APPENDIX D

Climate Change Vulnerability Assessment

County of San Diego

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Table of Contents

Section **Page**

Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
AB	Assembly Bill
APG	California Adaptation Planning Guide
CAL FIRE	California Department of Forestry and Fire Protection
CalBRACE	California Department of Public Health’s Building Resilience Against Climate Change
CalEMA	California Emergency Management Agency
CalEPA	California Environmental Protection Agency
Caltrans	California Department of Transportation
CEC	California Energy Commission
CESA	California Endangered Species Act
CNRA	California Natural Resources Agency
County	County of San Diego
CWPP	community wildfire protections plan
DEH	County of San Diego Department of Environmental Health
EHRP	Excessive Heat Response Plan
ESA	federal Endangered Species Act
FMP	County Floodplain Management Plan
GHG	greenhouse gas
HERO	Home Energy Opportunity
HHSA	County of San Diego Health and Human Services Agency
IPCC	Intergovernmental Panel on Climate Change
LCP	Local Coastal Program
MHMP	Multi-Jurisdictional Hazard Mitigation Plan
MSCP	Multiple Species Conservation Program
OES	County of San Diego Office of Emergency Services
PHS	County of San Diego Public Health Services
SACOG	Sacramento Area Council of Governments
SB	Senate Bill
SDCWA	San Diego County Water Authority
SGMA	Sustainable Groundwater Management Act
UHIE	Urban Heat Island Effect

1 Introduction

The purpose of this vulnerability assessment is to identify the primary threats from a changing climate facing the unincorporated areas of San Diego county, and its vulnerability to these threats.

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization and the United Nations Environment Programme to provide a global scientific view on climate change and its potential effects. Global climate change has the potential to result in many adverse effects on natural resources and the human population. These include:

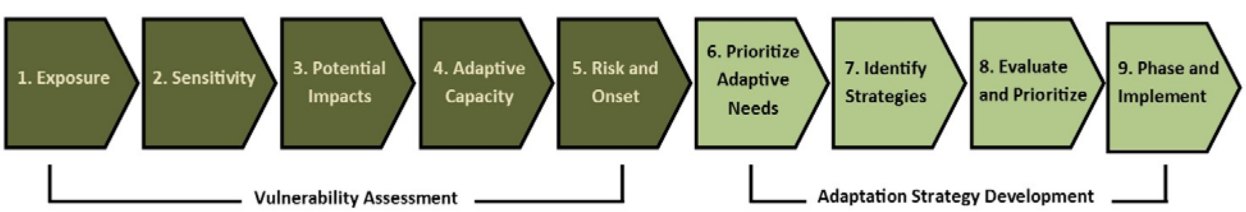
- rising sea levels around the world due to melting of polar ice caps and sea ice, which can inundate low-lying areas and increase the severity of flooding risk;
- changes in the timing or amounts of rainfall and snowfall, leading to changes in water supply;
- increased stress to vegetation and habitat, leading to adverse effects on biological resources and sensitive species;
- changes in the frequency and duration of heat waves and droughts, which can affect human populations and infrastructure on which they depend; and
- increases in wildfire hazards and related effects on forest health.

These changes over the long term have the potential for a wide variety of secondary impacts including detrimental impact on human health and safety, economic continuity, water supply, ecosystem function, and provision of basic services (California Natural Resources Agency [CNRA] 2012:3). On a more local level, climate change is already affecting, and will continue to affect, the physical environment throughout California, the Southern California region, and the county. However, specific effects and impacts of climate change on the county vary due to physical, social, and economic characteristics. For this reason, it is important to identify the projected severity these impacts could have on the county and ways vulnerability to projected climate changes can be reduced. Communities that begin to plan now will have the best options for adapting to climate change and increasing resilience (CNRA 2012:4).

2 Climate Change Adaptation Planning Process

The California Adaptation Planning Guide (APG) provides climate adaptation planning guidance to cities, counties, and local governments. The APG, developed by the California Emergency Management Agency (CalEMA) and CNRA, introduces the basis for climate change adaptation planning and details a step-by-step process for local and regional climate vulnerability assessment and adaptation strategy development (CNRA 2012:i). As shown in Figure 1, the planning process follows a sequence of steps:

Figure 1: The Nine Steps in Adaptation Planning Process



1. Exposure: assessing exposure to climate change impacts.
2. Sensitivity: assessing community sensitivity to the exposure.
3. Potential Impacts: assessing potential impacts.
4. Adaptive Capacity: evaluating existing community capacity to adapt to anticipated impacts.
5. Risk and Onset: evaluating risk and onset, meaning the certainty of the projections and speed at which they may occur.
6. Prioritize Adaptive Needs: setting priorities for adaptation needs.
7. Identify Strategies: identifying strategies to address adaptation needs.
8. Evaluate and Prioritize: evaluating and setting priorities for strategies.
9. Phase and Implementation: establishing a phasing and implementation plan.

The first five steps of the process represent the vulnerability assessment phase, which is a method for determining the potential impacts of climate change on community assets and populations. The severity of these impacts and the community's ability to respond will determine how these impacts affect a community's health, economy, ecosystems, and socio-cultural stability. The second phase of the process is adaptation strategy development, in which effective climate adaptation strategies and measures are identified and prioritized to County of San Diego (County) assets, systems or populations that may be vulnerable to climate change. Adaptation strategies cross-cut with multiple resource areas and should be aligned with other County planning efforts to be effective. Therefore, the County to address the second phase of the adaptation planning process through on-going initiatives, such as the County's portion of the Multi-Jurisdictional Hazard Mitigation Plan (MHMP), prepared by the County's Office of Emergency Services (OES), and planning initiatives, such as the Local Coastal Program (LCP), and the Multiple Species Conservation Program (MSCP). In addition, Senate Bill (SB) 379 requires the safety elements of general plans to be reviewed and updated to include climate adaptation and resiliency strategies. The County will incorporate adaptation and resiliency strategies into the next update of the Safety Element of the General Plan.

3 Vulnerability Assessment

A vulnerability assessment involves the first five steps in climate change adaptation planning development, and is intended to answer the following questions:

1. Exposure: What climate change effects will a community experience?
2. Sensitivity: What aspects of a community (i.e., functions, structures, and populations) will be affected?
3. Potential Impacts: How will climate change affect the points of sensitivity?
4. Adaptive Capacity: What is currently being done to address the impacts?
5. Risk and Onset: How likely are the impacts and how quickly will they occur?

Based on the work of IPCC and research conducted by the State and partner agencies and organizations, climate change is already affecting the county and will continue to further in the future. These effects are analyzed further below.

