2022

Adelanto Climate Vulnerability Assessment

Climate Vulnerability Assessment
City of Adelanto

2022

Prepared by
W. M. Keck Science Department, Claremont McKenna College, Pitzer College, Scripps College
EA100 Global Climate Change, Fall 2021
Professor Branwen Williams, Izzy Dean, Maisie Debruyn, Jeanne Demeo, Catherine Donson, Corin Elmore, Sage Fletcher, Alex Futterman, Anna Gillespie, Kyle Greenspan, Elizabeth Hernandez, Cameron Howard, Ivy Jones, Lily, Keville, Kiran Kruse, Graeme Logan, Chase Mendell, Serena Myjer, Case Ostrom, Emma Reder, Anna Reitman, Amay Shah, Anthony Shing, Eric Warmoth, and Kimberly Zamora Delgado

Supported by
Professor Susan Phillips and Teresa Sabol Spezio
Robert Redford Conservancy of Southern California, Pitzer College

Table of Contents

Figures

Executive Summary

This climate vulnerability assessment evaluates the impacts of climate change on the City of Adelanto. It serves as a guide to strengthen the city's climate resilience and potentially minimize the effects of climate change on the city's residents. This report was compiled by faculty and students at the Claremont Colleges studying climate change.

Introduction: This section highlights key demographic statistics about the City of Adelanto. It identifies the city's location in the high desert of California, providing context on the city's climate. Briefly introducing global climate change, this section provides an overview of the drivers of climate change and model projections of its global effects into the future.

Impacts: This section discusses the effects of climate change on the City of Adelanto. Data show that temperatures will fluctuate more dramatically between summer and winter months, with summer temperatures increasing by up to 4-10 °F. This change will exacerbate existing issues in the region but will also raise other concerns. For example, the number of hot weather days the city faces will sharply increase in the near future, which will likely affect public health and worker productivity. Local ecosystems will also suffer from a loss of biodiversity because of increasing temperatures.

Increasing temperatures will alter precipitation patterns, leading to more severe droughts, as evidenced by the current drought, that are subsequently punctuated by flooding events. Drought-driven alteration to the soils will likely increase the city's historical susceptibility to flash flooding caused by sudden, heavy rain. Floods in this region often cause debris flows, which pose threats to human life, property, and critical infrastructure.

The City of Adelanto currently relies largely on groundwater sources for its water supply (most significantly on the Mojave River Groundwater basin). However, recent long-term

trends suggest that these groundwater reserves are not being replenished as rapidly as they are being depleted. More extensive droughts will further compromise recharge of these reservoirs, reducing the reliability of the city's water reserves.

Located at the wildland-urban interface, the City of Adelanto is at risk from wildfires as fuels interact with developed areas to increase fire damage. Further development in the city, especially into the interface region should proceed with caution as it increases the fire risks to city residents and their property. Fires across the state are also increasingly affecting the city due to the air pollution and dust that they cause.

Socio-economic Impacts: Rising temperatures, particularly a rise in the number of extreme hot weather days, will harm the residents of the City of Adelanto, particularly vulnerable populations (those living in poverty, the elderly, and the incarcerated). This warming will compound air pollution issues, through directly enhancing the production of air pollutants and by regional intensification of wildfires and their related air pollutants.

Industry: The manufacturing and supply industries, which have witnessed tremendous growth in the last few years, will feel the impacts of climate change due to rising temperatures and drought. This will manifest through reduced worker productivity, damage to temperature-sensitive equipment, higher electricity demand and supply chain disruptions caused by variable weather. These industries must work to make their facilities more climate-resilient and energy efficient. Agriculture, specifically indoor cannabis cultivation, will also be dependent on reliable energy sources to combat rising temperatures and reliable water for irrigation. Finally, the city's prison industry will need to adapt to the increase in extreme hot weather days, as the prison population is vulnerable to heat-related illness and existing infrastructure may be insufficient to deal with the changes in temperature.

Climate resilience strategies: The city can take several steps to pre-empt the worst effects of the various changes to the region's climate. Proactively enacting these strategies will provide substantial savings compared to costs associated with repairing

damage caused by the changing climate. Some of the recommendations are consistent with those presented in the City's 2020 Local Hazard Mitigation Plan and the City's 2014 Adelanto North 2035 Comprehensive Sustainable Plan.

The most pressing issues for the city are:

Water Security. The extreme drought conditions throughout California will require the city to put in place water conservation measures. Minimizing irrigation of residential lawns, minimizing permeable surfaces in new construction and promoting the removal of permeable surfaces in existing infrastructure are some of the strategies to minimize water use and maximize groundwater recharge. Investigating innovative, climate smart technologies for water production is recommended.

Water Quality: Contaminants in the water from local wells (PFAS) as well as off-color, odorous, or hard water should be addressed in order to guarantee that local wells can continue to be a source of local water as the city faces severe drought.

Rising temperatures. To mitigate its effects, the city can make a series of changes ranging from using more reflective materials on roofs and pavements, to increasing the green cover by planting more trees and adding vegetation which will reduce surface temperatures. These strategies may be sources of employment and will also improve the city's attractiveness.

Flooding. Infrequent but severe flood risk is a significant issue in the area which will require mitigation strategies, particularly considering their increased predicted frequency. To this end, the city may build barriers in vulnerable areas to protect structures and ensure that stormwater drains are adequately sized. Citizens should also be educated to ensure that they are aware of the risks of flooding. Furthermore, an evacuation plan in the event of flash flooding should be prepared and circulated to ensure that people are able to reach safety. Capturing water from storm events and returning it to groundwater via permeable surfaces, rain gardens, and other features to

retain the water will help strengthen the city's water security.

Wildfires. Wildfires at the city's wildland-urban interface regions are exacerbated by strong Santa Ana winds along with more extensive droughts, both of which also lead to soil erosion and health consequences. Creating adequately large defensible spaces, or gaps between vegetation and structures is a great strategy to minimize the intensity and spread of wildfires.

Increased Energy Use. Increased energy use can be mitigated by boosting the city's distributed generation capacity through rooftop solar and deploying other sources of renewable energy locally. These measures may also reduce prices of electricity saving individuals and businesses money. The City of Adelanto has already made great strides with local solar facilities and should ensure that some of this produced energy is reserved for city residents.

Strengthening Social Networks. Studies show that increased equity and strong community networks allow residents to weather heat or disasters. Investment in community resilience activities, such as senior centers or community gardens, that bring people together are recommended.

Introduction

City Background and Demographics

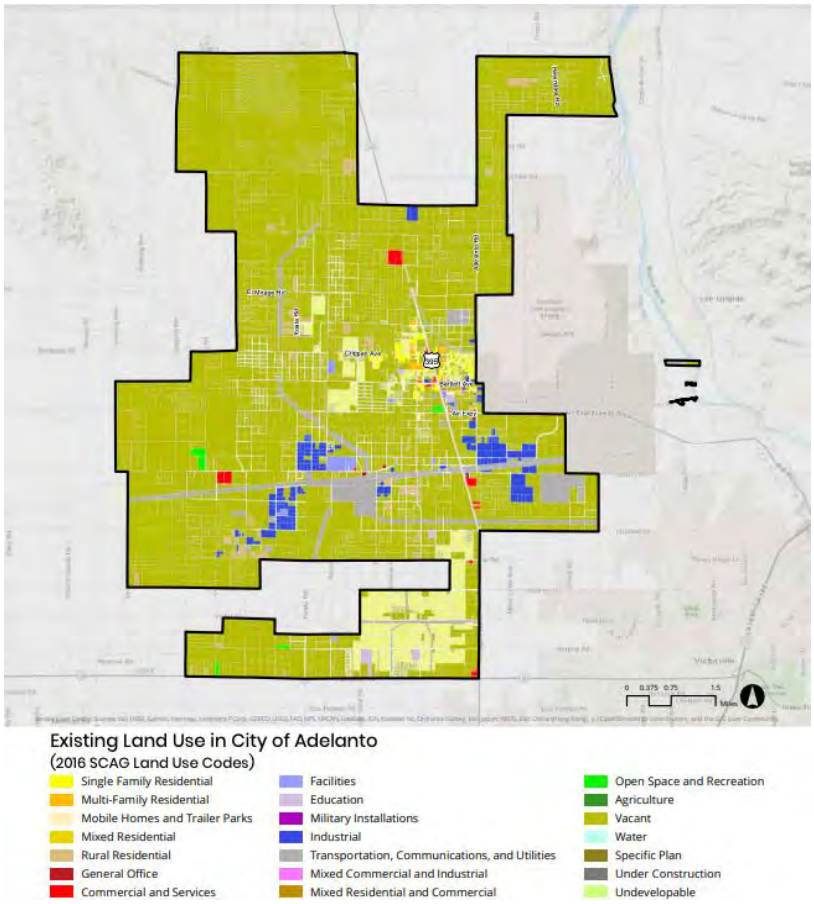

Figure 1. *The City of Adelanto with Current Land Use. Figure from (Southern California Association of Governments 2019).*

The City of Adelanto is located within the Victor Valley section of the Mojave Desert in San Bernardino County, 35 miles from the City of San Bernardino and 70 miles northeast of the City of Los Angeles. The burgeoning city was founded by E.H. Richardson in 1915, as its land use was transitioning from fruit orchards to urban development. The city population is growing, with a greater than 7% increase since 2010 and a population of over 38,000 in 2021 (U.S. Census Bureau 2019). Because of this growth, which is largely a result of people moving into the city for economic opportunities, the population of the City of Adelanto is relatively young, with a median age of 27.5 ± 1.2. Over 14,000 residents are employed, and the median household income is $42,380 (U.S. Census Bureau 2019). The largest job sectors are manufacturing, transportation, and education with the Adelanto School District being the largest employer. In the last 18 years, median household income has increased by $2,680 (Martinez 2020).

