INNOVATING FOR A BETTER TOMORROW

Extreme Heat & Public Health Report

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SCAG™
INNOVATING FOR A BETTER TOMORROW

ABOUT SCAG

SCAG is the nation's largest metropolitan planning organization (MPO), representing six counties, 191 cities and more than 19 million residents. SCAG undertakes a variety of planning and policy initiatives to encourage a more sustainable Southern California now and in the future..

MISSION STATEMENT

To foster innovative regional solutions that improve the lives of Southern Californians through inclusive collaboration, visionary planning, regional advocacy, information sharing, and promoting best practices.

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What is Extreme Heat?

Extreme Heat

Extreme heat conditions are defined as weather that is substantially hotter than average for a specific time and place (EPA, 2016). Extreme heat events, also known as “heat waves,” have no standard definition but are generally defined based on the potential for hot weather conditions that can cause a high level of health effects such as illness and mortality (Minister of Health, 2011). An extreme heat event is an extended period of time with unusually hot weather conditions (CDC, n.d). These events are characterized by stagnant warm air and consecutive nights with above average temperatures, and they are considered a public health problem that will be exacerbated by global warming, urbanization, and an aging population (Luber, 2008). The chances of an extreme heat event happening where you live are increasing as temperatures continue to rise at an alarming rate. The United States is already experiencing an increase in extreme heat events, which are expected to become more common, severe, and longer-lasting as the climate continues to change (EPA, 2016).

Heat Index

The heat index is a measure of what temperature feels like when relative humidity is factored in with the air temperature. The National Weather Service (NWS) refers to it as the “feels like” weather and is also known as apparent temperature. Relative humidity is the ratio of the percentage of moisture in the air and the maximum amount of moisture the air can hold. Humidity is an important factor when measuring the human body’s comfort because when it gets too hot, the human body perspires in order to cool itself off. When humidity is high, water is not able to evaporate as easily; therefore, the body is unable to regulate its temperature by sweating (Dahl, 2019). When relative humidity increases, the rate of perspiration decreases and vice versa. That is why the human body feels warmer when in humid conditions. A heat index of greater than 115 degrees Fahrenheit has a heat related illness risk level of very high to extreme (OSHA).

Heat Index thresholds are used by the NWS to issue heat advisories and excessive heat warnings. The NWS will issue a heat advisory if a region’s heat index reaches or exceeds 100 degrees Fahrenheit for 48 hours. An excessive heat warning will be issued if the heat index reaches or exceeds 105 degrees Fahrenheit for 48 hours (NWS ndb as cited in Dahl, 2019). A heat index above 127 degrees Fahrenheit is considered off the charts, and for values above 130 degrees Fahrenheit, the NWS is unable to provide standard guidance. Typically heat advisories are also issued by the state and/or the county where the conditions are anticipated or are being experienced and include a list of impacts and precautionary actions and recommendations. Extreme heat-health outcomes depend on local environmental conditions and the degree to which people are acclimated. Therefore, some regions have higher thresholds than others. For example, South Carolina, a state where residents are accustomed to extreme heat have raised their threshold for extreme heat warning from 105 degrees Fahrenheit to 115 degrees Fahrenheit (Dahl, 2019). As global temperatures continue to rise, extreme heat events become more frequent, and high heat index conditions increase, causing exceedance of dangerous thresholds (Dahl, 2019).

Why is Extreme Heat on the Rise?

Extreme heat events are caused by the increase of average temperatures. Global temperatures have been rising over the past few decades as a result of rising heat trapping emissions from anthropogenic activities such as fuel combustion from motor vehicles, heat and power generation and industrial facilities (WHO, 2020). The leading cause is the burning of fossil fuels (Dahl, 2019). Annual average temperature has been rising since the beginning of the 20th century, and temperatures are expected to continue to rise through the end of this century (EPA, 2016). Since 2000, 15 of the 16 warmest years on record have occurred on a global scale, apart from 1998 (EPA, 2016). According to Climate Central, the entire world is reaching a global temperature increase of 2.7 degrees Fahrenheit, and the nation's fastest-warming regions are the Southwest and Alaska, a number which the Intergovernmental Panel on Climate Change (IPCC) says we need to stay under in order to prevent the worst climate change impacts (Kutz, 2020).

Forecasts of Extreme Heat (United States, California & Region)

The intensity of the upcoming heat depends heavily on our current and near-term fossil fuel use choices. Global warming and the number of extreme heat days can only be slowed down if we lower emissions immediately and intensely. The Union of Concerned Scientists (UCS) conducted an analysis on extreme heat projections throughout the United States over the next century. The analysis was based on three global climate scenarios in relation to emissions levels and future warming. Each scenario also reflects different levels of emissions reductions action levels, from no action to rapid action. The results show that even for the rapid action scenario, communities will still experience substantially increased extreme heat, which means that more aggressive and intensive action needs to be taken than outlined in the scenarios used for the analysis. According to the UCS, if we don’t change our emissions path, extreme heat days will rise significantly in severity and frequency, and will be longer lasting in the next few decades. Reduction rates of global heat-trapping emissions in the coming decades will determine the future frequency of extreme heat events in the United States (Dahl, 2019).

MID-CENTURY

The results for the “no action to reduce heat-trapping emissions” scenario of the analysis indicated that by mid-century (2036-2065) compared to average conditions between 1971-2000, show the likelihood of many changes in the United States, such as the following (Dahl, 2019):

Days per year with a heat index above 100 degrees average will more than double.

Over a third of the United States will experience heat conditions once a year, on average exceeding the heat index range.

About one-third of the 481 urban areas in the United States with a population of 50,000 people or more will experience an average of 30 or more days per year with a heat index above 105°F.

LATE CENTURY

The results for the “no action to reduce heat trapping emissions” scenario of the analysis indicated that by the late century (2070-2099) (Dahl, 2019):

On average, the United States will experience four times as many days per year with a heat index above 100°F, and almost eight times as many days per year above 105°F, as it has historically.

On average, more than 60 percent of the United States will experience off-the- charts conditions that exceed the NWS heat index range and present mortal danger to people, at least once per year.
More than 60 percent of urban areas in the United States will experience an average of 30 or more days with a heat index above 105°F.
An additional 9,300 heat-related annual deaths will occur across the country.

SCAG REGION

California is expected to have an increase in annual average temperatures of 5 degrees Fahrenheit by 2030, and 10 degrees Fahrenheit by the end of the century (SCAG, 2019). The SCAG region is projected to have an average increase of 35 extreme heat days from 2040-2060 (SCAG, 2019). The county in the SCAG region with the highest projections is Imperial County, which is expected to have over 43 extreme heat days per year from 2040-2060 (SCAG, 2019). Riverside, San Bernardino, and Los Angeles Counties are expected to have 42, 41, and 37 extreme heat days, respectively, per year. Ventura County is projected to have 32 extreme heat days. Orange County is expected to have 15 heat days per year which is the lowest projection of extreme heat days in the SCAG region from 2040-2060 (SCAG, 2019). Extreme heat days per year are expected to more than double across the entire region after 2085 (SCAG, 2019).

Urban Heat Island Effect

The Urban Heat Island (UHI) Effect is the phenomenon in which temperatures are significantly higher in urban and metropolitan areas in comparison to rural areas on any given day due to characteristics of urban environments (CalEPA, 2020). Those characteristics include heat-retaining surface areas and lack of vegetation. This is an increasingly growing problem that is responsible for human discomfort and human casualties. The decline of climate is caused by alterations of surface area, inadequate urban planning, and air pollution (Nuruzzaman, 2015). On average, daytime temperatures in urban areas are one to six degrees higher than in rural areas. In California, nighttime temperatures can be drastically higher in urban areas than surrounding areas because the extra heat absorbed during the day is gradually released from heat-trapping surfaces at night (CalEPA, 2020).

The Urban Heat Island Effect is particularly more harmful during an extreme heat event because the increasing nighttime temperatures reduce or eliminate the ability for people in urban areas to get physical and mental relief (Dahl, 2019). This can result in major increases in hospitalizations, emergency room visits, and deaths. Heat-related death rates have been much higher in urban areas than in rural areas as a result of the Urban Heat Effect (EPA, 2020).

The size of the urban area is related to the level of the heat island effects. Smaller cities have an average increase of 5 degrees Fahrenheit, while larger cities have an average increase of 9 degrees Fahrenheit, compared to non-urban areas (CalEPA, 2015). Southern California experiences a “urban heat archipelago” which happens as a result of different urban heat islands running into each other (Totten, 2015). Some parts of the Los Angeles region can be up to 19 degrees higher than non-urban areas during summertime (Totten, 2015). The highest temperatures are in the east side of downtown Los Angeles, which are pushed into the inland valley by ocean winds (Totten, 2015).

As technology advances, more areas around the world are being urbanized, causing a cause for concern. More than half of the global population now lives in cities, up from 30 percent from 60 years ago (Lubber, 2008). In 2012, 95 percent of California’s population lived in urban areas (U.S Census Bureau, 2012). It is crucial to learn more about and address the effects of Urban Heat Island because the heat concentration creates excessive health risks, not limited to heat exposure but also to the amplification of air pollutants (CalEPA 2020). Ground-level ozone, which is created when common air pollutants have chemical reactions caused by heat has higher levels during hot weather (Dahl, 2019). As climate change continues to increase, future projections show that nighttime temperatures will warm faster than daytime temperatures causing more urban area residents to be exposed to extreme heat stress.

SURFACE URBAN HEAT ISLAND

Surface UHI can cause urban surface areas to become 50 to 90 degrees Fahrenheit warmer than the air temperature and is present at all hours of the day and the night, but is most intense during the day and in the summer. Due to changes in the sun's intensity, its magnitude varies with seasons (EPA, 2008). Surface UHI contributes to human discomfort during the day and an increase in energy demand for air conditioning. If a person does not have access to air conditioning, the daytime heat can lead to heat-related illnesses.

ATMOSPHERIC URBAN HEAT ISLAND

Atmospheric UHI is defined as warmer air in urban areas than in the surrounding areas and may be small and non-existent during the day and most intense at night and during the winter due to the slow release of heat from urban infrastructures (EPA, 2008). Atmospheric UHI causes human discomfort during the night and like surface UHI, can have negative public health impacts. Heat experts usually categorize them by two types (EPA, 2008):
Canopy layer urban heat islands exist in the layer of air where people live, from the ground to below the tops of trees and roofs.
Boundary layer urban heat islands start from the rooftop and treetop level and extend to the point where urban landscapes no longer influence the atmosphere.

CAUSES (NURUZZAMAN, 2015):

- Low Albedo Materials – Urban areas have dark, paved, and impermeable surfaces such as asphalt, steel, and brick that store solar energy and increase temperatures.
- Large Populations – The higher the population, the more Carbon Dioxide will be emitted into the atmosphere. Since Carbon Dioxide stores heat, it contributes to rising temperatures.
- Increased Use of Air Conditioning – There are ecological consequences of excessive air conditioning. It creates an inescapable feedback loop in urban areas. Air conditioning contributes to the urban heat island effect by discharging waste heat into the atmosphere and causing air temperature levels to rise at night, increasing the need for even more air conditioning.
- Destruction of Trees – Forests are wiped out to meet urban facilities demands. Trees are carbon sinks that absorb carbon dioxide, which means that the fewer trees we have, the less is the cooling efficiency.
- Urban Canopy – Multilayer buildings in urban areas cause heat reflected by a building to become trapped by a taller building in proximity.
- Wind Blocking – Wind that would otherwise help blow trapped heat away, has its velocity significantly reduced because of an abundant amount of large buildings in urban areas.
- Air pollutants – Solar radiation is trapped by the release of exhaust gases from vehicles and industrial pollutants into the environment, causing the microclimate effect to become stronger.

