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Using Remotely Sensed Data and GIS Tools to Characterize Living Environments for Evaluation with Blood Pressure Data

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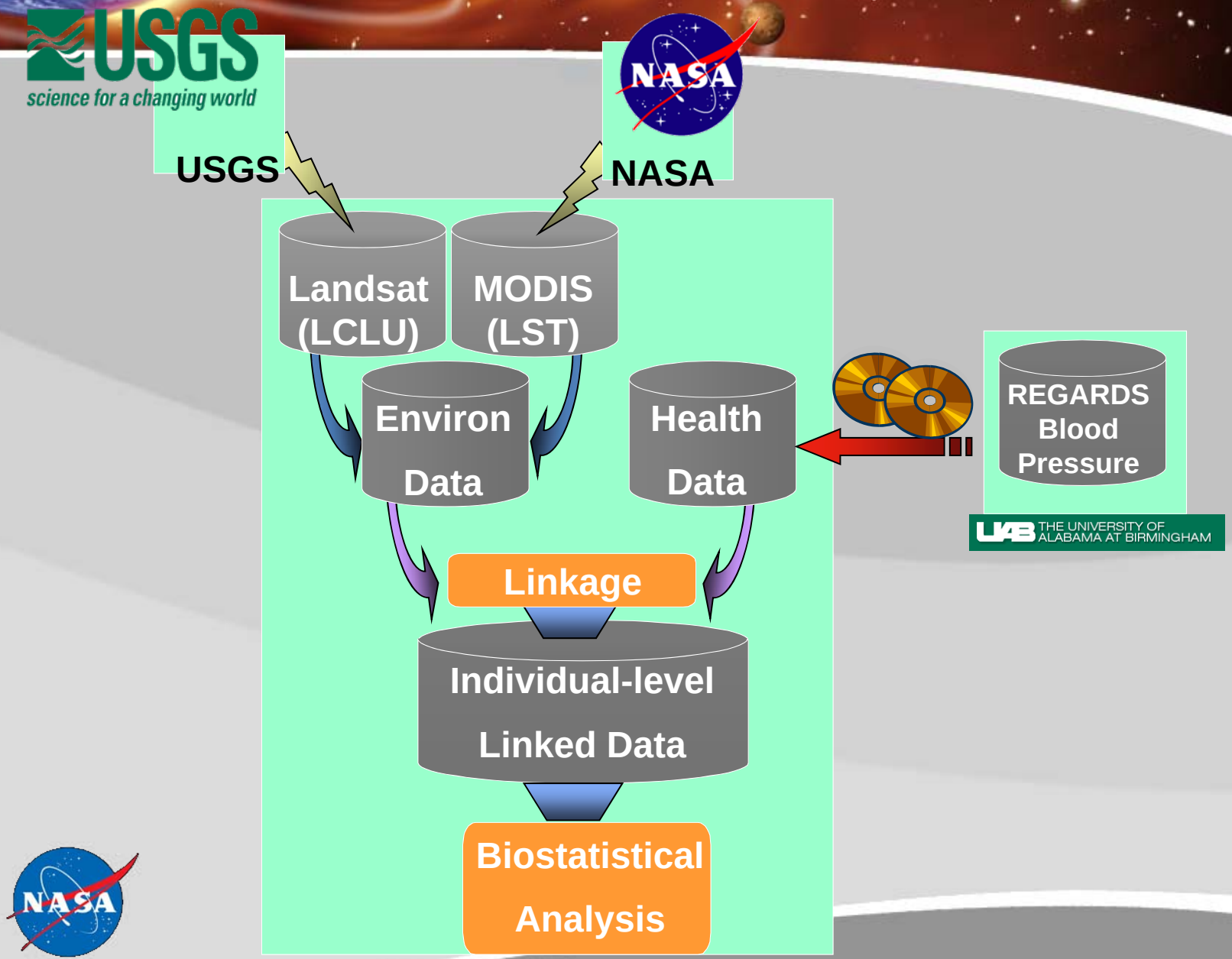
Objectives

- Examine the relationship between living environment (urban, suburban, and rural) residents and blood pressure (measured as both Systolic (SBP) and Diastolic (DBP))
  - Hypothesis: Residents living in urban environments, as opposed to suburban or rural environments, will be associated with an increase in blood pressure.
- Examine land surface temperature changes for each category of living environment to validate classification and determine if higher LST is associated with higher blood pressure

