THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

Exploring Areas with Heat Island Effects in Birmingham, Air Quality Monitoring and Tree Plantation as Mitigation Strategy

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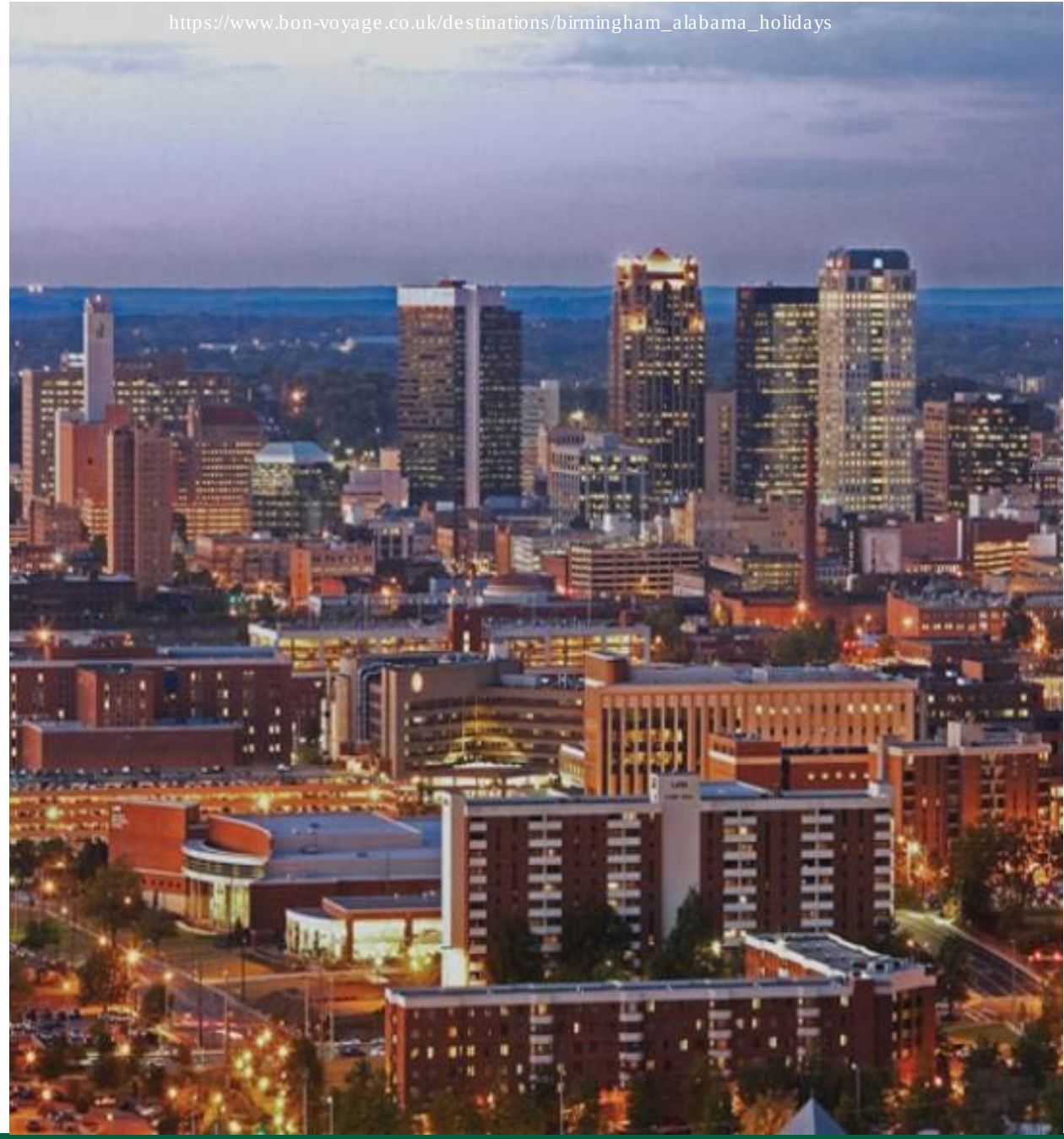
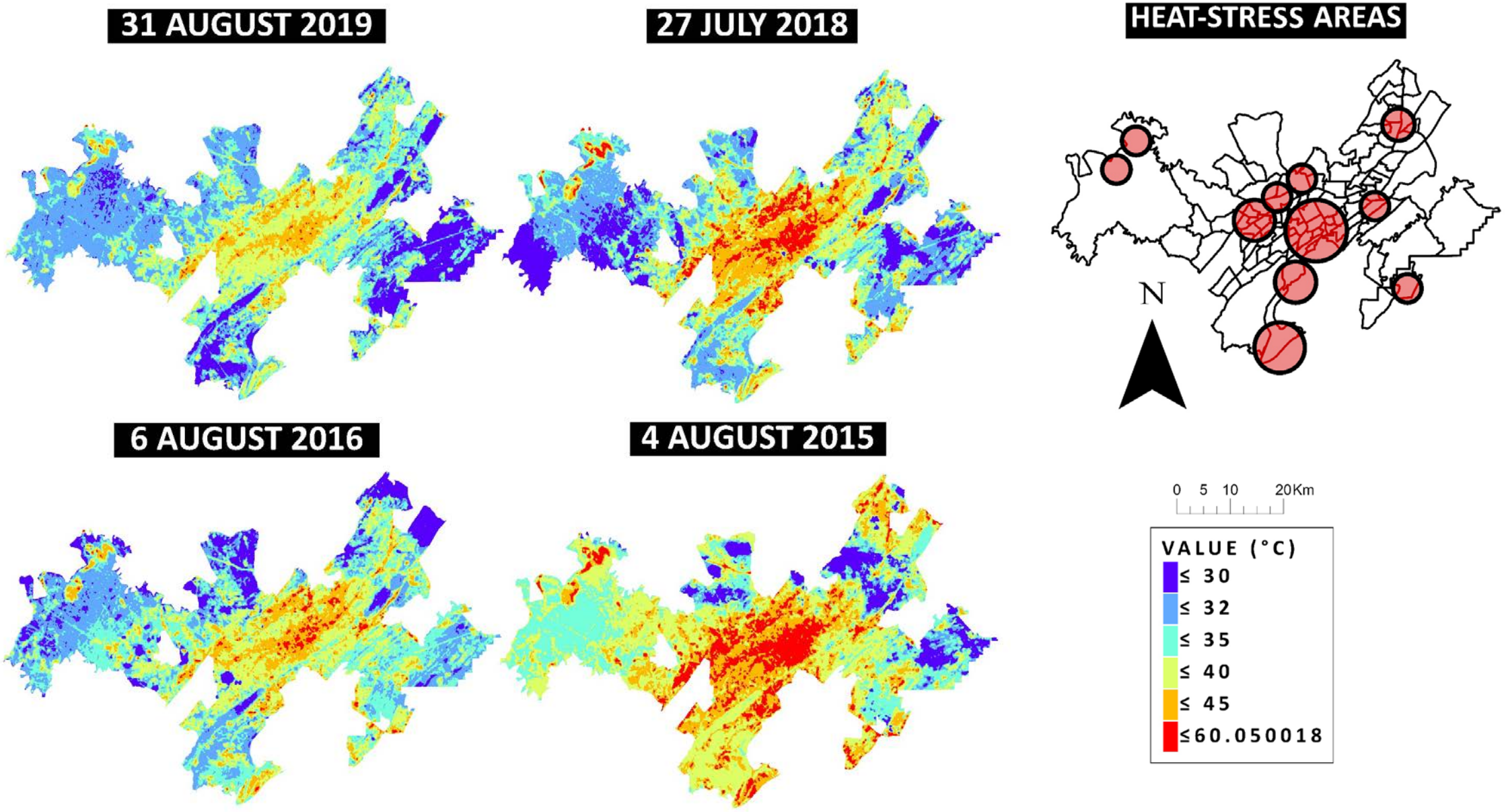
Introduction

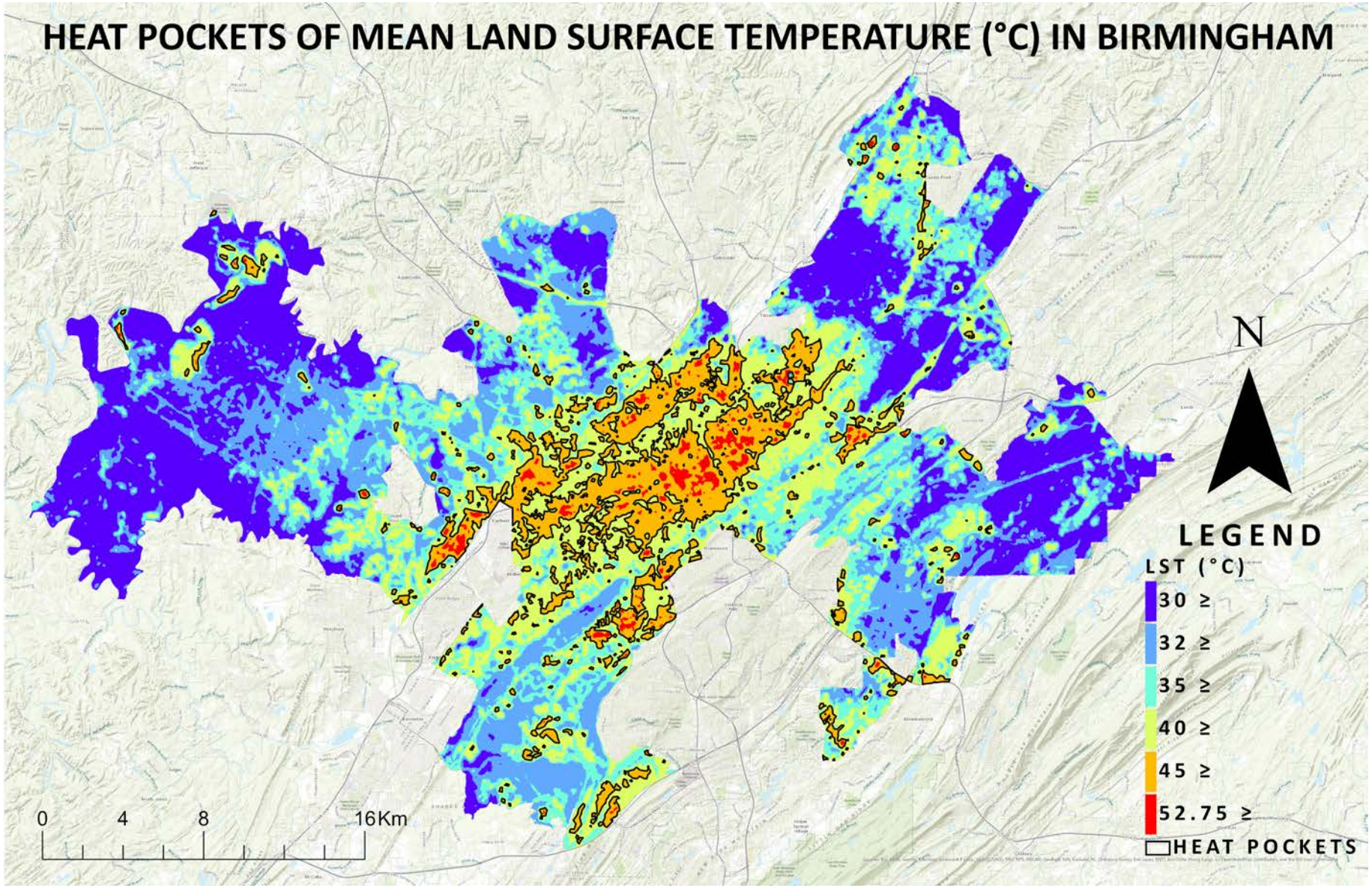
- In a study during March 1 to August 31 of 201, Birmingham had an average 3.84℉ daytime heat intensity difference.
- Auburn-Opelika area an average 4.39℉ heat intensity difference between urban and rural areas during the day.
- Due to high height/width ratio and enough shading in the city, daytime heat intensity was less compared to Auburn-Opelika
- Reverse scenario is observed at nighttime. High heat intensity at nigh in Birmingham compared to Auburn-Opelika (Hug, 2014)
- Not much studies conducted focusing on UHI in Birmingham city.



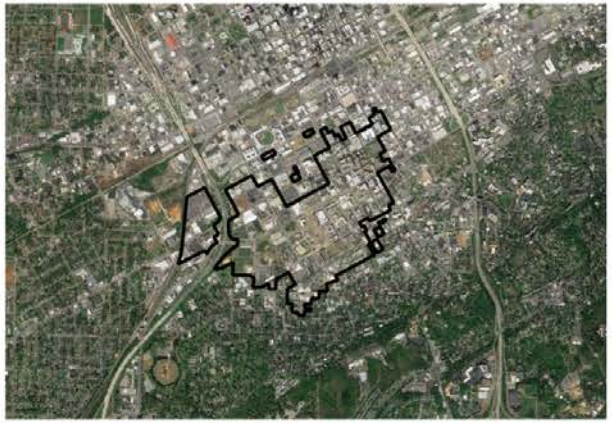
Observing Heat Islands using Satellite Imageries

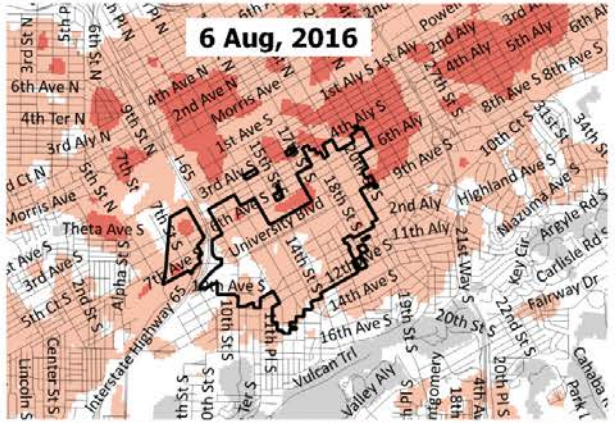


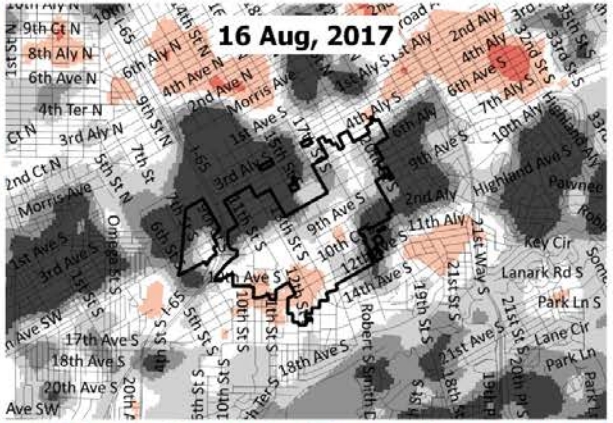
Identified heat pockets in Satellite images (2015 -2019)