3.1 Step 1: Exposure

The first step in the vulnerability assessment is to identify what climate change effects the county will experience in the future. For purposes of this assessment, where possible, climate change effects in the county are characterized for two periods of time: midcentury (around 2050) and the end of the century (around 2100). Historical data are used to identify the degree of change by these two future periods in time.

The direct, or primary, changes analyzed for the county include average temperature, annual precipitation, and sea-level rise. Secondary, or indirect impacts, which can occur because of individual or a combination of these changes, are also assessed and include extreme heat and its frequency, wildfire risk, and snowpack (CNRA 2012:16-17).

To begin identifying these impacts, the APG encourages communities to use Cal-Adapt as a means of assessing potential climate change impacts over time. Cal-Adapt is a climate change scenario planning tool developed by the California Energy Commission (CEC) and the University of California Berkeley Geospatial Innovation Facility. Using the Localized Constructed Analogs technique developed by the Scripps Institution of Oceanography, Cal-Adapt downscales global climate simulation model data to local and regional resolution under two emissions scenarios: the RCP 8.5 Scenario (High-Emissions Scenario) assumes that emissions continue to rise strongly through 2050 and plateau around 2100, while the RCP 4.5 Scenario (Low-Emissions Scenario) assumes that emissions will peak at around 2040, then decline. These scenarios are composite values derived from four models selected by State agencies for the Fourth California Climate Assessment Report and characterize variations in future atmospheric conditions (i.e., HadGEM2-ES [warm and dry future conditions], CNRM-CM5 [cool and warm future conditions], CanESM2 [average future conditions], and MIRCOC5 [a complement of the aforementioned conditions]).

With the Cal-Adapt tool, users can explore projections of annually averaged maximum temperature, minimum temperature, and precipitation. Consistent with guidance provided by Cal-Adapt, this vulnerability assessment assumes the High-Emissions Scenario will be more likely to occur; however, results from both emissions scenarios are considered in this vulnerability assessment and distinguished where possible.

While Cal-Adapt provides information on a local level, county-wide data are not readily available for all climate change effects. Most of the data presented in Cal-Adapt have been “downscaled” to grid cells that are six kilometer (km) by six km (approximately 22 square miles) in size and cannot be easily aggregated. Within the unincorporated county, over a dozen grid cells are located entirely or partially within county boundaries. For purposes of this vulnerability assessment, where county-wide data were not available, a composite score for six grid cells chosen to represent climate variability in the unincorporated county is used.

Where applicable, Cal-Adapt data for each impact for the unincorporated county are summarized in the following sections Data are supplemented by additional resources where appropriate.

3.1.1 Increased Temperatures

According to IPCC, global average temperature is expected to increase relative to the 1986–2005 period by 0.3–4.8 degrees Celsius (°C) (0.5-8.6 degrees Fahrenheit [°F]) by the end of the 21st century (2081–2100), depending on future greenhouse gas (GHG) emission scenarios (IPCC 2014:SPM-8). According to CNRA, downscaling of global climate simulation model data suggests that average temperatures in California are projected to increase 2.7 °F above 2000 averages by 2050 and, depending on emission levels, 4.1–8.6 °F by 2100 (CEC 2012:2).

Figures 2 and 3 show the annual averages of observed and projected maximum temperature values under the Low-Emissions Scenario (i.e., Figure 2) and High-Emissions Scenario (i.e., Figure 3). The gray line represents observed data from 1950–2013, and the colored lines (i.e., red, green, blue, and purple) represent the four downscaled climate models for 2006–2100. Specifically, the red line shows the projections using the HadGEM2-ES model, the green line represents the CanESM2 model, the blue line depicts the CNRM-CM5 model, and the purple line shows the MIROC5 model. The oscillating nature of the graph demonstrates climate variability on a year-to-year basis. The light gray band in the background shows the lowest and highest annual average values from all downscaled climate models.

Figure 2: Projected Changes in Annual Average Maximum Temperatures under the Low-Emissions Scenario (1950–2100) (CEC 2017a)

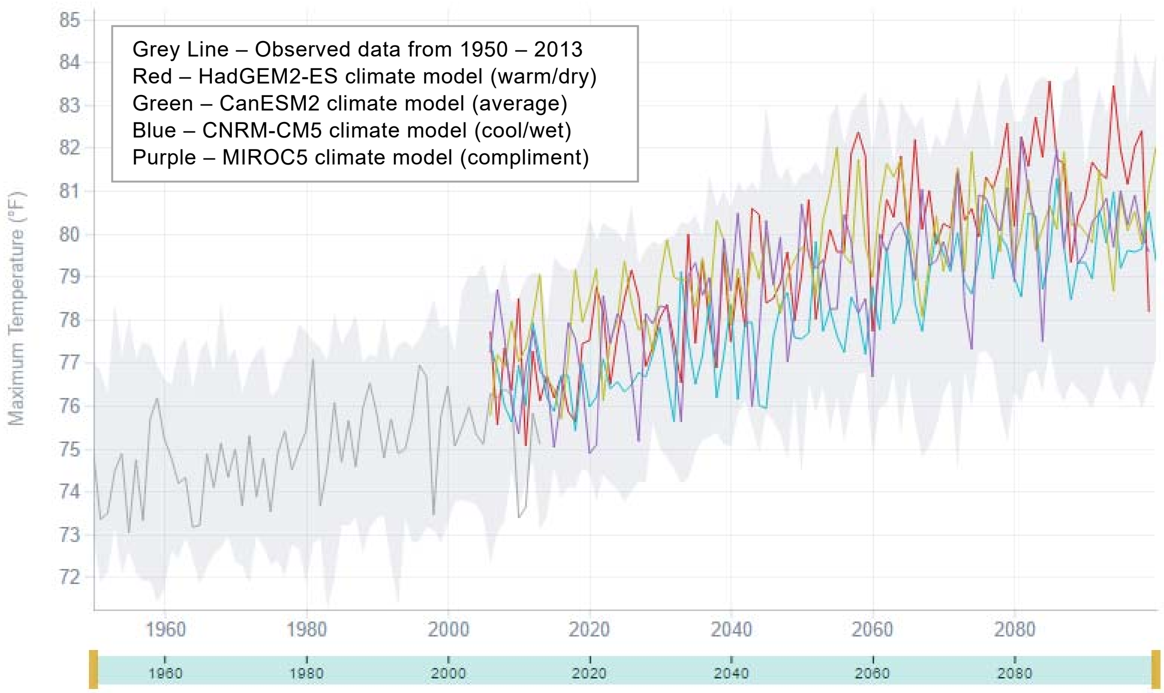
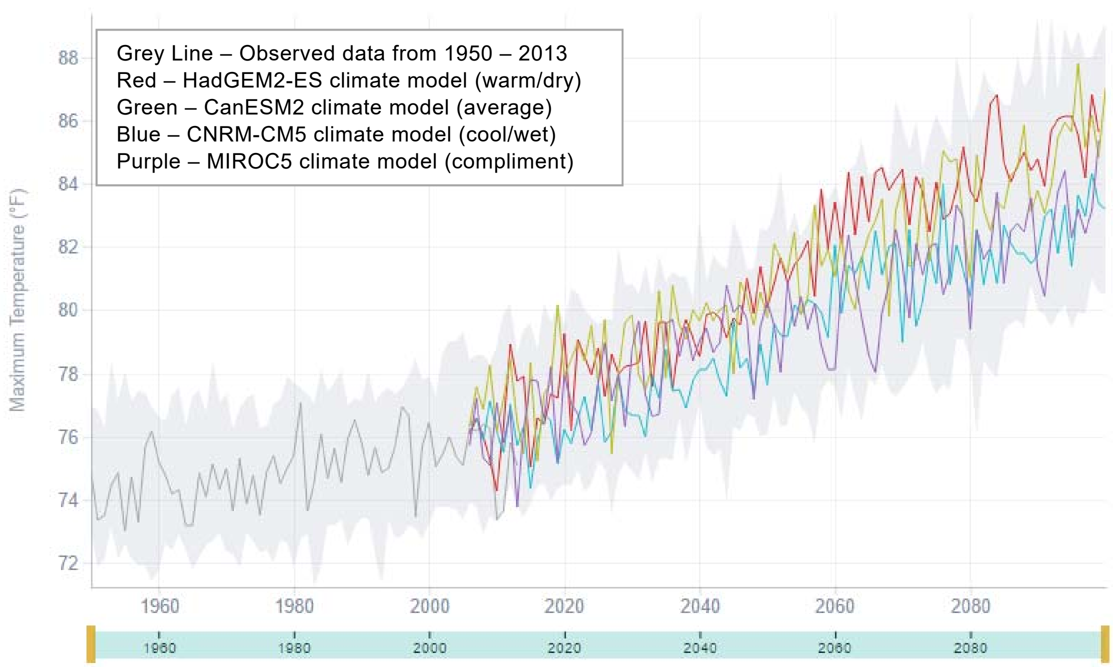


