Neighborhood Ecosystems: Human-Vegetation-Climate Interactions in a Desert Metropolis

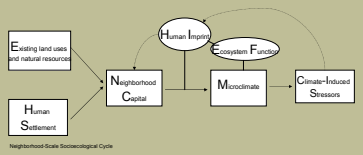
Nancy Jones, Anthony Brazel, Chris Eisinger, Sharon Harlan, Brent Hedquist, Sara Grineski, Darrel Jenerette, Larissa Larsen, Matthew Alan Lord, John Parker,

Lela Prashad, William L. Stefanov and Danielle Ziegler

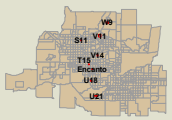
I. Introduction

This project investigates the interactions of human activities and biophysical-climatological processes on a neighborhood-scale in the Phoenix, AZ metropolitan area. We have performed a pilot comparison of vegetation abundance, ground temperatures, and climatic variables (air temperature, humidity, and levels of shade) with demographic data (income level, ethnicity, etc.) and neighborhood vegetative indices (NDVI and SAVI) as part of an REU NSF summer project. Our initial results from six of the eight neighborhoods did not suggest a strong correlation between physical and social variables possibly due to the narrow variability of biophysical neighborhood characteristics among the sites chosen.

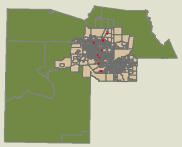
We are currently in the process of reconstructing the history of human, ecological and climate variables to define the dominant community makeup of eight neighborhoods. This is also being conducted at census tract and block group levels to place the neighborhoods in context within the CAP-LTER region.



Neighborhood-Scale Socioecological Cycle



Neighborhoods in the Region



Region within Maricopa County

II. Regional Scale

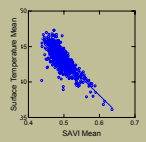
In order to place the neighborhoods in this study in a broader context, a regional-scale analysis is being conducted. Driving this research is the question: What are the relationships between changes in population distributions, vegetation and temperature? Do socioeconomic variables correlate with surface temperature and soil adjusted vegetation index (SAVI)?

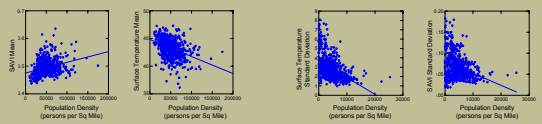
To approach this, we are analyzing the variation in biophysical and socioeconomic data among census tracts within the CAP-LTER region.

Examples of Ongoing Analysis

	SAVI Mean	Surface Temp Mean
Population Density	-.134	.189
% Hispanic	-.235	.41
Median Household Income	.30	-.39

Examples of significantly correlated variables (p < .05)



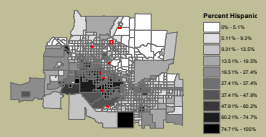


Preliminary Analysis

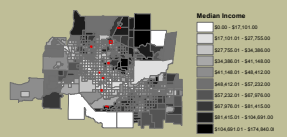
- There is a strong correlation between SAVI and surface temperature among census tracts in the CAP-LTER region. In addition to this biophysical relationship, SAVI and surface temperature are also related to various socioeconomic patterns.
- Population density is inversely related to variability of surface temperature and SAVI; as populations increase, biophysical variability decreases. It appears that people do influence the spatial pattern of the environment.

Further analysis is being conducted among census tract level and block group level data that will enhance the understanding of data at the neighborhood scale.

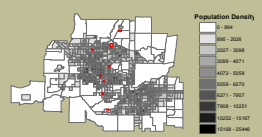
Examples of Socioeconomic Variables among Census Tracts (N=647, Year 2000)



Percent Hispanic per Census Tract

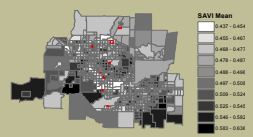


Median Income per Census Tract

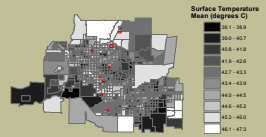


Population Density per Census Tract (persons per Square Mile)

Examples of Biophysical Variables among Census Tracts (N=647) Based on Landsat thermal image, June 9, 2001, 10:45 a.m.



