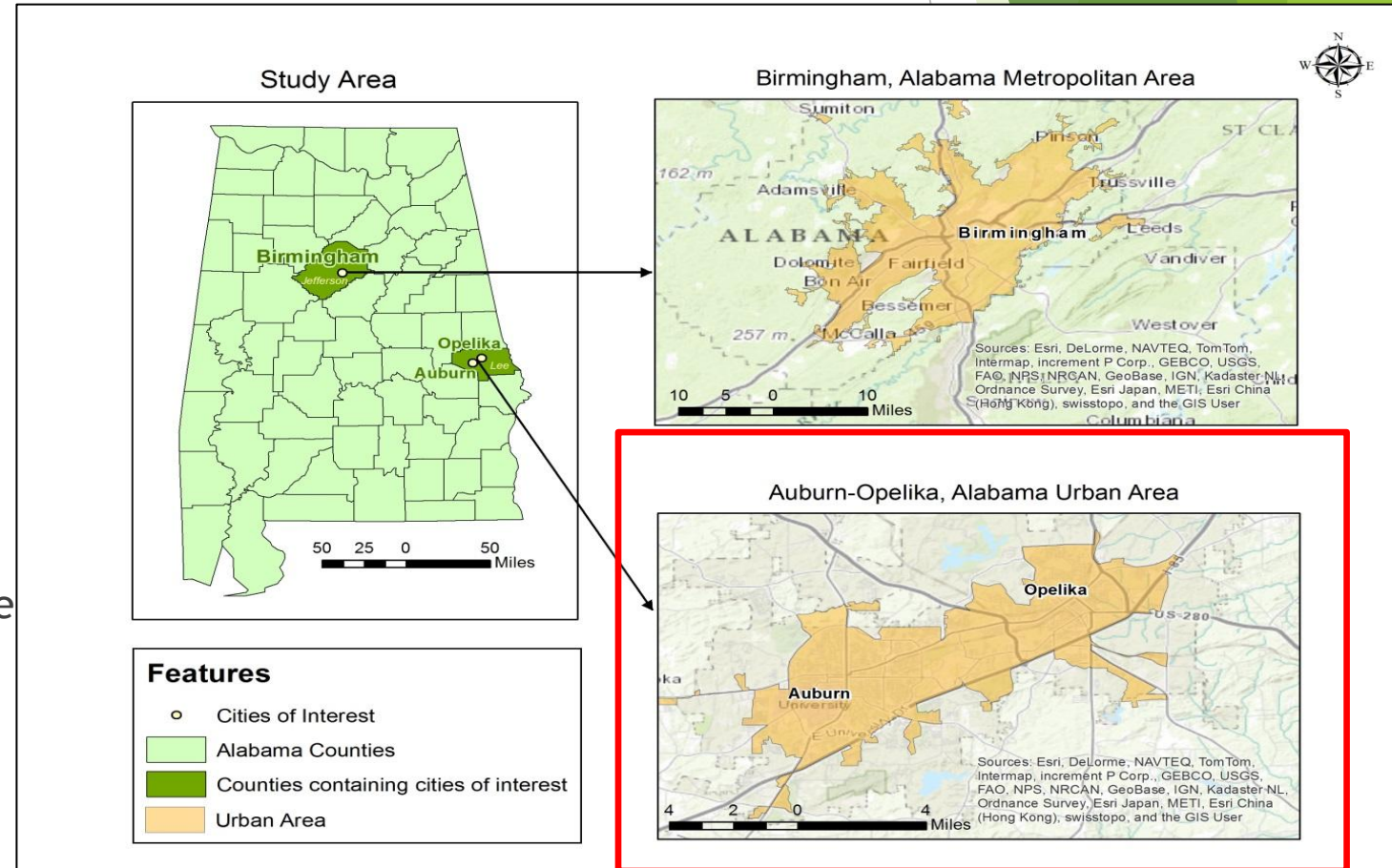
► Originally planned for Birmingham, AL, USA

- Lack of suitable data available
- Lack of city expertise (lack of knowledge in city structures, design, layout)

► Revised Pilot Study Location:

► Auburn-Opelika, AL, USA

- Population 150,000 people
- Suitable Data Available
- Ability to feasibly visit sites of interest
- Ability to cooperate with Auburn City GIS Office



