Linking Urban Heat Island Research to Community-based Greening Efforts: Collaborative Research in Community Partnership

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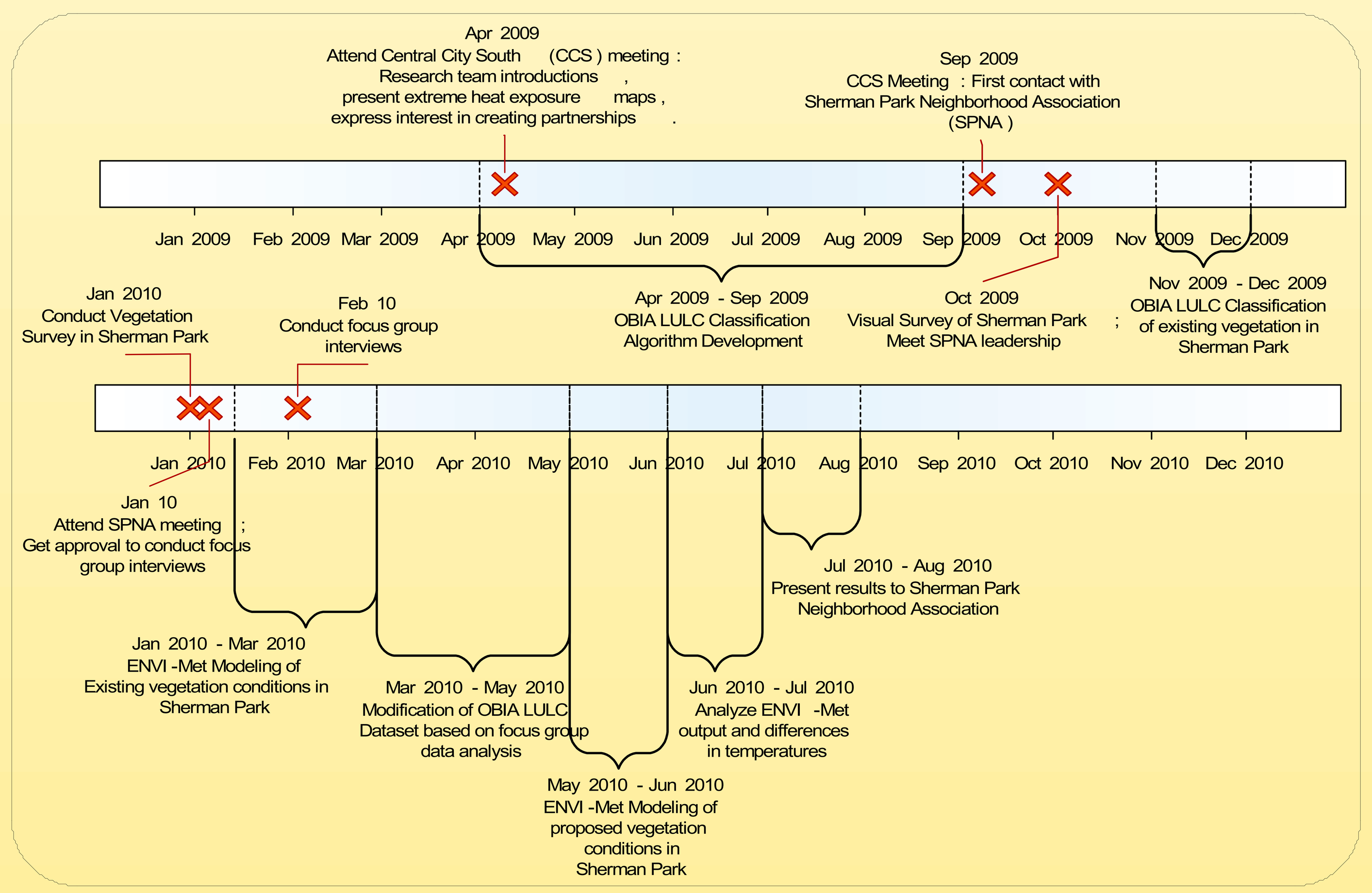
Introduction