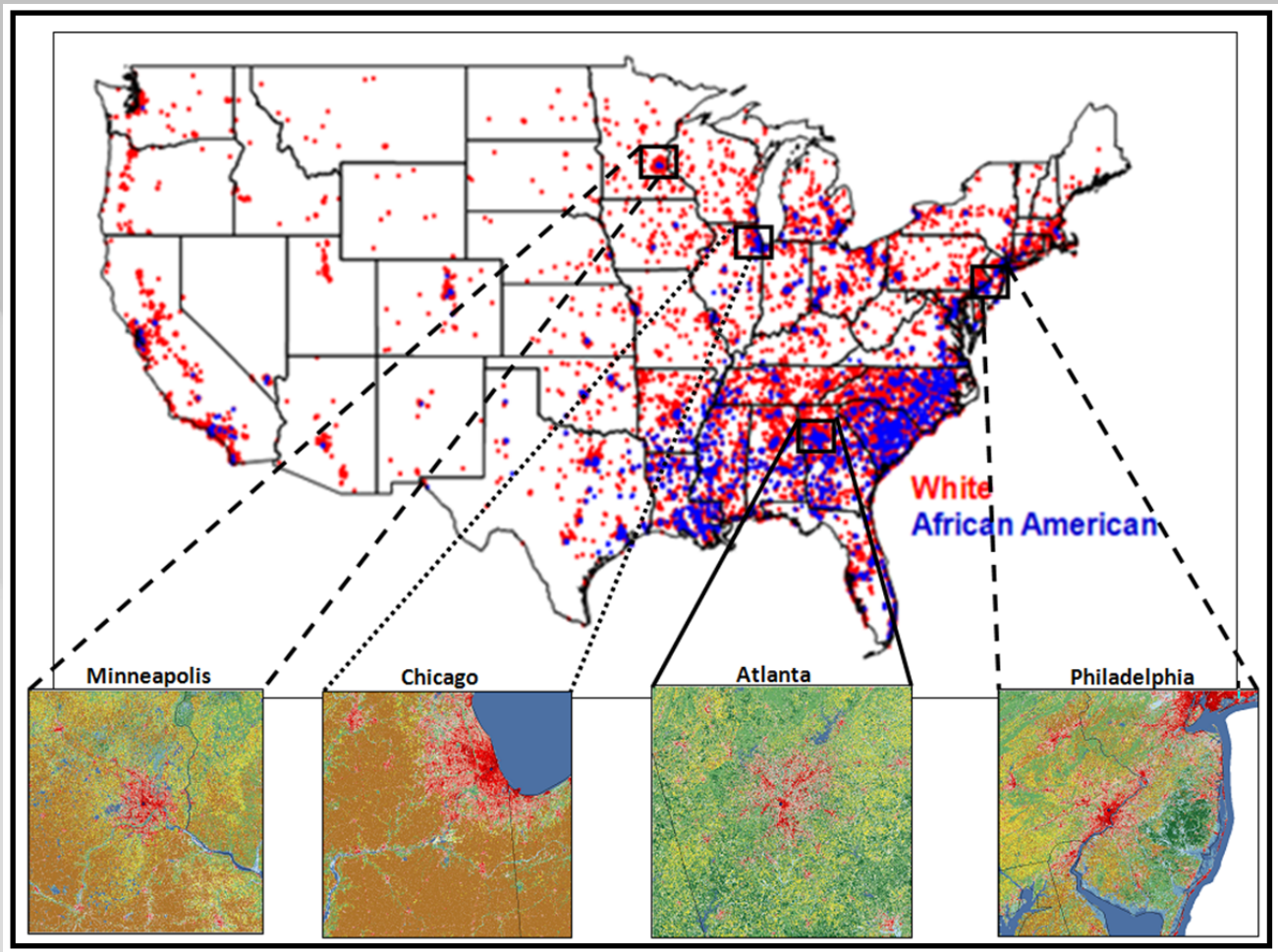
Data Linkage



REasons for Geographic And Racial Differences in Stroke (REGARDS) Study Population

- Longitudinal population-based cohort of over 30,000 volunteers age 45 and older
- Completed In-Home Participants on February 1st, 2007)
- Racial representation
  - 50% African American
  - 50% white
- Sex representation
  - 50% male
  - 50% female
- Geographic representation
  - 20% from the buckle of the stroke belt
  - 30% from the stroke belt
  - 50% from the rest of the contiguous US

Study Areas and Landsat-derived NLCD



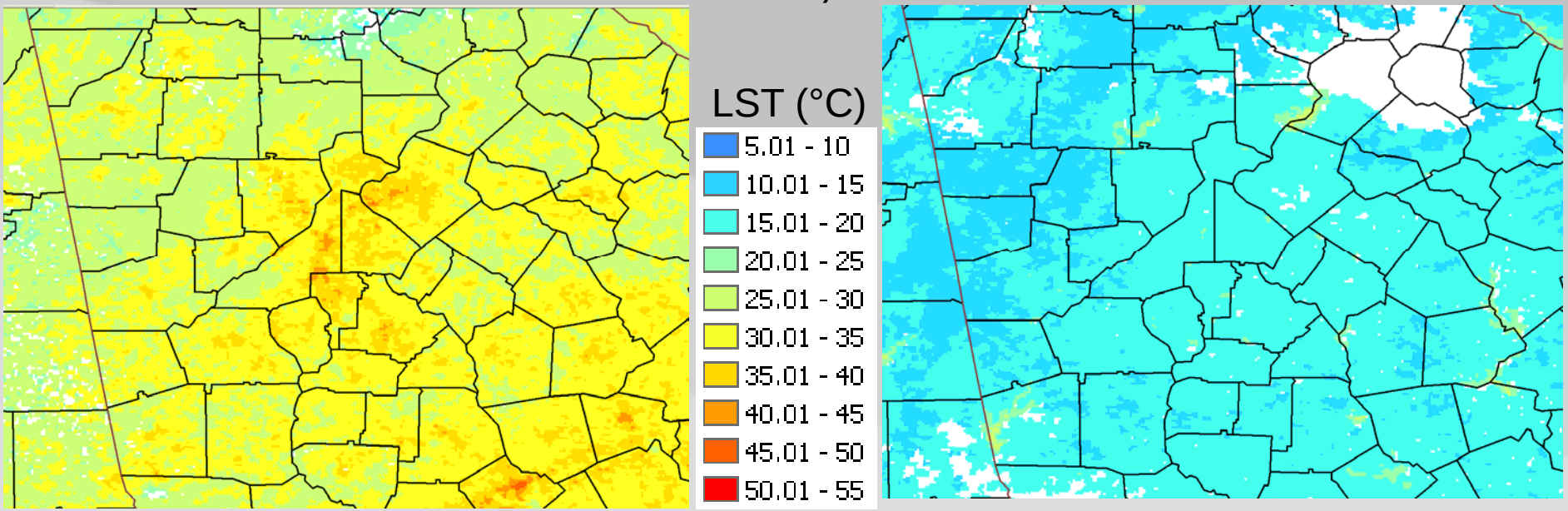
Landsat-derived NLCD 2001

- Open Water
- Perennial Ice/Snow
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land (Rock/Sand/Clay)
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands

NASA MODIS Land Surface Temperature (LST)

- A 1-km spatial resolution
- Daytime and nighttime observations
- Clear-sky coverage only

Atlanta, GA



Day (1:30 PM)

August 01, 2004

Night (1:30 AM)

Challenges

- Development of a methodology to delineate LCLU classes into rural, suburban, and urban living environments and evaluate it