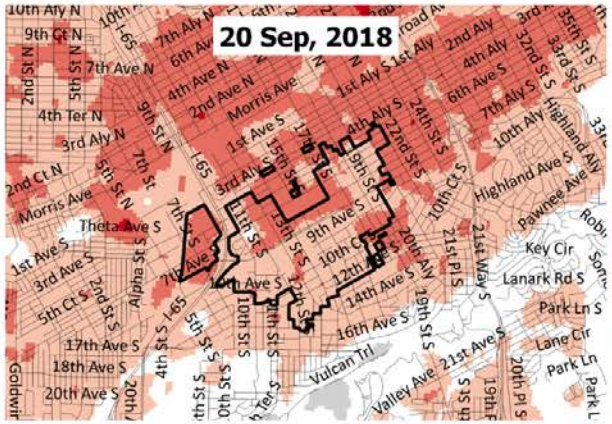


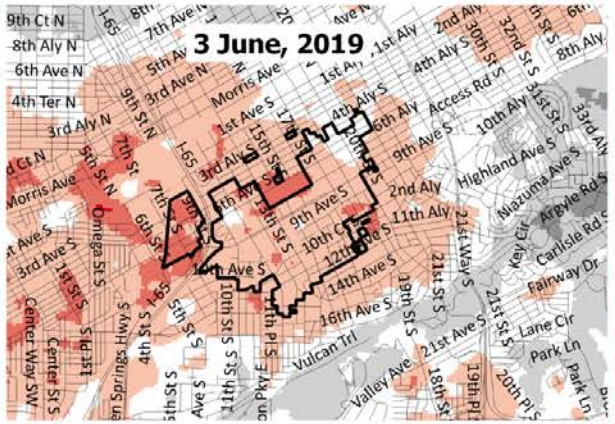
Heat-stress in the campus of University of Alabama at Birmingham

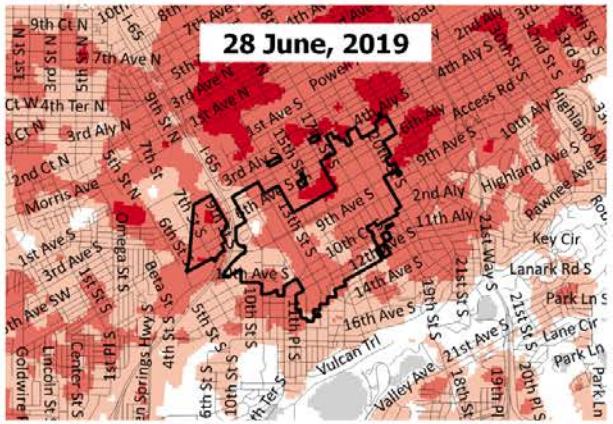


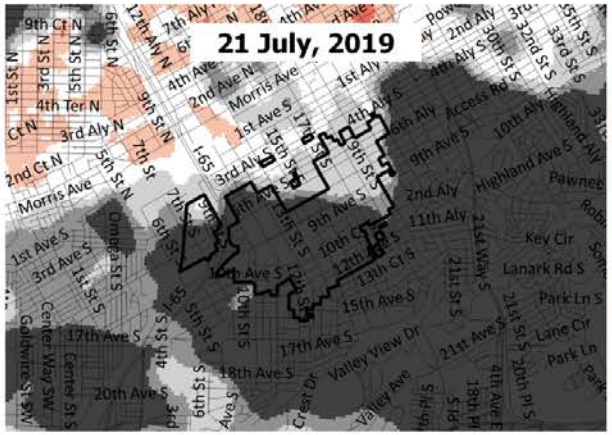


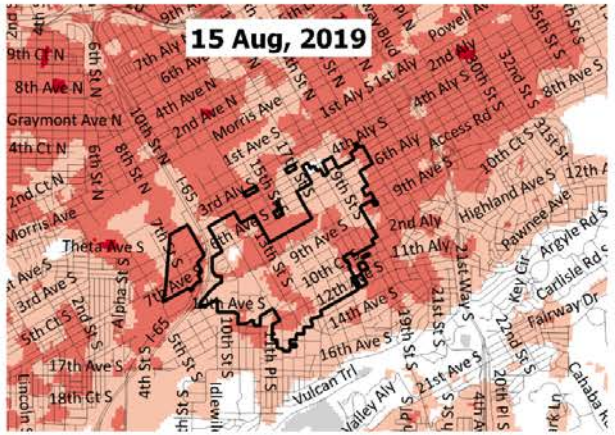


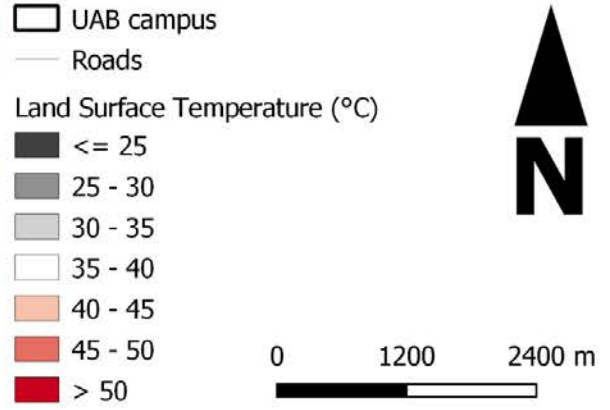




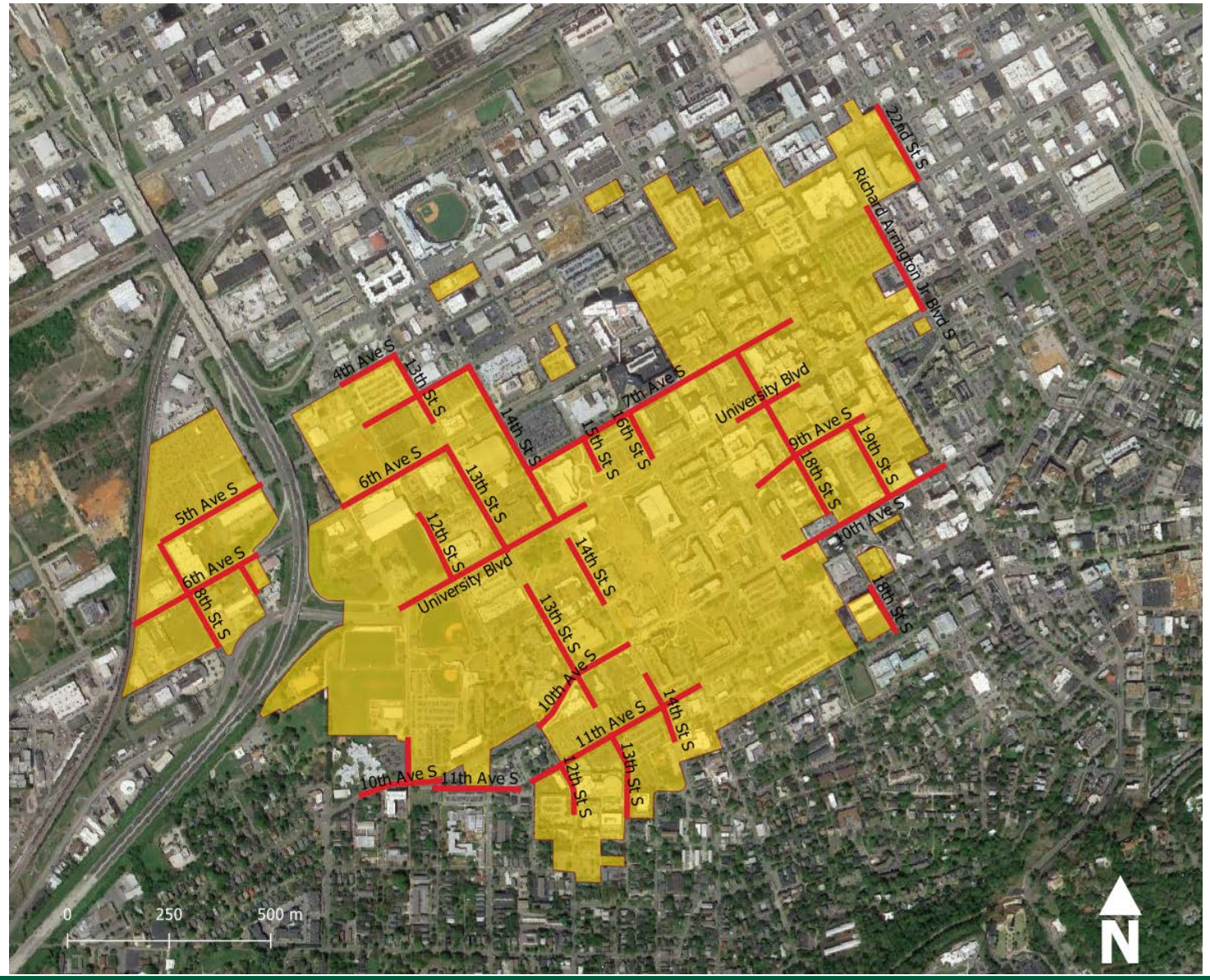




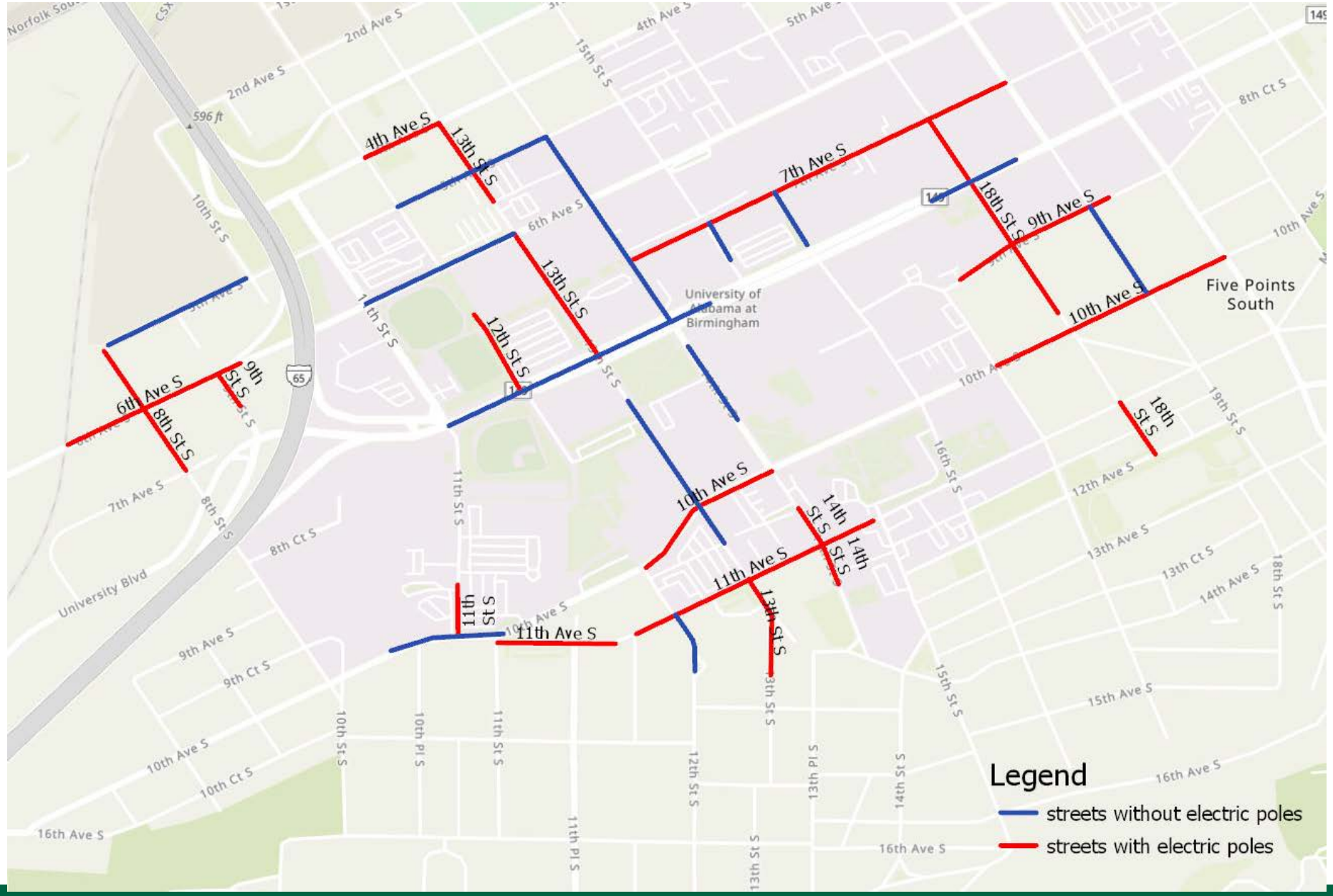




Identified streets with constant hot -spots in UAB campus



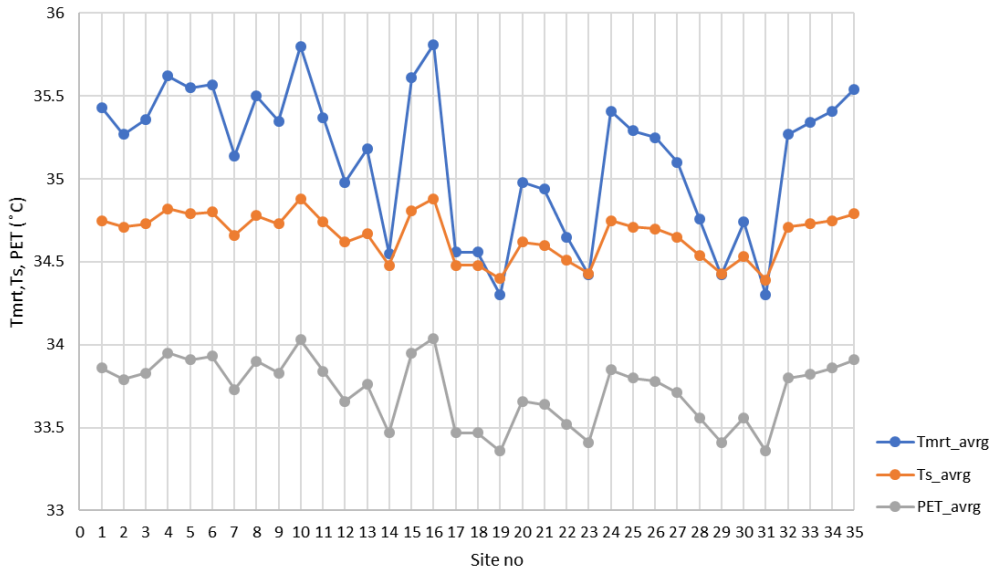
Identifying streets without electric poles for future tree plantation



