The City of SAN DIEGO

City of San Diego

HEAT DATA SUMMARY

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Acronyms and Abbreviations

°C	degrees Celsius
CalEPA	California Environmental Protection Agency
CAL OSHA	California Division of Occupational Safety and Health
CDC	Centers for Disease Control
CMIP	Coupled Model Intercomparison Project
°F	degrees Fahrenheit
FAR	floor area ratio
HVAC	heating, ventilation, and air conditioning
I	Interstate
LOCA	Localized Constructed Analogs
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
RCP	Representative Concentration Pathway
SSP	Shared Socioeconomic Pathway

Glossary

Adaptive Capacity: The combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities (*Intergovernmental Panel on Climate Change)*

Albedo: A measure of the percentage of sunlight that a surface reflects away *(NASA)*

Coupled Model Intercomparison Project (CMIP): An ongoing, iterative, international climate modeling project designed to better understand past, present, and future changes in the global climate. This multi-model approach is updated in phases; CMIP6 is the most recent phase, and the next phase, CMIP7, will likely be released in 2026

Environmental Justice Communities: Areas of a city most impacted and negatively affected by environmental burdens and associated health risks *(City of San Diego Environmental Justice Element)*

Extreme Heat: Weather that is much hotter and humid than average for a particular time and place *(Climate Resilient SD)*

Heat Exposure: The inventory of elements in an area in which heat events may occur (*adapted from Intergovernmental Panel on Climate Change)*

Heat Health Event: Any heat event that results in negative public health impacts, regardless of the absolute temperatures *(CalHeatScore)*

Heat Risk: The possibility of adverse effects in the future from heat. Exposure and vulnerability are both components of heat risk (*adapted from Intergovernmental Panel on Climate Change)*

Heat Vulnerability: The propensity of exposed elements such as human beings, their livelihoods, and assets to suffer adverse effects when impacted by heat (*adapted from Intergovernmental Panel on Climate Change)*

Heat Wave: Periods of abnormally hot weather that last two or more days *(National Oceanic and Atmospheric Administration [NOAA])*

Land Surface Temperature: A measure of how hot the “surface” of the earth would feel to the touch in a particular location *(NASA)*

Localized Constructed Analogs (LOCA): A technique for downscaling climate model projections of the future climate

Minimum Mortality Temperature: A location's Minimum Mortality Temperature is the daily average temperature at which the risk of heat-related death is lowest *(Climate Central)*

Representative Concentration Pathways (RCPs): Greenhouse gas concentration scenarios adopted by the Intergovernmental Panel on Climate Change in its Fifth Assessment Report

Shared Socioeconomic Pathways (SSPs): Emissions scenarios that consider social dynamics and inequalities, utilizing the latest CMIP6 modeling to show possible future development pathways

Thermal Comfort Modeling: An approach to calculating the cumulative effects of direct radiation from the sun, reflected radiation from surfaces, ambient air temperature, wind level and humidity on human heat exposure *(World Resources Institute)*

Urban Heat Island: Where impervious surfaces such as buildings and roads absorb and re-emit heat close to the ground, causing higher temperatures in urban areas *(Heat.gov)*

EXECUTIVE SUMMARY

The San Diego region is known for its relatively mild climate; however, rising heat is already a cause for concern. Extreme heat is one of the deadliest weather-related hazards in the United States and one of most impactful hazards in San Diego.

San Diego is experiencing an increase in the frequency, strength, and duration of heat waves, as well as a gradual rise of daytime high and nighttime low temperatures. This means that residents will experience longer and more frequent stretches of unsafe temperatures, even in areas that have historically stayed cooler, and will have fewer opportunities to cool off at night. These changes pose growing risks to public health, infrastructure, economic stability, and community well-being.

The Heat Data Summary synthesizes the best available state, regional, and local data to describe how extreme heat exposure, vulnerability, risk, and adaptive capacity are distributed across the City of San Diego and how these conditions are expected to change over time. The document evaluates current and projected heat conditions, identifies populations and geographic areas facing disproportionate risk, and reviews the analytical tools and policy frameworks currently used to support heat planning and response efforts.

The burden of extreme heat is not felt equally. Exposure to extreme heat is tied to land use decisions, and areas with more pavement, a smaller tree canopy, and less green space tend to be hotter. Discriminatory land use decisions, such as redlining, and historic disinvestment in low-income communities and communities of color has created disparate heat risk in communities across the City of San Diego. Extreme heat can also deepen existing inequities. The need for cooling contributes to rising energy costs, placing additional burdens on low-income residents; and residents with underlying health burdens such as heart disease and diabetes face a greater risk of heat-related illness and injury.

Observed impacts of extreme heat in San Diego already include increased heat-related illness and mortality, higher demand for emergency and healthcare services, workplace injuries, strain on the energy grid, and rising household energy burdens. Future projections indicate that the number of extreme heat days, warm nights, and heat health events will continue to increase through mid- and late century, expanding both the duration and intensity of heat exposure across the City.

The understanding of the distribution and impacts of heat risk is improving. An analysis of state, City of San Diego, and community-scale plans and policies reveals significant opportunities to enhance partner coordination, data quality, and knowledge sharing to help communities build resilience to extreme heat.

These opportunities include, but are not limited to:

1. Mapping “best use” cases for state and local datasets to enhance understanding of heat exposure, vulnerability, and adaptive capacity.
2. Engaging with community groups and organizations to understand lived experiences with heat and local adaptive capacities.
3. Developing an Extreme Heat Response Protocol to document and enhance internal City protocols for responding to extreme heat events.
4. Integrating state and local heat datasets with local planning tools (e.g., San Diego Hazard Mitigation Plan, Park Needs Index).

By consolidating current knowledge and highlighting areas for improved coordination and analysis, the Heat Data Summary provides a foundation to support informed decision-making and ongoing implementation of policies, programs, and investments aimed at protecting public health and advancing equitable climate resilience in the City of San Diego.

INTRODUCTION

This summary was developed as part of the University of San Diego's *Solutions for Heat Adaptation & Equity in San Diego* Project, led by the San Diego Regional Climate Collaborative and funded by the California Office of Land Use and Innovations' Extreme Heat and Community Resilience Program. The project is a collaborative effort to accelerate heat action planning for communities across the San Diego region. This summary synthesizes state, city, and localized heat data for existing and future conditions. It will be used to understand how exposure, vulnerability, risk, and adaptive capacity of extreme heat are experienced by the people and infrastructure of the City of San Diego (City), and how this understanding has evolved over time in response to new data sources and scientific development.

Local, regional, and state policies, planning goals, strategies, and projects used to address extreme heat were also reviewed for this document. Opportunities to enhance the City's capacity for heat planning were assessed using applicable frameworks, including the 2025 Framework for a Heat Ready Nation, developed for the Federation of American Scientists, and the Capability Assessment developed for the San Diego Hazard Mitigation Plan.[1,2] This summary provides a foundation for understanding existing heat policy, plans and programs, and potential opportunity areas to better address extreme heat risk and align heat planning efforts across the region.

EXTREME HEAT

Understanding Extreme Heat

There is no standard definition of extreme heat; rather, it varies based on local climate norms and acclimatation. The 5th National Climate Assessment (2023) defines extreme heat as "temperatures that are much hotter and/or humid than average."[3] Cal-Adapt defines extreme heat as when the **daily maximum temperature**[a] exceeds the 98th historical percentile of daily maximum temperatures.[4] The threshold for extreme heat in the City is generally considered a daily temperature above 93.1 degrees Fahrenheit (°F). The City experiences roughly four extreme heat days per year.[5]

Since 1970, average annual temperatures in the City have gotten 0.3°F warmer.[6] The City now experiences seven more days per year with maximum temperatures above 78.3°F[b] and 10 more days per year above 80°F compared to 1970 (Figure 1).[7,8]

In addition to daily maximum temperatures, there are several metrics that can be used to measure, prepare for, and respond to extreme heat. How extreme heat is defined and measured directly shapes policy decisions, including the activation of early warning systems and the identification of health risks at established heat thresholds.[9,10,11]

Metrics of Heat Risk Include:

- Daytime Maximum Temperatures
- Nighttime Minimum Temperatures
- Heat Waves (Strength, Duration and Frequency)
- Land Surface Temperature
- Air Temperatures
- Urban Heat Island Effect
- Heat Index (Temperature and Humidity)
- Wet Bulb Globe Temperature (WBGT)
- Heat Alerts
- Heat Season

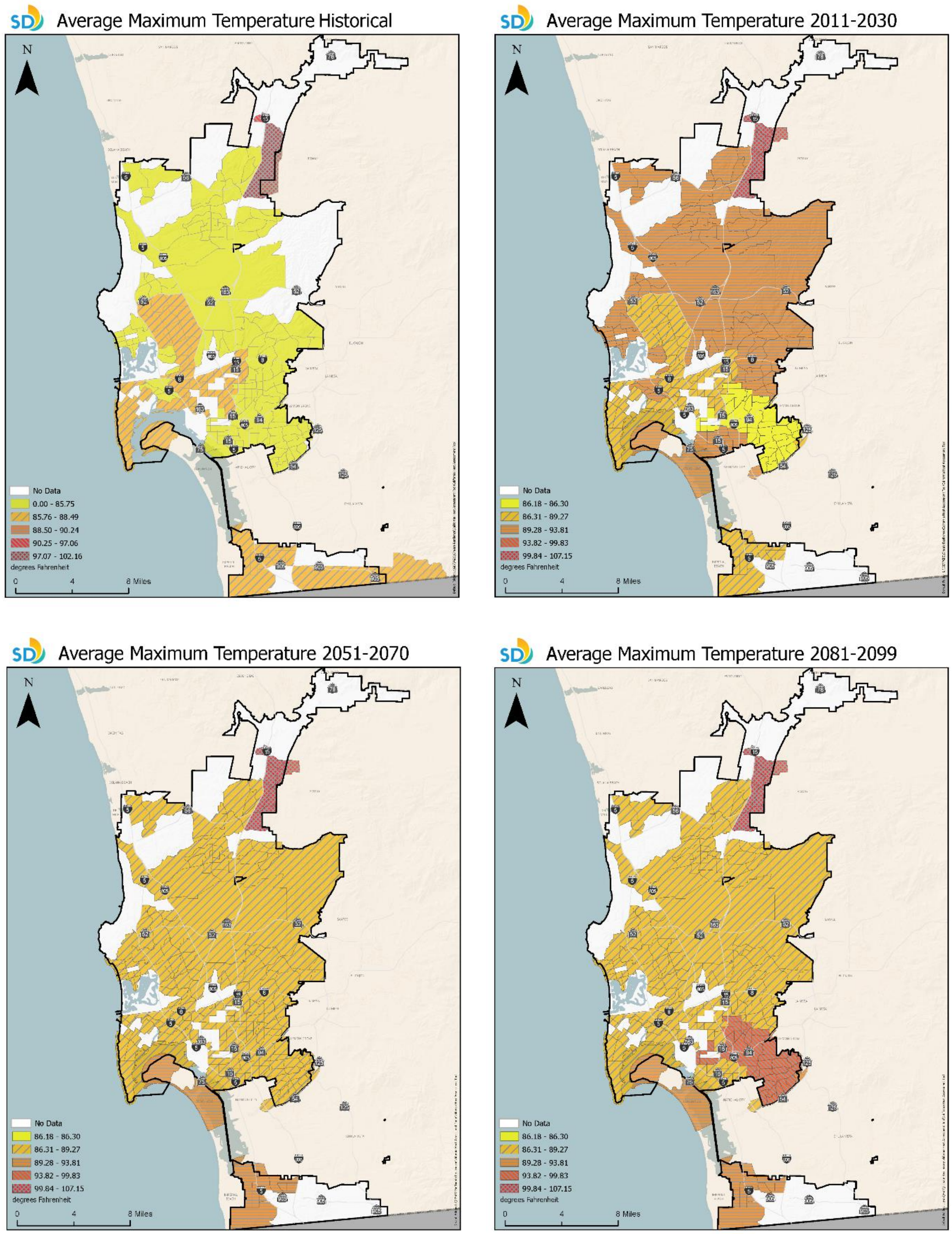
METRICS TO DEFINE EXTREME HEAT

Several metrics can be used to define extreme heat and activate heat response protocols with respect to historical climate data.

[a] Based on data observed from 1961-1990 between April and October

[b] 78.3°F is hotter than 95% of local temperatures from 1991-2020

Figure 1. Average Maximum Temperatures for City of San Diego over time (California Heat Assessment Tool)



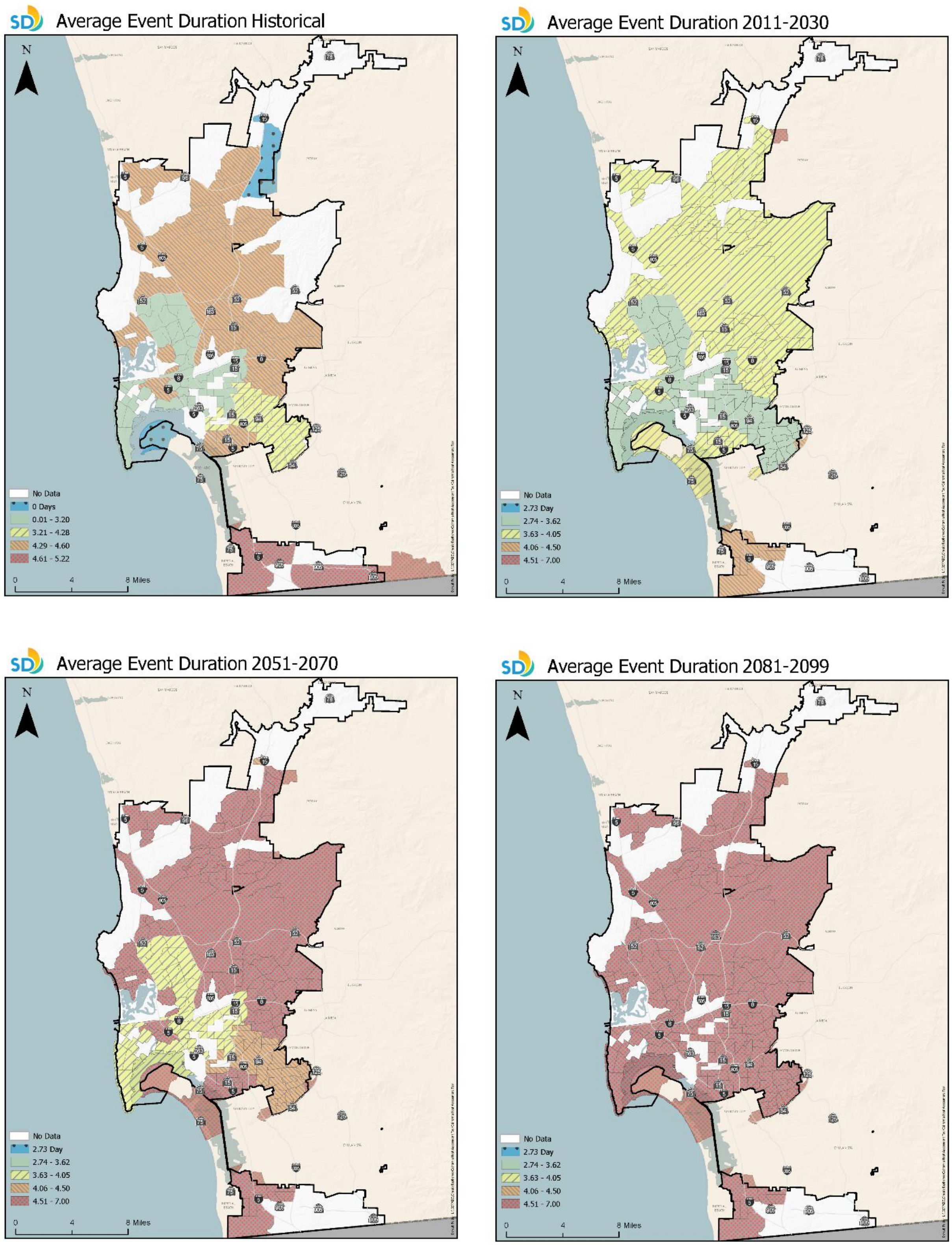
Nighttime Minimum Temperatures: Nighttime or daily minimum temperatures can indicate abnormally hot weather. Daily minimums, generally the nighttime low temperature, allow people and infrastructure to cool off each day. Some research suggests that nighttime temperatures can better predict heat-related health outcomes than daytime temperatures.[12] Cal-Adapt defines a warm night as a day when the daily minimum temperature exceeds the 98th historical percentile of daily minimum temperatures.[c] It is considered a "warm night" in the City when daily minimum temperatures are above 67.9°F. On average, the City experiences roughly four warm nights per year.[13] The City has seen an increase the number of warm nights per year since 1970.[d] It is estimated that climate change has made these local temperatures at least two times more likely.[14]

Heat Waves: Other metrics for extreme heat include the frequency and duration of heat waves. There is no standard definition of a heat wave or "heat streak," although the general consensus is that they are occurring more often.[15] Heat waves are often defined and tracked based on local climates. NOAA defines a heat wave as a period of unusually hot weather that typically lasts two or more days.[16] The City tracks heat waves as the occurrence of four-day events when maximum temperatures exceed 93.1°F, consistent with the definition provided by CalAdapt-.[17,18] Historically, the City has experienced about one heat wave every other year (Figure 2), averaging four extreme heat days per year and a maximum of 2.5 consecutive extreme heat days annually.[19] Heat waves tend to occur in July for inland regions and in September for coastal areas, where Santa Ana winds can trap dry, hot air along the coast.[20] Extreme heat events are projected to become more frequent and more intense.

[c] Based on observed data from 1961–1990 between April and October

[d] In this analysis, a "warm night" is defined as a day with a minimum temperature warmer than the 1991-2020 nighttime normal

Figure 2. Average Extreme Heat Event Duration for City of San Diego (California Heat Assessment Tool)



METRICS FOR IDENTIFYING GEOGRAPHIC AREAS OF EXTREME HEAT

The section below summarizes several metrics that can be used to identify and compare locations that are exposed to extreme heat.

Urban Heat Islands: Extreme heat is also exacerbated by the urban heat island effect, where impervious surfaces such as buildings and roads absorb and re-emit heat close to the ground, causing higher temperatures in urban areas.[21] The urban heat island effect also plays a role in higher nighttime temperatures, leaving fewer opportunities for people and infrastructure to cool off overnight during heat waves.[22]

Land Surface and Air Temperatures: Land surface temperature, or how hot the ground is, is often measured using high-resolution satellite data.[23] Land surface temperature can be useful in comparing different parts of cities amid varying concentrations of vegetation, land cover, reflectivity, and permeable surfaces. Air temperatures, measured via weather stations or mobile sensors (e.g., from cars, people) are often useful in understanding the conditions people experience day-to-day and comparing temperatures across time, although they do not account for factors like humidity or sunlight. Research suggests a combination of surface temperatures and air temperatures offers a more complete picture of a city's heat island effect and how people experience heat across a city, rather than using either metric alone.[24,25,26] The City's Urban Heat Vulnerability Index relied on daytime and nighttime land surface temperatures to identify areas of highest heat exposure.[27]

Time-Sensitive Data: Localized heat exposure data captured over specific timeframes are a meaningful measure. In 2021, the City partnered with the CAPA Strategies LLC Heat Watch Program to collect thousands of temperature and humidity data points in the morning, afternoon, and evening across the City over a two-day period.[28] The results showed significant differences in heat exposure by neighborhood based on the ways local landscape features affect temperature and humidity. The study also demonstrated how heat exposure can vary throughout the day. Time-sensitive heat data, which can be as simple as an hourly temperature forecast, can be a critical input in designing heat mitigation strategies. For example, employers can design work schedules to minimize the exposure of outdoor workers to the highest temperatures of the day. Residents can prepare cooling strategies such as fans or evaporative cooling in advance of an unusually warm night, while local governments or aid organizations may rely on time-sensitive heat data to schedule splash pad operation or water distribution during temperature spikes.

HEAT HEALTH THRESHOLDS

This section summarizes several metrics that can be used to define extreme heat and activate heat response protocols with respect to potential health impacts.