Current land use in the city is primarily single family residential, industrial zones, commercial zones, and recreational open space (Figure 1, (Southern California

Association of Governments 2019)). However, roughly 85% of land in the city is currently vacant and undeveloped, and the city is undergoing efforts to continue economic development by encouraging industrial growth and building affordable housing.

Climate Context for Adelanto

The City of Adelanto is situated in the High Desert of Southern California. As such, the city experiences extreme daily and seasonal temperature variability. Daily minimums (5-day averages) range from 23.45°F in the winter months to 104.9°F in the summer months (for the period of 1999 to 2009, data from (Menne et al. 2012)) while monthly averages range from 45°F in the winter months to 75°F in the summer. Since the 1950s, winter temperatures have warmed over 2.5°F while summer temperatures have warmed just over 0.9°F (Fan and van den Dool 2008). Precipitation in the City of Adelanto is highest during the winter months of January and February with the city receiving, on average, 5.5 inches of annual rainfall and 1.4 inches of snowfall. Additionally, the City of Adelanto experiences strong wind, averaging 10.9 mph in the northeast direction with seasonal Santa Ana winds events (Rolinski et al. 2019). Overall, Adelanto's climate can be described as a sunny, arid desert. In the summer 2022, the U.S. Drought Monitor has classified the City of Adelanto to be in an Extreme Drought. Projections show that droughts will increase.

Climate Change

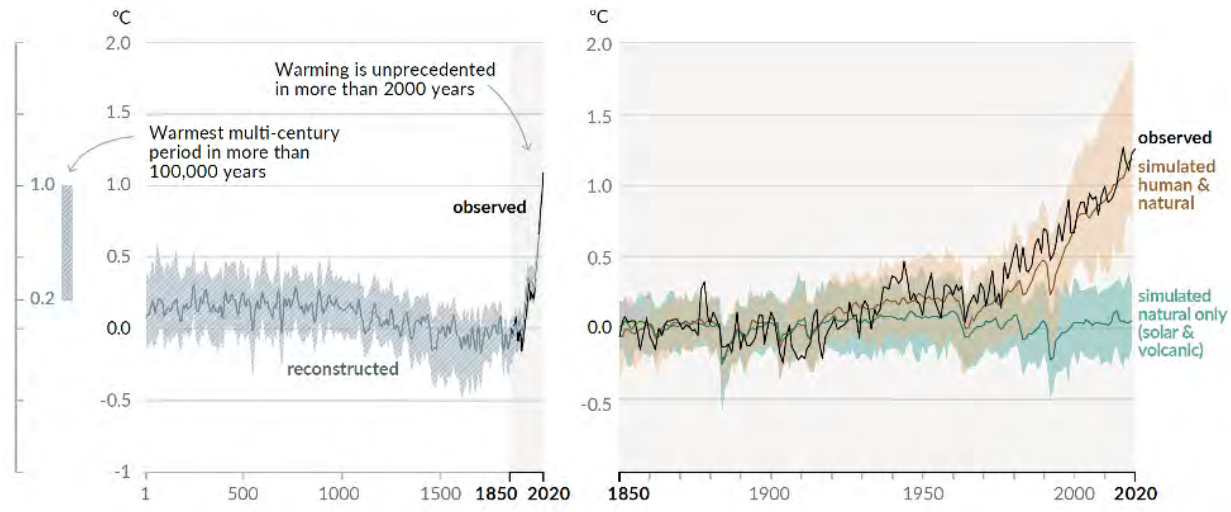

Figure 2. *Left: Global change in decadal-averaged temperatures from instruments (observed) and reconstructed (from natural environmental archives) showing that temperature now exceed the warmest multi-century period in more than 100,000 years. Right: Temperature changes since the mid-20th century can only be explained if human activities are included in climate models. Figure from (Masson-Delmotte et al. 2021).*

Anthropogenic factors, those caused by humans, have directly caused the Earth to warm (Figure 2) (Masson-Delmotte et al. 2021). When the sun's solar radiation enters the atmosphere, some of it is absorbed and re-radiated back from the Earth's surface into space. Greenhouse gases in the atmosphere trap a portion of the energy that is re-radiated to the Earth, preventing it from leaving the atmosphere. When these gases, primarily carbon dioxide, are emitted by human activity, they enhance the greenhouse gas effect, leading to global warming. Global temperatures have increased more than 1.8°F from the baseline average temperatures for the period of 1850 to 1900; this exceeds the warmest multi-century period in more than 100,000 years. The warming is melting land ice, elevating sea levels, and intensifying weather events (Masson-Delmotte et al. 2021). The State of California is projected to warm by more than 4 °F by the end of the century, which will lead to more extremely hot days and fewer freezing days (Bedsworth et al. 2018). Higher temperatures will enhance evaporation and precipitation, leading to more intense storms and flooding events but also more extensive droughts, the latter of which will stress water resources (Dettinger et al. 2015; Masson-Delmotte et al. 2021). In California, enhanced evaporation and drought

conditions may lead to increased acres burned by wildfires (Bedsworth et al. 2018).

Projections of future climate conditions depend on the socio-economic pathways that society pursues in the future. For example, the amount of fossil fuels the world continues to burn versus moving toward non-fossil fuel energy sources. As such, the impact of global climate change on the City of Adelanto is discussed below in the context of two different greenhouse gas level predictions: Representative Concentration

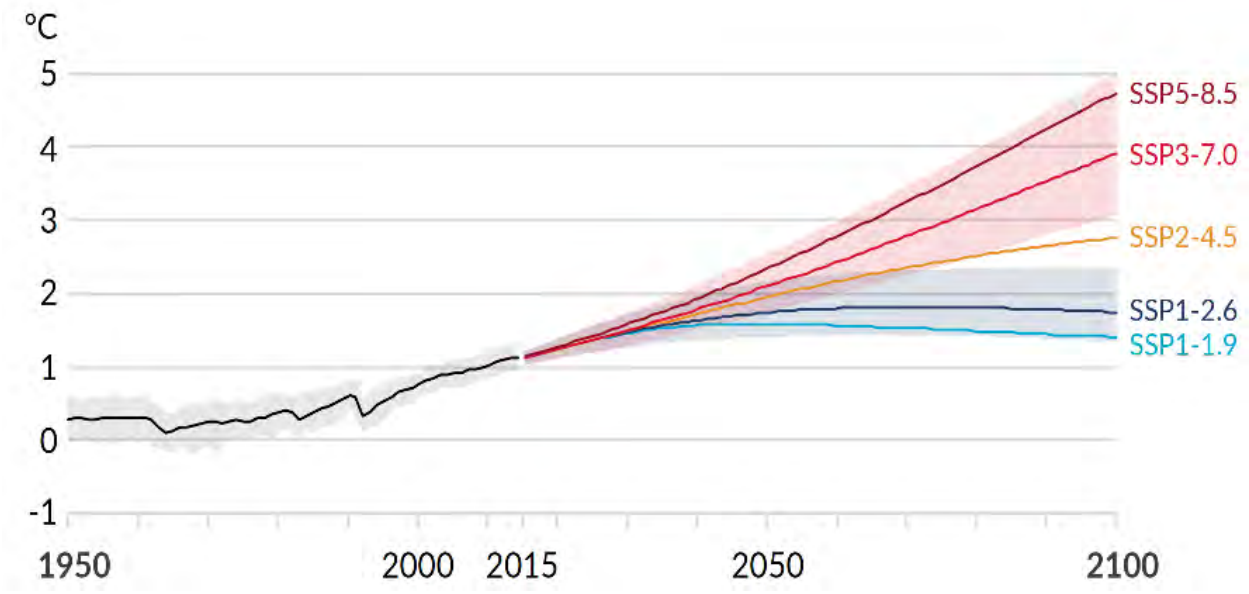

Figure 3. *Measured (black line) and projected global surface temperature change (in °C) relative to 1850-1900 under different socio-economic scenarios. Figure from (Masson-Delmotte et al. 2021)*

Pathway (RCP) 4.5 and 8.5. RCP 8.5 marks estimates of the future climate as emission trends are currently proceeding, while RCP 4.5 indicates a decrease in overall fossil fuel emissions by the mid-21st century (Masson-Delmotte et al. 2021). Under both scenarios, warming will continue through the end of the century, but under RCP 8.5, temperatures are elevated relative to RCP 4.5 based on higher greenhouse gas emissions: for example, global temperatures are projected to increase close to 5.0°F and 8.5°F for the RCP 4.5 and RCP 8.5, respectively, by the end of the century (Figure

3).

Purpose

The projected warming due to fossil fuel emissions will alter the local climate. Therefore, the purpose of this report is to evaluate the impacts of global climate change on the City of Adelanto, taking into account the interconnecting social and economic consequences. Through this report, we offer the City of Adelanto insights into the risks of climate change specific to the community and potential avenues for adaptation to reduce harm.

Climate Impacts

Temperature

The impact of global warming on the City of Adelanto's climate can be measured using California's Cal-Adapt tool (Thomas et al. 2018). Cal-Adapt is a collaboration between California agencies, universities, and the private sector that provides climate data in an accessible manner for California planners, agencies, and local governments. Using the tools available through Cal-Adapt, temperatures in the City of Adelanto are projected to increase 5.4 °F and 9.0 °F by the end of the century under the RCP 4.5 and RCP 8.5 scenarios, respectively (https://cal-adapt.org/) Thomas et al. 2018). Currently, an average of 90 days per year in the Mojave and 135 days per year in Palm Springs reach 95 °F. Under the RCP 8.5 model, these numbers reach 141 and 179 days per year, respectively, by the end of the century (Hopkins 2018). These 56% and 33% increases suggest that the entire Inland Desert region would approach the 95 °F threshold for nearly half of the year. Projections of low temperature extremes are additionally expected to decrease significantly. For example, in the neighboring city of Victorville, the number of days with temperatures below freezing is expected to decline from 44 days currently to approximately 9 days by midcentury (Hopkins 2018). Regionally, this warming will increase the number of hot weather days, increase evapotranspiration,

change precipitation patterns, and melt snow. These changes have implications for flooding, drought, wildfires, soil properties, and ecosystems.