REDUCTION STRATEGIES (EPA, 2019):

- Trees and other vegetation – Increase of trees and vegetation in urban environments lower surface and air temperatures. Trees and vegetation reduce energy use by providing direct shade to buildings, decreasing air conditioning demand.
- Green Roofs – Growing a vegetative layer on a rooftop can provide shade and reduce roof surface and air temperatures. Green roofs are ideal for built environments with limited vegetation because they can moderate the urban heat island effect.
- Cool Roofs – Installing a roof made of materials that reflect sunlight away from the building can reduce roof temperatures, improve human health and comfort and reduce energy use.
- Cool Pavements – Using paving materials that reflect more energy than the conventional pavements can cool pavement surface and surrounding air, enhance water evaporation, improve human comfort, and improve nighttime visibility.
- Smart Growth – Strategies that provide an opportunity to reduce the urban heat island effect. Smart growth covers a wide range of development and conservation strategies that protect the natural environment while also making communities more livable and economically stronger.

Extreme Heat & Public Health Effects

Many serious illnesses are caused by extreme heat exposure and over the last 30 years, extreme heat was the leading weather-related cause of death in the United states (NWS 2018). The following are negative impacts that extreme heat has on human health.

HEAT CRAMPS

Heat cramps are muscle spasms, often in the abdomen, arms, or calves, caused by excessive sweating, which causes loss of large amounts of water and salt from the body (EPA, 2016). Heat cramps often occur after prolonged exposure to extreme heat combined with dehydration usually happening while participating in strenuous outdoor physical activities (EPA, 2016). A heat index of 90 degrees Fahrenheit increases the probability of certain risk groups experiencing heat cramps (Dahl, 2019).

HEAT EXHAUSTION

Heat exhaustion is the most common heat-related illness. Symptoms include sweating, weakness, nausea, vomiting, dizziness, fatigue, headache, and anxiety. A person experiencing heat exhaustion can have a core body temperature below normal, normal or above normal. If mild to moderate signs go unrecognized or untreated, it can progress to heat stroke (Luber, 2008).

HEAT STROKE

Heat stroke, also known as hyperthermia, is the most severe medical condition caused by extreme heat and requires emergency treatment (EPA, 2016). Heat stroke occurs when body's regular temperature of 98.6 degrees Fahrenheit rises to 104 degrees Fahrenheit as a result of the body not being able to regulate its temperature. During an extreme heat event, body temperature rises quickly and can reach 106 degrees Fahrenheit (EPA, 2016). Heat stroke is often a result of not treating other heat-related illnesses, such as heat cramps or heat exhaustion, causing symptoms to progress and cause further damage to the body. What makes heat stroke particularly dangerous is that it can also strike suddenly without prior symptoms and can result in death if not treated immediately (EPA, 2016). Even people who have spent their whole lives in regions that experience hot weather can miss the signs of heat stroke (Kutz, 2020). Symptoms of heat stroke include very high body temperature, altered mental state, nausea, dizziness, throbbing headache, confusion, body aches and unconsciousness (EPA, 2016).

HEAT-RELATED MORTALITY

Heat-related deaths are preventable, yet hundreds of people succumb to extreme heat every year in the United States alone. Extreme Heat is the leading cause of death- regarding weather-related hazards, including hurricanes, flooding, and tornadoes (EPA, 2016). According to the Center for Disease Control and Prevention (CDC), about 700 Americans die from extreme heat each year. However, a recent study by Climate Central estimates that the total heat-related mortality rate in the U.S. is closer to 12,000 per year. The number disparity is a result of misclassification of the cause of death. They often classify these deaths as "kidney failure" or "dehydration" instead of what caused those illnesses: extreme heat (Atkin, 2020). Many medical examiners do correctly classify these deaths, but the determination criteria used to determine heat-related causes of death vary among states. This is partly the cause of underreporting of heat-related death and the reporting of heat contributing as a factor rather than the underlying cause (Luber, 2008). The U.S. currently has not assigned any federal agency the task of keeping track of deaths caused by heat (Kutz, 2020).

Each consecutive day of an extreme heat event causes a greater risk of heat-related mortality, especially for people who lack extreme heat adaptations. Extreme heat events cause an increase in heart attack, cardiovascular death, and respiratory death rates. Deaths can occur quickly without cooling, typically the same day or the day after outside heat exposure, which means there needs to be a quick response to extreme heat conditions (Dahl, 2019). In California, there is no evident trend because heat related deaths vary from year to year, but rates do increase during heat waves (CalEPA, 2019). In 2006, at least 140 California residents died following the prolonged record-breaking heat wave (CalEPA, 2019).

RESPIRATORY ILLNESS

Cities have very high levels of ground-level ozone pollution. Hotter temperatures speed up the chemical reactions that create ground-level ozone, which is the main component of smog (LACDPH, 2014). The creation of ground-level ozone occurs when heat triggers chemical reactions between some common pollutants associated with electric utilities, industrial facilities, and vehicles (Martin Perera and Sanford 2011 as cited by Dahl, 2019). High exposure to ground-level ozone can lead to respiratory such as asthma, bronchitis, heart attack, and even premature death. Daily hospital admissions due to asthma are frequently associated with an increase of ground-level ozone levels, and rising temperatures will only worsen these problems (LACDPH, 2014). In 2016, 13.8 percent of residents in the SCAG region were diagnosed with asthma (SCAG, 2019). Rising heat caused by climate change will increase the amount of pollution and other air contaminants which can exasperate asthma and other respiratory diseases (SCAG 2019).

VECTOR-BORNE DISEASE

Rising temperatures create new risks for the United States, including the risk of exposure to vector-borne illnesses, that are transmitted to humans and other animals by blood-feeding insects such as mosquitos, ticks, and flies. Global rising temperatures lengthen the season and expand the geographic span for these vectors (Climate Nexus, 2016). Various species of mosquitoes feed more frequently and breed more rapidly in warmer weather. Mosquitoes are an increasing concern in the Los Angeles region. In 2013, mosquitoes that carried West Nile Virus caused 9 deaths and 165 infections in the county (LACDPH, 2014). Since the 1980s, there has been a 76 percent mosquito increase in major cities in the United States because of the rising humidity and heat (Climate Nexus, 2016). The World Health Organization (WHO) reports that there are over 1 billion cases and over 1 million deaths each year from vector-borne diseases (Climate Nexus, 2016).

WATER QUALITY

Evaporation of bodies of water can be exacerbated by heat. Snowfall is reduced because what would have fallen as snow instead falls as rain, which leads to increasing demand for water. By 2050, California is expected to lose approximately 25 percent of the Sierra snowpack, which is the primary source of water for the state (SCAG, 2019). When water resources diminish, the country is negatively affected in ways such as lack of water and by the quality of water. Pollutants that are already present in the water supply become more concentrated in smaller water bodies, which increases the risk of water-borne illnesses (LACDPH, 2014). Ash and debris from wildfires create an additional cause for concern when there is a drought because they can contaminate drinking water resources. (LACDPH, 2014).

Most Vulnerable to Extreme Heat Impacts

INFANTS & SMALL CHILDREN UNDER THE AGE OF 4

Studies have found that infants and small children are especially at risk of extreme heat as they adjust more slowly than adults to the changes in environmental heat (UNICEF, 2018). As temperature climbs, smaller bodies lose water faster than larger bodies, which can lead to dehydration (Stillman, 2019; Li et al., 2015). Moreover, infants and young children are more likely to suffer from heat stroke because they cannot regulate their body temperature and control their surrounding environment. Other pediatric diseases or conditions are also affected by heatwaves, such as allergy, renal disease, respiratory disease, electrolyte imbalance, and fever (Xu et al., 2014).

CHILDREN UNDER THE AGE OF 14

In comparison to healthy adults, children under the age of 14 are more vulnerable to extreme heat. The reason could be that they are less likely to seek proper hydration and help when they need it the most (Xiao et al., 2017). In 2015, roughly a 20 percent of the population were under the age of 14 (SCAG, 2015). According to a 2013 survey on public schools in the U.S., 30 percent have air conditioning systems in just fair or poor condition (Alexander and Lewis, 2014). Minority and low-income students are disproportionately affected by extreme heat because they are most likely to live in homes and attend schools without air conditioning (Goodman et al., 2018; Graff Zivin. Hsiang, & Neidell, 2018).

POPULATION OVER 65 YEARS OF AGE

People aged 65 and over are at higher risk of heat-related illnesses. Like young children, older adults cannot adjust to sudden changes in temperature (CDC, 2017). In 2016, 13.3 percent of the SCAG region is 65 and over and is expected to increase to 20.6 percent by 2045 (SCAG, 2019). Extreme heat is associated with increases in cardiovascular and respiratory-related deaths in this age group (Åström, Bertil, & Joacim, 2011; Anderson & Bell, 2009). Risk factors that increase the risk of heat stress in the elderly population include (CDC, 2017; Department of Health and Human Services, 2020):

- Self-care problems – Some older people are feeble (i.e., lacking physical strength) or have reduced mobility or mental health problems, which make it difficult for the person to take adequate care in hot weather.
- Living in isolation – There is no one to take care of the person if they live in isolation and ignore the symptoms and heat-related illnesses.
- Chronic medical problems – Older people are more likely to have a chronic medical condition that changes normal body responses to heat.
- Medications – They usually take medicines for different chronic medical problems. Often those medications can hinder the body’s ability to regulate temperature.
- Kidney conditions – If older people take medications for kidney problems, they need to consult with their doctor before increase the amount of fluid they drink.

RURAL RESIDENTS

Extreme heat waves have severe consequences to rural residents' health and quality of life. The hospitalization rate is higher among rural and small urban areas than in larger urban communities for heat-related illnesses (Schmeltz et al., 2015). Moreover, hot temperatures can negatively affect crop production- adversely affecting several processes, including flowering and photosynthesis (Lobell et al. 2013). The dairy industry is specifically vulnerable to heat conditions in the rural areas, with milk production decreasing due to heat stress (West, 2003). Heat stress already costs the average American dairy an estimated $39,000 annually (Key, Sneeringer, and Marquardt, 2014).

CITY DWELLERS

People living in the city areas are among the most vulnerable groups to extreme heat impacts, especially the poor and the minorities (Leal Filho et al., 2018). Due to the "urban heat island effect," metropolitan areas are warmer than the surrounding rural areas. As previously described, heat islands are urbanized areas that experience higher temperatures than outlying areas. Structures such as buildings, roads, and other infrastructures, made from heat retaining materials such as asphalt, pavement, and cement, absorb and re-emit heat from the sun more than natural landscapes. Urban areas, where the structures are highly concentrated, and greenery is limited, become "islands" of higher temperatures relative to outlying areas. Daytime and nighttime temperatures in urban areas are about 1-7 degrees F higher and 2-5 degrees F higher, respectively, than temperatures in outlying regions (U.S. Environmental Protection Agency, 2020).

OUTDOOR WORKERS

Outdoor workers in the United States, such as construction workers, police officers, farmworkers, military personnel, roofers, postal workers, landscapers, and others, are at greater risk of heat stress when temperatures soar. Construction workers and farmworkers are at risk of more than 33 percent of occupational heat-related deaths occurring in the construction sector and about 20 percent occurring in the agriculture/forestry/fishing/hunting sector (Gubernot, Anderson, and Hunting, 2015). In the U.S., the highest occupational heat-related fatalities rates were found among men, among Latinos, and among employees at very small organizations that may lack resources to enact rigorous heat-safety measures or whose employees may carry out work alone (Gubernot, Anderson, and Hunting, 2015; Yorio and Wachter, 2013). Moreover, some business models can also make occupational heat-related injuries and illnesses more likely by creating incentives for workers to push themselves beyond safe limits. For instance, on U.S. farms, field workers are often paid by the amount they harvest, incentivizing them to skip breaks and work in ways that increase their risk of heat-related illness or death (Gubernot, Anderson, and Hunting, 2015).

LOW-INCOME COMMUNITIES

Not all U.S. residents are equally at risk of extreme heat. However, various factors increase residents' vulnerability to extreme heat (Hayden et al., 2017). In dozens of the U.S. major cities, low-income neighborhoods are more likely to be hotter than their wealthier counterparts, only by virtue of where they live (NPR, 2019). Poverty also determines, at least in part, how people perceive the risks to which they are exposed, how they respond to evacuation orders and other emergency warnings (SAMHSA, 2017). The poor are more likely to perceive the hazards as risky; less likely to prepare for hazards or buy insurance and lower healthcare access. They are also less likely to respond to the heat warnings; lack of access to or inability to afford air conditioning, and more likely to die, suffer injuries, and have proportionately higher maternal losses (Fothergill & Peek, 2004). Furthermore, low-income and poor people suffer more from psychological trauma and face more obstacles during the period of response, recovery, and reconstruction (Fothergill & Peek, 2004). These differences are significant and portray a systematic pattern of stratification within the United States (Hayden et al., 2017; Fothergill & Peek, 2004).