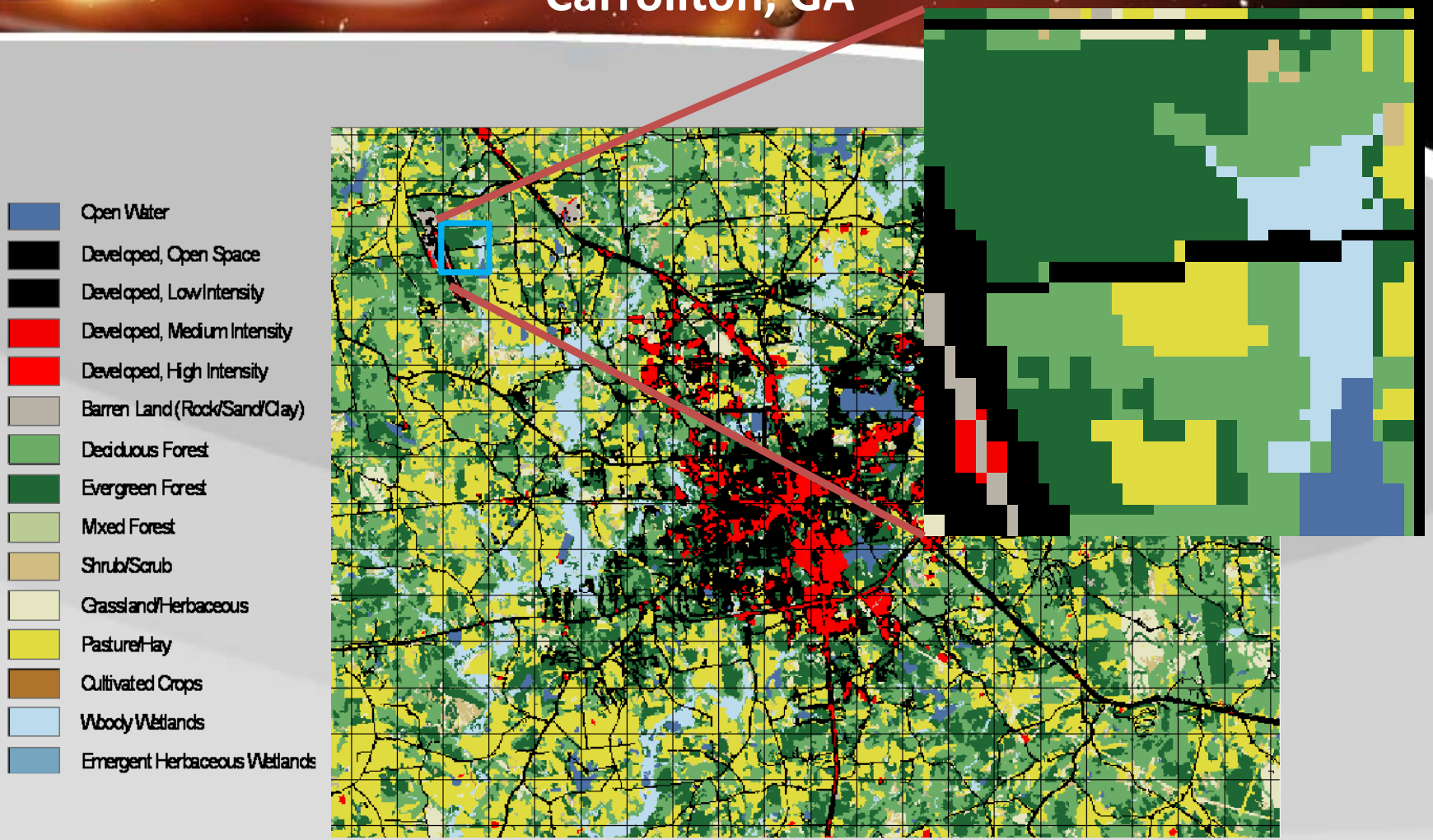
- Linkage of REGARDS data with classifications

Spatial Resolution and Resampling Methods

- People don’t live in a (30 m x 30 m) box
- Resampled NLCD to 1 km and 3 km
- Standard Resampling Methods
  - Bilinear Interpolation **(Numeric Data)**
  - Cubic Convolution Interpolation **(Numeric Data)**
  - Nearest Neighbor **(Nominal Data)**

