

**Does the Spatial Configuration of Urban Landscape Matter?
Examples of Urban Warming and Cooling**

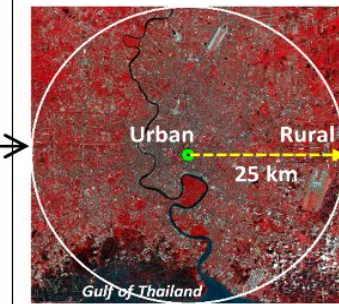
**Soe W. Myint
School of Geographical Sciences and Urban Planning
Arizona State University**

Bangkok, Jakarta, and Manila

(a) Southeast Asia

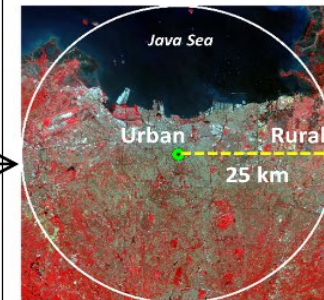


(b) Landsat-8 OLI/TIRS



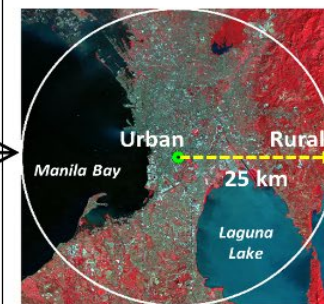
BANGKOK

2 Feb 2014
GMT 3:39
Local time 10:39



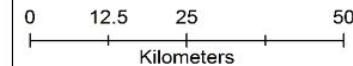
JAKARTA

13 Sep 2014
GMT 3:00
Local Time 10:00



MANILA

7 Feb 2014
GMT 2:18
Local Time 10:18



LST (°C)

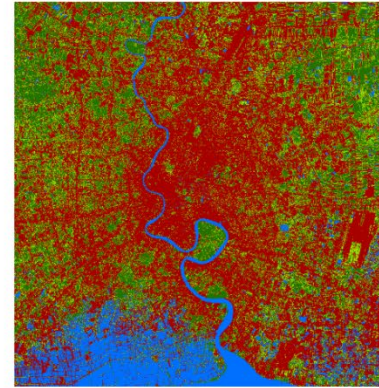
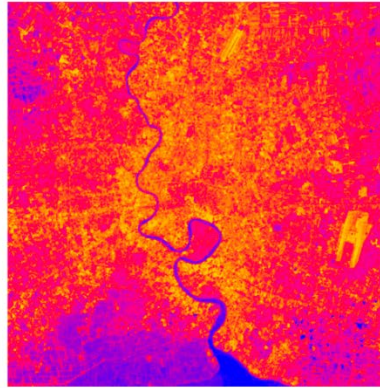
Land Cover

BANGKOK

2 Feb 2014

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Local time 10:39

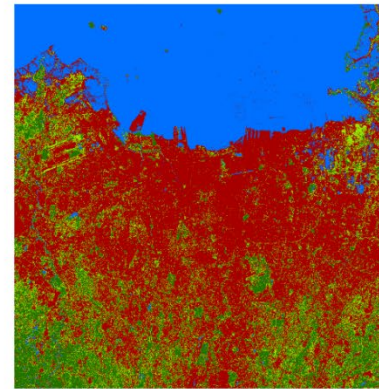
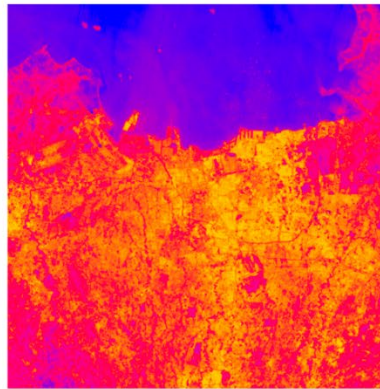


JAKARTA

13 Sep 2014

GMT 3:00

Local time 10:00

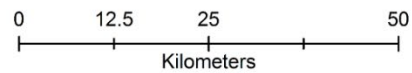
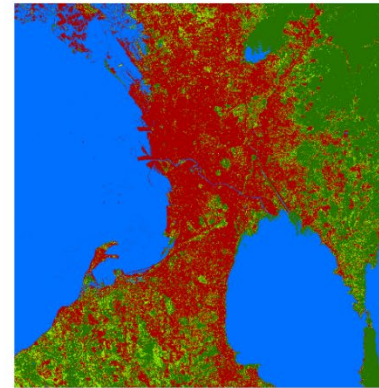
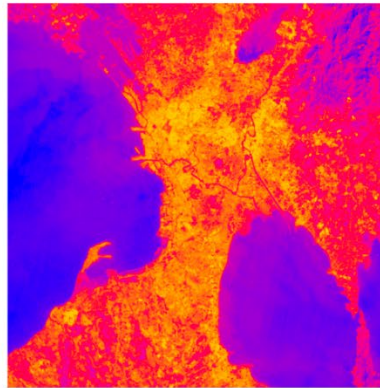


MANILA

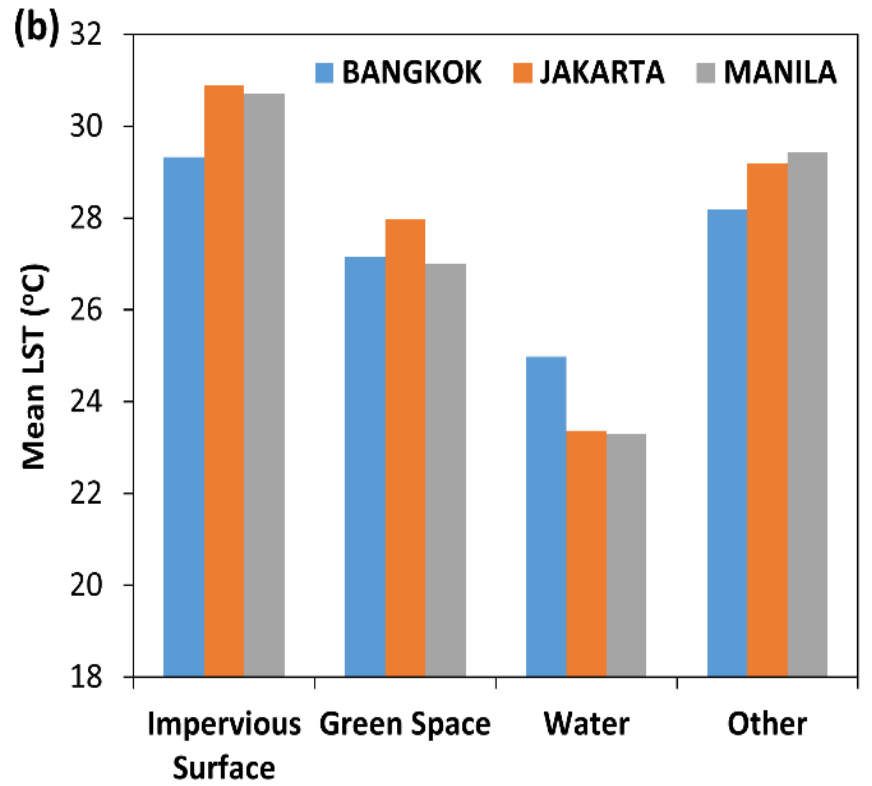
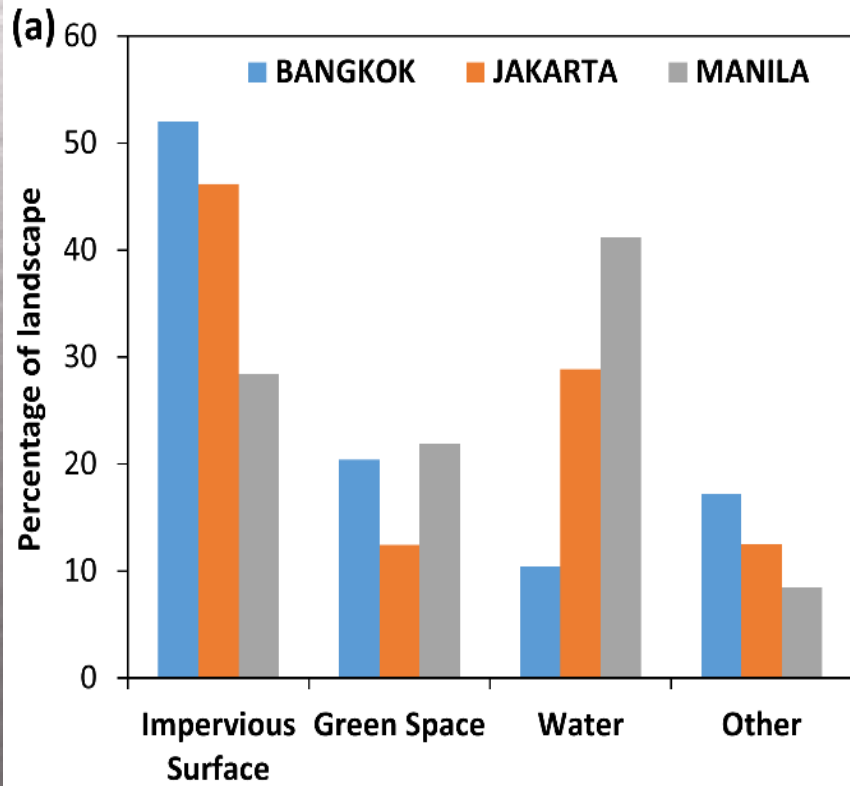
7 Feb 2014

GMT 2:18

Local time 10:18

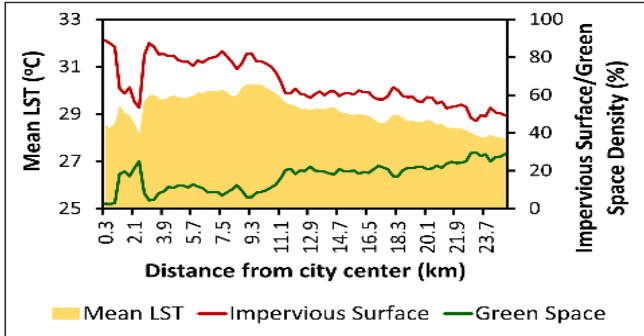


- Impervious Surface
- Other
- Green Space
- Water

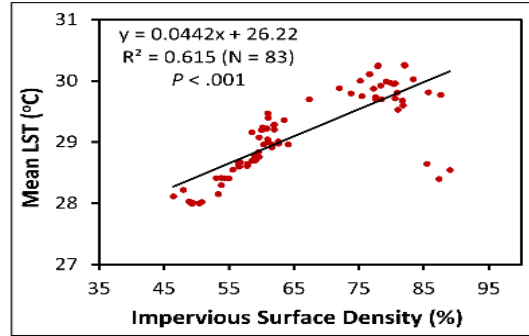


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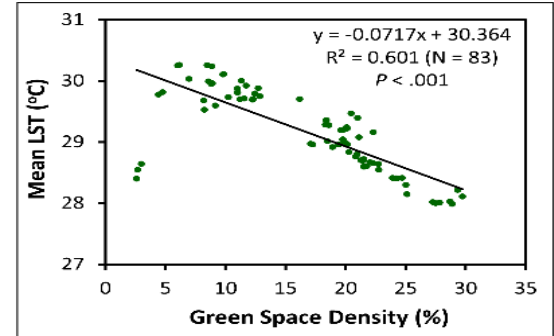
Urban-Rural Gradient



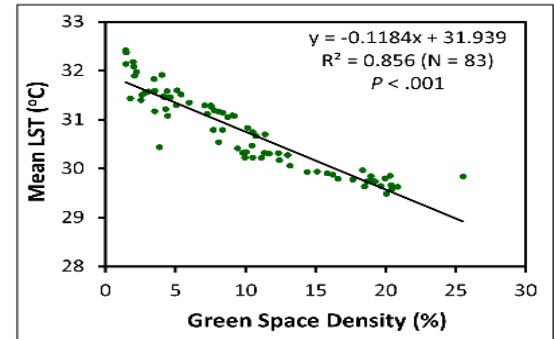
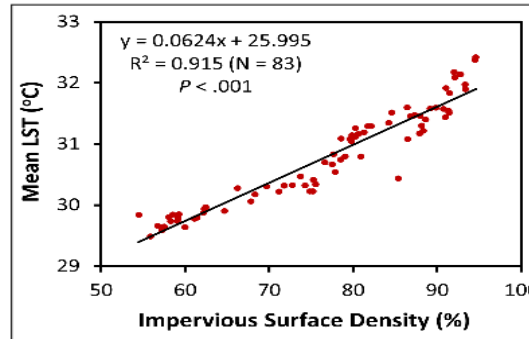
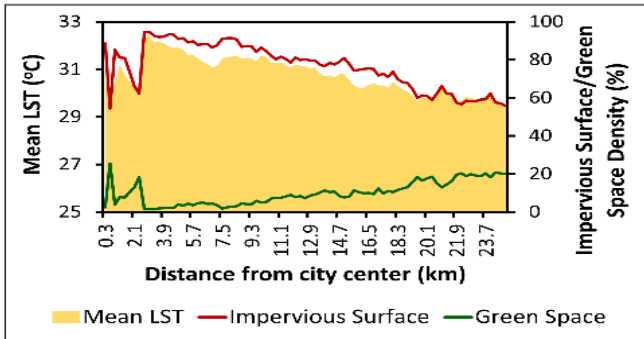
Impervious Surface Density vs. Mean LST



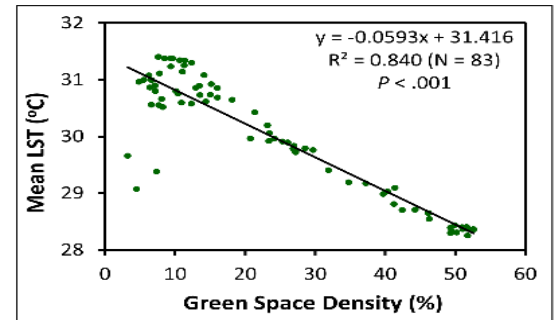
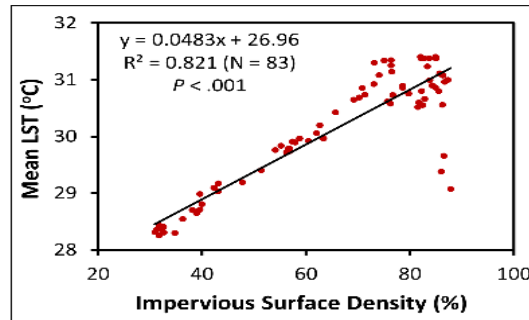
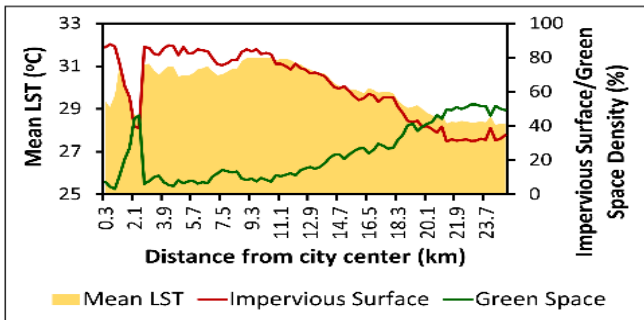
Green Space Density vs. Mean LST



J
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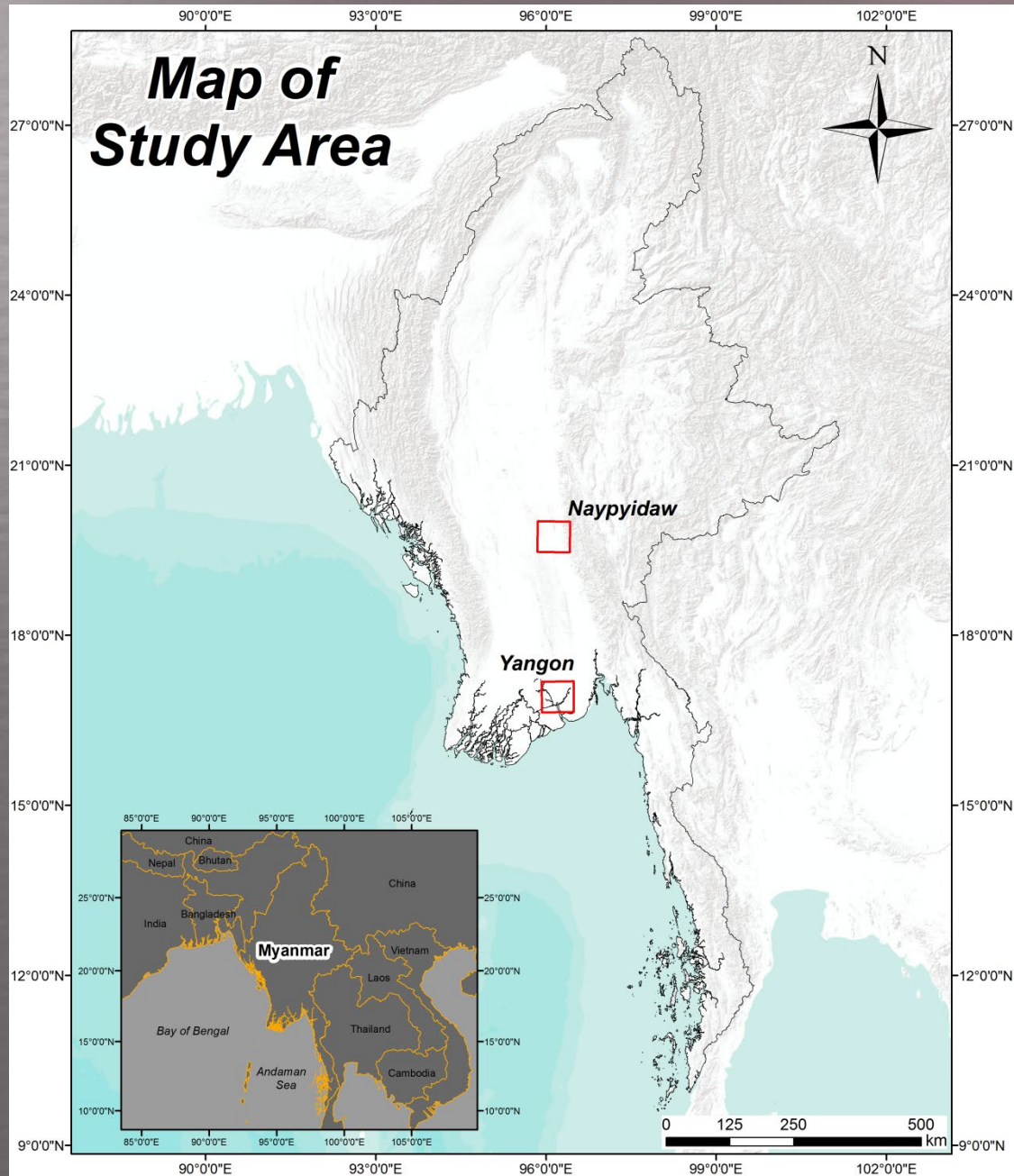


