2023

Understanding Urban Heat Islands and Impacts

Darbi Berry

Nicole Fassina

A-bel Gong

Climate Collaborative
SAN DIEGO REGION

URBAN HEAT ISLANDS AND IMPACTS

San Diego Regional Climate Collaborative

Heat on the Rise: Urban Heat Islands

Over the last few decades, climate change has contributed to a wide range of challenges and impacts including rising temperatures, which in recent years have compounded issues; strengthening storms, heat waves, floods, and droughts. Urban areas are more vulnerable to heat which can be explained by the urban heat island (UHI) effect. UHIs are a phenomenon that occur due to the presence of synthetic and built structures, such as buildings, pavements, and streets. The materials used by these structures absorb temperatures in dense urban environments.[1] A UHI can be identified by measuring the temperature differences between an area of interest relative to surrounding areas. These areas that experience higher temperatures can also experience greater pollution, and as a result additional negative health impacts to community members, especially during seasonally hotter months. The San Diego region is experiencing the impacts of climate change, especially implications concerned with temperature rises and the UHI effect. According to the Climate Change Sixth Assessment Report, the past five years have been the hottest on record globally.[2] Additionally, temperatures are expected to rise by 5-10°F by the end of this century; this could lead to more frequent and intense heat waves, in addition to higher variation in rainfall[3]. These conditions could threaten the lives of native plants, animal populations, and decrease the quality of life for inhabitants in the San Diego region.

What is an Urban Heat Island?

In urban areas, hard surfaces like rooftops, asphalt, and sidewalks absorb and retain heat.

Reduced natural landscape contributes to hotter temperatures because they cool the air by providing shade and evaporating water surface.

Urban Heat Island Impacts

Water

Surfaces which retain high temperatures, such as pavement and rooftops, can heat up stormwater runoff that is drained into storm sewers which raises water temperatures as it is released into other rivers, streams, and lakes. These temperature changes in water can be damaging to surrounding aquatic systems.

Electricity

Heat islands increase both electricity demand as well as peak energy demands. Because of this, there is an increase in demand and use of air conditioning in places where urban heat islands occur. This means that during extreme heat events, the increased demand for air conditioning can overload systems which can cause blackouts.

Air Pollutants

The increase in demand for electricity over the summer leads to an increase in air pollutants and GHG emissions because companies that supply electricity rely heavily on fossil fuel power plants. These pollutants are harmful to human health and the environment as they also contribute to air quality problems.

Inequality of Heat

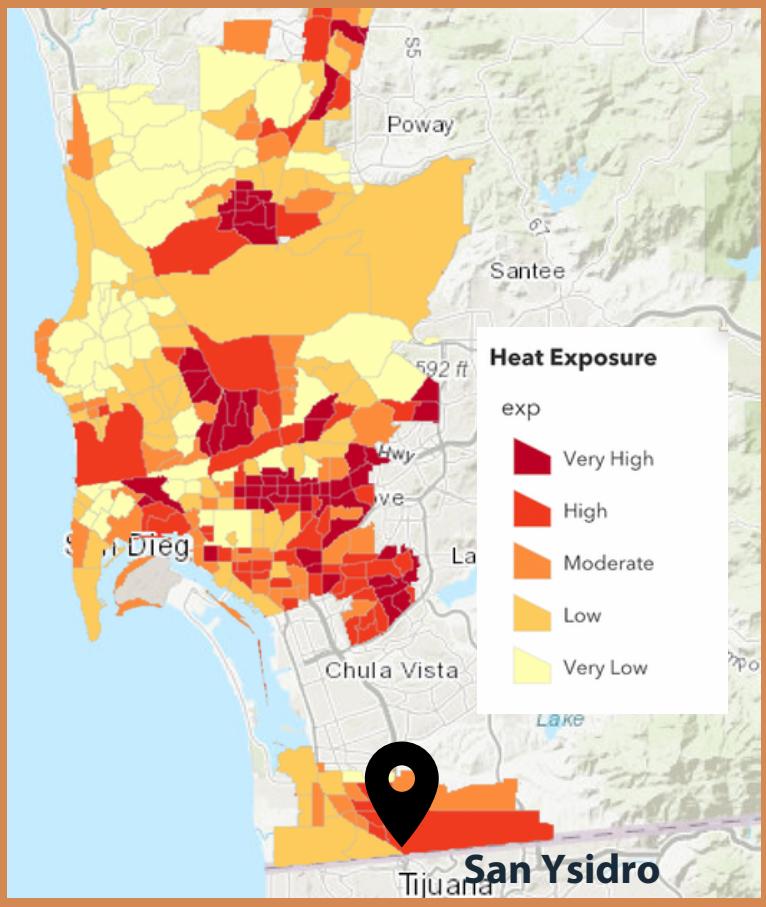
Communities of concern face higher exposure to urban heat in major cities across the U.S. which directly exacerbates the UHI effect. Much of these compounded impacts can be explained by income disparities within these communities of concern. Studies have shown that on average, lower-income neighborhoods have 15.2% less tree cover and are 1.5°F hotter than high-income neighborhoods[4]. Lower income neighborhoods often have less access to public amenities that could alleviate the intensity of the UHI effect. These amenities include: access to parks and green space, tree canopy cover, recreation facilities, and open natural spaces.