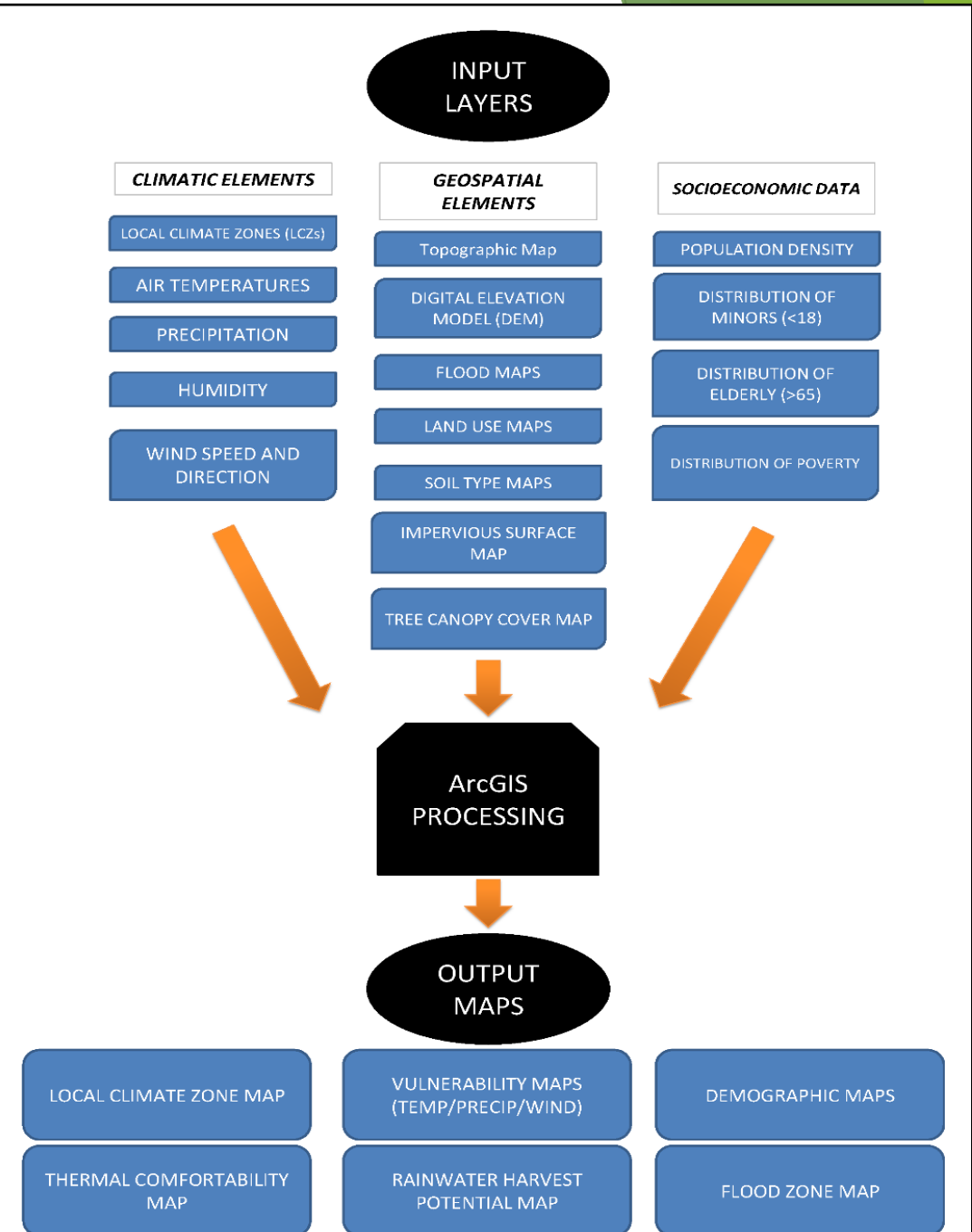
Objectives

- ▶ Develop Interactive/Predictive Maps for Sustainable Cities
 - ▶ Utilizing GIS and Remote Sensing
- ▶ Tool for creating a weather-ready city population
 - ▶ Better disaster management and planning
- ▶ Potential to be applied to Web-based user portal and/or an App
 - ▶ Encourage policy improvement and better environmental regulation