Furthermore, as a city located within the desert, the City of Adelanto is vulnerable to the urban heat island effect, where pavement and concrete infrastructure warm the urban area as they absorb the heat incoming from solar radiation rather than reflect it, which amplifies local temperatures (Bedsworth et al. 2018). As the city continues to expand its built infrastructure, the city will experience warming in addition to that projected by climate models as undeveloped land is developed into urban surfaces.

Hot Weather Days

Extreme heat days and heat waves are both key metrics for measuring the intensity and scope of climate changes impact on a region. A heat wave is defined by the United States Environmental Protection Agency (USEPA) as two or more consecutive days exceeding the 85th percentile of regional historical July/August temperatures. An extreme heat day is any day where the temperature exceeds the current 98th percentile of daily highs. For the City of Adelanto, the current 98th percentile of daily highs is 104 °F (cal-adapt.org). Extreme heat days and heat waves have both been linked to a plethora of health risks for residents living under these conditions. For establishing a baseline, USEPA data has established that decade-over-decade since the 1960s, heat wave frequency, duration, intensity, and the length of annual heat wave season have increased (National Oceanic and Atmospheric Administration 2021).

The model projections for future extreme heat days (> 104 °F) per year for the City of Adelanto increase from a historical baseline (for the period 1961 to 1990) of 5 days per year to 29 days per year under RCP 4.5 and 56 days per year under the RCP 8.5, including a spike year projection of up to 110 days by the end of the century (for the period 2070-2099) (Figure 4). To state it another way, under RCP 8.5, by the century's end the City of Adelanto could experience extreme heat one in every 6 days, with almost one in every 3 days crossing that threshold in a spike year. Projections for the longest stretches of consecutive extreme heat days in a given year are equally

escalated, with an increase from the 3-day baseline period (1961-1990) to 12 and 22 consecutive days under the RCP 4.5 and RCP 8.5 scenarios, respectively, by the end of the century (https://cal-adapt.org/tools/extreme-heat). Finally, data show the number of long heat waves, defined as four or more days, increase. The annual baseline of extended heat waves rising from essentially no events per year to 6 and 11 events per year under the RCP 4.5 and RCP 8.5 projections, respectively (https://cal-adapt.org/tools/extreme-heat).

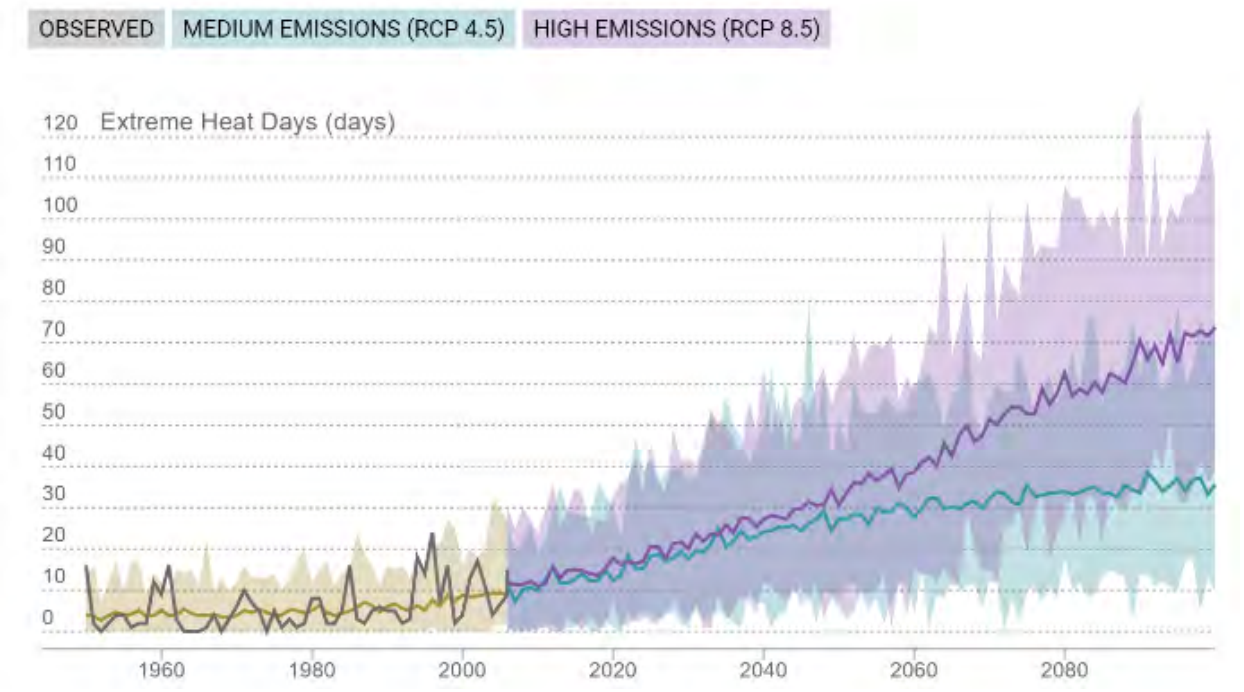

Figure 4. *Number of days in a year when daily maximum temperature is above a threshold temperature of 104.0 °F. Figure from Cal-adapt.*

Water Cycle

Average annual precipitation is not projected to change by the end of the century (Figure 5); however, precipitation is projected to occur during less frequent, more intense storms interspersed by longer, more severe droughts (Figure 6). Furthermore, warmer temperatures will lead to a larger proportion of precipitation to fall as rain instead of snow; therefore, winters will be shorter. Moreover, average water supply from snowpack is projected to decline to two-thirds of historic levels in the western

mountainous region of the United States (Bedsworth et al. 2018).

Reductions in precipitation, amplified by increased evapotranspiration may cause increased drying of soil, which can lead to drought and decreased water quality measured as increases in salinity, harmful bacteria, and algae (Mosley 2015). Finally, hot weather increases the demand for water from agricultural and residential users which compounds the effects of the changes in water frequency and duration.

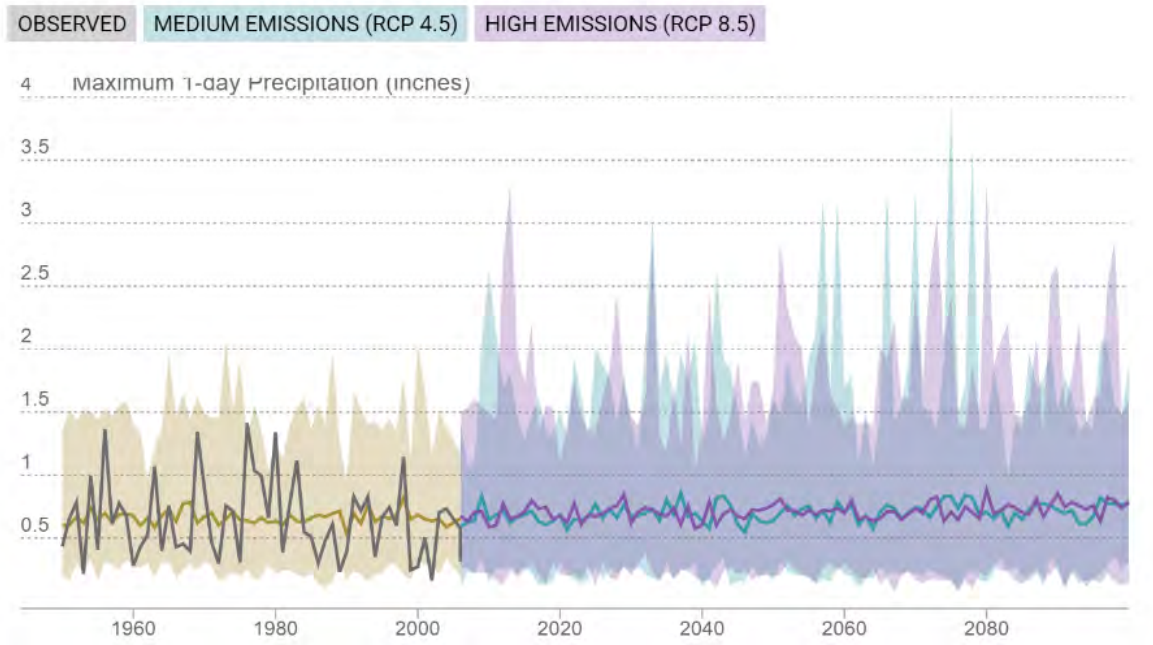

Figure 5. *The maximum amount of precipitation (rain or snow) over a 24 hour period for each year. Figure from https://cal-adapt.org/tools/local-climate-change-snapshot.*

The Mojave Water Agency has had numerous complaints filed over upstream users decreasing the amount of water available to the downstream users (Reyes et al. 2021). As the frequency and duration of drought increases, the rate of water flowing into groundwater aquifers declines, and the water level is not sustained. This is coupled with groundwater depletion from overallocation and over pumping that increase water scarcity. As the City of Adelanto grows, the rapid increase in population may create conflicts with other water users.