SAVI Mean per Census Tract (Soil Adjusted Vegetation Index)

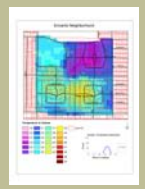


Surface Temperature Mean per Census Tract

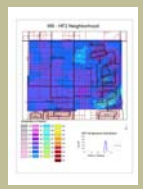
III. Neighborhood Scale

This study is investigating eight neighborhoods within the City of Phoenix. These are included in the Phoenix Area Social Survey (PASS) and are classified as being High-income, Middle-income and Low-income within the urban core, suburban areas, and the fringe. Data has been collected for the same variables used in the regional analysis. It is currently being assembled to characterize each neighborhood. Initially, we are looking for patterns similar to those at the regional scale while defining socioecological differences between the neighborhoods.

Neighborhood	SAVI Mean (Mean, Min, Max)			Surface Temperature ° C (Mean, Min, Max)		
W9	.477	352	599	44.647	40	49
V11	.461	.371	.831	44.104	35	53
S11	.472	.276	.642	45.136	36	49
V14	.483	.298	.663	42.923	38	47
T15	.472	.341	.714	44.586	33	49
Encanto	.568	.351	.777	39.604	32	46
U18	.485	.328	.673	45.274	41	48
U21	.469	.414	.636	41.052	36	47



Landsat Image, dated June 9, 2001 (10:45 a.m.)



Landsat thermal Image, dated April 8, 1993 (a.m.)

Preliminary Research

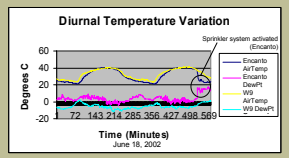
The neighborhoods are being characterized by biophysical and socioeconomic data. Early results show that there is little variability in year 2001 remote sensed data between the neighborhoods. Historic data is being analyzed to determine temporal changes. These biophysical characteristics will be merged with socioeconomic data covering the same period. The graphics presented here indicate biophysical variation between neighborhoods.

IV. A Tale of Two Neighborhoods

Two of the study sites, Encanto and W9 represent the extreme differences among the neighborhoods. Encanto is located in the urban core, is designated as historic, and is flood irrigated. W9 is located on the northern fringe of the city, composed of a mix of horse properties and subdivisions, consisting of xeric landscapes.

Encanto Neighborhood

W9 Neighborhood



This graph highlights the microclimatic differences between the two neighborhoods. The flood irrigated, urban core neighborhood maintains slightly lower air temperatures, while having an elevated dew point. Note the changes that occur during an irrigation incident at the Encanto residence. This suggests variability in human comfort level due to the humidity factor. Other differences are illustrated in the following table.

	Encanto (mesic)	W9 (xeric)
Mean Air Temperature (°C)	31 (range 21 – 40)	33 (range 23 – 41)
Mean Dew Point (°C)	4 (range -5 to 18)	-6 (range -12 to -12)
Discomfort*	85 (range 60 to 110)	80 (range 58 to 100)
UV exposure	6 hours	12 hours

* Real Comfort Index = (T+0.5(T−55) - \|w + S\); T = air Temperature °F; T_d = dew point °F; w = wind in knots; S = sun factor (12=daytime, 0=night)

<80 comfortable; 80-90 some fatigue if long exposure; 90-100 possible heat exhaustion over long duration; 105-130 likely sunstroke, heat stroke if prolonged exposure

V. Moving Forward

As characterization continues at the neighborhood scale, analysis is being performed on regional data.

IGERT Workshop – Several students and faculty are collaborating to look at physical and climatic characteristics of the eight neighborhoods and how change in these factors is associated with demographic shifts over time.

Additional research will seek to understand equity related to socioecological patterns among neighborhoods. There is also potential for this research to provide influential knowledge to stakeholders for use in more effective socioecological planning of neighborhoods and regions.

Funded by NSF Grant # 0216281