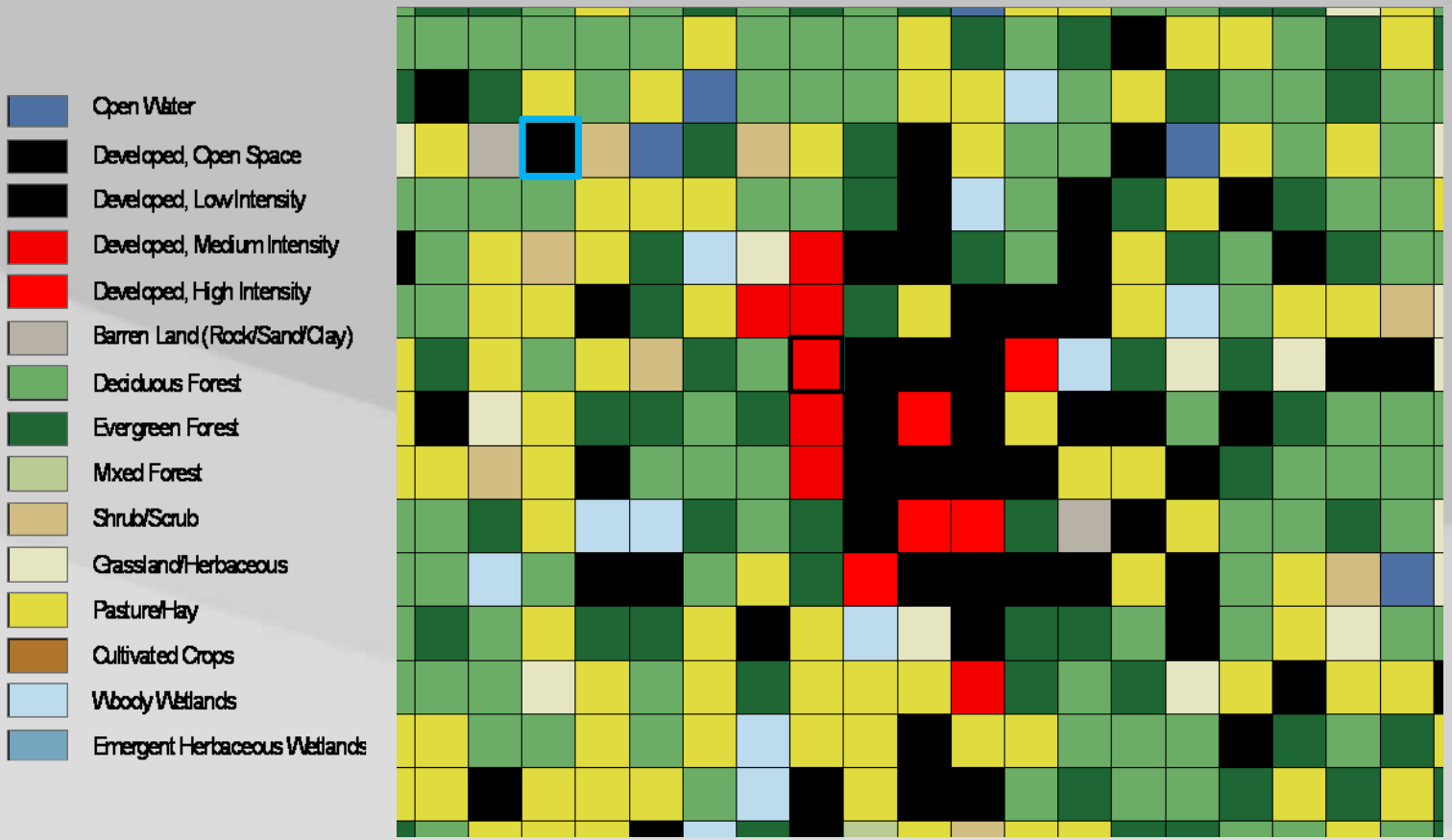
2001 NLCD 30 m

Carrollton, GA



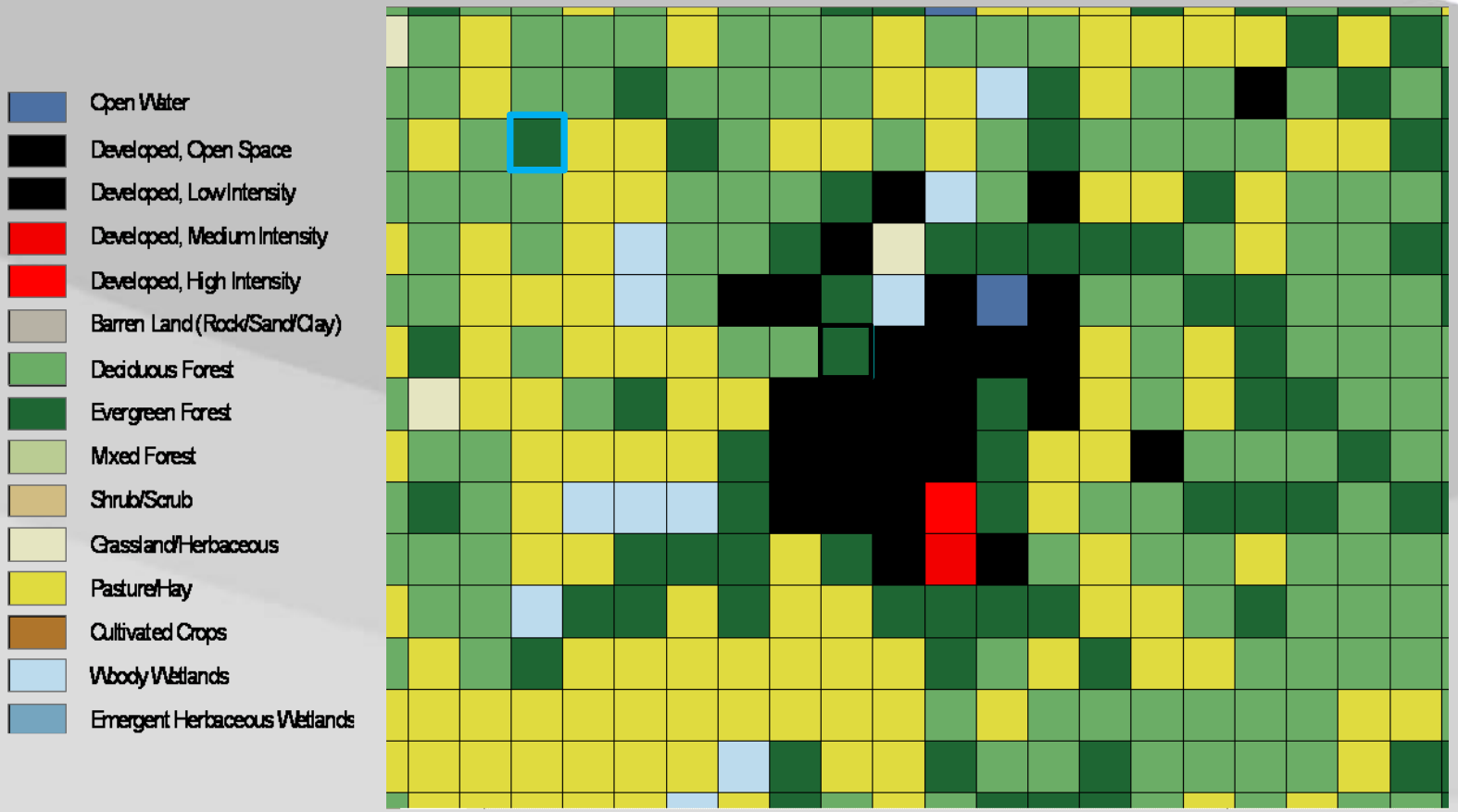
2001 NLCD Resampled 1 km (Nearest Neighbor Method)

Carrollton, GA



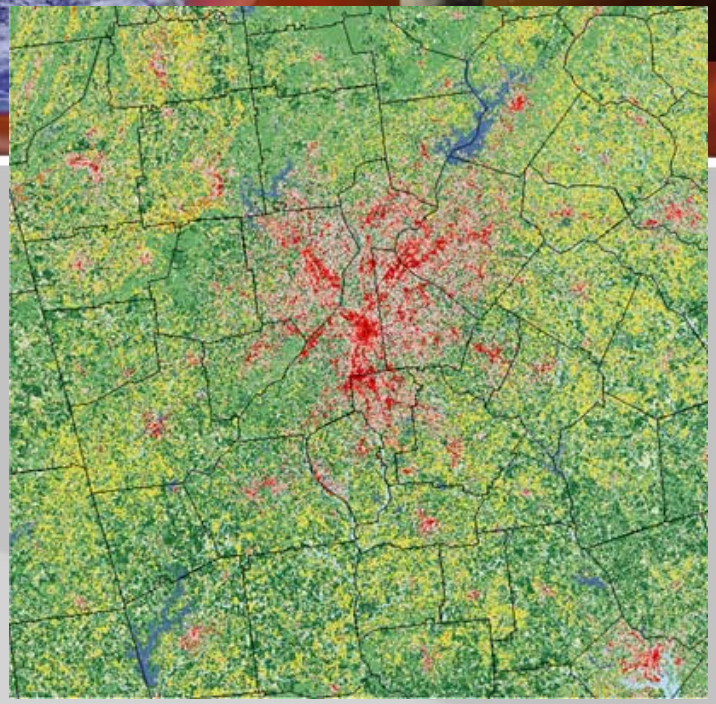
2001 NLCD Resampled 1 km (Dominant Class Method)

Carrollton, GA



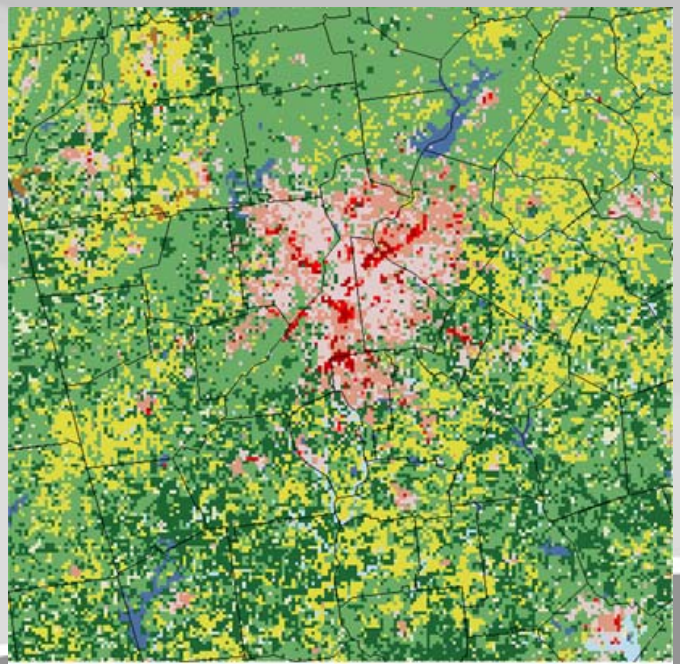
Atlanta, GA

Raw Resolution (30m)