Figure 3: Projected Changes in Annual Average Maximum Temperatures under the High-Emissions Scenario (1950–2100) (Source: CEC 2017b)



Figures 2 and 3 show that annual averages of projected maximum temperature values continue to climb steadily. The county's historical average annual maximum temperature, based on historical data from 1950 to 2005, is 74.9 °F. Under the Low-Emissions Scenario shown in Figure 2, annual average maximum temperature is projected to increase to 79.8 °F by the end of the century (2099), an increase of 4.9 °F (CEC 2017a). The annual average maximum temperature under the High-Emissions Scenario shown in Figure 3 is projected to increase 9.9 °F to 84.8 °F by the end of the century (2099) (CEC 2017b).

Figures 4 and 5 illustrate the annual averages of observed and projected minimum temperature values under the Low-Emissions Scenario (i.e., Figure 4) and High-Emissions Scenario (i.e., Figure 5).

The county's average annual minimum temperature, based on historical data from 1950 to 2005, is 47.8 °F. Under the Low-Emissions Scenario shown in Figure 4, annual minimum temperature is projected to increase to 53.3 °F by the end of the century (2099), an increase of 5.5 °F (CEC 2017c). The annual average minimum temperature under the High-Emissions Scenario shown in Figure 5 is projected to increase to 57.7 °F by the end of the century (2099), an increase of 9.9 °F (CEC 2017d).

Figure 4: Projected Changes in Annual Average Minimum Temperatures under the Low-Emissions Scenario (1950–2100) (Source: CEC 2017c)