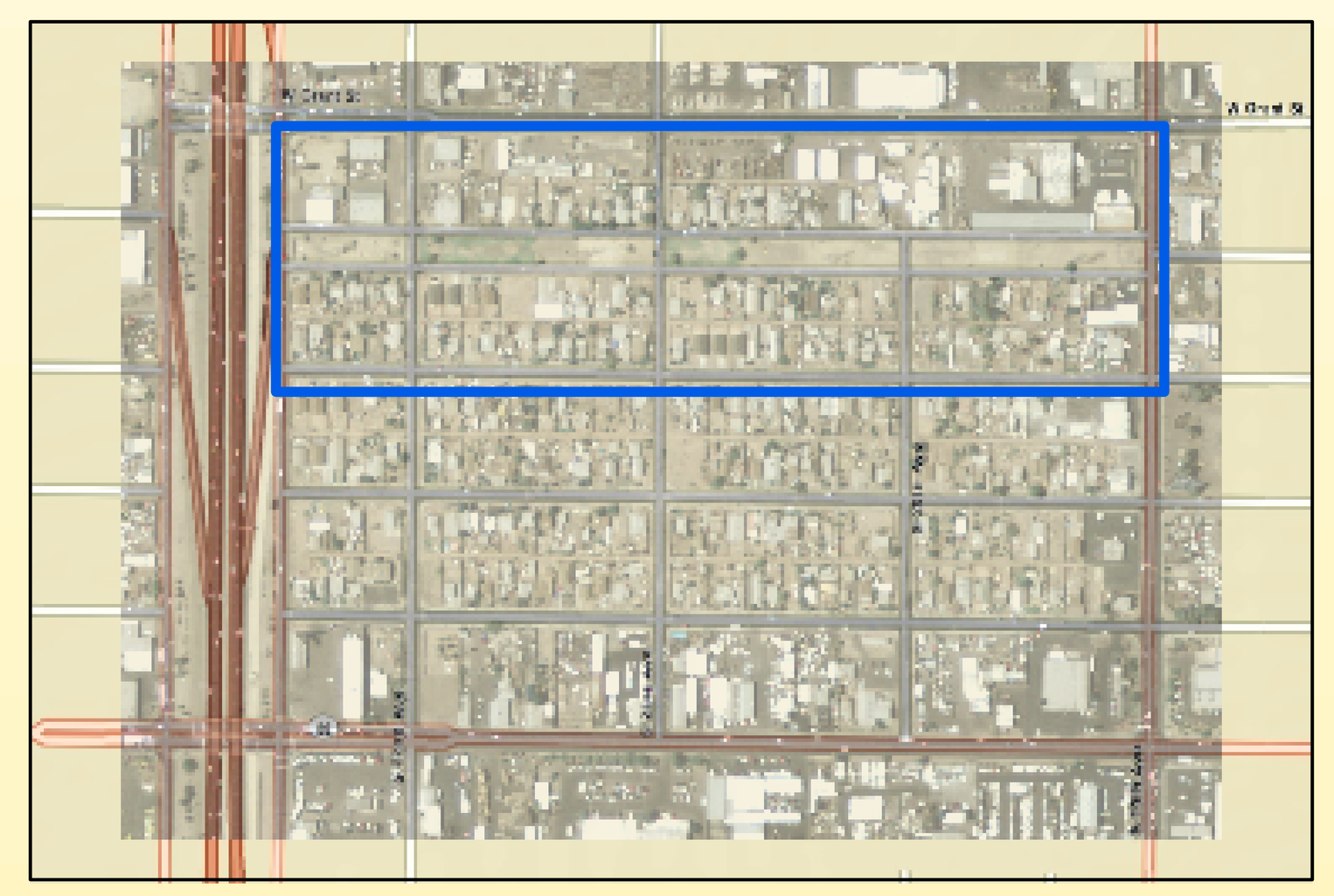
Mitigation of the Urban Heat Island (UHI) is one of the most pressing concerns of environmental scientists in urban environments. Recent research shows that vulnerability to the UHI is mediated by socio-economic status and the presence (or absence) of trees and grass in neighborhoods. Residents of the communities most affected by the UHI often have valuable insights about how increasing urban vegetation could improve their local environment and help mitigate UHI. In this research, we attempt to link UHI modeling to such local knowledge in order to provide valuable information to a historically marginalized community in inner-city Phoenix, Arizona.
We conduct microclimate simulations of urban canopy layer interactions with vegetation, soil, and surfaces under two vegetation regimes: the study area's current vegetation cover, and a proposed vegetation regime, informed by residents' stated quality of life goals and historical knowledge of their neighborhood.