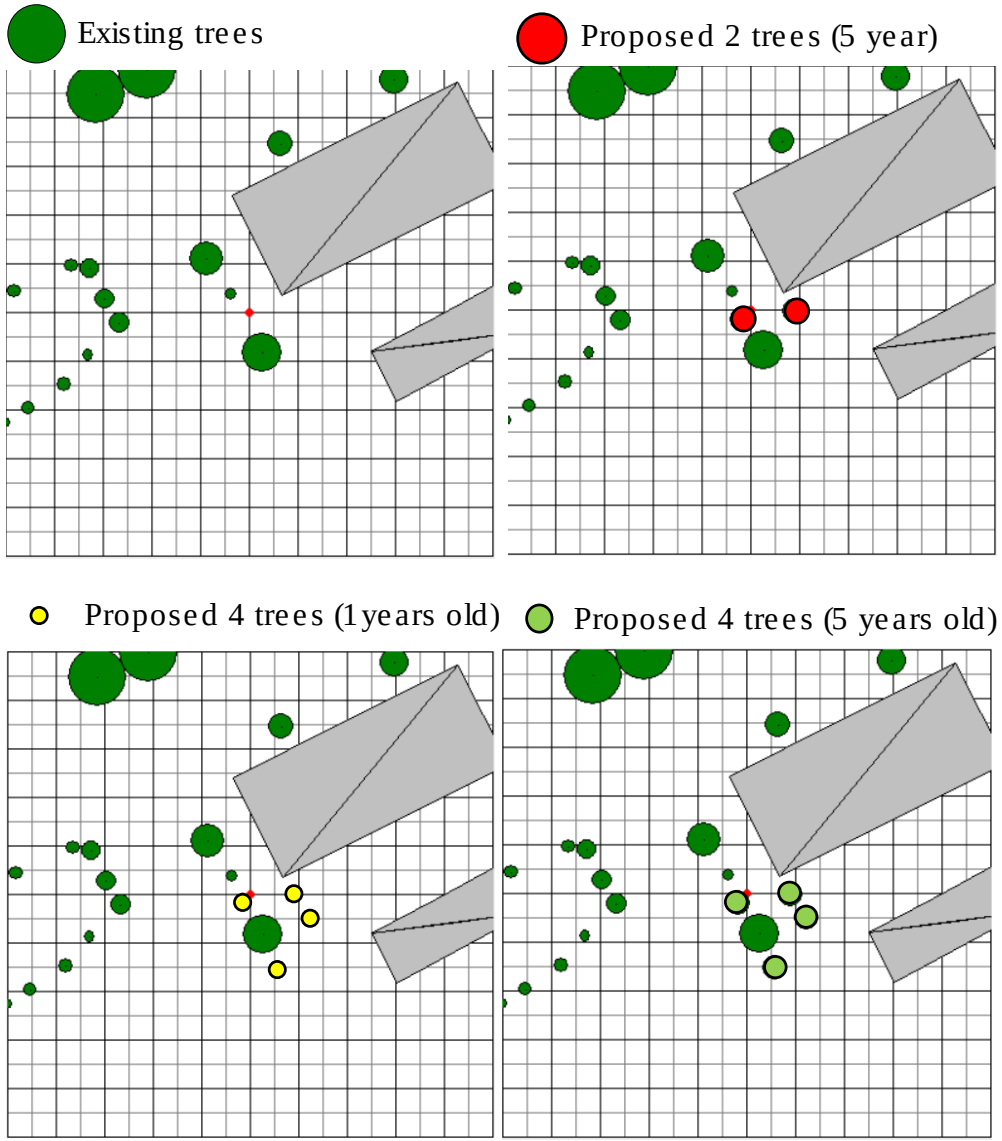
Summary result for 35 sites

site no	Site Name	min			average			max		
		Tmrt	Ts	PET	Tmrt	Ts	PET	Tmrt	Ts	PET
1	13th St S	20.1	24.3	20.8	35.43	34.75	33.86	60.8	55.5	50.4
2	University Blvd	19.9	24.3	20.8	35.27	34.71	33.79	60.7	55.4	50.4
3	12th St S	20	24.3	20.8	35.36	34.73	33.83	60.8	55.4	50.4
4	13th St S	20.4	24.4	20.9	35.62	34.82	33.95	61	55.5	50.5
5	4th Ave S	20.3	24.4	20.8	35.55	34.79	33.91	60.9	55.5	50.5
6	5th Ave S	20.3	24.4	20.9	35.57	34.8	33.93	60.9	55.5	50.5
7	5th Ave S	19.7	24.2	20.8	35.14	34.66	33.73	60.6	55.4	50.3
8	14th St S	20.2	24.4	20.8	35.5	34.78	33.9	60.9	55.5	50.5
9	22nd St S	20	24.3	20.8	35.35	34.73	33.83	60.8	55.4	50.4
10	15th St S	20.6	24.5	20.9	35.8	34.88	34.03	61.1	55.6	50.6
11	16th St S	20	24.3	20.8	35.37	34.74	33.84	60.8	55.5	50.4
12	University Blvd	19.5	24.1	20.7	34.98	34.62	33.66	60.5	55.3	50.3
13	18th St S	19.8	24.2	20.8	35.18	34.67	33.76	60.7	55.4	50.4
14	9th Ave S	18.9	23.9	20.6	34.55	34.48	33.47	60.2	55.1	50.1
15	10th Ave S	20.4	24.4	20.9	35.61	34.81	33.95	61	55.5	50.5
16	18th St S	20.6	24.5	20.9	35.81	34.88	34.04	61.1	55.6	50.6
17	19th St S	18.9	23.9	20.6	34.56	34.48	33.47	60.2	55.2	50.1
18	7th Ave S	18.9	23.9	20.6	34.56	34.48	33.47	60.2	55.2	50.1
19	13th St S	18.5	23.8	20.6	34.3	34.4	33.36	60.1	55.1	50
20	11th Ave S	19.5	24.1	20.7	34.98	34.62	33.66	60.5	55.3	50.3
21	13th St S	19.4	24.1	20.7	34.94	34.6	33.64	60.5	55.3	50.2
22	12th St S	19	23.9	20.7	34.65	34.51	33.52	60.3	55.2	50.1
23	Richard Armington Jr Blvd S	18.7	23.8	20.6	34.42	34.43	33.41	60.1	55.1	50.1
24	11th Ave S	20.1	24.3	20.8	35.41	34.75	33.85	60.8	55.5	50.4
25	10th Ave S	19.9	24.3	20.8	35.29	34.71	33.8	60.8	55.4	50.4
26	11th St S	19.9	24.2	20.8	35.25	34.7	33.78	60.7	55.4	50.4
27	10th Ave S	19.6	24.2	20.7	35.1	34.65	33.71	60.6	55.3	50.3
28	14th St S	19.2	24	20.7	34.76	34.54	33.56	60.4	55.2	50.2
29	14th St S	18.7	23.8	20.6	34.42	34.43	33.41	60.1	55.1	50.1
30	14th St S	19.1	24	20.7	34.74	34.53	33.56	60.4	55.2	50.2
31	6th Ave S	18.5	23.8	20.6	34.3	34.39	33.36	60	55.1	50
32	8th St S	19.9	24.3	20.8	35.27	34.71	33.8	60.7	55.4	50.4
33	5th Ave S	20	24.3	20.8	35.34	34.73	33.82	60.8	55.4	50.4
34	9th St S	20.1	24.3	20.8	35.41	34.75	33.86	60.8	55.5	50.5
35	6th Ave S	20.3	24.4	20.8	35.54	34.79	33.91	60.9	55.5	50.5

18th St S, 15th St S, 13th St S, 4th Ave S, 5th Ave S, 14th St S, 10th Ave S, 6th Ave S among 35 sites showed high average Tmrt, Ts and PET temperature throughout the whole day.

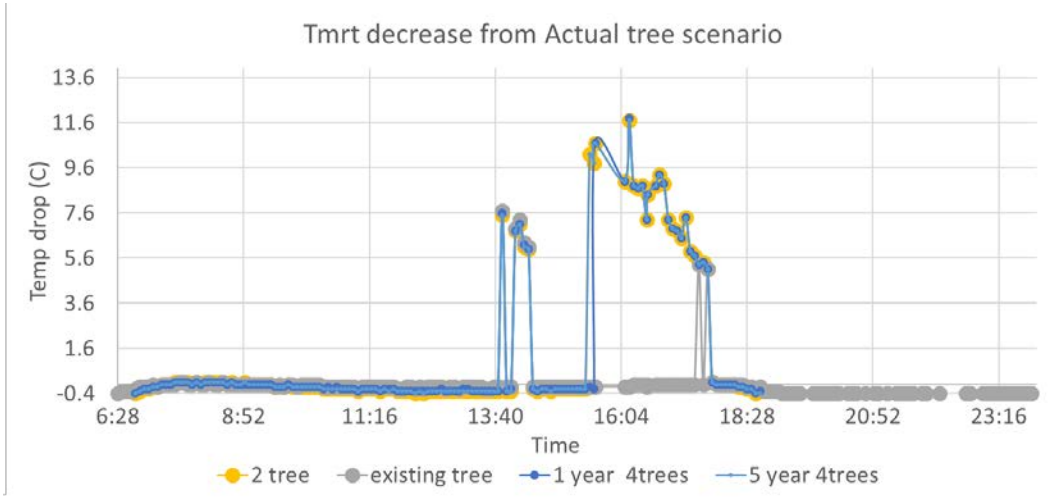


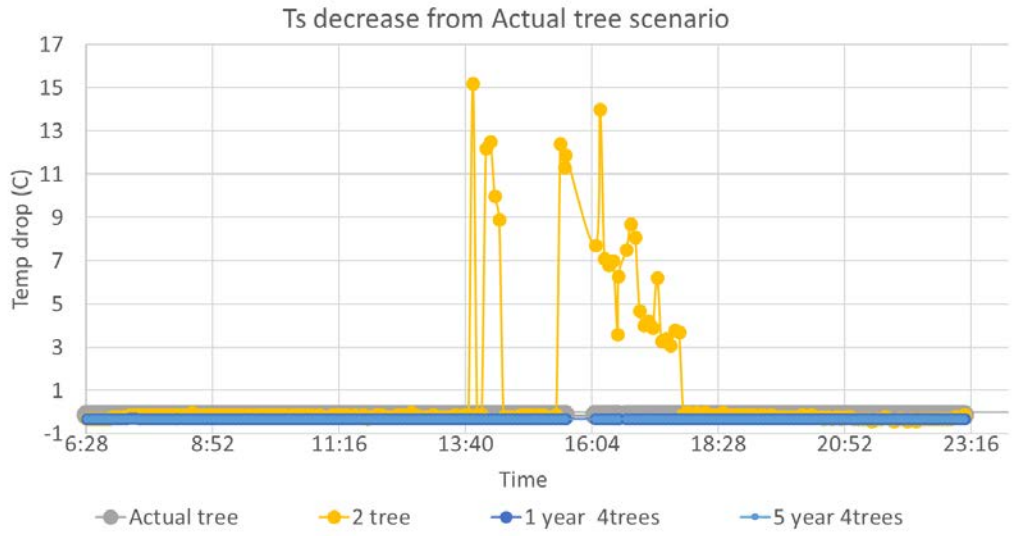
Example Rayman simulation for 8TH STREET S



Summary Statistics on Tmrt drop (℃)

	Existing trees	2 tree (5 year)	4 trees (1 year)	4 trees(5 year)
min	-0.3	-1.1	-1	-1.1
max	7.7	11.7	11.8	11.7
Average	-0.09	0.22	0.193	0.21



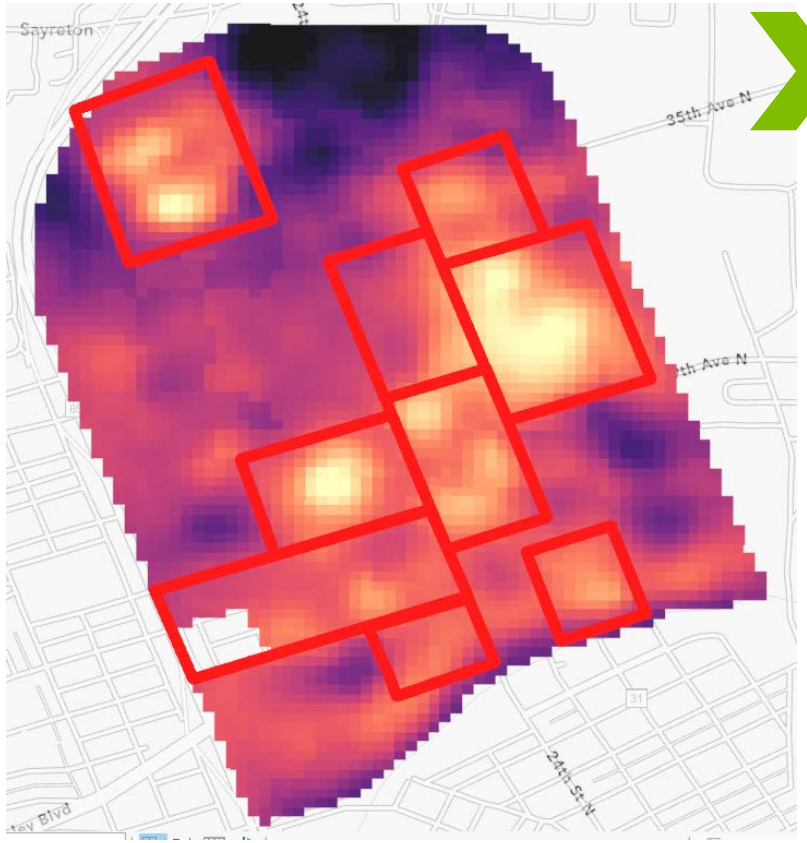


Study in North Birmingham (ongoing)

Extracted buildings and vegetation from LIDAR data to be used in simulation

North Birmingham

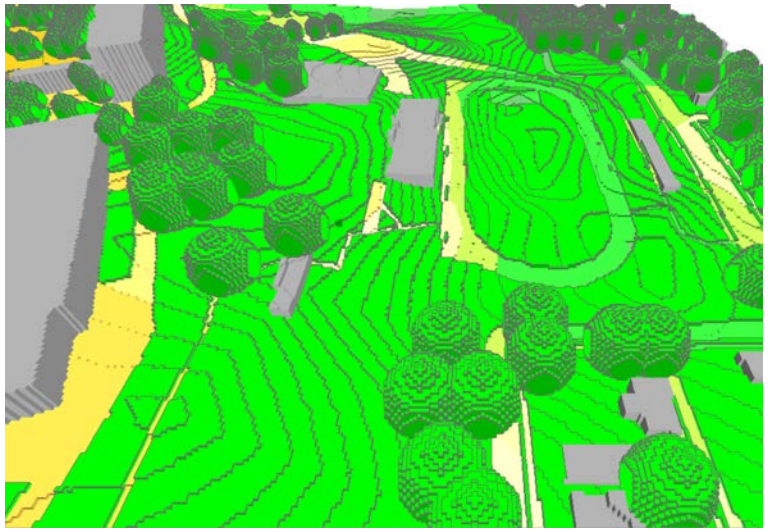
Study in North Birmingham (ongoing)