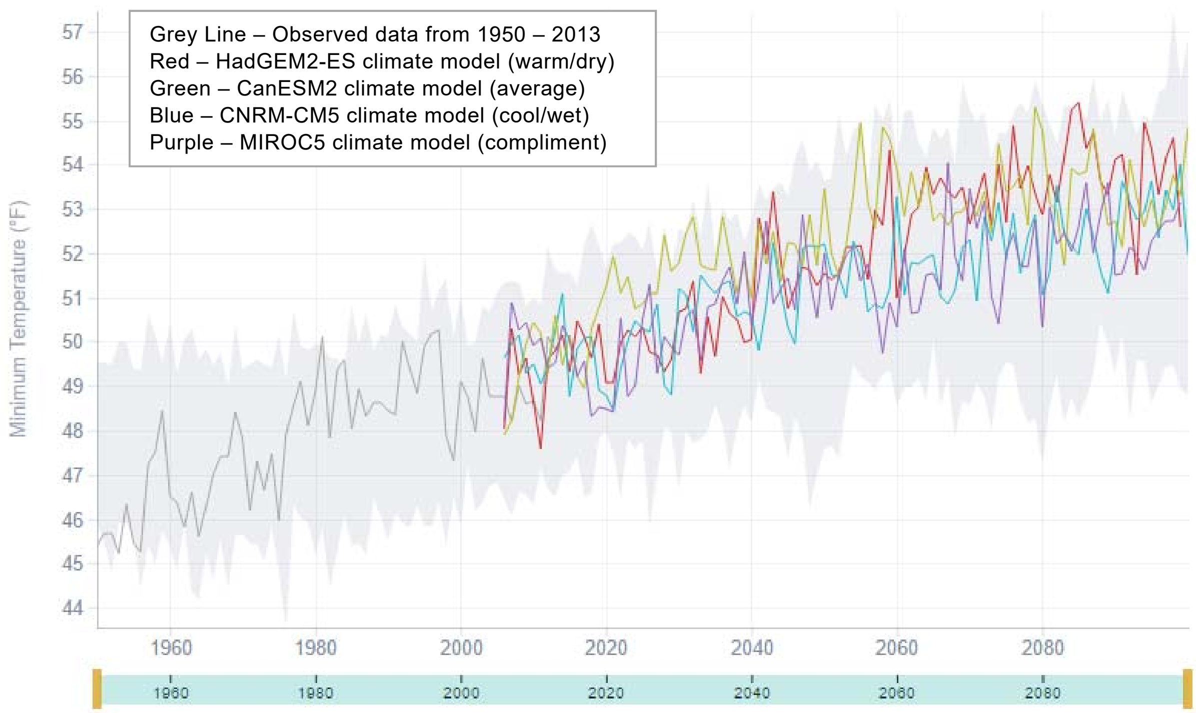
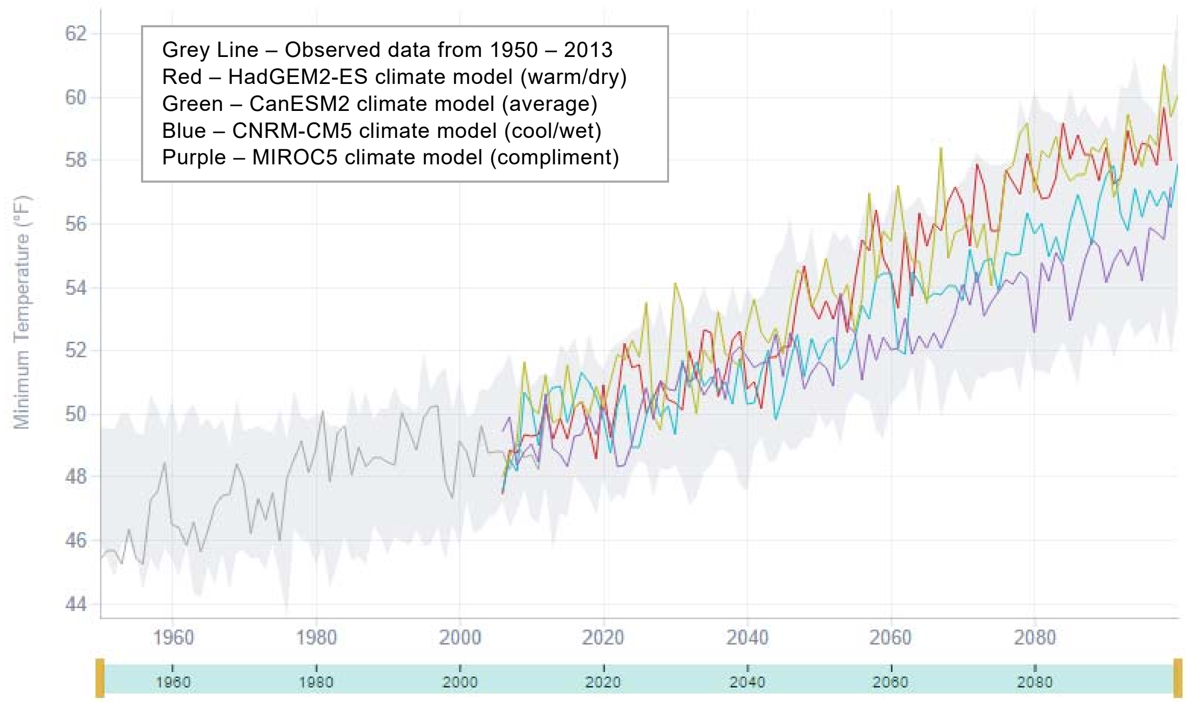


Figure 5: Projected Changes in Annual Average Minimum Temperatures under the High-Emissions Scenario (1950–2100) (Source: CEC 2017d)



Extreme Heat Events

Increased temperature is expected to lead to secondary climate change impacts, including increases in the frequency, intensity, and duration of extreme heat days in California. Using Cal-Adapt's Extreme Heat tool, historical data from the county were used to project the change in frequency and timing (in the calendar year) of extreme heat days for the Low- and High-Emissions Scenarios in 2050 and at the end of the century (2099).

Cal-Adapt defines the extreme heat day threshold for the county as 96.3 °F or higher. An extreme heat day is defined as a day between April 1st through October 31st where the maximum temperature exceeds the historical maximum temperatures from 1961-1990. The county had a historical average of 4.2 extreme heat days a year between 1950 and 2005. Figures 6 and 7 show the number of days the county is projected to exceed the area's extreme heat day threshold for each year from 1950 to 2100 under both emissions scenarios. The gray line represents observed data from 1950-2013 and the colored lines are projections from four leading climate models selected for California.

Figure 6: Projected Changes in Number of Extreme Heat Days under the Low-Emissions Scenario (1950–2100) (Source: CEC 2017e)