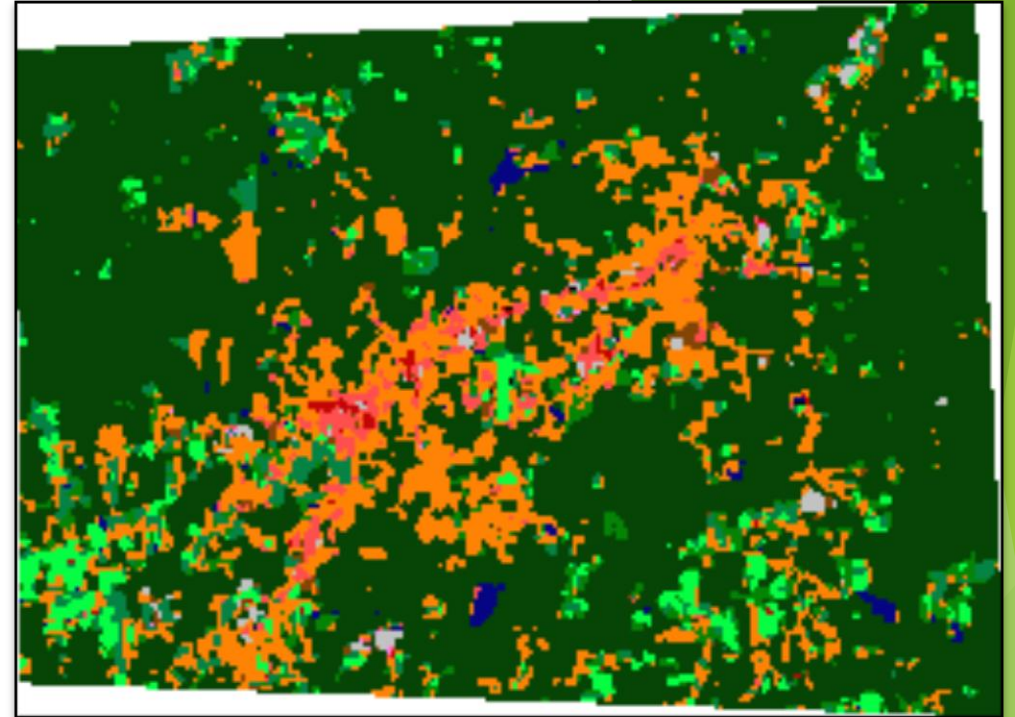
Methodology

- ▶ Primary programs being used:
 - ▶ ArcGIS
 - ▶ ERDAS IMAGINE
- ▶ Data Required:
 - ▶ Climatic Elements
 - ▶ Geospatial Elements
 - ▶ Socioeconomic Data
- ▶ Process:
 - ▶ Gather Inputs → ArcGIS and ERDAS Processing → Create Output layers → Analyze Results
 - ▶ NEXT STEP - web-based and/or App