Heat Index: The heat index combines two factors—temperature and humidity—to measure how heat feels to the human body (i.e., a "feels like" temperature). When humidity is high, sweat evaporates more slowly, lowering the ability of the human body to cool itself. This makes the air feel hotter on days that are both hot and humid. Humidity is more dangerous, leading to significantly heightened risk of heat-related illnesses like heat stroke.[29] The Heat Index helps capture a fuller picture of heat exposure based on its potential health impacts and is a component of heat advisories and warnings issued by the U.S. National Weather Service (see Table 1). The City currently experiences roughly two days per year with a heat index above 90°F compared to one day in 1979.[30]

Table 1. National Weather Service Heat Index Thresholds for Public Health

Classification	Heat Index	Effect on the body
Caution	80°F-90°F	Fatigue possible with prolonged exposure and/or physical activity
Extreme Caution	90°F -103°F	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/ or physical activity
Danger	103°F -124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
Extreme Danger	125°F or higher	Heat stroke highly likely

Wet Bulb Globe Temperature: Wet Bulb Globe Temperature is a forecast tool that estimates the effect of wind speed and solar radiation on the human body in addition to temperature and relative humidity. It makes it easier to determine how hot a person feels on a sunny, breezeless day. It is an effective indicator of heat stress for active populations such as outdoor workers and athletes. Military agencies and athletic organizations use it, and the U.S. Occupational Safety and Health recommends its use for workplace heat safety. The National Weather Service and NOAA provide forecasts of Wet Bulb Globe Temperature.[31,32,33]

Thermal Comfort Modeling: Thermal comfort modeling considers the cumulative effect of meteorology, direct and reflected radiation, tree canopy, buildings, land use, and shade on human perception of heat. Modeling is typically calculated at local scales of one to five meters and can capture variations in city design, such as the difference in temperature someone feels when walking from an unshaded to a shaded part of the street. It is a useful metric for predicting the potential impact of a heat mitigation solution, such as installing a shade canopy or cool pavement.[34] Outdoor thermal comfort models are an ongoing area of research incorporating a variety of physical conditions, as well as unique calibrations for children, older adults, and even different racial groups.[35]

Heat Alerts: Heat alerts are an important tool for identifying extreme heat events with the potential to impact public health and coordinating preventive and emergency responses. The National Weather Service issues heat watches, warnings, and advisories based on local conditions to help the public and decision-makers take protective action. A Heat Watch may be issued to warn residents that extreme heat conditions are possible, while a Heat Warning warns residents to modify their activity during an active heat event.[36] For the San Diego region, the National Weather Service issues heat alerts based on time of year. From October to May, temperatures prompting Excessive Heat Warnings

Table 2. National Weather Service HeatRisk Scale

Category	Risk of Heat-Related Impacts
Green 0	Little to no risk from expected heat.
Yellow 1	Minor- Primarily affects those who are extremely sensitive to heat and without cooling/ hydration.
Orange 2	Moderate – Affects those who are sensitive to heat, especially those without cooling/ hydration, and some health systems and industries.
Red 3	Major – Affects anyone without cooling/ hydration as well as health systems and industries.
Magenta 4	Extreme – Rare and/ or long-duration extreme heat with no overnight relief affecting anyone without cooling/ hydration as well as health systems, industries, and infrastructure.

are between 95°F and 113°F. From June to September, temperatures prompting Excessive Heat Warnings are between 100°F and 117°F.[37] Public health offices such as the County of San Diego Health and Human Services Department rely on these heat thresholds to activate planned interventions and community outreach.[38] The National Weather Service also offers HeatRisk, a supplemental tool to official heat watches, warnings, and advisories that provides guidance for populations that are especially sensitive to extreme heat, such as older adults, young children, or people with chronic illnesses (see Table 2). Additionally, the California Division of Occupational Safety and Health (CAL OSHA) requires workplace high-heat procedures to be implemented when outdoor temperatures reach 80°F and indoor temperatures reach 82°F.[39]

Heat Season: Some communities have expanded their understanding of extreme heat to include a "heat season." This allows communities to address the impacts of prolonged, chronic heat exposure, in addition to preparing for distinct heat events. The City of Phoenix, for example, organizes its prevention and communications strategies around the summer heat season, followed by an end-of-season Arizona Heat Summit held in October.[40] Miami, where temperatures above 90°F for one-third of the year, has officially recognized a heat season spanning from May 1 to October 31.[41] In San Diego, summer temperatures now extend a week later than during the early 1970s.[42]

METRICS FOR INFRASTRUCTURE IMPACTS

Several temperature thresholds can be used to track potential heat impacts on infrastructure.

- 90°F – Sustained temperatures over 90°F are associated with damage to asphalt roads.
- 100°F – Air temperatures above 100°F are associated with rail equipment failure. For example, the Sacramento Regional Transportation District implements speed restrictions for overhead catenary system when the temperature reaches 100°F.[43] At 104°F, it monitors for warping of light rail tracks.

Extreme heat affects roads, rails, bridges, and vehicle operations as well as lifespans. Extreme heat can reduce passenger and cargo loads for aircraft and damage roadways and railways. Heat also increases the burden on public safety systems.[44] Additional metrics for bridges, airports, water infrastructure, public safety, and other assets may be available based on local climate, technology, and other factors.

Ultimately, selecting an appropriate heat metric depends on the user and their goals. Defining extreme heat is important for understanding who is most exposed, most vulnerable, and why, and for designing appropriate cooling solutions, coordinating heat response, and raising public awareness.[45,46] Developing research by the World Resources Institute provides recommendations for the best use of a sample of heat metrics.[47] Choosing and applying heat metrics for cities is an ongoing area of research. Additional research may be incorporated into the development of the City's Extreme Heat Action Plan.

Table 3. Potential Heat-Related Goals and Tracking Metrics (World Resources Institute)

Heat-Related Goal	Metrics to Inform Implementation
Lower citywide temperatures	Air temperature
Protect pedestrians outdoors	Thermal comfort indices
Set safety limits on outdoor activities	Heat index; wet bulb globe temperature
Keep people cool at transit stops or in public spots	Thermal comfort indices
Reduce indoor heat exposure and energy use	Air temperature; land surface temperature of roofs
Reduce the formation of ground-level ozone	Air temperature

Who Is Impacted by Extreme Heat

> **Older adults, young children, pregnant people, the chronically ill, unhoused populations, and people who work outside are among the populations who face the greatest risk from extreme heat.**

Although heat-related deaths and illnesses are preventable, heat is one of the deadliest weather-related hazards in the United States, killing more than 600 people per year between 1999 and 2009, more than all other disasters (except hurricanes) combined.[48,49] Between 2004 and 2018, that number rose to more than over 700 heat-related deaths per year.[50] NOAA's Billion Dollar Weather Disaster database lists heat waves as number six of the top ten deadliest U.S. disasters since 1980.[51] Exposure to extreme heat can cause a range of health problems including heat rash, sunburn, heat cramps, heat exhaustion, and life-threatening heat stroke, especially during prolonged exposure to extreme heat in events like multi-day heat waves.[52] Extreme heat can also cause disproportionate impacts for certain groups, including:

People with Preexisting Health Conditions: Heat exposure can cause stress on the body and exacerbate existing health conditions like cardiovascular, respiratory, or autoimmune disease and diabetes; risk of heat illness and death can also increase for people with preexisting medical conditions, chronic illness, and disabilities.[53] Cardiovascular illness has been demonstrated to be one of the leading causes of death during a heat wave.[54,55] One-fifth of heat-related deaths since 1999 list cardiovascular disease as an underlying cause.[56] Extreme heat can also disrupt care for people with long-term and serious medical conditions by increasing the frequency of power outages and putting additional strains on emergency room and hospital resources.[57] Finally, some medications used to treat mental illnesses have been found to increase a person's risk for heat-related illness.[58]

Older Adults: Older adults are often more vulnerable to heat impacts because older bodies do not adapt as well to heat.[59] In addition, heat can cause interactions with some medications and preexisting health conditions may be exacerbated by high temperatures.[60] Data from the Centers for Disease Control (CDC) from the last two decades show that adults over the age of 65, a population that is expected to grow in California to 22% by 2040[61], are several times more likely to die from heat-related cardiovascular disease.[62] Older adults are less likely to sense the signs of heat and thirst.[63] Older adults may also have a harder time preparing for or responding to a heat event. For example, an elevator outage, while a common inconvenience to some, can make it impossible for older residents and those with disabilities to leave the building to access cooling centers on high heat days. Older adults without health insurance may delay seeking care for heat-related illness.[64, 65]

> **Without air conditioning, a 1°F hotter school year reduces that year's learning by 1%.**

Children and Infants: Children are particularly sensitive to extreme heat; young children sweat less, acclimate to heat less efficiently than adults, and may miss symptoms of heat stress.[66] Young children and infants[67] in particular are vulnerable to heat-related illness and death, as are child athletes.[68] According to the CDC, heat-related illnesses are a leading cause of death or disability among high school and college athletes. Heat exposure is also correlated with an increase in children's emergency room visits, asthma, and fluid and electrolyte imbalances.[69] Extreme heat exposure has also been linked to decreased academic achievement, a trend that disproportionately impacts minority students who are unequally exposed to hot classrooms.[70]

Pregnant People: A pregnant body must work hard to cool down and may become dehydrated mor easily.[71] Poor birth outcomes such as low birth weight, preterm birth, stillbirths, and congenital cataracts have been correlated with high temperatures in multiple studies.[72,73,74] Several U.S. studies have also found that Black and Asian mothers face higher rates of preterm births associated with heat waves.[75,76]

Outdoor Workers: Workers in outdoor or non-air-conditioned environments—such as farming, agriculture, commercial fishing, transportation, construction, warehousing, delivery, and emergency response—are among the least protected from the impacts of extreme heat. Physical labor, heat-trapping protective gear, and lack of access to air conditioning can make conditions more dangerous for workers.[77] Heat stress can impair judgment and coordination, leading to increased workplace injuries and reduced productivity.[78] An analysis of Los Angeles communities showed found a 7.9% increase in heat-related hospitalizations for each percentage increase in residents working in construction.[79] California is one of the few states that has heat-related protective standards for outdoor workers that are enforceable under State law. Still, language barriers, gaps in health coverage, and concerns about immigration status can act as barriers to enforcement and reporting non-compliance.[80]

> **Extreme heat can deepen existing inequities including negative health outcomes, rising energy burdens, and poor air quality.**

Unhoused Populations: Lack of shelter and preexisting health conditions can make unhoused populations more vulnerable to heat-related illnesses. Unhoused populations are more likely to require an emergency department visit in the event of a heat wave; the same study found that unhoused patients who were younger or elderly and required a psychiatric consultation were especially vulnerable to heat waves.[81]

People of Color: People of color face disproportionate exposure and vulnerability to extreme heat due to economic inequities caused by ongoing systemic discrimination, exclusion, and under- or disinvestment.[82,83] Disparities in heat exposure have been correlated with redlining, a historical, discriminatory policy practiced by lending institutions to deny investment to neighborhoods based on their racial or ethnic makeup, resulting in neighborhoods with a smaller tree canopy, fewer green spaces, and more impervious surface than non-redlined neighborhoods. Today, redlined areas tend to experience higher temperatures compared to non-redlined areas.[84,85] Redlining has also been correlated with high rates of heat-related illness.[86] Children of color have been found to experience 7.5 more heat island days than white children across the same timeframe.[87] Research indicates that some communities of color and some low-income, unhoused, and immigrant populations have lower capacity to adapt to extreme heat because they more commonly lack access to adequately insulated housing, air conditioning, cooling centers, and adequate healthcare.[88,89,90,91,92] Several studies have observed disproportionately poor heat-related health outcomes for non-white populations. For example, CDC data indicate that non-Hispanic Black people experience disproportionately high rates of heat-rated mortality.[93]

Environmental Justice Communities: Environmental justice communities face overlapping risks due to higher heat exposure compared to other areas, underlying health burdens such as heart disease and diabetes, and limited access to air conditioning or cooling centers.[94,95] These risks may result in disproportionate vulnerability to heat-related illness, higher energy burdens, and other impacts. High temperatures also increase the production of ground-level ozone, a component of smog and poor air quality; heat speeds up the formation of ozone and increased air conditioning use can drive greater electricity demand supplied by fossil fuel power plants, which emit precursors to ground-level ozone.[96,97,98]

People Who Rely on Public Transportation: Extreme heat causes disruptions and inconvenience for transit users. High heat can damage rail infrastructure and requires slower speeds to operate, leading to delays.[99] Riders face heat exposure while walking to or waiting at unshaded bus stops.[100] Vehicles with poor ventilation or cooling can also increase heat exposure. These challenges are especially burdensome on individuals and families without alternative transportation options.

Energy-Burdened Households and People Without Access to Air Conditioning: With rising heat, more households may struggle to afford the energy needed to cool their homes, even if they have air conditioning.[101] This increased expense creates a disproportionate burden on environmental justice communities, where the annual cost of energy as a percentage of median household income is higher compared to this metric across the City.[102] According to a 2009 survey, 47% (516,824 households) of households in San Diego County are without air conditioning.[103] In a study of economic impacts in California, Pasadena households spent 12% more (an average of $75) on electricity during the 2022 heat season with 111 days above 90°F, compared to what they would have spent if those same days were 80°F to 90°F.[104] A recent study of 300,000 low-income households in California found a 1.2% increase in the risk of disconnection from electricity services following heat events for each day above 95°F.[105] One study estimated that a 20% increase in penetration of air conditioning units could decrease estimated heat mortality associated with a high emissions scenario by 33% by 2050.[106]

Coastal Communities: People living near the coast are believed to have a more difficult time cooling down during a heat wave because they are less acclimated to extreme heat and less likely to have air conditioning. In California, more severe health impacts from recent heat waves have been found along the coast.[107] A 2012 analysis of heat health impacts observed that hospitalizations occurred more frequently and at lower temperatures along the coast than in inland areas during heat events.[108] A 2018 analysis of heat health impacts in San Diego County observed health impacts at lower temperatures in coastal areas compared to more inland locations for multiple disease categories including heat illness, dehydration, acute renal failure, and respiratory disease. Within the coastal region, rates of heat-related morbidity and hospitalizations were found to be higher in zip codes where air conditioning saturation was lowest.[109]

DOCUMENTED HEAT VULNERABILITIES

Exposure, Vulnerability, Risk, and Adaptive Capacity

A comprehensive analysis of state, city, and local heat data and data mapping tools was conducted to understand how heat vulnerabilities are documented by the City and by the broader community of planners, policymakers, and experts. Extreme heat planning commonly distinguishes between metrics of heat exposure, vulnerability, risk and adaptive capacity, consistent with a globally understood framework of disaster and climate risk.[110] A growing body of national, state, and local resources and tools has been developed to support public health experts, planners, and policymakers in leveraging these metrics to mitigate the impacts of extreme heat.

In 2020, the City completed a Climate Change Hazard Vulnerability Assessment to evaluate the exposure and sensitivity of the City's people, infrastructure, services, and natural systems to major climate change hazards. It focuses on four primary hazards—sea level rise, extreme heat, changes in precipitation (including drought and flooding), and wildfire—and assesses vulnerability by considering each hazard's projected impacts, the sensitivity of different assets, and their adaptive capacity. The assessment focuses on critical City assets (like public safety facilities, water systems, transportation, parks, and buildings). In 2021, the City developed an Urban Heat Vulnerability Index in partnership with NASA's DEVELOP program to identify heat exposure, vulnerability, and risk across San Diego's distinct communities and community planning areas. The Urban Heat Vulnerability Index was developed to map heat vulnerabilities, building on the City's 2020 Climate Change Vulnerability Assessment.[111]

In the context of heat planning, **heat exposure** refers to the frequency and/ or magnitude of heat events.[112] Exposure can be measured in several ways, including the number of extreme heat days, daily minimum and maximum temperatures, the frequency of warm nights, hottest traverse points, or the number and duration of heat waves. The Urban Heat Vulnerability Index measures heat exposure by variations in land surface temperatures (using 2015-2020 data) across City neighborhoods.[e]

Heat vulnerability refers to the likelihood of people, their livelihood, and assets to suffer adverse effects when exposed to heat.[113] Drivers of vulnerability include socioeconomic, health-based, or other conditions that influence someone's susceptibility to heat-related

[e] Data used by the Urban Heat Vulnerability Index was provided by Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS), and Ecosystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS) imagery.

impacts. The Urban Heat Vulnerability Index, for example, calculates vulnerability using both preexisting medical conditions and socioeconomic factors.

Exposure and vulnerability are both components of **Heat Risk.**[114] In simple terms, the Urban Heat Vulnerability Index, defines risk as "Risk = Exposure x Vulnerability."

HEAT EXPOSURE

Heat Risk = Exposure x Vulnerability

Understanding Heat Exposure

In 2015, the California Environmental Protection Agency (CalEPA) released the Urban Heat Island Index for California, showing the urban heat island effect for census tracts throughout the state.[115] This tool is unique in that it quantifies the extent and severity of urban heat islands for cities. Census tracts are assigned a score based on atmospheric modeling over 2 three-month-long summer seasons: 2006 (the year of a major heat wave) and 2013 (the most recent year for which data were available). The Urban Heat Island Index is intended as a multi-use tool to help governments prioritize activities to mitigate heat islands, track the impact of mitigation activities over time, and support public preparedness. The City's Urban Heat Vulnerability Index, by comparison, uses remotely sensed land surface data for the summer to assess both daytime and nighttime exposure to high temperatures. The index identifies urban heat islands based on variations in mean land surface temperature across the City compared to non-urbanized reference sites (Torrey Pines State Natural Reserve in Northern San Diego, Mission Trails Regional Park, and the Tijuana River Preserve south of the City proper).[116]

Heat exposure has economic and racial disparities; it is also correlated with the historical and discriminatory practice of redlining.

Tools that Measure Heat Exposure

Several heat exposure mapping tools have been developed since the California Urban Heat Island Index. Many of these tools tie metrics of heat exposure to impacts on human health, enabling planners and public health experts to direct preventive and emergency resources to vulnerable communities. For example, the California Heat Assessment Tool (released in 2019) measures exposure by the frequency of heat health events, defined as any heat event that results in negative public health impacts, regardless of absolute temperatures. The California Natural Resources Agency funded the California Heat Assessment Tool as part of the state's Fourth Climate Change Assessment. It is most effective when used as a long-term planning tool to assess future heat health impacts throughout the state and to screen and prioritize resources for communities that are most affected.

Similarly, the California Healthy Places Index, developed by the Public Health Alliance of Southern California and the UCLA Luskin Center for Innovation in 2022, is intended primarily as a policymaking tool. It helps decision-makers prioritize public and private investments and resources across California communities by comparing heat exposure and vulnerability. The tool provides datasets on projected future heat exposure for California by county, city, and census tract using multiple metrics under the RCP 8.5 scenario.

The 2025 Vulnerable Communities Platform, developed by the Governor's Office of Land Use and Climate Innovation's Climate Services program, was designed to identify which California communities are most vulnerable to climate change. It can compare heat exposure between California communities (via census percentiles of the state average) using the "Climate Vulnerability Map" or "Individual Indicators" function.

CalHeatScore was built in 2023 as a public health tool offering real-time data for local emergency response and coordination; it assigns daily rankings of forecasted heat-related health impacts across California zip codes.[117] CalHeatScore was built as a result of Assembly Bill No. 2238 (L. Rivas, Chapter 264, Statutes of 2022) requiring CalEPA to develop a statewide extreme heat ranking system.

A detailed summary of these tools and their best use cases is provided in the "Summary of State Tools" section.

Factors that Contribute to Heat Exposure

Urban heat exposure is influenced largely by geography and land use, including the area of impervious surfaces, tree canopy coverage, magnitude of barren land, and proximity to the ocean.[118] Urban environments are particularly vulnerable to the urban heat island effect because the abundance of nonreflective materials absorb more heat, while the loss of vegetation reduces the natural cooling effects of shading and evaporation.[119,120] In recent years, the City's impervious surface area has expanded, resulting in greater absorption of incoming solar radiation compared to the surrounding undeveloped landscape.[121] This growth intensifies the urban heat island effect and exacerbates heat stress throughout the City.[122]

Urban Greening: The Urban Heat Vulnerability Index found that areas with lower heat risk typically have lower amounts of impervious surfaces, less infrastructure, and higher tree canopy coverage; many of these areas are also closer to San Diego Bay and the Pacific Ocean. Conversely, areas of high impervious surfaces and low tree canopy include infrastructure such as Interstate (I)-805 and I-15. Higher nighttime temperatures were also shown to correlate with low tree canopy and more impervious surfaces.[123] Albedo, the percentage of sunlight that a surface reflects away, has also been found to have an impact on the urban heat island effect. Darker colored asphalt, which has lower albedo and absorbs more sunlight, has been associated with higher temperatures.[124]

The 2021 Urban Heat Vulnerability Index found that areas exposed to the warmest temperatures correlate with high impervious surface area and low tree canopy, such as the Mid-City communities, Eastern Area, and College Area. These inland areas also do not receive the same cooling effect of the ocean.

> **Heat exposure has economic and racial disparities; it is also correlated with the historical and discriminatory practice of redlining.**

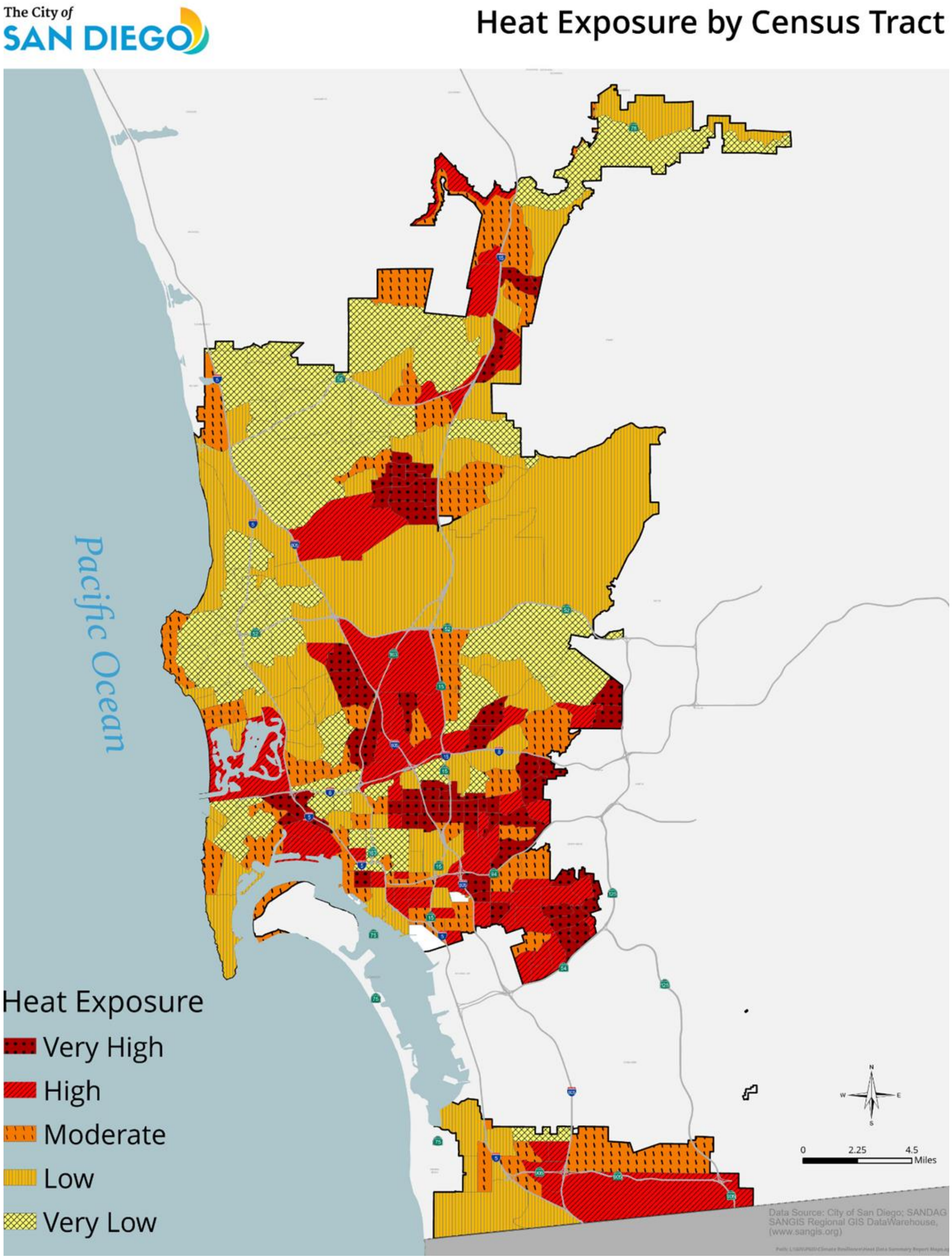
Economic and Racial Disparities: The distribution of heat exposure has also been demonstrated to have economic and racial disparities in San Diego. For example, research has found that the lowest income neighborhoods were roughly 2.5 degrees Celsius (°C [4.5°F]) warmer on extreme heat days compared to the wealthiest in San Diego; Latinx neighborhoods were also found to be approximately 2°C (3.6°F) warmer than white neighborhoods on extreme heat days.[125] Communities of color are often hotter due to historical, discriminatory practices that result in smaller tree canopies, fewer green spaces, and more impervious surfaces. [126,127] Groundwork San Diego's mapping efforts illustrate the impact of historical redlining and disinvestment in tree canopy cover, impervious surface, and land surface temperature in the Encanto, Southeast, and other Chollas Creek neighborhoods.[128]

Areas of San Diego Most Exposed to Heat Events

Based on measurements of daytime and nighttime land surface temperatures, the Urban Heat Vulnerability Index determined that the areas of Mira Mesa, the Mid-City communities, Normal Heights, College Area, and Skyline-Paradise Hills face the highest heat exposure. Conversely, Carmel Valley, Del Mar Mesa, and La Jolla/University City have the lowest heat exposure.[129] Heat exposure by census tract as identified by the City's Urban Heat Vulnerability Index is shown in Figure 3.