Furthermore, storms bringing precipitation that break up extended periods of drought

increase the risk of floods since the drier ground does not readily absorb water. As a result, when heavy rainfall occurs, there is a higher chance for mudslides and flash flooding. The floods will transport sediments downstream and debris flows can endanger people, homes, and infrastructure. As flooding has a large direct impact on human lives, flash floods are one of the highest ranking natural disasters (Khosronejad et al. 2019). Flash floods in dry-bed desert streams can destabilize bridge foundations. Many of these structures can become unstable during flooding events when the washes fill up with water, sediment, and mud from debris flows. When debris flows out of

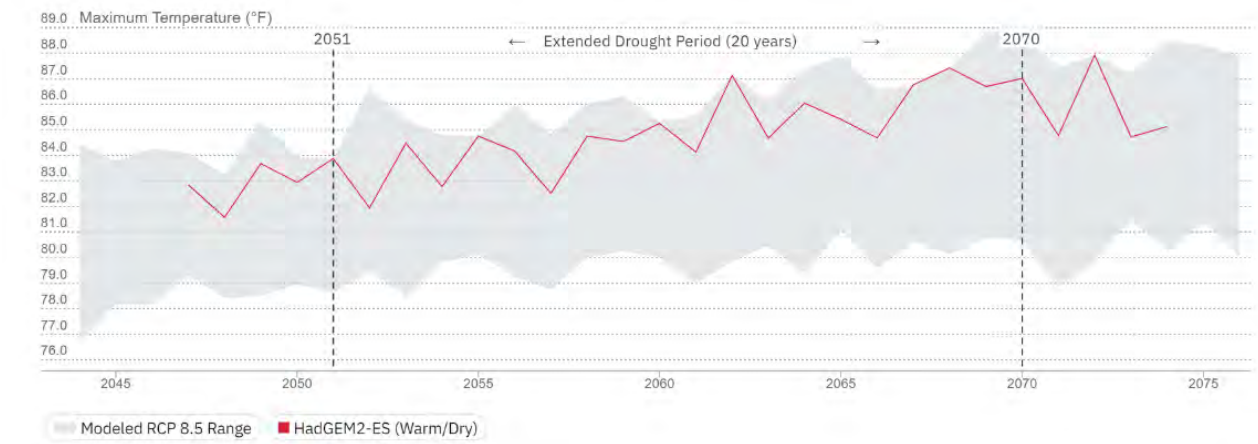

Figure 6. *Extended drought forecast for the CIty of Adelanto. Figure from https://cal-adapt.org/tools/extended-drought.*

canyons in the mountains near the desert, the leading wall of the debris flows can be substantial, running far into the desert plains (Warner 2004). Because the dry soil and the lack of vegetation reduces water absorption, the water can easily flow out of the mountains and into the alluvial fans of the desert.

The most direct impact of flooding for the community of Adelanto will be infrastructure damage and endangerment to human populations. Additional possible impacts of the aftermath of flash floods include damage to transportation routes and public transportation. This could, in turn, decrease the social and emotional health of the City of Adelanto's residents. The City of Adelanto and the greater southern California region rely on the 15 to transport commercial products and produce between the greater Los Angeles area, the High Desert communities, Las Vegas, and other major cities in the Western United States. Damage to the 15 from flooding could lead to potential problems

for the city in terms of accessing resources and transporting the major goods manufactured in the City of Adelanto to regions outside of the City of Adelanto.

Water Security

The City of Adelanto received approximately four million gallons of water per day from eight wells in the Mojave River Groundwater Basin in 2020 (City of Adelanto 2020). The groundwater basin runs from its headwaters near Silverwood and Arrowhead Lakes in the San Bernardino Mountains to its underground path adjacent to the City of Adelanto (Figure 7). There is intermittent annual streamflow in the Mojave River Groundwater Basin, usually between the months of January and March (United States Geological Survey). The Mojave River is the only natural recharge in the basin. Increasing withdrawal rates from the aquifers in this basin relative to recharge rates can lead to land subsidence, which in turn can reduce the capacity of the aquifers (United States Geological Survey). In addition to the natural streamflow recharge, the State Water Project

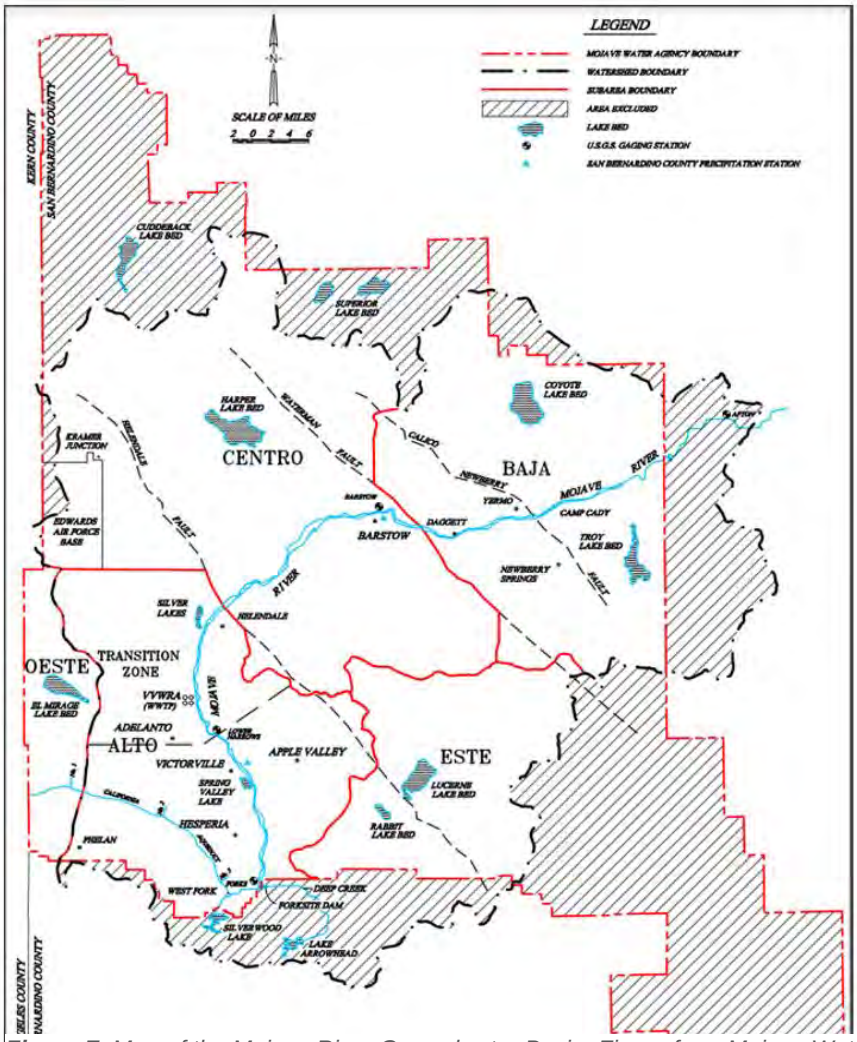

Figure 7. *Map of the Mojave River Groundwater Basin. Figure from Mojave Water Agency (www.mojavewater.org/files/mbamap_1.pdf).*

provides recharge services to the Mojave River Groundwater Basin (United States Geological Survey). Currently, the City of Adelanto is expected to be able to meet full water usage demands through a 5-year drought (Landstedt Consulting 2021).

The resilience of the City's water resources may change with climate change: extended drought conditions (exceeding 5 years) may be more common in the future: records of past drought variability show evidence of extended droughts and future projections show more years with lower precipitation (Berg and Hall 2015; Cook et al. 2015). This decreased precipitation with rising temperatures will lead to lower snowpack amounts in the mountains. In addition, the snow may melt sooner in the year as opposed to a slow release throughout the summer as temperatures will rise above freezing earlier in the year. The water will be collected in dams but will be less available to replenish the groundwater sources. There could be a concern that if the scheduled State Water Project (SWP) recharging is altered or water is over-extracted from the basin, then the City of Adelanto could face greater water scarcity. While the Mojave Basin has historically been a reliable source of groundwater, the city's water resilience will most likely be dependent on future county and state regulations surrounding the Mojave basin in response to climate change (Mann and Gleick 2015).

The vulnerability of the San Bernardino National Forest recharge capacity depends on the evolution of the water cycle with rising temperatures. Three different projected climate scenarios within the RCP 8.5 include: a hotter drier climate, a moderate climate (warmer but not wetter or drier), and a warmer wetter climate, using the overall temperature projections of the RCP 8.5 reveal different futures (Underwood et al. 2018). Under the moderate and drier climate scenario, the San Bernardino National Forest will experience a reduction in runoff which supplies the Mojave River Groundwater Basin. The moderate projection's recharge capacity is reduced to 80% of its current average, while the hotter drier model is expected to be reduced to 50% of the current average. Under the warmer wetter projection, recharge capacity is expected to increase to 106% of the current average by mid-century. Moreover, one third of 385 watersheds in the national forests of Southern California are vulnerable under the moderate projection.

The most vulnerable watersheds are in the San Bernardino National Forest. A key takeaway is that higher elevation areas are more sensitive to projected changes in runoff and thus their recharge capacity. Each of these situations present a unique challenge for water resource management. While there is immense uncertainty around the impact of climate projections on water security, this should not deter planning for the most likely scenarios (Underwood et al. 2018).