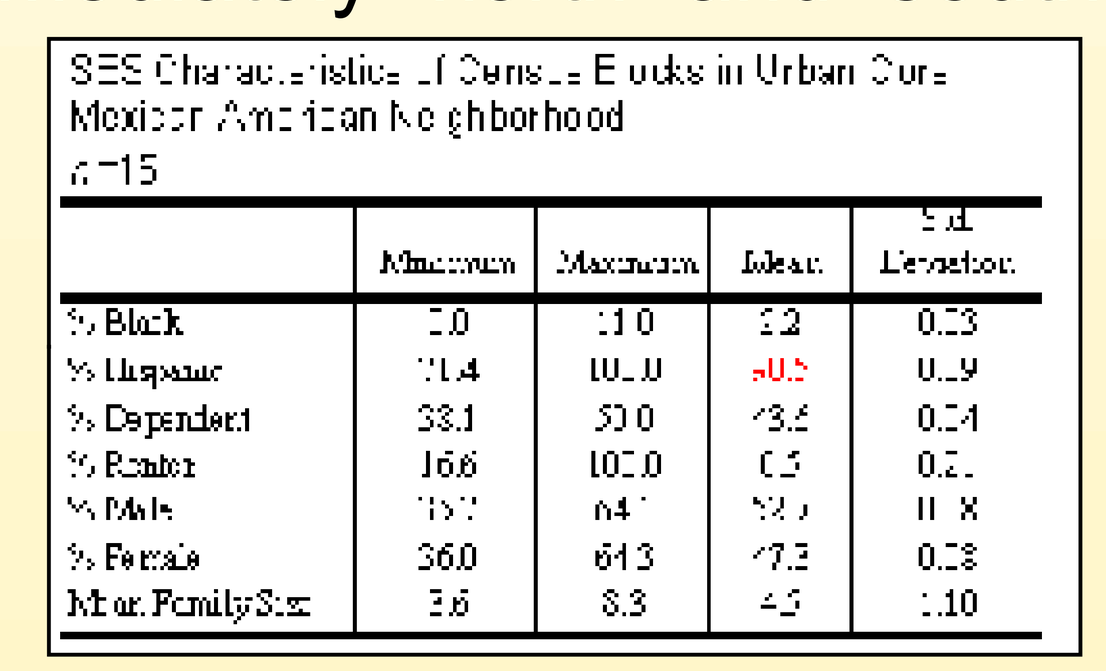
Participatory Research Timeline



Study Area

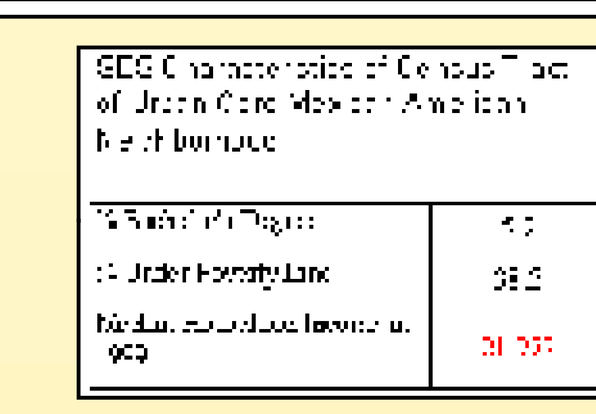
The Sherman Park neighborhood is a predominantly low-income Hispanic neighborhood in the urban core south of downtown Phoenix. The neighborhood has very little vegetation, and is bounded by industrial land uses to the north, south, and east, and by the Interstate 17 to the west. A central feature of the neighborhood is a linear park space almost entirely devoid of vegetation. We focus our analysis on the park, and also on the industrial and residential blocks immediately north and south.





SES Characteristics of Census Blocks in Urban Core Mexican American Neighborhood
n=15

	Minimum	Maximum	Mean	Std. Deviation
% Black	0.0	[illegible]	[illegible]	0.03
% Hispanic	71.4	100.0	[illegible]	[illegible]
% Dependent	33.1	50.0	[illegible]	0.04
% Renter	16.6	100.0	[illegible]	[illegible]
% Male	[illegible]	[illegible]	[illegible]	[illegible]
% Female	36.0	64.3	[illegible]	0.08
Mean Family Size	3.6	8.3	[illegible]	[illegible]