A full list of community planning areas with exposure to extreme heat is provided in Appendix B.

Figure 3. Heat Exposure by Census Tract in San Diego According to the 2021 Urban Heat Vulnerability Index



HEAT VULNERABILITY

Understanding Heat Vulnerability

Developed in 2019, the Climate Equity Index is one of the City's planning tools for addressing the nexus of environmental justice and social equity. The Climate Equity Index measures level of access to opportunity and assesses degree of potential impact from climate change; areas with less access to opportunity are assumed to have more limited capacity to adapt to climate hazards such as extreme heat. Communities most affected by climate change, or "Communities of Concern" are identified using 35 indicators in the categories of environmental, mobility, housing, health, and socioeconomic factors. This includes asthma rates, healthy food access, tree coverage, and median income, to name a few.

San Diego's Urban Heat Vulnerability Index includes many of the same indicators as the Climate Equity Index, as well as other demographic, socioeconomic, and preexisting health factors specific to heat vulnerability. Heat vulnerability incorporates both elements of susceptibility (preexisting conditions, age, race, occupation) as well as adaptive capacity (access to cooling, services, and opportunity).

Tools that Measure Heat Vulnerability

Vulnerability can also be defined and measured to support actionable heat mitigation strategies. The CA Healthy Places Index can be used to understand and compare factors that contribute to vulnerability at the county, city, and census tract level, and other relevant demographics such as school districts and medical service study areas. The user can filter results by vulnerability indictor, including the percentage of populations known to be disproportionately vulnerable to heat health impacts, such as youth, outdoor workers, older adults, and mothers and infants. This tool might be useful, for example, for identifying a pilot location for a youth athletics heat-safety training program or a program that provides safety check-ins for seniors on extreme heat days. For example, the CA Healthy Places Index indicates that both Mid-City and Encanto will face greater heat risk with a projected 36.3 and 26.6 days above 90°F in midcentury (2035–2064) under the RCP 8.5 scenario. However, Mid-City has 29% of people over the age of 65 living alone compared t0 12.3% in Encanto.

The California Heat Assessment Tool can compare demographic and environmental factors that contribute to greater heat vulnerability and subsequently poor heat health outcomes, such as rate of cardiovascular disease or percent of tree canopy cover. For example, the tool can be used to compare the percentage of outdoor workers by census tract to identify pilot locations for a workplace heat-safety training program.

The Vulnerable Communities Platform provides a similar comparison of vulnerability factors, as a census percentile of the state average

In addition, the California Department of Public Health's Climate Change & Health Vulnerability Indicators tool may be useful for comparing vulnerabilities and directing resources and services between counties.

Factors that Contribute to Vulnerability

Vulnerability to extreme heat has been tied to a multitude of preexisting health conditions, socioeconomic factors, and geographic conditions, as documented in the section "Who is Impacted by Extreme Heat."

Age and Health: Youth, old age and preexisting health conditions are commonly correlated with high heat vulnerability and poor heat health outcomes.

Socioeconomic Conditions: Socioeconomic and resource disparities are strong drivers of heat vulnerability and the disproportionate vulnerability experienced by people of color. The Urban Heat Vulnerability Index observed that percent Latinx, percent high school diploma, and percent English language proficiency correlate with higher heat risk.[130]

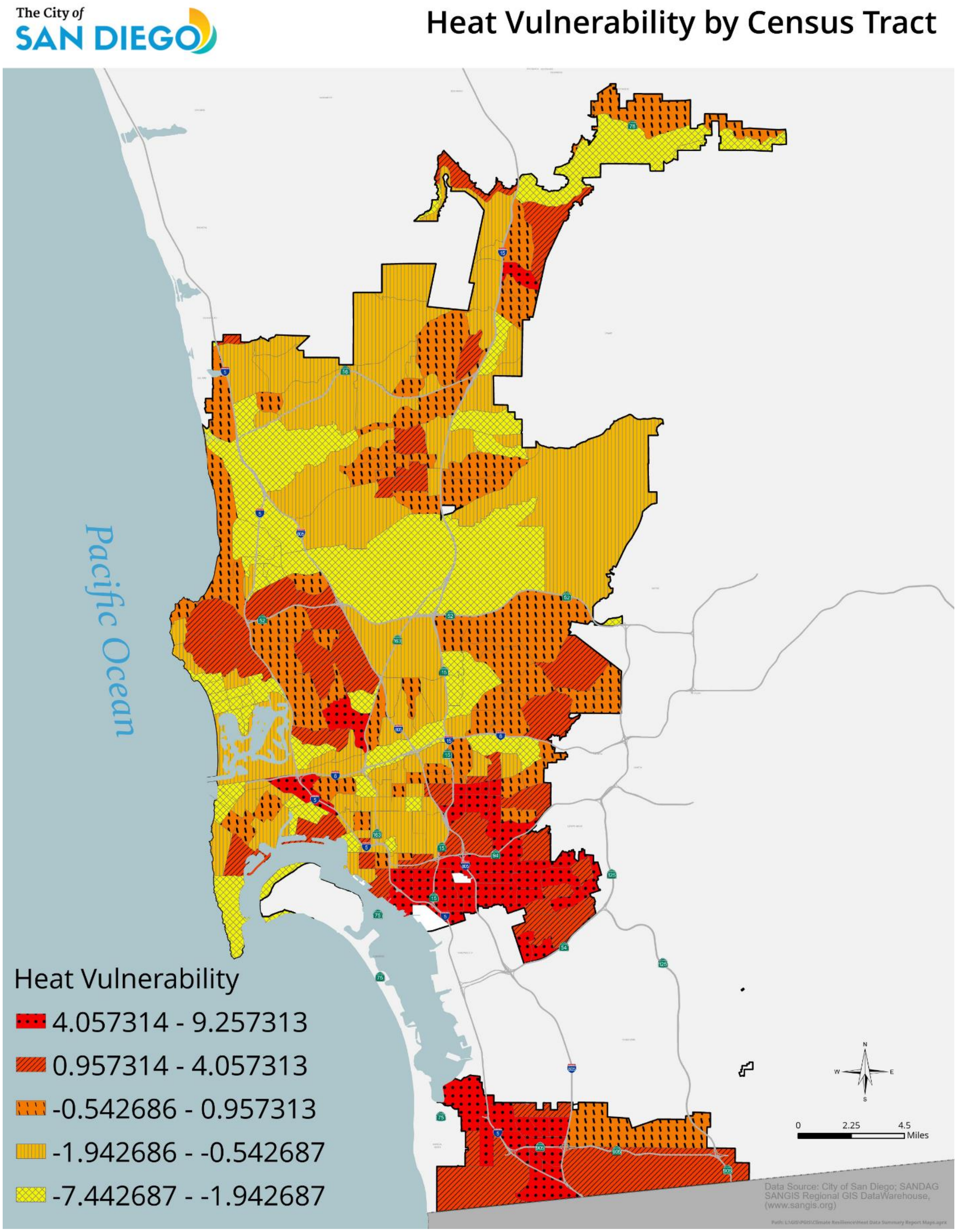
Local Geography: Emerging research indicates coastal communities are vulnerable to heat illness at lower temperatures, potentially because they are less acclimated to extreme heat and less likely to have air conditioning. However, more research is needed to understand this effect and its drivers in the San Diego region.

Locations of Populations Most Vulnerable to Heat in San Diego

Based on the 2021 Urban Heat Vulnerability Index, heat vulnerability is highest in communities such as Southeastern San Diego, Skyline/Paradise Hills, Barrio Logan, Encanto, Mid-City neighborhoods as well as Otay Mesa-Nestor and San Ysidro. Heat vulnerability by census tract as identified by the City's Urban Heat Vulnerability Index is shown in Figure 4. A full list of community planning areas that are vulnerable to extreme heat is provided in Appendix B.

In addition, there are other areas of the City where certain groups may be disproportionately vulnerable to heat. According to data provided by the California Heat Assessment Tool, areas of Mid-Way Pacific Highway and Southeastern San Diego have some of the highest rates of outdoor workers. Old Town, Downtown, Balboa Park, Southeastern San Diego, Encanto, and San Ysidro have the lowest rate of vehicle access. Areas of Mira Mesa and Scripps Miramar Ranch, University, Otay Mesa-Nestor, Downtown, Uptown, North Park, Mid-City: Kensington-Talmadge, Skyline-Paradise Hills and Encanto have lower percent birth weight. And according to data provided by the California Healthy Places Index, in areas of Uptown, the Peninsula, La Jolla, at least 30% of residents are over the age of 65. Otay Mesa-Nestor, Downtown, Southeastern, City Heights, College Area, and Encanto communities are among the most energy-burdened areas in the City.[131]

Figure 4. Heat Vulnerability by Census Tract According to the 2021 Heat Index



HEAT RISK

Understanding Heat Risk

In the state and local datasets reviewed for this report, heat exposure and vulnerability are commonly documented determinants of heat risk. The Urban Heat Vulnerability Index provides a composite heat risk score of 0 to 1 that combines heat exposure and heat vulnerability. Regions with higher scores have higher risk. Heat risk scores developed by the City's Urban Heat Vulnerability Index are provided by census tract..

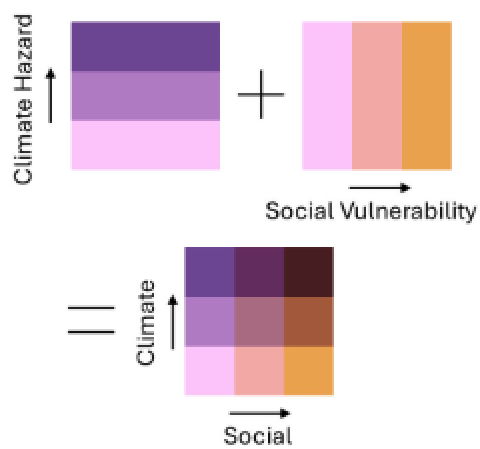
An important finding is that areas of higher heat exposure do not necessarily correlate with higher vulnerability. The same heat event can be experienced differently; someone with a preexisting condition may be more susceptible to heat illness than someone without this condition. Similarly, a family that cannot afford the cost of cooling their home may be more vulnerable to heat stress than neighbors who can run their air conditioning.

The Urban Heat Vulnerability Index combines exposure and vulnerability to give a composite heat risk score for each census tract in the City. This approach allows communities to better identify where heat exposure has the greatest impact based on the vulnerability of the population. In turn, this informs heat mitigation planning and the allocation of resources to communities with the greatest need.

Tools that Measure Heat Risk

The Vulnerable Communities Platform is one of few tools that combines heat exposure and social vulnerability into a composite heat risk score by census block group. Per the Platform's methodology, a higher "hazard" (i.e., heat exposure) score and a higher "social vulnerability" (i.e., heat vulnerability) score equals a higher "climate vulnerability" (i.e., heat risk). The areas with the highest heat risk are a dark maroon color while the lowest are light pink (Figure 5).

Figure 5. Climate Risk Scale Used by the Vulnerable Communities Platform



Factors that Contribute to Heat Risk

Heat risk is typically a measure of both exposure and vulnerability. Areas with both high exposure and high vulnerability typically have high risk. The Vulnerable Communities Platform offers a helpful visualization of this relationship.

Areas of San Diego Where Both Exposure and Vulnerability are Greatest

According to the methodology of the Urban Heat Vulnerability Index, areas with the highest heat risk tend to have both the highest exposure and highest vulnerability.

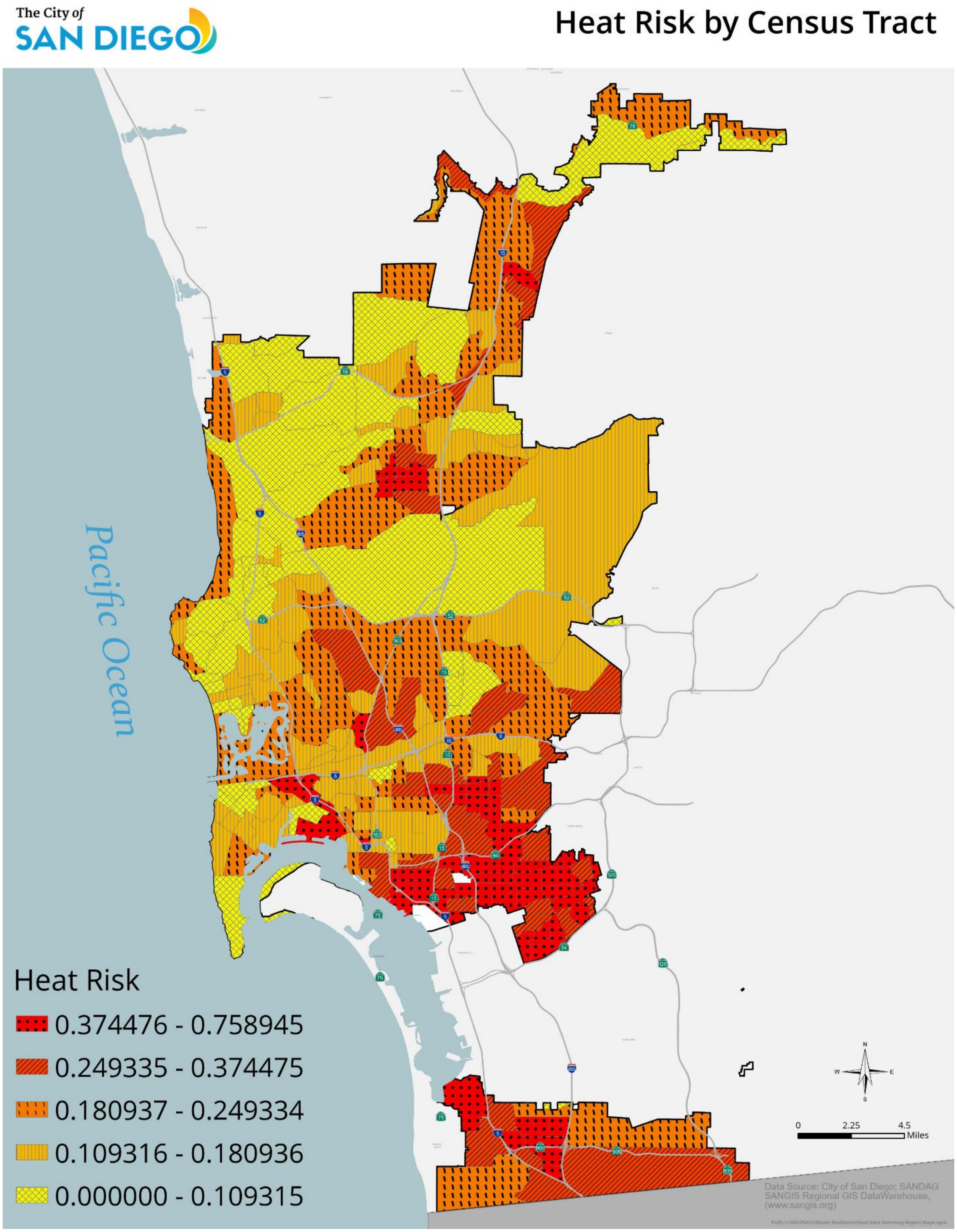
The analysis found that the Mid-City area, including City Heights and the Eastern Area, has the highest heat risk, with a risk score of 0.4, compared to the average risk for the City of 0.25. Other areas of identified high risk include Rancho Bernardo; San Ysidro; the Mid-City, Eastern, and College Areas (including parts of City Heights, Kensington-Talmage, and Normal Heights), as well as the Southeastern, Skyline-Paradise Hills, Encanto, Barrio Logan, and Otay Mesa-Nestor neighborhoods; portions of Old Town San Diego; and the area west of I-5, Linda Vista (Figure 6).

These regions of high risk typically have a large population of people of color, low high school attainment, and high preexisting health conditions, along with high heat exposure. For example, the neighborhood of Normal Heights was found to have high daytime and nighttime land surface temperatures. The neighborhood has a population with a large number of Latinx residents, people who are isolated and over the age of 65, and low high school attainment rates. The population in its associated census tract also has high rates of obesity and poverty. City Heights also has a population with a large number of people of color, people with limited English proficiency, and low high school attainment. The census tract associated with City Heights has higher than average values of people with preexisting health conditions, poverty and no access to health insurance.[f]

A full list of community planning areas that have high risk from extreme heat is provided in Appendix B.

[f] Datasets included socioeconomic and sociodemographic data from the 2018 American Community Survey (ACS) and health data from the CDC 500 Cities dataset.

Figure 6. Heat Risk by Census Tract According to the 2021 Heat Index



ADAPTIVE CAPACITY

Understanding Adaptive Capacity

Adaptive capacity, as defined by Intergovernmental Panel on Climate Change, is the "combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities."[132] In other words, while vulnerability may measure *lack* of opportunity, adaptive capacity measures the *abundance* of opportunity to mitigate or adjust to heat.[133] With regard to extreme heat mitigation, adaptive capacity is often measured in terms of the factors that have the potential to lessen heat exposure or mitigate heat health outcomes: tree canopy coverage, air conditioning access, adequately insulated housing, air conditioning, energy cost burden, cooling centers, park access, adequate healthcare, hydration stations, and impervious surface area, to name a few.

> **Research indicates that some communities of color and some low-income, unhoused, and immigrant populations have lower capacity to adapt to extreme heat, because they more commonly lack access to adequately insulated housing, air conditioning, cooling centers, and adequate healthcare.**

Tools that Measure Adaptive Capacity

The California Department of Public Health Climate Change & Health Vulnerability Indicators tool identifies counties as having more or less adaptive capacity according to the extent of air conditioning, tree canopy coverage, and impervious surfaces.

Other state tools allow for a comparison of adaptive capacity at the local level. The California Heat Assessment Tool includes data layers for percent of impervious surface and percent of population with no tree canopy and can rank these areas by priority accordingly. Additionally, the CalHeatScore tool maps the location of cooling centers across the state, while the California Healthy Places Index also maps the distribution of parks, impervious surface, and tree canopy coverage.[134]

San Diego's Environmental Justice Element, adopted as part of the City General Plan, considers heat risk data from the Urban Heat Vulnerability Index as well as energy cost burden and tree canopy in its Climate and Resiliency mapping. Geographic areas with the overlapping conditions of residents that shoulder a higher cost energy burden, a lower tree canopy, and a higher heat risk, would have a lower adaptive capacity.[135]

Factors that Contribute to Adaptive Capacity

Urban tree canopy, energy cost burden, cool zones, and walk access to parks can be used as potential metrics of adaptive capacity, in addition to others not included in the Environmental

Justice Element. Other potential metrics, which may require additional study, include access to health care, adequate housing insulation, and proximity to hydration stations.

Urban Tree Canopy: The City's urban tree canopy coverage (see Figure 7) can be used as one indicator of a community's adaptive capacity to mitigate extreme heat because trees reduce surface and air temperatures through shading and evapotranspiration. Areas with sparse canopy are more vulnerable to heat exposure, particularly where impervious surfaces dominate. Tree canopy data can be used to identify heat-vulnerable neighborhoods and prioritize tree planting in these areas to help reduce ambient temperatures, improve thermal comfort, and deliver co-benefits such as improved air quality and stormwater management.

Energy Cost Burden: Energy cost burden (see Figure 8), or the share of household income spent on energy, signals a population's ability to adapt to extreme heat through cooling strategies such as air conditioning. Households with high energy burdens may limit cooling use during heat events, increasing health risks. This information can be used to target heat response measures, including utility bill assistance, weatherization programs, energy-efficient cooling upgrades, and the siting of cooling centers.