UHIs identified in LST
Study areas selection

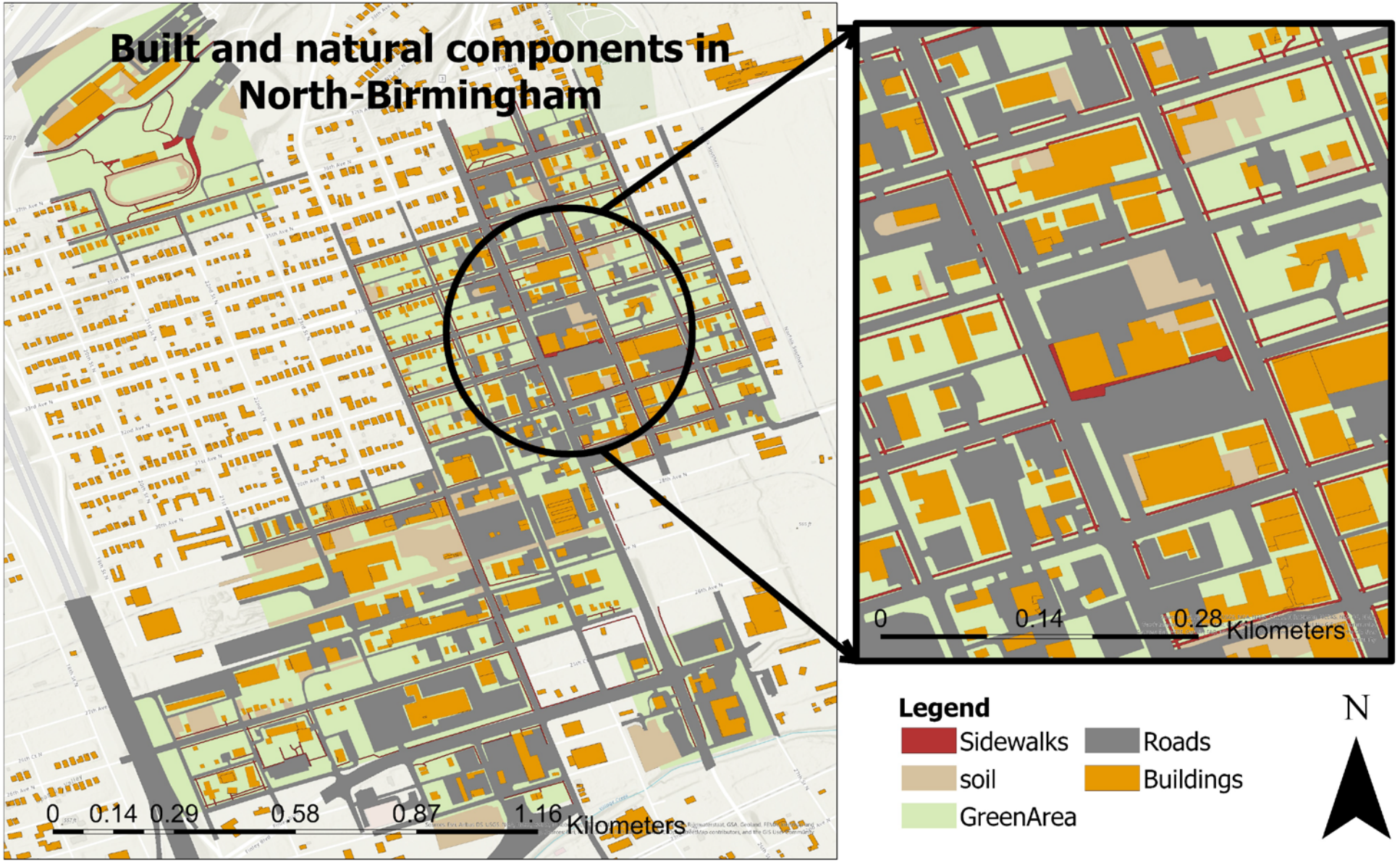
Digitization
(Building, sidewalk, trees, green lands, roads, soil)

EnviMet Software



- Evaluates biometeorological parameters in high spatial resolution
- Includes surface materials
- Can choose different tree species

Digitization of Urban Components



Identifying Social Vulnerability due to Heat Island Effects in Birmingham, AL

Census Data

1. Percentage population that is Hispanic
2. Percentage population that is Black
3. Percentage population that is foreign born
4. Percentage population who speak English less than 'very well'
5. Percentage population with income below poverty level
6. Percentage population over 65 years of age
7. Percentage population over 65 years of age and living alone
8. <16/18 and living alone
9. Percentage population (18-64 years) that has a disability
10. Percentage population (16+) that are unemployed
11. Percentage houses built before 1980
12. Percent population without health insurance
13. Public transportation users

Surface characteristics

1. Land Surface Temperature
2. P_v
3. Normalized Difference Water Index (NDWI)
4. DEM
5. % imperviousness
6. Building density per square mile