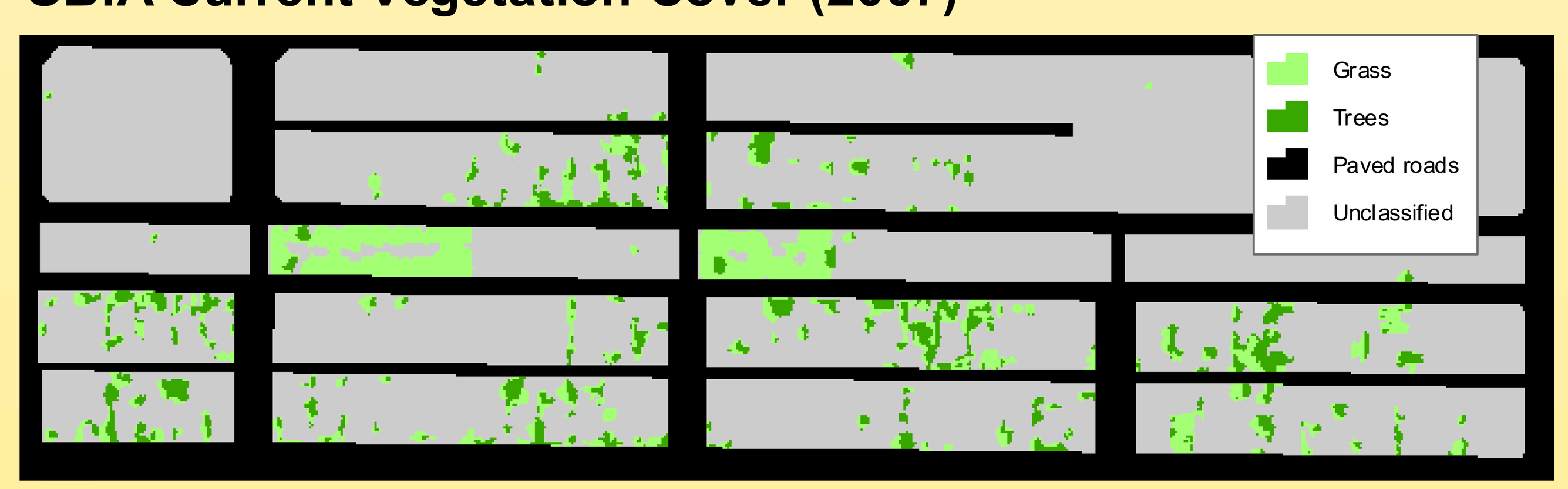


SES Characteristics of Census Tract of Urban Core Mexican American Neighborhood

[illegible]	[illegible]
% Under Poverty Line	[illegible]
[illegible]	[illegible]

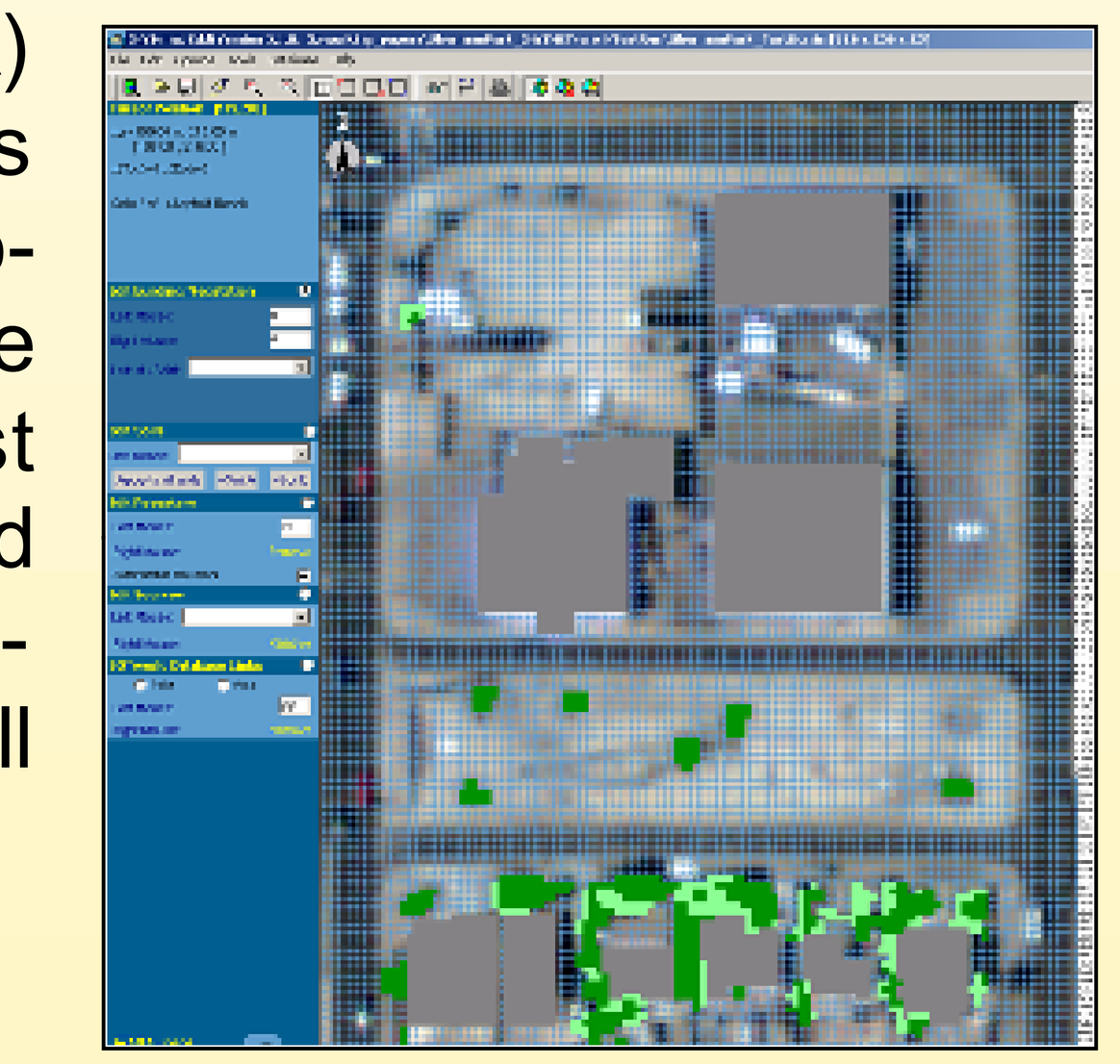
True Color Aerial View (2007)