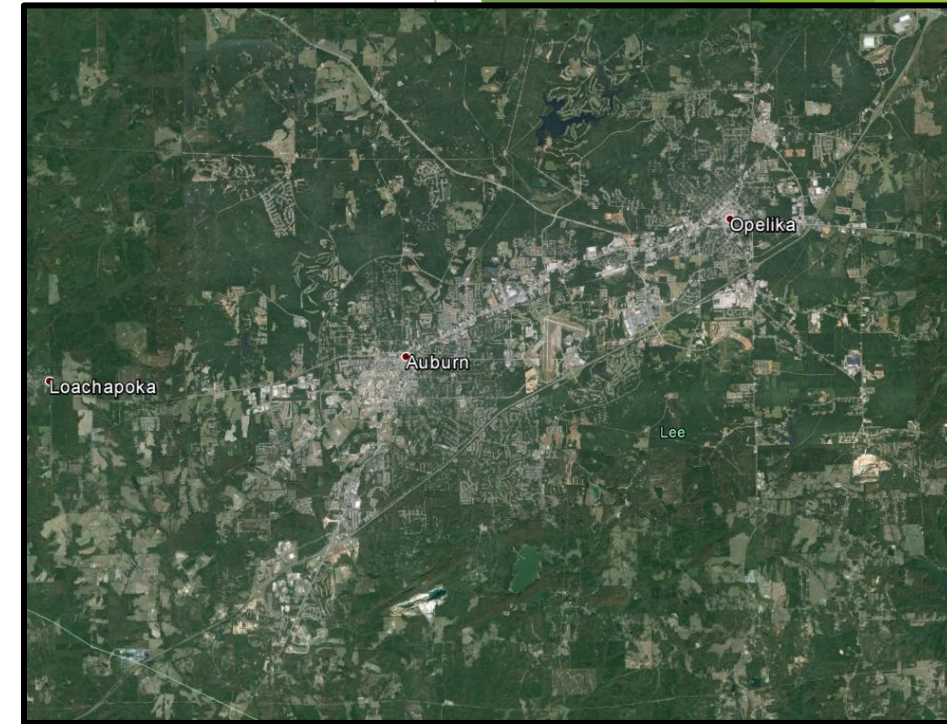
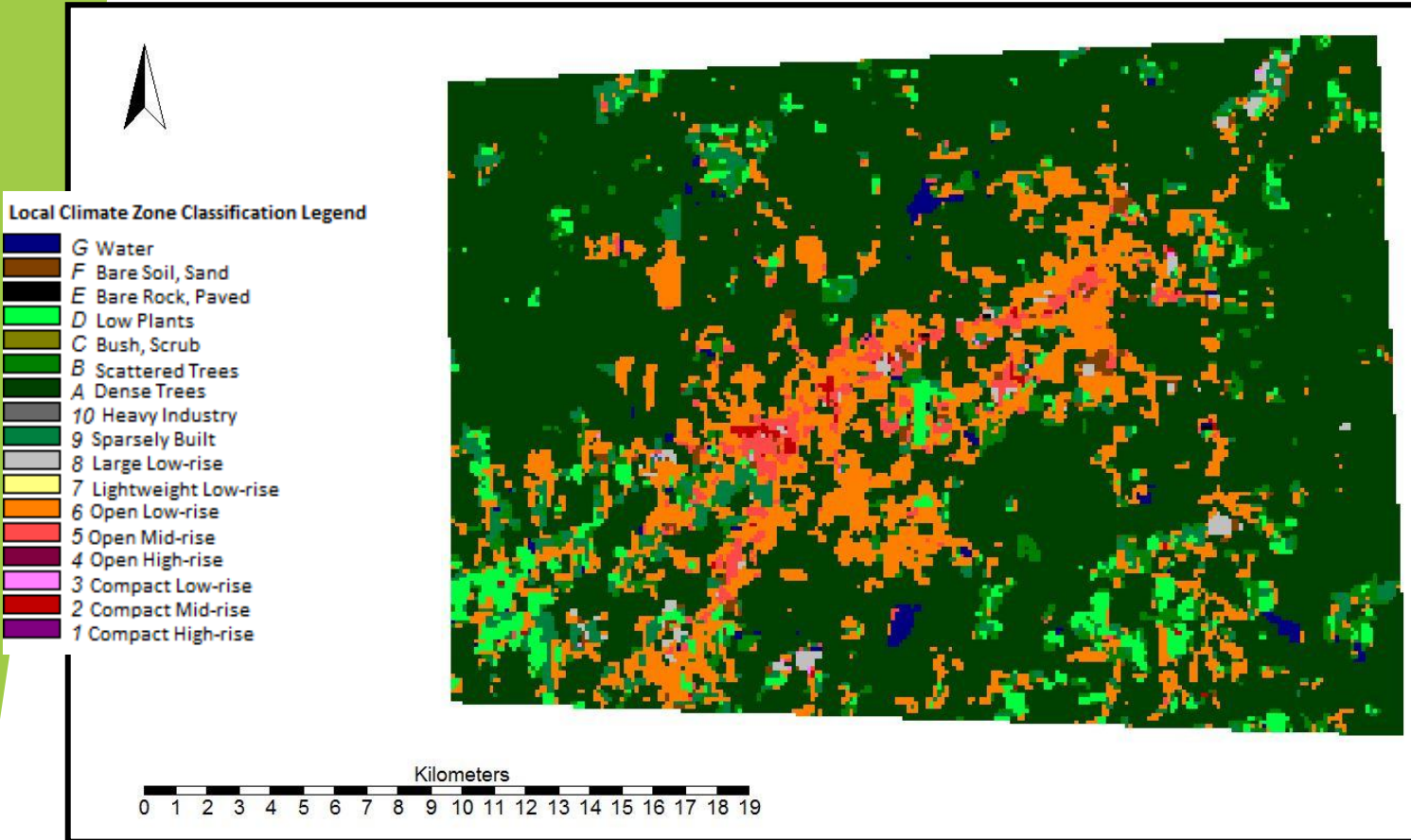
Climatic Elements

- ▶ Local Climate Zones
 - ▶ Stewart and Oke 2012
 - ▶ Classification system for microclimates
- ▶ Air Temperatures
 - ▶ Monthly Averages
 - ▶ National Oceanic and Atmospheric Administration (NOAA)
- ▶ Precipitation
 - ▶ Monthly Totals
 - ▶ National Oceanic and Atmospheric Administration (NOAA)
- ▶ Humidity and wind speed
 - ▶ Monthly Averages