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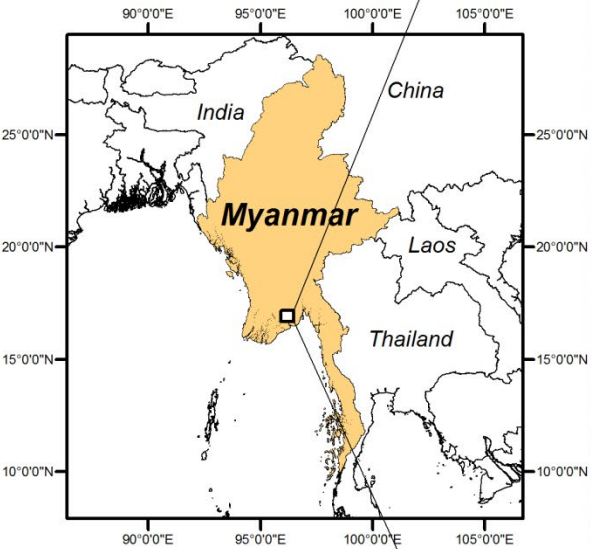
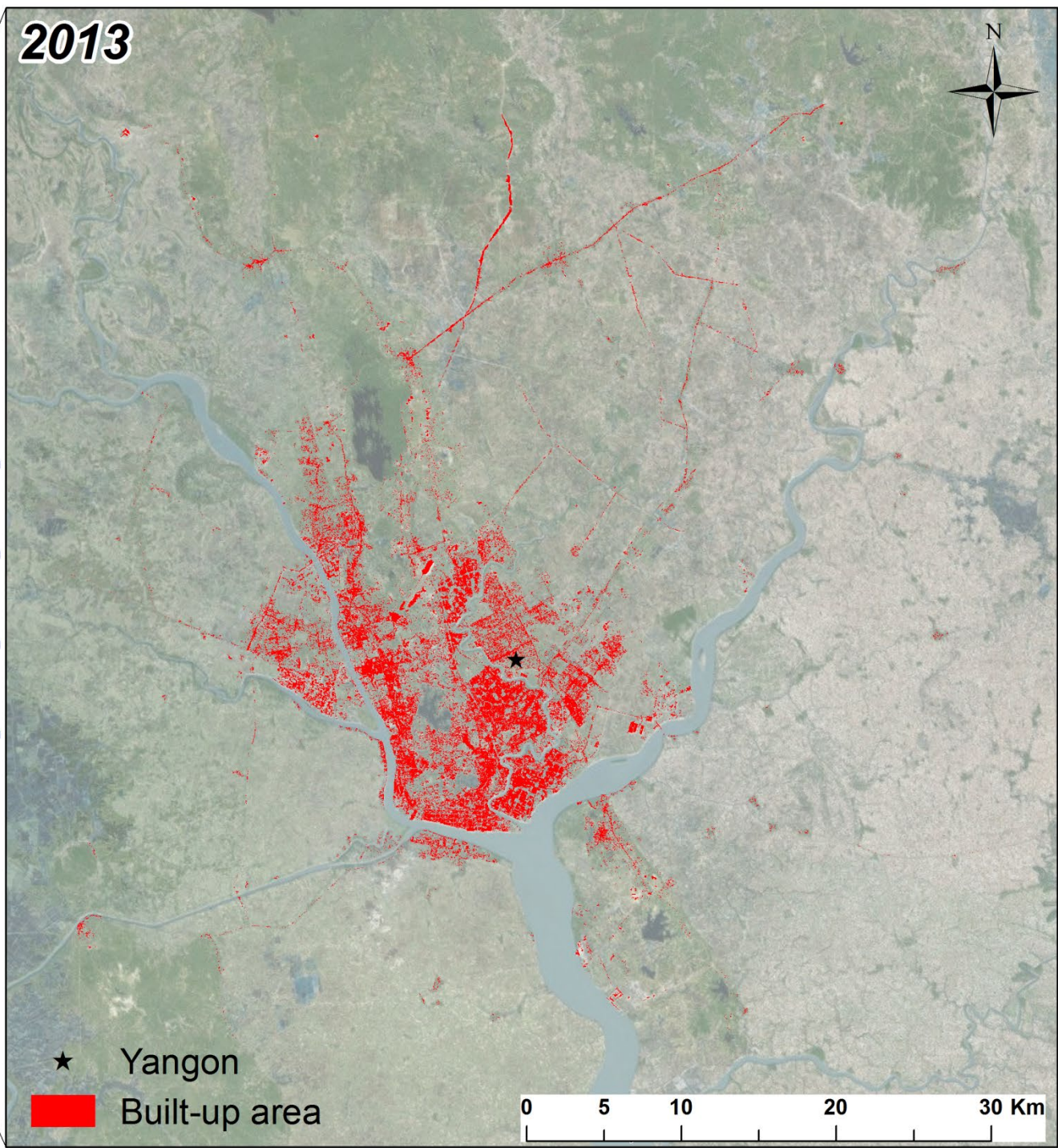


Estoque, R.C., Y. Murayama, and S.W. Myint, 2016. Effects of landscape pattern on land surface temperature: an urban heat island study in the megacities of Southeast Asia, *Science of the Total Environment*, 577: 349–359.

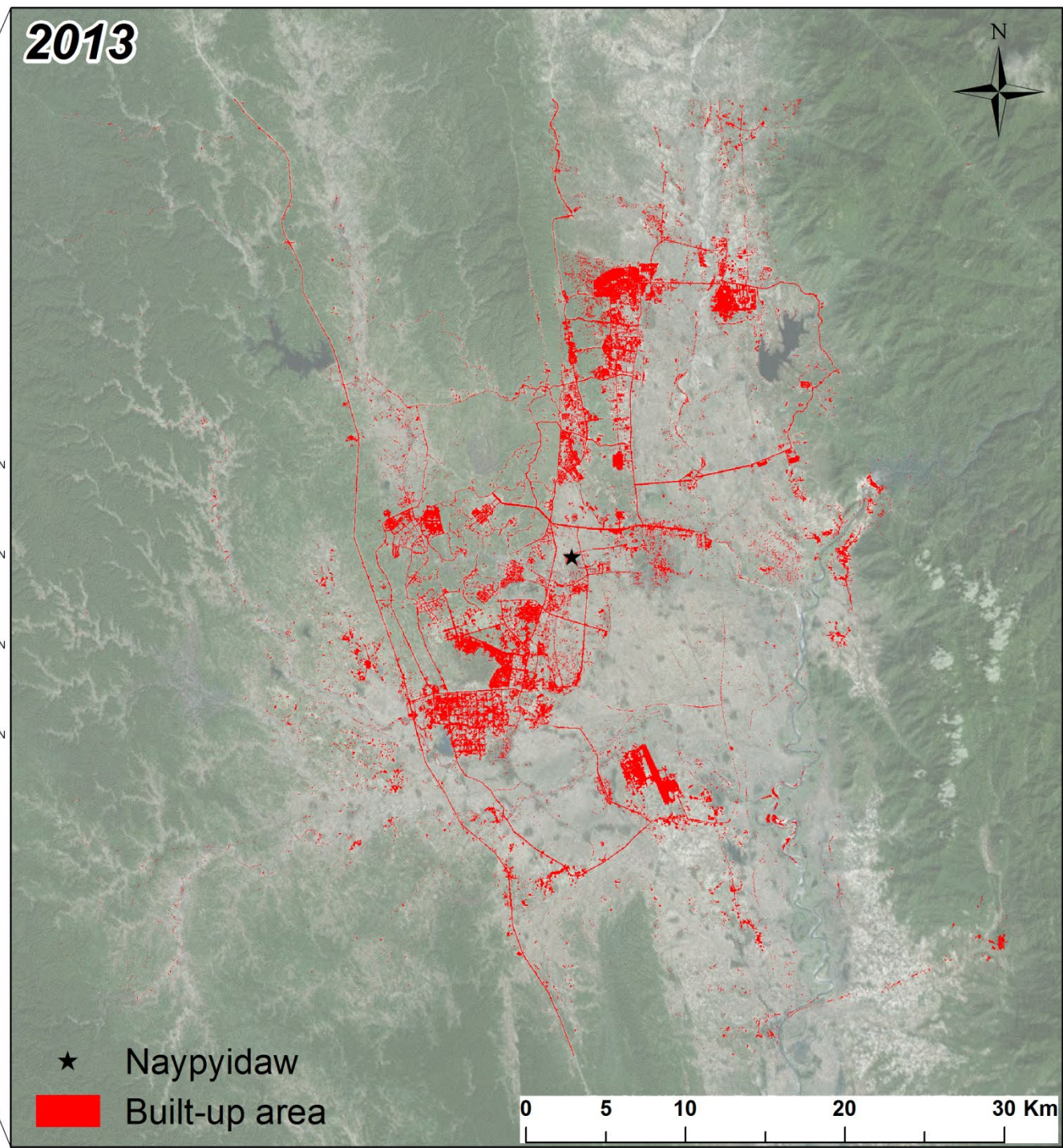
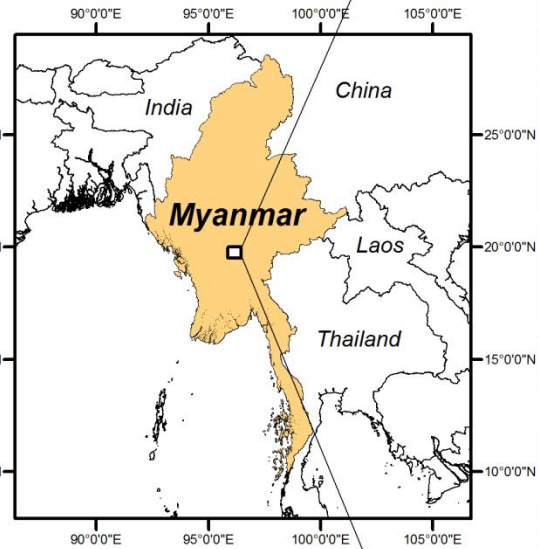
Study Area



2013

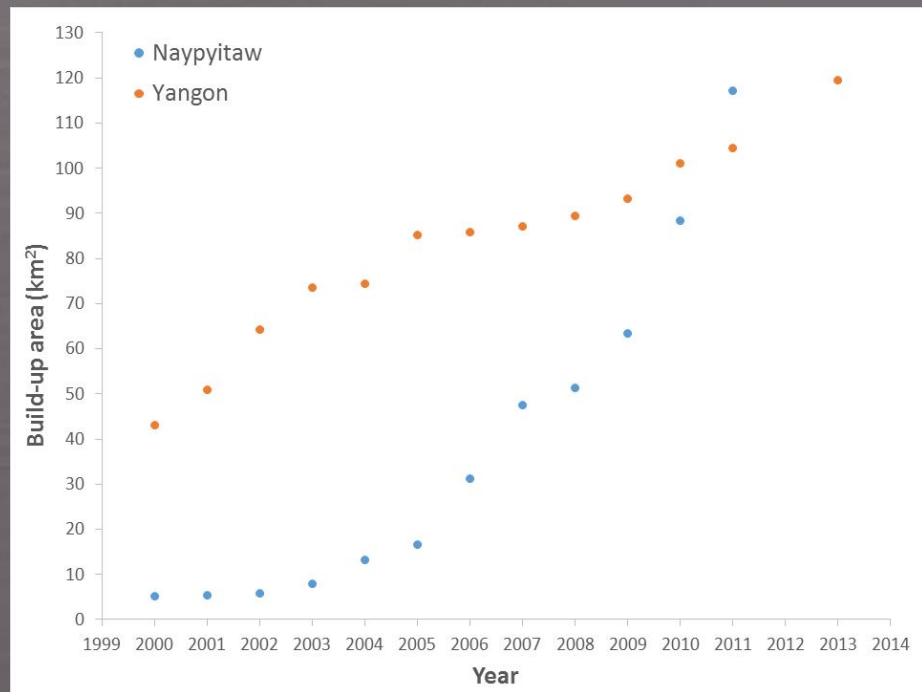
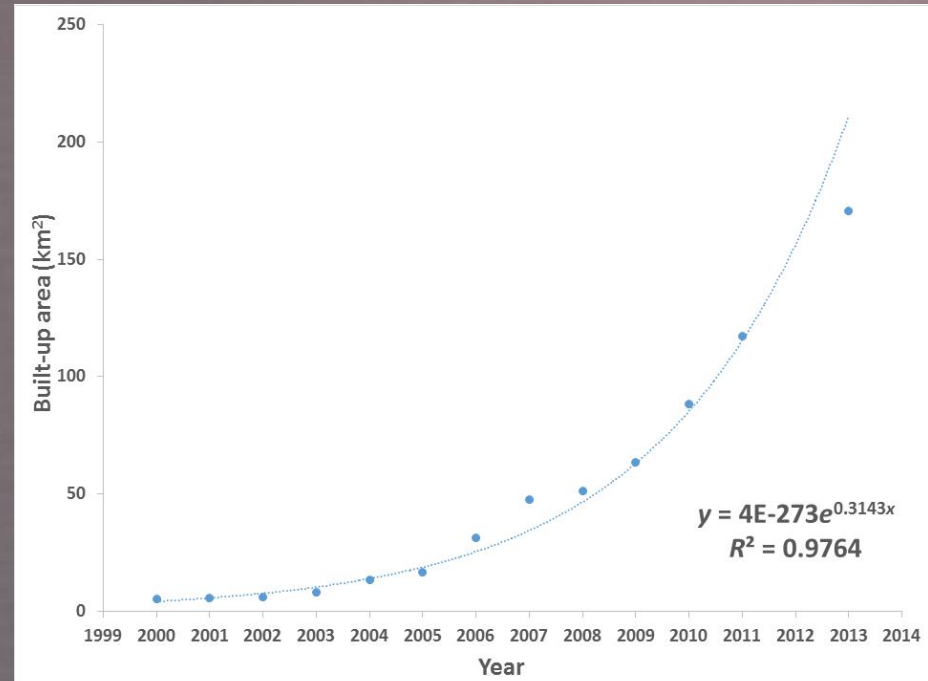
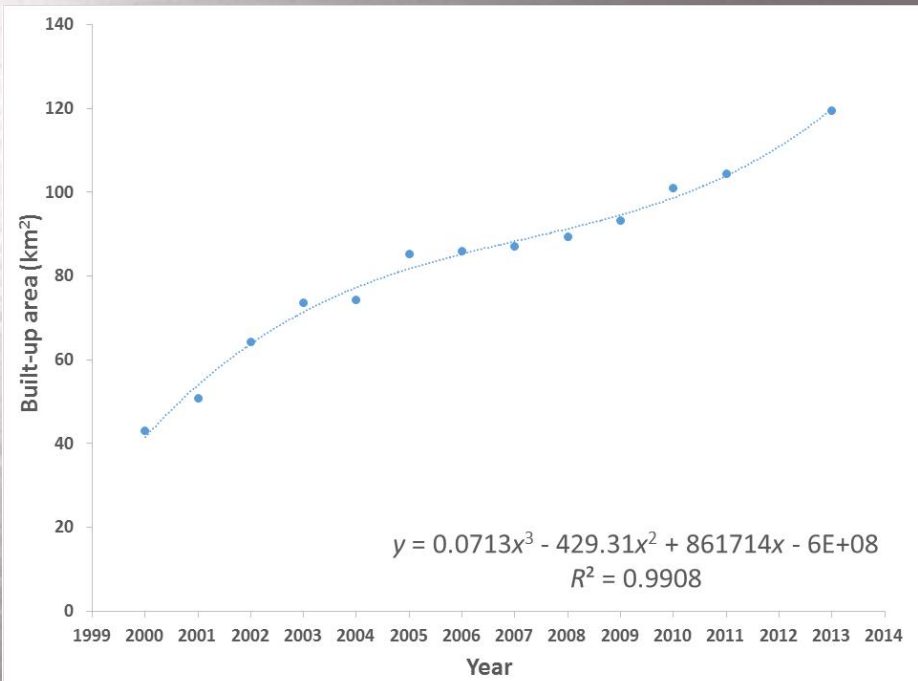


2013



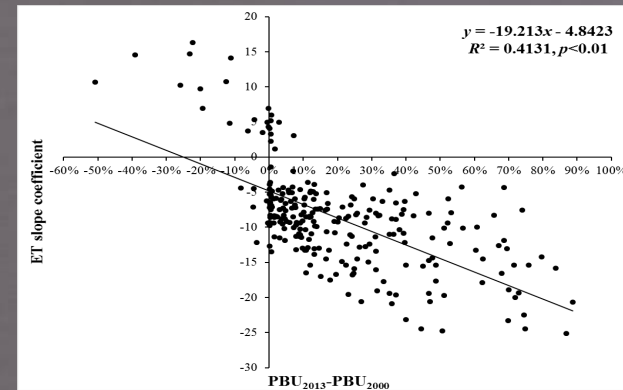
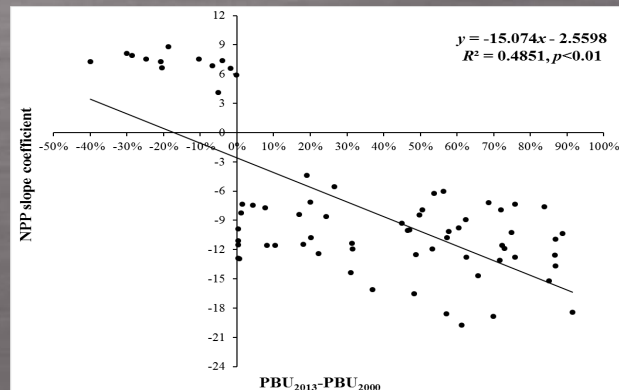
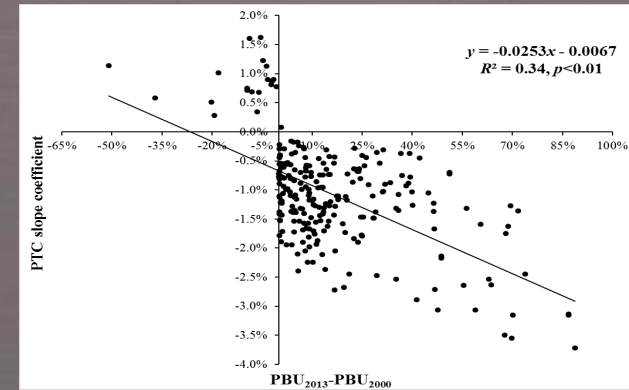
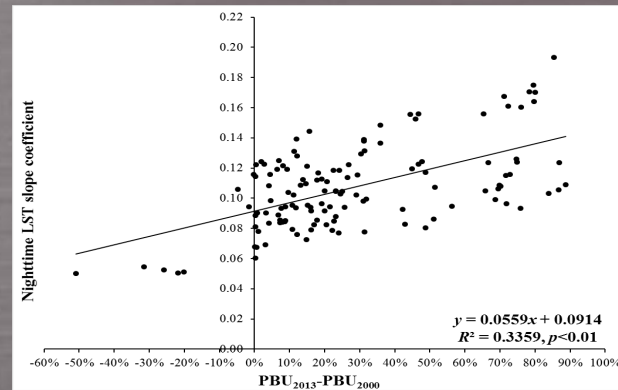
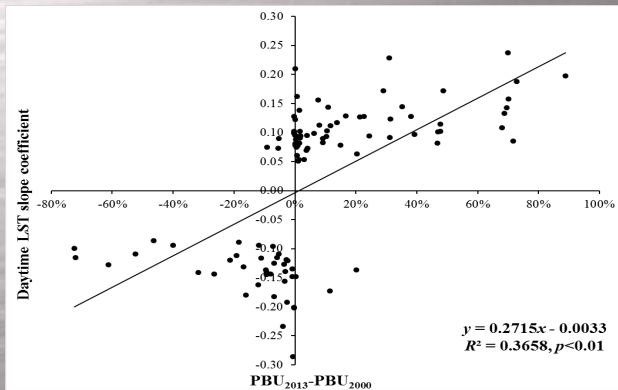
★ Naypyidaw
■ Built-up area