Nearest Neighbor (1km)

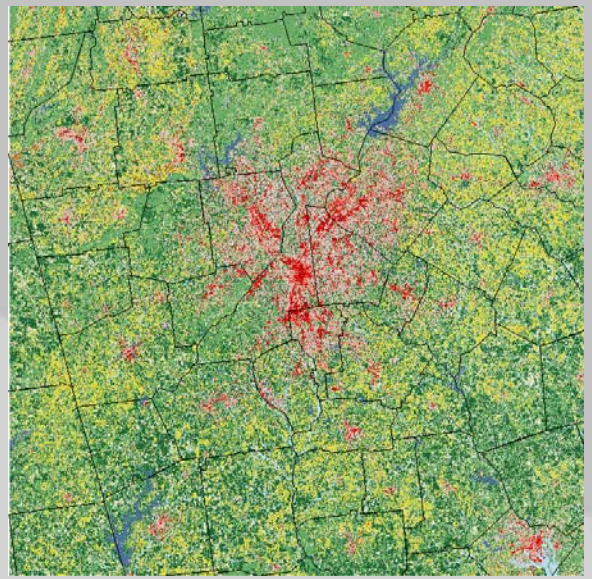
- Open Water
- Perennial Ice/Snow
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land (Rock/Sand/Clay)
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands



Most Dominant Class (1km)

Resampling and Urban, Suburban, Rural Delineation Methodology

Atlanta, GA



30-m NLCD

- Open Water
- Perennial Ice/Snow
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land (Rock/Sand/Clay)
- Deciduous Forest
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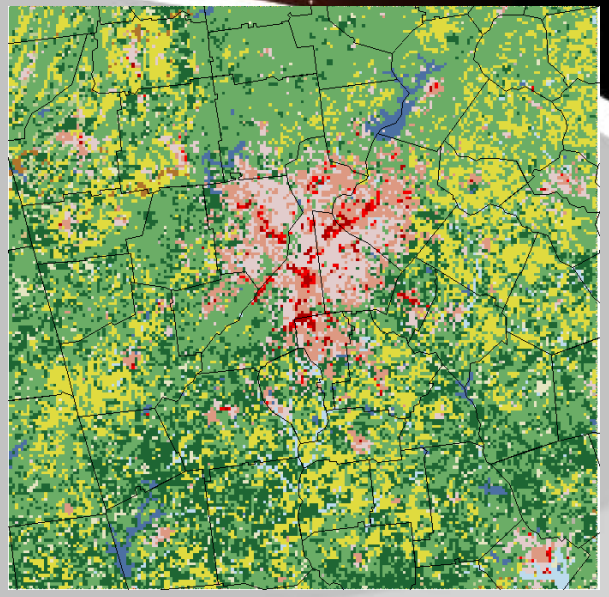
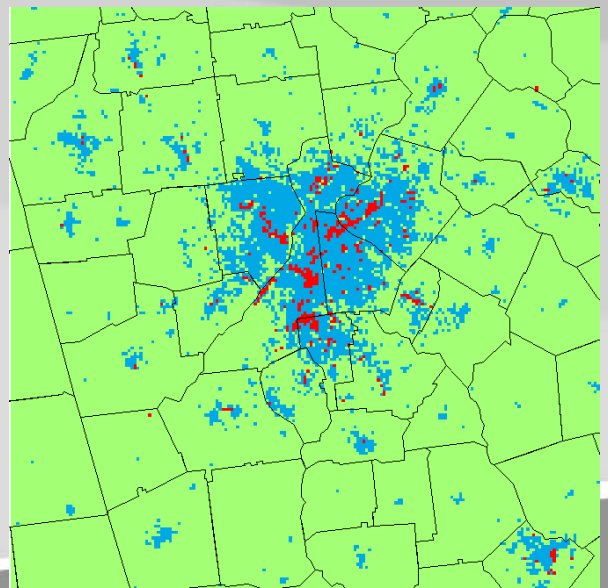