OBIA Current Vegetation Cover (2007)



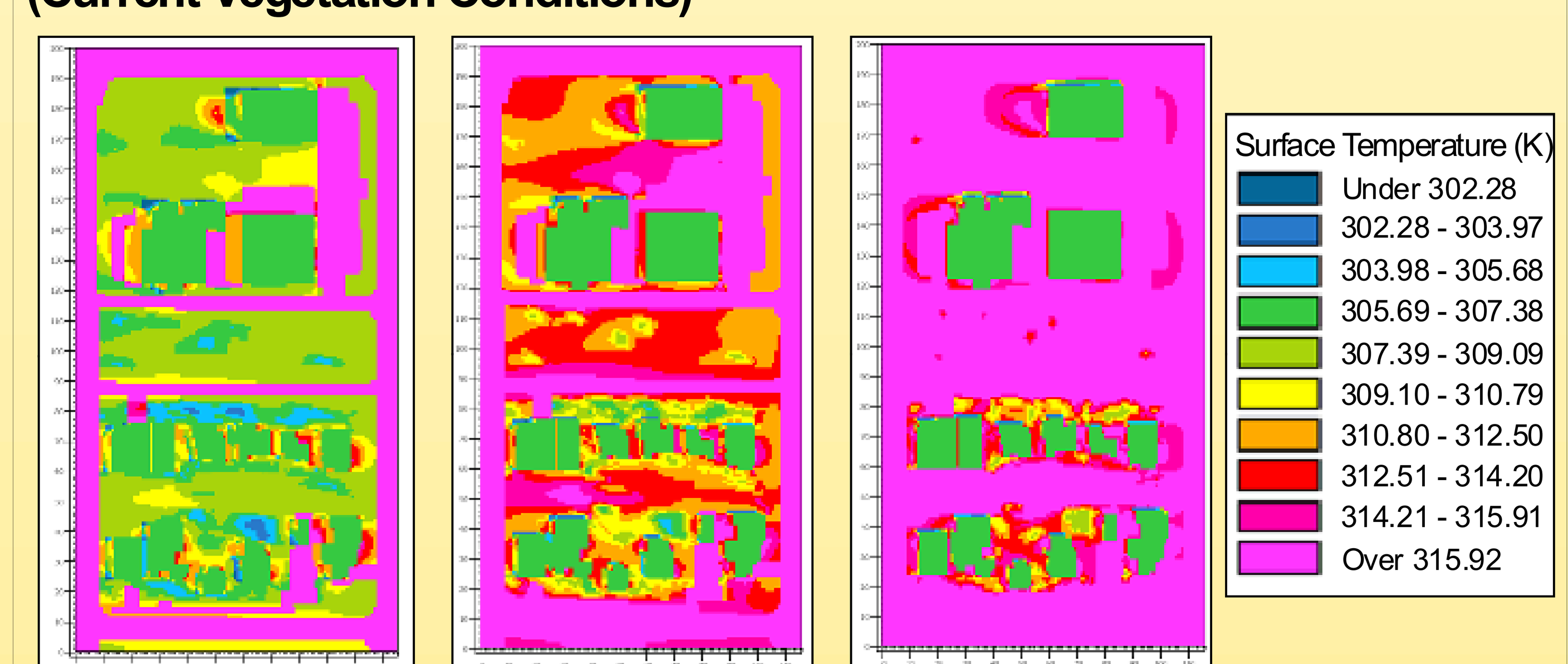
Urban Heat Island Modeling

We conduct microclimate simulations in the ENVI-Met 3.1 modeling system to evaluate the impact of vegetation in reducing extreme temperatures. The modeling system divides a study area into cells, at which temperature, air flow, and other indicators are predicted based on user-provided initial atmospheric conditions.
We developed a 1-meter pixel size Object-Based Image Analysis (OBIA) land cover dataset for Sherman Park. This dataset is input into the ENVI-Met microclimate modeling system to characterize soil, vegetation, and buildings. We first model air temperatures during a recorded heatwave event in the city, under vegetation conditions current in 2007. We will then alter the land cover classification based on focus group interviews with neighborhood residents, and run the model again. We will then map the temperature and human thermal comfort results and compare the differences.



ENVI-MET Input Area File

Preliminary Results for Surface Temperature (K) of 17 July 2005 Test Run (Current Vegetation Conditions)