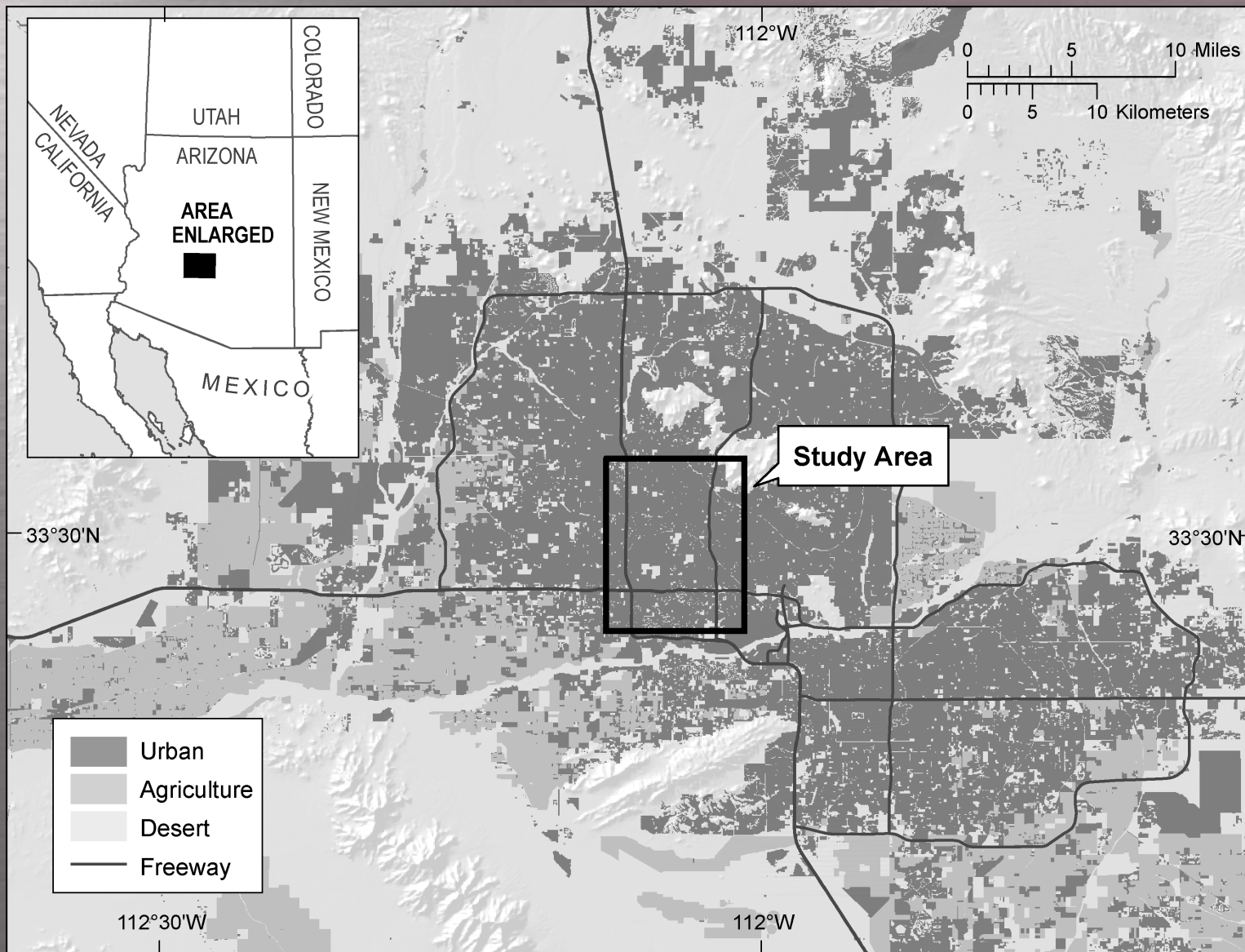


Urban Growth

Relationships between Percent Built Up (PBU) differences and the slope coefficient values from time-series trend analysis of daytime LST (a), nighttime LST (b), PTC (c), NPP (d), and ET (e) for Nay Pyi Taw



Study Area and Data



White Buildings
Ratio PCA3 not 0.45 > < 0.58

Level 1

Level 3

Level 2

Level 4



Other Water Bodies Mean PCA1

Level 1
0-8000

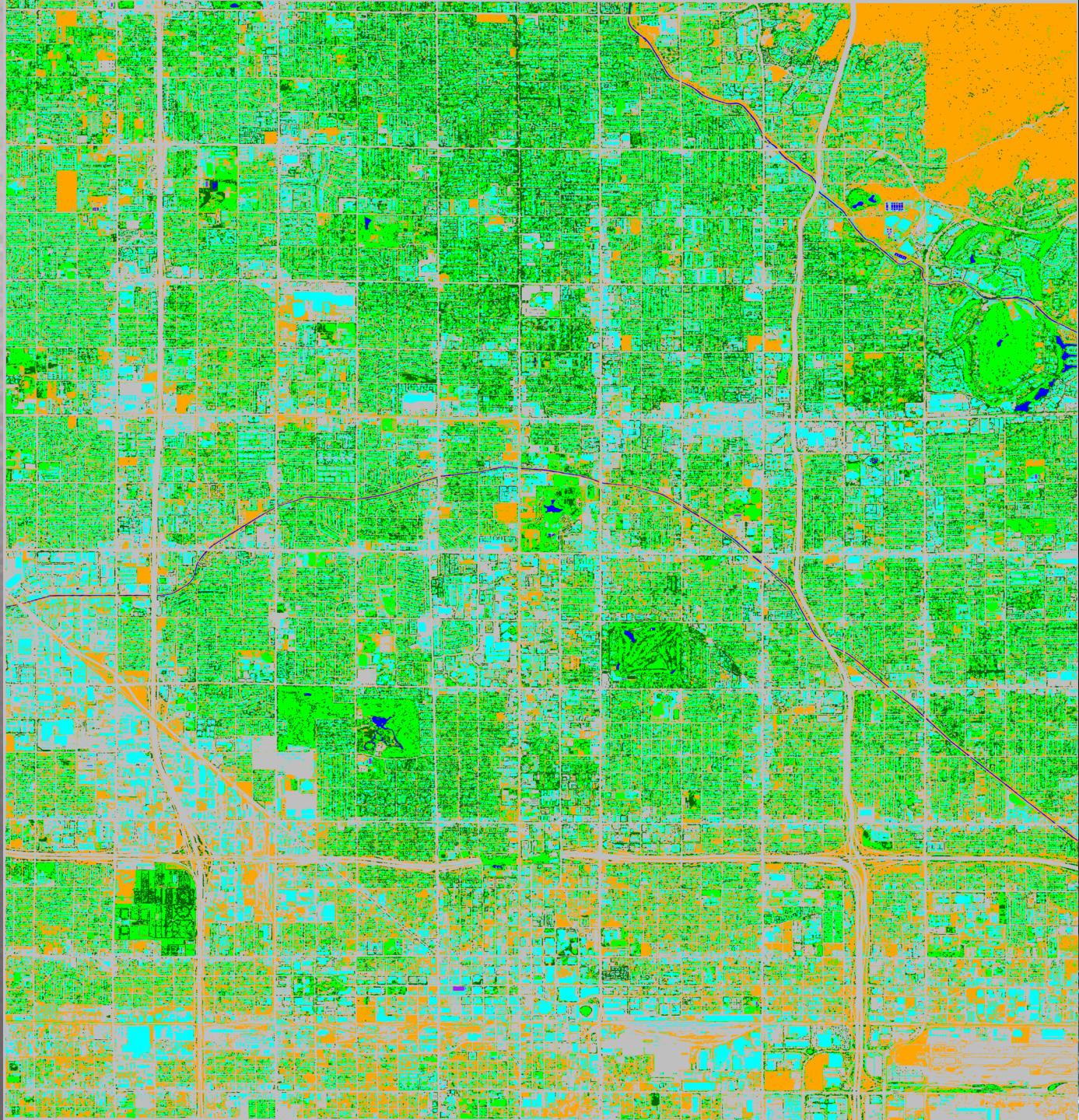
Level 1
0-4000

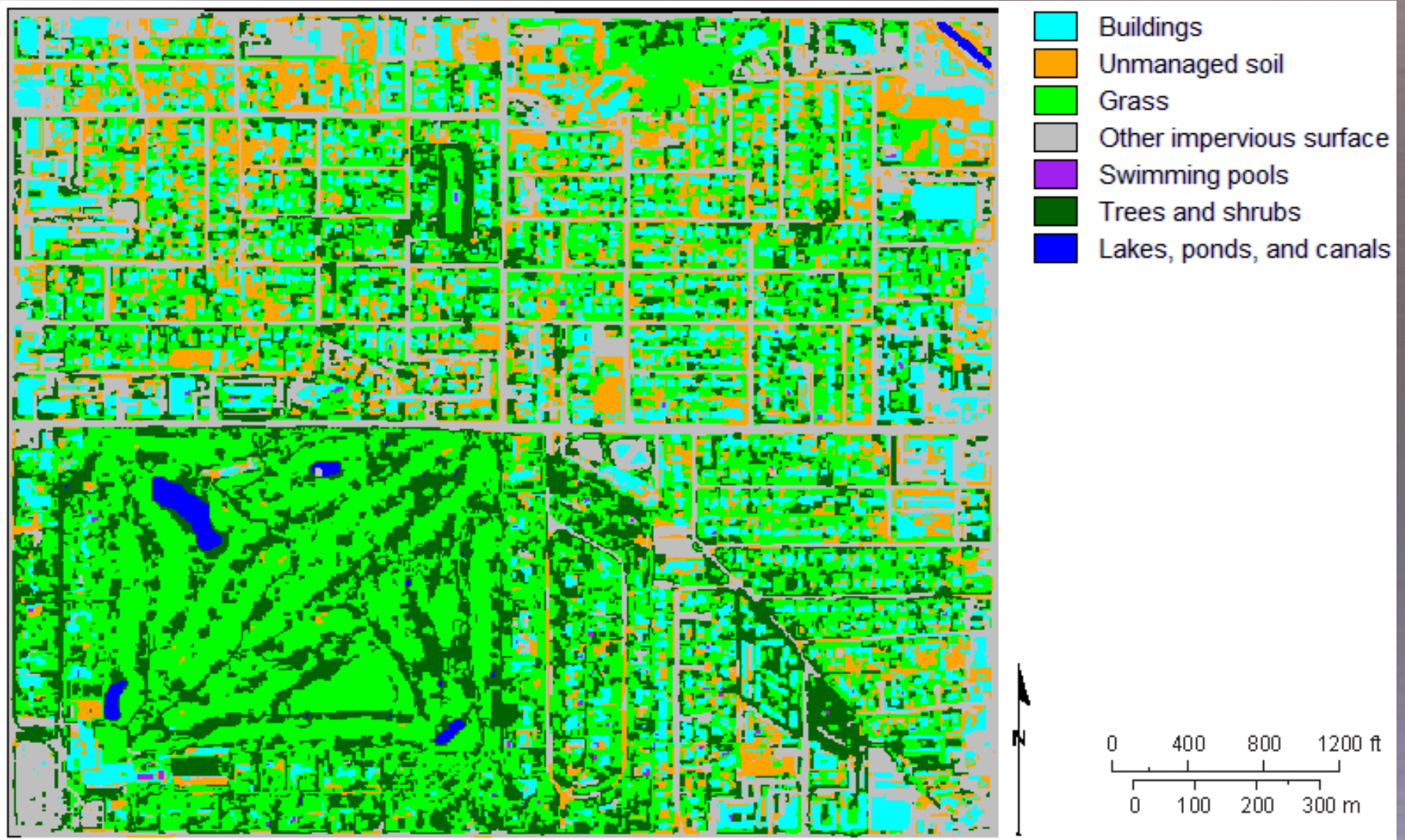
Level 2



Level 3

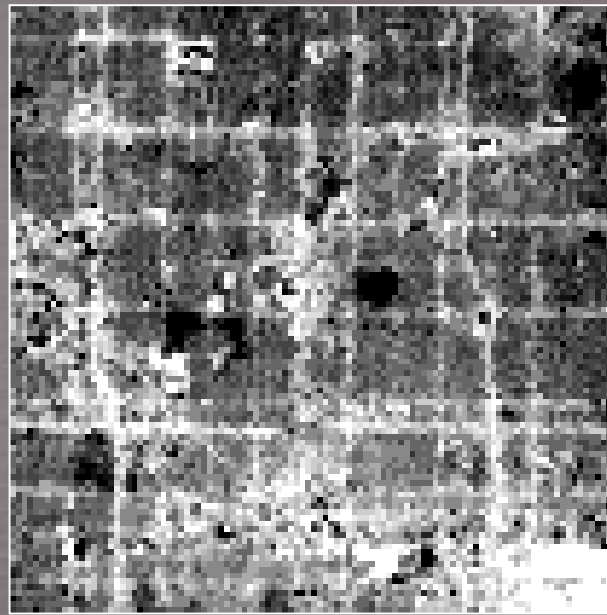
Level 4



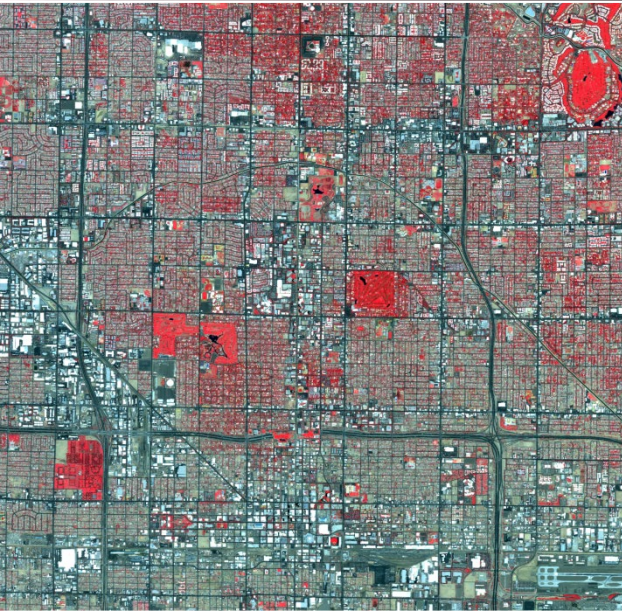
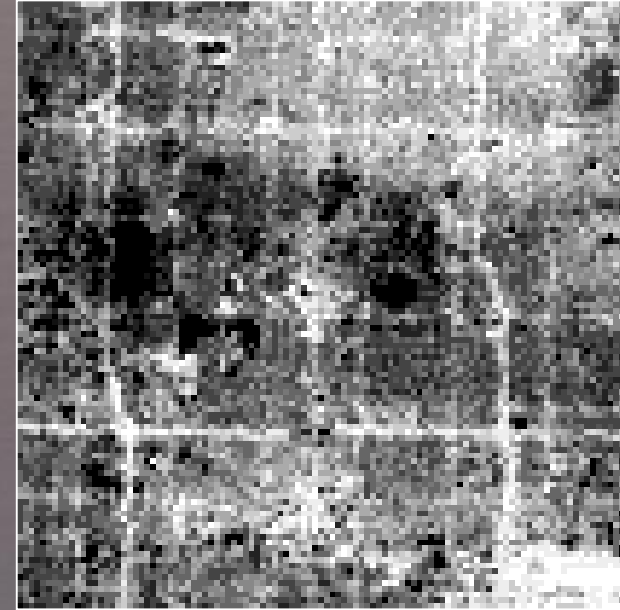


Myint, S.W., et. al., 2011. Per-pixel versus object-based classification of urban land cover extraction using high spatial resolution imagery, *Remote Sensing of Environment*, 115(2011): 1145-1161.

