POLICY POINTS

POLICY POINTS BRINGS RELEVANT DATA TO TIMELY PUBLIC POLICY ISSUES IN ARIZONA

The Urban Heat Island: Jeopardizing the Sustainability of Phoenix

By Sally Wittlinger, a research analyst for Decision Center for a Desert City, a unit of the Global Institute of Sustainability at Arizona State University. DCDC conducts climate, water, and decision research and works to bridge the boundary between scientists and decision makers.

In a desert city such as Phoenix, summertime heat is a way of life, but how much does the built environment contribute to the intensity of the heat on a summer night? In urbanized Phoenix, nights don't cool down as much as in the surrounding rural areas and on more and more summer nights, the official Phoenix temperature fails to drop below 90 degrees. Climate plays a huge role in the comfort and quality of life of residents, with numerous implications for tourism, energy demand, water use, and the vulnerability of low-income families. While experts agree that climate change will cause temperatures to rise in the southwestern United States, the growing urban heat island (UHI) is already challenging the livability of the Phoenix metropolitan area by raising temperatures in the urban core.

> The Urban Heat Island (UHI) is a phenomenon of higher nighttime temperatures in the urban core compared to the surrounding rural countryside. The UHI results from urbanization and the replacement of natural land surfaces with materials that retain heat; it has resulted in a marked increase in urban nighttime temperatures during the past forty years. Environmental heat sources, such as automobile exhaust and industrial operations also contribute to urban heating. UHI conditions influence the environmental, social, and economic characteristics of the region and decrease the comfort level for those living there.

Less Nighttime Relief: Residents Swelter, Tourists may Stay Home

The difference in nighttime temperature between urbanized Phoenix and surrounding rural areas may be experienced as one drives from an event downtown to their home in a neighborhood on the urban fringe still dominated by desert or agriculture. This effect is a year-round occurrence, but in the summer, nighttime temperatures in the urban core can remain elevated to such an extent that it results in discomfort for urban residents and tourists. Tourists, indoors for conferences or family visits during the hot days, are unable to enjoy the city, even at night. As nighttime temperatures creep higher, only the most hardy residents and visitors will venture outside for nighttime activities, which can impact businesses in the urban core.

In 2010, there were seven days with a recorded low temperature over ninety degrees at Sky Harbor Airport; on these same days the low temperature in Queen Creek, in the southeast Valley periphery, was consistently ten degrees lower. Nighttime low temperatures recorded at Phoenix Encanto Park were between these two extremes. The park, although also located in the urban core,

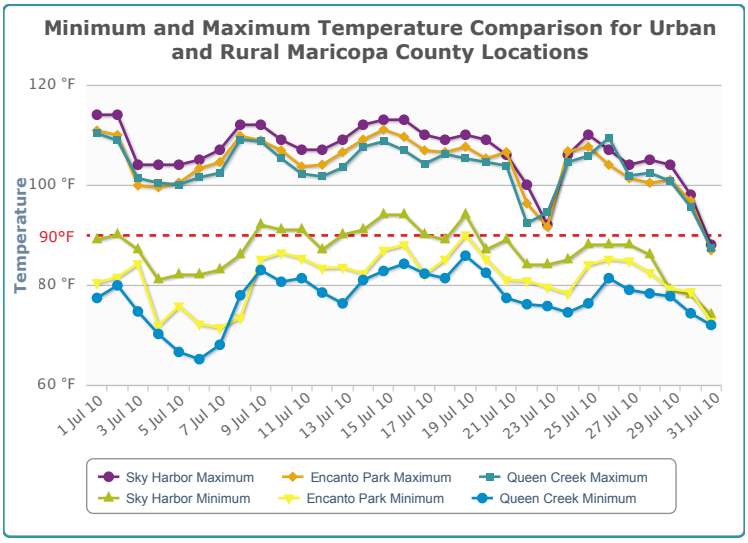

Figure 1: *Minimum and Maximum Temperature Comparison for Urban and Rural Maricopa County Locations.*
Source: NOAA's National Climatic Data Center, Satellite and Information Service (Sky Harbor); Arizona Meteorology Network [AZMET] (Encanto Park and Queen Creek).

ARIZONA INDICATORS

POLICY POINTS
VOLUME 3 / ISSUE 3
JULY 2011
arizonaindicators.org

Arizona Indicators is an online information resource and analysis tool that centralizes data about the state and its communities. Arizona Indicators presents interactive visualizations, clear data descriptions, and public opinion data in a broad range of content areas.

This project is made possible by generous support from the Arizona Community Foundation and Arizona State University.

For more information, contact Andrea Whitsett at (602) 496-0217 or andrea.whitsett@asu.edu.

Arizona Indicators is a project of Morrison Institute for Public Policy.