Additionally, the areas with the hottest heat islands are also most frequently areas where communities of color are concentrated. This disparity can be traced back to the legacy of housing segregation and neighborhood redlining.

Redlining was a systematic denial of financial services to residents based on their race or ethnicity. Redlining was a discriminatory practice that started in the 1930s which consisted of the systematic denial of financial services to residents based on their race or ethnicity. During this time, neighborhoods were assigned letter grades based on the level of risk banks would take investing in the area. The letter “A” coincided with the best areas for investments and “D” being the areas associated with high-risk loans. Redlining practices continue to shape neighborhoods in San Diego today with zoning maps largely following old redlining maps. Current single family zones are mostly found in the old A and B zones, and denser housing such as apartment complexes, duplexes, etc. are mostly found in redlined areas which also coincide with concentrated industrialized areas in the City of San Diego.[5]

Case Study Spotlight: San Ysidro

The San Ysidro community is particularly vulnerable to high heat risks. This areas has a high population of people with health conditions like heart disease and diabetes, and also high heat exposure compared to other areas in the San Diego County. This area, and other similar regions, have high surface temperatures and low tree canopy. They are also farther away from the ocean so they don't receive the same cooling effects as those who live by the coast.



This map highlights areas with higher temperatures due to urbanization.[4]

Climate Collaborative
SAN DIEGO REGION

Heat Exposure Impacts on Communities

Socioeconomic Disparities

Communities of color and low-income neighborhoods often experience higher temperatures due to a lack of green spaces, limited tree canopy coverage, and increased impervious surfaces such as roads and parking lots. These areas typically have fewer park and trees that can provide shade and mitigate the heat island effect. As a result, residents in these neighborhoods are more vulnerable to the negative impacts of UHIs, such as heat-related illnesses and increased energy costs for cooling.

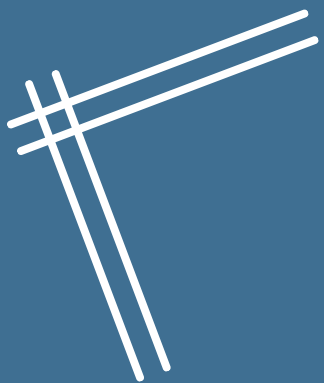
Climate Change Impacts

Climate change is exacerbating UHIs in San Diego and around the world. Rising temperatures due to climate change intensify the heat island effect and increase the frequency and severity of heatwaves. Vulnerable communities that lack the resources to adapt to these changing conditions, such as access to air conditioning, cooling shelters, and even natural spaces like parks and beaches are disproportionately affected by heat-related health risks.

Urban Development

Urban design and development practices can contribute to UHIs in San Diego. For example, areas with dense buildings, extensive paved surfaces, and little greenery can trap and absorb more heat, resulting in higher temperatures. In contrast, neighborhoods with more green spaces, tree cover, and permeable surfaces provide cooler microclimates. However, historically marginalized communities often have limited influence on urban planning decisions, leading to uneven distribution of green spaces and vegetation, and exacerbating UHIs in those areas.