Auburn-Opelika, AL Local
Climate Zone First
Attempt

Auburn-Opelika Local Climate Zone Classification



Open and compact low and midrise buildings

HOBOS placed in different LCZs to measure temperature

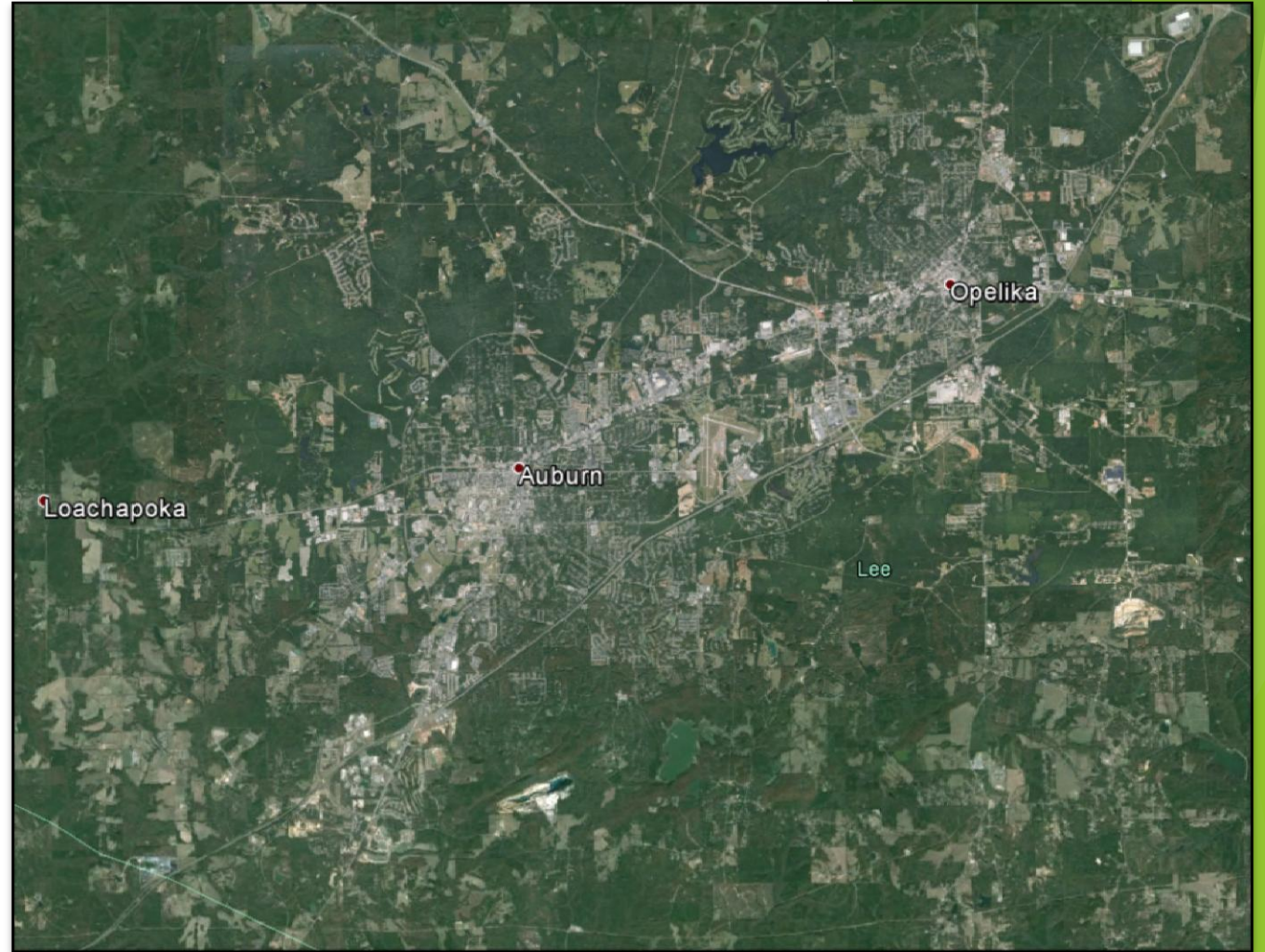


Stevenson screen in open mid-rise



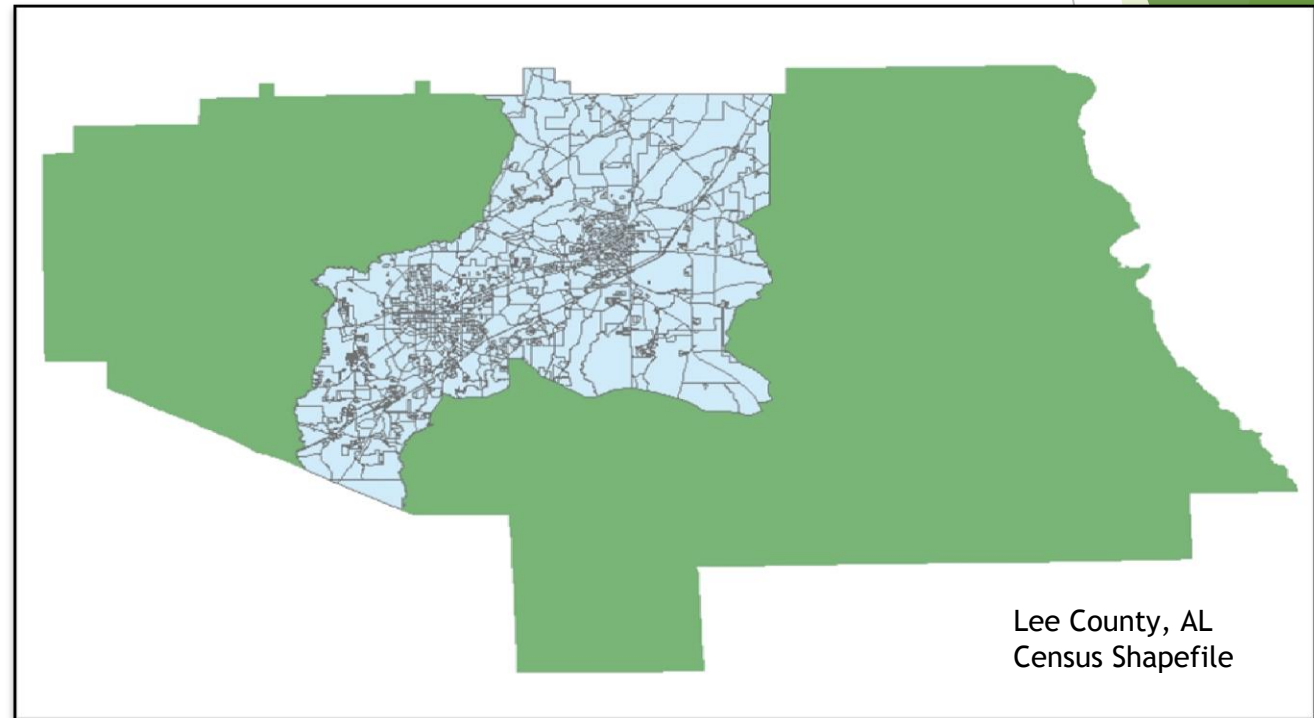
Geospatial Elements

- ▶ Topographic Map
 - ▶ United States Geological Survey (USGS)
- ▶ Digital Elevation Model (DEM)
 - ▶ United States Geological Survey (USGS)
- ▶ Floodplain Map
 - ▶ Auburn City GIS Office
- ▶ Land Use Map
 - ▶ National Land Cover Database (NLCD)
- ▶ Soil Type Map
 - ▶ Auburn City GIS Office



Socioeconomic Elements

- ▶ U.S. Census Bureau Data
 - ▶ Population Density
 - ▶ Distribution of Minors (<18)
 - ▶ Distribution of Elderly (>65)
 - ▶ Distribution of Poverty
 - ▶ Tract and Block group shapefiles



Anticipated Results

Output layers:

- ▶ LCZ with individual zone temperature and humidity
- ▶ Vulnerability Maps (example heat vulnerability map)
- ▶ Demographic maps showing where minors and elderly people mostly live as well as poor people live
- ▶ Rainwater harvesting potential areas
- ▶ Flash flood prone area map
- ▶ Thermal comfort maps
- ▶ Solar map (with LiDAR data)