10:00 AM 11:00 AM 12:00 PM

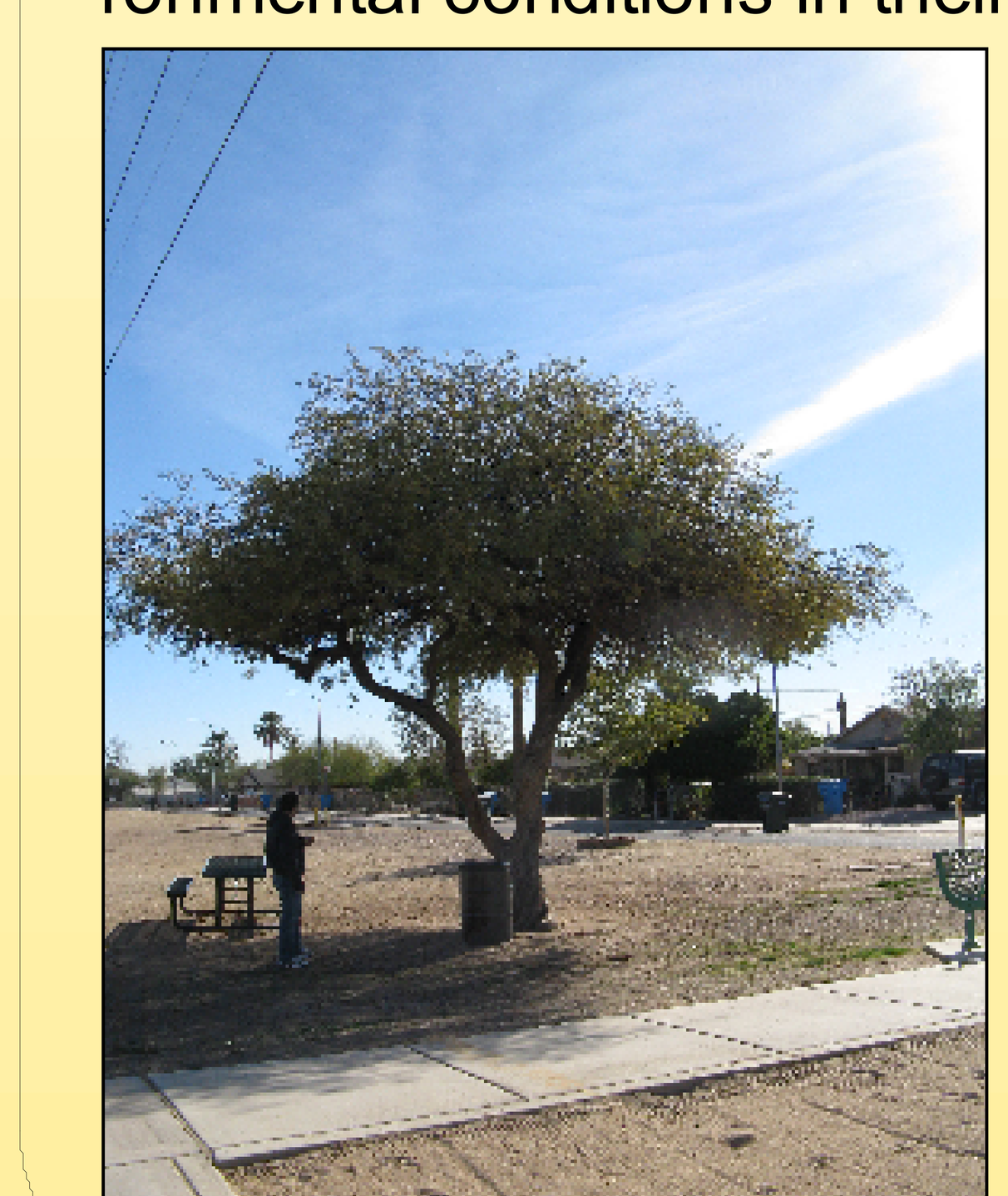
Research Contributions

This study contributes to both urban climate and participatory research literature. It offers an innovative microclimate modeling exercise by integrating an OBIA-derived land cover dataset into the ENVI-Met framework.

Using participatory research methods, the study will implement localized environmental knowledge and history into a neighborhood's vision of the park's past vegetation regime, and