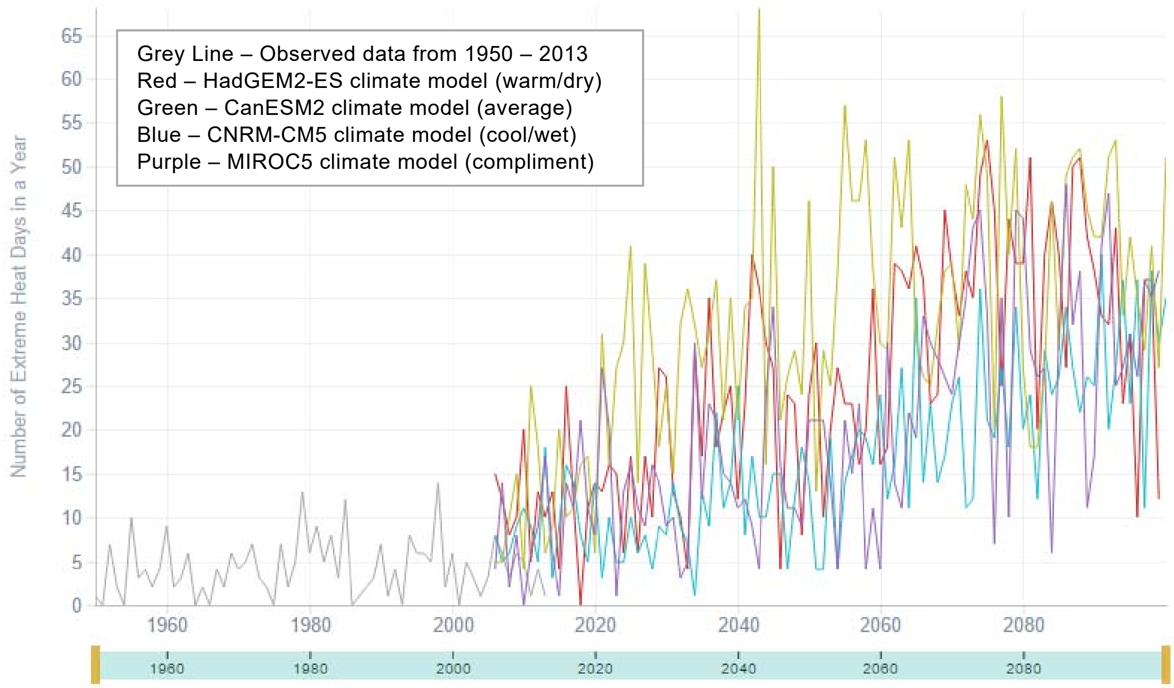
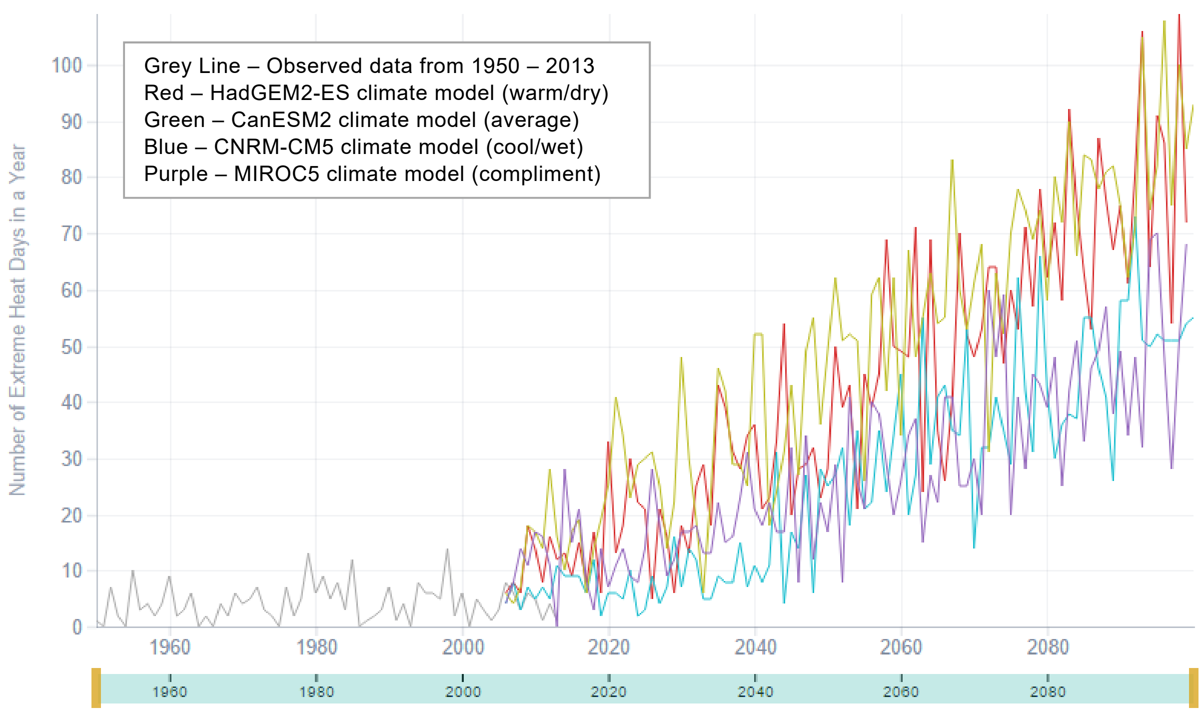


Figure 7: Projected Changes in Number of Extreme Heat Days under the High-Emissions Scenario (1950–2100) (Source: CEC 2017f)



As shown in Figures 6 and 7, the number of extreme heat days is projected to go up by the end of the century. To account for variable uncertainty on a year-to-year basis, an average composite score was developed over the course of the last decade of the century (2090–2099) for the Low- and High-Emissions Scenarios. Under the Low-Emissions Scenario, the county is projected to experience an average of 33 extreme heat days between 2090 to 2099, an increase of about 29 days. Under the High-Emissions Scenario, the county is projected to experience an average of 67 extreme heats days between 2090 to 2099, an increase of about 63 days.

The number of extreme heat days may also occur over an extended period throughout the year as compared to historical records. Heat days may manifest earlier in the year and continue to occur in later months. Figures 8 and 9 plot extreme heat days by their historic and projected occurrence over the calendar year under both emissions scenarios between 1950–2099. For both figures, each point represents a day exceeding the extreme heat day threshold for the county graphed by time of occurrence in the period in which extreme heat days can occur (i.e., between April and October).

Figure 8: Projected Changes in the Timing of Extreme Heat Days under the Low-Emissions Scenario (1950–2100) (Source: CEC 2017g)