PEOPLE WITH CHRONIC DISEASES

Extreme heat can be more dangerous for those with chronic medical conditions such as heart disease, mental illness, poor blood circulation, respiratory diseases, and obesity. People with chronic disease may be less likely to sense and respond to changes in temperature (CDC, 2017). Moreover, the medications they take for different chronic conditions can make the effect of extreme heat worse. For instance, overweight or obese individuals tend to retain more body heat (CDC, 2017)

ADULTS LIVING ALONE

The impact of extreme heat events can affect anyone, but people who are socially isolated potentially encounter more serious harm. For example, the 1995 Chicago heat wave caused 739 heat-related deaths in Chicago over a period of five days. Most of the heat wave victims were elderly poor residents who lived in isolation and could not afford air conditioning and did not open windows or sleep outside due to fear of crime (Klinenberg, 2002). On the other hand, people living with others have been found to be more likely to take preventive measures, such as drinking more liquids during heat waves (McGeehin & Mirabelli, 2001). Social isolation is related to some of the other vulnerable groups, such as older people, people with disabilities and/or in poor health, people reliant on social services for home care, people living alone, ethnic minorities, people living alone, people who are substance abusers and people living in rural areas (WHO, 2013).

Conclusion

Extreme weather conditions caused by climate change, in particular, extreme heat, have adverse effects on public health. Heat cramps, heat exhaustion and heat stroke are all heat-induced illnesses, that are expected to increase as extreme heat days increase. Many other serious illnesses derive from excess heat exposure, and for vulnerable populations, they can also be life threatening. Climate change effects will be difficult to avoid but with rapid action, extreme heat is among the most avoidable (Dahl, 2019). As many have noted in climate change and extreme heat research, "Actions we take now to curb warming can help contain the future scale of the problem and bolster our ability to cope and adapt" (Dahl, 2019, p.31).

Vulnerabilities in the SCAG Region

Imperial County

ANTICIPATED NUMBER/DURATION OF EXTREME HEAT EVENTS

Imperial County is projected to have 194.2 days above 90°F by Mid-Century (2035–2064) where the median value for the state is 78.8 days (California Healthy Places Index). The projected temperature changes by 2099 are +3.4°F under a low-emission scenario and +6.4°F under a high-emission scenario for Imperial County (Cal-Adapt).

EXTREME HEAT VULNERABILITY

Due to extreme heat conditions, there is a high risk of wildfire in the county. In 2010, less than 1 percent (29 residents) of the county's total population (174,528) lived in fire hazard zones of moderate to very high severity (Maizlish et al., 2017). By using Coupled Global Climate Model, scientists projected wildfire risk under low and high carbon emissions scenarios for the county. In 2085, under a low carbon scenario, the burned area would be 0.98 acreage where in 2020 the burned area is 0.89 acreage. Under a high carbon emission scenario, the burned acreage would be 0.84 acreage (California Energy Commission, 2019).

Climate change and extreme heat conditions also affect the social and environmental drivers of health outcomes and have a huge toll on human health. According to 2010 data, there were 13,526 children under the age of 5 years and 18,152 adults aged 65 years and older were in the climate-vulnerable groups in the county. In 2010, regarding the need for emergency support, there were approximately 10,517 people living in nursing homes, dormitories, and other group quarters where institutional authorities would need to provide transportation in the event of emergencies (Maizlish et al., 2017). In 2005-2010, there was an annual average of 135 heat-related emergency room visits and an age-adjusted rate of 78 emergency room visits per 100,000 persons (the statewide age-adjusted rate was 10 emergency room visits per 100,000 persons) (Maizlish et al., 2017).

Social and demographic factors and inequities affect individual and community vulnerability to the health impacts of climate change and extreme heat conditions. In 2010, 21 percent of households (10,046) did not have a household member 14 years or older who spoke English proficiently (called linguistically isolated; the statewide average was 10 percent) to communicate during emergency situations (Maizlish et al., 2017).

Imperial County had approximately 6,366 outdoor workers whose occupation increased their risk of heat illness in 2010. According to 2010 data, roughly 10 percent of households did not own a vehicle that could be used for evacuation (statewide average was 8 percent) (Maizlish et al., 2017).

According to 2011 data, only 2 percent of the county's land area had tree canopy, which provides shade and other environmental benefits, where the statewide average was 8 percent. In 2009, approximately 32 percent of households were estimated to lack air conditioning which is one of the essential tools during heat waves (Maizlish et al., 2017).

LA County

ANTICIPATED NUMBER/DURATION OF EXTREME HEAT EVENTS

If nothing is done to control greenhouse gas emissions, according to a new study by UCLA scientists, parts of Los Angeles County are forecast to experience triple or quadruple the number of extreme heat days by 2050 (Sun, Walton, & Hal, 2015). From 2040 to 2060, Los Angeles County is expected to have 37 extreme heat days per year (SCAG). The County is projected to have 73.6 days above 90°F by Mid-Century (2035–2064) where the median value for the state is 78.8 days (California Healthy Places Index).

EXTREME HEAT VULNERABILITY

In Los Angeles County there has seen an increase in the number of heat-related emergency room visits in recent years, and heat-related mortality and morbidity are also projected to increase (National Academies of Sciences, Engineering, and Medicine, 2019; Ostro et al., 2011). Large portions of the population in the county do not have access to air conditioning which makes the extreme heat condition more dangerous and hazardous to people's health (Morello-Frosch et al., 2011). According to 2009 data, approximately 34 percent of the households lacked air conditioning (statewide average was 36 percent) (Maizlish et al., 2017).

Hot and dry weather also triggers wildfires. People who live in mountain and forest communities more often encounter displacement or loss of their homes. Moreover, surrounding residents are more vulnerable to asthma, bronchitis, and other respiratory ailments due to smoke and ash from such fires (LACDPH, 2014).

Due to extreme heat conditions, there is a high risk of wildfire in the county. In 2010, approximately 7.65% (751,193 residents) of the county's total population lived in fire hazard zones of moderate to very high severity (Maizlish et al., 2017). By using Coupled Global Climate Model, scientists projected wildfire risk under low and high carbon emissions scenarios for the county. In 2085, under a low carbon scenario, the burned area would be 1.01 acreage and under a high carbon emission scenario, the burned acreage would be 1.04 acreage (California Energy Commission, 2019).

Climate change and extreme heat condition also affects the social and environmental drivers of health outcomes and have a huge toll on human health. According to 2010 data, there were 645,793 children under the age of 5 years, and 1,065,699 adults aged 65 years and older were in the climate-vulnerable group in the county. In 2010, regarding the need for emergency support, there were approximately 171,659 people living in nursing homes, dormitories, and other group quarters where institutional authorities would need to provide transportation in the event of emergencies (Maizlish et al., 2017). In 2005-2010, there was an annual average of 630 heat-related emergency room visits and an age-adjusted rate of 6 emergency room visits per 100,000 persons (the statewide age-adjusted rate was 10 emergency room visits per 100,000 persons) (Maizlish et al., 2017).

Social and demographic factors and inequities affect individual and community vulnerability to the health impacts of climate change and extreme heat conditions. In 2010, 15% of households (498,319) did not have a household member 14 years or older who spoke English proficiently (the statewide average was 10%) to communicate during emergency situations (Maizlish et al., 2017).

Los Angeles County had approximately 252,385 outdoor workers whose occupation increased their risk of heat illness in 2010. According to 2010 data, roughly 10 percent of households did not own a vehicle that could be used for evacuation (statewide average was 8 percent) (Maizlish et al., 2017).
According to 2011 data, only 6 percent of the county's land area had tree canopy, which provides shade and other environmental benefits, where the statewide average was 8 percent (Maizlish et al., 2017).

Orange County

ANTICIPATED NUMBER/DURATION OF EXTREME HEAT EVENTS

Orange County is projected to have 46.6 days above 90°F by Mid-Century (2035–2064) where the median value for the state is 78.8 days (California Healthy Places Index). The projected temperature changes by 2099 are +3.6°F under a low-emission scenario and +6.1°F under a high-emission scenario for Orange County (Cal-Adapt).

EXTREME HEAT VULNERABILITY

Due to extreme heat conditions, there is a high risk of wildfire in the county. In 2010, less than 7 percent (198,006 residents) of the county's total population lived in fire hazard zones of moderate to very high severity (Maizlish et al., 2017). From 1980 to 1989 (a pre-climate change baseline), 12 wildfires consumed a total of 91,634 acres in Orange County (Maizlish et al., 2017). By using the Coupled Global Climate Model, scientists projected wildfire risk under low and high carbon emissions scenarios for the county. In 2085, under a low carbon scenario, the burned area would be 0.8 acreage (in 2020 the burned area was 1 acreage). Under a high carbon emission scenario, the burned acreage would be 0.87 acreage (California Energy Commission, 2019).

Climate change and extreme heat conditions also affect the social and environmental drivers of health outcomes and have a huge toll on human health. According to 2010 data, there were 191,691 children under the age of 5 years and 349,677 adults aged 65 years and older were in the climate-vulnerable groups in the county. In 2010, regarding the need for emergency support, there were approximately 39,222 people living in nursing homes, dormitories, and other group quarters where institutional authorities would need to provide transportation in the event of emergencies (Maizlish et al., 2017). In 2005-2010, there was an annual average of 151 heat-related emergency room visits and an age-adjusted rate of 5 emergency room visits per 100,000 persons (the statewide age-adjusted rate was 10 emergency room visits per 100,000 persons) (Maizlish et al., 2017).

Social and demographic factors and inequities affect individual and community vulnerability to the health impacts of climate change and extreme heat conditions. In 2010, 10 percent of households (100,112) did not have a household member 14 years or older who spoke English proficiently (called linguistically isolated; the statewide average was 10 percent) to communicate during emergency situations (Maizlish et al., 2017).

Orange County had approximately 69,688 outdoor workers whose occupation increased their risk of heat illness in 2010. According to 2010 data, roughly 5 percent of households did not own a vehicle that could be used for evacuation (statewide average was 8 percent) (Maizlish et al., 2017).
According to 2011 data, only 5 percent of the county's land area had tree canopy, which provides shade and other environmental benefits, where the statewide average was 8 percent. In 2009, approximately 28 percent of households were estimated to lack air conditioning which is one of the essential tools during heat waves (Maizlish et al., 2017).

Riverside County

ANTICIPATED NUMBER/DURATION OF EXTREME HEAT EVENTS

Riverside County is projected to have 154 days above 90°F by Mid-Century (2035–2064) where the median value for the state is 78.8 days (California Healthy Places Index). The projected temperature changes by 2099 are +3.7°F under a low-emission scenario and +6.5°F under a high-emission scenario for Riverside County (Cal-Adapt).

EXTREME HEAT VULNERABILITY

Due to extreme heat conditions, there is a high risk of wildfire in the county. In 2010, less than 10 percent (212,946 residents) of the county's total population (2,189,641) lived in fire hazard zones of moderate to very high severity (Maizlish et al., 2017). From 1980 to 1989 (a pre-climate change baseline), 115 wildfires consumed a total of 487,583 acres in Riverside County (Maizlish et al., 2017). By using the Coupled Global Climate Model, scientists projected wildfire risk under low and high carbon emissions scenarios for the county. In 2085, under a low carbon scenario, the burned area would be 0.2 acreage (in 2020 the burned area was 0.46 acreage). Under a high carbon emission scenario, the burned acreage would be 0.22 acreage (California Energy Commission, 2019).