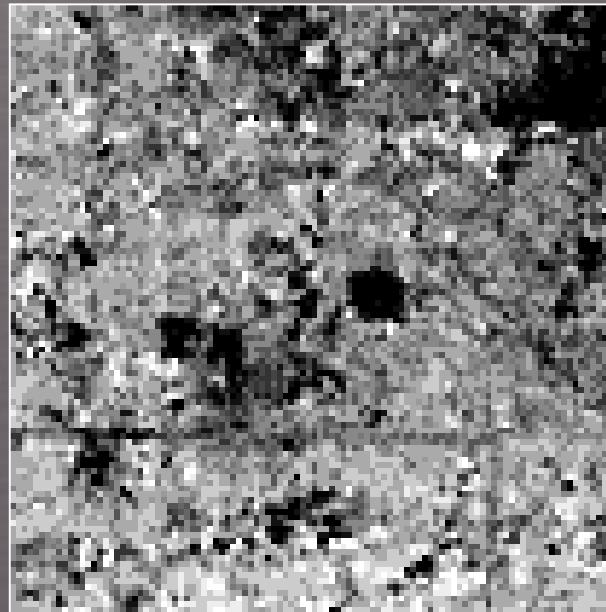
22 Aug 2005 – Nighttime



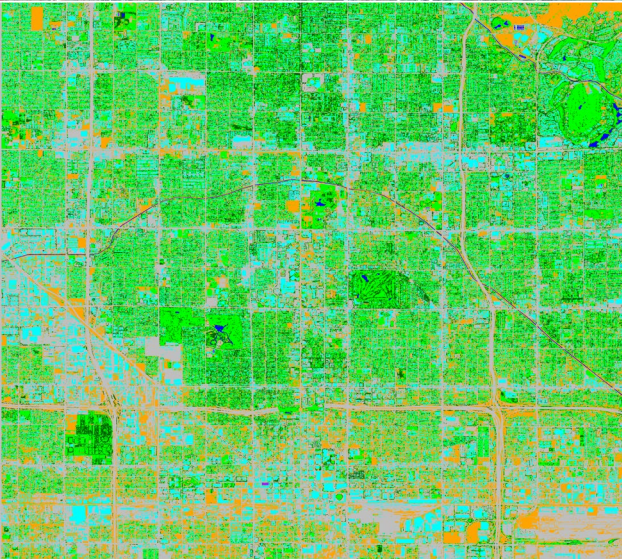
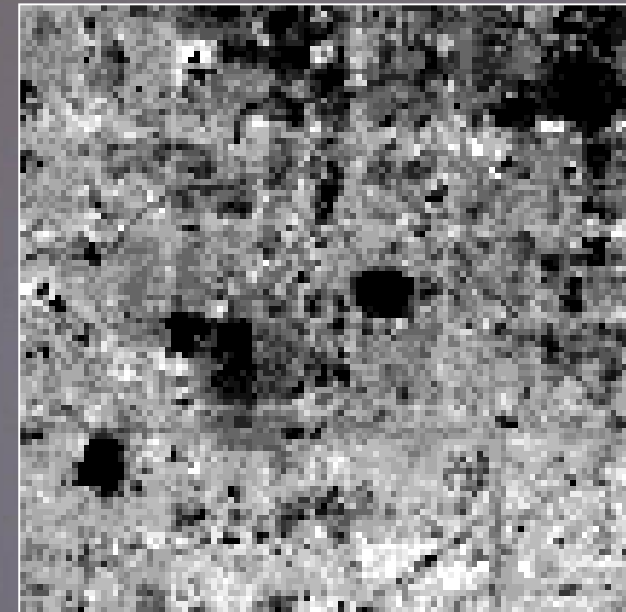
5 March 2007 – Nighttime



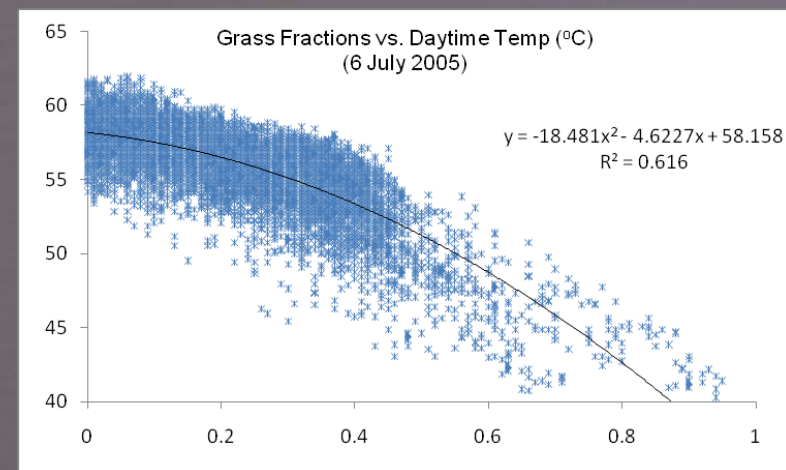
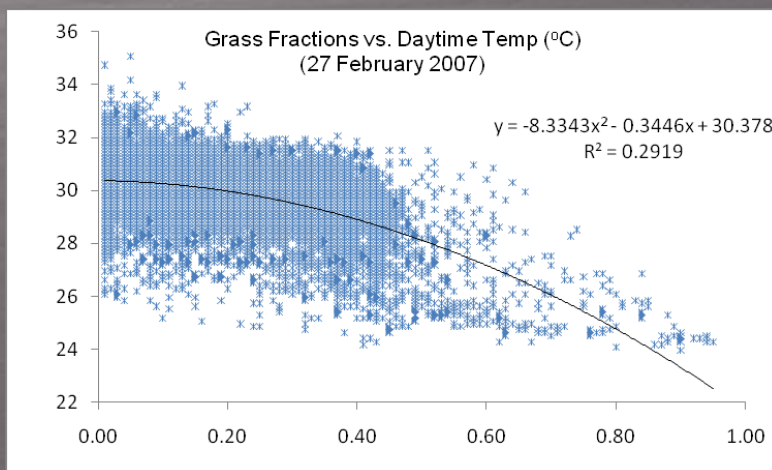
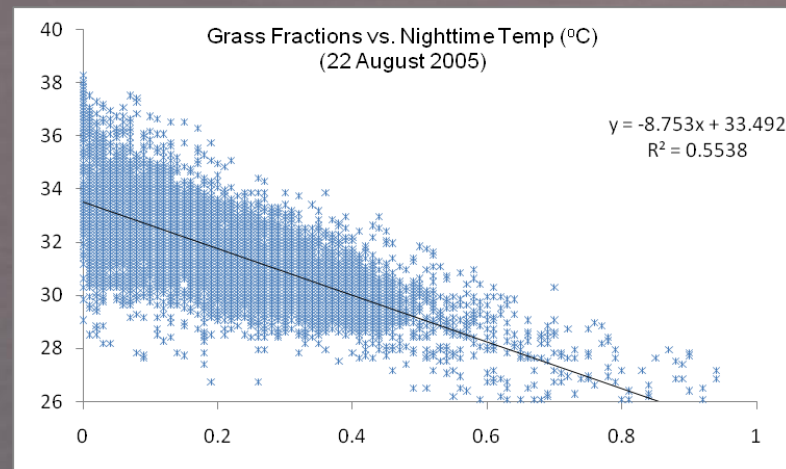
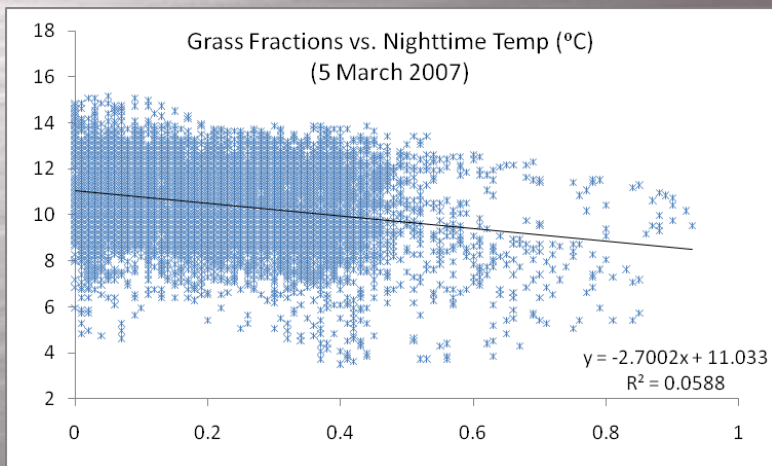
27 Feb 2007 – Daytime



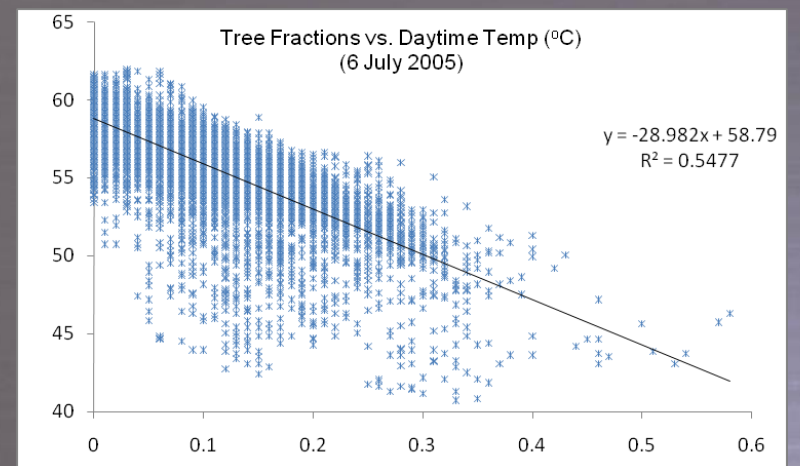
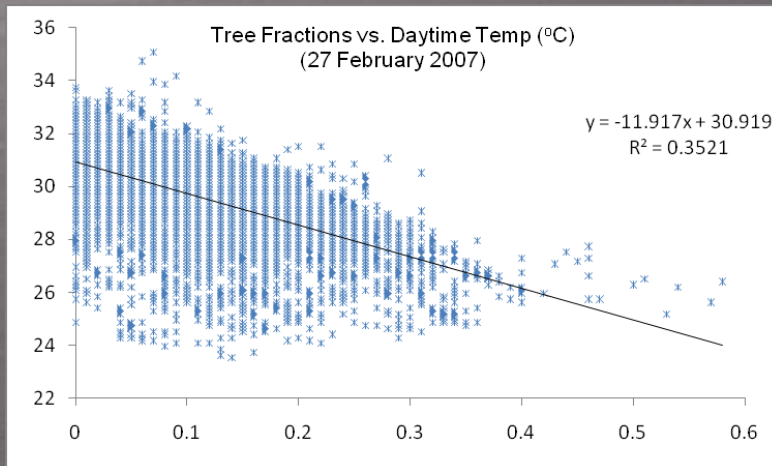
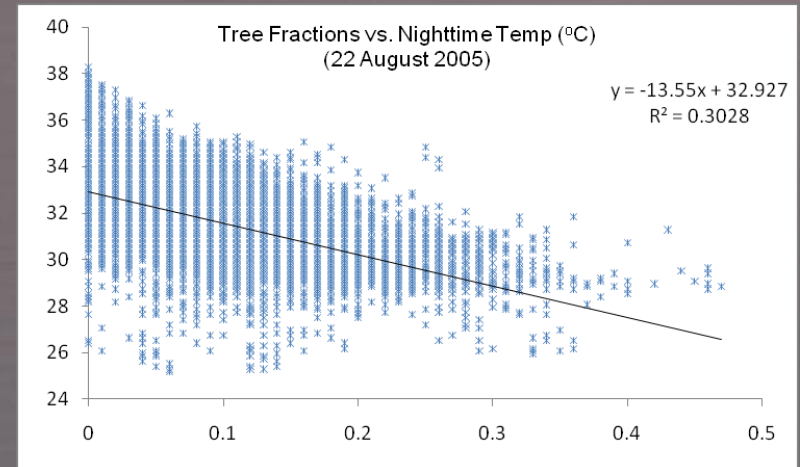
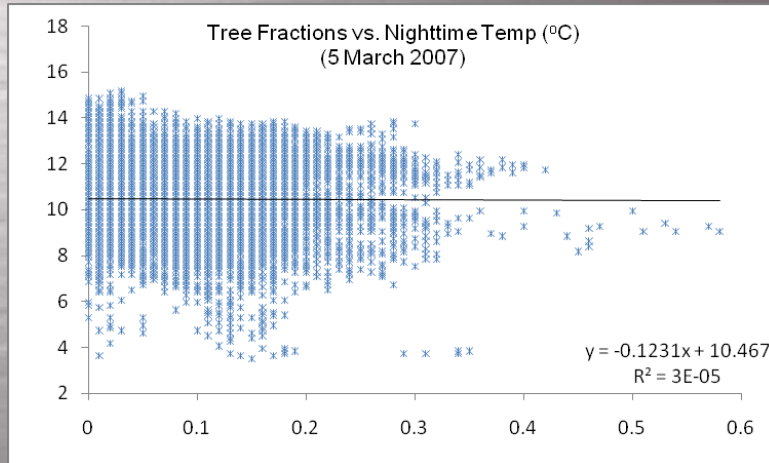
6 July 2005 – Daytime



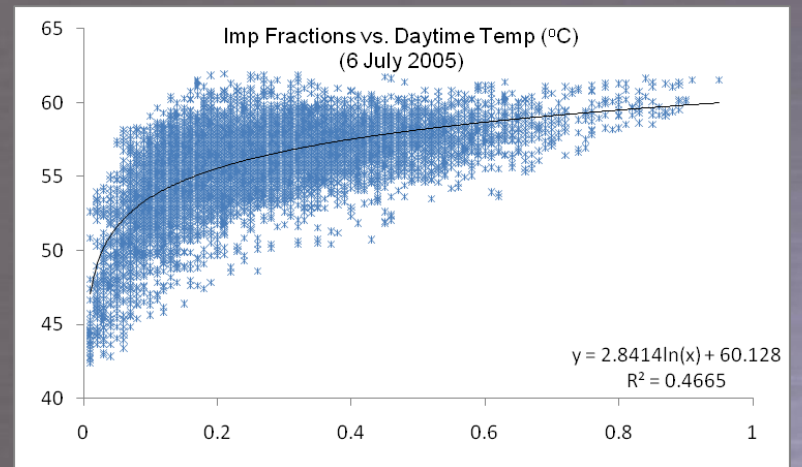
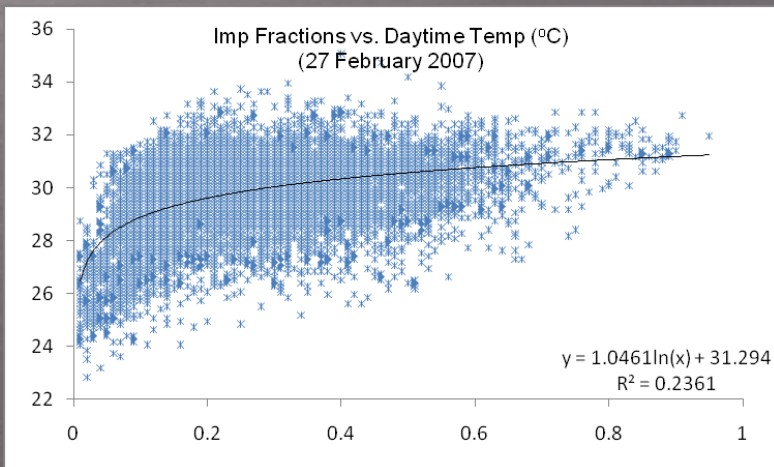
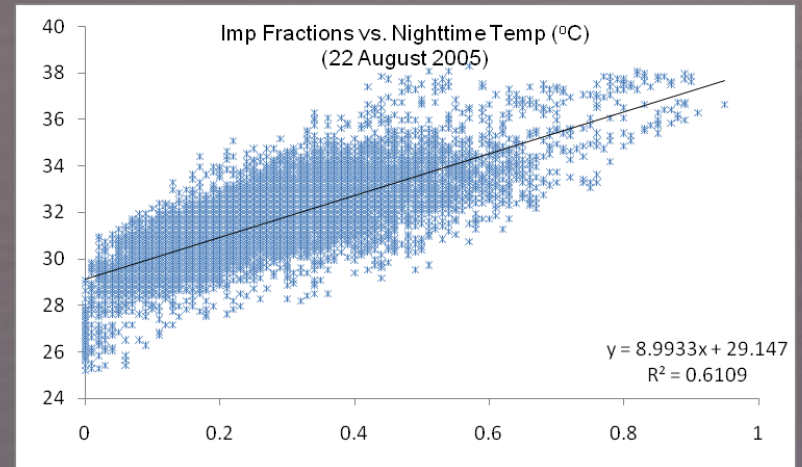
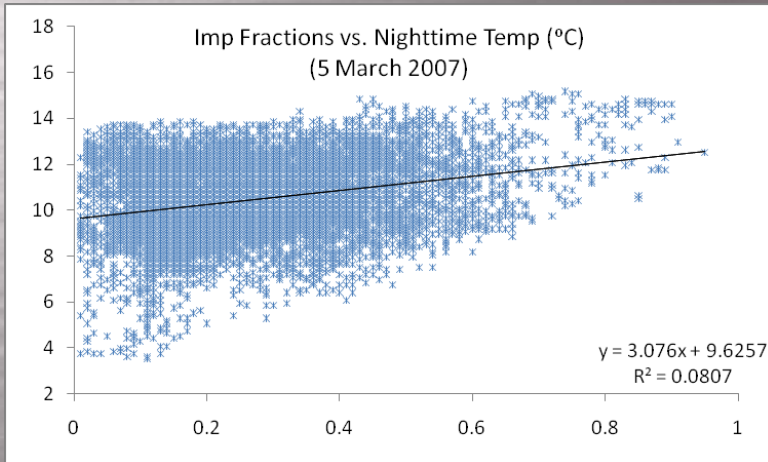
Grass