Cool Zones: The City designates certain recreation centers, libraries, and other public buildings as cool zones, or place for San Diegans to seek relief during periods of extreme heat. Access to cooling spaces, like libraries and shopping malls, has been found to lower heat-illness deaths.[136] Cool zones (see Figure 9) welcome service animals and offer a safe environment where people can cool down, rest, and hydrate. Cool zones provide adaptive capacity for communities and are especially important for individuals who may not have access to air conditioning at home or who are at higher risk of heat-related illness, including older adults, young children, and people with underlying health conditions. As part of a broader extreme heat response strategy, cooling centers help protect public health and reduce the risk of heat-related emergencies.

Walk Access to Parks: Walk access to parks (see Figure 10) reflects a community's proximity to shaded, open spaces that can provide thermal relief and support physical and mental well-being during heat events. Limited access can exacerbate heat vulnerability, especially in dense or underserved neighborhoods. Park access metrics can identify gaps in cooling amenities and prioritize investments in new parks, shaded corridors, and improved pedestrian connectivity.

Figure 7. City of San Diego Urban Tree Canopy Cover

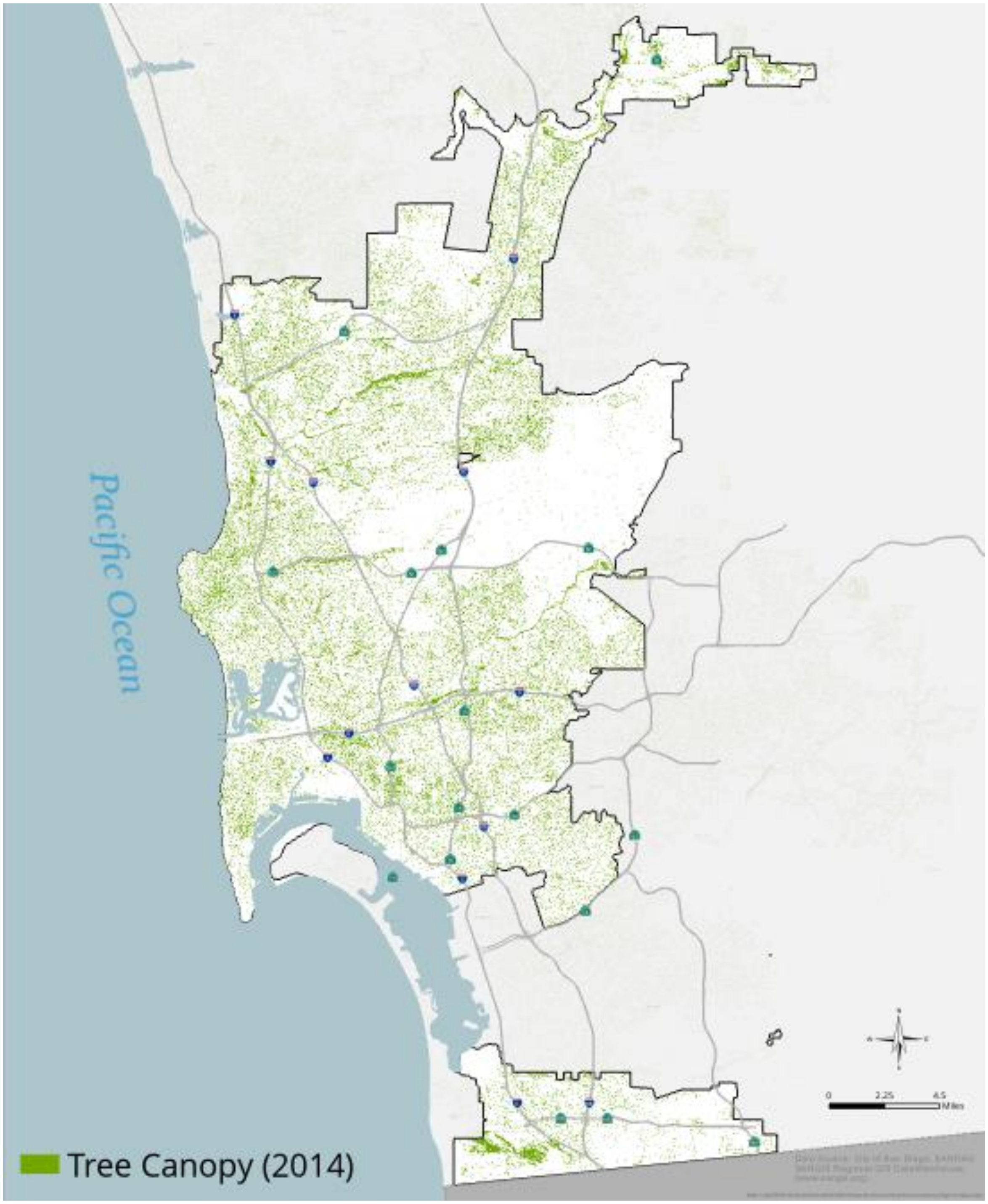


Figure 8. City of San Diego Energy Cost Burden

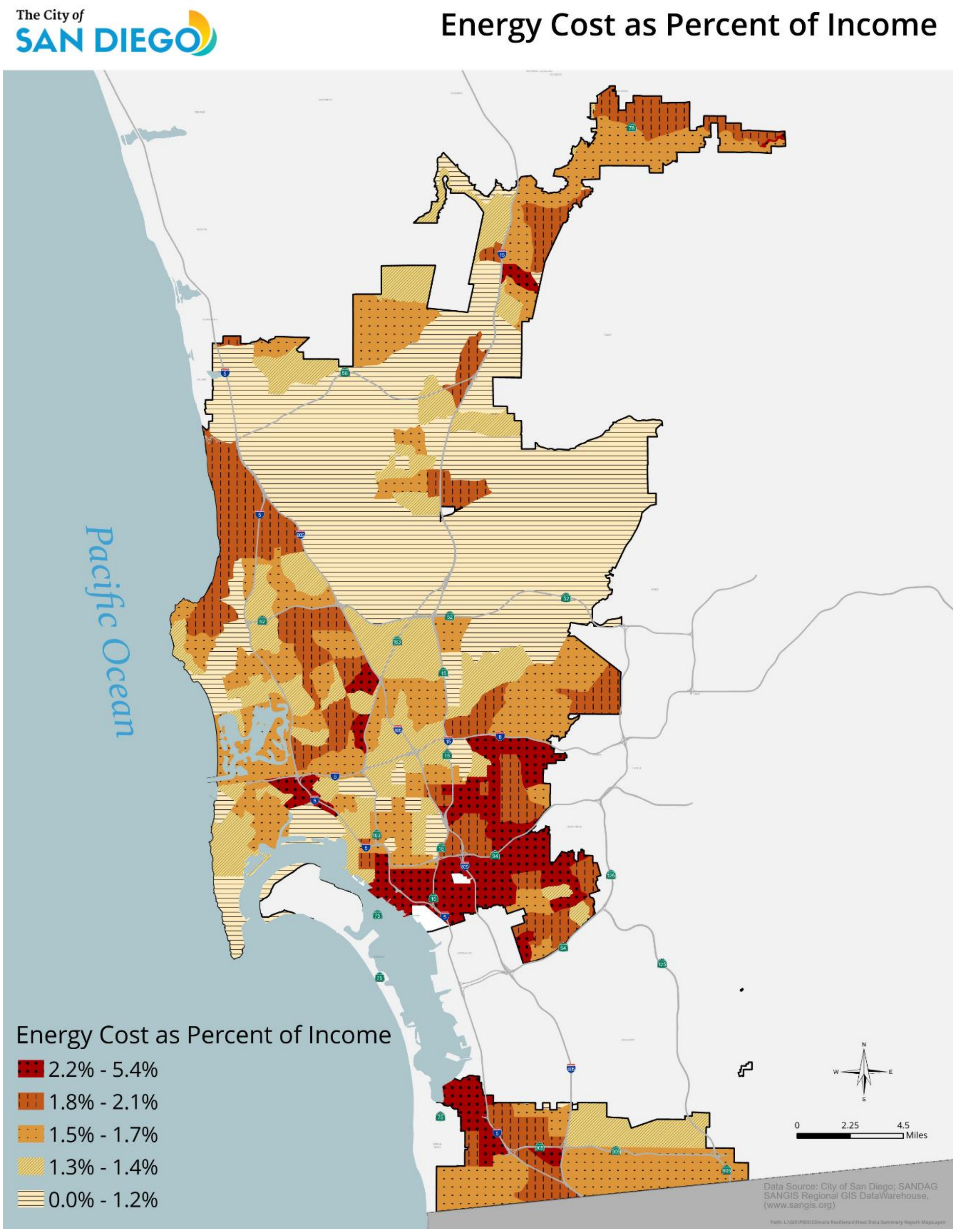


Figure 9. City of San Diego Cool Zones

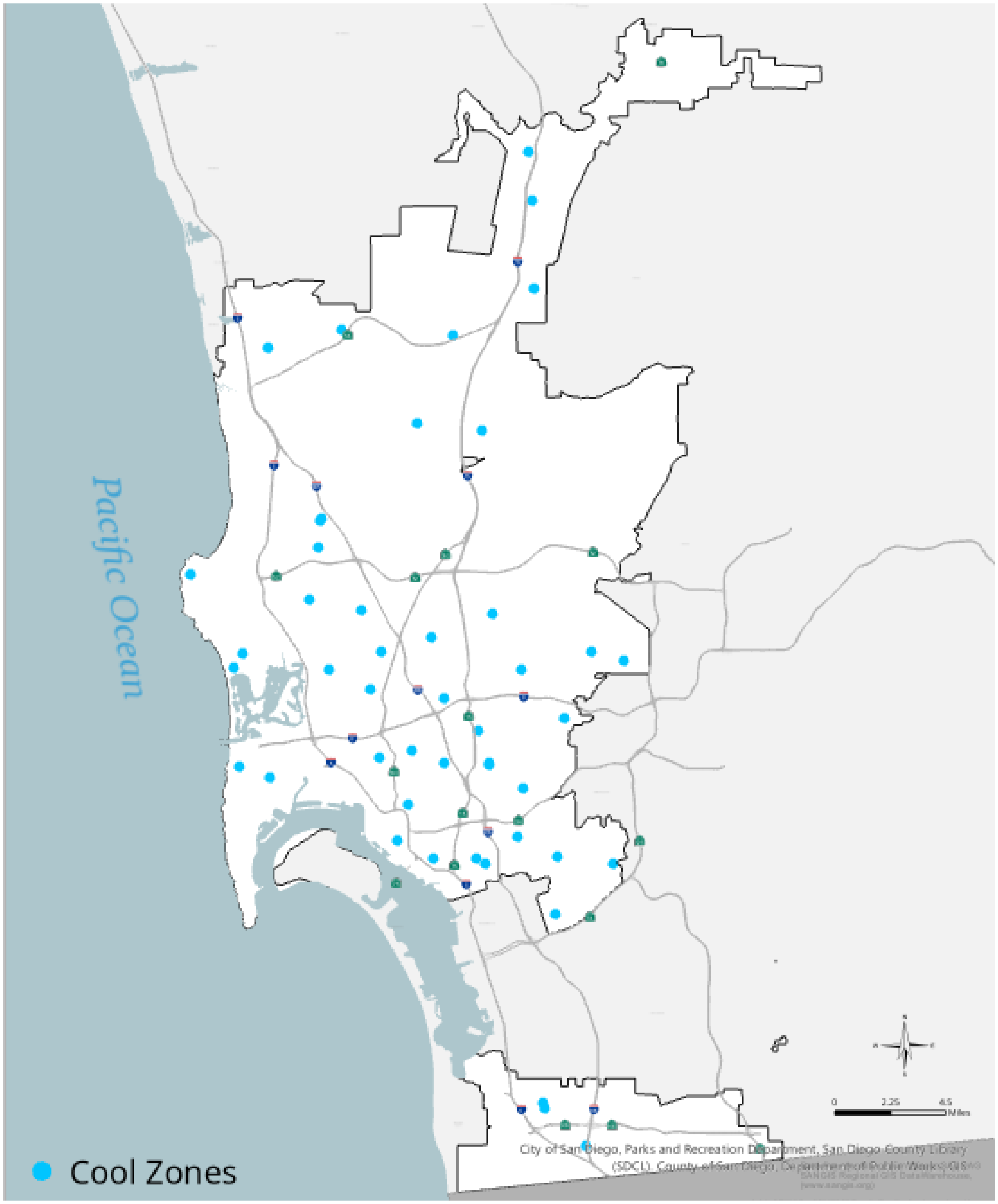
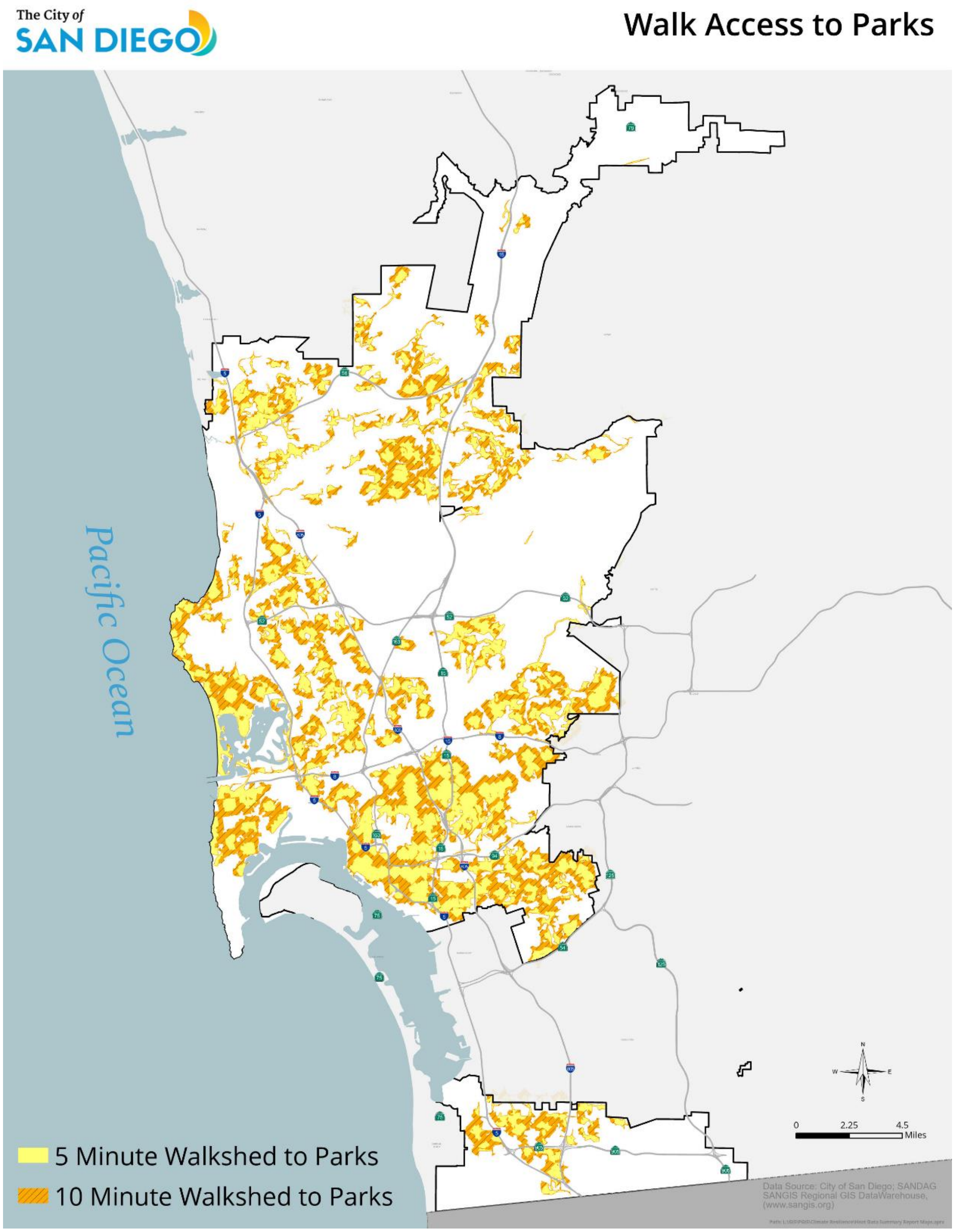


Figure 10. City of San Diego Walk Access to Parks



Areas of San Diego Where Adaptive Capacity Is Greatest

While the Urban Heat Vulnerability Index does not directly evaluate the City's adaptive capacity, it does estimate daytime and nighttime cooling or "heat mitigation" capacity of the land and model the cooling potential of an expanded tree canopy. Areas considered harder to cool are Southeastern San Diego, Mid-City Normal Heights, Encanto, North Park, and Mira Mesa. The Torrey Pines area was found to be comparatively easier to cool, due in part to its two nature preserves, trailheads, and parks.

Future updates to the City's Urban Heat Vulnerability Index may include the following metrics of adaptive capacity: energy cost burden, access to cool zones, walk access to parks, availability of air conditioning, access to health care, adequate housing insulation, or proximity to hydration stations.

Impacts Already Being Observed in San Diego

Extreme heat is already resulting in measurable impacts on public health, emergency services, economic stability, and workplace productivity.

25% of participants who responded to the 2022 SD Climate Action Plan survey reported that they have been impacted by heat and increased temperatures.

Public Health: Rising heat places more residents at risk of heat-related illness or death and exacerbates preexisting health conditions. Over the past three decades, there has been an upward trend in the number of San Diego County residents experiencing heat illness or injury, and a rising number of hospitalizations and deaths related to heat illness. Between 1991 and 2022, there were an average of 25 hospitalizations and 3 deaths due to heat-related illness per year.[137] In 2021, San Diego saw the highest number of deaths from heat illness or injury since 1991 with eight deaths.[138] The risk of heat-related death increases steeply on "Risky" heat days, coined by Climate Central as days when temperatures rise above the local minimum mortality temperature.[g,139] From June to August 2025, the City saw 12 "Risky" heat days, 11 of which are attributable to climate change.[140]

[g] Minimum mortality temperature is the daily average temperature at which the risk of heat-related death is lowest. In the City, this threshold is 72.5°F. That is warmer than 90% of temperatures observed at that site over the 1991-2020 period, or about the temperature local people would consider "hot."

Emergency Services: Rising temperatures are also contributing to a larger burden on emergency services, including emergency room capacity and emergency dispatch. San Diego County sees an average of 10.7 pre-hospital calls on heat event days. Pre-hospital care includes medical assistance provided to a patient before they arrive at a hospital or medical center and is frequently initiated by a 911 call to a dispatch center. Between 2006 and 2022, San Diego County experienced an upward trend in emergency department discharges for heat illness and injury, with an average of 194 visits annually.[141] In analyses of San Diego and California emergency department visits, people older than 65 and unhoused individuals had higher rates of emergency room visits.[142,143]

2006 California Heat Wave Impacts

Lives lost: 140

Hospitalizations: 1,182

Hospital Patients over 65: 52%

Added Emergency Room Visits: 16,166

Added Health Costs: $132 million

Economic Stability: Extreme heat is projected to have far-reaching economic impacts across the state, from productivity losses to infrastructure damage. A 2024 analysis by the California Department of Insurance estimates an economic loss of almost $1 billion from the 2018 SoCal Coastal Event.[144] This event also created an estimated $84 million in manufacturing output losses, more than $2 million in repair costs for City roads, $81 million in lost wages, and more than $3 million in rail costs.[145] Municipal and state governments are expected to carry the brunt of these costs, including an estimated $3 to $35 million per heat event resulting from rail and road infrastructure damage and delays.[146] Lost time resulting from heat-affected workplaces is estimated to cost between $7.7 million and $210 million per heat event, while reductions in manufacturing output range from $2.6 million to $310 million per observed heat event.[147]

Energy Grid: Increased demand for cooling can overburden energy grids, while high heat can decrease the carrying capacity of transmission and distribution lines, causing more frequent power outages.[148,149] Data from Climate Central indicate that heat season outages in the United States now happen 60% more often than during 2000–2009.[150] Power outages attributed to seven heat events in California between 2013 and 2022 are believed to have caused an estimated $580 million in combined damages.[151] During the September 2022 California heat wave, record-breaking temperatures pushed the statewide grid to its limit, prompting emergency conservation alerts to avoid widespread outages and causing a significant increase in heat-related mortality across the state.[152] These events underscore how heat hazards intersect with energy reliability and community health—conditions that are expected to intensify as the climate continues to warm.

Power outages are more common during periods of high heat, when energy needs for cooling grows; public safety power shutoffs, triggered by wildfires, often coincide with drought and extreme heat conditions.

Extreme heat can also reduce the capacity and lifespan of electrical infrastructure, contributing to more heat-induced power outages. For example, a 1°C rise in ambient temperature over the 40-year lifespan of a substation transformer is estimated to decrease the transformer's lifespan by about 10%, or four years, requiring more frequent replacement.[153] Insurance typically does not cover this risk, nor does it cover the impact of power outages on most businesses, who must cover the costs of these losses themselves.

Workplace Injury: Heat stress and fatigue in the workplace have also resulted in more frequent workplace injury. Across California, there has been an increase in workers' reports of heat-related illness (reported as injury claims that specified heat-related illness).[154] Workplace heat injuries also incur a financial cost. A study of workplace heat-related injuries in California estimated that the health care expenditures, lost wages and productivity, and disability claims cost between $525 and $875 million per year. The same study found that lower-income households are five times more likely to be affected by heat-related workplace injuries than higher income households.[155] This may be due, in part, to lower-income workers living in areas with more frequent extreme heat days, underlying health conditions, or because they are more likely to work jobs exposed to extreme heat.

San Diego County has the second highest rate of heat-related workplace injury claims in the state at a rate of 32.7 claims per 100,000 workers (based on Workers' Compensation Information System data, California Department of Industrial Relations, 2000-2017).