Climate change and extreme heat conditions also affect the social and environmental drivers of health outcomes and have a huge toll on human health. According to 2010 data, there were 162,438 children under the age of 5 years and 258,586 adults aged 65 years and older were in the climate-vulnerable groups in the county. In 2010, regarding the need for emergency support, there were approximately 35,829 people living in nursing homes, dormitories, and other group quarters where institutional authorities would need to provide transportation in the event of emergencies (Maizlish et al., 2017). In 2005-2010, there was an annual average of 405 heat-related emergency room visits and an age-adjusted rate of 20 emergency room visits per 100,000 persons (the statewide age-adjusted rate was 10 emergency room visits per 100,000 persons) (Maizlish et al., 2017).

Social and demographic factors and inequities affect individual and community vulnerability to the health impacts of climate change and extreme heat conditions. In 2010, 8 percent of households (54,341) did not have a household member 14 years or older who spoke English proficiently (called linguistically isolated; the statewide average was 10 percent) to communicate during emergency situations (Maizlish et al., 2017).

Riverside County had approximately 74,261 outdoor workers whose occupation increased their risk of heat illness in 2010. According to 2010 data, roughly 5 percent of households did not own a vehicle that could be used for evacuation (statewide average was 8 percent) (Maizlish et al., 2017).

According to 2011 data, only 3 percent of the county's land area had tree canopy, which provides shade and other environmental benefits, where the statewide average was 8 percent. In 2009, approximately 5 percent of households were estimated to lack air conditioning which is one of the essential tools during heat waves (Maizlish et al., 2017).

San Bernardino County

ANTICIPATED NUMBER/DURATION OF EXTREME HEAT EVENTS

San Bernardino County is projected to have 131.1 days above 90°F by Mid-Century (2035–2064) where the median value for the state is 78.8 days (California Healthy Places Index). The projected temperature changes by 2099 are +3.8°F under a low-emission scenario and +6.7°F under a high-emission scenario for San Bernardino County (Cal-Adapt).

EXTREME HEAT VULNERABILITY

Due to extreme heat conditions, there is a high risk of wildfire in the county. In 2010, less than 9 percent (181,436 residents) of the county's total population (2,035,210) lived in fire hazard zones of moderate to very high severity (Maizlish et al., 2017). From 1980 to 1989 (a pre-climate change baseline), 62 wildfires consumed a total of 191,170 acres in San Bernardino County (Maizlish et al., 2017). By using Coupled Global Climate Model, scientists projected wildfire risk under low and high carbon emissions scenarios for the county. In 2085, under a low carbon scenario, the burned area would be 1 acreage (in 2020 the burned area was 1.02 acreage). Under a high carbon emission scenario, the burned acreage would be 0.98 acreage (in 2020 the burned area was 1.04 acreage) (California Energy Commission, 2019).
Climate change and extreme heat conditions also affect the social and environmental drivers of health outcomes and have a huge toll on human health. According to 2010 data, there were 158,790 children under the age of 5 years and 181,348 adults aged 65 years and older were in the climate-vulnerable groups in the county. In 2010, regarding the need for emergency support, there were approximately 35,336 people living in nursing homes, dormitories, and other group quarters where institutional authorities would need to provide transportation in the event of emergencies (Maizlish et al., 2017). In 2005-2010, there was an annual average of 334 heat-related emergency room visits and an age-adjusted rate of 17 emergency room visits per 100,000 persons (the statewide age-adjusted rate was 10 emergency room visits per 100,000 persons) (Maizlish et al., 2017).

Social and demographic factors and inequities affect individual and community vulnerability to the health impacts of climate change and extreme heat conditions. In 2010, 9 percent of households (52,012) did not have a household member 14 years or older who spoke English proficiently (called linguistically isolated; the statewide average was 10 percent) to communicate during emergency situations (Maizlish et al., 2017).

San Bernardino County had approximately 60,807 outdoor workers whose occupation increased their risk of heat illness in 2010. According to 2010 data, roughly 5 percent of households did not own a vehicle that could be used for evacuation (statewide average was 8 percent) (Maizlish et al., 2017).

According to 2011 data, only 4 percent of the county's land area had tree canopy, which provides shade and other environmental benefits, where the statewide average was 8 percent. In 2009, approximately 9 percent of households were estimated to lack air conditioning which is one of the essential tools during heat waves (Maizlish et al., 2017).

Ventura County

ANTICIPATED NUMBER/DURATION OF EXTREME HEAT EVENTS

Ventura County is projected to have 45.6 days above 90°F by Mid-Century (2035–2064) where the median value for the state is 78.8 days (California Healthy Places Index). The projected temperature changes by 2099 are +3.6°F under a low-emission scenario and +6.0°F under a high-emission scenario for Ventura County (Cal-Adapt).

EXTREME HEAT VULNERABILITY

Due to extreme heat conditions, there is a high risk of wildfire in the county. In 2010, less than 1 percent (143,826 residents) of the county's total population lived in fire hazard zones of moderate to very high severity (Maizlish et al., 2017). From 1980 to 1989 (a pre-climate change baseline), 25 wildfires consumed a total of 364,977 acres in Ventura County (Maizlish et al., 2017). By using Coupled Global Climate Model, scientists projected wildfire risk under low and high carbon emissions scenarios for the county. In 2085, under a low carbon scenario, the burned area would be 1.37 acreage (in 2020 the burned area was 1.17 acreage). Under a high carbon emission scenario, the burned acreage would be 1.49 acreage (in 2020 the burned area was 1.22 acreage) (California Energy Commission, 2019).

Climate change and extreme heat conditions also affect the social and environmental drivers of health outcomes and have a huge toll on human health. According to 2010 data, there were 55,336 children under the age of 5 years and 96,309 adults aged 65 years and older were in the climate-vulnerable groups in the county. In 2010, regarding the need for emergency support, there were approximately 9,251 people living in nursing homes, dormitories, and other group quarters where institutional authorities would need to provide transportation in the event of emergencies (Maizlish et al., 2017). In 2005-2010, there was an annual average of 53 heat-related emergency room visits and an age-adjusted rate of 6 emergency room visits per 100,000 persons (the statewide age-adjusted rate was 10 emergency room visits per 100,000 persons) (Maizlish et al., 2017).

Social and demographic factors and inequities affect individual and community vulnerability to the health impacts of climate change and extreme heat conditions. In 2010, 8 percent of households (19,833) did not have a household member 14 years or older who spoke English proficiently (called linguistically isolated; the statewide average was 10 percent) to communicate during emergency situations (Maizlish et al., 2017).

Ventura County had approximately 30,742 outdoor workers whose occupation increased their risk of heat illness in 2010. According to 2010 data, roughly 4 percent of households did not own a vehicle that could be used for evacuation (statewide average was 8 percent) (Maizlish et al., 2017).
According to 2011 data, only 5 percent of the county's land area had tree canopy, which provides shade and other environmental benefits, where the statewide average was 8 percent. In 2009, approximately 42 percent of households were estimated to lack air conditioning which is one of the essential tools during heat waves (Maizlish et al., 2017).

Extreme Heat Best Practices

Introduction

Cities across the U.S will experience temperatures beyond heat index thresholds within the next century. By midcentury, the number of days with a heat index above 100 will more than double across the nation. Towns and cities that regularly experience milder summer weather will soon experience a dramatic spike in extreme heat days (Neuhauser, 2019). According to the Proceedings of the National Academy of Science, metropolitan cities that will see the greatest absolute increase in people affected by extreme heat include New York, Los Angeles, and Washington, D.C. (Pullano, 2020). Researchers determined which major US cities anticipate the most dramatic heat exposure within the coming decades by considering local factors, such as population size, urban development, and average temperatures. Rapidly growing cities, such as Orlando, Miami, and Austin, will inevitably expose more residents to heat. People living in major U.S. cities will experience up to 30 times more extreme heat days compared to previous projections by the end of the century (Pullano, 2020). In the SCAG region, the inland areas of Los Angeles County will be most impacted by rising temperatures, with projections of 60-90 additional extreme heat days per year by the end of the century (SCAG, 2020). It is critical that cities prepare for projected extreme heat at the local level to avoid increasing numbers of death and illness caused by extreme heat.

Best Practices

There is a level of urgency to prepare for extreme heat to reduce the burden that it will have on communities. It is important for cities to start taking actions as soon as possible to ensure the wellbeing and health of residents. The following are best practices that jurisdictions across the country have taken or plan to implement; these range from policies to strategies with the common goal of mitigating extreme heat impacts.

Existing SCAG Region Policies, Plans & Strategies

Adaptation Strategies

COACHELLA

City of Coachella Urban Greening and Connectivity Project

The Grapefruit Boulevard Urban Greening and Connectivity Project is helping to revitalize the Pueblo Viejo Downtown District in the City of Coachella (CCI, 2020). The purpose of this project is to address key community-identified barriers, issues, and opportunities by providing greenspaces that help revitalize the community and provide environmental benefits while creating social connectivity (CCI, 2020)

Project Goals:

- Plant a total of 288 trees: 144 on each side of grapefruit boulevard
- Plant 1,100 native, drought tolerant and low water plantings
- Install security lighting
- Construct class 2 bicycle lanes
- Bioswales
- Wayfinding signage
- Install drinking fountains
- Provide shaded structures with benches and bicycle racks

INDIO

City of Indio General Plan Safety Element (2019)

Extreme heat events in and the City of Indio are becoming more frequent and dangerous due to a rapidly changing climate. From 1950 to 2005, Indio experienced about 4 extreme heat days per year, on average (Indio General Plan, 2019). The Coachella Valley area is expected to experience a significant increase in the number of extreme heat days over the next century. Indio is anticipated to have 25 extreme heat days by mid-century, and 51 extreme heat days by late century (Indio General Plan, 2019). Indio has implemented a set of goals and strategies that will maintain high quality emergency services and response. The purpose of the following goal is to establish a framework for Indio to begin addressing climate change impacts (Indio General Plan, 2019).

GOAL SE-5: Community Resilience. A community that is prepared for the potential impacts of climate change.
5.3- COOLING CENTERS: Establish cooling centers to reduce Indio's resident's vulnerability to extreme heat events and severe storms
5.5 NEIGHBORHOOD AND BUILDING COOLING: Encourage new development and redevelopment to take steps to reduce impacts of extreme heat events:

- Protect the cities healthy trees and plant new ones to provide shade
- Shade public parks and open spaces including bus shelters
- Support residential energy efficiency and weatherization programs

- Design buildings to use less cooling through passive heat and cool techniques

INGLEWOOD

Energy and Climate Action Plan (2013)

The City of Inglewood plans to incorporate rising extreme heat events and prolonged heat waves into the Inglewood Hazard Mitigation Plan. The plan will also consider disparities in climate vulnerabilities. Low income communities will be disproportionately affected by extreme heat, specifically outdoor workers. To protect those workers, the City of Inglewood will explore ways to coordinate with employers on ways to educate workers on how to stay safe during extreme heat events (Inglewood ECAP, 2013). Along with heat-related diseases, transportation and industrial exhaust produces ground-level ozone that accumulates at high concentrations on warm days. Respiratory illness such as asthma can be caused and worsened by unhealthy concentrations of pollutants. Inglewood plans on establishing a notification process in partnership with the Air Quality Management District and the Los Angeles County Public Health Department.

Inglewood is expected to have a larger number of extreme heat days, warm nights, and more prolonged periods of extreme heat events. Periods of increased high temperatures or extended high temperatures can lead to increased heat-related mortality, cardiovascular-caused mortality, respiratory mortality, heart attacks, and other causes of mortality (Inglewood ECAP, 2013). Inglewood plans to work with Los Angeles County to expand access to the drop-in cooling centers for vulnerable populations. This set of actions includes (Inglewood ECAP, 2013):

- Organizing a transportation-assistance program and disseminating information about the health effects of heat.
- Exploring starting a heat island program to reduce the heat threats of higher temperatures in urbanized areas of Inglewood.
- Including street and neighborhood-scale measures such as tree planting and park expansion as well as building-specific actions such as cool roofs and light-colored paving.

LAGUNA WOODS

Laguna Woods Climate Adaptation Plan (2014)

In Laguna Woods, a high temperature of at least 85 degrees Fahrenheit is considered extreme heat (Cal OES and CNRA 2012, as cited in Laguna Woods, 2014). On average, Laguna Woods currently experiences 3 heat waves per year (Cal OES and CNRA 2012; CEC 2013; Tamrazian et al. 2008, as cited in Laguna Woods, 2014). Forecasts by the California Adaptation Planning Guide show that by 2050, Laguna Woods will experience an average of 3 to 5 additional heat waves per year and an average of 12 to 14 additional heat waves per year by 2099 (Laguna Woods CAP, 2014).