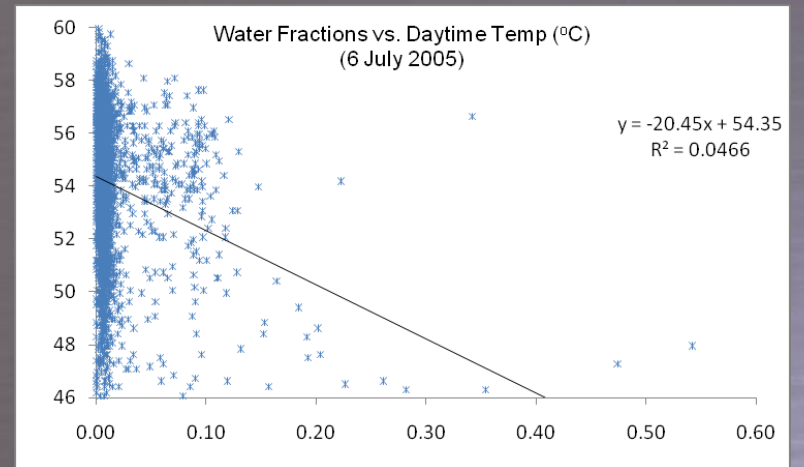
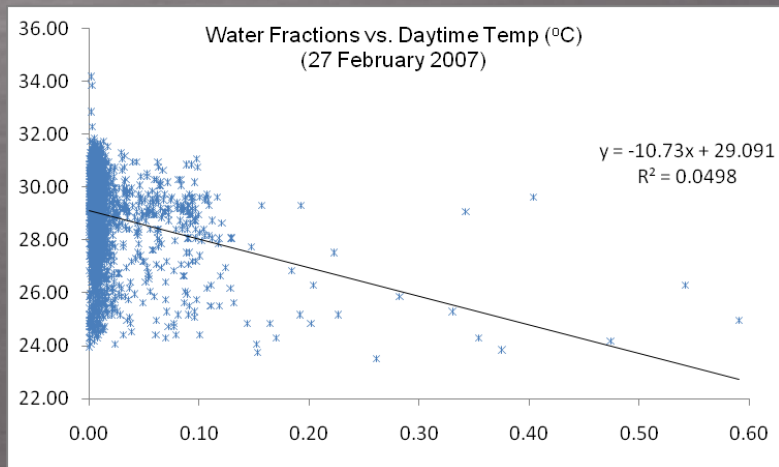
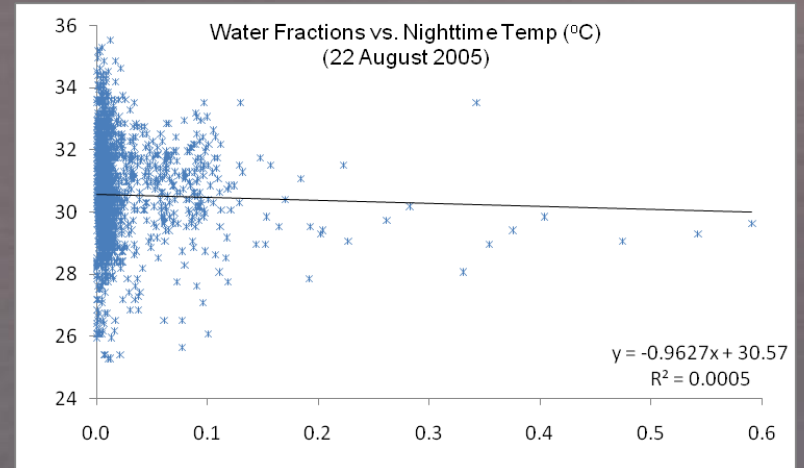
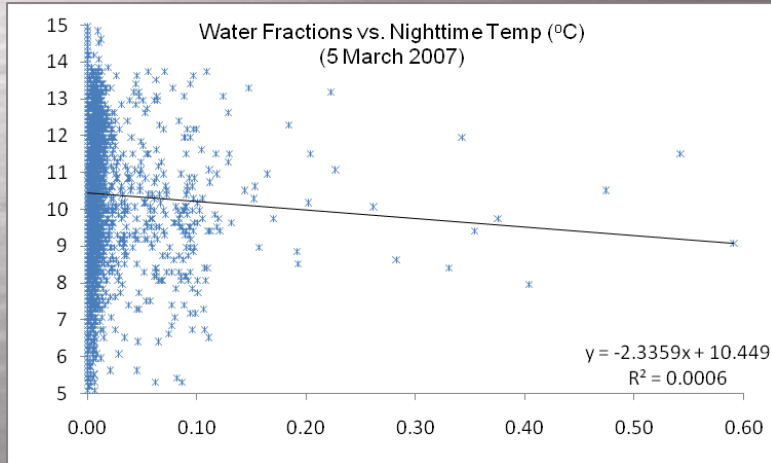
Trees



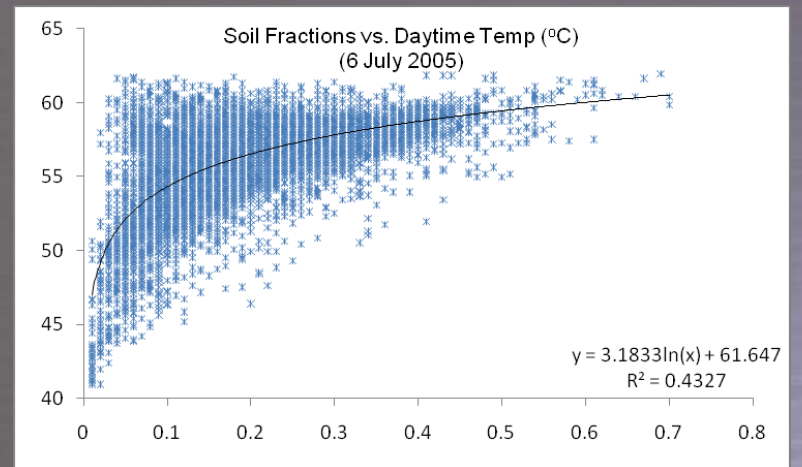
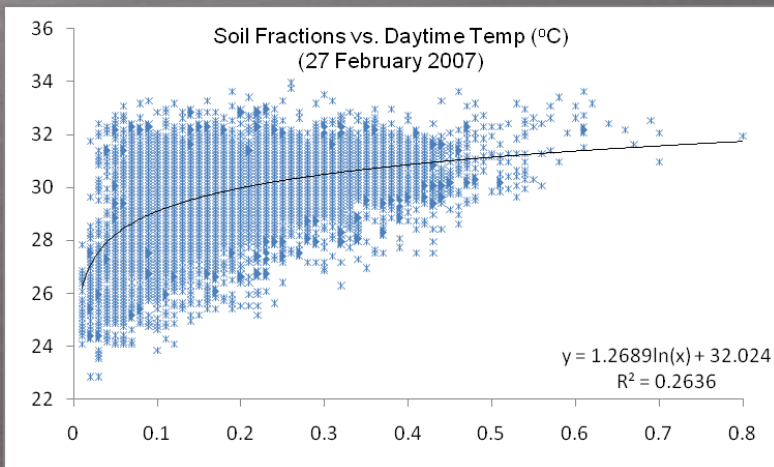
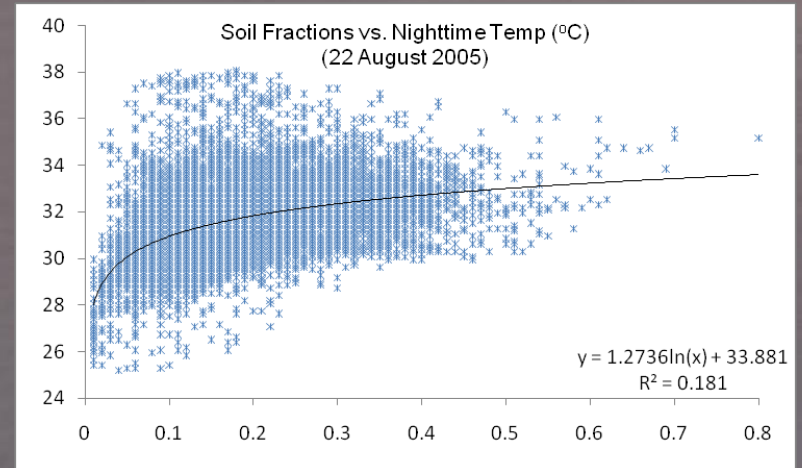
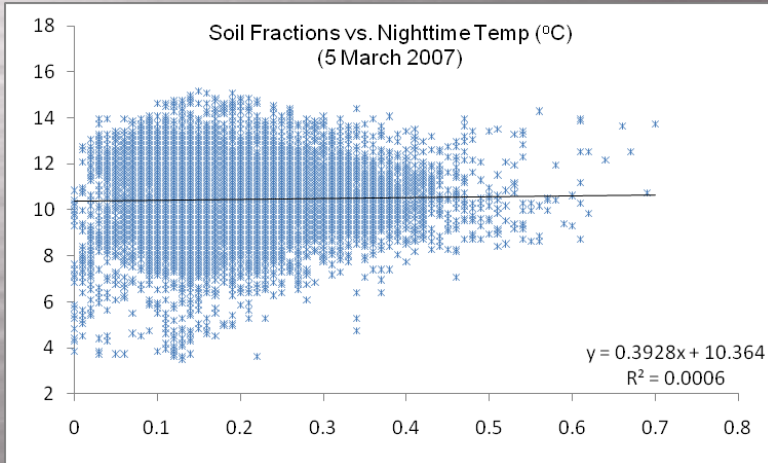
Impervious



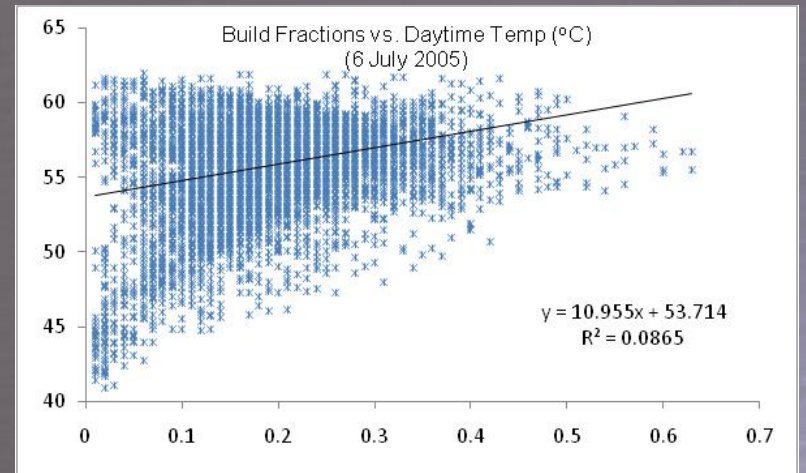
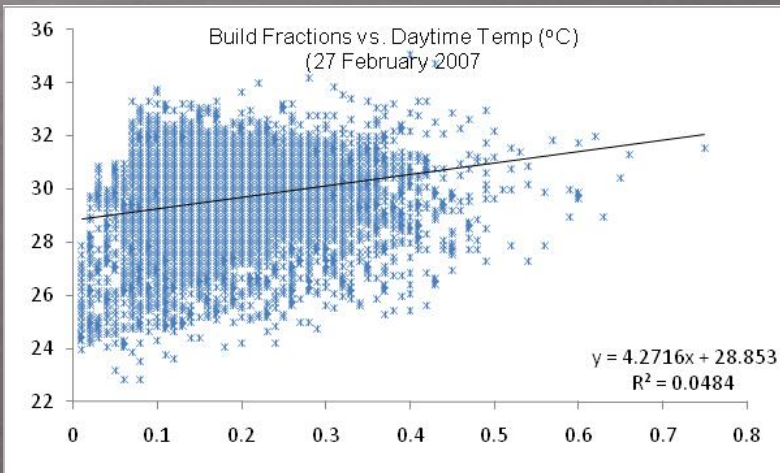
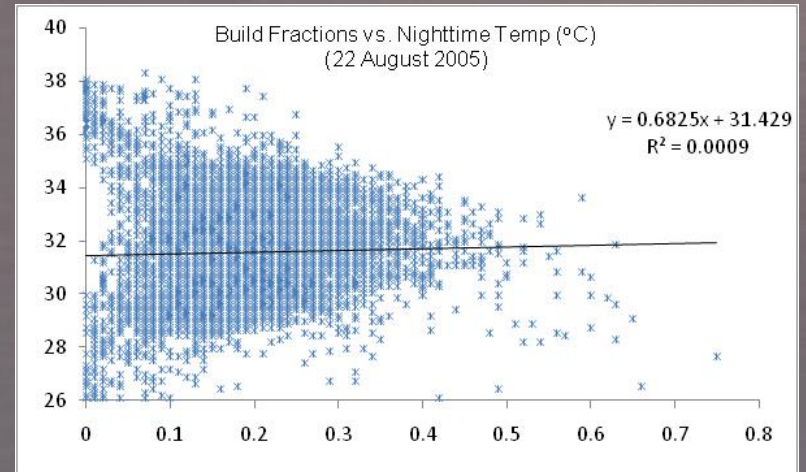
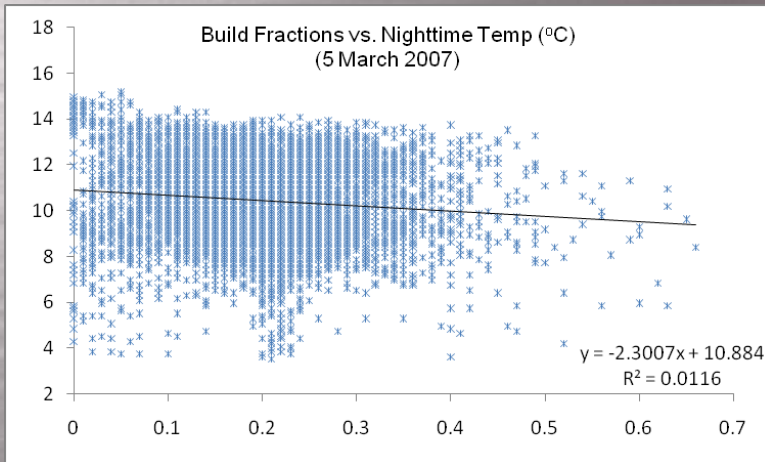
Water

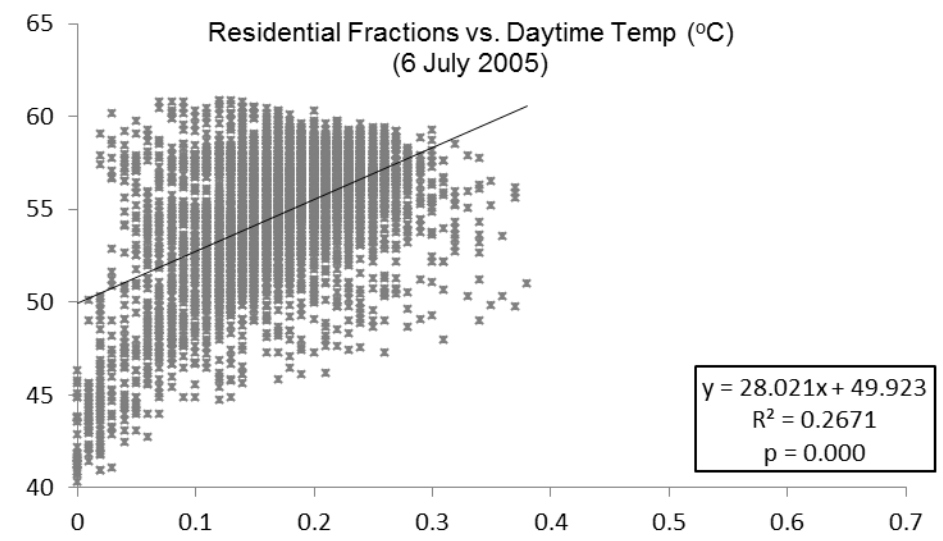
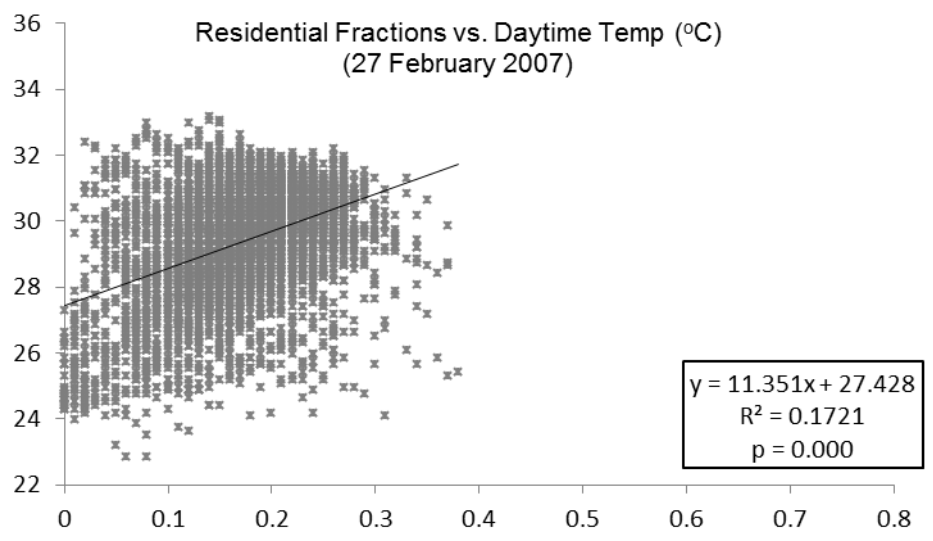
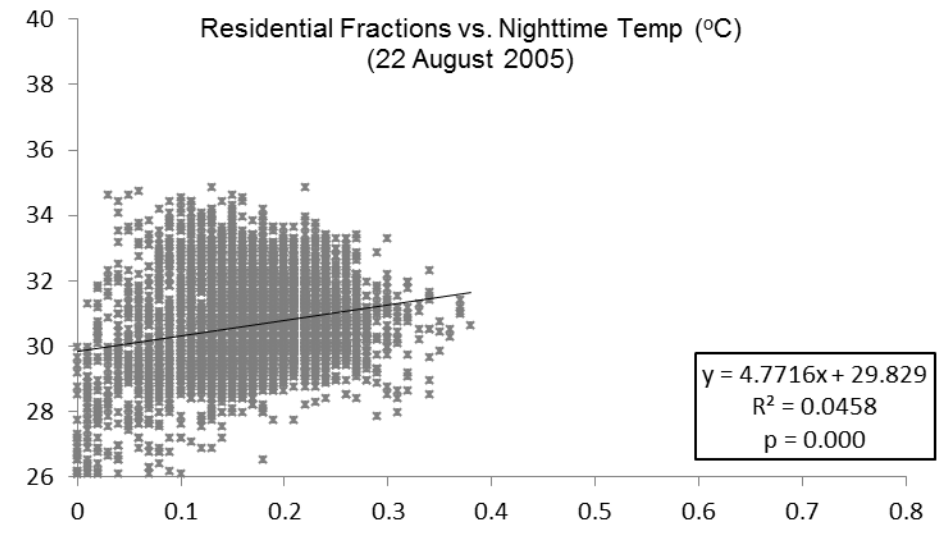
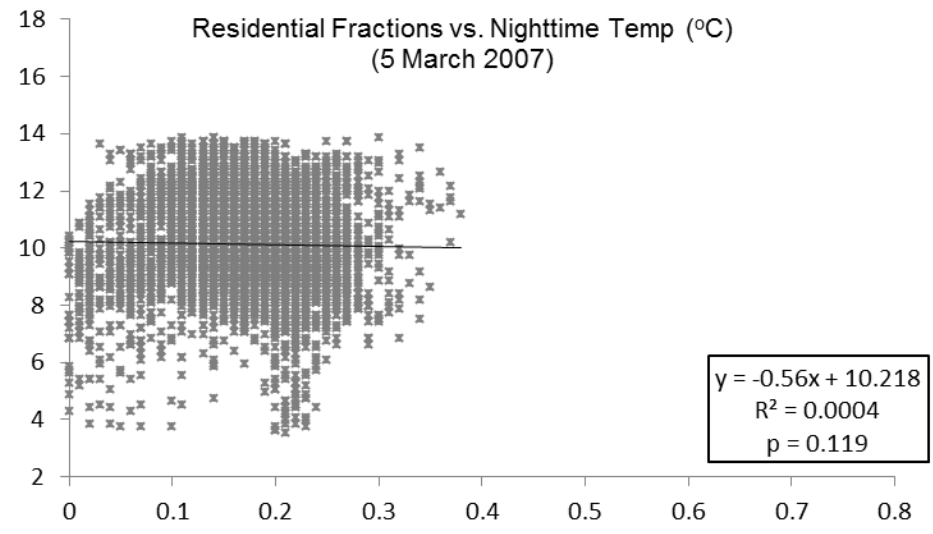