Historical Redlining & Disinvestment



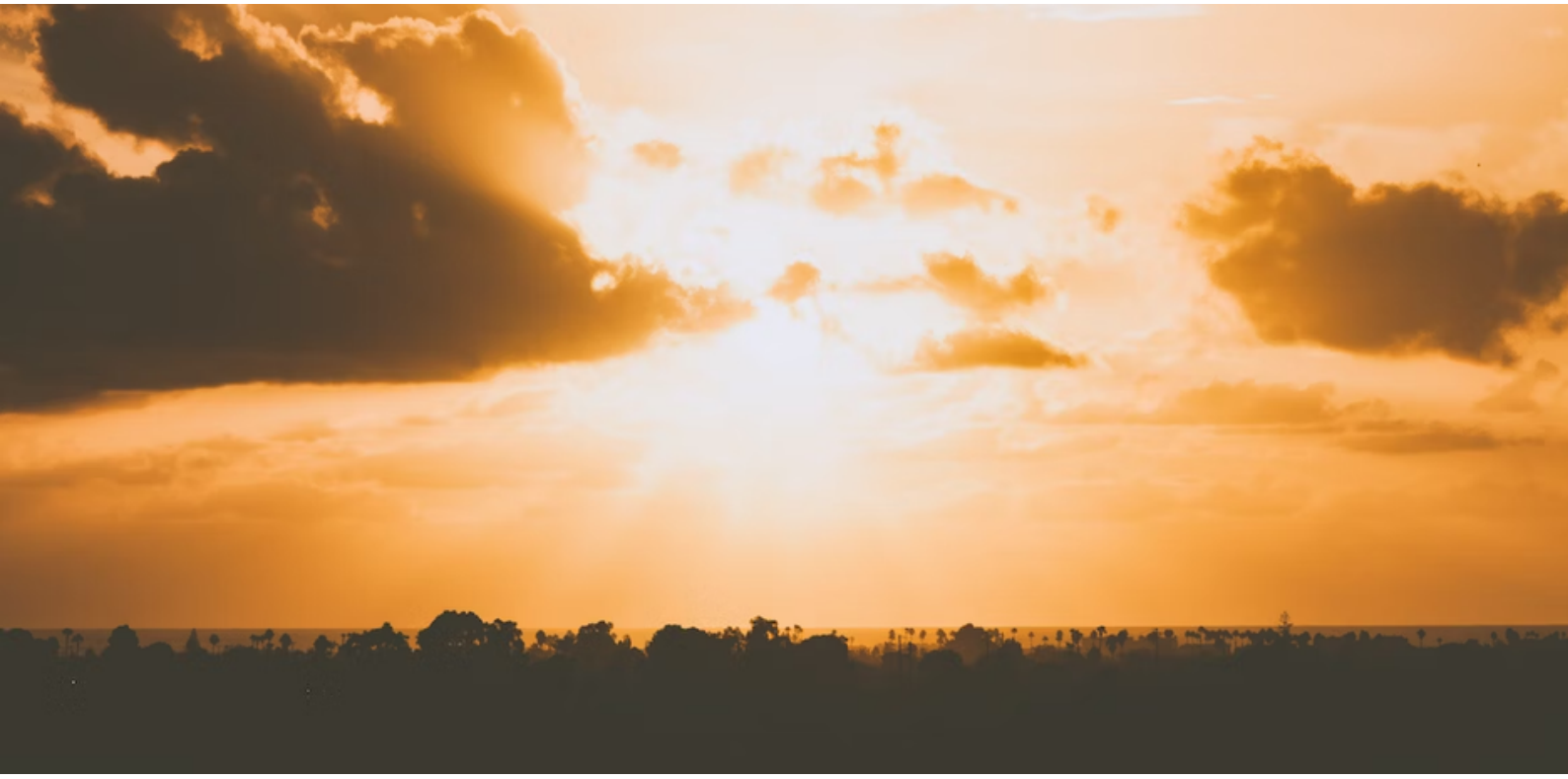
The historical practice of systematically denied access to loans and investments to communities of color, have resulted in disparities in infrastructure and development. These communities often lack the infrastructure and resources needed to adapt to extreme heat, such as tree-lined streets, green roofs, and well-insulated buildings. This can further exacerbate the UHIs in those neighborhoods, as they are more likely to have fewer adaptive measures in place to cope with heat.