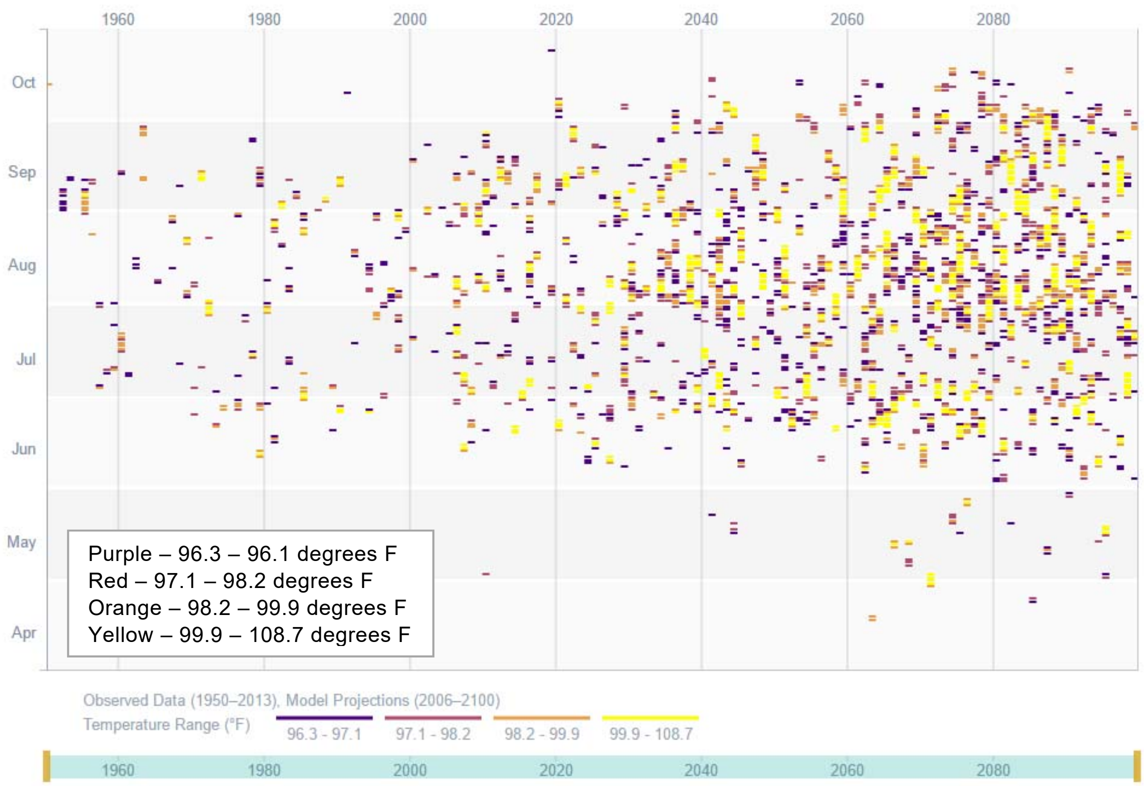
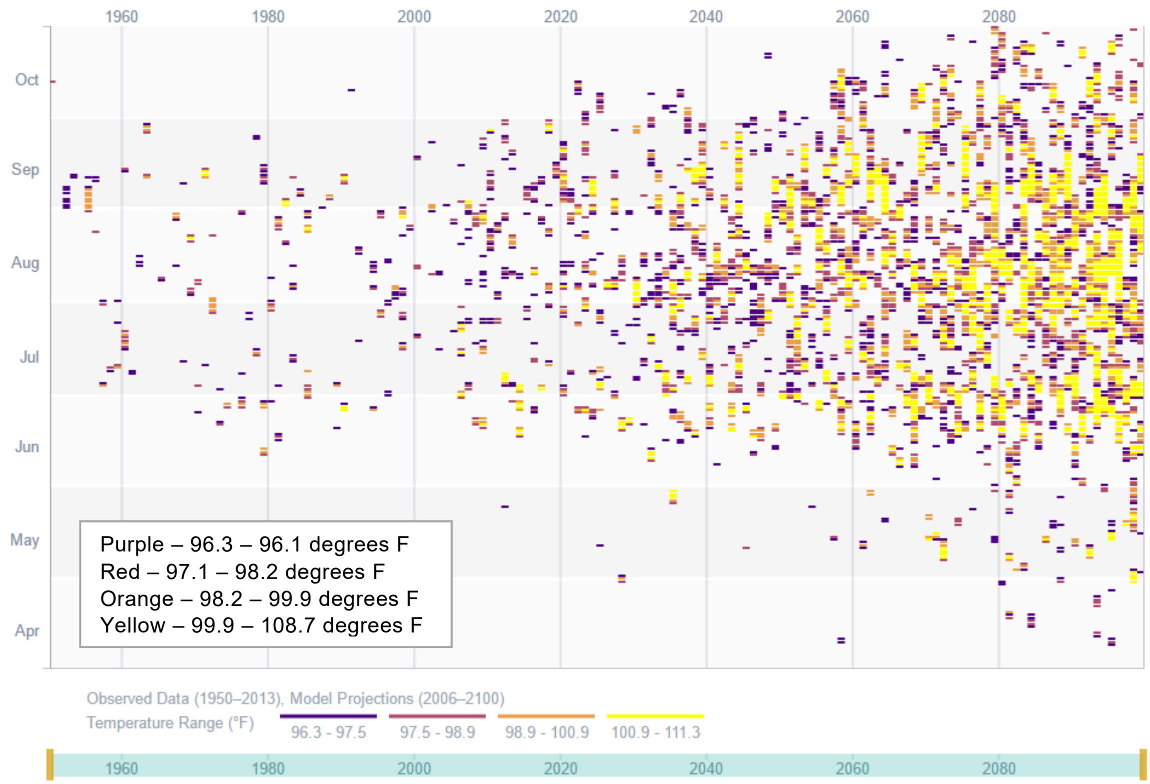


Figure 9: Projected Changes in the Timing of Extreme Heat Days under the High-Emissions Scenario (1950–2100) (Source: CEC 2017h)



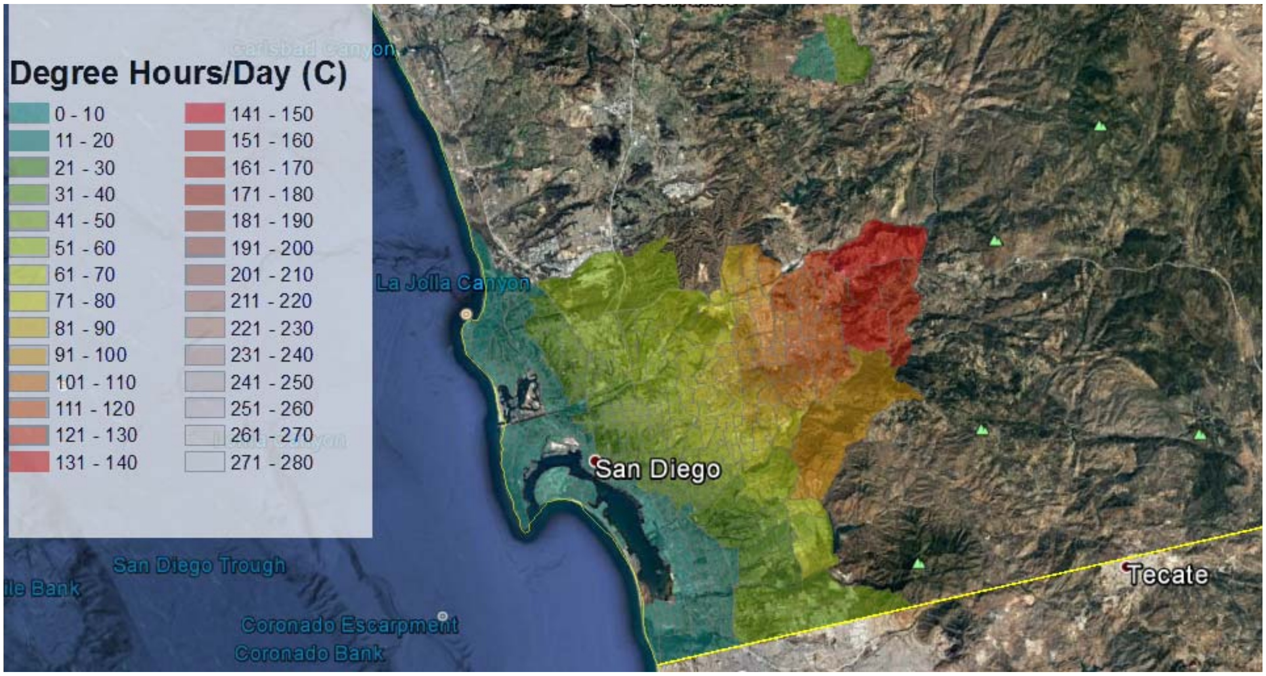
Urban Heat Island Effect

Locations where development dominates the landscape experience higher temperatures due to the Urban Heat Island Effect (UHIE), compared to landscapes that support mostly landscaped or natural vegetation features (e.g., grass, trees). Human-made materials, such as asphalt and concrete, absorb heat and alter microclimate conditions by several degrees, exacerbate emissions of air pollutants, and increase the rate of photochemical production of ozone. The impacts of UHIE are more pronounced in the summer months when daily temperatures are highest during the year, leading to degraded air quality or increased heat exposure. The county has among the highest percentages of impervious surfaces in the state, increasing the potential impacts of UHIE (OES 2014).