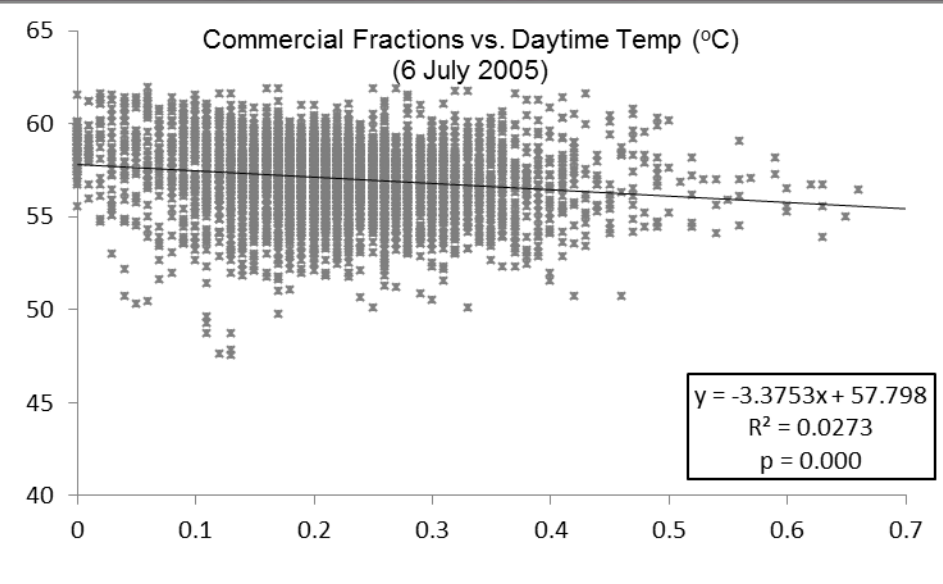
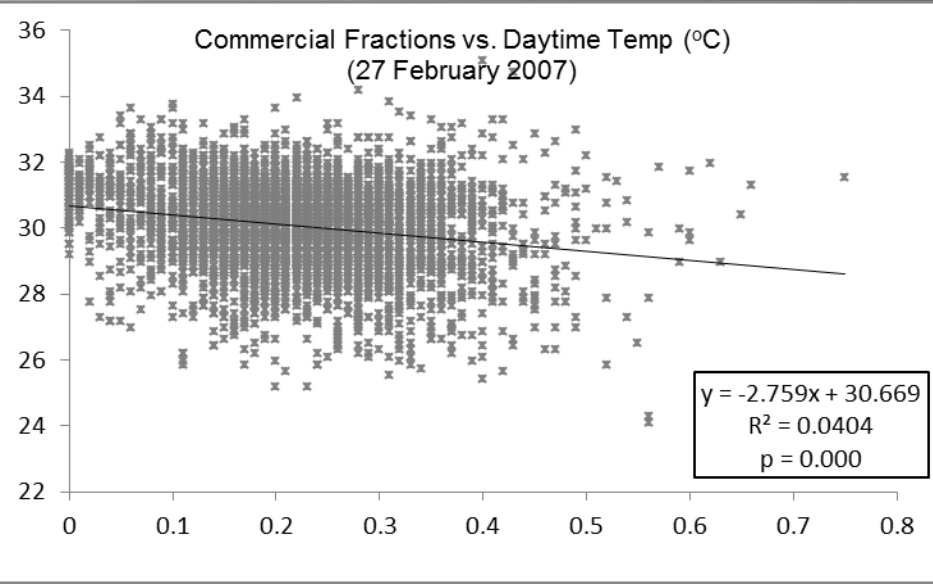
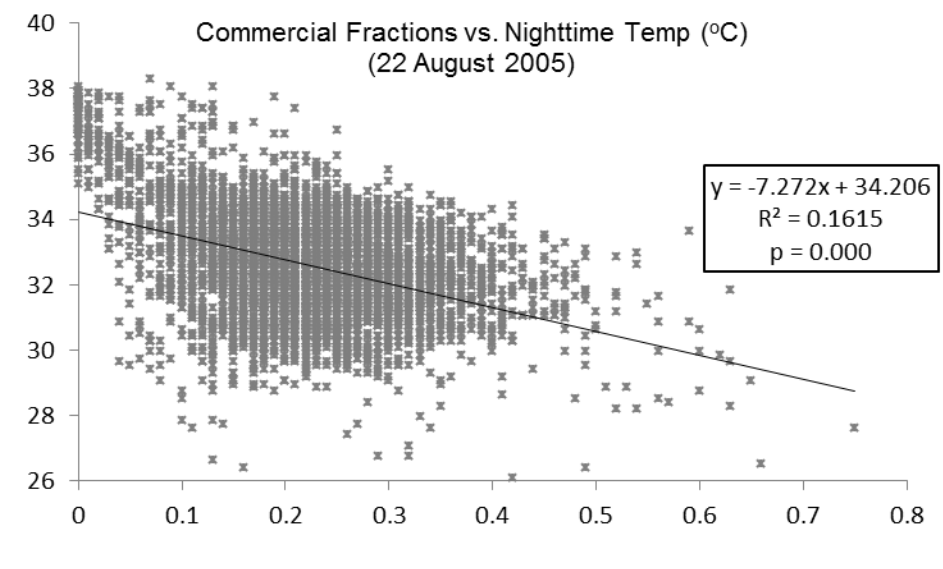
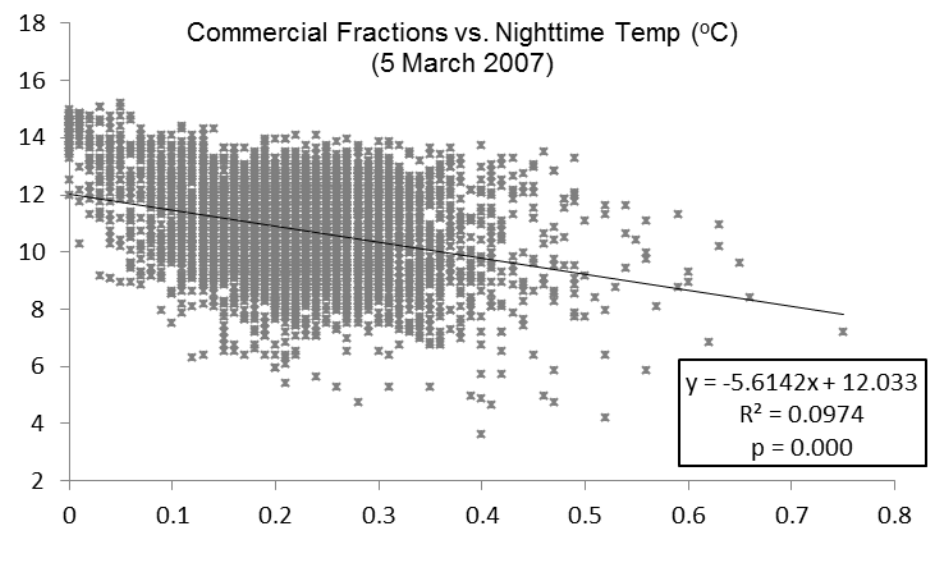
Unmanaged Soil



Buildings







Myint, S.W., E.A. Wentz, A.J. Brazel, and D.A. Quattrochi, 2013. The impact of distinct anthropogenic and vegetation features on urban warming, *Landscape Ecology*, 28:959-978.

These studies did not consider spatial arrangements.

Does spatial arrangements, spatial pattern, or spatial configuration play an important role?

Spatial Autocorrelation

- (1) Local Moran's I = measure of spatial arrangement.**
(dispersed \leftarrow ==== or ==== \rightarrow clustered)

$$I_i(d) = \frac{n(x_i - \bar{x})}{\sum_i (x_i - \bar{x})^2} \sum_j w_{ij}(d) (x_j - \bar{x})$$

- (2) Local Geary's C**

- (3) Getis G = measure of land composition. The Getis-Ord G measures the degree of local concentration of the attribute of interest (hot spot or cold spot).**

$$G_i^*(d) = \frac{\sum_j w_{ij}(d) x_j}{\sum_j x_j}$$

Spatial pattern?

0	0	0	0	0	0	0
0	1	1	1	1	1	0
0	1	1	1	1	1	0
0	1	1	1	1	1	0
0	1	1	1	1	1	0
0	1	1	1	1	1	0
0	0	0	0	0	0	0

(a) Extremely clustered
Moran's I = 0.5167

1	0	0	0	0	0	1
1	1	0	1	0	1	1
0	0	1	1	1	0	0
0	1	1	1	1	1	0
0	0	1	1	1	0	0
1	1	0	1	0	1	1
1	0	0	0	0	0	1

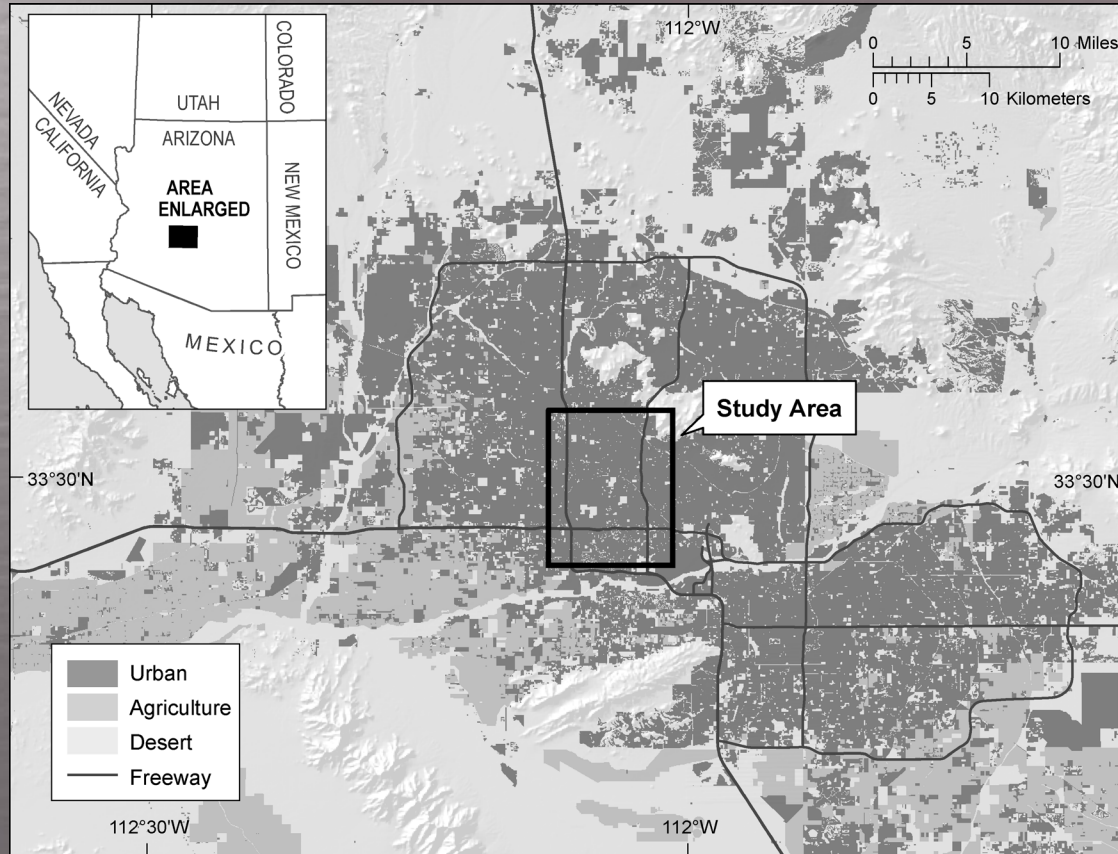
(b) Systematically arranged
Moran's I = 0.0461

1	0	1	0	1	0	1
0	1	0	0	0	1	0
1	0	1	1	1	0	1
0	1	0	1	0	1	0
1	0	1	1	1	0	1
0	1	0	0	0	1	0
1	0	1	0	1	0	1

(c) Extremely dispersed
Moran's I = -0.7142

Hypothetical images showing different spatial patterns of vegetation with the same amount of fraction: $25/49 = 51\%$.

Study area

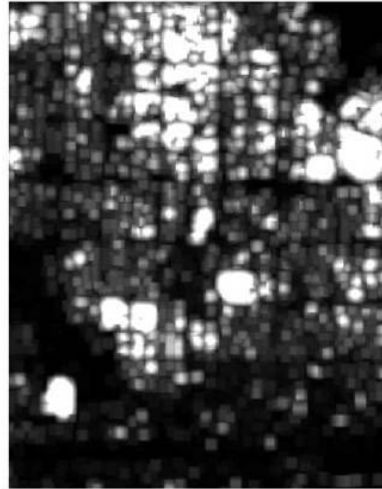


a. PLAND



Kilometers
0 0.5 1 2 3 4
High : 99.99
Low : 0.01

b. LPI



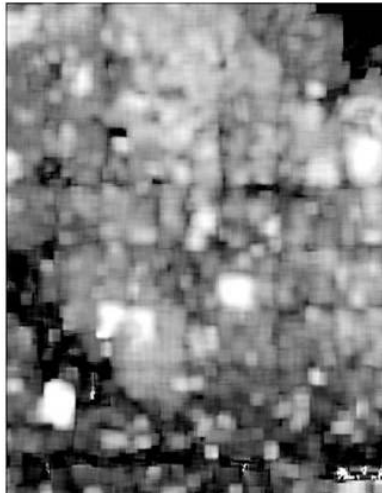
Kilometers
0 0.5 1 2 3 4
High : 99.99
Low : 0.01

c. PD



Kilometers
0 0.5 1 2 3 4
High : 1183.99
Low : 9.25

d. AI



Kilometers
0 0.5 1 2 3 4
High : 100.00
Low : 25.00

PLAND = Percentage of Landscape

LPI = Largest Patch Index

PD = Patch Density

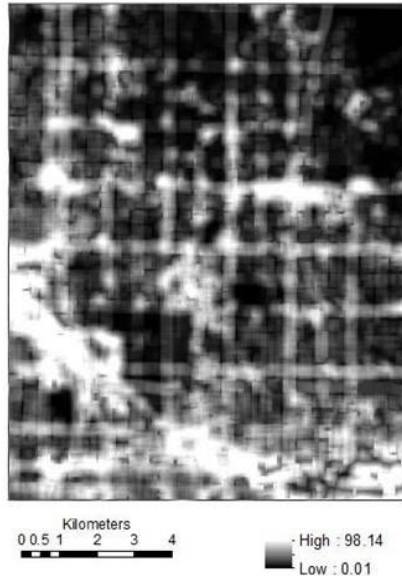
AI = Aggregation Index

Output raster grids of moving window analysis for vegetation class metrics derived from QuickBird imagery for Phoenix urban area on May 24, 2007: a. PLAND; b. LPI; c. PD; d. AI.

a. PLAND



b. LPI



c. PD



d. AI



PLAND = Percentage of Landscape

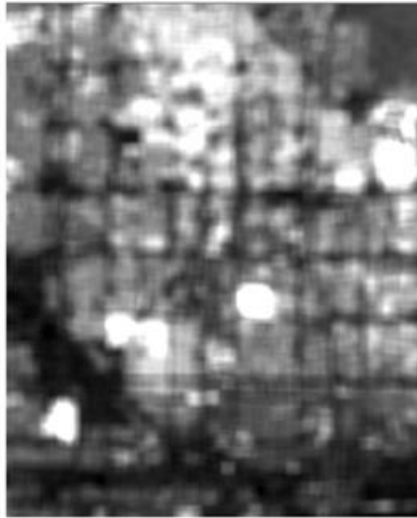
LPI = Largest Patch Index

PD = Patch Density

AI = Aggregation Index

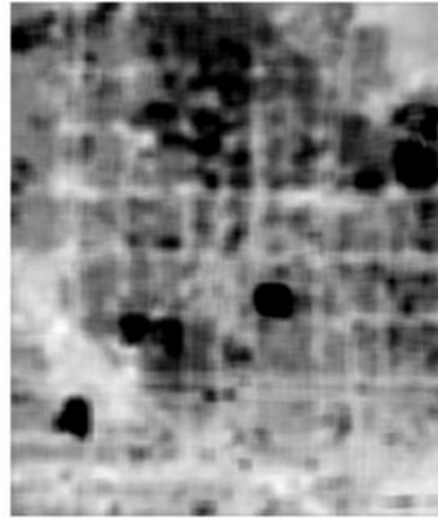
Output raster grids of moving window analysis for built-up class metrics derived from QuickBird imagery for Phoenix urban area on May 24, 2007: a. PLAND; b. LPI; c. PD; d. AI.