1-km resampled NLCD

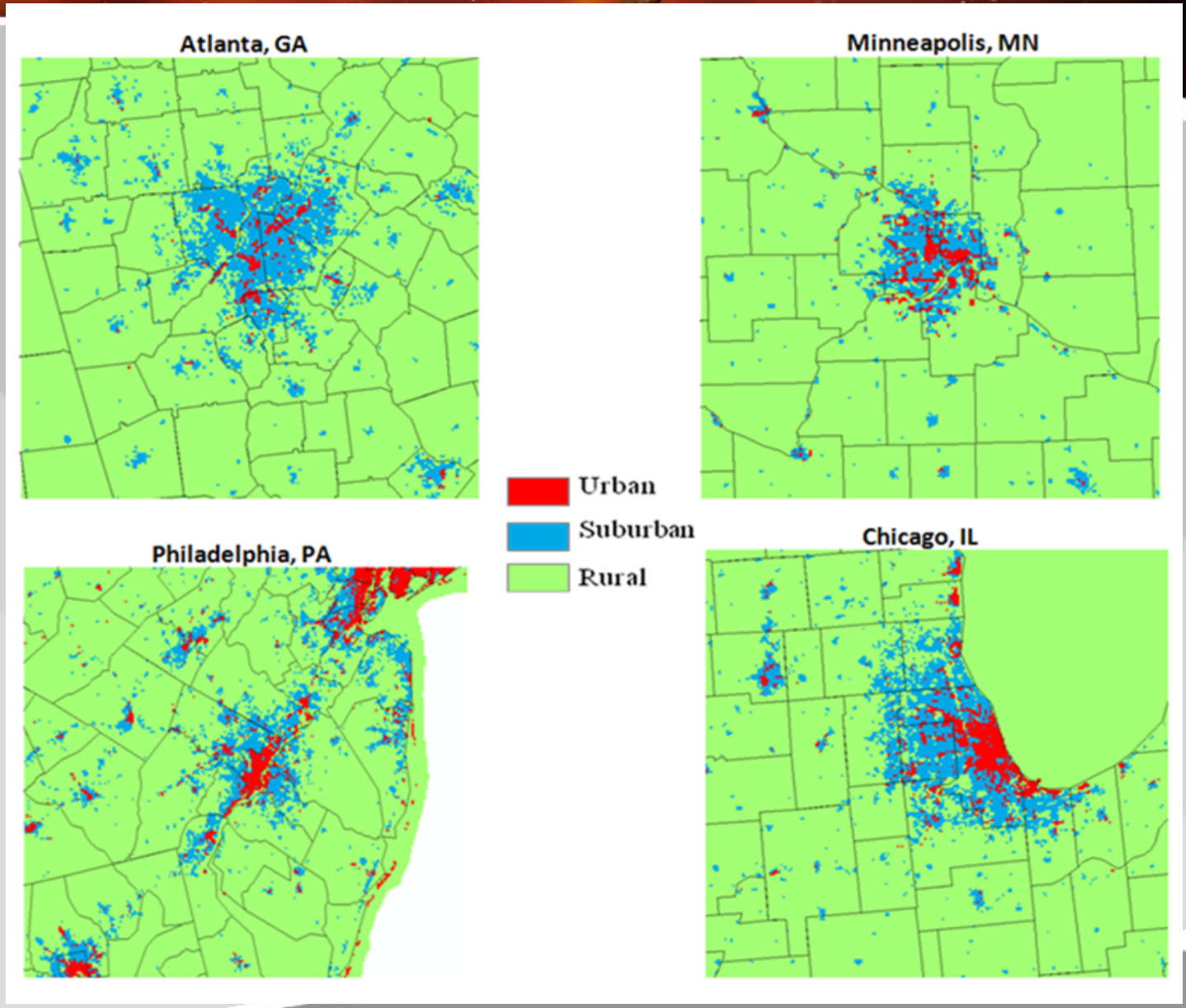


0 km 100 km

N

Urban	Developed High Intensity or Developed Medium Intensity
Suburban	Developed Low Intensity or Developed Open Space
Rural	Others

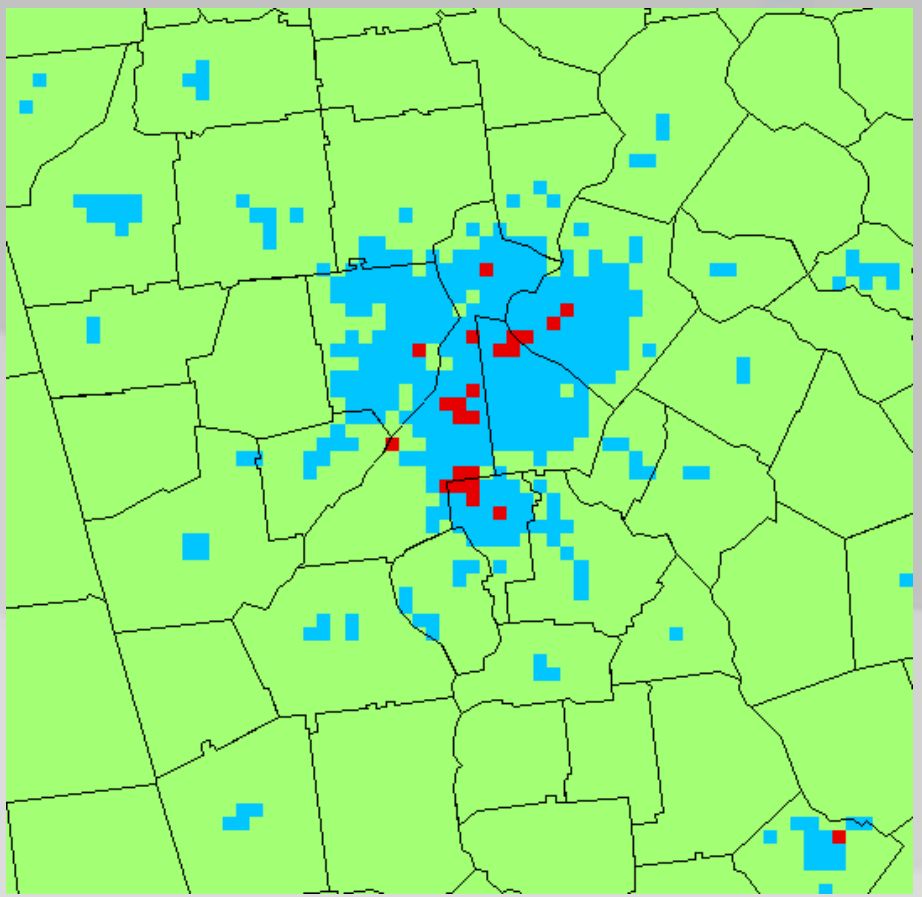
Landsat-derived Living Environment Categories at 1 km