Heat Stress in Schools: Across the United States, children are experiencing more extreme heat days on average than generations before them. According to data gathered by Climate Central, a young adult (someone turning 18 this year) in San Diego will experience 731 hot days in their lifetime, with 45% of those days attributable to climate change.[156] Hot classrooms can put children at risk of heat stress and illness. In the City, an estimated 78% of K-12 students (130,463 students) attend public schools in extreme urban heat zones (census block groups with an Urban Heat Island Index of at least 8°F).[157]

The San Diego Unified School District spent $460 million between 2013 and 2019 to install air conditioning systems in 118 schools so that all 175 schools are now equipped.[158] However, efforts to cool schools face challenges from increased demand, limited financial resources, aging facilities, and lack of knowledgeable technicians.[159] Extreme heat events can strain even relatively new heating, ventilation, and air conditioning (HVAC) systems.[160] Climate change increases the demand for cooling, while aging school facilities require greater maintenance and replacement to keep HVAC systems functioning. The City has seen a 4% increase in back-to-school cooling demand since 1970[161]

DOCUMENTED INFRASTRUCTURE AND COMMUNITY ASSET VULNERABILITIES

In addition to the impacts already observed, the City has also identified other areas of existing and future infrastructure vulnerability.

The City's Climate Change Vulnerability Assessment evaluates how the City's infrastructure, services, and natural systems are exposed and sensitive to major climate change hazards, including extreme heat.[162] Extreme heat was analyzed using CalEPA's Urban Heat Island Index data. CalEPA's index measures the temperature difference over time between urban census tracts and nearby rural reference locations, reported as "degree-hours per day," where higher scores represent hotter areas resulting from land cover, the built environment, and lack of vegetation. Assets located within higher heat island index score zones (e.g., 80–100+) were considered more exposed to extreme heat. This heat exposure layer was combined with assessments of sensitivity (how much heat could damage or disrupt an asset) and adaptive capacity (an asset type's ability to cope or respond) to assign overall vulnerability scores for each asset type relative to extreme heat.

The City's Climate Change Vulnerability Assessment identified multiple asset classes as having medium to high vulnerability to extreme heat, based on combined evaluations of exposure, sensitivity, and adaptive capacity. Assets with higher vulnerability tend to be those that are directly exposed to elevated temperatures, rely on heat-sensitive materials or mechanical systems, or have limited capacity to adapt without significant upgrades or operational changes. A summary of assets with medium or high heat vulnerability is shown in Table 4.

Public safety assets were generally found to have low vulnerability to extreme heat. Many assets have high adaptive capacity due to backup systems or vehicles, energy efficient equipment or air conditioning. However, extreme heat can reduce workforce efficiency, increase health and safety risks to staff, and stress building systems that were not designed for prolonged high temperatures. As public safety assets are critical for emergency response, even small heat-related disruptions could pose meaningful risk.

Water infrastructure assets were found to have low to medium vulnerability, with water pump station, distribution reservoirs and wastewater treatment plants the most vulnerable. Extreme heat affects water assets by increasing thermal stress on infrastructure, accelerating material degradation, and influencing water quality and biological processes. Heat also drives increased water demand, placing additional strain on systems with limited adaptive capacity. Assets that rely heavily on mechanical or electrical components are particularly susceptible to overheating and operational failure during prolonged heat events.

Transportation and stormwater infrastructure also showed widespread medium vulnerability to extreme heat. Bridges, major arterial roads, outfalls and airports were all rated as medium vulnerability due to the sensitivity of pavement, concrete, and structural components to sustained high temperatures, which can lead to expansion, cracking, and increased maintenance needs.

Open space and environmental assets were the only asset class to have high vulnerability to heat. Conservation areas, open space, and source water lands were rated as highly vulnerable due to direct exposure and ecological sensitivity. Extreme heat can stress vegetation, reduce ecosystem function, and increase wildfire risk. Community parks were rated as moderately vulnerable because high temperatures reduce usability for the public and place stress on landscaping, facilities, and maintenance operations, particularly where tree canopy and shade are limited.

Community-serving and cultural assets have low to medium vulnerability to extreme heat. Libraries and City buildings had low vulnerability while recreation centers were rated as having medium vulnerability. This was generally driven by greater exposure of recreation centers to extreme heat. Extreme heat may strain indoor environments, cooling systems, and operations. Libraries and recreation facilities often serve as critical public spaces during heat events, increasing their importance to heat response efforts. Historical, tribal cultural, and archaeological resources were rated as medium vulnerability because many are composed of heat-sensitive materials and may be difficult or costly to repair.

Table 4. Extreme Heat Vulnerability Findings Climate Change Vulnerability Assessment

Asset Class (Sector)	Extreme Heat Vulnerability
Public Safety Assets	
Fire Stations	Low
Lifeguard Stations	Low
Fire Logistics & Dispatch	Low
Maintenance Facilities	Low
Police Stations	Low
Police Patrol & Specialty Vehicles	Low
Other Public Safety	Low
Water Assets	
Dams	Low
Water Pipes	N/A
Wastewater Pipes	N/A
Water Pump Stations	Medium
Wastewater Pump Stations	Low
Distribution Reservoirs	Medium
Water Treatment Plants	Low
Wastewater Treatment Plants	Medium
Transportation & Storm Water	
Airports	Medium
Bridges	Medium
Major Arterials	Medium

Asset Class (Sector)	Extreme Heat Vulnerability
Drain Pump Stations	Low
Outfalls	Medium
Levees	Low
Open Space and Environment	
Conservation Areas / Open Space / Source Water Land	High
Community Parks	Medium
Miramar Landfill	Low
CNG Fueling Station	Low
Beaches	Low
Additional Assets	
Recreation Centers	Medium
Libraries	Low
City Buildings	Low
Historical, Tribal Cultural, and Archaeological Resources	Medium

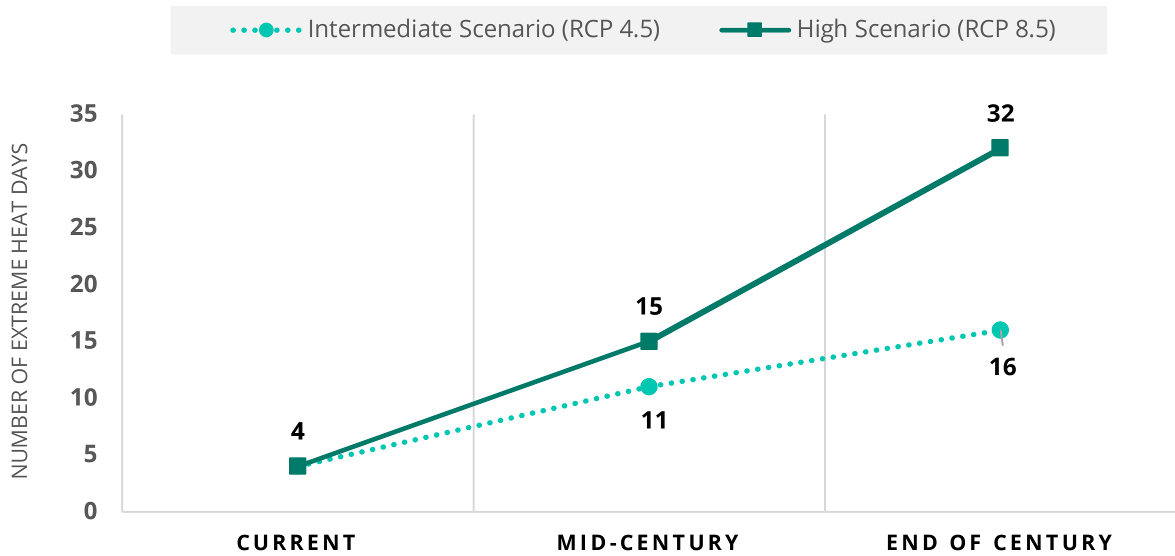
EVALUATION OF FUTURE HEAT IMPACTS

Changes to San Diego's Heat Exposure, Vulnerability, and Adaptive Capacity Over Time

The following section summarizes projected future heat impacts for the City, primarily drawing from Cal-Adapt data summarized for Climate Resilient SD, as well as supplemental data provided by state heat planning tools. This data includes the most recent generation of climate models with publicly available processed data localized to the San Diego region. New data, based on updated climate projections, may become available with the publication of the 5th California Climate Assessment and the regional Urban Heat Vulnerability Index, developed as part of this project.

Daily Maximums: The highest temperatures in the San Diego region typically occur in July and August; however, higher temperatures are increasingly starting earlier and ending later each year.[163] According to an analysis of Cal-Adapt data from CMIP5, the most recent generation of climate models with publicly available processed data localized to the San Diego region, the number of high heat days is expected continue rising over the coming decades (see Figure 11). By midcentury, extreme heat days could increase from an average of 4 to 11 days annually under an intermediate emissions scenario (RCP 4.5) and up to 15 days annually under a very high emissions scenario (RCP 8.5). By the late century, San Diego could see up to 16 extreme heat days per year under the intermediate emissions scenario (RCP 4.5) and 32 days per year under the high emission scenario (RCP 8.5).[164] This is equivalent to up to a month each year with daily highs over 93°F by the 2080s.[165]

Figure 11. Projected Number of Extreme Heat Days Per Year Above 93°F (Cal-Adapt Data)



Other resources are available to the San Diego region that synthesize data from Cal-Adapt to understand how projected heat exposure may vary across different landscape features and geographies. The use of different time horizons and thresholds for extreme heat makes direct comparison between tools difficult; however, because these tools rely on the same Cal-Adapt dataset, their results generally remain consistent. California Healthy Places for example, predicts 11.8 extreme heat days (compared to the historical baseline) under RCP 8.5 for midcentury (2035-2064) and 25.9 for the end of century (2070-2099). The California Healthy Places Index ranks census tracts based on the projected number of extreme heat days, as well as days above 90°F and 100°F, through mid- and end of century under a very high emissions scenario (RCP 8.5).[166]

Longer and hotter heat seasons means residents and outdoor workers will experience longer and more frequent stretches of unsafe temperatures, even in areas that have historically stayed cooler.

Additionally, the Vulnerable Communities Platform allows for a comparison of current and future heat metrics by census block group, including maximum temperatures and percent of summer days over 100°F. However, because the Vulnerable Communities Platform utilizes an emissions scenario not reflected in most of the other tools (SSP 3-7.0, high emissions),[h] its

[h] Representative Concentration Pathways (RCPs) describe potential future greenhouse gas emissions trajectories. A more recent update to these trajectories, Shared Socioeconomic Pathways (SSPs), incorporate social, economic, and institutional factors to describe future development pathways. Both RCPs and SSPs are used to model future climate scenarios.

results are not directly comparable with the results from these other tools as they assume different future emissions trajectories.

Heat Health Events: The California Heat Assessment Tool allows for a comparison of heat exposure across census tracts on 20-year time intervals, including average maximum and minimum temperature and humidity, as well as the frequency and duration of heat health events, as shown in Table 5.[167] According to the California Heat Assessment Tool, the City will see more frequent and longer lasting summer heat health events annually under intermediate (RCP 4.5) and very high (RCP 8.5) emissions scenarios through the end of the century (see Figure 12). This effect will become more pronounced by the 2041-2060 interval.

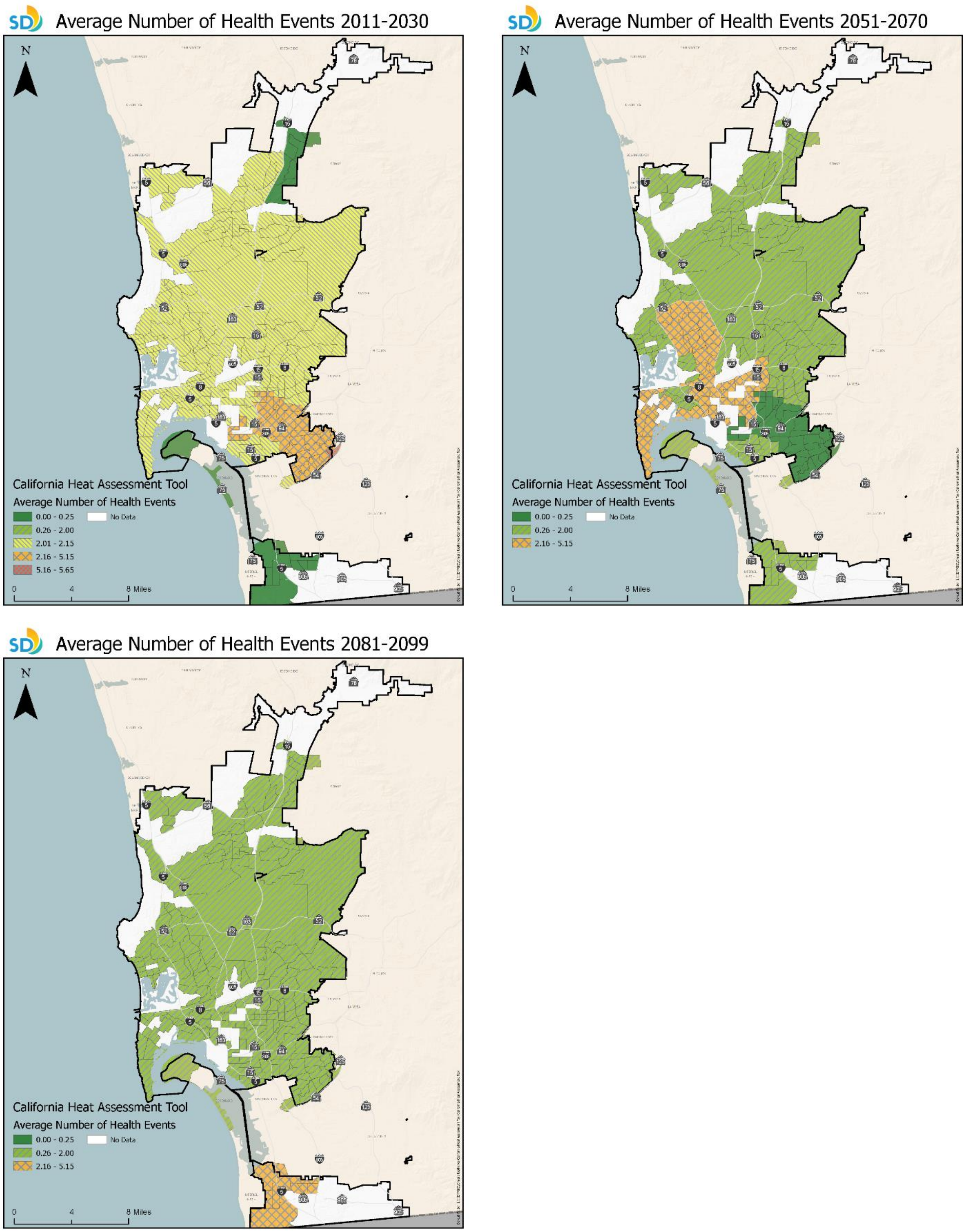
Table 5. Heat Health Events for the City of San Diego General Population Based on the Three Hottest Months: June, July, and August

Summertime Heat Health Events	Historical	2041–2060		2071–2090	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Number per Year	0	1 *(0–2)*	1 *(0–2)*	1 *(0–3)*	2 *(1–4)*
Average Duration (days)	6 days	5 days (*5–6 days*)	6 days (*4–6 days*)	6 days (*5–7 days*)	8 days (*5–9 days*)

Note: Values shown are the 50th percentile, and the 5th and 95th percentiles are italicized in parentheses to provide uncertainty bounds.

The tool can be used to compare neighborhood-level impacts. For example, Otay Mesa is expected to experience 1.4 heat health events per year under RCP 4.5 by the 2041-2060 period and 1.85 health events per year under RCP 8.5 by the 2041-2060 period, compared to the historical average of 0.3 events per year.

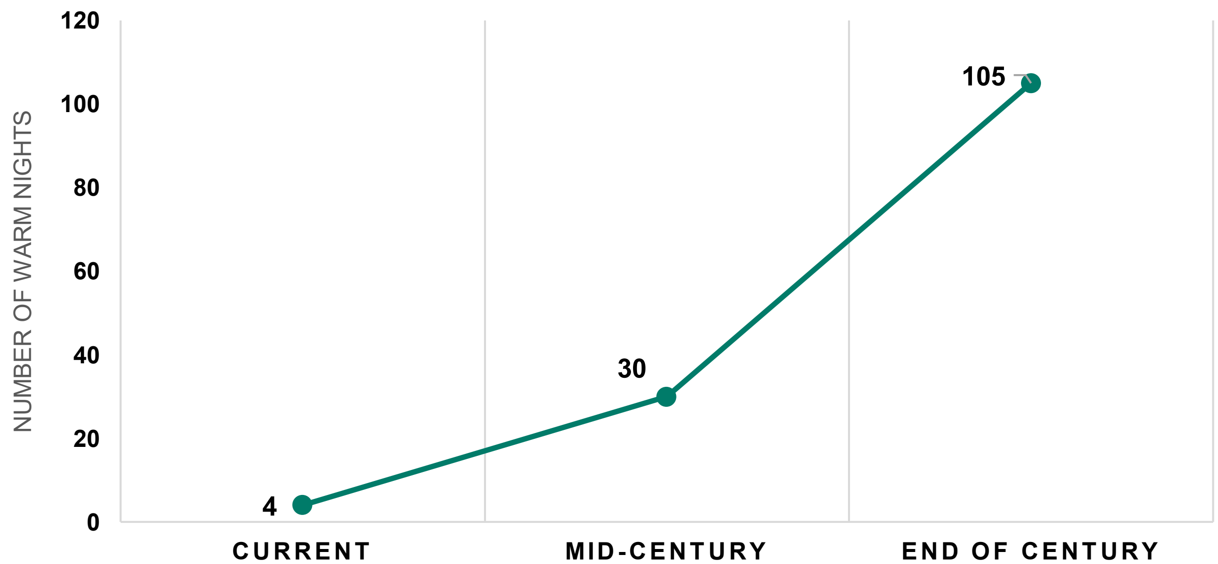
Figure 12. Projected Number of Heat Health Events Through the End of the Century in the City of San Diego



Daily Minimum (Nighttime) Temperatures: Daily minimum temperatures are expected to increase, causing more warm nights in San Diego. It is considered a "warm night" in the City when daily minimum temperatures are above 67.9°F. In October 2015, San Diego experienced the top three warmest low temperatures in October since 1875.[168] Under a very high emissions scenario, daily minimum temperatures could be 8°F warmer by the end of the century than they are currently.[169] San Diego could experience between three weeks to just over a month of warm nights per year by midcentury and between a month to more than three and a half months of warm nights per year by late century under a very high emissions scenario (see Figure 13).[170] The Vulnerable Communities Platform also allows for a comparison of present and future warm nights by census tract.

Rising minimum (nighttime) temperatures means residents may use more energy to cool their homes; others will have fewer opportunities to cool down at night when there are typically fewer options for accessing cooling spaces (e.g., libraries, school, or other places with air conditioning).

Figure 13. Projected Number of Warm Night per Year for City of San Diego (Cal-Adapt Data)



Heat Waves: While there is no standard definition of a heat wave, it is generally agreed upon that heat waves are expected to increase in intensity and frequency in the San Diego region. The 4th California Climate Assessment projects that the number of heat wave days will increase 20-50% under a 6°F temperature increase.[171] By midcentury, heat waves could occur three to five times more often, and last at least twice as long, according to data from Cal-Adapt.[172] San Diego is projected to see one additional four-day heat wave annually by midcentury, and roughly four additional

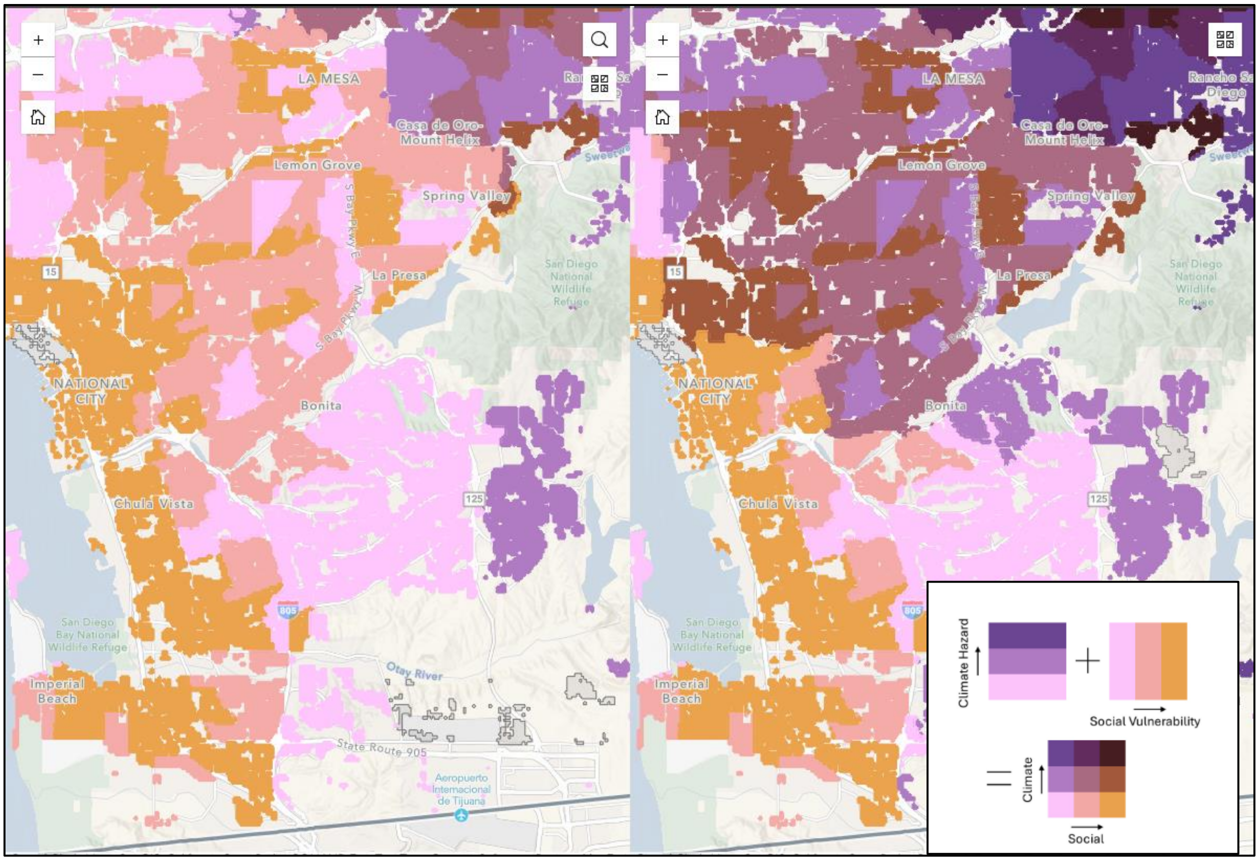
San Diego is facing an increase in the frequency, duration, and strength of heat waves.

heat waves annually by late century.[173] These heat waves will also likely become more humid with higher nighttime temperatures, further stressing public health and increasing risks for residents without access to cooling.[174,175] Recent regional events have already shown the consequences that heat waves can have, both now and in the future—for example, the 2022 heat wave that pushed the grid capacity to its limits. These events will only become more frequent and disruptive in the future.