a. Getis of NDVI



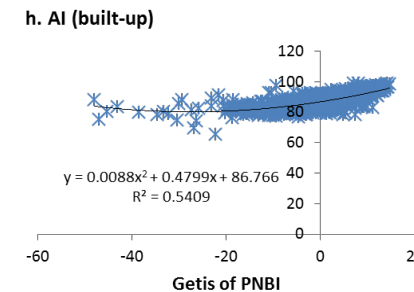
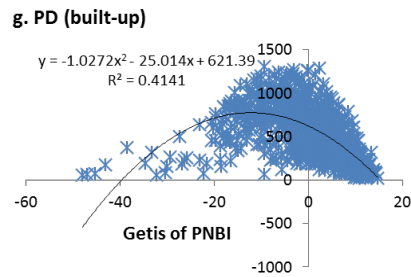
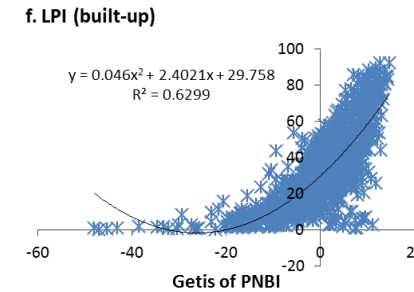
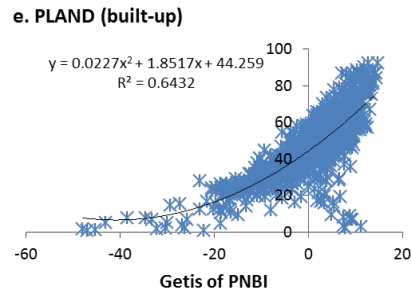
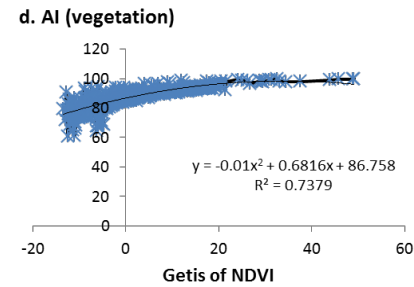
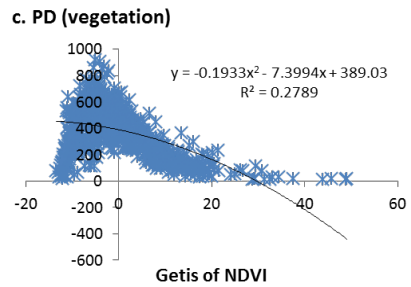
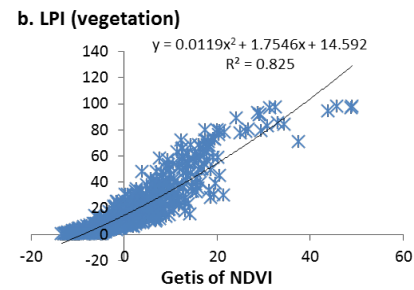
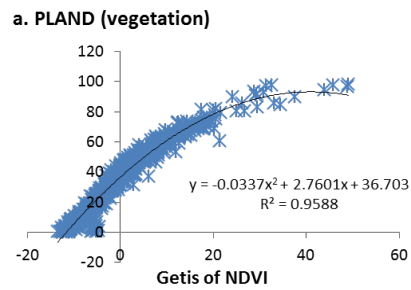
Kilometers
0 0.5 1 2 3 4
High : 52.41
Low : -14.30

b. Getis of PNBI



Kilometers
0 0.5 1 2 3 4
High : 17.12
Low : -53.66

Getis-transformed maps from Landsat TM imagery for Phoenix area on May 17, 2007: a. Getis of NDVI; b. Getis of PNBI



Scatterplots of class metrics vs. Getis statistics: a-d. vegetation class metrics vs. Getis of NDVI; e-h. built-up class metrics vs. Getis of PNBI

Regression statistics (n = 1,000)

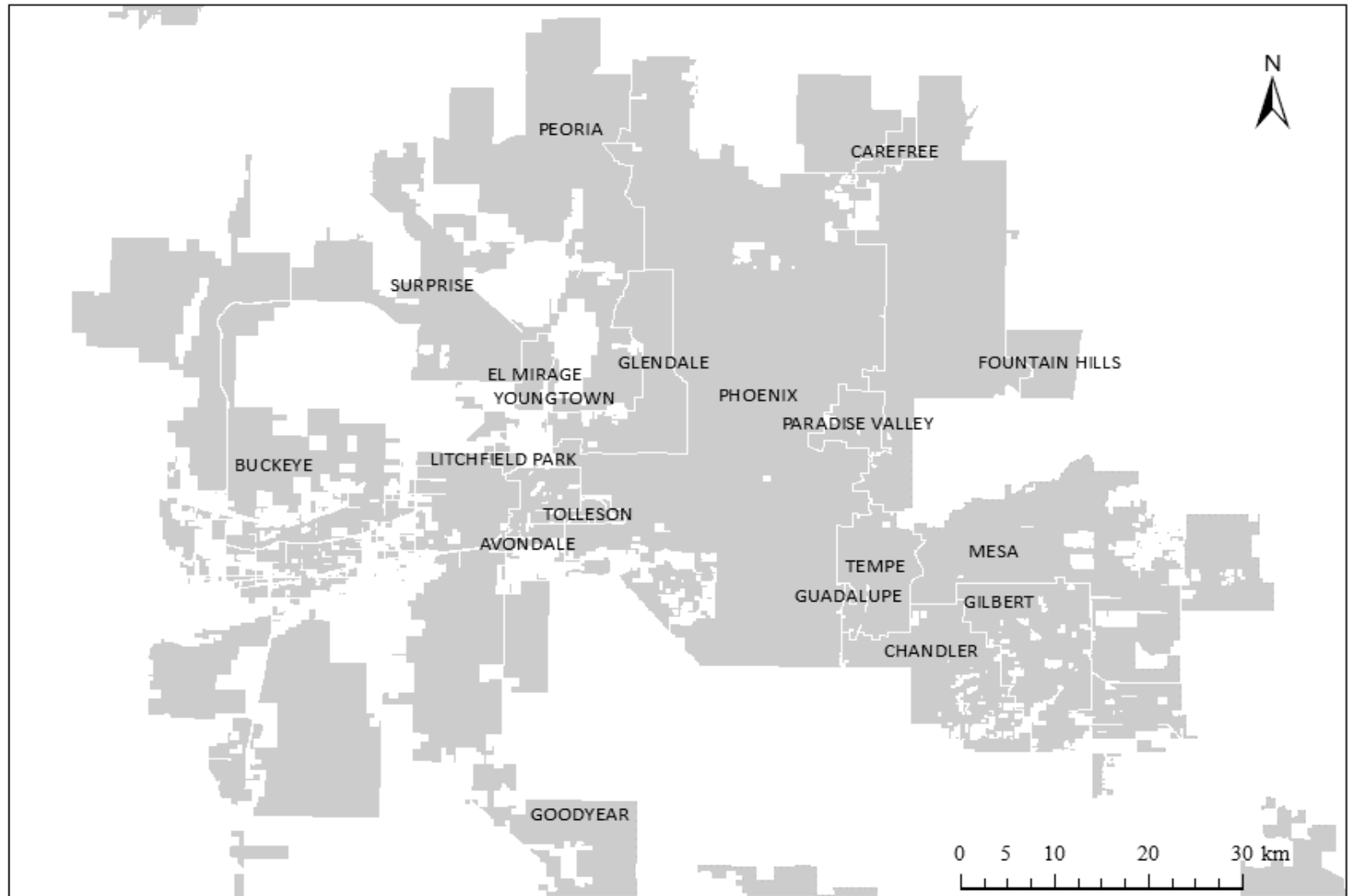
Statistics	CONTAG	LSI
R ²	0.380	0.247
Adjusted R ²	0.377	0.244
S.E.	8.855	2.217

Parameter estimates for multiple regression models (n = 1,000)

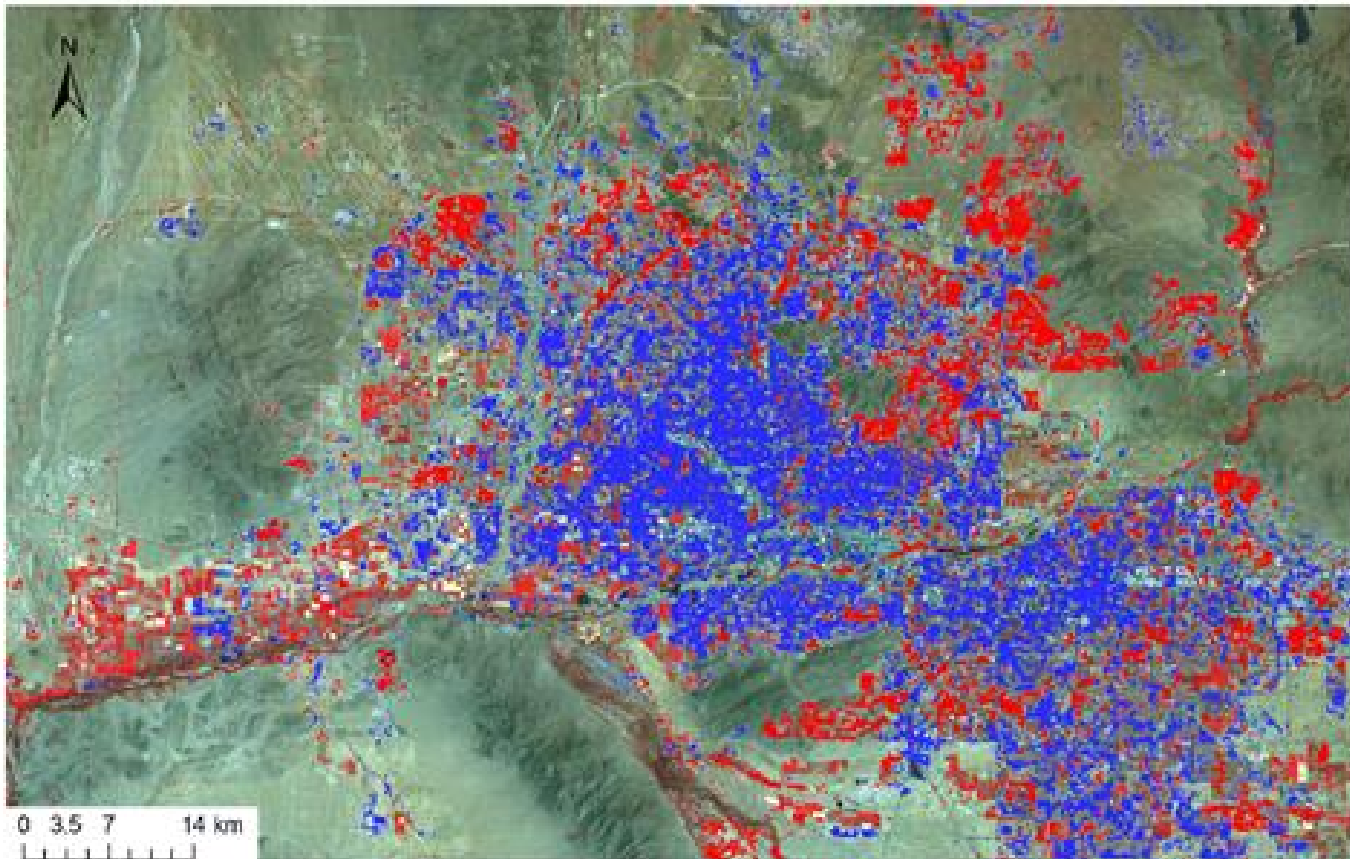
	Coefficients	Standard error	t-statistic	p-value
CONTAG				
Intercept	44.305	0.293	151.262	< 0.001
Getis of NDVI	5.366	0.379	14.161	< 0.001
Getis of PNBI	5.074	0.448	11.335	< 0.001
Getis of NDSI	-0.315	0.120	-2.623	0.009
LSI				
Intercept	10.693	0.073	145.849	< 0.001
Getis of NDVI	-1.253	0.095	-13.215	< 0.001
Getis of PNBI	-1.234	0.112	-11.014	< 0.001
Getis of NDSI	0.039	0.030	1.296	0.195

Fan, C. and Myint, S.W., 2014. A comparison of spatial autocorrelation indices and landscape metrics in measuring urban landscape fragmentation. *Landscape and Urban Planning*, 121, 117-128.

Study Area (Phoenix)



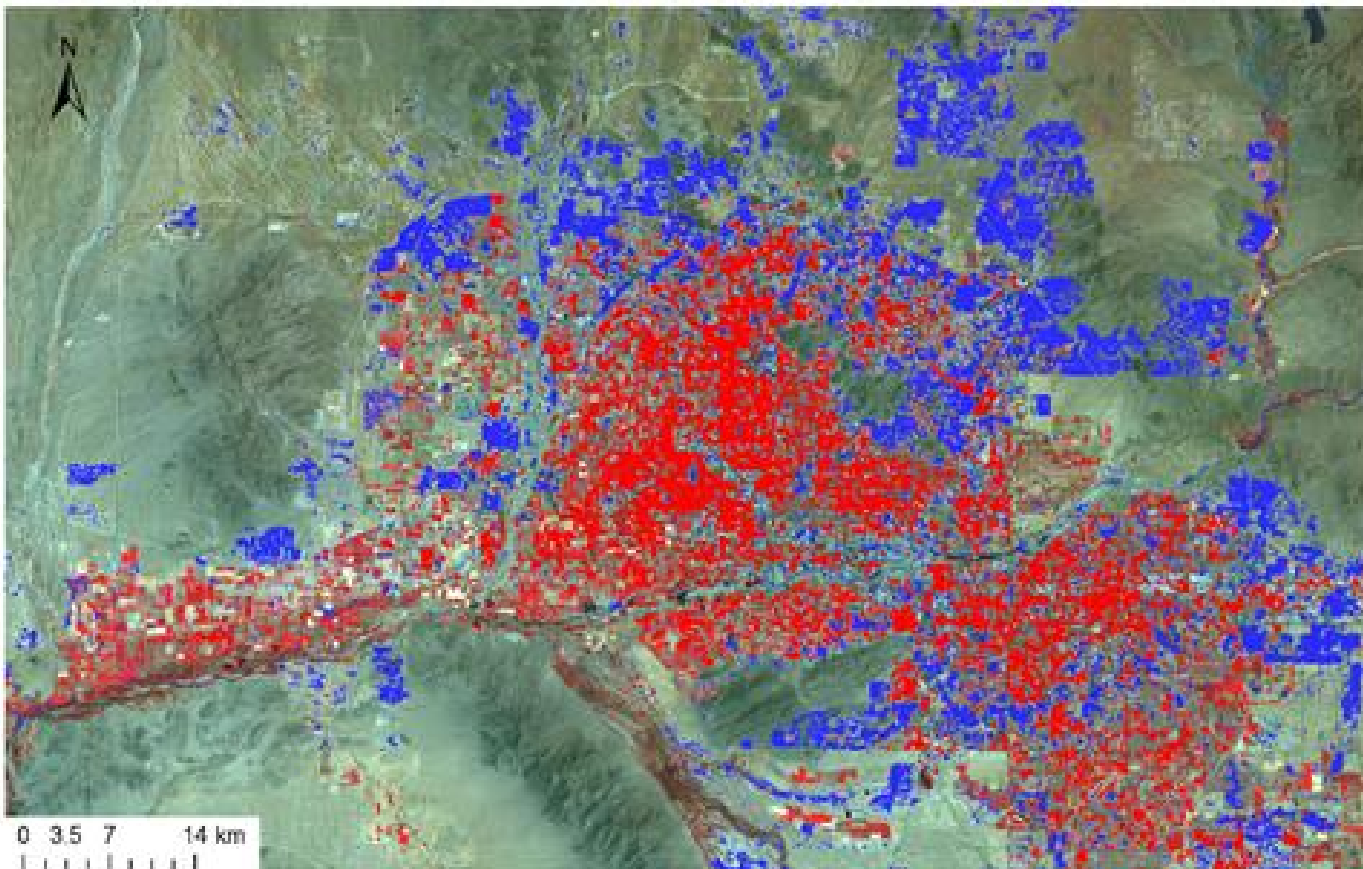
Spatiotemporal changes in vegetation abundance over the Phoenix metropolitan area (red: significant increase; blue: significant decrease).



Built-up area changes from 1991 to 2010

	Original	Significant
Built-up area increase (km ²)	1449.58	637.29
Percent area with built-up increase (%)	50.41	22.16
Built-up area decline (km ²)	1387.33	718.26
Percent area with built-up decline (%)	48.25	24.98

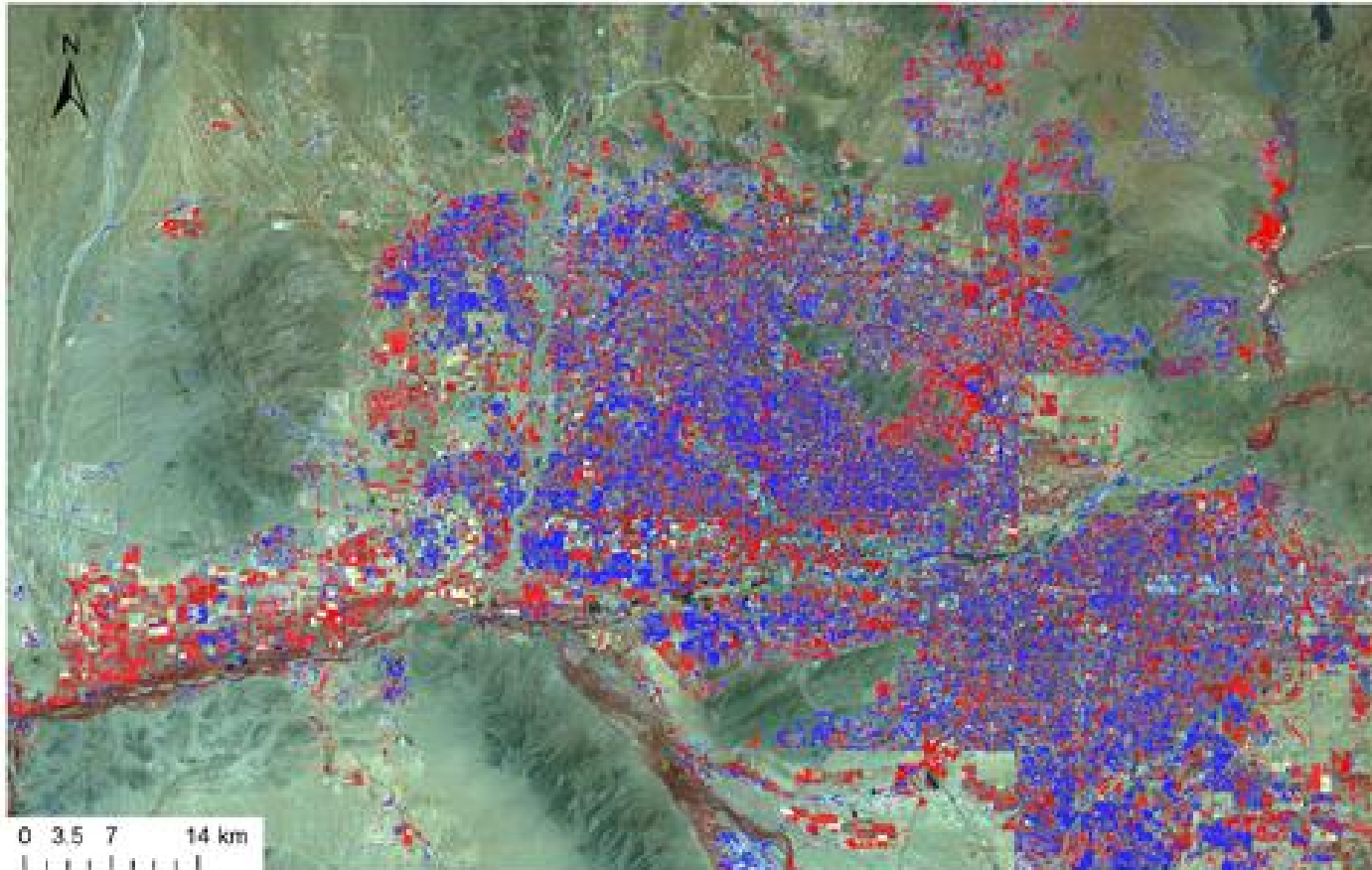
Spatiotemporal changes in built-up area abundance over the Phoenix metropolitan area (red: significant increase; blue: significant decrease)