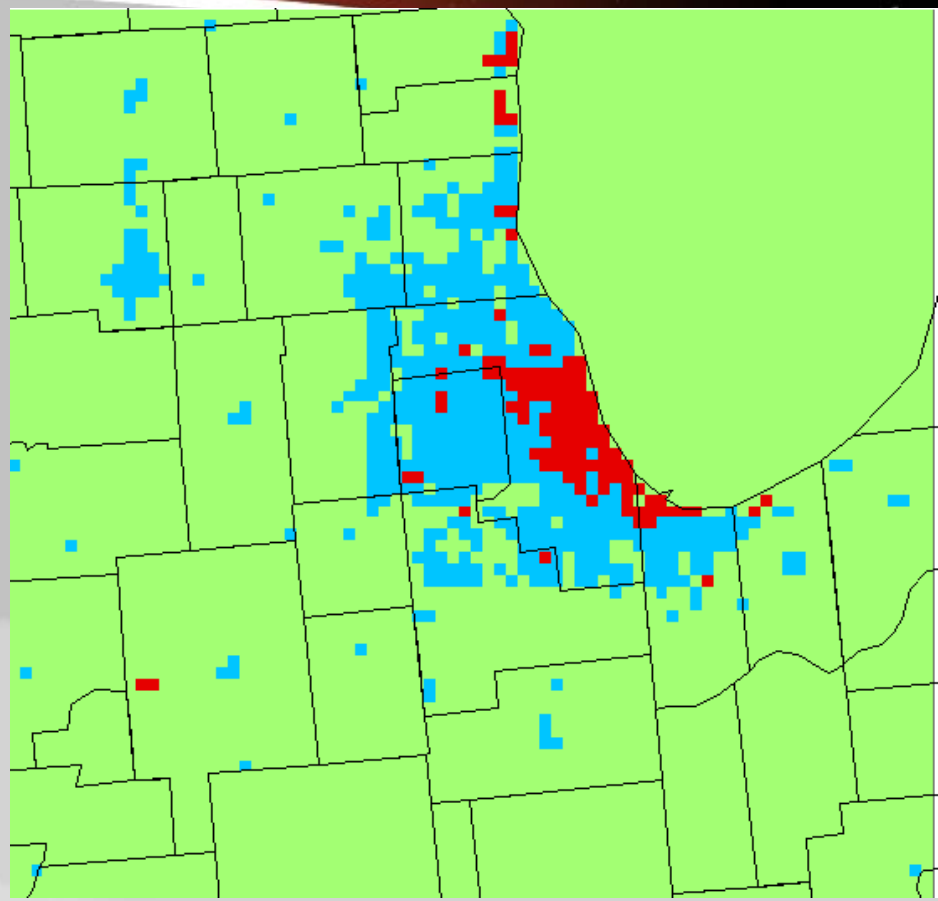


Landsat-derived Living Environment Categories at 3 km

Atlanta

Chicago





N

0 km

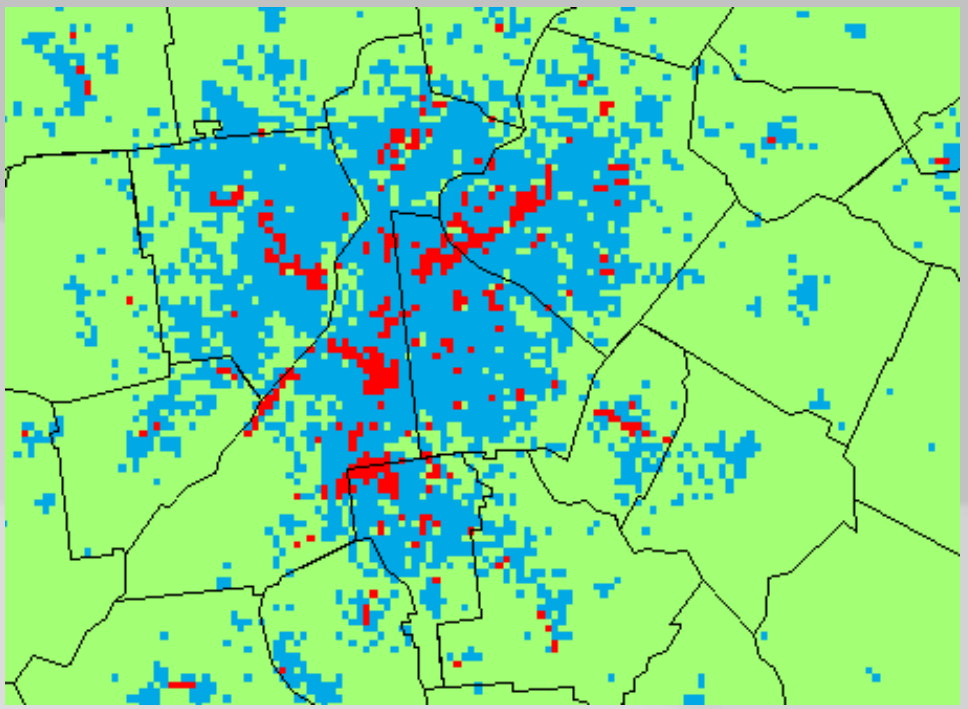
100 km

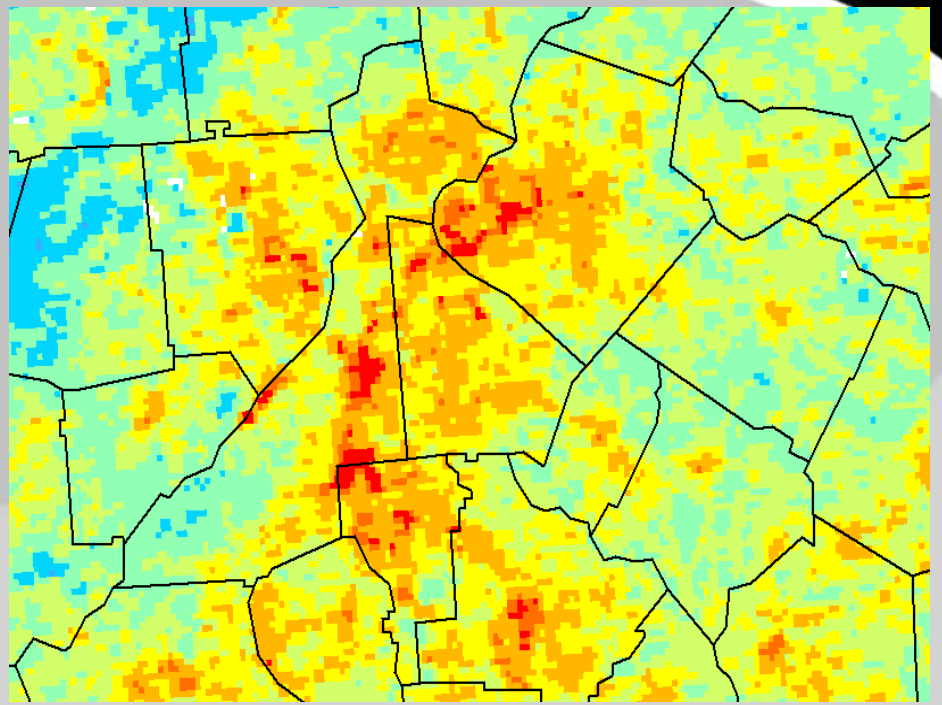
Urban

Suburban

Rural

Living Environment Category vs. LST (At 1 km Spatial Resolution)





Living Environment Category

- Urban
- Suburban
- Rural

LST (°C)

- 0.00 - 20.85
- 20.86 - 24.66
- 24.67 - 27.21
- 27.22 - 29.75
- 29.76 - 32.3
- 32.31 - 34.84
- 34.85 - 38.66
- 38.67 - 40
- 40.01 - 51.39

August 01, 2004

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Linkage of Environmental and Health Data