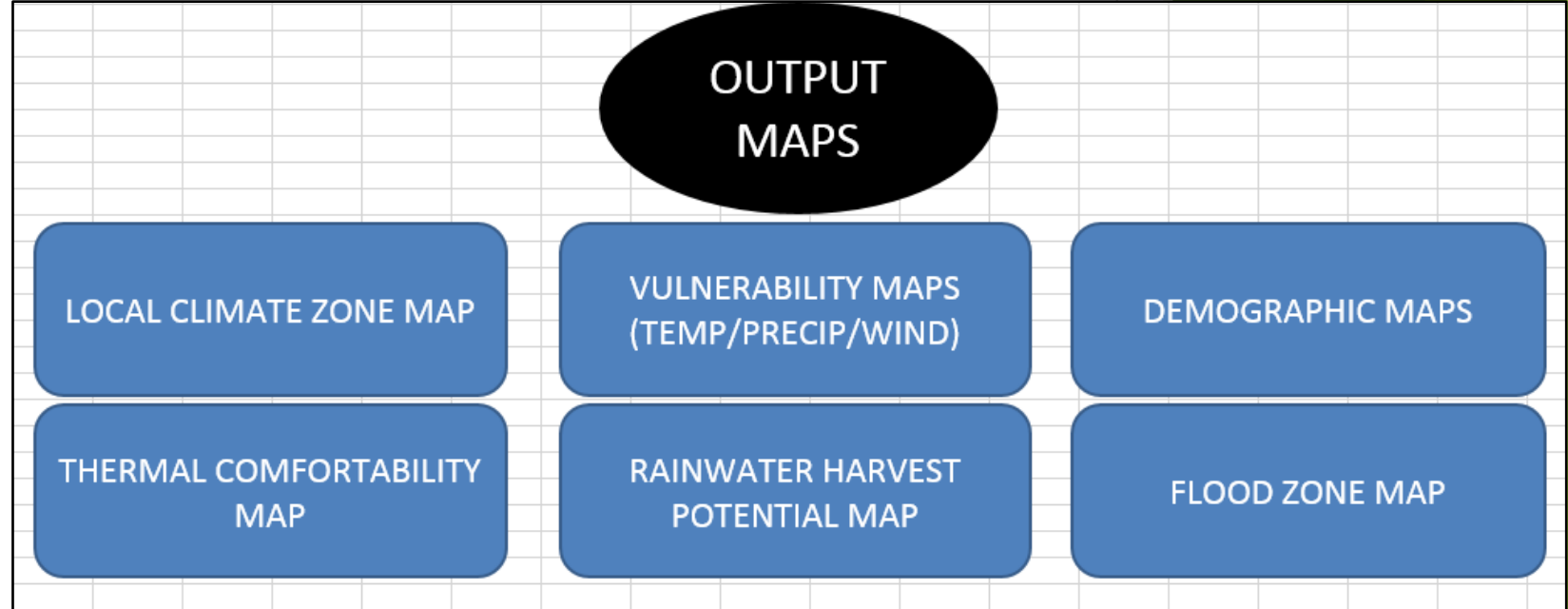


Significance

- ▶ Many different GIS Map layers
 - ▶ Depicts spatial distribution of vulnerable populations in regards to environmental conditions
 - ▶ Can be used by City Developers, Researchers, and Civilians in projects relating to urban sustainability improvements
 - ▶ Promotes awareness of potential spatial hazards, such as flooding, heat wave, drought, etc.
- ▶ Potential GIS Database
 - ▶ Allows for continuous improvements and development of urban GIS layers

Acknowledgments

- ▶ Undergraduate Researchers:
 - ▶ Austin Bush
 - ▶ Patrick Goodman
 - ▶ Tyler Finley
- ▶ Graduate Researchers:
 - ▶ Andy Hug



SUGGESTIONS and comments would be valuable



1. Measure the magnitudes and intensities of the atmospheric UHIs in Birmingham and Auburn-Opelika from 1 May 2014 to 31 August 2014.

- Data Source: **40 iButtons** (temperature sensors with 0.5°C).