Area and percent changes in the local Moran's I of NDVI from 1991 to 2010

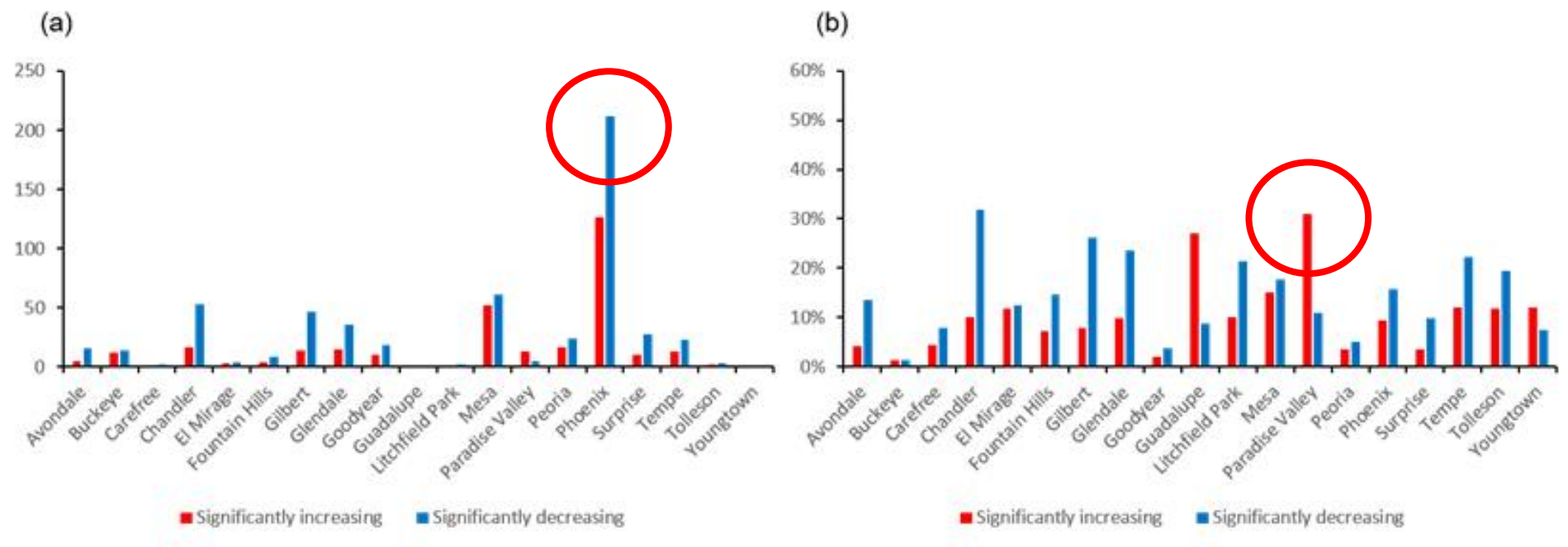
	Original	Significant
Area increase in local Moran's I (km ²)	1200.40	458.52
Percent area increase in local Moran's I (%)	41.75	15.95
Area decline in local Moran's I (km ²)	1634.91	703.54
Percent area decline in local Moran's I (%)	56.86	24.47

Spatiotemporal changes in the local Moran's I of NDVI over the Phoenix metropolitan area (red: significant increase; blue: significant decrease)

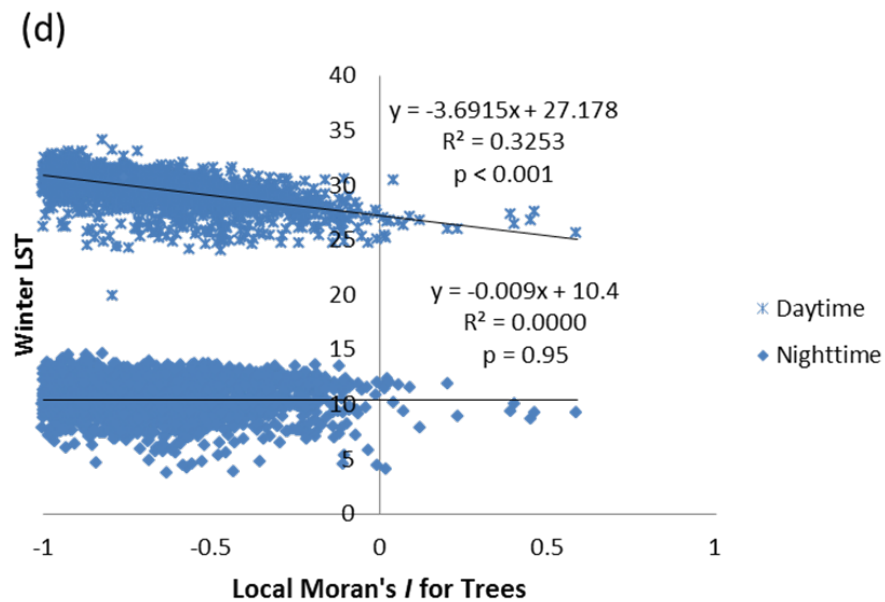
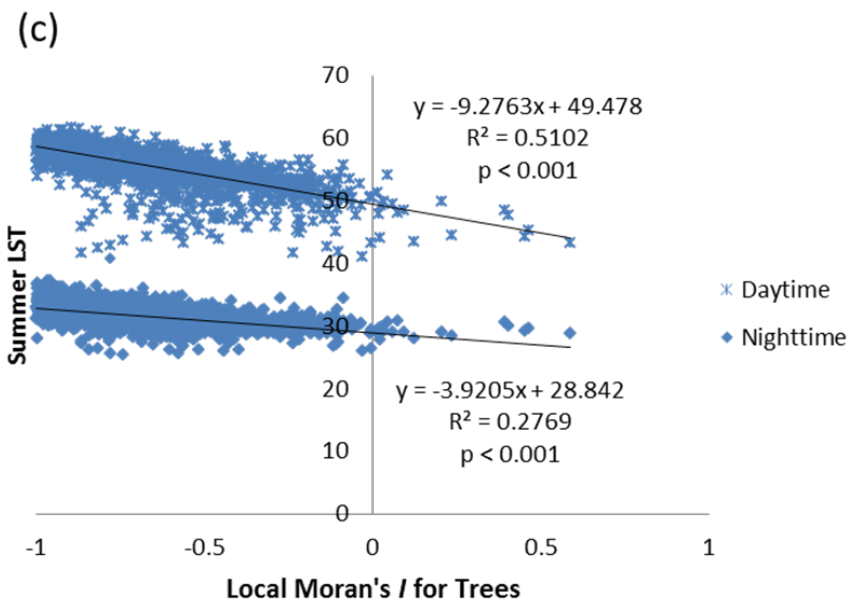
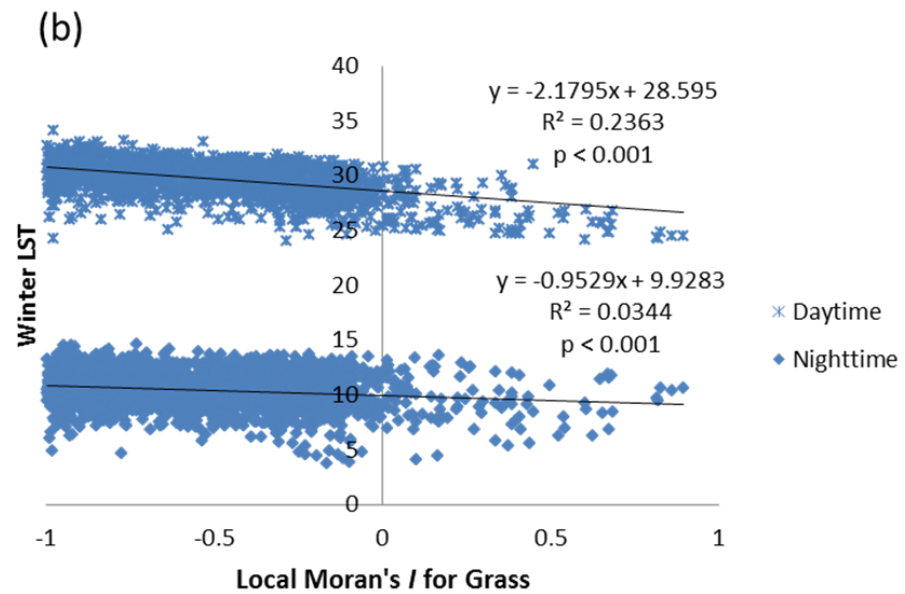
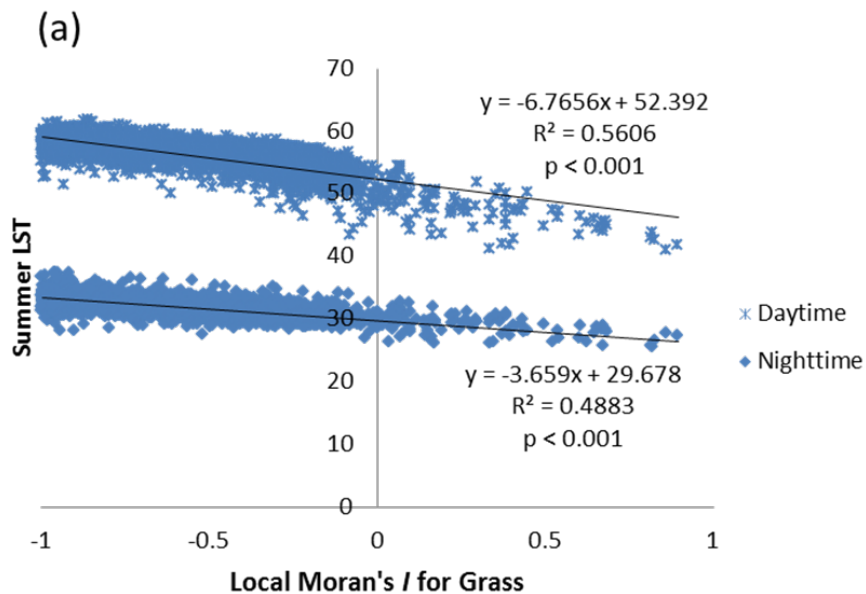


City level changes

Changes in the local Moran's I (NDVI) for major municipalities over the Phoenix metropolitan area: (a) area changes; (b) percent area changes.



Fan, C. and S.W. Myint, 2016. Time series analysis of urban dynamics using sequential Landsat imagery and spatial statistical modeling, *International Journal of Applied Earth Observation and Geoinformation*, 58:12-25.

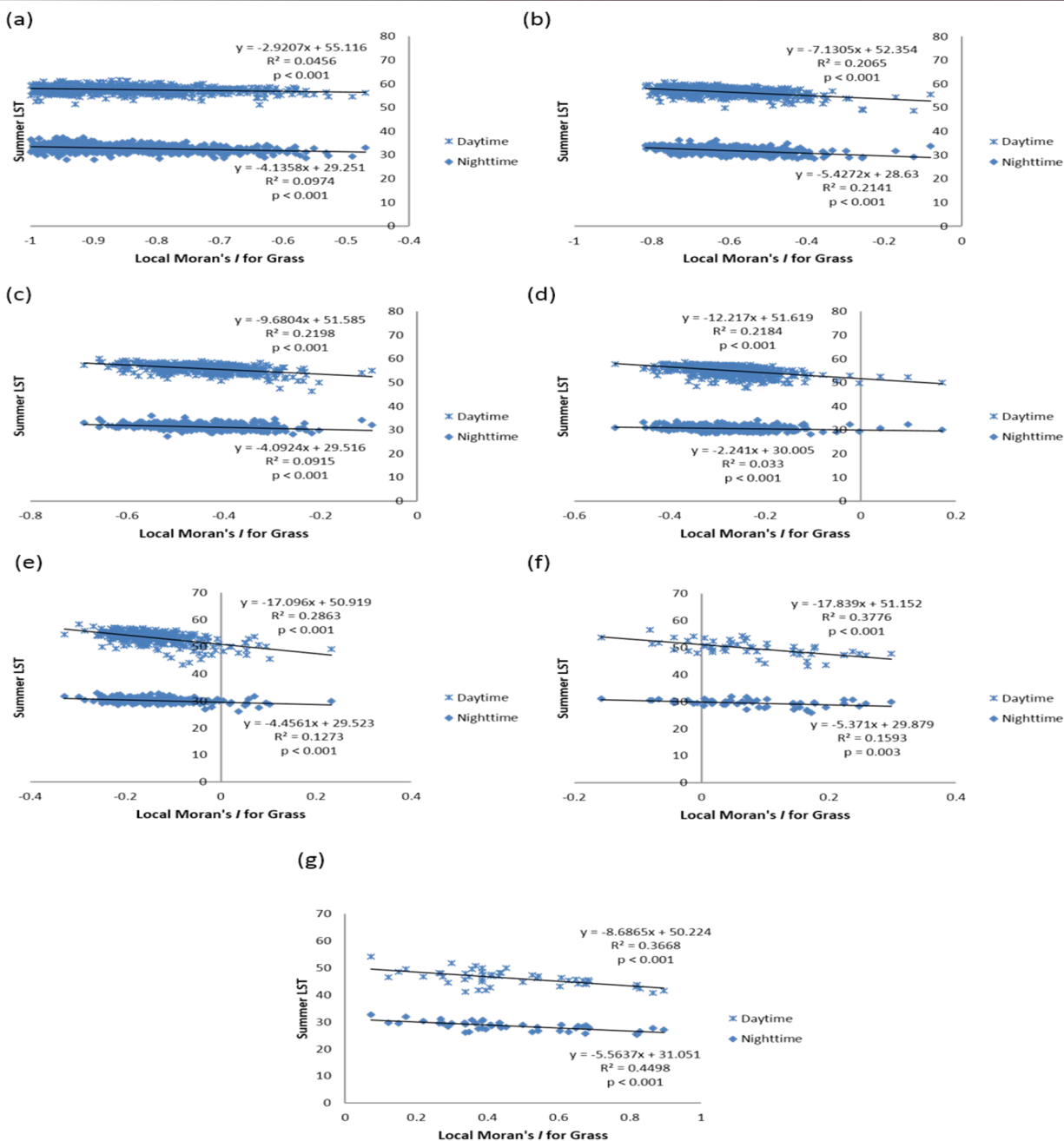


← Dispersed

Clustered →

← Dispersed

Clustered →



- (a) Grass fraction is 0-10%
- (b) Grass fraction is 10%-20%
- (c) Grass fraction is 20%-30%
- (d) Grass fraction is 30%-40%
- (e) Grass fraction is 40%-50%
- (f) Grass fraction is 50%-60%
- (g) Grass fraction is 60%-100%.

PS*	Land cover fraction %			Daytime	Nighttime	Local Moran's I'		n	
	GV†	Soil	Building	r	r	Min.	Max		
10-19	0-9	30-39	40-49	-	0.45	-0.74	-0.27	21	
		40-49	30-39	-	0.37	-0.69	-0.08	21	
		50-59	20-29	0.49	0.53	-0.77	0.13	19	
		60-69	10-19	-	0.43	-0.77	-0.33	22	
		80-89	0-9	-	0.33	-0.64	-0.25	16	
	20-29	0-9	50-59	0.51	0.43	-0.76	0.18	31	
		10-19	40-49	0.36	0.48	-0.83	-0.15	48	
		30-39	0-9	40-49	-	0.38	-0.81	-0.15	49
		10-19	30-39	-	0.51	-0.81	-0.17	122	
	40-49	20-29	10-19	-	0.38	-0.86	0.08	245	
		30-39	0-9	-	0.34	-0.78	-0.21	20	
		50-59	20-29	10-19	-	0.36	-0.83	-0.16	58
		70-79	0-9	10-19	-	0.34	-0.85	0.18	133
	80-89	0-9	0-9	0.53	0.60	-0.68	-0.28	27	
20-29	0-9	20-29	40-49	0.34	-	-0.69	0.13	33	
	10-19	40-49	10-19	-	0.37	-0.73	0.07	72	
	20-29	0-9	40-49	0.36	0.31	-0.62	0.02	43	
	0-9	30-39	-	0.46	-0.69	-0.06	68		
	30-39	10-19	20-29	-	0.41	-0.77	0.03	198	
		20-29	10-19	-	0.33	-0.69	0.08	135	
		30-39	0-9	-	0.51	-0.71	-0.15	36	
	40-49	10-19	10-19	-	0.33	-0.77	0.06	242	
		20-29	0-9	-	0.39	-0.71	0.03	38	
		50-59	10-19	0-9	-	0.38	-0.75	0.10	78
30-39	20-29	30-39	0-9	0.34	0.35	-0.70	0.16	41	
40-49	0-9	40-49	0-9	-	0.33	-0.31	0.21	47	
		50-59	0-9	-	0.43	-0.28	0.28	25	
	10-19	10-19	30-39	0.31	-	-0.43	0.20	116	
	20-29	0-9	20-29	-	0.39	-0.37	0.19	57	
		20-29	10-19	0.36	0.48	-0.38	0.24	38	
50-59	0-9	40-49	0-9	-	0.53	-0.09	0.37	44	
	30-39	0-9	0-9	-	0.38	-0.19	0.36	22	
60-69	0-9	20-29	0-9	-	0.30	0.01	0.55	73	
		30-39	0-9	0.33	0.47	0.06	0.60	47	
	10-19	0-9	10-19	-	0.32	-0.03	0.48	55	

Zheng, B., Myint, S.W., and C. Fan, 2014. Spatial configuration of anthropogenic land cover impacts on urban warming, *Landscape and Urban Planning*, 130(2014):104-111.

Conclusion

Spatial arrangements of land cover or land use play an important role.

We have developed spatial algorithms that work on both binary and continuous data.

Thank you