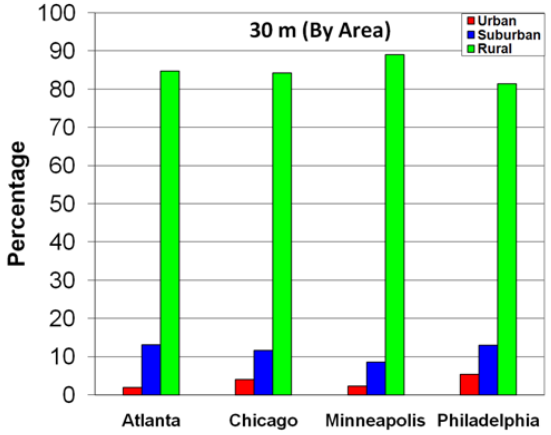
Data Linkage Outputs

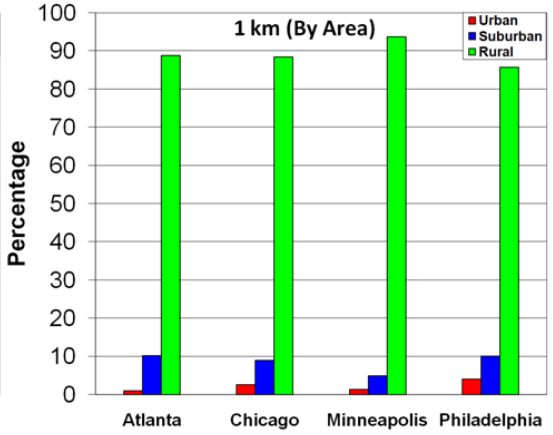
Date	Participant _ID	Living Environment Category	LST (°C)
1/7/2000	1811	Suburban	35.1
5/5/2001	15299	Rural	34.6
6/5/2001	15879	Urban	36.2

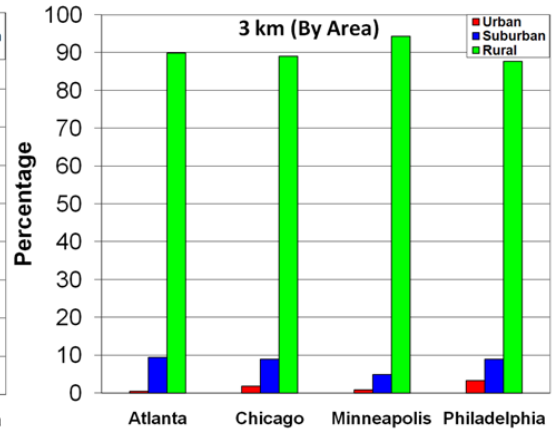
***Simulated Data Set.**

Percentage of Areal Coverage and Participants

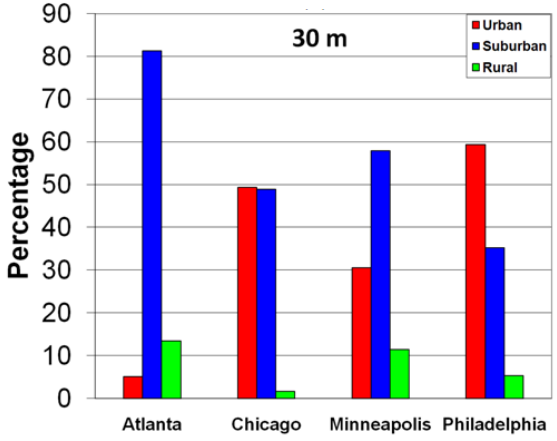
By Area

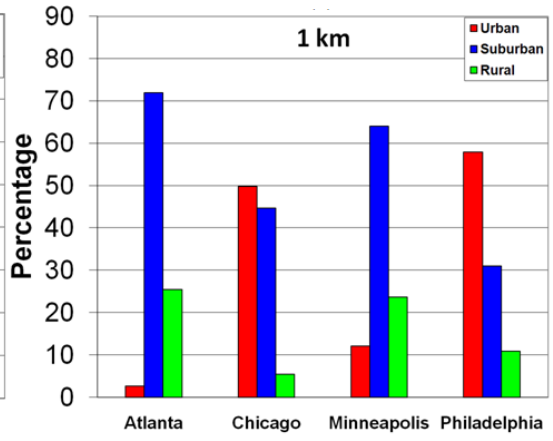


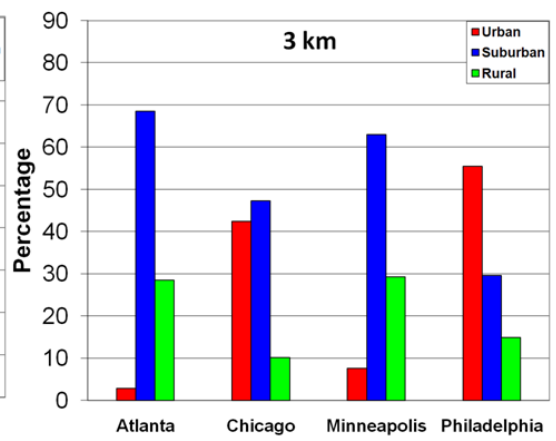




By Participants







Biostatistical Analyses

Relationship between LCLU Living Environment and SBP, DBP, and Hypertension (1 km)

Living Environment	Model 0[a]	Model 1[b]	Model 2[c]
Mean SBP			
Urban	131 (0.54)	130 (0.58)	128 (0.81)
Suburban	127 (0.42)	127 (0.42)	127 (0.61)
Rural	127 (0.76)	128 (0.77)	127 (0.99)
p-value	<0.0001	0.0021	0.2
Mean DBP			
Urban	78 (0.31)	77 (0.33)	77 (0.47)
Suburban	77 (0.24)	77 (0.24)	77 (0.35)
Rural	76 (0.44)	76 (0.45)	76 (0.57)
p-value	<0.0001	0.28	0.71
Hypertension			
Urban	1.7 (1.4, 2.1)	1.2 (0.92, 1.5)	1.2 (0.85, 1.6)
Suburban	1.3 (1.1, 1.6)	1.1 (0.89, 1.3)	1.1 (0.84, 1.4)
Rural	REF	REF	REF
p-value	<0.0001	0.47	0.62

Abbreviations: SBP-systolic blood pressure, DBP-diastolic blood pressure

Hypertension: SBP > 140, DBP > 90, or Self-reported anti-hypertinsive medication

[a] Univariate

[b] Adjusted for race

[c] Adjusted for race, sex, age, BMI, income, education, and city of residence

Biostatistical Analyses

BP vs. Race

	Overall (n=3298)	African American (n=1855)	White (n=1398)
SBP	128 (17)	131 (19)	125 (17)
DBP	77 (10)	78 (10)	76 (9)
Hypertensive	1996 (61%)	1284 (69%)	712 (51%)

LCLU vs. Race

	Overall (n=3298)	Urban (n=1058, 32%)	Suburban (n=1715, 52%)	Rural (n=525, 16%)
African American	1878 (57%)	871 (82%)	860 (50%)	147 (28%)
White	1419 (43%)	187 (18%)	854 (50%)	378 (72%)

Conclusions

- Remotely sensed data can be used to characterize LCLU living environment for public health applications
- Such remote sensing and GIS methods have the potential to facilitate additional research linking environmental variables to public health concerns
- LCLU living environment is associated with hypertension in univariate models but that relationship is no longer present after adjustment for cardiovascular risk factors
- Further study regarding living environment & hypertension should focus on additional environmental characteristics such as air quality

Thanks!

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