how it contributed to extreme heat mitigation. Focus group interviews can help build a consensus around a future vision of park vegetation to support the community's stated Quality of Life goals.

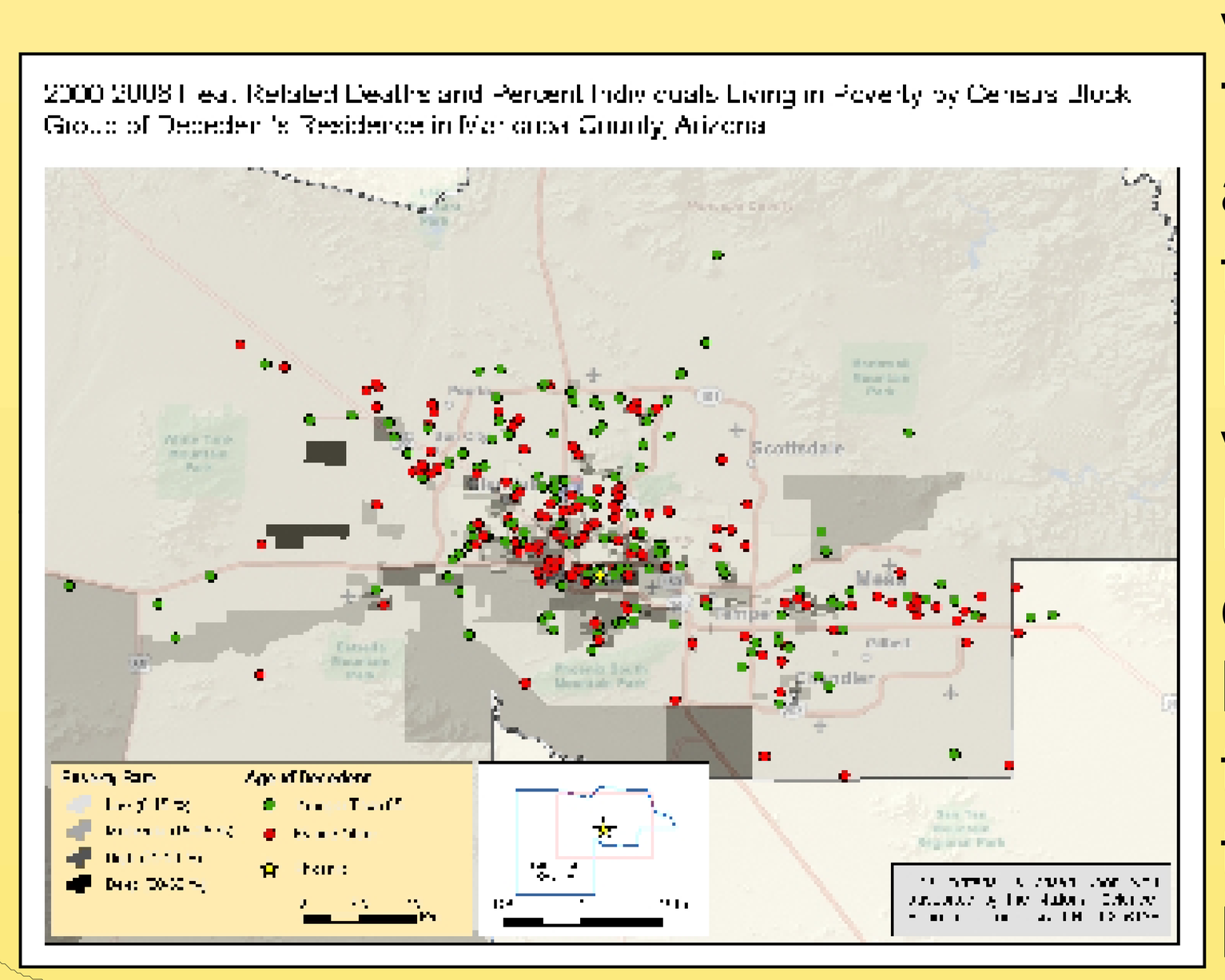
In addition to peer-reviewed journal articles, this research will be made available to the Sherman Park neighborhood through a professional report that describes the research, summarizes findings, and offers recommendations for extreme heat mitigation.