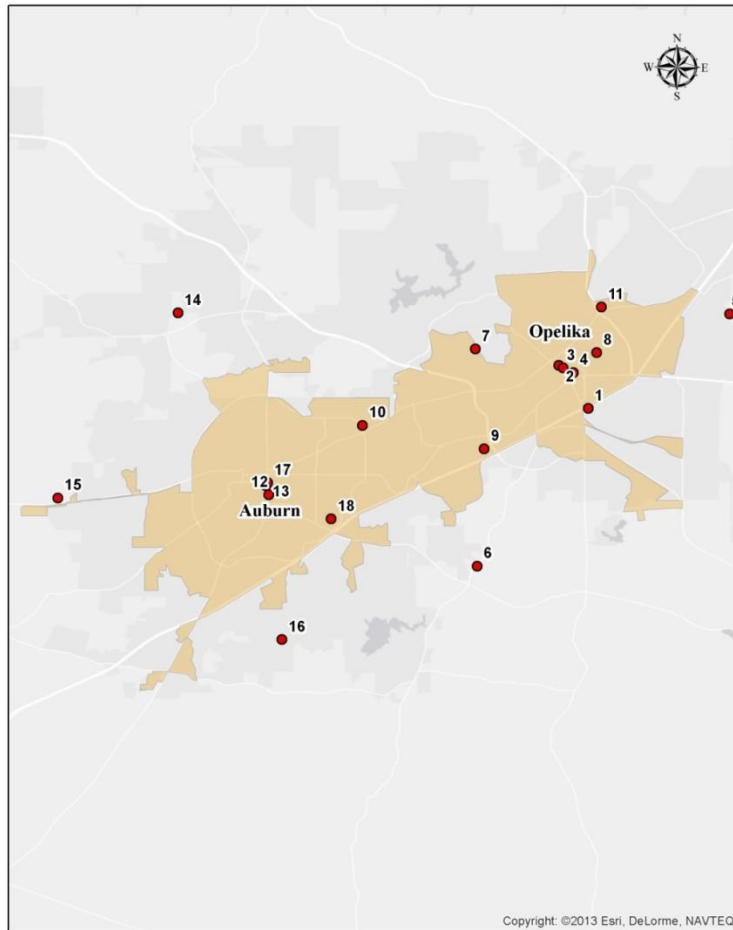
- **Methods:**

- ▶ Satellite imagery: locate installation sites.
- ▶ Instruments synchronized with the local time.
- ▶ iButton and locations given identification numbers and **GPS coordinates**.
- ▶ **60 minute recording frequency** from 1 May 2014 to 31 August 2014.
- ▶ Installed on street signs in urban, suburban, and rural locations



iButton Locations

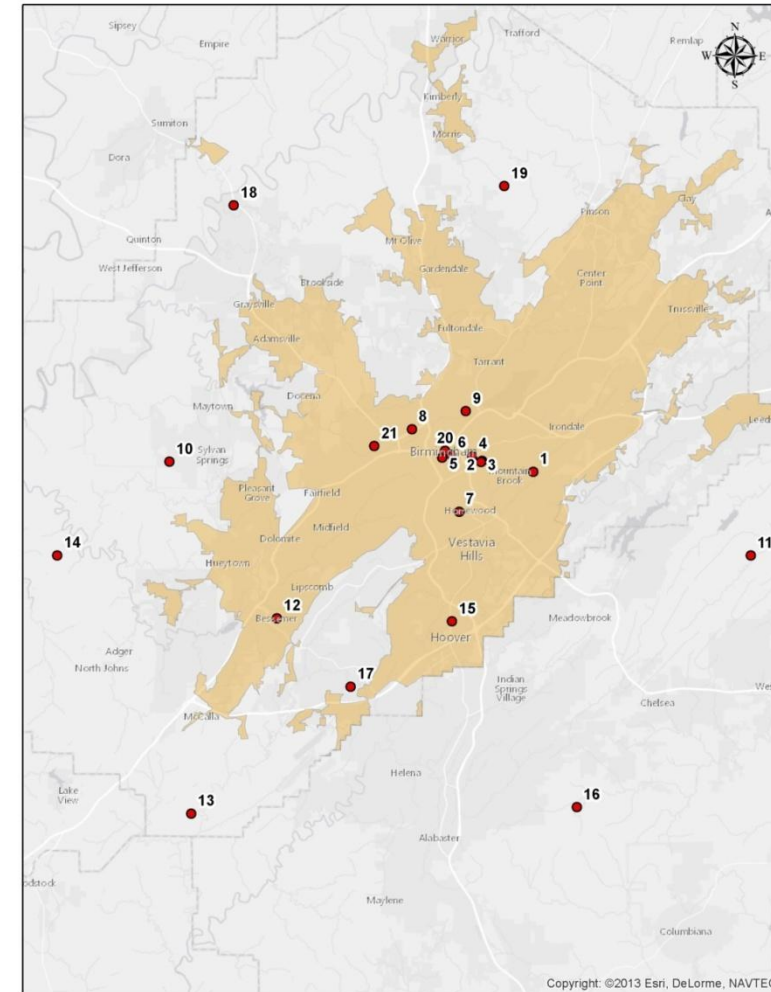
Auburn-Opelika, Alabama iButton Locations



● iButton Location

2 1 0 2 4 6 Miles

Birmingham, Alabama iButton Locations



● iButton Location

4 2 0 4 8 12 Miles

Conclusions

- ▶ Both study areas have well defined **UHI effects**.
- ▶ **UHI magnitude peaks nocturnally**, regardless of study area.
- ▶ Daytime UHIs intensified in low H:W ratio areas, while nighttime UHIs intensified in high H:W ratio areas.
 - ▶ Birmingham average UHI intensity of 3.84°F over study period.
 - ▶ peaked during the night .
 - ▶ Auburn-Opelika average UHI intensity of 4.39°F over study period.
 - ▶ peaked during the day.



August 6-8; 21-23, 2014 Diurnal Average Temperatures for Birmingham

