3-26-2020

The Urban Heat Island Effect in Nevada

Ember Smith
University of Nevada, Las Vegas, ember.smith@unlv.edu

Kaylie Pattni
University of Nevada, Las Vegas, kaylie.pattni@unlv.edu

Caitlin Saladino
The Lincy Institute and Brookings Mountain West, caitlin.saladino@unlv.edu

William E. Brown
The Lincy Institute and Brookings Mountain West, william.brown@unlv.edu

UNLV | THE LINCY INSTITUTE & BROOKINGS MOUNTAIN WEST

THE URBAN HEAT ISLAND EFFECT IN NEVADA

Environment Fact Sheet, No. 1 | March 2020

Prepared by Ember Smith, Kaylie Pattni, Caitlin J. Saladino, and William E. Brown, Jr.

PURPOSE

This fact sheet explores the temperature difference between Nevada cities and their undeveloped surrounding areas using reports by the Urban Land Institute, Climate Central, National Public Radio (NPR), and various governmental organizations. We investigate what "urban heat islands" are, their effects, the correlation between heat and income, and factors that contribute to rising temperatures in Las Vegas, North Las Vegas, Henderson, and Reno.

KEY FINDINGS

1. Las Vegas ranked as the most intense urban heat island in the United States in both daytime and nighttime metrics between 2004 and 2013.[1]
2. In the summer, Las Vegas experiences temperatures up to 24°F higher in the city than in nearby rural areas.[2]
3. Las Vegas and North Las Vegas both exhibit a "strong" negative correlation between heat and income while Henderson and Reno have a "moderate" negative correlation.[3]
4. The average temperature in Las Vegas is increasing faster than any other city in the country, almost 5.76°F since 1970.[4]

URBAN HEAT ISLANDS

Cities are warmer than surrounding rural areas because they replace open areas and vegetation with pavement, buildings, and other heat-absorbing infrastructure. This phenomenon is referred to as the "urban heat island" effect. The mean annual air temperature in a city with over 1 million residents can be 1.8 - 5.4°F warmer than surrounding areas during the day and over 20°F warmer at night.[5] The heat island effect has worsened over time; today, cities experience ten more "extreme heat events" on average than they did in the mid-1950s.[6]

Urban heat is a particularly salient problem in Las Vegas, the city with the largest difference between urban and rural temperatures in the country. Climate Central reported that Las Vegas average temperatures are increasing faster than any other city in the U.S., almost 6 degrees in total since 1970. The report also shows that in the last 10 summers, cities were 2.4°F hotter than their rural counterparts. Although the national separation between urban and rural temperatures is staggering, Las Vegas, Albuquerque, and Denver had the three most dramatic summer heat island effects in the country with daily urban-rural temperature differences of 7.3°F (Las Vegas), 5.9°F (Albuquerque), and 4.9°F (Denver).[7]

Table 1 displays the U.S. cities with the greatest increase in average temperature since 1970 based on a Climate Central report. Las Vegas is an outlier among the top twenty fastest-warming cities in the United States. For context,

[1] Katharine Burgess and Elizabeth Foster, "Scorched; Extreme Heat and Real Estate," 2019, Urban Land Institute (americas.uli.org/wp-content/uploads/sites/2/ULI-Documents/Scorched_Final-PDF.pdf).
[2] Climate Central, "Hot and Getting Hotter: Heat Islands Cooking U.S. Cities," August 20th, 2014. Climate Central (www.climatecentral.org/news/urban-heat-islands-threaten-us-health-17919).
[3] Meg Anderson and Sean McMinn, "As Rising Heat Bakes U.S. Cities, the Poor Often Feel it Most," September 3, 2019, NPR (www.npr.org/2019/09/03/754044732/as-rising-heat-bakes-u-s-cities-the-poor-often-feel-it-most). The correlation strength is determined based on a correlation coefficient (R) generated in NPR's analysis. Their scaling is not public.
[4] Climate Central, "American Warming: The Fastest-Warming Cities and States in the U.S.," April 2019 (assets.climatecentral.org/pdfs/April2019_Report_EarthDay.pdf).
[5] United States Environmental Protection Agency (EPA), "Heat Islands," (www.epa.gov/heat-islands/learn-about-heat-islands).
[6] Burgess and Foster, "Scorched; Extreme Heat and Real Estate," 9.
[7] Climate Central, "Hot and Getting Hotter: Heat Islands Cooking U.S. Cities."

the difference in temperature change between Las Vegas and El Paso, the second fastest-warming city in the U.S., is 1.02°F. The difference between El Paso and the twentieth fastest-warming city, Medford, OR, is 1.23°F.