Cooling Efforts in the City of San Diego

To adapt and plan for UHI and other climate change impacts, the City of San Diego created *Climate Resilient SD*, which is a comprehensive climate adaptation and resiliency guide. The plan addresses four primary climate change related hazards which include extreme heat, extreme rainfall or drought, wildfires, and sea level rise. Climate Resilient SD also outlines different adaptation and resilience strategies for the climate change related hazards that are outlined above. There are mitigation efforts, adaptation efforts, and resilience efforts with each of them focusing on one aspect of climate change problem-solving. Mitigation efforts focus on reducing greenhouse gas emissions to avoid the worst potential impacts of climate change, adaptation efforts focus on reducing impacts from climate change related hazards, and resilience efforts focus on the ability to bounce back from a disruptive event. Some of the mitigation strategies outlined in the Climate Resilient SD include: providing safe and accessible transportation infrastructure to improve connectivity to employment and residential areas while also decreasing fossil fuel use (1), increasing access to parks and open spaces to provide a cooling effect during extreme heat and improve air quality (2), and establishing a community garden program in order to gain support for the conversion of private or City owned vacant lots to community spaces (3)[7]. Structural and systemic racial practices such as redlining is a critical reason why historically marginalized groups are disproportionately affected by most environmental stressors, like the urban heat island effect. Neighborhoods that were redlined, back in the 1930s, tend to be the hottest parts of town during the summer while neighborhoods that were not redlined tend to have cooler temperatures, and this is a pattern seen nationwide. In a study done in more than 100 cities, formerly redlined neighborhoods, on average, were 5°F warmer in the summer than areas that were once favored for housing loans, and some cities even saw a difference in temperatures as large as 12 °F .[8] Urban heat islands pose a significant challenge to the well-being of city-dwellers and the environment. The rise in temperature in cities is caused by various anthropogenic activities, including transportation, industrial activities, and construction. Urban heat islands can have serious health consequences, such as heat exhaustion, heatstroke, and respiratory problems. Therefore, policymakers, urban planners, and citizens must work together to adopt and implement strategies to mitigate the effects of urban heat islands. These strategies include planting more trees, promoting green roofs and walls, using reflective materials, and reducing the urban heat island effect through smart urban planning.

These "Cool Zone" signs can be found on several city-owned buildings during heat waves in San Diego.

Parks and green spaces help cool ground temperatures and prevent UHIs. Photo by TSC Restoration.



REFERENCES

1. EPA, “Learn About Heat Islands,” EPA (Environmental Protection Agency, September 2022), https://www.epa.gov/heatislands/learn-about-heat-islands.
2. Paola A. Arias et al., “Climate Change 2021: The Physical Science Basis,” IPCC â Intergovernmental Panel on Climate Change, 2021, https://www.ipcc.ch/report/ar6/wg1/.
3. SCHOOL OF LEADERSHIP AND EDUCATION SCIENCES, “CLIMATE CHANGE AND REGIONAL PLANNING,” Climate change and regional planning - school of leadership and education sciences - university of san diego, 2021.
4. The City of San Diego, “Climate Resilient SD,” sandiego.gov/sites, 2022, https://www.sandiego.gov/sites/default/files/crsd_final_plan_with_appendices.pdf
5. NASA DEVELOP, A.-T. | J. D. (2021, August 30). Urban heat islands and its risk in San Diego, CA. ArcGIS StoryMaps. Retrieved April 20, 2023, from https://storymaps.arcgis.com/stories/d79916f065424f1a91c3663cb486a126
6. Service, City News. “San Diego County Announces Expanded Cool Zones, Free Rides during Heat Waves.” KPBS Public Media, 28 July 2021, www.kpbs.org/news/environment/2021/07/28/san-diego-county-cool-zones-free-rides-heat-wave.
7. Brad Plumer, Nadja Popovich, and Brian Palmer, “How Decades of Racist Housing Policy Left Neighborhoods Sweltering,” The New York Times (The New York Times, August 24, 2020),
8. Hannah Melville-Rea, “Heat Amplifies Racial Inequality in US Cities,” Data, 2021, https://datadrivenlab.org/big-data-2/heat-amplifies-racial-inequality-in-us-cities/.
9. “Chapter 18.16 Residential Zoning Districts Rev - Cityofgalt.org,” city of galt.org, 2015, https://www.cityofgalt.org/Home/ShowDocument?id=15928.

The San Diego Regional Climate Collaborative was established in 2011 as a network for public agencies to advance climate change solutions and is currently housed at The Nonprofit Institute at the University of San Diego.

Climate Collaborative
SAN DIEGO REGION