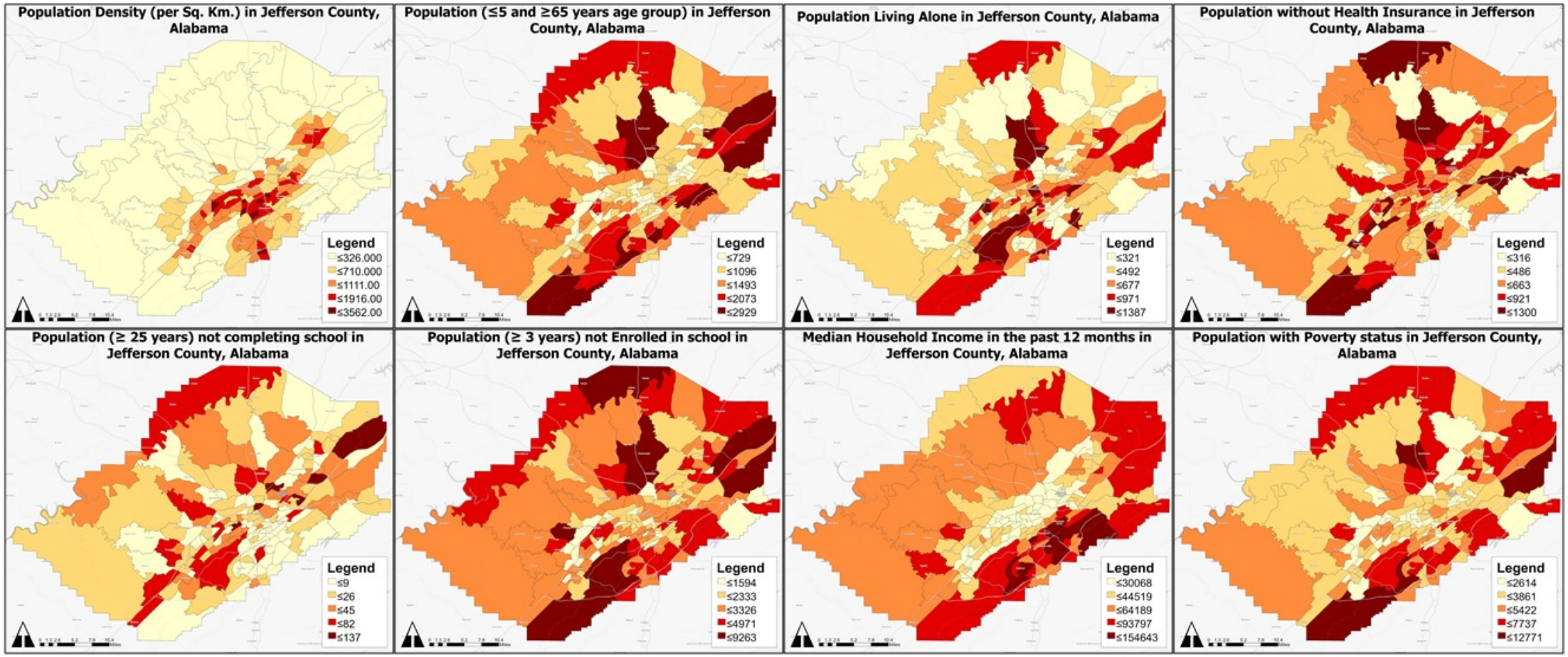
Health Data

1. CVD
2. Stroke
3. Asthma

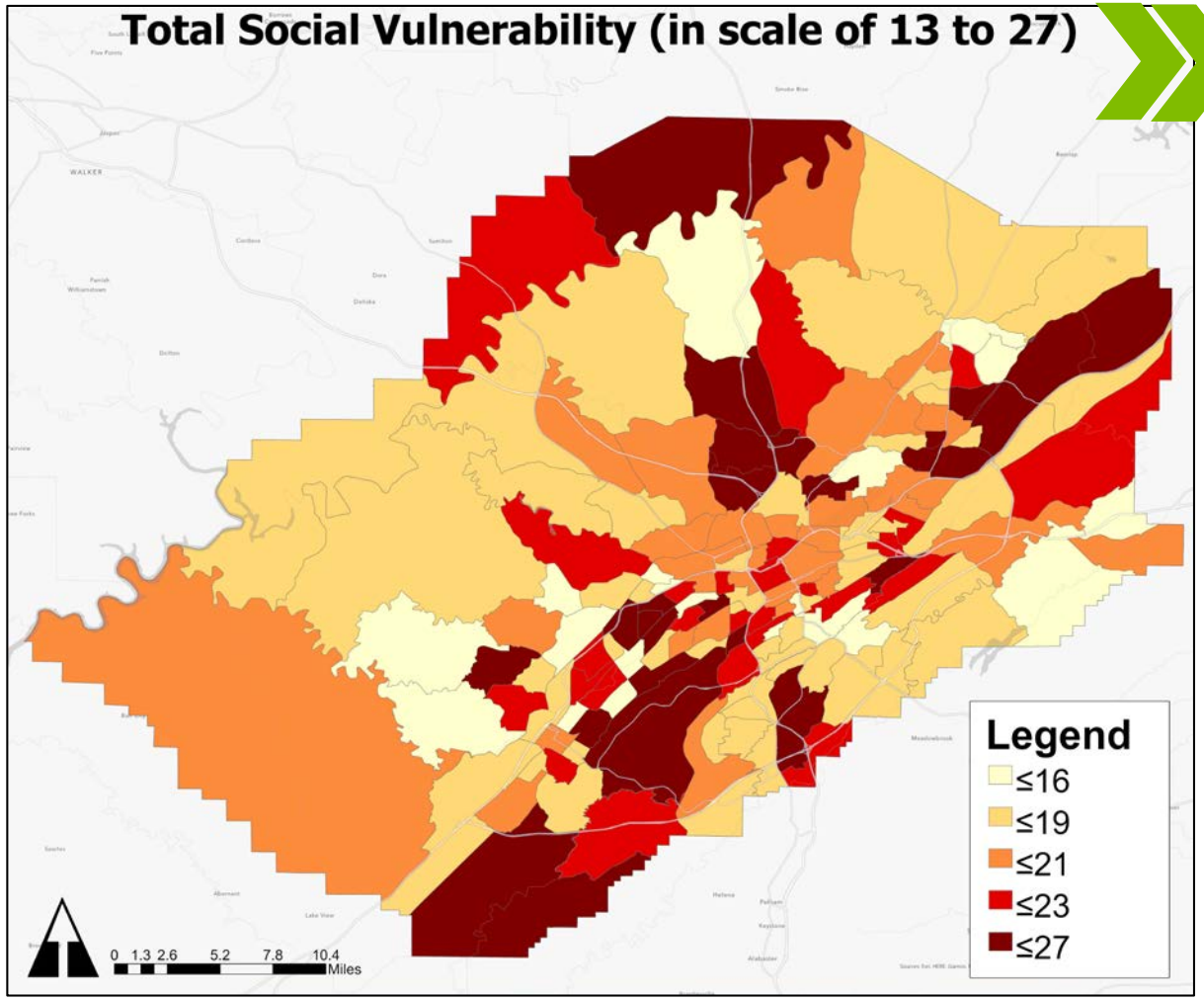
Principal Component Analysis

Factors reduction and merging → Risk mapping

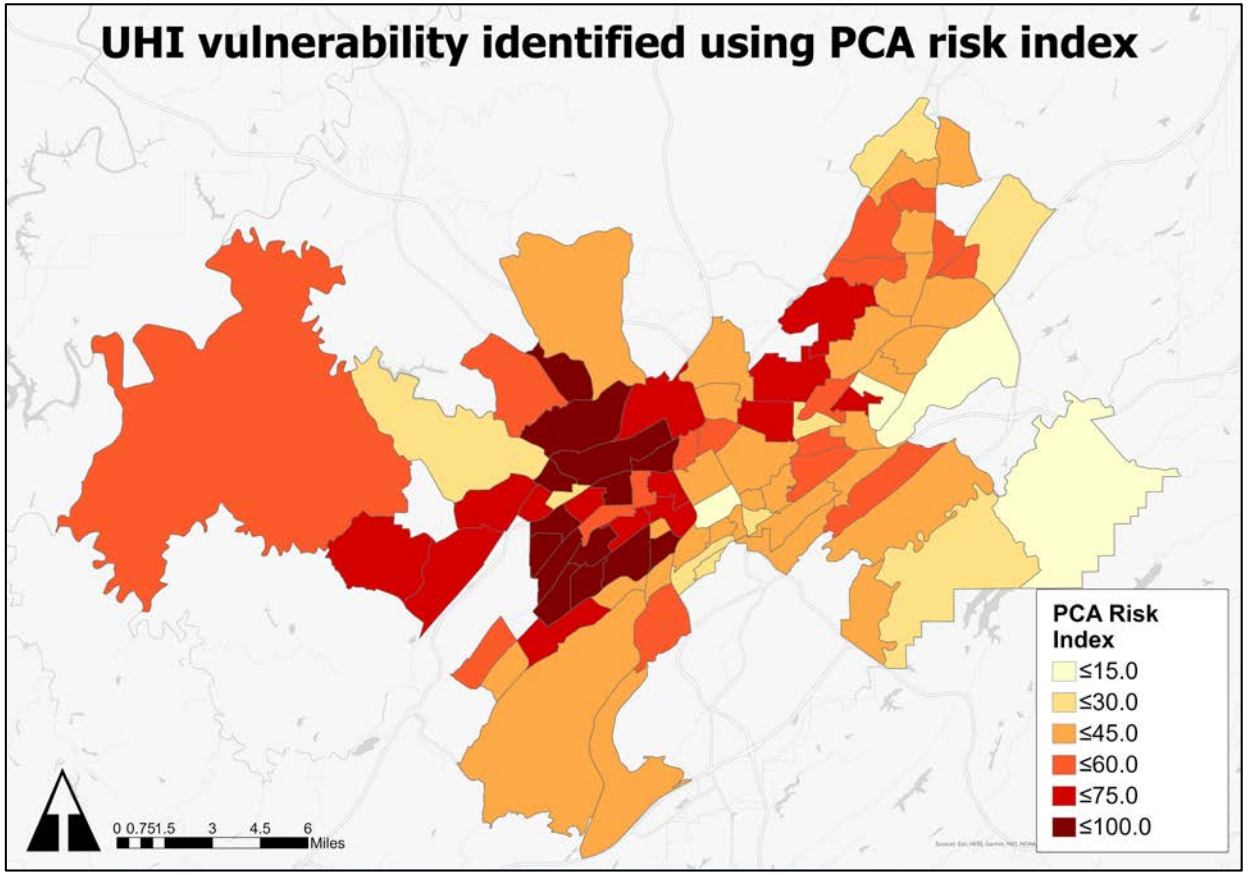
Jefferson County | Demographics



Social vulnerability to extreme heat

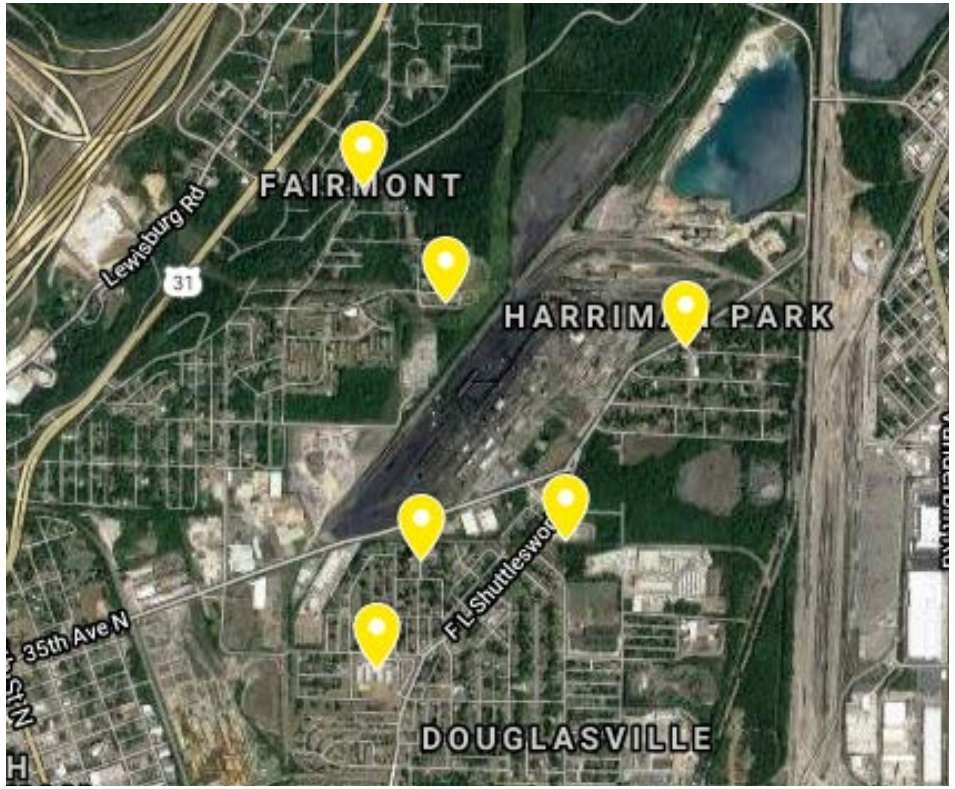


Principle component analysis (PCA) to model vulnerability in Birmingham city



Superfund site - Air Quality Monitoring

Benzene, Toluene, Ethylbenzene, Xylene, and Naphthalene



Calloway Elementary School

Hudson K-8 School School

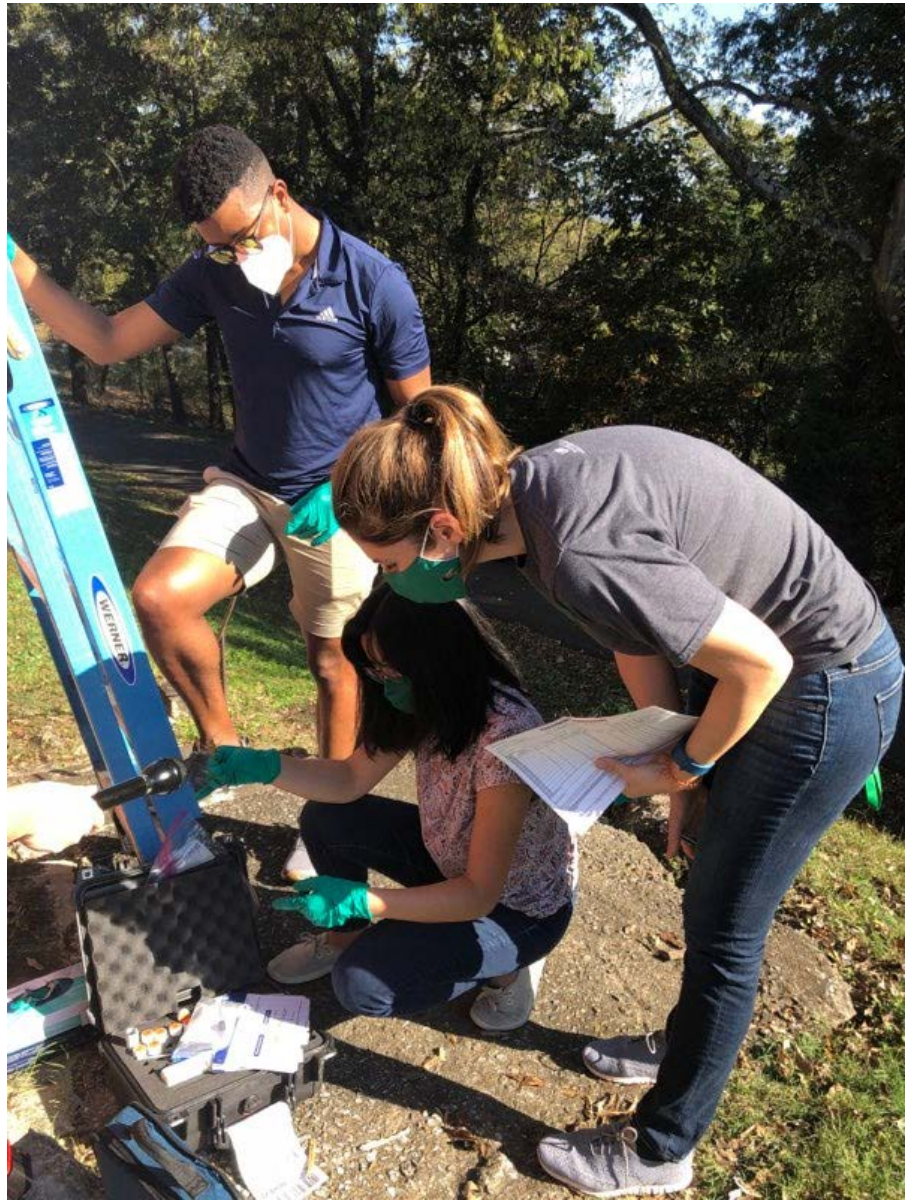
Reggins School

Sites:

- Reggins School
- Calloway Elementary School
- Shady Grove Baptist
- Resident's Home
- Hudson K-8 School
- St. Paul's Church