It is important to note that summarizing extreme heat by the frequency of heat waves alone is not always indicative of true heat risk. If four heat waves happen in a given year that last three days each, and four heat waves happen the following year that last five days each, the second year clearly experienced more extreme heat, though the number of heat waves stayed the same.

Communities at Risk: The Vulnerable Communities Platform compares present and future heat risk in the 2050s. The tool indicates that the communities such as Otay Mesa, the Mid-Cities, Skyline-Paradise Hills, Encanto, North Park, Mission Valley, Sierra Mesa, Kearny Mesa, Tierrasanta, Clairmont Mesa, and College Area will see increased heat risk in the 2050s (see Figure 14; the areas with the highest heat risk are dark maroon color while the lowest are light pink.). These areas are also identified in the San Diego Urban Heat Vulnerability Index as having high heat risk. The Vulnerable Communities Platform measures heat risk in census percentiles relative to the rest of the State of California for various metrics, such as frequency of hot nights and change in summer maximum temperatures. Given that this index uses a different calculation than other indices discussed in this summary, results should not be compared directly.

Figure 14. Current and Future Heat Risk Provided by Vulnerable Communities Platform (Close-Range)



Vulnerability and Adaptive Capacity: It is harder to predict how a community's vulnerability to heat may change over time or how a community may respond to programs designed to enhance their adaptive capacity. The majority of tools, such as CalHeatScore, CA Healthy Places, Vulnerable Communities Platform, and Climate Change & Health Vulnerability Indicators, do not measure future heat vulnerability. There are, however, a few available metrics that can be used to predict future vulnerability and adaptive capacity (Table 6).

Table 6. Changes in heat vulnerability metrics provided by the California Healthy Places Index - Extreme Heat

Indicator	Value	State Avg.
Projected Percent Change in Population in 2050	10.7%	N/A
Projected Percent Change of Population Aged 5-14 in 2050	10.0%	N/A
Projected Percent Change of Population Aged 65+ in 2050	21.6%	N/A
Projected Percent Change of Population Aged Under 5 in 2050	4.8%	N/A
Projected Workers Experiencing High Environmental Exposure in 2026	27.1%	N/A

For example, the California Heat Assessment Tool also provides "Change in Development" (an estimated percent change of land area from unpaved to paved due to development between 2001 and 2050). This metric could be used to predict the impact of impervious surfaces on future heat vulnerability and adaptive capacity.

The CA Healthy Places Index also provides some demographic projections, such as percent change in population in 2050 of adults over 65, children, and workers experiencing high environmental exposure. These projections can be used to predict a change in population known to be disproportionately vulnerable to heat.

Note that the Vulnerable Communities Platform's indicators of social vulnerability do not include future predictions; therefore, predicted changes in future climate vulnerability result from changes in heat exposure.

The Urban Heat Vulnerability Index provides an analysis of the City's current and future adaptive capacity by measuring the cooling capacity of the land and modeling the cooling potential of an expanded tree canopy. Areas considered harder to cool are Southeastern San Diego, Mid-City Normal Heights, Encanto, North Park, and Mira Mesa. The Torrey Pines area was found to be comparatively easier to cool, due in part to its two nature preserves, trailheads, and parks. Through the InVEST urban cooling model, the project modeled the cooling effect of increasing urban tree canopy by 5%, providing a picture of how targeted heat mitigation solutions might affect future heat exposure in San Diego, and indirectly how these communities could build resilience to rising heat. Expanding this type of analysis could help the City evaluate the effectiveness and most beneficial areas to introduce heat mitigation solutions and direct resources to grow the adaptive capacity of heat-burdened communities.

Opportunities to Advance Understanding of Heat Modeling

Several opportunities are available to expand existing knowledge to improve the understanding and applicability of the tools and resources available to the City of San Diego. These opportunities include:

Opportunity 1: Map and enhance understanding of "best use" cases for state and local datasets and different metrics of heat exposure, heat vulnerability, and adaptive capacity. A review of available data, research, and planning documents suggests specific metrics of extreme heat (e.g., heat index, daily maximum temperature) are meaningful for different outcomes and at different data scales. Understanding the variety of ways to define extreme heat, as well as the availability and limitations of this data, could allow for more meaningful and actionable analysis. For example, decision-makers may consider at what temperature certain vulnerable populations are most likely to experience health impacts as a metric to initiate water or fan distribution, while cooling center access is typically dependent on the pre-established start and end of heat season. This Data Summary offers a first draft of mapping "best use" cases for federal, state, and local heat datasets and metrics by identifying data granularity, intended user, and potential use cases. Mapping these resources in greater detail and in alignment with City departmental roles can foster more effective strategies, policies, and programs by equipping the City with the best tools and data. Planning for Extreme Heat: A National Survey of U.S. Planners offers a framework for organizing these tools around different planning capacities.[176]

Opportunity 2: Further research on predictive land use, urban growth, public health, and population change is needed to better predict how heat vulnerability is expected to change over time in tandem with projected heat exposure. Projections of future heat exposure are underpinned by climate data from state sources, including the California Climate Change Assessment, which makes its data available via Cal-Adapt. Modeled analyses like the Urban Heat Vulnerability Index can help predict the impact of heat mitigation strategies (i.e., adaptive capacity). However, there is less data available to predict how components of heat vulnerability (e.g., poverty rates, health conditions, energy burden) might change over time. Improving San Diego's understanding of predictive vulnerability will enable planners to better anticipate and direct resources toward community needs. Tools that can extrapolate future heat health outcomes or demographic data, such as the California Heat Assessment Tool and the CA Healthy Places Index may provide an avenue to improve predictions of future heat vulnerabilities.

Opportunity 3: Establish a local dataset capturing the intersection of household energy burden, aging infrastructure, and air conditioning use to better understand the City's heat vulnerability and adaptive capacity. Air conditioning has been found to be an effective strategy for reducing heat-related illness,[177,178,179] especially for residents who are unable to leave their homes during heat events. However, even for those who have air conditioning, energy-burdened households may not be able to cover the cost of using their air conditioning frequently. This suggests air conditioning use alone may not provide the full picture of a household's vulnerability and adaptive capacity.

Developing a local dataset that includes air conditioning availability, energy burden, and building age (to identify applicable building codes), would help the City to more effectively identify vulnerable populations and direct resources (e.g., cooling centers, fans, or residential incentive programs) to communities most in need. This dataset may also help to better understand the impact and distribution of air conditioning as a cooling strategy.

Existing datasets include:

- The Climate Change & Health Vulnerability Indicators tool is one of the few heat indices that provides an assessment of air conditioning availability as a component of adaptive capacity, although this information is limited to the county level.
    - This tool references the California Residential Appliance Saturation Study prepared by the California Energy Commission, which surveys 300,000 households.[180] This report was last published in 2003, 2009, and 2019.

- A new dataset produced by University of Kansas researchers provides the latest, most comprehensive map of air conditioning usage in the United States, supplemented by machine learning.[181] It distinguishes between homes with central air conditioning, window or portable units, evaporative coolers, and no air conditioning.
- The 2023 San Diego Housing Stock Analysis documented energy use intensity, energy burden, and ownership type, among other critical housing data.[182]
- Energy Cost Burden is also mapped in the City's Environmental Justice Element, adopted as part of the City's General Plan.[183]

A community-wide survey could also provide household-level data on air conditioning use. This new dataset could also be incorporated into future updates of the City's Urban Heat Vulnerability Index.

Opportunity 4: Create a protocol for updating City indices based on the latest global climate models. The climate projections referenced in Climate Resilient SD and other tools referenced in this report are primarily based on climate models from CMIP5, which was used in the fourth California Climate Assessment. These data are based on future emissions scenarios called RCPs, and most sources included in this report consider two emissions scenarios:

- RCP 4.5 (moderate emissions) – this scenario assumes fossil fuel dependence peaks in 2040 and declines for the remainder of the century.
- RCP 8.5 (very high emissions) – this scenario assumes that fossil fuel dependence increases and continues growing higher through the end of the century (this is now considered an unlikely and worst-case outcome).

The existing heat risk analyses reviewed for this report have not yet incorporated CMIP6, the most recent generation of climate models. As part of the Fifth California Climate Assessment, a robust hybrid statewide dataset was developed using the Localized Constructed Analogs (LOCA) statistical downscaling approach combined with dynamically downscaled data. As of October 2025, these data were available through the California Analytics Engine, housed by Cal-Adapt, though they have not yet been integrated into the online mapping tools, many of which are more user-friendly. This generation of data provides more accurate downscaling from the global scale of the climate models, better estimation of extremes, and increased spatial resolution. It also incorporates updated emissions scenarios (SSPs) which include consideration of social dynamics and inequalities.

Note the California Vulnerable Communities Platform provides a platform to compare current and future extreme heat conditions using the latest LOCA 2 CA Hybrid Maximum Temperature Projections Data (SSP 370) published in 2023. Users can currently use the "Individual Indicators" function and toggle back and forth to compare current and 2050 conditions (e.g., percent of summer days over 100°F) for high-risk areas or use the "Compare Tool" to compare current and future heat risk scores. This tool may enable the City to assess future heat exposure based on newly available climate data while the City updates the Urban Heat Vulnerability Index.

Opportunity 5: Engage community planning groups, organizations, and community members to identify hyperlocal "hotspots" that may signal need for action. Block to block, some locations may get hotter faster than others or even exceed a temperature threshold before a heat alert is issued. An analysis of hyperlocal temperatures in Miami revealed maximum heat index values across the City are on average 11°F higher than the airport, where the sensor used to issue National Weather Service alerts is located.[184] In 2023, the National Weather Service began a pilot program for Miami-Dade County to reduce the Heat Index threshold for Heat Advisories and Warnings, to more effectively warn community members of heat risks before thresholds reach extreme levels. Hyperlocal heat data may more accurately reflect the lived experiences of community members and can be an important tool for preparing for and activating heat response protocols, in addition to National Weather Service alerts[185] in identifying these "hot spots" for their communities.

Opportunity 6: Emerging research indicates coastal communities are vulnerable to heat illness at lower temperatures, potentially because they are less acclimated to extreme heat and less likely to have air conditioning.[186,187] However, more research is needed to understand this effect and its drivers in the San Diego region. This research could be supported by the updated Urban Heat Vulnerability Index that will be completed as part of this project.

EXISTING STATE, CITY, AND COMMUNITY ANALYSES, PLANS, AND POLICIES

Methodology

Plans and policies from the state, city, and community level were reviewed and analyzed to gather information on existing and future heat exposure and vulnerability as well as targeted solutions and projects. These data sources were also reviewed to determine alignment with current climate models and available heat data to identify where updates may be beneficial. The goal of this review was to determine whether and how San Diego communities are preparing for extreme heat, how their understanding of heat impacts has evolved over time, and to document best practices and innovative solutions to guide actionable steps.

Summary of State Tools

Table 7 summarizes key state tools that inform the City of San Diego's ability to mitigate the impacts of extreme heat.

Summary of the County of San Diego and City of San Diego Policies and Plans

Table 8 summarizes key policies, plans, and regulations that guides how the City of San Diego currently addresses drivers and impacts of extreme heat. These policies and plans are categorized according to actionable heat mitigation strategies, including interventions for land use, the built environment, emergency response, and public communication/outreach. The table represents a sample of the plans and policies reviewed for this report. Unless otherwise noted the resources included in this table are City plans and resources. A comprehensive list of materials and documents evaluated is available in Appendix A.

Table 7. State Heat Action Planning Tools

Policy/Plan	Date Published	Summary	Data Granularity	Intended Users	User Summary
Cal-Adapt	2011 (Cal-adapt 2.0 released 2023)	Cal-Adapt is the companion tool to the California Climate Assessment and provides climate change scenarios and climate impact research as well as maps, tools, and other guidance to advance climate research and planning. Several heat planning tools, including the California Healthy Places Index, California Heat Assessment Tool, and Climate Change & Health Vulnerability Indicators tool rely on these data.	Localized	Researchers, Planners, Community Members	At the time of this report, users can download aggregated climate data from the global climate datasets downscaled to California, including the latest Coupled Model Intercomparison Project (CMIP6) data packages. These data are not yet available in the Cal-Adapt map tool. Cal-Adapt is useful as a resource to download and synthesize detailed data for technical analyses of heat projections. Data are synthesized and visualized via summaries and maps for non-technical audiences.
Urban Heat Island Index for California	2015	In 2012 the California Legislature (AB 296, Chapter 667, Statutes of 2012) required that the CalEPA develop an Urban Heat Island Index and to design it so that "cities can have a quantifiable goal for heat reduction." In 2015, CalEPA created an Urban Heat Island Index to quantify the extent and severity of urban heat islands for individual cities. The study also produced Urban Heat Island Interactive Maps, showing the urban heat island effect for census tracts throughout the state.	Localized	Researchers, Planners	This tool is useful to researchers and government agencies to understand the impact of the urban heat island effect and use results to identify priority areas for public health education and preparedness for extreme heat. This tool is especially useful for identifying and assessing the impacts of applicable land use cooling strategies (i.e., urban greening cooler roofs and pavements).

Policy/Plan	Date Published	Summary	Data Granularity	Intended Users	User Summary
California Heat Assessment Tool	2019	The California Heat Assessment Tool was developed by the State of California to estimate future heat health events, or periods of extreme heat where public health impacts become more likely. The tool was funded by the California Natural Resources Agency as part of the state's Fourth Climate Change Assessment.	Localized (Census Tract)	Researchers, Planners, Community Members	This tool is most effective when used as a long-term planning tool to assess future heat health impacts throughout the state, and to screen and prioritize action, including directing resources to communities that are most affected. It may be used to understand underlying socioeconomic disparities (e.g., pollution) and adaptive capacities (e.g., impervious surface, tree canopy coverage) that exacerbate heat vulnerability at a census tract level. The platform is highly visual and accessible to non-technical audiences.
Climate Change & Health Vulnerability Indicators for California	2019	The tool is the interactive data visualization platform for the Climate Change & Health Vulnerability Indicators for California produced by the Climate Change and Health Equity Section – CalBRACE Project, part of the California Department of Public Health. This tool was developed to provide local health departments and partners with tools to better understand the people and places in their jurisdictions that are more susceptible to adverse health impacts associated with climate change, including extreme heat.	County	State/Regional Agencies, Local Governments, Planners	This tool may be used to understand and compare factors that contribute to vulnerability and adaptive capacity at the county level (e.g., Heat + elderly, outdoor workers, health insurance, air conditioning, tree canopy, and impervious surfaces).

Policy/Plan	Date Published	Summary	Data Granularity	Intended Users	User Summary
California Healthy Places Index: Extreme Heat Edition	2022	The California Healthy Places Index: Extreme Heat Edition, was developed by the Public Health Alliance of Southern California in partnership with the UCLA Luskin Center for Innovation. This is a policymaking tool to help prioritize public and private investments and resources across California communities.	Localized (County, City, and Census Tract)	Researchers, Planners, Community Members	The tool provides datasets on projected future heat exposure for California by county, city, and census tract using multiple indicators under the RCP 8.5 scenario. It can be used to understand and compare factors that contribute to vulnerability and adaptive capacity at the county, city, and census tract level. The tool has a sophisticated interface that is accessible to both technical and non-technical users. It also provides a list of state resources and funding opportunities to address extreme heat that can be filtered to the user (e.g., schools, workplaces, non-profits). Note, not all data is available at the census tract level.
CalHeatScore	2024	CalHeatScore was built as a result of Assembly Bill No. 2238 (L. Rivas, Chapter 264, Statutes of 2022) requiring CalEPA to develop a statewide extreme heat ranking system. It was developed to raise awareness for extreme heat and provide up-to-date information about heat events and resources to keep individuals and communities safe.	Localized (Zip Code)	Local Governments, Community Members	This tool is intended a public health tool offering real-time data for local emergency response and coordination; it assigns daily rankings of forecasted heat-related health impacts across California zip codes. The tool has a sophisticated interface that is accessible to both technical and non-technical users. Individuals and communities can use this tool to search by zip code to identify and prepare for extreme heat events. It also maps existing cooling centers.

Policy/Plan	Date Published	Summary	Data Granularity	Intended Users	User Summary
Vulnerable Communities Platform	2025	The Governor's Office of Land Use and Climate Innovation's Climate Services program began development of the Platform in 2021. The purpose of the Platform is to help users understand where climate hazards will be most severe in California, which communities are most vulnerable, and what makes them vulnerable. The Platform will soon be able generate reports that summarize climate vulnerability for any city, town, zip code, or census tract. A climate hazard high score indicates that the community would benefit from adaptation planning.	Localized (Block Group)	State/Regional Agencies, Local Governments, Planners, Community-Based Organizations	The Platform was designed for two user groups: 1. To help state and regional agencies identify the most climate-vulnerable populations and determine where to focus outreach, projects, or funding and 2.To help local organizations, such as city, county, and Tribal governments and community-based organizations identify risks in their community. This tool can be used to compare current and future heat risk side by side. This feature is not yet available to use for specific indicators (i.e., comparing the number of current v. future high heat days). Note this is the only state tool at the time of this report to use the most up-to-date climate dataset LOCA2 CA Hybrid Data published in 2023. However, because this tool assumes a high emissions scenario (SSP 3-7.0) and most of the other tools listed rely on lower or higher scenarios RCP 4.5 and RCP 8.5, Platform results cannot be compared to the results from these other tools easily. Users can also choose individual heat indicators to compare heat risk by census tract. Heat risk is provided as a census percentile of the state average. The tool also provides user guides.

Table 8. City of San Diego and San Diego County Key Policies, Plans, and Regulations

Policy/Plan	Planning Category	Summary
[In Development] Extreme Heat Action Plan	Land Use	The San Diego Regional Climate Collaborative at USD, in partnership with UC San Diego, was awarded $750,000 from the State of California to develop heat action plans for San Diego, Chula Vista, and La Mesa. The Extreme Heat Action Plan will address land use drivers of extreme heat and work with community members to identify specific cooling solution projects within the City's most heat-vulnerable neighborhoods. The Extreme Heat Action Plan will be aligned with heat mitigation strategies within Climate Resilient SD and be informed by the City's Urban Heat Vulnerability Index.
2021 Urban Heat Vulnerability Index	Land Use	The Urban Heat Vulnerability Index is an important tool for mapping the distribution of heat risk across San Diego and understanding the heat mitigation potential of land use decisions, including expanding the tree canopy and reducing impervious surfaces. The model results show that widespread cooling is expected to occur with a 5% increase in tree canopy (from 12 to 17%). Updated City light detection and ranging (LiDAR) shows the tree canopy increased 2% from 2014 to 2021.
2021 Climate Resilient SD	Land Use	Climate Resilient SD synthesizes Cal-Adapt data to summarize the City's existing and future exposure to extreme heat. The plan includes land use policies in alignment with the Climate Action Plan and other City plans to mitigate the impacts of extreme heat, with an emphasis on addressing impacts to vulnerable populations. It details strategies for heat mitigation including urban greening, expanding tree canopy cover parks, and shade access.
2024 Blueprint SD	Land Use	Blueprint SD is the City of San Diego's 2024 "refresh" of the General Plan. It provides alignment between the General Plan, Climate Action Plan, and the San Diego Association of Governments' Regional Transportation Plan. Heat mitigation policies are primarily addressed through the Environmental Justice Element.
2024 Environmental Justice Element	Land Use	Adopted as part of the City General Plan to inform decision-making to advance environmental justice. It maps heat risk in combination with heat-mitigating elements such as tree canopy coverage and cool zone sites. The Element documents policies to address the impacts of extreme heat on environmental justice communities, including developing an urban greening program to expand urban green spaces and developing a Heat Action Plan to implement cooling strategies for communities identified by the Urban Heat Vulnerability Index.