The effects of UHIE are heavily influenced by local wind patterns and can be distributed regionally. Assembly Bill (AB) 296 tasked the California Environmental Protection Agency (CalEPA) with defining UHIE, developing an index to track it, and producing a standard specification for sustainable or cool pavements. Pursuant to AB 296, CalEPA developed a study and an interactive map to track the effects of UHIE throughout the state. The study and map demonstrate how local wind patterns dissipate the adverse impacts of UHIE. The UHIE index is a function of heat and time whereby a rating is given based on degrees Celsius over a period of time and is reported in degree-hours per day. For example, an area that experiences an increase of six degrees over the course of eight hours would have a UHIE index value (degree-hours per day) of 48.

With respect to the county, UHIE-related impacts are dispersed by coastal wind patterns. These westerly winds blow in from the ocean and help disperse heat and air pollutants inland. As demonstrated in Figure 10, which displays the county's UHIE index developed by CalEPA, the UHIE manifests in the southern portion of the county and incrementally increases in the east of the incorporated City of San Diego. These elevated temperatures occur due to the movement of heat originating in urbanized areas of the county as a result of oceanic wind patterns.

Figure 10: Urban Heat Island Index for San Diego County (CalEPA 2015)



3.1.2 Changes to Precipitation Patterns

Global climate change will affect physical conditions beyond average temperatures, including changes to precipitation patterns. While projections generally show little change in total annual precipitation in California and trends are not consistent, even modest changes could have a significant effect on California ecosystems that are conditioned to historical precipitation levels. Reduced precipitation could lead to higher risks of drought, while increased precipitation could cause flooding and soil erosion (CNRA 2014:25). Changes in weather patterns resulting from increases in global average temperatures could also result in a decreased volume of precipitation falling as snow in California and an overall reduction in snowpack in the Sierra Nevada. Based upon historical data and modeling, the California Department of Water Resources (DWR) projects that the Sierra snowpack will decrease by 25 to 40 percent from its historic average by 2050 and 48 to 65 percent by 2100 (DWR 2008:4, 2013:3-64).

While the county is not located in an area where snow typically accumulates, major water districts and utilities in the county receive about 20 percent of total water from the State Water Project, which depends on spring and early-summer snowmelt in the Sierra Nevada for water supply. Sixty-four percent of water supply comes from the Colorado River, 70 percent of which heads in the high elevations of the Rocky Mountains (San Diego County Water Authority [SDCWA] 2016, Christensen et al. 2004). The unincorporated county overlays 37 discrete groundwater basins which supply about six percent of the county's water supply. The State has designated four of these basins as medium-priority and subject to the Sustainable Groundwater Management Act (SGMA) (i.e., Borrego Valley, San Diego River Valley, San Luis Rey Valley, and San Pasqual Valley) (County of San Diego).

Cal-Adapt's Annual Averages Tool depicts an annual average precipitation from 1950 to 2005 of 14.6 inches. Under the Low-Emissions Scenario (Figure 11), annual precipitation in the county is projected to be 15.6 inches per year by the end of the century (2099), a rise of 1 inch. Under the High-Emissions Scenario (Figure 12), annual precipitation is projected to be 19.3 inches by the end of the century (2099), a rise of 4.7 inches.

Figure 11: Projected Changes in Precipitation under the Low-Emissions Scenario (1950–2100) (Source: CEC 2017i)