411 N Central Ave
Suite 900
Phoenix, Arizona
85004-0692
(602) 496-0900 Main
(602) 496-0964 Fax
MorrisonInstitute.asu.edu

ASU Morrison Institute for Public Policy
ARIZONA STATE UNIVERSITY

has its monitoring station located on a golf course, where the vegetation acts to mitigate the UHI effect. Daytime highs in the urban core may feel much hotter than those in rural areas due to reflection from building materials and protection from cooling breezes; however, in reality the daily maximum temperatures differ only slightly and it is the nighttime lows where the urban heat island causes large differences between urban and rural temperatures.

The number of June days with a minimum temperature above ninety degrees at Sky Harbor Airport has increased dramatically in the past forty years. Prior to 1970, there were no recorded occurrences of a nighttime low—daily minimum temperature—above ninety degrees, but in each decade since, the number of days with a minimum temperature above ninety degrees has increased: from three in the 1970s, to six in the 1980s, to eight in the 1990s, to fifty in the most recent decade of 2000-2009. Although much of this increase has to do with the urban heat island effect, rising global temperatures may also contribute to warmer summer temperatures, resulting in higher nighttime lows. As reported in a recent AP story by Richard Schmid, the National Oceanic and Atmospheric Administration's (NOAA) *State of the Climate in 2010* lists 2010 as tied with 2005 as the warmest year on record; in addition, the NOAA National Climatic Data Center also recently reported that the 1981-2010 normal temperatures for the United States were 0.5°F warmer on average than those for between 1971-2000. Driven by these extremes, the average low temperature for June at Sky Harbor Airport has risen about ten degrees during the last fifty years, as the population soared both in Phoenix and in Maricopa County. As the Phoenix metropolitan area continues to sprawl and natural land surfaces are replaced with materials such as asphalt that retain heat, the urban heat island will expand from the urban core further into suburban regions and nighttime temperatures will continue to rise.

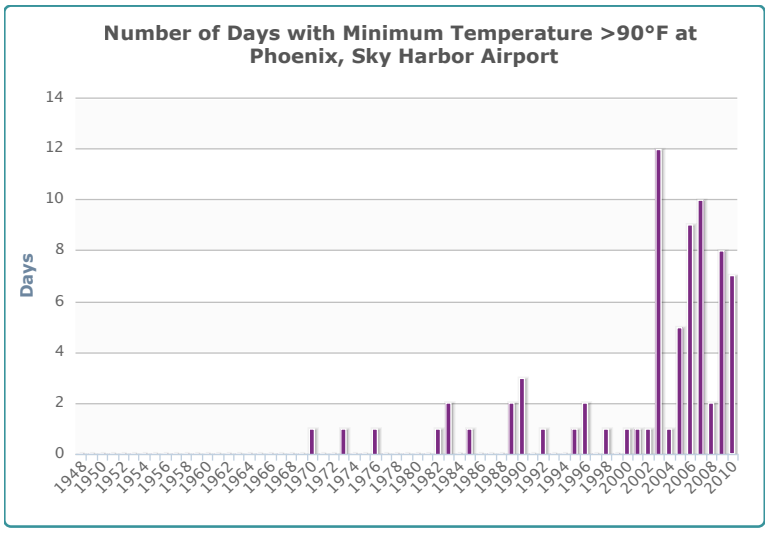

Figure 2: *Number of Days with Minimum Temperature Greater than 90°F at Phoenix Sky Harbor Airport.*
Source: NOAA's National Climatic Data Center, Satellite and Information Service.

Increased Energy Costs Disproportionately Impact Those Least Able to Pay

With increases in minimum temperatures, energy demand rises with the almost continuous running of air conditioning units. Cooling degree days (the sum of the differences between the daily mean temperature and 65°F) are an estimate of the amount of cooling needed to maintain a comfortable interior environment. Cooling degree days have increased greatly over the years, leading to rising energy demand to cool building interiors. With higher energy costs in the summer, there is an economic impact which disproportionately affects the most vulnerable portions of the community, such as lower income residents who may not be able to afford the high electric bills resulting from the greater use of air conditioning. In addition, research has confirmed that throughout the urban area, microclimates result from differences in vegetation and building density, and that low income neighborhoods populated by ethnic minorities are generally hotter than wealthier Anglo-dominated neighborhoods that tend to contain a higher percentage of vegetated land cover. People living in these poorer neighborhoods, as well as the homeless population, many of whom sleep outside and are dependent on nighttime cooling for relief, are more vulnerable to the heat and at a greater risk of experiencing heat-related illnesses such as sunstroke, heat cramps, and heat exhaustion.