The State Water Project (SWP) (Figure 8), the other source of recharge for the Mojave

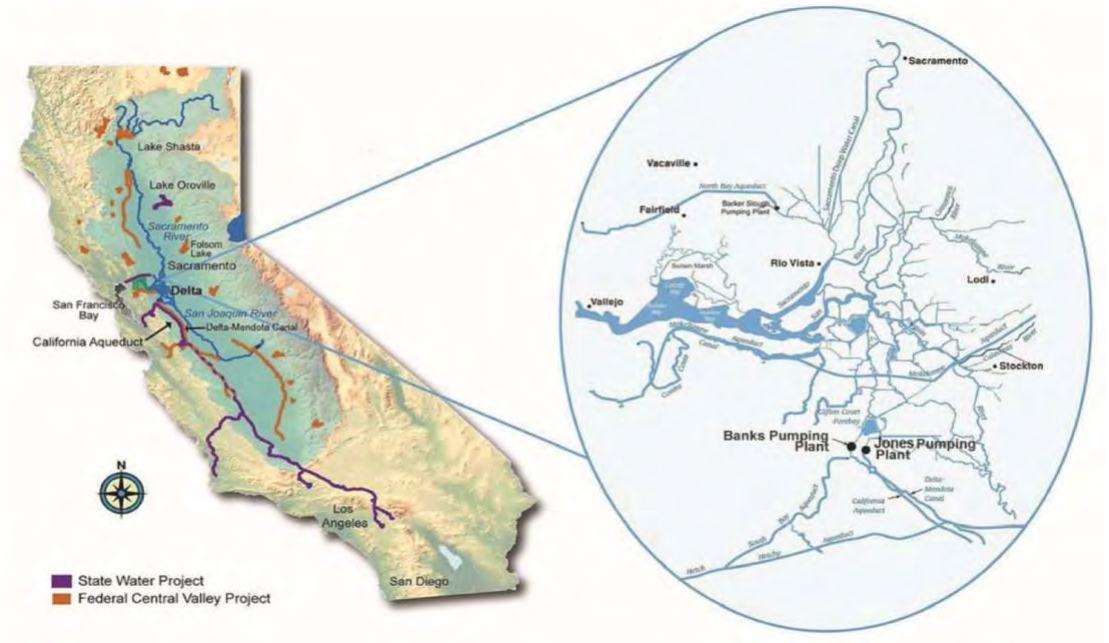

Figure 8. *State Water Project and Central Valley project in California. Figure from Wang et al. (2018).*

River Groundwater Basin, also faces climate vulnerabilities. Seasonal pattern shift in the water cycle is a major factor for the SWP. The extra runoff from early snow melting and longer winters along with spring rainfall is not conserved in reservoirs, and thus cannot be used to meet increased summer demand. The SWP East Branch Aqueduct carries water from the west through the Antelope Valley to the Silverwood Reservoir via the Mojave Siphon Powerplant. A portion of this water may be used in the Mojave River watershed to recharge groundwater, but due to increased drought most of the water from the SWP travels through the San Bernardino Tunnel to Lake Perris for use in southern San Bernardino and Riverside counties. SWP exports are expected to be

reduced by approximately 163 billion gallons by 2050. If mitigation were to be improved to the RCP 4.5 track instead of RCP 8.5, the reduction in Delta exports would shrink by approximately 81.5 million gallons, and carryover storage would be increased by approximately 163 billion gallons. Carryover capacity is defined as the sum of end of September storage in four project reservoirs north of Delta: Lake Shasta, Trinity Lake, Oroville Reservoir, and Folsom Lake (Wang et al. 2018). The impact of reduced SWP recharge capacity on supply to the Mojave River Groundwater basin is uncertain.

Wildfires

The City of Adelanto is already considered a “community at risk” for wildfires due to its proximity to wildland fuels in an urban environment (Placeworks and Dudek 2018). The wildland-urban interface is the zone where wildland vegetation and fuels intersect with developed, urban areas (Placeworks and Dudek 2018). Low-level brush and weeds growing in this interface often accumulate in the presence of urban expansion, and the accumulation causes an increased risk that fires can jump from the wildland environment to urban settings (Jericho Systems, 2019). Increased human expansion into the wildland urban interface also increases the likelihood of human-caused wildfires in areas where the fuel may be more susceptible to rapid burning and spreading of wildfires. The risk is amplified in the future due to the rise in temperatures and drought conditions. Prescribed burns, a practice linked to preparing environments for wildfires by decreasing fuel loads and facilitating less spread when wildfires break out, which are traditionally used to mitigate severe wildfires are limited when humans are closer in proximity to the wildland areas that need to be pre-burned (Radeloff et al. 2018). Thus, this management tool may not be available to mitigate the wildfire risk.

As climate change intensifies, the Santa Ana winds also have the potential to intensify the effects of wildfires on the City of Adelanto. The winds have been linked to wildfires throughout San Bernardino County in numerous instances of more rapidly spreading wildfires (Placeworks and Dudek 2018). While changes in the frequency and intensity of the wind with climate change are unknown, the Santa Ana winds are predicted to become hotter, which has the potential to feed and spread wildfires even more rapidly in

the future (Bedsworth et al. 2018).

The impacts of wildfires include increased air pollution, disruption of ecosystems, and the withdrawal of homeowners insurance. Following fires in August 2021, pollutants such as $PM_{2.5}$ (particulate matter less than 2.5 microns) and ground-level ozone increased throughout the City of Adelanto, with poor air quality and smoke attributed to even far away fires in Northern California (McGee 2021). Throughout California, climate change is predicted to expand the prevalence of wildfires. In a scenario with continued greenhouse gas emissions, the area burned by wildfires will increase by 77% and the frequency of fires burning over 25,000 acres will increase by almost 50% by the end of the century (Bedsworth et al. 2018). The higher frequency of wildfires associated with further expansion into the wildland urban interface is also linked to ecosystem disruptions. Wildfires leave behind a layer of soot that allows erosion to occur, depositing pollutants and ash into water supplies that wildlife and humans rely on (Placeworks and Dudek 2018). Increased wildfires also lead to a higher chance of ecosystem destruction from mudslides, as the burned soil is less permeable (less water will soak into the ground), which will amplify existing flooding issues during storm events.

In the Inland Desert there is not one clear contributing cause of fires. Approximately 67% are from miscellaneous causes, 22% from equipment use, and only about 10% of fires were started by lightning. Climate change models predict that lower precipitation will decrease monsoon influence, so there will be a decrease in fires that could be started by lightning. This will have a minimal impact to reduce wildfires in the vicinity of the City of Adelanto since only a small percentage of local fires are started by lightning. One area for concern is that approximately 60% of large fires were caused by and related to human activity (Hopkins 2018). This risk will only intensify as populations continue to rise and communities expand.

Soil

Adelanto’s desert soils will become drier and warmer in the future, which may alter

vegetation and will lead to increased erosion. The city is currently characterized by dry, alkaline, very deep, moderate- to well-drained soils of loamy and sandy textures (National Resource Conservation Service 2019). The primary soil orders present are aridisols, or arid-land soils, and entisols, or soils with little development of layers. The available water storage of these soils is low, which means they provide little capacity to absorb water during extreme precipitation events (National Resource Conservation Service 2019). Changes in precipitation and declining soil moisture will increase erosion and dust production in the City of Adelanto (Li and Fang 2016 and Duniway et al. 2019). One mechanism through which this may occur in arid regions is the alteration of biological soil crusts since changing precipitation patterns reduce biocrusts which stabilize soil surfaces (Johnson et al. 2012). In turn, erosion deteriorates physical, chemical, and biological properties of soil, depletes soil nutrients, and decreases plant production (Li and Fang 2016). Wind erosion and attendant dust generation has implications for soil and human health through diminished air quality. Increases in dust related to increasing aridity in the southwestern U.S. are expected to increase rates of *Coccidiomycosis*, or Valley Fever, and increase hospital admissions for cardiovascular and respiratory illnesses by up to 300% (Duniway et al. 2019). Atmospheric dust is also linked to silicosis, allergens, airborne pathogens, and chemical contaminants. While increased aridity and temperatures are likely to intensify dust production, land use also plays a role in mitigating or compounding dust production, and land uses including unpaved roads, energy exploration and development, and off-road recreation can exacerbate dust.

With climate change, soil temperatures are rising slightly faster than air temperatures: between 1982 and 2000, air temperature in the Mojave region increased at an average rate of 1.13 °F per decade, while soil temperature increased at an average rate of 1.42 °F per decade (Bai et al. 2013a). Soil temperature influences physical, biological, and microbiological processes in the soil (Bai et al. 2013a). Thus, warming of soils may affect such processes, changing the soil properties in the City of Adelanto, similar to the changes in precipitation patterns. One anticipated effect of warming soils is significant alterations in the distribution patterns of vegetation in the Mojave region (Bai et al.

2013b).

Ecosystem

The City of Adelanto's ecosystem will shift with warmer, drier climate conditions and increased wildfire events. This combination of conditions will expand the Mojave Desert ecosystem and lead to a loss of biodiversity within the desert due to the loss of habitats (Environmental Protection Agency 2016) (Underwood et al. 2019). For example, one of the many species likely to be endangered as temperatures increase is the Mohave ground squirrel *Xerospermophilus mohavensis*. Under hotter and drier conditions, vegetation communities such as the shadscale and winterfat will be unable to survive. These vegetation communities form part of the Mohave ground squirrel's diet, hence not only will the Mohave ground squirrel population be reduced by hotter and drier temperatures, but the shadscale and winterfat populations will likely be as well (Inman et al. 2016). The decrease in Mohave ground squirrel, shadscale, and winterfat populations will impact the local ecosystem's food web, further escalating biodiversity loss in the City of Adelanto area.

Habitat loss in the City of Adelanto is due to shifts in climate, but also the growing energy industry. Solar development in the Mojave Desert alters ecosystems by disrupting non-bee insect pollinators that are crucial to the survival of cacti populations. As the insect pollinators are disrupted, biodiversity loss enhances itself as the cacti populations that are dependent on these pollinators diminish and the consumers dependent on the cacti populations also decrease as a result (Grodsky et al. 2021). The growing solar farm industry in the City of Adelanto will decrease biodiversity as habitat loss disrupts the growth of insect pollinators, cacti populations, and other consumers within the food web. Losses in biodiversity can be reduced by siting solar on alternative locations such as contaminated lands or rooftops (Grodsky et al. 2021).