GOAL 1: INCREASE RESILIENCE TO CLIMATE CHANGE-RELATED HAZARDS (LAGUNA WOODS CAP, 2014):

- **POLICY OBJECTIVE 1:** Maintain low levels of heat-related illness and death
    - Implementation Action 1.1.1: Amend the Emergency Operations Plan to include an Extreme Heat Annex. The Emergency Operations Plan is the framework for the City’s response to extraordinary emergency situations. Functional annexes (or, “chapters”) are included in the Emergency Operations Plan to describe response efforts with

respect to individual hazards (e.g., specific activities related to earthquakes, fires, floods). CHAPTER 4 CITY OF LAGUNA WOODS CLIMATE ADAPTATION PLAN 33 The Extreme Heat Annex will be coordinated with the Orange County Operational Area's (OA) Extreme Heat Annex, identify potential cooling centers in Laguna Woods, promote access to regional cooling centers, and consider the needs of individuals with disabilities and access and functional needs.

- **IMPLEMENTATION ACTION 1.1.2:** Adopt development standards to mitigate urban heat island effects (Laguna Woods CAP, 2014):
    - The urban heat island effect is a phenomenon in which temperatures in the local climate increase due to certain aspects of the built environment that retain or emit heat to a greater extent than would ordinarily exist in lesser developed areas (e.g., large areas of asphalt and impervious surfaces). The City will consider adopting development standards intended to reduce the solar reflectance and thermal properties of new and significant redevelopment projects. The City will specifically consider the adoption of standards requiring greater use of cool roofs, pervious surfaces, high albedo pavement, and shade over asphalt areas
        - **ISSUE:** Average temperatures may increase over time, and extreme heat is Laguna Woods' most likely and impactful near-term climate change exposure.
        - **BENEFIT:** Reduction of factors contributing to temperature increases in the local climate.
        - **COST:** One-time: Low (staff time to prepare development standards and seek City Council adoption). Ongoing: Low (staff time to ensure compliance with standards as a part of the development review process).
        - **COORDINATION:** Low (review of development standards and best practices from outside organizations).
        - **DELIVERABLE:** Development standards to mitigate urban heat island effects.
        - **SUCCESS:** Enforcement of development standards to mitigate urban heat island effects.

LOS ANGELES COUNTY

OurCounty

Urban residents of Los Angeles County face exacerbated health impacts caused by UHI, therefore we must start preparing for the inevitably rising temperatures in order to decrease mortality caused by extreme heat. The County of Los Angeles has developed a sustainability plan called OurCounty, which has a number of actions that specifically address extreme heat and extreme heat vulnerabilities. The plan is organized by 12 cross cutting goals, 37 strategies, and 159 actions for Los Angeles County to achieve sustainability. The following are the 7 Key Actions that address extreme heat (OurCounty):

HEAT RESILIENCE ACTIONS

ACTION 26

- Develop minimum requirements and best practices for amenities, programming, and accessibility of cooling centers.

ACTION 30

- Build shade structures at major transit stops, such as those identified in Metro's Active Transportation Strategic Plan, prioritizing communities with high heat vulnerability.

ACTION 44

- Implement locally tailored, youth based tree and vegetation planting and maintenance projects in collaboration with community based organizations to reduce the impacts of heat island in low canopy areas.

ACTION 52

- Promote walkability through various tools, including zoning that enables a mix of uses, and pedestrian enhancements

URBAN FOREST MANAGEMENT PLAN

ACTION 43

Create and Implement a community informed urban forest management plan that incorporates equitable urban forest practices, identifies county funding sources and prioritizes:

- Tree and park poor communities
- Climate and watershed-appropriate and drought/pest-resistant vegetation
- Appropriate watering, maintenance, and disposal practices;
    - shading
    - biodiversity

CLIMATE VULNERABILITY ASSESSMENT

ACTION 28A

Conduct a countywide climate vulnerability assessment that addresses social vulnerability and use it to guide priorities for investments in public health preparedness, emergency preparedness and response planning, and community resiliency.

ACTION 28B

Conduct a countywide climate vulnerability assessment that addresses physical infrastructure improvements, and zoning and code changes

Policies

IMPERIAL COUNTY

In Imperial County, during the next few decades, the projected average temperature rise is 3.4-degree Fahrenheit under low-emissions scenario and 6.4-degrees Fahrenheit under high-emissions scenario (PIER, 2012). Plans and policies in the County of Imperial to reduce the impact of extreme heat events in the region include:

- Improving ways to notify the public about the heat events. When temperatures rise, officials notify healthcare professionals, schools, senior centers, nursing homes, and businesses on ways to reduce heat-related illnesses (Imperial County Public Health Department, 2021).

- Establishing local hydration stations where drinking water will be available during extreme heat events (Imperial County Public Health Department, 2021).

LOS ANGELES COUNTY

The average annual temperatures in Los Angeles County rose 2.3 degrees Celsius - or 4.1 degrees Fahrenheit - between 1895 and 2018. Los Angeles County is 1 of 71 counties nationwide where temperatures jumped more than 2 degree Celsius during that time - a threshold that climate scientists have warned could be disastrous on a global scale (Mufson et al., 2019). By 2050, in the Downtown area, the number of days per year higher than 95 degrees could nearly triple according to research (Sun et al., 2015). Plans and policies County of Los Angeles to reduce the impact of extreme heat events in the region include:

- Requiring cool roofs for all new and refurbished homes. In 2013, the City of Los Angeles was the first major city to enact this requirement. Los Angeles Department of Water and Power (LADWP) provides cool roof rebates to help residents offset the cost (Resilient Los Angeles, 2018).
- Laying down cool pavement. Los Angeles was the first city to pilot cool pavements for on-road use (Resilient Los Angeles, 2018).
- Building up the city’s green infrastructure, such as trees for shading and cooling (Resilient Los Angeles, 2018).
- In partnership with experts, the City of Los Angeles supports the development of a neighborhood retrofit pilot program that will test cost-effective cooling strategies to increase vegetation cover and reflectivity. The retrofit program demonstrates cooling, public health improvements, and other benefits for residents. It also features education and engagement supporting community action and behavior changes (Resilient Los Angeles, 2018).
- The City of Los Angeles supports tree-planting programs and direct urban forestry resources to areas with low canopy cover to improve air quality and reduce the impact of increasing heat (Resilient Los Angeles, 2018).
- Developing a comprehensive cooling center program to establish additional location and programming goals that prioritize vulnerable populations, consider co-location with other services, ensure transit accessibility, incorporate sustainability goals, and encourage development of potential private-public partnerships (Resilient Los Angeles, 2018).

ORANGE COUNTY

Over the next few decades, the projected average temperature rise in Orange County is 3.6-degrees Fahrenheit under low-emissions scenario and 6.1-degrees Fahrenheit under high-emissions scenario (PIER, 2012). Plans and policies in Orange County to reduce the impact of extreme heat events in the region include:

- 2-1-1 Orange County, which is a free 24-hour emergency hotline linking to thousands of local health and human services resources, has been activated to provide heat-related information and referrals as part of the County of Orange Emergency Operations Plan (Orange County 2-1-1).
- Establishing cooling centers for their residents who may need to protect themselves from the heat wave.

RIVERSIDE COUNTY

Riverside is the 4th fastest-warming city in the U.S. (Climate Central). During the next few decades, the projected average temperature rise is 3.7-degree Fahrenheit under low-emissions scenario and 6.5-degrees Fahrenheit under high-emissions scenario in the Riverside County (CDPH, 2017). Plans and policies in the County of Riverside to reduce the impact of extreme heat events in the region include:

- Identifying and mapping cooling centers in locations accessible to vulnerable populations and establish standardized temperature triggers for when they will be opened. WRCOG intends to help jurisdictions in the subregion work toward ensuring that a sufficient number of new cooling centers are located in areas with higher concentrations of disadvantaged individuals using the Social Vulnerability Index and other tools (WRCOG).
- Identifying ways for individuals with restricted mobility to reach cooling centers. For example, senior citizen housing complexes with their own shuttle services can include cooling centers as a destination during extreme heat events. Similarly, in locations with a large concentration of individuals with limited mobility, it may be effective to establish a temporary shuttle service to and from the nearest cooling center for the duration of the extreme heat event (WRCOG).
- Augmenting employee and worker training in industries with outdoor work, including assurance of adequate water, shade, rest breaks, training on heat risks, and vector-borne disease avoidance (WRCOG).
- Working with local volunteer emergency response teams to include extreme heat as a hazard of concern and update core competencies to address the health-related risks of extreme heat events. To help ensure that volunteer emergency responders remain effective in WRCOG subregion communities, all volunteers should receive extreme heat training. This training should include the health threats posed by extreme heat, the individuals most at risk from extreme heat, and details on both preventative and curative care. Extreme heat training should also be included in required recurring training sessions (WRCOG).
- Using materials and features in transportation infrastructure that can improve resiliency to extreme events. Increasing transportation resiliency including the use of special sealants and other materials can help prevent roadways from softening during extreme heat or fire, treating rail lines to be heat-resistant, and incorporating expansion joints into rails that reduce the risk of damage during high temperatures (WRCOG).
- Coordinating with regional transit providers to identify alternative routes and stops if normal infrastructure is damaged or closed as a result of extreme events. The location of alternative routes should also be clearly communicated to riders through signage and flyers, television, radio, print media, and digital services. All communication should occur in relevant languages and be culturally appropriate (WRCOG).

SAN BERNARDINO COUNTY

San Bernardino County is projected to experience major increases in extreme heat days, particularly in the southeastern and central portions of the County. The projected temperature increases begin to diverge at mid-century so that, by the end of the century, the temperature increases projected in the higher emissions scenario are approximately twice as high as those projected in the lower emissions scenario. During the next few decades, the projected average temperature rise is 3.8-degree Fahrenheit under low-emissions scenario and 6.7-degree Fahrenheit under high-emissions scenario in the San Bernardino County (CDPH, 2017). Policies in the County of San Bernardino to reduce the impact of extreme heat events in the region include:

- San Bernardino County could help jurisdictions in the area work toward ensuring that enough new cooling centers and resilience hubs are located in areas with higher concentrations of disadvantaged individuals, including homeless and low-income community members. Establishing a set temperature for when cooling centers open based on community-defined extreme heat thresholds, and by setting other triggers for resilience hub operations, can help residents know with greater certainty if a center will be open, reducing confusion during times of emergency (SBCRS, 2019).
- Identifying ways for individuals with restricted mobility to reach cooling centers and resilience hubs. For example, senior citizen housing complexes with their own shuttle services can include these facilities as a destination during extreme heat events (SBCRS, 2019).
- Encouraging and coordinating emergency, resilience, and cooling centers to establish backup power and water resources in case of power outages and emergencies (SBCRS, 2019).
- Continuing to develop resources and materials that effectively communicate with non-English speakers in emergency and evacuation situations (SBCRS, 2019).
- Local communities should coordinate with agencies and organizations that provide homeless services to provide shelter during hazardous conditions, such as extreme heat events, poor air quality, and severe weather events. These emergency shelters should provide information about hazardous events and basic supplies such as insect repellant and hygiene supplies that can increase the adaptive capacity of individuals experiencing homelessness (SBCRS, 2019).
- Using resilient materials and design approaches for transportation infrastructure such as projections of extreme heat to ensure heat specifications related to pavement materials consider increasing temperatures (SBCRS, 2019).
- Updating maintenance regimes to better tackle climate hazards can involve shifting outdoor physical labor hours to earlier in the morning during extreme heat days (SBCRS, 2019).
- Providing adequate shade on sidewalks is important for residents who walk or use public transportation to get to their destinations. To increase the comfort of pedestrians on hot days, local jurisdictions can install high albedo pavement, which absorbs less heat than traditional asphalt and helps reduce the urban heat island effect. Heat-reflective pavement can be applied either by replacing existing surfaces or by coating surfaces with a highly reflective coating (SBCRS, 2019).
- Local jurisdictions can add more trees along walkways to provide shade, particularly in residential and disadvantaged communities (SBCRS, 2019).
- Encouraging jurisdictions to improve cooling energy and reduce the urban heat island effect using natural infrastructure. Natural infrastructure strategies can range from strategically planting trees and other plants to provide shade over buildings to installing green roofs or green walls (SBCRS, 2019).