TABLE 1: FASTEST-WARMING CITIES IN THE UNITED STATES[8]

City	Temperature Change °F (1970-2018)	City	Temperature Change °F (1970-2018)
1. Las Vegas, NV	5.76°	11. Ft. Smith, AR	3.92°
2. El Paso, TX	4.74°	12. St. Louis, MO	3.85°
3. Tucson, AZ	4.48°	13. Boise, ID	3.84°
4. Phoenix, AZ	4.35°	14. Minneapolis, MN	3.72°
5. Burlington, VT	4.13°	15. Milwaukee, WI	3.70°
6. Chattanooga, TN	4.11°	16. Duluth, MN	3.67°
7. Helena, MT	4.11°	17. Fresno, CA	3.66°
8. Erie, PA	4.06°	18. Odessa, TX	3.59°
9. McAllen, TX	4.03°	19. Houston, TX	3.58°
10. Las Cruces, NM	4.01°	20. Medford, OR	3.51°

THE EFFECTS OF HEAT ON CITIES

An increasingly large body of evidence suggests that without substantial effort to thwart rising city temperatures, heat threatens to worsen public health, hurt economic productivity, and damage infrastructure.[9]

1. Public Health

Each year, 618 people in the United States are killed by extreme heat.[10] Because extreme heat events are projected to become more common, that figure is expected to become closer to 3,000 to 5,000 deaths per year by 2050 if the U.S. continues on its current trajectory.[11] Therefore, the urban heat effect may exacerbate existing health problems in cities.

2. Economic Productivity

Additionally, rising temperatures may disrupt economic productivity as workers' health declines. Cities may struggle to sustain their workforce and remain productive throughout warming summers. Tourism and retail sectors are likely to suffer as extreme weather events depress consumer activity.[12]

3. *Infrastructure*

Further, rising temperatures are expected to increase utility demand in cities. Without infrastructure improvement, increased energy demand could result in more power outages. Heat is already damaging roads, transit, and other infrastructure in the U.S. and cities face increasingly expensive deterioration and maintenance costs.[13]

[8] Climate Central, "American Warming: The Fastest-Warming Cities and States in the U.S." (assets.climatecentral.org/pdfs/April2019_Report_EarthDay.pdf).
[9] Burgess and Foster, "Scorched; Extreme Heat and Real Estate."
[10] Centers for Disease Control and Prevention, "About Extreme Heat," June 17th, 2017 (www.cdc.gov/disasters/extremeheat/heat_guide.html)
[11] Burgess and Foster, "Scorched; Extreme Heat and Real Estate."
[12] Ibid.
[13] Ibid.

URBAN HEAT AND INCOME

An investigation conducted by NPR and the University of Maryland's Howard Center for Investigative Journalism[14] evaluates the relationship between heat and income in the 97 most populous U.S. cities with income data from the U.S. Census Bureau and thermal satellite images from NASA and the U.S. Geological Survey. The NPR report finds that the poorest populations in cities typically reside in areas most affected by the urban heat island effect. Those exposed to extreme heat as a result of disparate neighborhood planning are also, according to NPR's report, disproportionately people of color.

Income-based temperature disparities today are evident in neighborhoods that were redlined in the twentieth century.[15] Redlining is the often-racialized process of excluding people from living in certain an area. A new study indicates that redlined neighborhoods are about 5°F warmer than non-redlined neighborhoods in 94 of the 108 investigated cities.[16] While this study did not include cities in Nevada, the NPR report found a strong correlation between income and heat in Las Vegas and North Las Vegas.

Higher-income areas have more tree coverage than lower-income areas because they have more resources to maintain landscaping and parks. The tree coverage disparity makes low-income communities more susceptible to rising temperatures and extreme heat waves. Lower-income communities are less able to afford constantly running air conditioning, which compounds the impact of environmental inequality.[17]

The geographic and demographic characteristics of suburban areas like Summerlin and Henderson make them substantially cooler than lower-income areas in the Las Vegas Valley. Factors contributing to the regional temperature dispersion are described in the next section but may also include varying altitudes across neighborhoods.

Figure 1 displays side-by-side heat maps of the income and temperature of the four Nevadan cities included in the NPR report. A darker red color indicates higher average temperatures and dark green represents higher income. The areas of each city with the highest surface temperatures are typically lower income neighborhoods, showing the inverse relationship between heat and income.

Henderson

Henderson, highlighted in Figure 1, attributes disparate heat outcomes to the distribution of parks and vegetation.[1] Henderson city officials noted that the poor soil quality and the cost of irrigation make it difficult to maintain vegetation. The city created a landscaping program to incentivize desert landscaping among low-income residents, but it has not yet proven effective. Of the four cities highlighted below, only Henderson provided a response to NPR's request for comment.