Social Impacts

Public Health

Without intervention, the impacts of climate change will likely harm human health in the City of Adelanto. Climate change will increase hot weather days, increase regional wildfire risk, and cause more severe droughts, which will cause heat-related illnesses, breathing troubles, heart issues, contamination of food and water, injuries, mental health challenges, and spreading of infectious diseases (Constible et al. 2019). Heat-related illnesses impact human cardiovascular and nervous systems in a variety of ways leading to heat stress, heat stroke, and respiratory problems (Halaharvi et al. 2020). Increases in heat are correlated to increased hospital visits. Youth, in particular, have a 72% increase in risk of negative mental health outcomes in higher heat conditions (Basu et al. 2018). The health care costs are substantial: estimated health care costs for six United States climate change-related events between 2000 and 2009 was $740 million, with costs up to $14 billion when the value of lives lost prematurely was taken into account (Knowlton et al. 2011).

The general increase in injury and illness that occurs in high heat weather can put a strain on the local health infrastructure and hospital system. It is also important to consider that extreme heat days can become more deadly with the risk of energy blackouts shutting off life-saving air conditioning. Particularly when access to coolants is limited, high temperatures over an extended period put the human body under strain. When the body is unable to effectively cool itself at night, it exerts significantly more energy which can cause unhealthy amounts of bodily stress.

Select groups in the City of Adelanto are particularly vulnerable to climate change. Social vulnerability factors include age, socioeconomic status, race, and disability status. Though climate change effects will be felt by everyone, impacts will differ based on these social vulnerabilities. One at-risk group are those living in poverty, which is 28.5% of the population in the City of Adelanto (U.S. Census Bureau 2019). People

living in poverty are likely to be more affected by extreme heat because they may have limited access to air conditioning, or they may have jobs that are outside and increase exposure to heat. Those living in poverty that have air conditioning may face rising prices of electricity to power the air conditioner during extreme heat events because the demand for energy will increase.

The elderly population (over 65) makes up 5.6% of the City of Adelanto and is vulnerable to high heat. The elderly population is more likely to have chronic medical conditions that change normal body responses to heat and take prescription medicines that affect the body's ability to control its temperature or ability to sweat. In addition, the elderly experience adverse health effects due to increased exposure to air pollution, leading to increased mortality, hospital admissions and visits primarily due to exacerbations of already present chronic diseases or respiratory infections (Simoni et al. 2015). In addition, elderly people often have diminished social networks and financial constraints, which also place them at higher risk.

Heat-related illness is compounded in the City of Adelanto by air pollution which causes higher rates of asthma and other respiratory illnesses. The occurrence of freight rail yards, like the one in the City of Adelanto, are associated with higher asthma-related emergency room visits especially for low-income minority children (Hwang et al, 2018). The youth population (under 18) makes up 34% of the City of Adelanto's population (U.S. Census Bureau 2019) and are particularly susceptible to adverse effects of air pollution. Air pollution can cause children's lung growth to be stunted (Gauderman et al. 2015). .

Industry

The current relaxed business regulations and convenient location next to U.S. Highway 395 has encouraged transportation and commerce that has been essential in supporting the City of Adelanto's economic bloom. The city is a hotspot for new investments, with a 20 percent increase in growth in the last decade by large manufacturing and tech

sectors which include solar panel farms, cannabis, and companies such as the Boring company, Rivian, Clark Pacific, and General Atomics (McBride, 2021). This rise in industries across sectors is a positive sign for the city's development.

Supply & Manufacturing

The effects of climate change may already be impacting the manufacturing industry both locally and globally. The high temperatures may be decreasing productivity and potentially causing health risk for workers and damaging temperature-sensitive technology (Huntington 2020). Resource scarcity, particularly related to energy consumption, may affect local industry. The City of Adelanto may have trouble providing enough power to industries and businesses if existing facilities are not converted to resilient or renewable energy sources. For example, as local temperatures continue to rise, more energy will be needed for other resources, such as cooling systems. Climate change and the depletion of resources used in energy generation will impact the functionality of manufacturing and commercial industry. Creating supply and manufacturing resiliency is especially important for the City of Adelanto if the city wants to sustain a balance between longevity and economic growth. Global weather events and projected scarcity of raw materials such as mined metals, rubber, industrial-quality clay, and sand will have a severe impact on manufacturing productivity (Oberle et al. 2019).

In addition to manufacturing, supply chain lines are vulnerable to the effect of climate change as they are reliant on weather, transport, and power facilities. The City of Adelanto is dependent on water, electricity, and material supply lines that provide the resources used in manufacturing. Variable and extreme weather events including floods and wildfires are predicted to cause outages, delays, and other complications in international supply chains, which are also vulnerable to projected sea level rise. Although the scale, timing, and location of these future events are largely unknown, as a globally connected system, consequences will be felt at multiple locations within the supply chain (World Business Council for Sustainable Development 2015).

In particular, the building of warehouses should be approached with caution due to the loss of open land, which is considered a top, nature-based solution to climate change. Undisturbed, desert lands sequester significant amounts of carbon. When larger-scale warehouses are built, this carbon is released and replaced with GHG producing infrastructure that also attracts diesel trucks and associated pollutants.

Cannabis Industry

The City of Adelanto became one of the first California cities to permit commercial cultivation of medical marijuana, resulting in a climb in local property values. At the same time, cannabis cultivation is water and nutrient intensive (Zheng et al. 2021), putting pressure on the municipal water system (National Cannabis Industry Association 2020). In California, cannabis farms rely heavily on wells outside of regulated groundwater basins that do not fall within the Sustainable Groundwater Management Act (SGMA) (Dillis et al. 2021). Water withdrawals deplete groundwater, alter streamflow and potentially harm fish and wildlife (Dillis et al. 2021). Regulations such as the SGMA prohibit surface diversions for certain lengths during the dry season to protect stream habitats. However, the use of the wells outside of SGMA regulation may lead to groundwater withdrawals that deplete surface flow (Dillis et al. 2021). The effects of streamflow depletion are not immediate because of the slow movement of water through the subsurface (Dillis et al., 2021). Despite this lag, streamflow depletion is not only detrimental to the wildlife but also the sustainability of cannabis agriculture in the City of Adelanto.

Along with water use, energy use is another major concern because cannabis is one of the most energy-intensive industries in the United States (Warren 2015). The energy-intensive equipment falls into two categories: lighting and precise microclimate control (Zheng et al. 2021). High intensity lighting is the main contributor to electricity for indoor production facilities (Zheng et al. 2021). Therefore, it is important to make sure that most of the lighting is LED and that the most efficient heating, ventilation and air-conditioning systems with integrated dehumidification equipment have been put in place. Although high-pressure sodium bulbs are inexpensive, they are not as efficient

and therefore are more expensive to maintain.

Prisons

The City of Adelanto gets approximately 10% of its revenue from the prison industry, which is composed of the Desert View Modified Community Correctional Facility, the High Desert Detention Center, the Adelanto ICE Processing Center (East and West), and the San Bernardino County Adelanto Detention Center (McBride 2021). The Adelanto ICE Processing Center and the Desert View Modified Community Correctional Facility are private prisons owned and operated by GEO Group, a national prison operator that house immigrants to the United States.

The prison industry is susceptible to the rise in cases of extreme heat and duration of extreme heat events ((Figure 4) as prisons are typically lacking in the infrastructure to mitigate hotter temperatures. Mental illness, cardiovascular disease, and pulmonary diseases have been found to increase risk of death during heat waves (Bouchama et al. 2007; Halaharvi et al. 2020). This places inmates at an increasingly vulnerable position: about 37% of inmates in state/federal prisons and 44% of inmates in locally-run jails having been diagnosed with a mental illness (Prison Policy Initiative 2022), cardiovascular disease is already one of the leading causes of death in US prisons (Wang et al. 2017), and incarceration elevate the risk of pulmonary disease (Viglianti et al. 2018). Given the toll that extreme heat days have already taken on human life (Vaidyanathan et al. 2020) it is very important that the infrastructure in the prison systems supports cooling during extreme heat days.

Recommendations

To address the impacts of current and future climate change, city officials can take steps to reduce harm and promote the resilience of the city, with the goal of improving how people and systems operate under climate-related stressors. The key variables to consider with potential recommendations to mitigate the impacts and increase resilience are described below. Some of these recommendations may address multiple variables and may already be identified in the Martinez (2020) Local Hazard Mitigation Plan for the city. Furthermore, some of these recommendations may align with features in the Sustainability Plan and city officials are encouraged to interpret the features in the context of future climate stressors during implementation of the Sustainability plan (MIG Hogle-Ireland et al. 2014). But sustainability and resilience are not the same thing, as sustainable planning is often established under stable conditions, while planning for resilience accounts for unpredictability and stressors in order to determine how systems "weather" these changes.

Temperature

Extreme heat might be the most pressing issue facing the City of Adelanto. To address this, the city can make physical adjustments to alter the heat retention of buildings and other structures. The following are a few of the main heat mitigation solutions.

1) **Roofs.** Changing roofs to increase reflectivity can cut building energy use by up to 20%. Strategies include painting roofs white or using "cool roofs," highly reflective tiles or shingles.
2) **Pavement and road surfaces.** Similar to cool roofs, the use of lighter colored paving materials with higher reflectivity such as concrete roads instead of asphalt roads reduces the urban heat island effect. Additionally, the use of more permeable pavement materials can help cool pavements by increasing evaporation (US EPA 2014).
3) **Vegetation.** Adding a layer of vegetation over roofs and walls of buildings can shade the material underneath, reducing the heat absorption of buildings. Increasing the number of trees and amount of urban vegetation coverage helps

reduce evapotranspiration. Vegetation can also help mitigate flood risk in urban areas. The choice of vegetation will need to be balanced with watering demands; in general, trees should be prioritized.