VENTURA COUNTY

Heat waves will become more common and much more extreme in the years 2021-40 in Ventura County. The average temperature in the county will increase by at least 3-5 degrees Fahrenheit in the next 20 years in the inland and elevated areas of the County (WRCC). During the next few decades, the projected average temperature rise is 3.6-degrees Fahrenheit under low-emissions scenario and 6.0-degrees Fahrenheit under high-emissions scenario in the Ventura County (CDPH, 2017). Policies in the County of Ventura to reduce the impact of extreme heat events in the region include:
Establishing cooling centers during extreme heat waves in the county (Ready Ventura County).

Ordinances

Cities and counties throughout the country have already implemented ordinances to mitigate and adapt to extreme heat. The following are examples of ordinances in the SCAG region.

Los Angeles Cool Roofs Ordinance (2014)

As of October 2014, Los Angeles Green Building Code requires that roofing material used in residential buildings meet minimum values for 3-year aged solar reflectance and thermal emittance (LADWP, 2015). The purpose of the ordinance is to help the Los Angeles region to reduce urban heat island effects.

- An excerpt from Los Angeles' recent update to its green building code includes a reflectivity requirement for new and replaced residential roofs.
- The ordinance requires low-slope roofs to have a minimum three-year solar reflectance of 0.63 and a thermal emittance level of 0.75.
- Steep slope roofs must have a minimum three-year solar reflectance level of 0.20 and thermal emittance of 0.75.

HEAT ILLNESS PREVENTION IN OUTDOOR PLACES OF EMPLOYMENT

California Code of Regulations, Title 8, Section 3395 (2015)

To ensure the safety of outdoor workers during an extreme heat event, it is important that employees be monitored for early symptoms of heat illness. Outside workers are among the most vulnerable groups to extreme heat impacts. The State of California put this ordinance in place to decrease the number of deaths caused by extreme heat exposure in the workplace.

T8CCR 3395(E) STATES THE FOLLOWING:

- (e) High-heat procedures. The employer shall implement high-heat procedures when the temperature equals or exceeds 95 degrees Fahrenheit. These procedures shall include the following to the extent practicable:
    - Ensuring that effective communication by voice, observation, or electronic means is maintained so that employees at the work site can contact a supervisor when necessary. An electronic device, such as a cell phone or text messaging device, may be used for this purpose only if reception in the area is reliable.
    - Observing employees for alertness and signs or symptoms of heat illness. The employer shall ensure effective employee observation/monitoring by implementing one or more of the following:
        - Supervisor or designee observation of 20 or fewer employees, or
        - Mandatory buddy system, or
        - Regular communication with sole employee such as by radio or cellular phone, or
        - Other effective means of observation.
    - Designating one or more employees on each worksite as authorized to call for emergency medical services, and allowing other employees to call for emergency services when no designated employee is available.
    - Reminding employees throughout the work shift to drink plenty of water.

- Pre-shift meetings before the commencement of work to review the high heat procedures, encourage employees to drink plenty of water, and remind employees of their right to take a cool-down rest when necessary.
- For employees employed in agriculture, the following shall also apply:
  When temperatures reach 95 degrees or above, the employer shall ensure that the employee takes a minimum 10 minute net preventative cool-down rest period every 2 hours. The preventative cool-down rest period required by this paragraph may be provided concurrently with any other meal or rest period required by Industrial Welfare Commission Order No. 14 if the timing of the preventative cool-down rest period coincides with a required meal or rest period thus resulting in no additional preventative cool-down rest period required in an eight hour workday. If the workday will extend beyond eight hours, then an additional preventative cool-down rest period will be required at the conclusion of the eighth hour of work; and if the workday extends beyond ten hours, then another preventative cool-down rest period will be required at the conclusion of the tenth hour and so on. For purposes of this section, preventative cool-down rest period has the same meaning as "recovery period" in Labor Code Section 226.7(a).

T8CCR 3395 (G) STATES THE FOLLOWING:

- All employees shall be closely observed by a supervisor or designee during a heat wave. For purposes of this section only, "heat wave" means any day in which the predicted high temperature for the day will be at least 80 degrees Fahrenheit and at least ten degrees Fahrenheit higher than the average high daily temperature in the preceding 5 days.
- An employee who has been newly assigned to a high heat area shall be closely observed by a supervisor or designee for the first 14 days of the employee's employment.

T8CCR 3395 (I) STATES THE FOLLOWING:

- (i) Heat Illness Prevention Plan. The employers shall establish, implement, and maintain, an effective heat illness prevention plan. The plan shall be in writing in both English and the language understood by the majority of the employees and shall be made available at the worksite to employees and to representatives of the Division upon request. The Heat Illness Prevention Plan may be included as part of the employer's Illness and Injury Prevention Program required by section 3203, and shall, at a minimum, contain:
  - Procedures for the provision of water and access to shade.
  - The high heat procedures referred to in subsection (e).
  - Emergency Response Procedures in accordance with subsection (f).
  - Acclimatization methods and procedures in accordance with subsection (g).
  -

Ventura County Tree Protection Ordinance (1992)

In 1992, Ventura County adopted the Ventura County Tree Protection Ordinance. The ordinance applies to the pruning (beyond specified limits), removal, trenching, excavation, or other encroachment into the protected (5 feet outside the canopy's edge and a minimum of 15 feet from the trunk) of protected trees in unincorporated areas (land outside of cities) (VCRMA).

Interventions & Strategies

In addition to preparing for extreme heat events, it is important for jurisdictions to consider actions they can take to help communities mitigate or adapt to extreme heat. A variety of interventions and strategies are being implemented across the country, some established best practices and others piloted projects.

Green Roofs

A green roof system is an extension of an existing roof that involves water proofing, drainage system, root repellent system, filter cloth, and plants. Green roofs absorb stormwater, provide space to grow food and habitat for pollinators, and most importantly for extreme heat, reduce ambient heat through evapotranspiration (Rippe, 2017). Green roofs can also reduce the distribution of dust and particulate matter, and the production of smog. These reductions can help reduce greenhouse gas emissions and adapting urban areas to a future climate with warmer summers (Greenroofs).

ELEMENTS OF GREEN ROOFS (RIPPE, 2017)

- **ROOT RESISTANT LAYER:** a barrier that deters roots from penetrating or damaging the structure.
- **DRAINAGE LAYER:** A layer used to channel excess water to drains.
- **FILTRATION LAYER:** A layer of material that prevents fine particles from draining out of the system, limiting impacts to stormwater quality.
- **VEGETATIVE LAYER:** A layer of plants that can sustain themselves in a relatively shallow growing medium.
- **GROWING MEDIUM:** A mineral-based medium up to six inches deep, which supports plant growth.

IMPLEMENTATION EXAMPLE

San Francisco Better Roof

As of January 2017, San Francisco requires that new buildings incorporate green roofs, solar, or both to 15 to 30 percent of roof space (Snow, 2016). The ordinance builds on another bill that was passed in April 2016 by the city's Board of Supervisors that requires new commercial and residential buildings that are 10 stories or less to install solar panels that covers 15 percent of the roof (Snow, 2016).

Cool Roofs

Urban areas are covered by roofs and pavement that are traditionally made of dark surfaces that have low surface reflectance of incoming radiation, therefore absorbing more heat. This is known also known as "low albedo effect." A cool roof is a roofing system that reflects more sunlight and absorbs less heat than traditional roofs. Cool roofs can decrease roof temperatures during hot days resulting in cooler temperatures inside homes, while also saving energy by reducing demand for air conditioning systems (LADWP, 2015). Each state has its own set of requirements for cool roofs. Requirements for the State of California can be found here.

IMPLEMENTATION EXAMPLE

New York City Cool Roofs

New York City has developed an initiative called "NYC Cool Roofs" in collaboration with the NYC Service and NYC Department of Buildings to help reduce the urban heat island effect and provide no cost cool roof installations to non-profits and low income housing buildings (NYC Cool Roofs, 2014).

Cool Pavements

Conventional pavements in the United States are made of impervious concrete and asphalt that have little solar reflectance, causing surface temperatures as high as 120-150 degrees Fahrenheit during summertime (CCES, 2017). Many cool pavement materials that are permeable with higher solar reflectance have already been developed. According to researchers at Lawrence Berkeley National Laboratory, every 10 percent increase in solar reflectance could decrease surface temperatures by 7 degrees Fahrenheit, and air temperature can be decreased by 1 degree if the entire city were to increase its pavement solar reflectance by 10-35 percent (CCES, 2017).

MEASURABLE BENEFITS (RIPPE, 2017)

- Comfort and health: cool pavements can reduce temperatures and associated health issues for communities and provide a more comfortable environment.
- Increased energy savings: reflective pavement can save energy by reducing energy needs for lighting and by offering increased durability.
- Durability: reduced pavement temperature can slow the aging effects sunlight and heat can have on asphalt materials.
- Water quality: cool pavements can lower runoff temperatures, reducing thermal shock to life in aquatic ecosystems.
- Safety: cool pavement can enhance nighttime visibility, which can increase the effectiveness of streetlamps and headlights, pedestrian and vehicle visibility, and reduce energy costs associated with lighting.

IMPLEMENTATION EXAMPLE

Los Angeles Cool Seal

Los Angeles conducted test applications of a light gray coating called "CoolSeal" that resulted in a 10-degree reduction in pavement temperature (C2ES, 2017). The City is continuing the application of the material to a larger neighborhood area. The Mayor of Los Angeles expects that by using cool pavements and other measures, the City could reduce its urban heat island effect by 3 degrees within the next 20 years. (McPhate 2017 as cited by C2ES, 2017).

Urban Tree Canopy

Trees and other vegetation can reduce heat by providing shade for buildings, pavement, and other surfaces to prevent solar radiation from reaching heat absorbing surfaces (C2ES, 2017). Urban tree canopy (UTC) provides communities with many benefits. The UTC reduces the Urban Heat Island effect by lowering air temperatures, reducing cooling costs, and reducing air pollution (Rippe, 2017).

IMPLEMENTATION EXAMPLE

LA's Green New Deal proposes to expand tree canopy in areas of greatest need to not only beautify neighborhoods but also improve air quality and decrease temperatures. The plan includes a goal of planting 90,000 trees by the end of 2021. As of July 2020, 31,000 trees had been planted on public land and by property owners (Margolis, 2020). LA's Green New Deal also has the following targets (pLAn 2019):

- Increase tree canopy in areas of greatest need by at least 50% by 2028
- Reduce urban/rural temperature differential by at least 1.7 degrees by 2025; and 3 degrees by 2035

Heat Response Plans Outside of the SCAG Region

A key action that jurisdictions can take in the near term is developing a plan to prepare for and respond to extreme heat events.