Policy/Plan	Planning Category	Summary
2022 Climate Action Plan	Land Use	The Climate Action Plan defines the City's greenhouse gas reduction targets and identifies community-wide policies to achieve these targets and enhance community resiliency. The Climate Action Plan establishes land use policies to enhance heat mitigation in alignment with the Urban Forest Management Plan, Land Development Code, municipal codes, and transit planning. It establishes a target of 28% urban tree canopy cover by 2030 and 35% by 2035.
2017 Urban Forestry Five-Year Plan	Land Use	The Urban Forestry Five-Year Plan builds on the Climate Action Plan by establishing a tree planting initiative implementation plan and identifying best management practices to maintaining and protecting the City's existing tree resources.
2021 Parks Master Plan	Land Use	The Parks Master Plan was the first comprehensive parks master plan update since 1956. The plan incorporates heat planning goals including expanding the park systems and improving community access, planting drought-resilient and native trees, installing living walls in new buildings in parks, and designing and retrofitting parks to enhance heat resilience. The plan also encourages the City to shade at least 50% of all hardscape, with at least 60% of the area shaded by tree canopies.
[In development] Parks Need Index	Land Use	An implementation tool of the Parks Master Plan that provides an understanding of park distribution and assesses where park investments are needed most (e.g., a high number of people per household indicates a need for more green space).
2018 Placemaking Ordinance	Built Environment	The Placemaking Ordinance allows residents to creatively reinvent underutilized spaces in their neighborhoods via small-scale, temporary development projects. The Ordinance has been used to create gathering places, showcase public art, or added needed illumination. The Ordinance could serve as an important tool for community members and organizers to develop local heat mitigation and resiliency solutions for their communities, including shading and cooling spaces.
San Diego Municipal Code: Chap 15 Art 06 Div 03, The Centre City Planned District	Built Environment	Incentivizes the use of eco-roofs to counter the increased heat of urban areas by offering floor area ratio (FAR) bonuses.
2025 Mid-City Existing Conditions Report	Built Environment	Recommends establishing a local dataset detailing building ages and areas suffering from high heat risk that can provide insights into disparities prevalent in older and less affluent areas to inform future community resilience strategies.

Policy/Plan	Planning Category	Summary
2015 Southeastern Community Plan	Built Environment	Documents several heat mitigation strategies for the community including: Strategy: P-UD-50: Minimize building heat gain and appropriately shading fenestrations through techniques P-UD-52: Provide on-site landscaping improvements that minimize heat gain and provide attractive and context sensitive landscape environments, street tree/ urban tree canopy goals
2025 San Diego County Extreme Heat Response Plan – Consumer Version **[County Resource]**	Emergency Response	This Extreme Heat Response Plan is the County of San Diego Health and Human Services Agency's public-facing protocol for coordinating emergency response and resident communication in response to an extreme heat event. During an extreme heat event, the Public Health Services branch of the County of San Diego Health and Human Services Agency is the lead agency responsible for coordinating with other County departments and external partners to communicate excessive heat information to the public. The San Diego County Extreme Heat Response Plan includes a three-phase heat alert system in which county actions are triggered by National Weather Service heat thresholds (Heat Advisory, Watch, and Warning). The County is responsible for notifying the City when a heat response phase has been activated.
2021 San Diego Excessive Heat Response Plan [County Resource]	Emergency Response	This Excessive Heat Response Plan is the County of San Diego Health and Human Services Agency internal protocol for coordinating emergency response and resident communication in response to an extreme heat event. It provides detailed steps on agency coordination and activity initiation.
2023 County of San Diego Annual Excessive Heat Report **[County Resource]**	Emergency Response	An annual report published by the County of San Diego Health and Human Services Agency to track heat health outcomes across the county, including hospitalization, pre-hospital calls, emergency dispatch, and deaths.
2023 Multi-Jurisdictional Hazard Mitigation Plan County of San Diego Annex **[County Resource]**	Emergency Response	The Multi-Jurisdictional Hazard Mitigation Plan identified extreme heat as a top threat to San Diego and establishes goals to support heat mitigation planning: Action 4.A.1 – Enhance existing City partnerships with appropriate local agencies, community support groups, and service providers to better mitigate hazards that may increasingly result from severe weather and/or climate change.

Policy/Plan	Planning Category	Summary
2017 Multi-Jurisdictional Hazard Mitigation Plan County of San Diego Annex [County Resource]	Emergency Response	The Multi-Jurisdictional Hazard Mitigation Plan identified extreme heat as a top threat to San Diego and establishes goals to support heat mitigation planning: (Goal 11, Objective 11B, Action 11.A.2) "Participate in "Excessive Heat Emergency Awareness" events and exercise heat emergency plans as established by Health and Human Services Agency, Aging and Independence Services, Emergency Medical Services, and Public Health Services." (Goal 11, Objective 11B, Action 11.A.3) "Continue to provide "Cool Zones" during excessive heat events."
2-1-1 San Diego	Communication, Outreach, and Resident Awareness	2-1-1 San Diego is a local nonprofit that provides 24/hour information and connections to community, health, and disaster resources in 200 languages. During extreme heat events, 2-1-1 connects people in San Diego to a transportation or rideshare service at no cost to transport San Diego County residents to and from cool zone locations.
***2021 Climate Resilient SD**	Communication, Outreach, and Resident Awareness	Climate Resilient SD describes strategies for community heat resilience, including resilience hubs, access to cool zones, climate communications programs, microgrant programs, and community centered action, that support communication, outreach and awareness for extreme heat. The plan also created a 'Vision and Goals Engagement Tool' to share foundational information on climate change driven impacts for the City of San Diego and share the goals of the Climate Resilient SD plan. The planning process included a survey where participants could share their own experience with the effects of climate change in their community and any ideas for how San Diego can adapt to changing conditions.
2019 Climate Equity Index	Communication, Outreach, and Resident Awareness	Includes a recommendation to seek grant funding for community engagement for resources and innovative, non-traditional methods. Focus should be on activating, organizing, and engaging residents within communities with very low to moderate access to opportunities.
***2017 Urban Forestry Five-Year Plan**	Communication, Outreach, and Resident Awareness	Incorporated community outreach via presentations to community groups and a survey. Public forums and stakeholder meetings were held as additional outreach efforts.
Social Media Guide for Climate Related Hazards (Internal Reference Guide)	Communication, Outreach, and Resident Awareness	The City currently has an internal calendar and standard language employed by its Public Information Officers and Communications Department that guides public outreach on specific climate hazards. Once the County has activated a heat response phase, the City's Public Information Officers will employ standard language to publish public outreach materials identifying cool zones and City cooling resources.

*The resources listed incorporate some components of communication and outreach and are therefore listed in multiple categories.

Areas for Alignment with Existing Heat Planning

The alignment between policies and heat mitigation planning across the City's Climate Resilient SD, the Climate Action Plan, Blueprint SD, and the Urban Forestry Five-Year Plan is strong; however, there is an opportunity for stronger alignment among county and City departments and plans to support the implementation of the City's heat mitigation goals.

- San Diego Hazard Mitigation Plan
    - The 2023 San Diego Annex of the Hazard Mitigation Plan positions the county to support regional efforts to prepare for excessive heat events, including participating in county "Excessive Heat Emergency Awareness" events, exercising county heat emergency plans, and providing "Cool Zones" during excessive heat events. These actions may be referenced by the Regional Cooling Solutions Toolkit and City's Extreme Heat Action Plan as opportunities for City collaboration with county agencies and County of San Diego Office of Emergency Services.
    - Development of the Extreme Heat Action Plan can draw from the Capability Assessment Framework used in the Hazard Mitigation Plan to assess additional opportunities to enhance City resources, tools, and capacities to implement extreme heat mitigation strategies.
- Urban Forestry Street Tree Web Map and Urban Forestry Management Plan
    - Incorporating heat risk into the Urban Forestry Street Tree Web Map and Urban Forestry Management Plan as a criterion for informing tree placement can help expand shade in communities with high heat exposure.
- Municipal Code
    - Several recommendations are defined in the San Diego Climate Action Plan to codify heat mitigation practices into municipal and land use codes, City transportation planning, and urban forestry management. For example, the City has proposed additional energy efficiency requirements beyond the 2025 California Building Code update to expand the adoption of cool roofs.[188] These policy and regulation changes are in varying stages of completion. Development of the City's Extreme Heat Action Plan should identify what additional code updates, based on best practices and local environment, are recommended for the City to adopt.
- Community Plans
    - The City has 52 community planning areas and 49 community plans. The City Planning Department regularly leads updates to community plans. However, based on the volume of community plans, many community plans have not been updated since adoption of Climate Resilient SD and may not reflect the latest data or understanding of local heat exposure and vulnerability. Developing a repository of heat planning resources and heat response protocols will enable planners,

community organizations, and community planning groups and community members to better coordinate local heat response efforts and inform community plans and other heat-relevant plans (e.g., general plan, parks plans) as they are updated. See Opportunity 9 for additional recommendations on engaging community planning groups in the heat planning process.

- 2021 Parks Master Plan and Park Needs Index
  - Parks and green spaces are effective natural cooling solutions for urban environments. The Parks Master Plan establishes goals to leverage park development, expansion, and maintenance to maximize the heat-mitigating capabilities of City parks. The companion Park Needs Index will help inform equitable investment in the City's parks and green spaces. To maximize the cooling potential of parks and support park investment to the City's hottest neighborhood, the City may consider incorporating considerations for heat risk, tree canopy coverage, or other cooling solutions into the Park Needs Index. These parameters could emphasize the value of including heat mitigation features at a park (e.g., installing park shade structures or siting parks where temperatures are highest and tree canopy is lowest).
  - Future research for the development of the Extreme Heat Action Plan should include shade design standards for parks and recreation planning. For example, the American Forests and UCLA's Luskin Center for Innovation partnered to create a Tree Equity Score Analyzer for Phoenix, Detroit, and Austin to establish minimum shade coverage requirements and assess existing shade coverage at City parks and bus stops.[189]

Opportunities to Advance Heat Response, Preparedness, and Planning

The following recommendations represent opportunities for the City of San Diego to advance heat response, preparedness, and planning in partnership with state and county agencies, community planning groups, neighborhood organizations, and local organizers. These recommendations were developed following an analysis of state, county, city, and other local planning tools, data analyses, and resources. The 2025 Framework for a Heat Ready Nation, developed for the Federation of American Scientists, and the Capability Assessment (p. 54) developed for the San Diego Hazard Mitigation Plan provide a guiding framework for the development of these opportunities.[190,191]

PLANNING AND REGULATORY OPPORTUNITIES

Planning and regulatory capabilities are the plans, policies, codes, and ordinances that prevent and reduce the impacts of extreme heat.

Opportunity 1: Develop an Extreme Heat Response Protocol to document and enhance internal City protocols for responding to extreme heat events

The County is responsible for notifying the City when a county heat response phase has been activated. This notification initiates City action, including management of the City's cool zones and coordination of public outreach with the City Communications Department to direct residents toward City cooling resources.

The City can build on the county's Excessive Heat Response Plan to improve documentation and coordination of the City's internal communications/public outreach procedures and coordination of resources once a heat alert has been issued. Documentation of these procedures may result in a City-specific Excessive Heat Response Protocol as a companion to the Extreme Heat Action Plan. To develop this protocol, the following steps are recommended:

- **Identify and map the current roles of all internal departments, agencies, and partners.** Potential City coordinating agencies and departments: Office of Emergency Services, Office of Emergency Medical Services, City Planning Department, Department of Risk Management, Homelessness Strategies and Solutions Department, Department of Parks and Recreation, Department of Race and Equity, Development Services Department, Transportation Department and the Communications Department. Additional external partners, including San Diego Metropolitan Transit System, businesses that offer public cooling access (e.g., malls), San Diego Gas and Electric, San Diego Community Power, SANDAG, San Diego County Public Health Services and organizations involved in ecosystem restoration or urban greening could play key roles in extreme heat response and would be identified through the development of the Extreme Heat Action Plan.
- **Develop a step-by-step response protocol to document internal City procedures once a heat alert has been issued by the county.** This protocol should clearly define responsibilities for each coordinating department once an extreme heat event has been identified. For example, what actions should be taken by the Homelessness Strategies and Solutions Department once a heat alert has been activated?
- Identify clear pathways of communication between the City's Office of Emergency Services and City departments and community members aware of incoming heat events and heat-safety protocols.

Opportunity 2: Coordinate with county and local partners to identify and expand access to cooling centers to address common barriers to access.

- Coordinate with the County Health and Human Services Agency to identify additional locations that may function as cooling centers and hydration stations (e.g., shopping malls, movie theaters, buses) with a focus on heat-vulnerable communities.
- Identify locations that address common barriers to access[192]; for example, the City of New York's Cool Options map identifies both wheelchair accessible locations and

locations that accept pets, while many public libraries offer extended hours during heat seasons.[193]

- Coordinate with the Office of Homelessness Strategies and Solutions to identify cool, safe spaces for unhoused populations. The City of Phoenix operates a "Safe Outdoor Space" in coordination with its Office of Homeless Solutions to provide safe, shaded environments for those who are not ready for indoor shelter.[194]
- Coordinate with the North County Transit District and San Diego Metropolitan Transit System to map existing and potential cooling centers accessible via public transit. Some transit agencies, such as Phoenix's Valley Metro Regional Public Transportation Authority, have opened buses and trains as cooling centers, allowing riders to board early or stay onboard in between trips to avoid the heat.[195] The City of Boston opens schools while out of session as cooling centers or "cool schools."

Opportunity 3: Develop a protocol for City workers, particularly those facing higher outdoor exposure (e.g., police officers, trash collection, contracted workers) to prepare for and know how to respond during extreme heat events. Coordinate standardized collection of data across departments to gather real-time data on heat-related workplace injuries and heat health events to inform heat response.

Climate Resilient SD establishes Policy CCS-4: "Build City capacity to be responsive to future climate change related events and challenges." This policy establishes goals of workforce preparedness and staff training for extreme heat days. These policies can be enhanced by documenting and building on local preparation and response protocols for City staff who work indoors and outdoors.

In 2005 and 2006, California established heat illness prevention standards (California Code of Regulations, Title 8, Section 3395 and 3396) for outdoor and indoor workers, requiring employers to provide employees with training, water, shade, and rest.[196] Many of these requirements are already in practice in the City. For example, construction workers in San Diego use a US OSHA-approved Heat Index application to monitor rising temperatures and attend multilingual heat trainings, while San Diego Gas and Electric workers emphasize proactive hydration and shade breaks to stay safe.[197,198,199,200]

In developing a heat response protocol, the City should review and align department heat illness prevention plans and procedures with state standards. The City's Parks and Recreation Department has an example heat prevention checklist.[201] A comprehensive heat response protocol would implement heat monitoring procedures, worker training, illness prevention protocols, and outreach and awareness, and identify leadership and reporting protocols. CAL OSHA offers a template for a heat illness prevention plan.[202]

The UCLA Labor Occupational Safety & Health Program offers a peer-trainer course for community health workers on workplace heat risk. In 2024, the program enrolled 100 people who provided training to 600 others, including workers in agriculture, landscaping, construction, garment manufacturing, warehousing and other industries.[203]

In addition, building a strong dataset on heat-related workplace injuries and heat health events among City staff would also help the City understand how its staff are affected and potential interventions to avoid workplace injury. These data may be provided by the San Diego Risk Management Department and the City's Medical Provider Network.[204]

Opportunity 4: Align applicable building and land use codes with heat mitigation goals.

Review applicable building and land use codes for opportunities to align development requirements with heat mitigation goals, including requiring techniques to minimize heat gain through new development. The City has proposed additions to the 2025 Building Code Update, including broader implementation of cool roof requirements, as recommended by Climate Resilient SD.

Other cities, such as Boston, have extended cool roof requirements to bus stops to provide targeted shade and heat mitigation for transit services.[205] Los Angeles County is currently considering a safe maximum temperature threshold for rentals.[206] The City of Tucson, Arizona, has implemented zoning design standards in its Downtown Area Infill Incentive District, including permitted uses, building heights, and building design standards, to ensure future developments and infrastructure can adapt to rising heat. The New Buildings Institute provides example code language and code amendments in its Extreme Heat and Urban Heat Island Code Overlay[207]; this resource is based on International Code Council codes, which share many common provisions with the California Building Standards Code.

Opportunity 5: Develop adaptation programs targeting the socioeconomic determinants of heat vulnerability (e.g., poverty, preexisting health conditions) to address the risks of extreme heat and chronic heat exposure.

Solutions that may help address short-term heat impacts (e.g., reduced work hours on extreme heat days) may not be sustainable for long-term heat stress. Solutions targeting the socioeconomic determinants of heat vulnerability (e.g., poverty, preexisting health conditions) may be more effective at mitigating the impacts of chronic heat stress. For example, the City of Phoenix offers low-flow agreements[208] to sustain basic critical services in the short-term for residents who are behind on their water bills; while Massachusetts offers an income-based utility discount rate[209] targeting residents facing chronic energy burdens. Miami-Dade County offers a combination of utility assistance, weatherization, and home rehabilitations services for low-income and disabled homeowners, and air conditioning installation for public housing.[210]

ADMINISTRATIVE AND TECHNICAL OPPORTUNITIES

Administrative and technical capabilities include staff and their skills and tools that can be used for heat mitigation planning and to implement specific heat mitigation actions.

Opportunity 6: Improve resource applicability by creating a comprehensive clearinghouse for San Diego's heat planning tools.

Several heat planning tools and indices are available at the state and city-level. It can be difficult for a typical user to locate and interpret the resource methodology and identify which of these tools are most applicable to their needs. Creating one comprehensive resource or clearinghouse for these data sources would allow for greater user efficiency, reduce redundancy, and help address existing data gaps. A clearinghouse would also improve the accessibility of these tools for local planners and community organizers. The City of San Antonio and the Louisiana Department of Health provide publicly accessible dashboards to organize heat planning resources and heat health data. The City of Los Angeles also maintains a comprehensive heat planning repository for its Heat Relief 4 LA campaign, including heat mapping tools, reports, communication campaigns, and mapped cool zones.[211]

Opportunity 7: Leverage new heat planning tools and datasets to develop and enhance targeted heat mitigation strategies.

Several state heat mapping tools have been developed since the publication of the Climate Change Vulnerability Assessment in 2020 and Urban Heat Vulnerability Index in 2021. These include new metrics for heat exposure and vulnerability that may be useful for the City's heat planning efforts. Daily temperature monitoring from the CalHeatScore may be used to alert and prepare vulnerable communities in advance of high heat days. Demographic and health data provided by California Healthy Places and California's Heat Assessment Tool can help planners locate vulnerable groups (e.g., outdoor workers, older adults) and design targeted adaptive strategies to keep them safe. The Vulnerable Communities Platform can also provide updated heat projections through 2050 based on updated climate data. These tools should be used in the development of the Extreme Heat Action Plan to utilize the best available science and tools to inform the City's planning for extreme heat.

Opportunity 8: Coordinate the sharing of public health and health care delivery data across health plans, providers, facilities, labs, and agencies at the state, county, and local level to collect real-time heat health data for communities impacted by extreme heat.

A gap exists in the availability of real-time heat health data (e.g., rates of emergency dispatch, hospitalizations, and deaths) to accurately attribute to heat events and inform heat mitigation planning and response. The County of San Diego Health and Human Services Department publishes an annual excessive heat report to synthesize heat-related deaths, hospitalizations, emergency dispatches, and pre-hospital care in the county. While informative, the Department does not currently provide real-time heat health information or disaggregate data for the City. The lack of heat morbidity and mortality data meant this information could not be included in the 2021 Urban Heat Vulnerability Index analysis. Additionally, the state does not currently have a system to monitor the real-time health effects of extreme heat, including deaths and emergency room visits. As a result, the true number of deaths related to extreme heat is likely underestimated.[212]

In communities such as Maricopa County, Arizona, and San Antonio, Texas, real-time heat health data is published on publicly available portals, which is made possible by the coordination of data sharing between hospital emergency departments, state and county health departments, and offices of the medical examiners, among others. In Phoenix, real-time heat health data are used to establish and track year-over-year reductions in heat fatalities and emergency response to evaluate the effectiveness of the City of Phoenix's heat planning programs.[213] A similar tool could be achieved via coordination between the City and the County of San Diego Health and Human Services Department (as the lead agency), which currently collects data from a multitude of health and emergency responders in San Diego County. As the lead agency, the County could coordinate data sharing from hospital emergency departments, state and county health departments, and offices of the medical examiners, with support from the City.

These data may be used to:

- Set health-based goals to track and evaluate the effectiveness of heat illness prevention strategies.
- Raise awareness for the impact of extreme heat on vulnerable populations.
- Provide data-driven evidence to prioritize resources and action to combat the impacts of extreme heat on vulnerable populations.

Develop heat metrics to inform and activate outreach and prevention strategies (e.g., at what temperature are heat-related hospitalizations and deaths most common?)

Opportunity 9: Incorporate monitoring and evaluation metrics in the Extreme Heat Action Plan to test and refine the effectiveness of heat mitigation programs and public outreach methodologies.

Several cities have incorporated metrics of success into their heat plans. The City of Tucson for example, tracks heat-related illness rates, cooling center utilization, and tree canopy coverage, while the City of Phoenix uses heat health data to evaluate the effectiveness of its heat planning programs.[214] Other program evaluation methods may include community-wide surveys; in Huntington Park, Philadelphia, a mobile station brought a heat survey to 20 community events and locations.[215] The Los Angeles Regional Collaborative employed social media engagement statistics, as well as QR codes on physical materials, to track engagement with the public outreach materials employed in its 2023 Extreme Heat Outreach Campaign.[216] These tools were used to inform future placement and frequency of the campaign materials.

FINANCIAL OPPORTUNITIES

Financial opportunities include those to support and expand heat mitigation and management activities conducted by the City and other organizations/groups serving the City and San Diego County.

Opportunity 10: Identify potential partners and organizations implementing heat mitigation and management programming as candidates for City of San Diego microgrants.

As part of the development of the Extreme Heat Action Plan, the City can identify current and potential partnerships with organizations, groups, and agencies effectively engaged in heat planning. The City could provide partnership in the form of financial support to select programs. For example, the City of Phoenix Office of Heat Response and Mitigation in partnership with ASU's Rob and Melani Walton Sustainability Teachers Academy and others, supports Canopy for Kids, an annual program that provides funding and training to schools to increase shade tree coverage and environmental education.[217]

EDUCATION AND OUTREACH OPPORTUNITIES

Education and outreach include programs and methods that could be used to implement mitigation activities and communicate hazard-related information.

Opportunity 11: Enhance San Diego's understanding of its adaptive capacity by creating a repository or resource accessible to community groups to document existing heat mitigation resources and resource gaps.