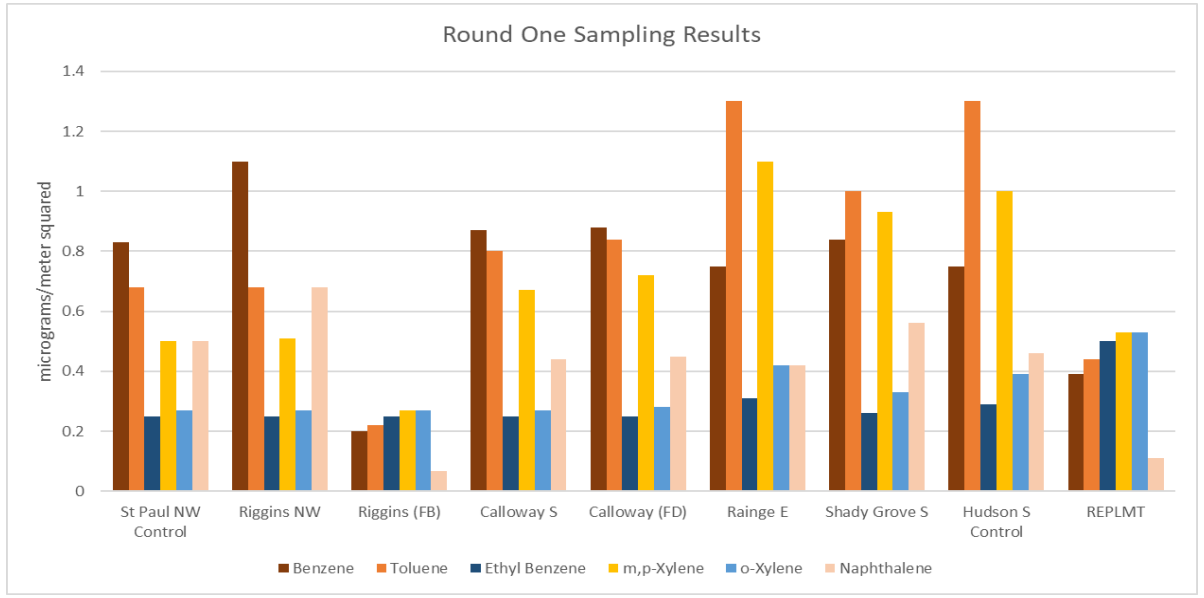
Sorbent Tubes& Shelter

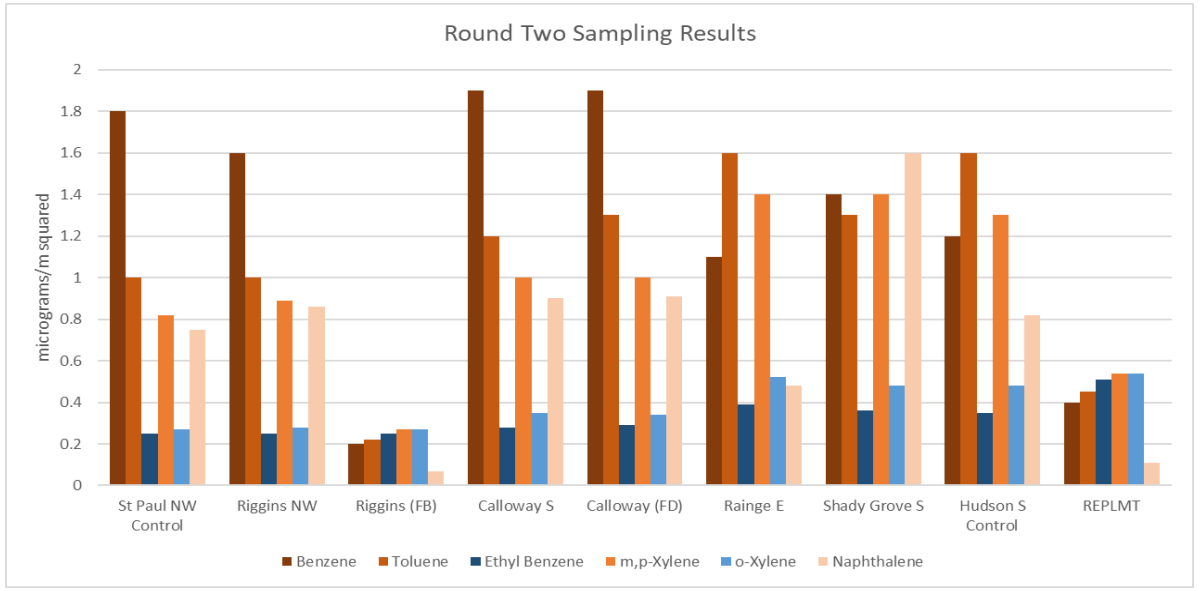
Sorbent Tubes Preparation and Setup

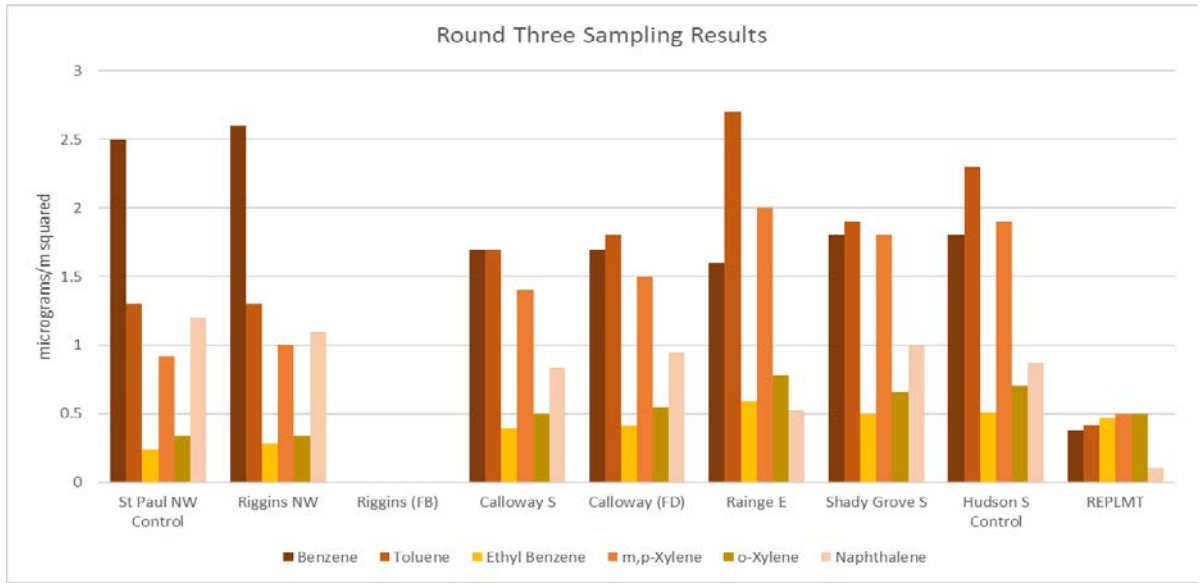


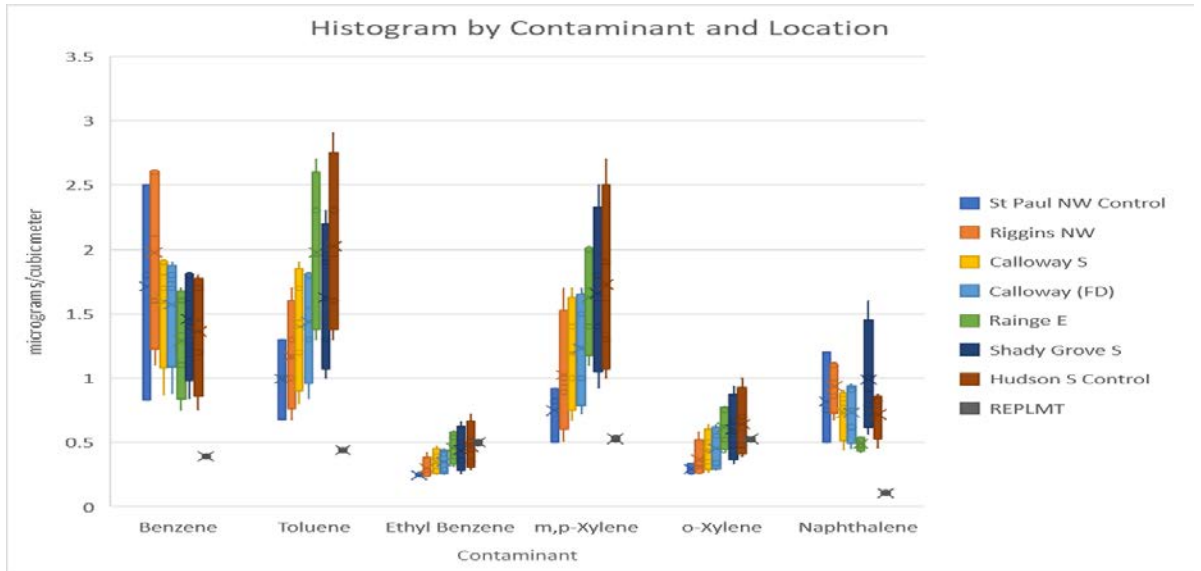
Switching out tubes every two weeks

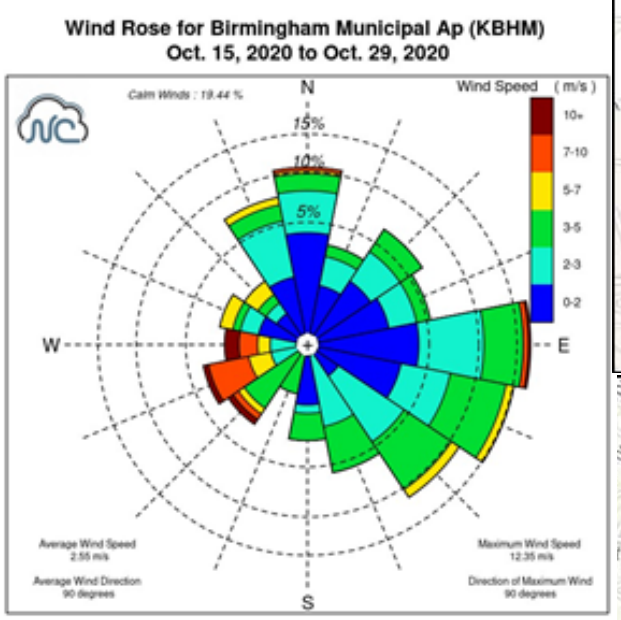
Three Rounds of Sample Analysis

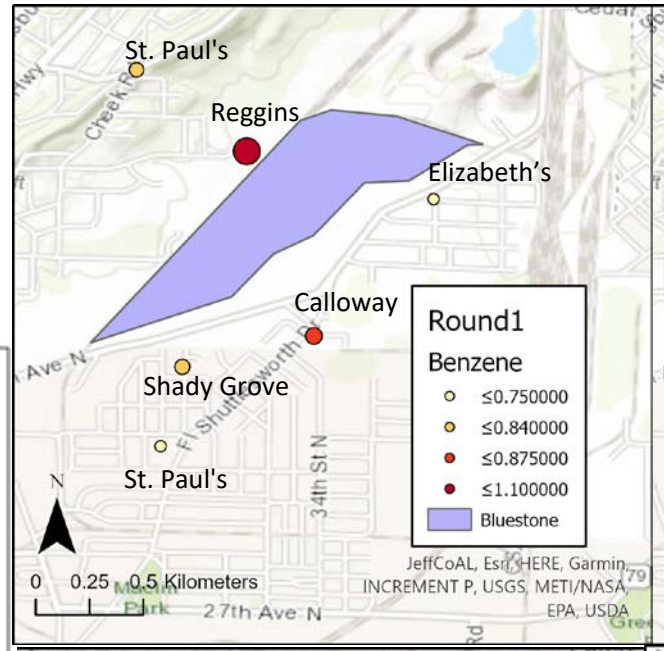


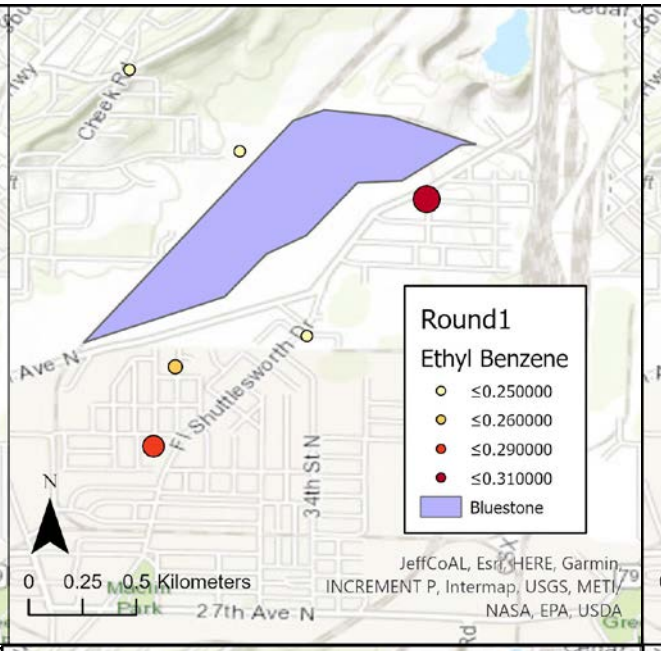


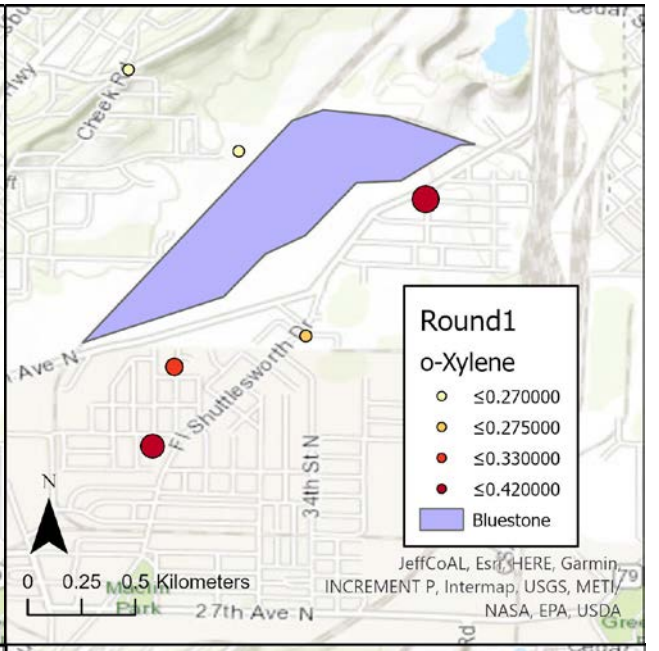


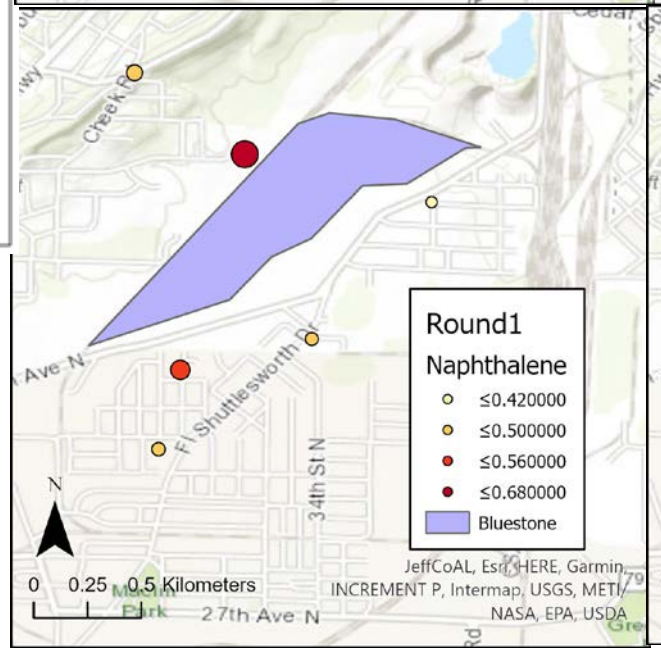


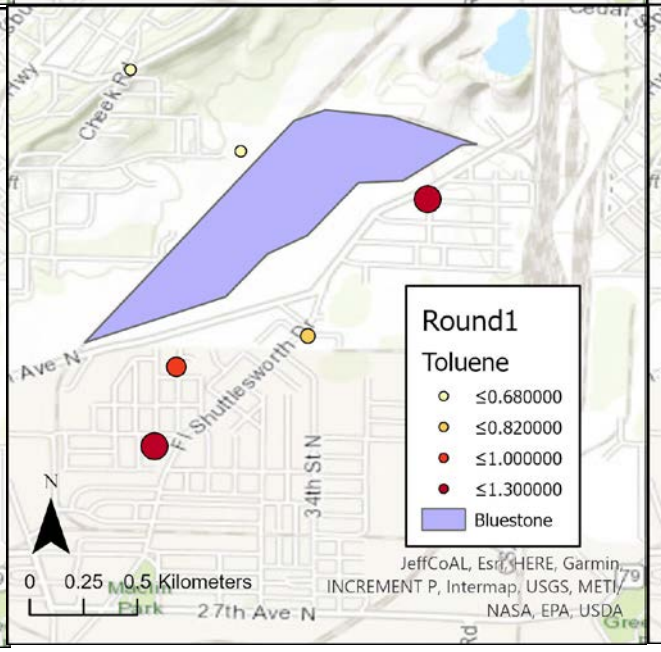


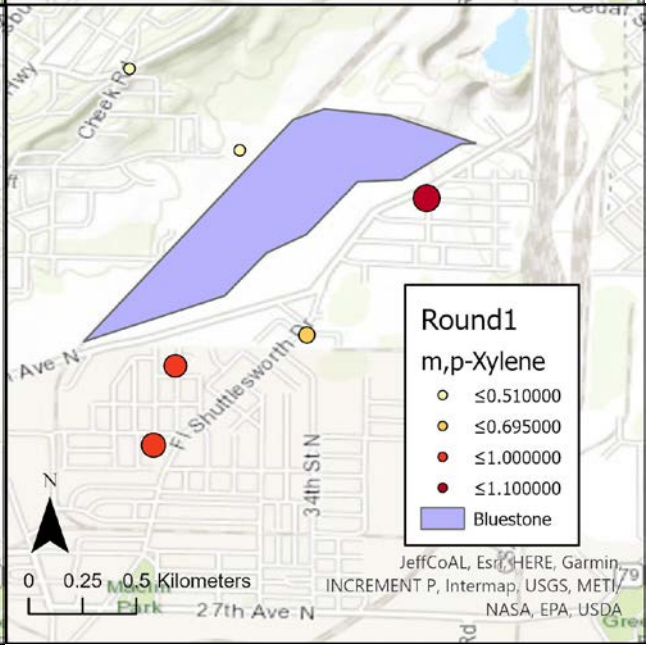