State of Minnesota

Minnesota Extreme Heat Toolkit (2012)
The State of Minnesota developed a heat response toolkit to provide local governments and public health officials with information about how to prepare for extreme heat events. The toolkit focuses on Minnesota examples and processes and describes practical, implementable steps and strategies to prevent morbidity and mortality from extreme heat at the local level. It also includes a generic heat response plan that can be tailored to meet the needs of a particular jurisdiction. Chapter 3 of the toolkit describes how to develop a heat response plan and offers a range of strategies that can be included in a heat response plan to prevent mortality from extreme heat events (Minnesota Extreme Heat Toolkit, 2012). The following are key steps for responding to an extreme heat event (Minnesota Extreme Heat Toolkit, 2012):

1. **CREATE A HEAT RESPONSE PLAN**
    a. The development of a heat response plan is the first step in preparing to respond to an extreme heat event. A heat response plan is essential for describing and coordinating activities and should be done before an extreme heat event to prevent heat-related morbidity and mortality.
2. **PREDICT EXTREME HEAT EVENTS**
    a. The lead agency of the response plan should develop a partnership with the NWS to ensure accurate and timely weather forecasts that are capable of predicting extreme heat conditions a few days before an extreme heat event in order to notify the public of an upcoming extreme heat event. In Minnesota, the NWS provides weather forecasts and determines the issuance of heat advisories, watches or warnings.
3. **ASSESS RISK AND DETERMINE ACTIVATION OF RESPONSE PLAN**
    a. Once the lead agency is informed of a possible extreme heat event, the agency, in collaboration with its partners, needs to determine if the characteristics are indicative of an extreme heat event that could trigger activation of the heat response plan.
4. **ACTIVATE RESPONSE PLAN AND NOTIFY THE PUBLIC**
    a. The lead agency activates the response plan. Immediately after a decision has been made to activate the extreme heat response plan, the public needs to be informed of the timing, severity and duration of the forecasted extreme heat event. Effective public notification of an upcoming extreme heat event helps eliminate the risk of the heat event taking a population by surprise. Notifying the public of anticipated conditions, strategies to stay cool and hydrated, and places to go to cool off will enable residents to prepare themselves and will enable the organizations involved in the response to concentrate on known high-risk individuals and locations
5. **IMPLEMENT RESPONSE PLAN**
    a. The strategies in the heat response plans must be implemented. The strategies should reflect the demographics and vulnerabilities of the community. The response plan should clearly delineate which participating agencies and organizations are responsible for implementing each strategy.

6. **EVALUATE RESPONSE PLAN**
    a. Each step of responding to an extreme heat event should be reviewed and evaluated after an extreme heat event. Evaluation is critical for improving the plan and making it more effective for preventing heat-related illnesses and deaths in the future.

The toolkit states that heat response plans should include the following elements:

1. Lead agency
2. Criteria for activating and deactivating the plan
3. Roles and activities of agencies and organizations
4. Communications plan
5. Identification of vulnerable persons
6. Evaluation

Heat Vulnerability Tool

The State of Minnesota developed a Heat Vulnerability Tool for the purpose of helping city/county planners, emergency managers, and public health professionals assess community vulnerability to extreme heat. The tool helps visualize datasets that contribute to a community's vulnerability, including sensitivity and exposure. Variables can be mapped individually or layered to develop a composite score.

State of Wisconsin

Wisconsin Extreme Heat Toolkit (2019)

The state of Wisconsin created an extreme heat toolkit to provide local governments, health departments, and citizens with information about preparing for and responding to extreme heat events. The toolkit provides background information, definitions, a heat illness chart, strategies to reduce illness and mortality, a list of vulnerable populations, talking points and, useful reference materials on this topic. It also provides checklists for extreme heat (Wisconsin Toolkit, 2019):

LONG TERM PREPARATION CHECKLIST

- Identify extreme heat event partners and define their roles and responsibilities.
- Involve community organizations and other stakeholders in the response planning process (include medical examiner/coroner in this process).
- Develop a response plan, including but not limited to the following:
    - Develop a cooling center plan that identifies and maps air-conditioned locations for cooling centers. Ensure that cooling centers are evenly distributed throughout jurisdiction.
    - Consider transportation options to cooling centers
    - Consider the accessibility of cooling centers
    - Develop strategies that can be used if there is a power outage.
    - Understand local and state roles in the reporting process for heat-related fatalities.
    - Develop a database/list of facilities and organizations that serve at-risk populations to extreme heat (e.g., social service agencies, senior living centers, daycare centers, long-term care facilities, organized sports, construction companies, etc.) so that they can be immediately contacted of an impending extreme heat event.
- Monitor weather reports for summer months.
- Develop maps of vulnerable populations, if feasible.
- Ensure that heat fact sheets are current.

ANTICIPATION OF IMMINENT HEAT EVENT CHECKLIST

- Notify local extreme heat partners
- Alert contacts in database/list of facilities and organizations that serve vulnerable populations
- Ensure that message map is current
- Work with media to alert public of the extreme heat event and advise people on recognizing and preventing heat-related illnesses
- Activate transportation assistance program
- Provide maps of locations of cooling centers and cool places (after permission from owner is received)
- Consider extension of hours at public pools and other public air-conditioned places
- Consider suspending outdoor public events
- Coordinate with relevant organizations to provide water to homeless people

EXTREME HEAT EVENT CHECKLIST

- Notify local extreme heat event partners
- Coordinate with medical examiner/coroner if heat fatality occurs
- Continue to monitor weather and make appropriate media release with safety tips
- Activate cooling center plans
- Continue promotion of cooling centers hours and locations
- Ensure outreach to vulnerable populations
- Consider canceling, rescheduling or heightening mitigation protections for outdoor public events

Adaptation & Mitigation Strategies Outside of the SCAG Region

City of Chicago, IL

Chicago Climate Action Plan (2008)

Chicago conducted a case study that identified and actively engaged vulnerable populations in adaptation planning for heat events. The city has also implemented green infrastructure to reduce the future impact of extreme heat and formed a green steering committee to address extreme heat.

STRATEGY 5: ADAPTATION (CHICAGO CAP, 2008)

- Update emergency response plan that will identify populations most affected by extreme heat
- Launch program that will attract innovative ideas to cool the city
- Conduct more research on urban heat island effect and find ways to cool hot spots

City of New York, NY

New York City Policy Agenda (2020)

New York City (NYC) conducted a climate change and extreme heat events vulnerability assessment to create a heat plan. This was done in partnership with We Act for Environmental Justice (We Act, 2020). We Act was created in 1988 by three community leaders that wanted to see community driven, political change. We Act's mission is to ensure that low income community members participate in the development of just environmental health policies and practices (We Act, 2020).

NYC is susceptible to extreme heat impacts because of its urban design characteristics and high population density that amplify the urban heat island effect. On average, NYC experiences over 100 heat related deaths and approximately 450 hospitalizations annually, caused by extreme heat events. Heat mortality rates are expected to rise significantly in NYC, resulting in a many as 3,300 annual deaths by 2080. Certain populations and neighborhoods in NYC are disproportionately affected by extreme heat events due to underlying inequalities that stem from structural and historical racism. In order to close the equity gap, NYC created the following objectives and recommendations (We Act, 2020):

OBJECTIVE 1: Expand LIHEAP to increase access to air conditioners and reduce the economic burden of electricity use for vulnerable populations.

- Allocate more funding to Low Income Home Energy Assistance Program (LIHEAP)
- Expand LIHEAP program to finance energy efficiency retrofits.
- Revise the definition of eligible recipients for LIHEAP to promote equity and extend support to vulnerable populations that do not meet the current prerequisites.

OBJECTIVE 2: Advocate for legislative action to address and mitigate extreme heat impacts

- Support Introduction 1563-2019 to codify cooling centers in NYC.

- Support New York City Council Introduction 1945-2020 to require that NYC DOHMH publish heat vulnerability data annually.
- Support New York City Council Introduction 1960-2020 requiring the City to submit their summer heat plan by March 1st each year.
- Introduce bills that survey the level of green roof and solar roof penetration in environmental justice and heat vulnerable communities.

OBJECTIVE 3: Coordinate emergency planning strategies during extreme heat events to prevent power outages and promote safety

- Allocate more funding to LIHEAP.
- Expand LIHEAP program to finance energy efficiency retrofits.
- Revise the definition of eligible recipients for LIHEAP to promote equity and extend support to vulnerable populations that do not meet the current prerequisites.

OBJECTIVE 4: Encourage the use of and improve the amenities offered by cooling centers

- Install and upgrade cooling systems throughout the City.
- Improve cooling center services to create a safer and more enjoyable environment.
- Develop and strengthen neighborhood-specific communication plans that promote the use of cooling centers.

OBJECTIVE 5: Design and implement new city and state protocols to protect vulnerable populations from heat related impacts

- Require that NYCHA develop an emergency plan for extreme heat.
- Require that NYCHA implement the findings from its study Sheltering Seniors from Extreme Heat to reduce heat retention in its buildings.
- Require that home health aides participate in trainings to learn how to identify health related heat impacts.
- Increase the collection of heat-related health data, analyze cumulative impacts, and share the findings with the EJ Advisory Board.

OBJECTIVE 6: Implement and expand channels of communication with vulnerable populations to increase awareness of extreme heat impacts

- Expand and permanently fund the Be a Buddy Program.
- Strengthen partnerships with faith communities.
- Develop a relationship between NYCEM and local television and radio stations.
- Require the announcement of extreme heat emergencies through the emergency broadcast system.

OBJECTIVE 7: Implement green design techniques and increase renewable energy production to promote natural cooling and reduce NYC's carbon footprint

- Plant vegetation and expand green spaces in neighborhoods with high heat vulnerability to reduce the urban heat island effect.
- Install shade covering over all pedestrian streets this summer.
- Advocate for equitable distribution of green roofs.
- Increase research and investment in renewable energy sources.

Conclusion

As extreme heat days are expected to increase in longevity and severity, cities must start or continue strategizing adaptation measures to combat heat-related illness and mortality. Based on research conducted and available information, the most common interventions are cooling centers. City websites often have a tool that will help residents locate the nearest cooling center. Recommendations for individuals to reduce the chance of developing heat-related symptoms and tips on how to identify those symptoms are often also found on city websites. The SCAG region has already developed some policies and ordinances to mitigate extreme heat impacts but has yet to create a heat response plan that prioritizes vulnerable populations.

Recommendations

Many existing state, city, and county plans and programs have already been developed to address extreme heat, but many still need to incorporate current climate change information. In 2013, the California Department of Public Health created a document with guidelines and recommendations on how to combat extreme heat titled Preparing California for Extreme Heat. The purpose of the document is to provide guidance for incorporating extreme heat projections that are based on current climate models, into planning and decision making in California (CDPH, 2013).

RECOMMENDATIONS FROM THE CDPH DOCUMENT THAT ARE STILL NECESSARY AND APPLICABLE TODAY INCLUDE (CDPH, 2013):

- Review and address changes as appropriate, to state and local regulations, codes and industry practices for buildings, land use, and design elements to identify opportunities to accelerate the adoption of cooling strategies for both indoor and outdoor environments
- Develop and urban heat island index
- Examine and expand the use of cool, porous, or sustainable materials in pavements
- Promote and expand urban greening and the use of green infrastructure as part of cooling strategies in public and private spaces
- Assess state, regional and local hazard mitigation plans, heat contingency plans and other hazard planning documents for potential incorporation and/or refinement of health impacts related to heat event (climate change) projections.
- Improve Heat-Health Alert Warnings
- Improve community resilience from the impacts of increasing heat events, especially for vulnerable populations
- Review and improve access to and use of air conditioning and other indoor cooling strategies
- Increase the health care system's extreme heat preparedness and resiliency
- Improve the timeliness and completeness of heat illness and death surveillance activities in order to understand the impact of heat events and guide real time public health planning and responses

Sample Methodologies for Prioritizing Efforts

The purpose of this literature review is to explore some of the different variables that influence how agencies and organizations are prioritizing and targeting resources to adapt to and mitigate impacts from climate change. How are jurisdictions distributing their funding and other resources? Are frontline communities receiving equitable responses to climate change? The goal of this work is to analyze which people and areas will be most impacted by climate change and determine how vulnerable populations can be prioritized for resources and support.

Greenlining Institute Guidance

California is already experiencing intense climate change impacts such as sea level rise, drought, wildfires, and extreme heat. These circumstances present an urgency to adapt to a changing environment, especially for the most vulnerable populations. In California, the people who are impacted first and worst by climate change include low-income communities, communities of color, indigenous peoples and tribal nations, and immigrant communities (Greenling (GI), 2019). This is a direct result of decades of underinvestment and institutionalized racism that has disproportionately left certain communities with high costs for energy, transportation, limited access to public services, high levels of poverty and pollution, and outdated critical infrastructure (GI, 2019). To protect all residents, plans and policies that prioritize equity must be put into action.

The Greenlining Institute created a guidebook titled Making Equity Real in Climate Adaptation and Community Resilience Policies and Programs which offers planners and policymakers a blueprint on how to operationalize equity in grant programs and policies (GI, 2019).