Finally, the participatory research component of this urban microclimate investigation furthers advocacy goals of social and biophysical scientists in extreme heat vulnerability mitigation by partnering with communities that are interested in improving environmental conditions in their neighborhoods.



Extreme Heat and Public Health in Phoenix, Arizona

Extreme high temperatures significantly impact human health and comfort. Phoenix, with high temperatures during the summer, led the U.S. in heat-related deaths from 1993 to 2002. The summer of 2005 was particularly deadly, claiming the lives of at least 18 people, the majority of which were homeless. Increasingly, scientists are looking at vulnerability to extreme heat as a socio-spatially differentiated condition.



The map below shows the spatial relationship between heat-related mortality, age, and poverty in metro Phoenix. Elderly decedents are concentrated in the central areas of the city, where much of the poverty is also concentrated. Poor neighborhoods in Phoenix are more exposed because of little or no vegetation to reduce extreme temperatures.
Research also suggests that increased vegetation can provide temperature reductions in neighborhood microclimates. Our research investigates the potential human thermal comfort improvements that additional vegetation can provide to a neighborhood with sparse vegetation.

References

1. Harlan, S., Brazel, A.J., Prashad, L., Stefanov, W.L., and Larsen, L. 2006. Neighborhood climates and vulnerability to heat stress. Social Science & Medicine 63:2847-2863.

2. Austin, D. 2004. Partnerships, not projects! Improving the environment through collaborative research and action. Human Organization 63(4):419-429.

3. Boone, C.G., Buckley, G.L., Grove, J.M., Sister., C. 2009. Parks and People: An Environmental Justice Inquiry in Baltimore, Maryland. Annals of the Association of American Geographers 99(4): 767 – 787.

4. Elwood, S. 2006. Negotiating Knowledge Production: The Everyday Inclusions, Exclusions, and Contradictions of Participatory Research. The Professional Geographer 58(2):197-208.

5. Oke, T.R. City size and the urban heat island. Atmos. Environ., 7, 769-779.

6. Voogt., J.A. 2002. Urban Heat Island.Causes and consequences of global environmental change. (3):660-666.

Developing Participatory Research Potential in Central City South

Communities in South Phoenix have been active in contesting environmental hazards in their neighborhoods, exemplified by mobilization following a toxic chemical fire and the expansion of a hazardous waste facility.
More recently, South Phoenix communities are framing parks and green space access as environmental equity issues, and developing or restoring green spaces is a priority in neighborhood associations' quality of life plans. This scenario provides an ideal opportunity to link UHI mitigation research to environmental grass-roots efforts to combat urban blight and air pollution. In this context, we began attending South Phoenix neighborhood association meetings and began conversations with community activists and members. During the course of these informal conversations, the Sherman Park community emerged as a likely candidate neighborhood with which to partner to conduct UHI participatory research with.

During the course of the next few months, we will conduct focus group interviews with community members to achieve a consensus on what a desirable outlook for the park could be, in terms of trees and grass. We are also interested in the resident's knowledge of the environmental history and change in the park and their neighborhood, and will ask long-time residents about their recollections of the park's state in the past and how its present state came to be.