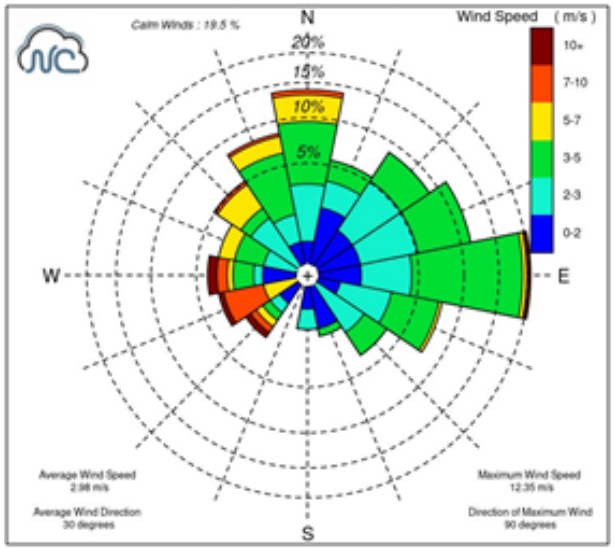


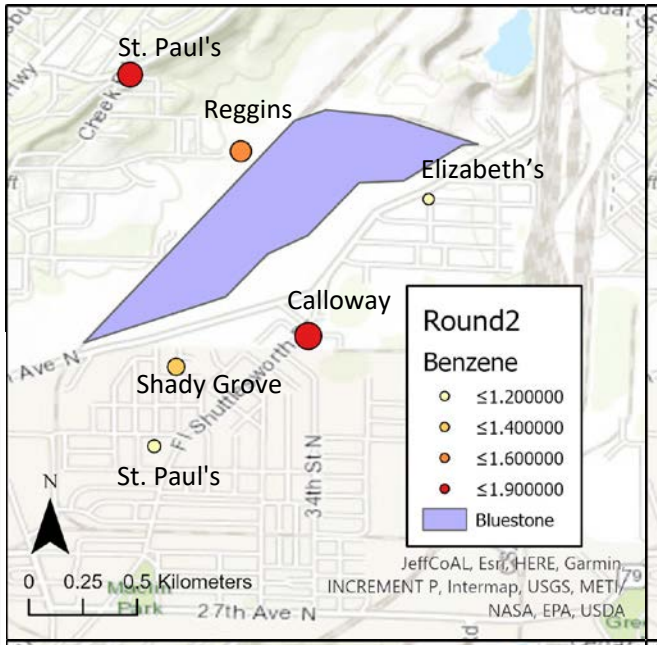


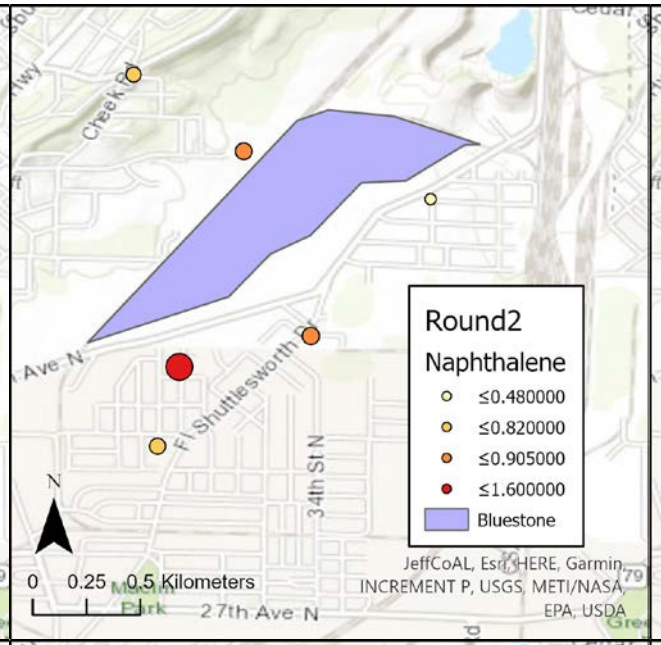


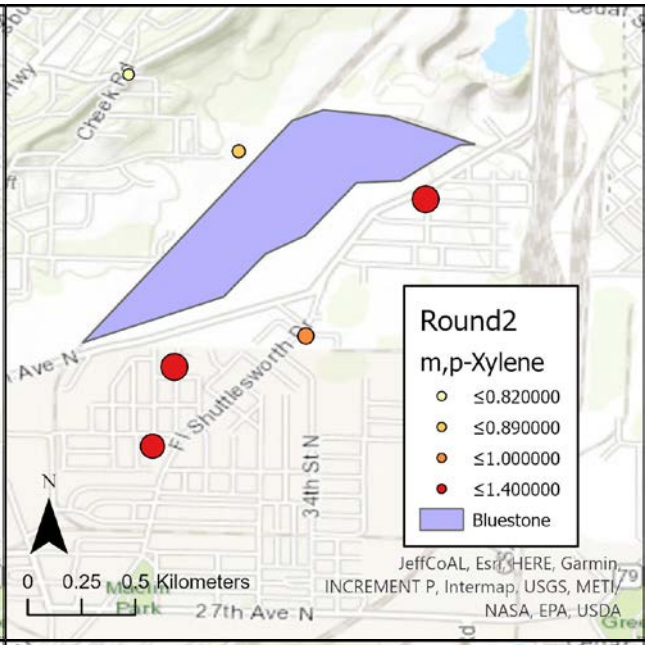


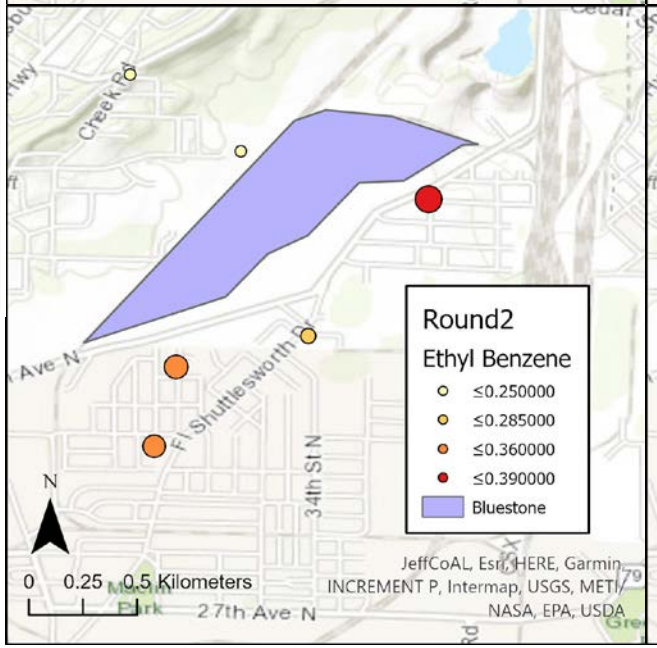


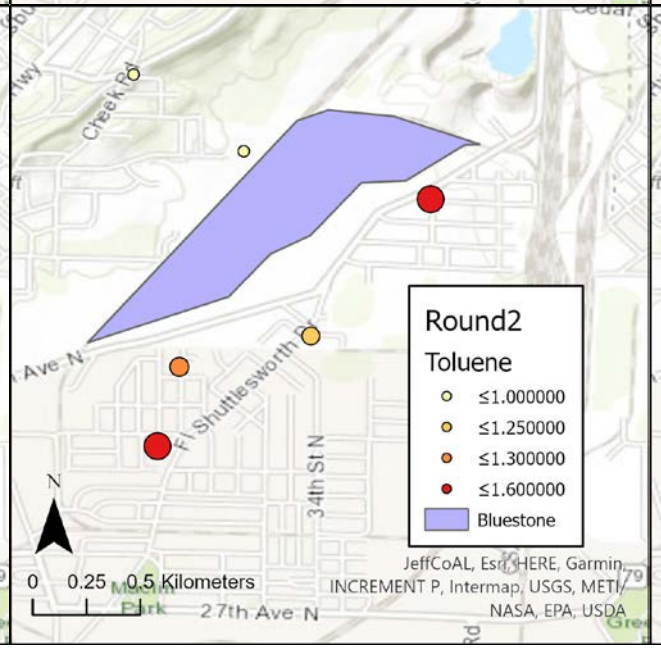


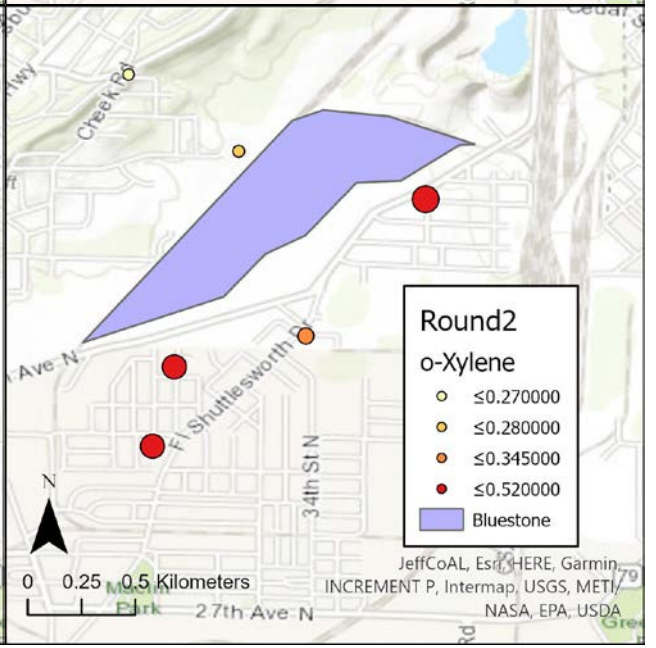




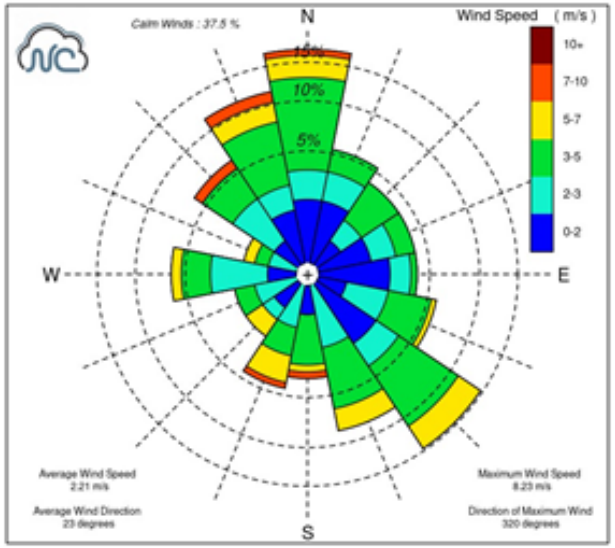


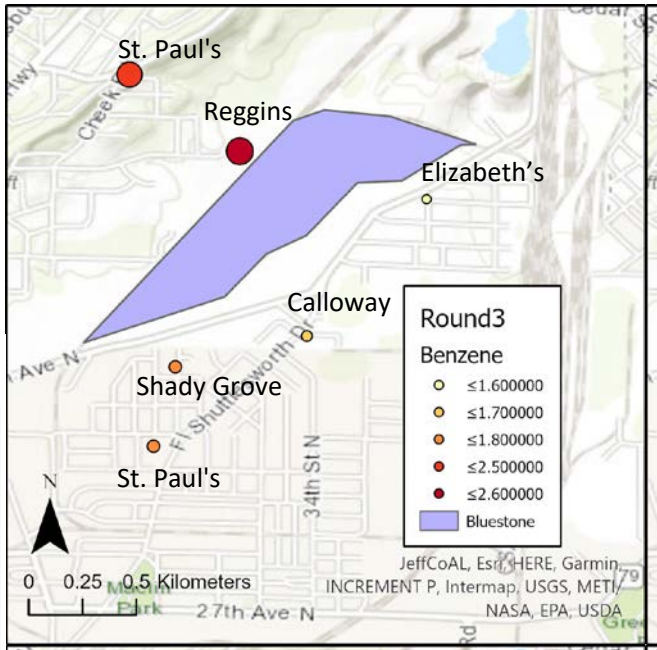


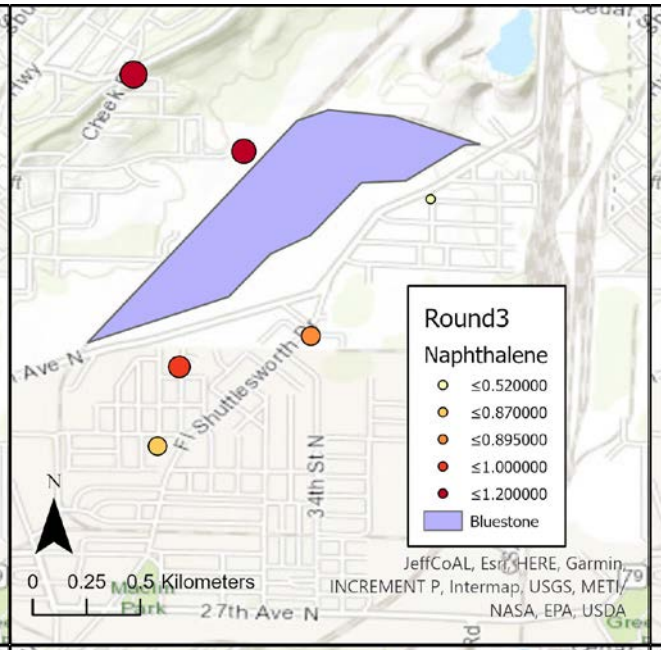


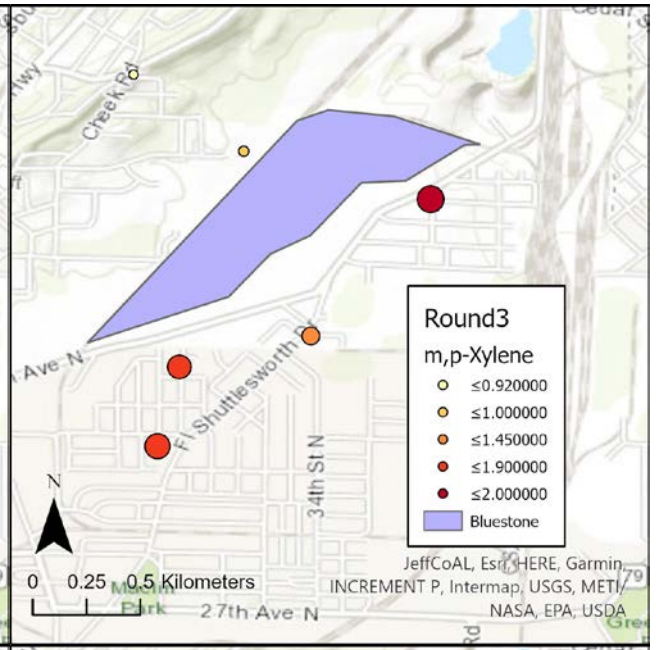


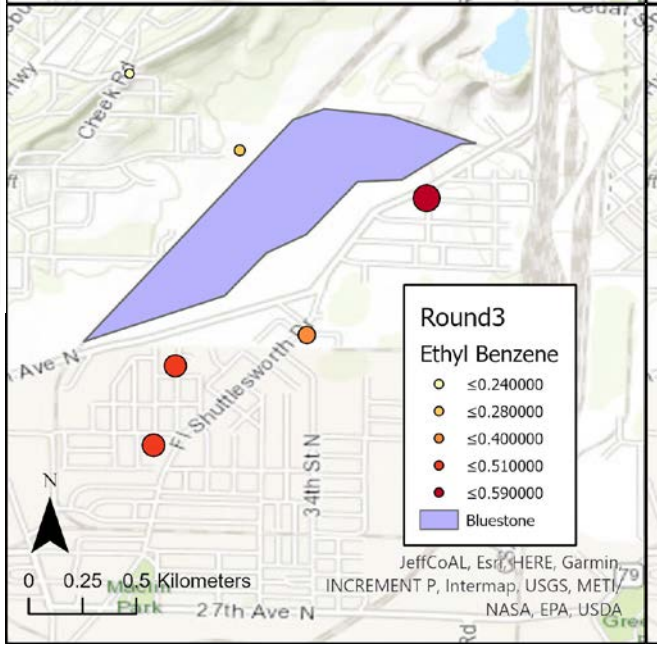
Wind Rose for Birmingham Municipal Ap (KBHM)
Nov. 12, 2020 to Nov. 27, 2020