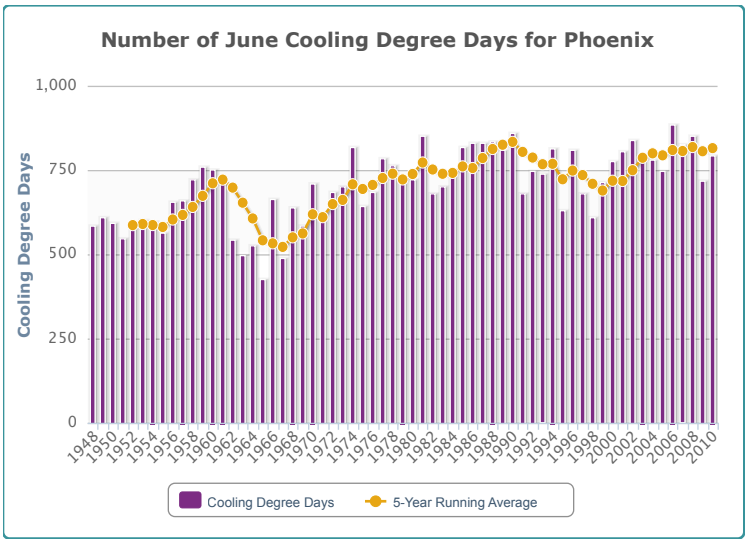

Figure 3: *Number of June Cooling Degreee Days for Phoenix.*
Source: NOAA's National Climatic Data Center, Satellite and Information Service.

Mitigating the Urban Heat Island for Sustainable Urban Living

Because the urban heat island is caused by an increase in heat-absorbing surfaces, efforts to decrease these surfaces in the urban core can help mitigate the UHI and lower nighttime temperatures. By definition, the urban core has more built surfaces than its rural counterpart, a situation that won't change. However, the characteristics of the built environment and its surroundings can have a strong influence on the amount of heat absorbed. Light-colored, reflective roofs reflect the daytime heat and can help reduce the urban heat island. Similarly, cool pavement, which can be used on parking lots, incorporates a coating that reflects light and heat and helps reduce daytime surface temperature by 25 to 30 degrees.

Increasing the amount of pervious surfaces in the urban core will also help to mitigate the urban heat island. Rural and natural desert areas contain large amounts of pervious surface in the form of desert or agricultural soil. These surfaces release heat quickly once the sun sets, while buildings, concrete, and asphalt hold the heat in, releasing it slowly through the night. Although we cannot do away with streets and sidewalks in our urban areas, pervious surfaces allow heat to be released more quickly at night. Pervious concrete, made possible by new technology and materials, is already being used for parking lots at some locations in the Valley. In residential areas, concrete driveways replaced by decomposed granite can also help to cool nighttime temperatures. In addition to heat island mitigation, pervious surfaces are advantageous because they allow rain to be absorbed into the ground instead of running into a storm drain, helping to recharge the aquifer.

Vegetation, in both residential and commercial areas, also helps to maintain cooler temperatures, but can require large amounts of water. Research has shown that the greatest gains in cooling can be made by the addition of irrigated vegetation to neighborhoods that are currently sparsely vegetated, while adding water to neighborhoods that already have an abundance of vegetation provides little additional cooling. In a desert city such as Phoenix, it is important to use valuable water supplies where they will have the greatest impact. Vegetated rooftops are also being used to reduce the urban heat island. The Tempe Transportation Center, a LEED Platinum certified building, uses a green desert vegetated roof that requires little water, and cools the air through evaporative cooling.

As the Phoenix metropolitan area continues to grow, it is important that development is done in such a way that minimizes the impact of the urban heat island, ensures the comfort of the city's residents, and considers the sustainability of our water and energy resources.

Some key points about the urban heat island to keep in mind:

- Nighttime temperatures are increasing in the Phoenix urban core, both extreme temperatures of nighttime lows over ninety degrees, as well as monthly averages of low temperature.
- As temperatures rise, the comfort level of residents decreases. Tourists and locals may choose to stay indoors instead of going out to patronize businesses at night.
- Rising temperatures translate to increased energy needs for air conditioning, and lower income residents who may not be able to afford higher electricity bills can be disproportionately affected.
- There are building strategies that can be used to mitigate the urban heat island. Policy makers and urban planners must consider these strategies to ensure the comfort of the city's residents and visitors and work towards the goal of maintaining a sustainable city.

Note: Arizona Indicators has been tracking four trends that are indicators of the urban heat island: the number of days with a minimum temperature above ninety degrees, the June average low temperature, the June average heat index, and cooling degree days. All use data from the National Climatic Data Center of the National Oceanic and Atmospheric Administration (NOAA) for the Phoenix Sky Harbor International Airport climate monitoring station, although the heat index is calculated by the Arizona State Climate Office. The Sky Harbor monitoring station is one of the closest monitoring stations to the downtown area and represents the official temperature for the City of Phoenix.