4) **Community spaces and community cooling centers.** Creating community cooling centers provides places for residents to congregate during extreme hear events. Developing the infrastructure provides opportunities to hire local construction and landscaping companies and increase the attractiveness of the city, providing welcoming urban area for City of Adelanto residents and increasing business for the city's restaurants and shops.
5) **Electrification and use of solar on residential, commercial and industrial buildings should be prioritized.** Every effort should be made to increase the capacity of the grid using renewable sources. Caution should be used in covering desert lands with solar arrays, as these impact habitat and environmental conditions.
6) **Creating a tree plan.** Tree planning is essential for the long-term health of the city. The city should conduct a shade equity audit between North and South Adelanto, and should consider utilizing recycled water or water that may not be suitable for human consumption to establish a stronger tree canopy. In addition, newer, innovative water catchment and graywater systems should be prioritized. Residents should be offered water subsidies to plant and maintain trees in the immediate and long term. Appropriate native species of trees and vegetation should be prioritized.

Flooding

Flooding is not likely to be a frequent concern to the City of Adelanto; however, 100-year flood events may occur more frequently than in the past. There are multiple mitigation strategies that could be used in this scenario of extreme flooding.

1) **Flood easements.** Leveraging flood easements to prevent accumulation of water, including physical removal of structures in the direct flood path and the creation of debris basins, levees and berms, and debris deflectors. Where appropriate, construct drainage channels and increase riverbank stability

(O'Brien and Garcia 2011).

2) **Flood barriers.** Constructing barriers to keep flood water away from structures. These barriers can be built out of dirt or soil, berms, concrete, or steel.
3) **Drainage.** Updating the city's Master Plan of Drainage to account for increases in frequency and impact of severe flooding events.
4) **Flood risks.** Ensuring people living in flood risk areas are aware of their location and the possibility of flooding in the area. Residents should have access to education regarding relocation and evacuation. This may include alluvial fan flood hazard mapping to identify homes and business in flood prone, including mudslides and debris flows, under future climate scenarios.
5) **Communication.** Providing people living in flood zones with information about and access to National Flood Insurance.

Water

Water conservation plans are important to consider due to more sporadic precipitation events and increased evapotranspiration. There are many mitigation strategies for water conservation and responsible use, many of which are detailed in the Reyes et al. (2020) Urban Water Management Plan.

1) **Water conservation.** Reducing water waste by preventing flooding or unnecessary runoff in gutters, driveways, and streets, limiting watering of lawns, trees, shrubs, or other landscaping to only what is necessary to sustain life, stopping washing of sidewalks, walkways, driveways, parking areas, etc.
2) **Water storage.** Promoting water storage through permeable surfaces that allow water to percolate through the surface back into the ground.
3) **Water use reduction.** Implementing the use of recycled water in cooling systems, low-flush toilets, and low-flow showerheads.
4) **Investigation of alternative water systems.** A great deal of research is being conducted about carbon neutral or negative water production systems that can function independent of an existing water system. We recommend some of these systems be assessed for strategic placement during climate emergency, tree

canopy or green infrastructure development, or daily usage.

5) **Communication.** Educating the community and businesses on decreasing water usage. Educating community members about Adelanto's Water Shortage Contingency Plan to ensure the community is aware of the city's preparedness and steps they may need to possibly take in the future.
6) **Address water quality.** Right now, the quality of Adelanto's water is of concern. Every effort should be made to protect and remediate water hazards so that the water coming to Adelanto residents is clean and safe.

Wildfires

Wildfire risk is usually associated with wildland-urban interface (WUI) areas, areas of transition between undeveloped wild land and land that has undergone human development and has manmade structures. Wildfires can cause power outages by destroying power lines, can negatively impact infrastructure, and harm people. Important wildfire mitigation strategies include:

1) **Defensible spaces.** Creating "defensible space" by moving fuel away from buildings. This may include educating community members as to what vegetation and other items are flammable and implementation of vegetation management plans to enforce the defensible space.
2) **Infrastructure.** Maintaining infrastructure, including power lines, in good condition since fires can lead to power outages from damaged lines.
3) **Communication.** Educating the community on wildfire risk and developing evacuation plans in case of a wildfire event.

Energy

Increasing temperatures will raise demand for energy for cooling and decrease efficiency of energy production, which may cause major disruptions to power grids. Increasing energy efficiency and local energy sources are useful methods for increasing efficiency and resilience are. Important strategies include:

1) **Demand.** Reducing the demand on heating, cooling, and lighting through the addition of insulation to facility walls and roofs, upgrading windows and outside

doors, and minimizing building areas that might be more susceptible to heat loss.

2) **Solar.** Using passive solar: south facing windows with overhangs can heat in the winter when the angle of the sun is low but receive shade in the summer; always shade east/west windows.
3) **Efficiency.** Installing more efficient boilers and heaters to reduce energy use. Using energy efficient lighting with occupancy or daylight sensors
4) **Renewable energy.** Increasingly implement local/regional and renewable energy sources, including solar power, to reduce dependency on conventional power plants and energy from other locations.
5) **Waste minimization.** Minimizing waste production and water use by composting, using low flow appliances, and capturing and reusing grey water for things like irrigation or toilets increases energy efficiency by reducing reliance on waste transportation while also building resilience through reuse (Feldbaum et al. 2011).
6) **Infrastructure.** Working with public utilities and large energy consumers to ensure that the infrastructure can meet the demands of renewable energy and increased peak demand.

Dust

Production of health-impacting dust will increase with drought, wildfires, shifts in vegetation and land use, and wind erosion. There are a few mitigation strategies to reduce dust:

1) **Vegetation.** Re-vegetating bare areas and limiting future removal of natural vegetation, particularly from dunes and slopes.
2) **Suppressants.** Applying gravel or dust suppressants on unpaved roads.
3) **Sensitive areas.** Using spatial information to identify sensitive areas where land use that disturbs vegetation and soil surfaces would most exacerbate dust production.
4) **Minimization.** Minimizing industries that create additional dust
5) **Landscaping.** Continuing to implement sustainable landscaping, such as using native desert plant species, decreasing the use of pavement and grass, and

having 50 percent of the ground covered by vegetation.

Industry

Industry is an integral part of the City of Adelanto. Boosting industries' resilience will help the City of Adelanto become more sustainable. Some suggestions for industry include:

1) **Renewable energy.** Increasing renewable and/or local energy including adding rooftop solar to large industrial facilities.
2) **Communication.** Transferring technology between industries and the city to minimize energy and water use.
3) **Holistic Strategies.** Adopting life-cycle thinking (to reduce carbon footprint and maximize efficiency).

References

Bai, Y., T. A. Scott, and Q. Min. 2013a. Climate change implications of soil temperature in the Mojave Desert, USA. Front. Earth Sci. **8**: 302–308, doi:10.1007/s11707-013-0398–3.

Bai, Y., T. A. Scott, and Q. Min. 2013b. Impacts of soil climate on desert scrubs distribution in the Mojave Desert. Arid Land Res. Manag. **27**: 79–89, doi:10.1080/15324982.2012.719572.

Basu, R., L. Gavin, D. Pearson, K. Ebisu, and B. Malig. 2018. Examining the association between apparent temperature and mental health-related emergency room visits in California. Am. J. Epidemiol. **187**: 726–735, doi: 10.1093/aje/kwx295.

Bedsworth, L., D. Cayan, G. Franco, L. Fisher, and S. Ziaja. 2018. Statewide Summary Report. California's Fourth Climate Change Assessment. SUMCCCA4-2018–013. SUMCCCA4-2018–013 California Governor's Office of Planning and Research, Scripps Institution of Oceanography, California Energy Commission, California Public Utilities Commission.

Beland, D., and D. L. Borg. 2021. Climate Change Adaptation. Sustainability Roadmap 2020-2021. California Department of Corrections and Rehabilitation, California Department of Corrections and Rehabilitation.

Berg, N., and A. Hall. 2015. Increased interannual precipitation extremes over California under climate change. J Clim **28**: 6324–6334.

Bouchama, A., M. Dehbi, G. Mohamed, F. Matthies, M. Shoukri, and B. Menne. 2007. Prognostic Factors in Heat Wave–Related Deaths: A Meta-analysis. Arch. Intern. Med. **167**: 2170–2176, doi:10.1001/archinte.167.20.ira70009.

City of Adelanto. 2020. City of Adelanto 2020 Consumer Confidence Report.

Constible, J., C. Morganelli, and K. Berquist. 2019. Climate change and health in California. Natural Resource Defense Council Issue Brief. Natural Resource Defense Council Issue Brief.

Cook, B. I., T. R. Ault, and J. E. Smerdon. 2015. Unprecedented 21st century drought risk in the American Southwest and Central Plains. Sci. Adv. **1**: e1400082, doi: 10.1126/sciadv.1400082.

Dettinger, M., B. Udall, and A. P. Georgakakos. 2015. Western Water and Climate Change. Ecol. Appl. **25**: 2069–2093, doi:10.1890/15-0938.1.

Dillis, C., V. Butsic, J. Carah, S. C. Zipper, and T. Grantham. 2021. Cannabis farms in California rely on wells outside of regulated groundwater basins. Environ. Res. Commun. **3**: 07005, doi:10.1088/2515-7620/ac1124.

Duniway, M. C., A. A. Pfennigwerth, S. E. Fick, T. W. Nauman, J. Belnap, and N. N. Barger. 2019. Wind erosion and dust from US drylands: A review of causes, consequences, and solutions in a Changing World. Ecosphere **10**: doi: 10.1002/ecs2.2650.

Enviromental Protection Agency. 2016. What climate change means for California. EPA 430-F-16-007. EPA 430-F-16-007.

Fan, Y., and H. van den Dool. 2008. A global monthly land surface air temperature analysis for 1948 – present. J. Geophys. Res. **13**: D01103, doi:10.1029/2007JD008470.