A goal of Climate Resilient SD is to "Utilize the Urban Heat Vulnerability Index to help inform implementation of adaptation strategies to address extreme heat events and identify priority areas for cooling interventions."

In addition to the San Diego Environmental Justice Element, which maps the intersections between higher cost energy burden, lower tree canopy, and a higher heat risk, there are state tools that allow for a comparison of adaptive capacity at the local level. These include the California Heat Assessment Tool, CalHeatScore, and California Healthy Places Index, which offer data on the distribution of parks, impervious surface, and tree canopy coverage. These tools provide measures of adaptive capacity, in combination with exposure and vulnerability, that may be useful in evaluating the impact of heat mitigation strategies.

Creating one common tool or resource repository to document the City's available heat resources, incorporating one or more of these state datasets, would better enable community groups to identify where resources are needed most and deploy them in response to or in anticipation of heat events. Building on the mapping effort developed for the Environmental Justice Element could be a good candidate for this opportunity. Maricopa County, Arizona, facilitates collaboration among multilevel governments, businesses, and community members through its Heat Relief Network. Network members map regional heat mitigation resources including water, respite, cooling, and donation sites, annually.[218]

Opportunity 12: Engage community planning groups, community organizations, and community feedback to build understanding of lived experiences with heat and local adaptive capacities.

- Identify opportunities to collect and incorporate lived experiences and storytelling into public messaging and heat planning materials. How do community members experience and adapt to extreme heat? Stories provide valuable insight for designing effective and accessible cooling solutions, identifying new cool zones, understanding vulnerabilities, and enhancing public awareness. The City of Boston's Extreme Heat engagement includes a public survey to identify experiences with heat and map cool and hot spots. Boston's Heat Resilience Story Comic Builder enables community members to illustrate their lived experiences with extreme heat.[219] San Diego could consider adapting its existing Infrastructure Priorities Engagement platform and Infrastructure priorities survey to create an "extreme heat" version.
- Engage community planning groups, community organizations and community members to identify personalized and localized thresholds for adaptive action. The same heat may affect community members differently. Some locations may get hotter faster than others or even exceed a temperature threshold before a heat alert is issued. Preparing local communities may include establishing local heat thresholds to initiate heat response efforts among community planning groups or guiding community members in developing a personalized plan of action in advance of extreme heat events (i.e., identifying the closest cooling center or checking in on a neighbor). This engagement can build off the community heat mapping efforts conducted in 2021. Philadelphia's Beat the Heat Toolkit includes a neighborhood heat mapping exercise.
- Engage community members in identifying and mapping local heat adaptation resources, capacities, and opportunities for growth. This type of engagement may enable communities to identify areas of opportunity and priority projects (e.g., installing shade structures or splash pads at high traffic intersections, playgrounds, and other gathering points). Consider engaging in this exercise in coordination with development of the Extreme Heat Action Plan as well as Community Plan updates. In Philadelphia, the Office of Sustainability worked with City departments and neighborhood groups in Hunting Park to create a replicable Beat the Heat Toolkit, including a design workshop for community members to identify specific cooling interventions.[220]

Opportunity 13: Build partnerships with health and weather reporters for preventive messaging.

A 2011 study on New York City heat messaging found that residents consider meteorologists and health reporters to be trusted sources of information, yet broadcasts may miss some vulnerable groups (e.g., the older adult, indoor workers) or adaptive strategies (e.g., air conditioning).[221] Partnerships with media outlets can be used to refine public broadcast messaging on heat events to better support community awareness and preparedness.

Opportunity 14: Enhance diversity, specification, and unification of messaging for public communication and outreach both before and during an extreme heat event.

In 2021, focus groups across San Diego County were asked to evaluate the reach and effectiveness of heat risk education. Localized recommendations to improve this messaging include: (1) diversification of communication channels, (2) specification of content, and (3) development of formally coordinated campaigns.[222]

1. The San Diego County Extreme Heat Response Plan relies on redundant communication channels, including county departmental websites, social media, news outlets, and mobile applications, to maximize community outreach.

2. This research suggests an effective communication plan relies on multi-language, multi-channel messaging; it will also identify distinct audiences, targeted messages, and the best ways to reach them (e.g., City workers, other outdoor workers, schools, hospitals). For example, the Heat Risk Education Curriculum was established by Live Well San Diego and its partners to train community leaders and residents about heat risk, heat-related illnesses, prevention, and response.[223] Coordination with the departments of Risk Management and Parks and Recreation could facilitate outreach to outdoor workers before heat events. Feedback from the 2021 focus groups recommends that messaging be available in multiple languages and be culturally competent (e.g., clarifies misconceptions and dispels myths) to enhance uptake.

3. Campaigns are thought to provide a more unified voice and prevent misinformation more effectively than disparate messaging.[224] San Diego is currently developing an adaptation and extension of the Los Angeles Regional Collaborative's LA County Extreme Heat Campaign.[225] The multi-week campaign features social media posts with regional resources and data, bus stop signage, print materials, and other collateral that will be distributed to regional partners.

Opportunity 15: Implement a seasonal approach to outreach and prevention to complement planning for extreme heat days and address the risks of chronic, moderate heat exposure.

Heat health impact data show that serious health impacts from heat are not confined to extreme heat days; the impacts of chronic heat stress are compounded and distinct from the impacts of acute heat stress.[226] For example, Maricopa County reported that in 2024, 55% of heat-related deaths occurred on days when the HeatRisk was designated as "Moderate, Minor, or None."[227] Chronic heat stress can impact long-term financial security by increasing energy burdens or reducing work security and productivity.[228]

Results suggest that a seasonal approach to heat planning, such as the Miami-Dade County's Heat Season campaign,[229] in combination with acute heat event response, can help address the impacts of chronic heat stress. A seasonal approach may include scheduling outreach, training, and campaigns in coordination with the identified "heat season."

CONCLUSION

Extreme heat in San Diego is a growing threat to public health, worker productivity, and public infrastructure. It places a growing burden on community members and municipal resources—from stretching emergency services to rising housing energy costs. Many of these impacts are already visible in San Diego communities; moreover, the burden of extreme heat is not felt equally.

The understanding of the impacts and distribution of extreme heat is improving with time and additional research. This report demonstrates that there are strong opportunities to enhance partner coordination, data quality, and knowledge sharing to help San Diego communities build resilience to extreme heat. The more San Diego can learn and share about these impacts, the better positioned it will be to prepare, plan for, and prevent adverse impacts of extreme heat.

APPENDIX A. MATERIALS AND DOCUMENTATION EVALUATED

The following list is a summary of the state, regional, and local planning documents, tools, and policies reviewed for this report. Additional data references are included in the references.

Annual Excessive Heat Report – County of San Diego (2023): The San Diego County Public Health Services Administration Branch developed this annual report to document the state of heat health impacts in the county. The report is developed in coordination with the Excessive Heat Response Plan.

Barrio Logan Community Plan (2023): The plan is designed to guide growth and development within Barrio Logan. The plan is a revision of the Barrio Logan/Harbor 101 Community Plan and Local Coastal Program adopted by the City Council in 1978. The plan includes policies to support urban greening projects or programs, such as expanded urban tree canopy, green roofs, green streets, and increased access to green spaces that provide air quality and natural cooling benefits during heat events.

Blueprint SD (2024): Blueprint SD is the 2024 "refresh" of the San Diego General Plan. The goal of Blueprint SD is to make a proactive effort to create an equitable and sustainable framework for growth with a focus on accessibility via walking, biking, and transit.

Cal-Adapt: Cal-Adapt synthesizes existing downscaled climate change scenarios and climate impact research and shares these data in an easily available, graphical format for local planning efforts. Most regional heat planning tools, including California Healthy Places Index, California Heat Assessment Tool, and Climate Change & Health Vulnerability Indicators for California, rely on these data.

California Adaptation Planning Guide: Developed by the California Governor's Office of Emergency Services to help local government, regional entities, and climate organizations incorporate best practices and current science and research into their adaptation plans.

CalHeatScore: CalHeatScore was built as a result of Assembly Bill No. 2238 (L. Rivas, Chapter 264, Statutes of 2022) requiring CalEPA to develop a statewide extreme heat ranking system. It was developed to raise awareness for extreme heat, offering real-time data for local emergency response and coordination; it assigns daily rankings of forecasted heat-related health impacts across California zip codes.

California Heat Assessment Tool: The State of California developed this tool to estimate future heat health events or periods of extreme heat where public health impacts become more likely.

California Healthy Places Index: Extreme Heat Edition: The California Healthy Places Index: Extreme Heat Edition, was developed by the Public Health Alliance of Southern California in partnership with the UCLA Luskin Center for Innovation. The tool provides datasets on projected heat exposure and vulnerability for California by census tract. It also provides a list of state resources and funding opportunities that can be used to address extreme heat.

Climate Change & Health Vulnerability Indicators for California: This is the interactive data visualization platform for the Climate Change & Health Vulnerability Indicators for California produced by the Climate Change and Health Equity Section – CalBRACE Project, part of the California Department of Public Health.

City of San Diego Climate Action Plan (2022): The 2022 Climate Action Plan establishes a community-wide goal of net zero by 2035, committing San Diego to an accelerated trajectory for greenhouse gas reductions. More than 4,000 San Diegans shared their feedback in the development of this plan.

Climate Action Plan Consistency Regulations (2022): The Land Development Code of the San Diego Municipal Code was amended to add the Climate Action Consistency Regulations to ensure future development projects that rely on the greenhouse gas emissions analysis in the Climate Action Plan are consistent with the assumptions of the Climate Action Plan.

City of San Diego Climate Action Implementation Plan (draft) (2023): The Climate Action Implementation Plan organizes the City's processes and government structure to implement the net zero target.

Climate Equity Index (2019): In 2019, the City of San Diego developed the Climate Equity Index, in partnership with several community-based organizations representing environmental justice communities and communities of concern. The Climate Equity Index measures residents' access to opportunity and assesses the degree of potential impact from climate change to these areas. The Climate Equity Index was updated in 2021.

Climate Resilient SD (2021): This City-level planning document summarizes the existing and future exposure to extreme heat in terms of frequency and duration of warm nights, the number of extreme heat days, and daily minimum temperatures. The plan documents City policy priorities to mitigate the impacts of extreme heat, with an emphasis on addressing impacts for vulnerable populations.

Climate Resilient SD Implementation Tracker: The implementation tracker demonstrates the work undertaken to implement Climate Resilient SD.

County of San Diego Multi-Jurisdictional Hazard Mitigation Plan and City of San Diego Annex (2023): The Multi-Jurisdictional Hazard Mitigation Plan is a countywide plan that identifies risks and opportunities to minimize damage from natural and human-caused disasters. The City of San Diego Annex focuses on local City priorities and inter-jurisdictional coordination.

Encanto Community Plan (2015): The Encanto Community Plan is designed to guide growth and development within Encanto neighborhoods. This plan is a revision of the previous Southeastern San Diego Community Plan that included Encanto neighborhoods. The plan includes several overarching goals/policies, including urban forestry, land use framework, restoration, urban agriculture, resource management, walkable communities, outdoor gathering spaces, urban canopy, education, and infrastructure redesign/development.

Environmental Justice Element (2024): This companion document to the City General Plan informs decision-making to advance environmental justice. It maps heat risk in combination with heat-mitigating elements such as tree canopy coverage and cool zone sites. The element documents policies to address the impacts of extreme heat on environmental justice communities, including developing an urban greening program to expand urban green spaces and developing a heat action plan to implement cooling strategies for communities identified by the Urban Heat Vulnerability Index.

Urban Heat Vulnerability Index StoryMaps (2021): This interactive storymap illustrates the results of the 2019 Urban Heat Vulnerability Index analysis.

Heat Watch Heat Mapping Report (2021): On September 13 and 14, 2021, the City partnered with CAPA Strategies, the San Diego Foundation, High Tech High, and other volunteers to conduct an urban heat mapping study. Using heat sensors, volunteers collected thousands of temperature and humidity data points in the morning, afternoon, and evening along designated routes. These data were used to create high-resolutions maps to show heat distribution across the City.

San Diego Building and Housing Stock Analysis (2023): A parcel-level building inventory for the City of San Diego was developed to assess common building typologies as well as ownership, social vulnerability, environmental risk, and other indictors. The goal of this analysis was to identify opportunities and barriers for building decarbonization, with a focus on San Diego's communities of concern.

Live Well San Diego: This collective of 600 organizations devoted to health and safety in San Diego County hosts the Heat Risk Education Curriculum.

Mid-City Draft Ideas Report (2025): The purpose of the Ideas Report is to solicit public input on ideas and concepts to inform the Draft Community Plan, which describes preliminary Mid-City visions, frameworks, and concepts informed by public engagement and an existing conditions analysis.

Mid-City Engagement Summary (2024): The draft Mid-City Engagement Summary for the Mid-City Communities Plan Update summarizes feedback provided by the community during the first year of the plan update process.

Mid-City Atlas Existing Conditions Report (2025): The Mid-City Atlas summarizes existing conditions, challenges, and opportunities in the Mid-City planning area, which includes the communities of City Heights, Eastern Area, Kensington-Talmadge, and Normal Heights. The document includes a summary of existing heat exposure, heat risk, energy cost burden, and urban tree canopy coverage, among other factors.

Multi-Jurisdictional Hazard Mitigation Plan County of San Diego Annex (2017): The City of San Diego annex identifies risks and ways to minimize damage by natural and human-caused disasters in the City; the annex is a companion document to the countywide plan.

Otay Mesa-Nestor Community Plan (2024): The Otay Mesa-Nestor Community Plan identifies issues, articulates community visions, and recommends strategies for improvement and for achieving those visions.

Parks Master Plan (2021): The Parks Master Plan was developed as part of the Parks for All of Us initiative and is an amendment to the General Plan Recreation Element. The plan incorporates heat planning goals, including expanding the park systems and improving community access, planting drought-resilient and native trees, installing living walls in new buildings in parks, and designing and retrofitting parks to enhance heat resilience. The plan also encourages the City to shade at least 50% of all hardscape, with at least 60% of the area shaded by tree canopies.

Placemaking Ordinance (2018): The San Diego municipal code was revised to allow residents to reimagine and creatively reinvent unused or underutilized spaces in their neighborhoods by applying for a placemaking project permit. The placemaking ordinance has been used to create gathering places, showcase public art, illuminate landscape, beautify forgotten parcels, and illustrate the area's cultural vibe. Placemaking projects are defined as temporary small-scale developments in the public right-of-way and on private property.

San Diego County Extreme Heat Response Plan – Consumer Version (2025): The plan was developed by County of San Diego's Public Health Services in support of Live Well San Diego. During extreme heat events, Public Health Services works with county and community partners to implement actions described in the plan, including community outreach and distribution of resources.

San Diego Excessive Heat Response Plan (2021): This internal plan details county agency coordination, roles, and responsibilities, and initiation of phased heat illness prevention and emergency response activities.

San Diego Municipal Code: Chap 15 Art 06 Div 03, The Centre City Planned District: Incentivizes the use of eco-roofs to counter the increased heat of urban areas by offering floor area ratio (FAR) bonuses.

San Ysidro Community Plan (2017): The San Ysidro Community Plan is a component of the City of San Diego's General Plan. The purpose of the plan is to document the General Plan goals and policies as they apply to San Ysidro through the provision of more site-specific recommendations, and it provides the basis for zoning and the Impact Fee Study.

Skyline-Paradise Hills (2006): The purpose of the Skyline-Paradise Hills Community Plan (Plan) is to guide future development within the Skyline-Paradise Hills community planning area. The plan contains goals and objectives established by the community, consistent with citywide policies.

Southeastern Community Plan (2015): The Community Plan is designed to guide growth and development within Southeastern San Diego. This plan is a revision of the previous Southeastern San Diego Community Plan. The plan includes strategies to minimize heat gain in the community.

2-1-1 San Diego: 2-1-1 San Diego is a local nonprofit that provides 24-hour information and connections to community, health, and disaster resources in 200 languages. During extreme heat events, 2-1-1 connects people to a transportation or rideshare service at no cost to transport San Diego County residents to and from cool zone locations.

Urban Forestry Five-Year Plan (2017): The Urban Forestry Program Five-Year Plan builds on the Climate Action Plan by identifying methods to implement a tree planting initiative and best management practices to protect the City's existing trees.

Urban Forestry: Ready, Set, Grow San Diego: The City of San Diego Urban Forestry Program was awarded a $10 million grant from the U.S. Forest Service, an agency of the U.S. Department of Agriculture for a five-year tree planting program, Ready, Set, Grow San Diego. The goal of the program is to empower community members with the knowledge and skills they need to care for and improve their neighborhoods through tree stewardship programs.

Urban Forestry: Street Tree web map: San Diego's street tree inventory and tree benefits, including avoided runoff, carbon storage, and oxygen production, are captured in an interactive map.

Urban Forestry: Trees for Communities: The Trees for Communities project is intended to increase the urban tree canopy cover and maximize the benefits of urban trees for community members.

Urban Heat Island Index for California (2015): CalEPA created an Urban Heat Island Index to quantify the extent and severity of urban heat islands for individual cities. The study also produced Urban Heat Island Interactive Maps, showing the urban heat island effect for census tracts throughout the state. This tool was designed to meet the requirements of AB 296, Chapter 667, Statutes of 2012) that required CalEPA to develop an Urban Heat Island Index and to design it so that "cities can have a quantifiable goal for heat reduction."

Urban Heat Vulnerability Index (2021): The City developed an Urban Heat Vulnerability Index partnership with NASA DEVELOP. The Urban Heat Vulnerability Index identifies a community's heat risk as a combination of heat exposure as well as social and health factors that may increase its vulnerability. In addition, land use/land cover, tree canopy, building intensity, and albedo were used in an urban cooling model to investigate changes in cooling rates in current and future scenarios for the City.

Vulnerable Communities Platform (2025): The Governor's Office of Land Use and Climate Innovation's Climate Services program began development of the Vulnerable Communities Platform in 2021. The purpose of the Platform is to help users understand where climate hazards will be most severe in California, which communities are most vulnerable, and what makes them vulnerable. The Platform will soon be able generate reports that summarize climate vulnerability for any city, town, zip code, or census tract. A climate hazard high score indicates that the community would benefit from adaptation planning.

APPENDIX B. 2021 URBAN HEAT VULNERABILITY INDEX (UHVI) SCORES BY COMMUNITY PLANNING AREA

*Some Community Planning Areas may have multiple Urban Heat Vulnerability Index polygons with multiple rankings. In these cases, the value of the largest Urban Heat Vulnerability Index polygon was selected.

Community Planning Area	UHVI Vulnerability Score	UHVI Exposure Score	UHVI Risk Score
BALBOA PARK	Low	Very Low	Low
BARRIO LOGAN	Very High	Low	Very High
BLACK MOUNTAIN RANCH	Low	Very Low	Very Low
CARMEL MOUNTAIN RANCH	Very Low	Very High	Moderate
CARMEL VALLEY	Very Low	Very Low	Very Low
CLAIREMONT MESA	Moderate	Low	Low
COLLEGE AREA	Very Low	Low	Low
DEL MAR MESA	Low	Very Low	Very Low
DOWNTOWN	Low	Moderate	Moderate
EAST ELLIOTT	Low	Low	Low
ENCANTO NEIGHBORHOODS	High	Moderate	High
FAIRBANKS RANCH COUNTRY CLUB	Low	Very Low	Very Low
GREATER GOLDEN HILL	Low	Low	Low
KEARNY MESA	Low	High	Moderate
LA JOLLA	High	Very Low	Very Low
LINDA VISTA	Very High	Very Low	Moderate
LOS PENASQUITOS CANYON	Very Low	Very Low	Very Low
MID-CITY:CITY HEIGHTS	High	Low	High
MID-CITY:EASTERN AREA	Very High	Very High	Very High
MID-CITY:KENSINGTON-TALMADGE	Moderate	Low	Moderate
MID-CITY:NORMAL HEIGHTS	Low	Very Low	Low
MIDWAY-PACIFIC HIGHWAY	Very High	Very High	Very High
MILITARY FACILITIES	Very Low	Low	Very Low
MIRA MESA	Low	High	Moderate

Community Planning Area	UHVI Vulnerability Score	UHVI Exposure Score	UHVI Risk Score
MIRAMAR RANCH NORTH	Low	Low	Low
MISSION BAY PARK	Low	High	Moderate
MISSION BEACH	Low	High	Moderate
MISSION VALLEY	Very Low	High	Low
NAVAJO	High	Very Low	Low
NCFUA SUBAREA II	Low	Very Low	Very Low
NORTH PARK	Low	Low	Low
OCEAN BEACH	Very Low	Low	Low
OLD TOWN SAN DIEGO	Very High	Very High	Very High
OTAY MESA	High	High	High
OTAY MESA-NESTOR	Very High	Low	Very High
PACIFIC BEACH	Very Low	Low	Low
PACIFIC HIGHLANDS RANCH	Low	Very Low	Very Low
PENINSULA	Very Low	Low	Very Low
RANCHO BERNARDO	High	Low	High
RANCHO ENCANTADA	Low	Low	Low
RANCHO PENASQUITOS	Moderate	Very Low	Very Low
SABRE SPRINGS	Low	Low	Low
SAN PASQUAL	Very Low	Very Low	Very Low
SAN YSIDRO	Very High	Low	High
SCRIPPS MIRAMAR RANCH	Low	Low	Low
SERRA MESA	Low	High	High
SKYLINE-PARADISE HILLS	Very High	High	Very High
SOUTHEASTERN SAN DIEGO	Very High	High	Very High
TIERRASANTA	Moderate	Very Low	Low
TIJUANA RIVER VALLEY	High	Low	Moderate
TORREY HIGHLANDS	Low	Low	Low
TORREY HILLS	Very Low	Very Low	Very Low
TORREY PINES	Moderate	Moderate	Moderate
UNIVERSITY	Very Low	Low	Very Low
UPTOWN	Moderate	Very Low	Low
VIA DE LA VALLE	High	Very Low	Low

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