[14] Meg Anderson and Sean McMinn, "As Rising Heat Bakes U.S. Cities, the Poor Often Feel it Most," September 3, 2019, NPR (www.npr.org/2019/09/03/754044732/as-rising-heat-bakes-u-s-cities-the-poor-often-feel-it-most). The correlation strength is determined based on a correlation coefficient (R) generated in NPR's analysis. Their scaling is not public.

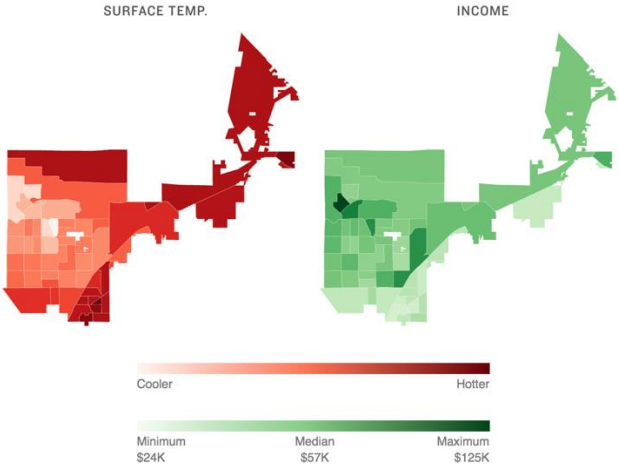
[15] Redlining describes the discriminatory practice where banks and other financial services did not offer the same services, rates, and prices to neighborhoods based on demographic composition.

[16] Jeremy S. Hoffman, Vivek Shandas, and Nicholas Pendleton, "The Effects of Historical Housing Policies on Resident Exposure to Intra-Urban Heat: A Study of 108 US Urban Areas," *Climate* 2020 (www.mdpi.com/2225-1154/8/1/12/htm).

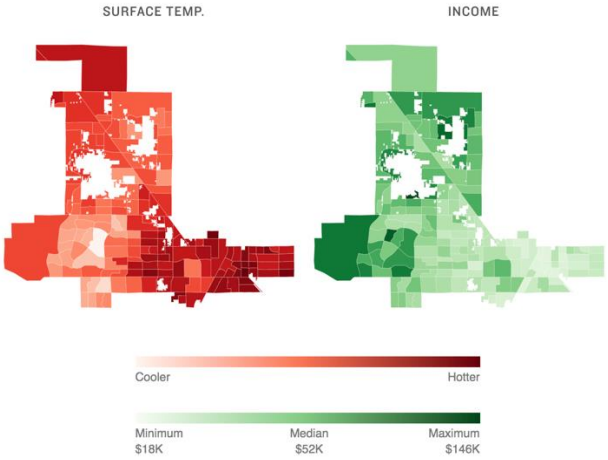
[17] Emily Badger, "The Inequality of Urban Tree Cover," *City Lab*, May 2013 (www.citylab.com/equity/2013/05/inequality-urban-tree-cover/5604/).

FIGURE 1: NEVADA CITIES' URBAN HEAT & INCOME DISTRIBUTION[18]

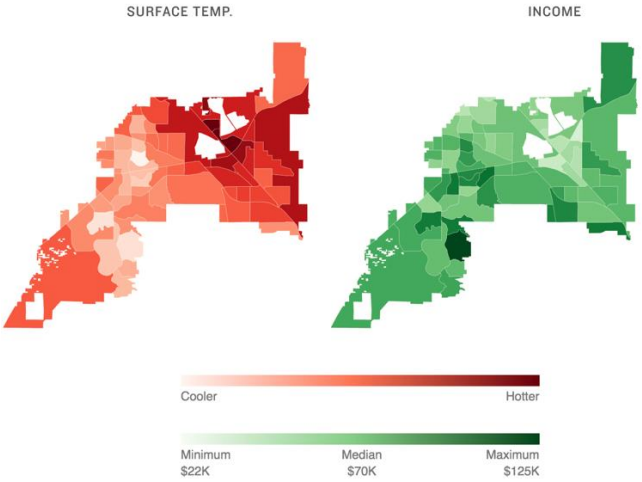
NORTH LAS VEGAS



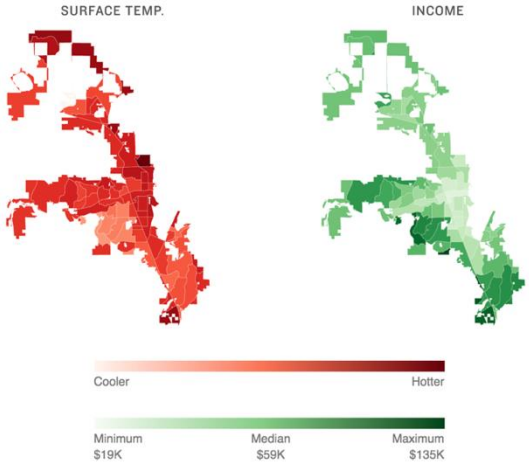
LAS VEGAS



HENDERSON



RENO



Note: Each city's key has a different income scale.