FOUR STEPS TO MAKING EQUITY REAL (GI, 2019)

1. Embed Equity in the Mission, Vision, & Values: Policies and grant programs should explicitly state a commitment to equity and specifically identify the vulnerable populations they seek to benefit. The effort must aim to create comprehensive climate strategies for communities that not only build the resilience of physical environments but address other health and economic injustices that climate impacts exacerbate.

2. Build Equity into the Process: Processes should deeply engage community members so as to learn about their priorities, needs and challenges to adapting to climate impacts. The information gathered should inform the development and implementation of the policy or grant program.

3. Ensure Equity Outcomes: The implementation of the policy or grant program must lead to equity outcomes that respond to community needs, reduce climate vulnerabilities, and increase community resilience. Outcomes can include improved public health and safety, workforce and economic development, and more.

4. Measure & Analyze for Equity: Policies and grant programs should regularly evaluate their equity successes and challenges to improve the effort going forward.

California Governor's Office of Planning & Research Guidebook

Community resilience is an important factor in combating the effects of climate change. Resilience involves building community capacity to prepare for, withstand, recover, and maintain its identity in the face of hazards (EPA, 2019). Resilience should also build a connection between the interdependencies among different geographies, including the individual communities, their regions, and the state (EPA, 2019). Communities should all have the capacity to change and adapt to challenges posed by a changing climate. Multi-hazard resilience addresses risks from extreme heat, wildfires, drought, sea-level rise, earthquakes, and more and should include actions that address immediate needs and decisions that will have long term effects (EPA, 2019).

Climate resilience and adaptation are often grouped together, but it is helpful to distinguish between them. Usually, adaptation is an action or set of actions, and resilience describes a desired outcome (OPR, 2018). The Governor's Office of Planning and Research guidebook a guidebook for state agencies titled Planning and Investing for a Resilient California. The guidebook is the product of the Technical Advisory Group (TAG) formed under Executive Order B-30-15 which identified three necessary actions to advance resilience and adaptation to climate change (OPR, 2019):

1. Preparation of Implementation Action Plans to identify the steps that will be taken to realize the goals in Safeguarding California
2. Direction to all State agencies to consider climate change in all planning and investment, including infrastructure investment
3. Direction to the Governor's Office of Planning and Research (OPR) to establish a Technical Advisory Group (TAG) to provide state agencies with guidance on how to integrate climate change into planning and investment.

PLANNING RESILIENCE HAS TWO COMPONENTS (OPR, 2019):

1. Planning for a different and changing future
    a. All planning and investment needs to reflect changing climate conditions, changing average conditions and increases in the frequency and severity of extreme events.
2. Making planning, operationalization, and implementation decisions differently
    a. Changing conditions require flexible and adaptive approaches to planning and investment

OPR also developed a four-step process to guide agencies on how to determine how to integrate climate considerations into planning and investment decisions (OPR, 2019).

1. Identify how climate change could affect a project or plan
    a. Identify impacts of concern
    b. Assess the scale, scope, and context of climate disruption
2. Conduct an analysis of climate risks
    a. Select climate change scenarios for analysis
    b. Select an analytical approach
3. Make a climate-informed decision
    a. Evaluate alternatives or design
    b. Apply resilient decision principles

4. Track and monitor progress
    a. Evaluate metrics to track progress
    b. Adjust as needed

United States Environmental Protection Agency Toolkit

The EPA created a Regional Resilience Toolkit to provide guidance to take action that can both protect communities from natural disasters while creating safe to live, work, and play. The toolkit includes five steps that are expected to improve planning over time (EPA,2019):

STEP 1. ENGAGE: ENGAGEMENT FOR RESILIENCE

- An understanding of why trust is so important, and how to build it
- Tools for effective storytelling
- A Stakeholder Map that includes your project team, advisory group, leadership and decision makers, interest groups, and the broader community
- An Engagement and Outreach Plan that identifies goals, target audiences, key messages, tools for outreach, strategies for outreach, and an implementation plan

STEP 2. ASSESS: CONDUCT VULNERABILITY ASSESSMENT

- Goals to guide the planning process, risk and vulnerability assessment, and development of mitigation and adaptation actions
- Prioritized hazards, hazard scenarios, and maps ü Assessment methodology and approach
- An inventory of assets to be used in the assessment ü Exposure analysis – maps and data describing which assets are exposed to which hazards
- Assessment information about risk, vulnerability, and potential consequences
- Vulnerability problem statements

STEP 3. ACT: IDENTIFY AND PRIORITIZE STRATEGIES

- Problem statements that summarize assessment findings
- Draft list of strategies to address hazard problem statements
- Basic information on each strategy to assist in evaluating and prioritizing strategies ü Prioritized list of feasible, impactful strategies with stakeholder buy in
- Completed Strategy Development and Implementation worksheets for each prioritized strategy
- A long-term implementation plan over 5-20 years
- A short-term action plan outlining actions that can start in the near-term
- Fulfillment of Element B3, C4, C5, and C6 in FEMA's Local Mitigation Plan Review Tool Checklist

STEP 4. FUND: FUND FOR ACTION

- How to engage funders and decision makers
- How to make the business case for your projects
- Connect engagement activities to resilience-building actions
- An initial finance strategy that starts with local funding options
- Understanding local tools for self-financing
- A comprehensive resilience finance menu that includes self -funding, public-private partnerships, philanthropic opportunities, regional funds, and grants
- Understanding federal, state, and philanthropic grants that may match your funding needs

STEP 5. MEASURE: EVALUATE RESULTS AND REFINE METHODS

- An understanding of how and when to use metrics
- A plan for choosing and implementing metrics
- A timeline for tracking, evaluating, and reporting metrics
- Rationale for and benefits of community resilience self-evaluation
- Designing metrics to support a living document

United Nations Guidance

People who are socially, economically, culturally, politically, institutionally, or otherwise marginalized are especially vulnerable to climate change (IPCC 2014, as cited in UN ,2019). Identification of communities and places vulnerable to climate change can help health departments and others assess and prevent associated adverse impacts.

The United Nations developed a document titled Considerations Regarding Vulnerable Groups, Communities, and Ecosystems in the Context of the National Adaptation Plans which aims to provide technical guidance on how to consider vulnerable communities in the planning process.
The following approaches or methods can be applied to identify vulnerable groups and communities (UN, 2018):

- Targeting based on climate change impacts. This considers groups and communities that have adversely been affected by climate hazards, and have limited ability to recover by themselves. This would include vulnerable groups and communities that have severely been affected by droughts, floods, coastal inundation, and extreme temperatures.
- Categorical targeting such as by gender, age, income, education, ability, ethnicity and social caste. For example, the State of California developed a resource guide for public agencies and the public to define vulnerable communities in an adaptation context. The guide includes a set of indicators for analyzing and defining vulnerable communities, including: demographics, housing security, mobility, health services, environmental hazards, business/jobs, available public and private utilities, social services, governance, community, fiscal health and culture.
- Geographical targeting. Under this method, the government or responsible authority identifies priority regions or boundaries whose groups and communities should be prioritized, based on specific criteria. Such criteria may include arid or semi-arid lands, mountain regions, or remote areas.
- Using locally derived assessment tools such as community-based targeting or community participatory methods. Community-based targeting is administered by local governing authorities, recognized community groups, non-governmental organizations or religious to decide on which groups and communities are most vulnerable to climate risks and hence deserve special consideration. Community-based targeting may also apply participatory approaches, which representative members of the authority or society are involved in deciding on the vulnerable groups and communities.

The following are recommendations for strengthening considerations regarding vulnerable groups and communities (UN, 2018):

- Policies and institutional arrangements to guide, coordinate and manage support for vulnerable groups and communities.

- Include vulnerable groups and communities or related systems in the assessment.
- Creating or dedicating funding towards the most vulnerable.
- Engaging vulnerable groups and communities and integrating their knowledge and experience in adaptation planning and implementation.
- Building the resilience of vulnerable groups and communities through social protection systems.

New York City Efforts

A jurisdiction-level example of prioritizing more vulnerable people can be found with New York City. NYC developed a citywide effort to combat extreme heat referred to as Cool Neighborhoods NYC. In June 2017, the Mayor of NYC signed an Executive Order committing NYC to the Paris Agreement and also developed a document called OneNYC which serves as a comprehensive roadmap to a resilient, sustainable, and equitable NYC (NYC, 2017). Research on New York's neighborhoods shows heat-related health impacts are prevalent in certain communities, especially those with higher rates of poverty and inadequate shade protection from trees and foliage (NYC, 2017). To close that gap NYC developed the following strategies (NYC, 2017):

HEAT MITIGATION STRATEGIES

- Conducting Targeted Street Tree Plantings for Cool Neighborhoods
    - To harness the cooling and ancillary benefits of urban vegetation, the City has committed an additional $82 million dollars to fund street tree plantings that will prioritize areas that are disproportionately vulnerable to heat risks.
- Strategically Implementing NYC °CoolRoofs
    - To harness the cooling and extensive benefits of urban vegetation, the City has committed an additional $82 million dollars to fund street tree plantings that will prioritize areas that are disproportionately vulnerable to heat risks.
- Understanding the Role that Cool Pavements Play in Addressing the Urban Heat Island Effect
    - Through the DOT Vision Zero Great Streets projects, the City is also adding close to 360,000 square feet of new planted space across Brooklyn, Queens and the Bronx.
- Implementing Green Infrastructure and Understanding its Co-Benefits
    - NYC Department of Environmental Protection continues to progress in development of its Green Infrastructure Program as part of a $1.5 billion by 2030 commitment.

HEAT ADAPTATION STRATEGIES

- Launching Climate Risk Training for Home Health Aides
    - In 2017, the City partnered with homecare agencies to promote heat-health messages to New Yorkers and engage Home Health Aides as key players in building climate resiliency.
- Encouraging New Yorkers to Check on At-Risk Neighbors through Be a Buddy NYC
    - The City is investing $930,000 to launch Be a Buddy NYC to create a community-led preparedness model that promotes social cohesion.
- Building Partnerships with Health and Weather Reporters for Preventative Messaging
    - The City will engage health and medical reporters and meteorologists to provide information on the health impacts of heat and provide tips on what individuals,

particularly those most vulnerable and their caregivers and social contacts, need to know to stay safe.

- Advocating for Reforms to the Low-Income Home Energy Assistance Program (LIHEAP)
    - Residents can obtain some financial relief through the Low-Income Home Energy Assistance Program (LIHEAP), which is administered by the U.S. Department of Health and Human Services and provides subsidies to low-income households to assist in paying for heating and cooling needs.
- Working to Improve Ventilation and Ensure Operable Windows in Residential Buildings
    - The City continues to explore potential building-level interventions to alleviate hot weather conditions in homes.
- Supporting Improvements to Signage and Programming at Cooling Centers
    - NYC Emergency Management will invest in improved signage so that the location of cooling centers will be more accessible to vulnerable New Yorkers.

MONITORING STRATEGIES

- Collecting Innovative Data to Deliver Inclusive and Health-focused Climate Policy.
    - To better understand the geography of NYC's microclimates and differentiated vulnerability, the City is investing $300,000 to collect baseline neighborhood-level temperature information.

Conclusion

Mitigating and adapting to climate change impacts is something that jurisdictions throughout the nation need to prioritize not in the future, but now, because the actions that cities and counties take now will dictate the burden that residents will have to bear in the future. Like many cities in the state, country and the world, many cities in the SCAG Region are particularly vulnerable to extreme heat. Although the inclusion of extreme heat adaptation strategies in the planning documents of some cities in the SCAG region is a step in the right direction, there is still a lot of work to be done. To close the equity gap, cities must provide funding based on the vulnerabilities of individual communities. It is beneficial and impactful for cities and counties to partner with other agencies and departments, such as the NWS and local health departments. While creating heat response plans, members of vulnerable populations should be part of the planning process. It is important to provide frontline communities with information and resources to reduce their risk to heat related illness and death, such as location of cooling centers and providing energy assistance. Community resilience can be made possible if resources are targeted properly, which is why cities and counties should assess the feasibility of expanding intervention strategies (tree canopy, cool roofs, cool pavements, etc.) in heat-vulnerable neighborhoods.

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