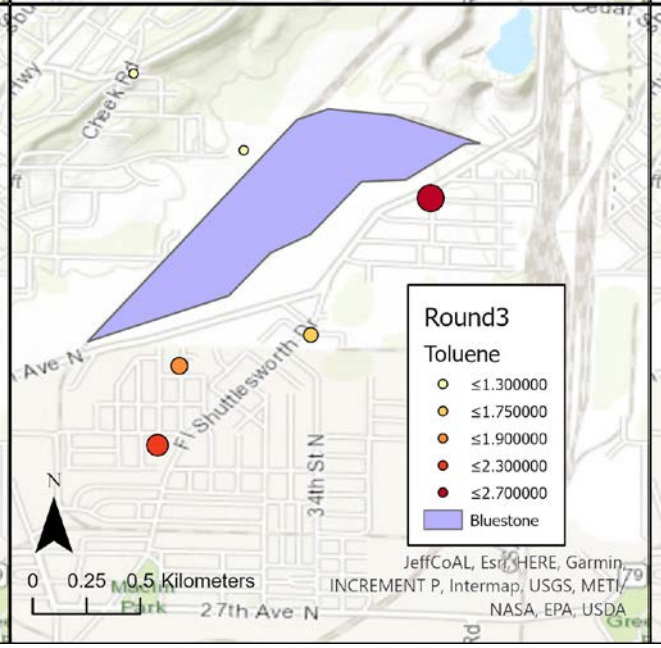


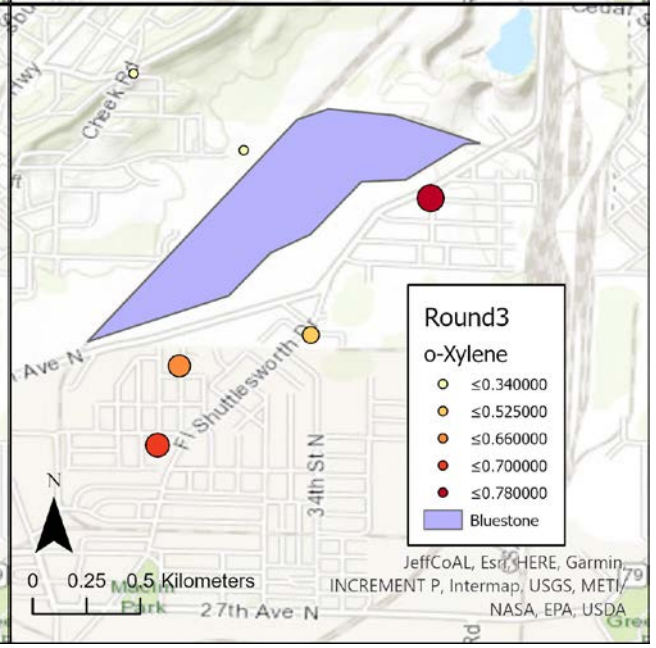




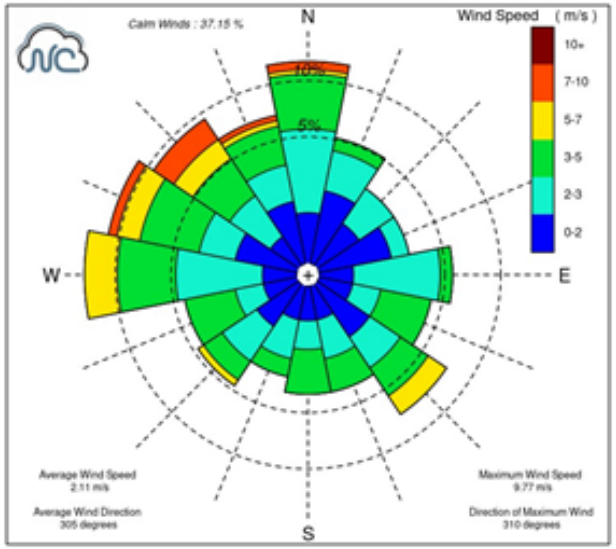


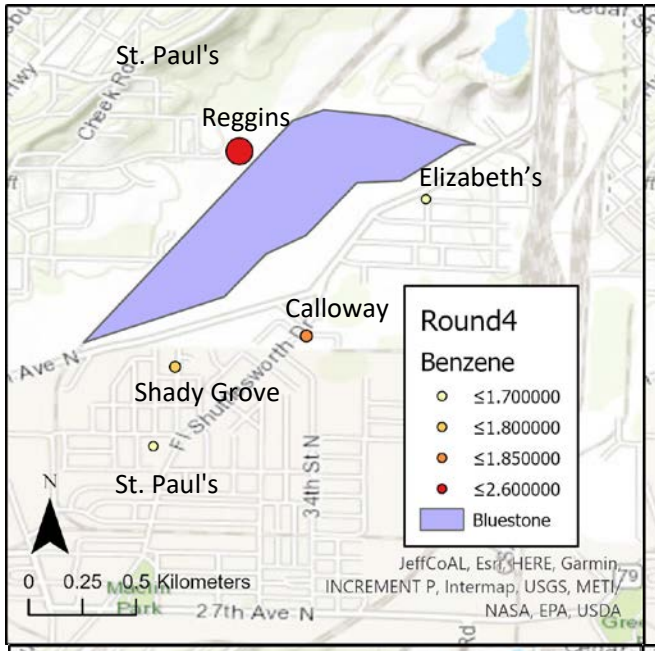


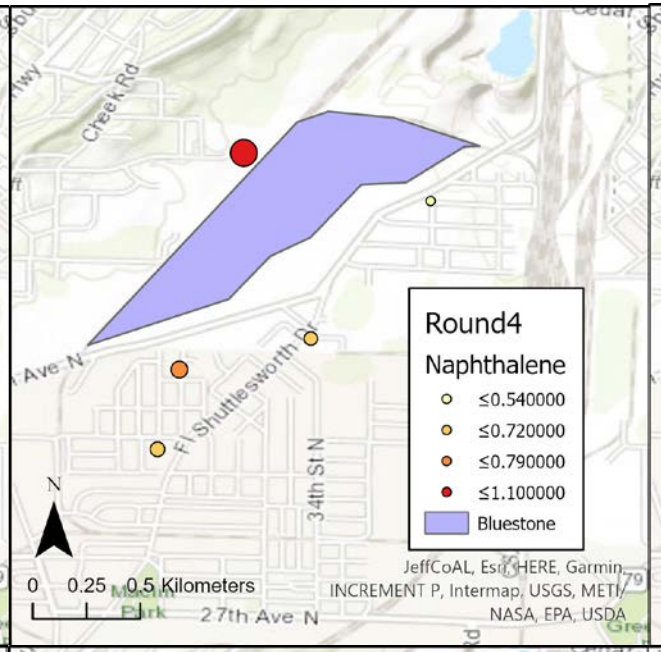


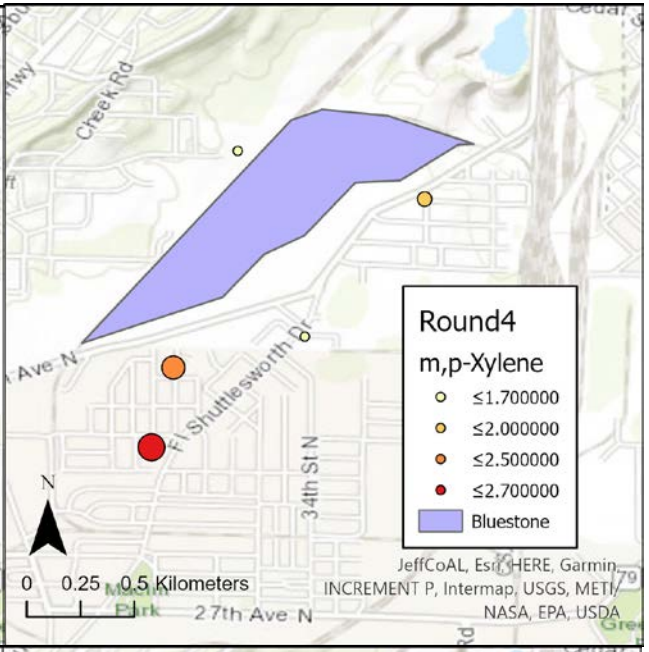


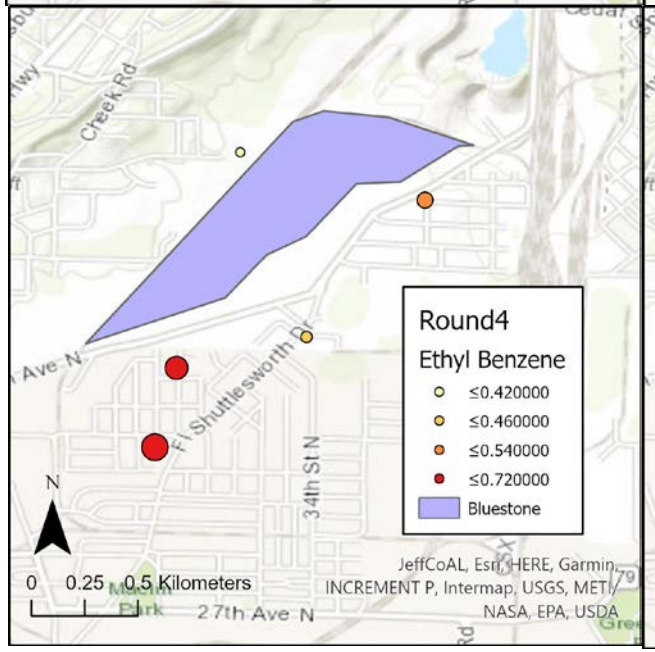
Wind Rose for Birmingham Municipal Ap (KBHM)
Nov. 27, 2020 to Dec. 11, 2020

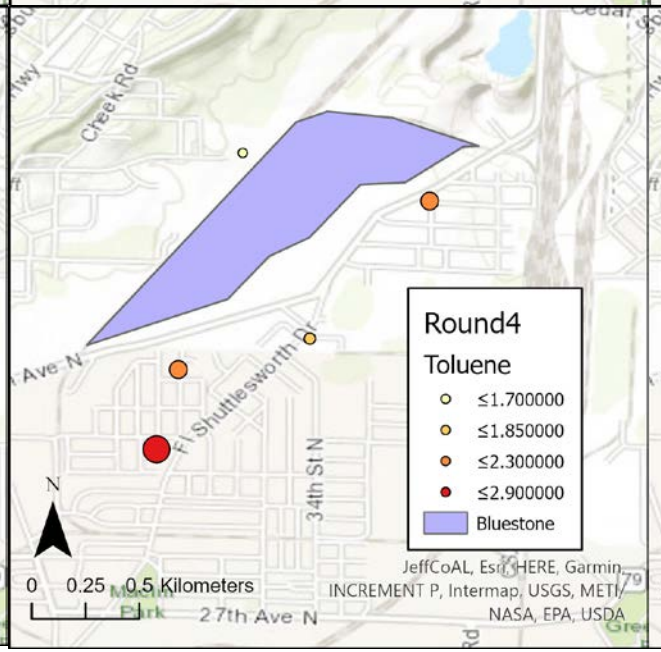


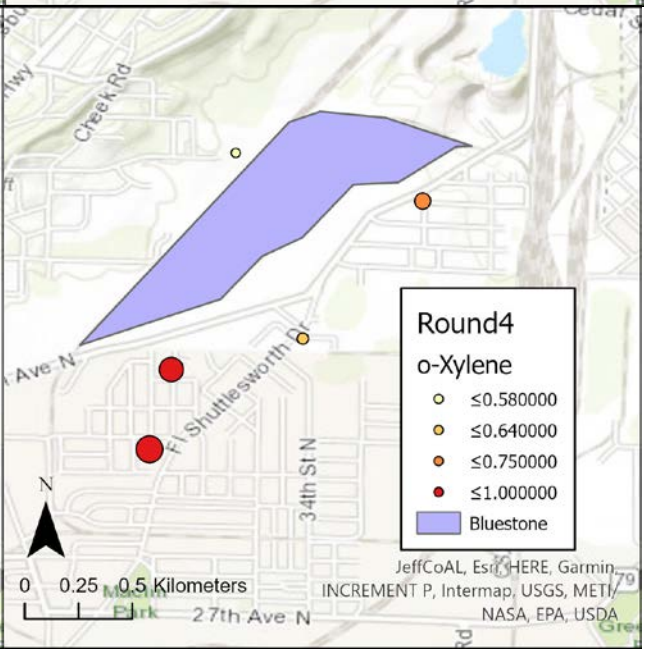










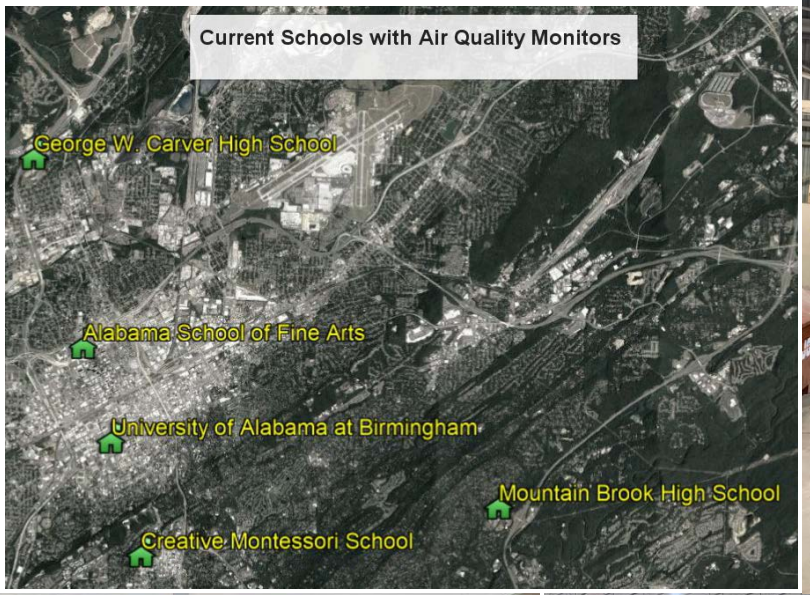


Birmingham Air Quality Monitoring

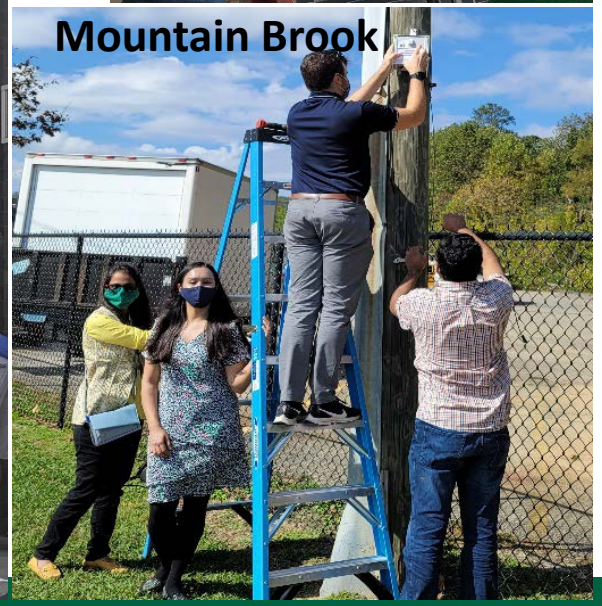
CO2, PM 1-10, SO2, O3, Temp, RH, Dew Point

Sites:

- George Carver High School
- Alabama School of Fine Arts
- Mountain Brook High School
- UAB School of Public Health
- Creative Montessori School-Homewood



UAB Utilities building the mounting device



THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

Thank you!

Questions?