THE EFFECTS OF HEAT ON CITIES

A few of the factors that contribute to the urban heat island effect are described here:

1. Vegetation

Vegetation, like trees and landscaping, is important to remove pollutants from the air, save energy, capture potentially destructive storm water, and provide aesthetic value. There are also other positive externalities associated with a robust urban tree population such as increased property value, more tourism, and higher retail sales.[19] Cities use landscaping to palliate the effects of rising urban heat by providing shade, absorbing

[18] Anderson, McMinn, "As Rising Heat Bakes U.S. Cities, the Poor Often Feel it Most."
[19] Urban Forest Resource Analysis, 2013 (forestry.nv.gov/wp-content/uploads/2014/01/Henderson-Resource-Analysis-12.13.13.pdf).

heat, and reducing asphalt coverage. Communities in urban heat islands without adequate tree coverage are likely to be hotter than those with trees.

2. Air Conditioning

Residents of extraordinarily hot climates cope with rising temperatures by using air conditioning (AC), but the heat emitted from air conditioning units raises the outside mean temperature by as much as 2°F.[20] Rising outside air temperatures, in part caused by increased AC use, generates greater AC demand.[21] Lower-income earners are disproportionately affected by rising electricity costs from more AC use because temperatures are higher in their neighborhoods and they are less likely to be able to afford utility costs. To help reduce the impact of this vicious cycle, AC companies in Nevada are now offering rebates to incentivize the use of more efficient air conditioning units.[22]

3. Infrastructure

Infrastructure, which is more heavily concentrated in urban areas than in rural areas, also increases the urban heat island effect. Buildings replace natural vegetation with pavement and other materials that absorb heat. On some level, the effects of development are inevitable, but green infrastructure would alleviate the exacerbating effects of developing urban areas.[23] Green infrastructure includes green roofs, pavement alternatives, and green parking.

Green roofs are layered roofing systems designed to mitigate the effects of rising temperatures by capturing rainfall, subsequently supporting plant growth and absorbing pollutants. The water drain design requires minimal upkeep and roofs are reported to last twice as long as normal roofs.[24] Many local governments offer tax rebates and subsidies to incentivize installing green roofs. Nevada provides incentives for solar roofs but has no provision for green roofs.[25]

Parking lots could be constructed with more permeable materials than pavement, lessening the likelihood of flash flooding.[26] City planners could use energy efficient lighting in parking lots to decrease the feedback loop and cool urban areas. Finally, an important aspect of all green infrastructure is maintenance. The green effects are only felt as long as buildings operate efficiently.[27]

Las Vegas planners have incorporated some mitigation techniques into the city's layout to address rising temperatures. Denser development would reduce the need for driving and could help lessen the heat effects of asphalt and building space.[28] The City of Las Vegas 2020 master plan contains mitigation strategies including building more condensed urban areas by taking actions like increasing high rise height provisions. Although Las Vegas is beginning to address the urban heat effect, current plans are insufficient to prevent temperatures from continuing to rise.

[20] Rhonda Olson, "Excess heat from air conditioners causes higher nighttime temperatures," May 2014 (asunow.asu.edu/content/excess-heat-air-conditioners-causes-higher-nighttime-temperatures).
[21] Ibid.
[22] "Las Vegas Air Conditioning," (lasvegasair.net/nv-energy/).
[23] "Reduce Urban Heat Island Effect," *EPA* (www.epa.gov/green-infrastructure/reduce-urban-heat-island-effect).
[24] "Green Roof in the District of Colombia," *Department of Energy & Environment* (doee.dc.gov/greenroofs).
[25] "Completed Programs," *Nevada's Governor Office of Energy* (energy.nv.gov/Programs/Completed_Programs/).
[26] "EPA's New Green Parking Lot Allows Scientists to Study Permeable Surfaces that May Help the Environment," *Science Daily* (www.sciencedaily.com/releases/2009/10/091028134628.htm).
[27] "Operation and Maintenance of Green Infrastructure Receiving Runoff from Roads and Parking Lots," *EPA* (www.epa.gov/sites/production/files/2016-11/documents/final_gi_maintenance_508.pdf).
[28] Jennifer Sollis, "Cities Look for Solutions to 'Urban Heat Island' Effect," October 2019, Nevada Current (www.nevadacurrent.com/blog/cities-look-for-solutions-to-urban-heat-island-effect/).