Feldbaum, M., F. Greene, S. Kirschenbaum, D. Makamal, M. Welsh, and R. Pinderhughes. 2011. The Greening of Corrections: Creating a Sustainable System. NIC Accession Number 024914. NIC Accession Number 024914 U.S. Department of Justice National Institute of Corrections.

Gauderman, W. J., R. Urman, E. Avol, and others. 2015. Gauderman WJ, Urman R, Avol E, Berhane K, McConnell R, Rapport E, Chang R, Lurmann F, Gilliland F. Association of improved air quality with lung development in children. N Eng J Med. 2015; 372: 905-913. N. Engl. J. Med. **372**: 905–913.

Grodsky, S. M., J. W. Campbell, and R. R. Hernandez. 2021. Solar energy development impacts flower-visiting beetles and flies in the Mojave Desert. Biol. Conserv. **263**: doi: 10.1016/j.biocon.2021.109336.

Halaharvi, H., P. Schramm, and A. Vaidyanathan. 2020. Heat Exposure and Cardiovascular Health: A Summary for Health Departments. Climate and Health Program, Centers for Disease Control and Prevention.

Hopkins, F. M. 2018. Inland Deserts Region Report. SUM-CCCA4-2018-008. SUM-CCCA4-2018-008 University of California, Riverside.

Huntington, S. 2020. Is Climate Change Having An Impact On Manufacturing? Online Trade Mag. Altern. Energy Sol. Wind Biomass Fuel Cells More

Inman, R. D., T. C. Esque, K. E. Nussear, P. Leitner, M. D. Matocq, P. J. Weisbert, and T. E. Dilts. 2016. Impacts of climate change and renewable energy development on habitat of an endemic squirrel, Xerospermophilus mohavensis, in the Mojave Desert, USA. Biol. Conserv. **200**: 112–121, doi:10.1016/j.biocon.2016.05.033.

Johnson, S. L., C. R. Kuske, T. D. Carney, D. C. Housman, L. V. Gallegos-Graves, and J. Belnap. 2012. Increased temperature and altered summer precipitation have differential effects on biological soil crusts in a dryland ecosystem. Glob. Change Biol. **18**: 2583–2593, doi:10.1111/j.1365-2486.2012.02709.x.

Khosronejad, A., S. Kang, and K. Flora. 2019. Fully coupled free-surface flow and sediment transport modelling of flash floods in a desert stream in the Mojave Desert, California. Hydrol Process **33**: 2772–2791.

Knowlton, K., M. Rotkin-Ellman, L. Geballe, W. Max, and G. M. Solomon. 2011. Six Climate Change–Related Events In The United States Accounted For About $14 Billion In Lost Lives And Health Costs. Health Aff. (Millwood) **30**: doi:10.1377/hlthaff.2011.0229.

Landstedt Consulting. 2021. Water Shortage Contingency Plan.

Li, Z., and H. Fang. 2016. Impacts of climate change on water erosion: A Review. Earth-Sci. Rev. **163**: 94–117.

Mann, M., and P. H. Gleick. 2015. Climate change and California drought in the 21st century. Proc. Natl. Acad. Sci. **112**: 3858–3859.

Martinez, D. 2020. Local hazard mitigation plan. Adelanto, CA: City of Adelanto.

Masson-Delmotte, V. P., P. Zhai, A. Pirani, and others. 2021. IPCC: Summary for Policymakers.

McBride, S. 2021. Elon Musk's Boring Company Finds Paradise in Town With 'Plenty of Dirt.' Bloom. Businessweek Bloom.

McGee, C. 2021. High Desert air quality faces harmful pollutants from two sides as South Fire adds to ongoing leak of northern wildfire smoke. Victorville Dly. Press

Menne, M. J., I. Durre, R. S. Vose, B. E. Gleason, and T. G. Houston. 2012. An Overview of the Global Historical Climatology Network-Daily Database. J. Atmospheric Ocean. Technol. **29**: 897–910. doi:10.1175/JTECH-D-11-00103.1

MIG Hogle-Ireland, FORMA, Fehrs & Peers, C&V Consulting, Inc., Stanley R, Hoffman Associates, and Candida Neal, AICP. 2014. Adelanto North 2035 Comprehensive Sustainable Plan.

Moret, B., and A. Schwertner. 2020. Why Sustainable Manufacturing Makes Economic as Well as Ethical Sense. World Econ. Forum

Mosley, L. 2015. Drought impacts on the water quality of freshwater systems; review and integration. Earth-Sci. Rev. **140**: 203–214, doi:10.1016/j.earscirev.2014.11.010.

National Cannabis Industry Association. 2020. Environmental Sustainability in the Cannabis Industry: Impacts, best managements practices, and policy considerations.

National Oceanic and Atmospheric Administration. 2021. Heat stress datasets and documentation.

National Resource Conservation Service. 2019. USA Soils Map Units.

Oberle, B., S. Bringezu, S. Hatfield-Dodds, S. Hellweg, H. Schandl, J. Clement, and et al. 2019. Global Resources Outlook 2019: Natural Resources for the Future We Want. A Report of the International Resource Panel. United Nations Environment Programme.

O'Brien, J. S., and R. Garcia. 2011. New Approaches for Alluvial Fan Flood Hazard, p. 59–87. *In* Flood Hazard Identification and Mitigation in Semi- and Arid Environments. WORLD SCIENTIFIC.

Placeworks, and Dudek. 2018. Safety Background Report.

Prison Policy Initiative. 2022. Mental Health: Policies and Practices Surrounding Mental Health.

Radeloff, V. C., D. P. Helmers, H. A. Kramer, M. H. Mokrin, P. M. Alexandre, A. Bar-Massada, and et al. 2018. Rapid growth of the US wildland-urban interface raises wildfire risk. Proc. Natl. Acad. Sci. **115**: 3314–3319, doi:10.1073/pnas.1718850115.

Reyes, G., D. Ramos, J. Jeanette, S. Evans, and J. Flores. 2021. 2020 Urban Water Management Plan. Adelanto, CA: City of Adelanto.

Rolinski, T., S. B. Capps, and W. Zhuang. 2019. Santa Ana Winds: A Descriptive Climatology. Weather Forecast. **34**: 257–275. doi:10.1175/WAF-D-18-0160.1

Ryder System, Inc. 2021. Supply Chain Transparency Creates Resilient Operations. Forbes

Simoni, M., S. Baldacci, S. Maio, S. Cerrai, G. Sarno, and G. Viegi. 2015. Adverse effects of outdoor pollution in the elderly. J. Thorac. Dis. **7**: 34–45, doi:10.3978/j.issn.2072-1439.2014.12.10.

Southern California Association of Governments. 2019. Profile of the City of Adelanto.

Thomas, N., S. Mukhtyar, B. Galey, and M. Kelly. 2018. Cal-Adapt: Linking Climate Science with Energy Sector Resilience and Practitioner Need. CCCA4-CEC-2018–015. CCCA4-CEC-2018–015 University of California Berkeley, California Energy Commission.

Underwood, E. C., A. D. Hollander, L. E. Flint, A. L. Flint, and H. D. Safford. 2018. Climate change impacts on hydrological services in southern California. Environ. Res. Lett. **13**: 124019. doi:10.1088/1748-9326/aaeb59

Underwood, E. C., A. D. Hollander, H. D. Safford, J. B. Kim, L. Srivastava, and R. J. Drapek. 2019. The impacts of climate change on ecosystem services in southern California. Ecosyst. Serv. **39**: doi: 10.1016/j.ecoser.2019.101008.

United States Geological Survey. Water-Level, Water-Quality and Land-Subsidence Studies in the Mojave River and Morongo Groundwater Basins.

U.S. Census Bureau. 2019. QuickFacts: Adelanto city, California.

US EPA, O. 2014. Using Cool Pavements to Reduce Heat Islands.

Vaidyanathan, A., J. Malilay, P. Schramm, and S. Saha. 2020. Heat-Related Deaths - United States, 2004-2018. MMWR Morb. Mortal. Wkly. Rep. **69**: 729–734, doi: 10.15585/mmwr.mm6924a1.

Viglianti, E. M., T. J. Iwashyna, and T. N. A. Winkelman. 2018. Mass Incarceration and Pulmonary Health: Guidance for Clinicians. Ann. Am. Thorac. Soc. **15**: 409–412. doi:10.1513/AnnalsATS.201711-895IP

Wang, E. A., N. Redmond, C. R. Dennison Himmelfarb, and others. 2017. Cardiovascular Disease in Incarcerated Populations. J. Am. Coll. Cardiol. **69**: 2967–2976. doi:10.1016/j.jacc.2017.04.040

Wang, J., Y. Hongbin, J. Anderson, E. Reyes, T. Smith, and F. Chung. 2018. Mean and Extreme Climate Change Impacts on the State Water Project. CCCA4-EXT-2018-004. CCCA4-EXT-2018-004 California Energy Commission, California Natural Resources Agency.

Warner, T. T. 2004. Desert Meteorology, Cambridge University Press.

Warren, G. S. 2015. Regulating pot to save the polar bear: Energy and climate impacts of the marijuana industry. Columbia J. Environ. Law **385**: doi:10.7916/cjel.v40i3.3541.

World Business Council for Sustainable Development. 2015. Building Resilience in Global Supply Chains.

Zhang, C., O. B. Kazanci, R. Levinson, and others. 2021. Resilient cooling strategies – A critical review and qualitative assessment. Energy Build. **251**: 111312. doi:10.1016/j.enbuild.2021.111312

Zheng, Z., K. Fiddes, and L. Yang. 2021. A narrative review on environmental impacts of cannabis cultivation. Cannabis Res. **35**: doi:10.1186/s42238-021-00090-0.