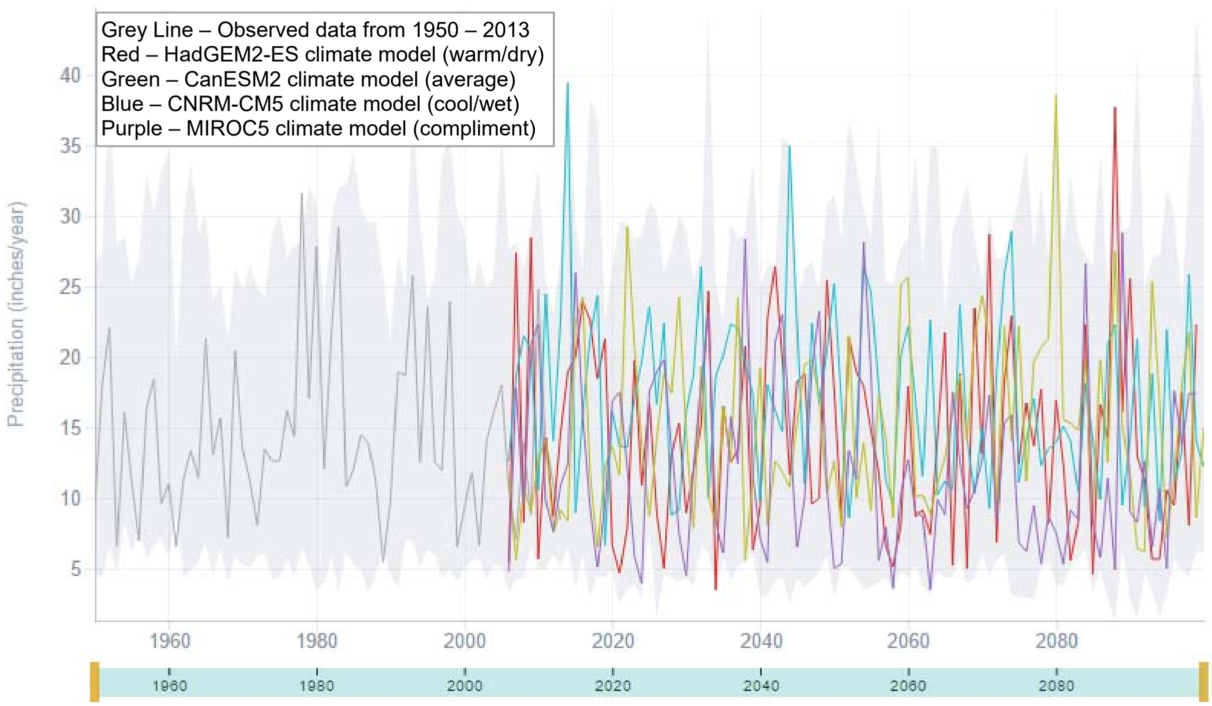
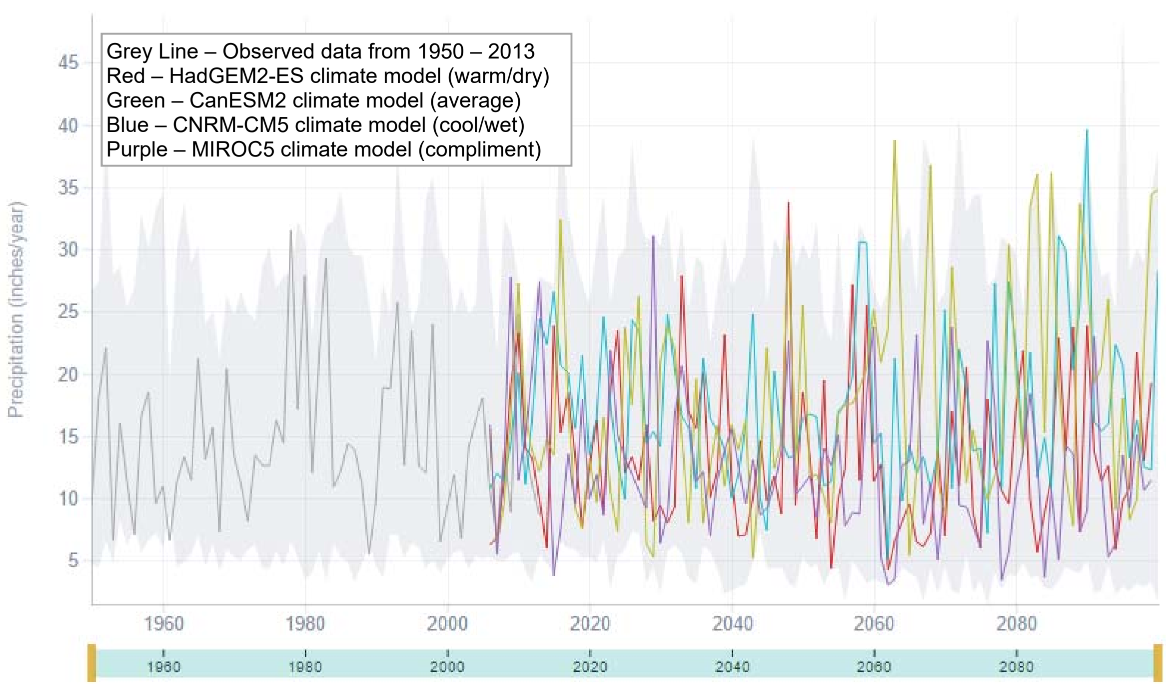


Figure 12: Projected Changes in Precipitation under the High-Emissions Scenario (1950–2100) (Source: CEC 2017j)



3.1.3 Increased Wildfire Risk

Changes in precipitation patterns and increased temperatures associated with climate change will alter the distribution and character of natural vegetation and associated moisture content of plants and soils. (CEC 2012:11). Increased temperature and frequency of extreme heat events, along with changes in precipitation patterns, can lead to a secondary impact of climate change: an increase in the frequency and intensity of wildfires (CNRA 2012:17).

The county's topography consists of a semi-arid coastal plain and rolling highlands which, when fueled by shrub overgrowth, occasional Santa Ana winds and high temperatures, creates an ever-present threat of wildland fire. Extreme weather conditions such as high temperature, low humidity, and/or winds of extraordinary force may cause an ordinary fire to expand into a less controllable, more intense fire.

According to San Diego's 2015 MHMP, the county and its incorporated cities have a history of wildfires, with more than 1,000,000 acres of the region's 2,897,000 acres burned since 1950 (OES 2014:4-43). In October of 2003, the second worse wildland fire in the county destroyed 332,766 acres of land, 3,239 structures, and 17 deaths costing $450 million. The county's worst fire occurred in October 2007. The wildland fire was composed of seven separate fires destroying 367,000 acres, 2,670 structures, 239 vehicles, and 10 civilian deaths (OES 2014:4-42).

CalAdapt's wildfire tool estimated an average of 21,042 acres each year from 1950 through 2005 due to wildfire in the county. Under the Low-Emissions Scenario, the tool projects an annual average of 17,971 acres of burned land by 2050 and 24,546 acres by 2099. Under the High-Emissions Scenario, an annual average of 20,972 acres are expected to burn in 2050 increasing to 29,499 acres by 2099 (CEC 2017).

Notably, Cal-Adapt's wildfire tool is based solely on climate projections and do not take landscape and fuel sources into account. New fire risk projections are currently being produced that take more landscape information into account.

3.1.4 Increased Likelihood of Flooding

Climate change is likely to lead to changes in frequency, intensity, and duration of extreme events, such as heavy precipitation and rainfall intensity. These projected changes could lead to increased flood magnitude and frequency and could place more pressure on the county, destroying land, buildings, roads, and crops (IPCC 2001:14).

Average annual precipitation in the county ranges from 10 inches on the coast to approximately 45 inches on the highest point of the Peninsular Mountain Range that transects the county, and 3 inches in the desert east of the mountains. Several factors determine the severity of floods, including rainfall intensity and duration. Flash floods occur when a large amount of rain falls over a short period of time. The National Weather Service's definition of a flash flood is a flood occurring in a watershed where the time of travel of the peak of flow from one end of the watershed to the other is less than 6 hours. There are no watersheds in the county that have a longer response time than 6 hours (OES 2014).

Seven principle streams originate or traverse through the area. From north to south they are the Santa Margarita, San Luis Rey, San Dieguito, San Diego, Sweetwater, Otay, and Tijuana Rivers. Coastal areas, including bays, coastal inlets, and estuaries are considered to be within the Federal Emergency Management Agency's (FEMA's) definition of a 100-year flood plain (i.e., areas with a 1 percent chance, on average, of flooding in any given year) (OES 2014).

In the county, flooding impacts will be most severe when combined with sea-level rise. As such, flooding exposure as it relates to sea-level rise is discussed in the following section.

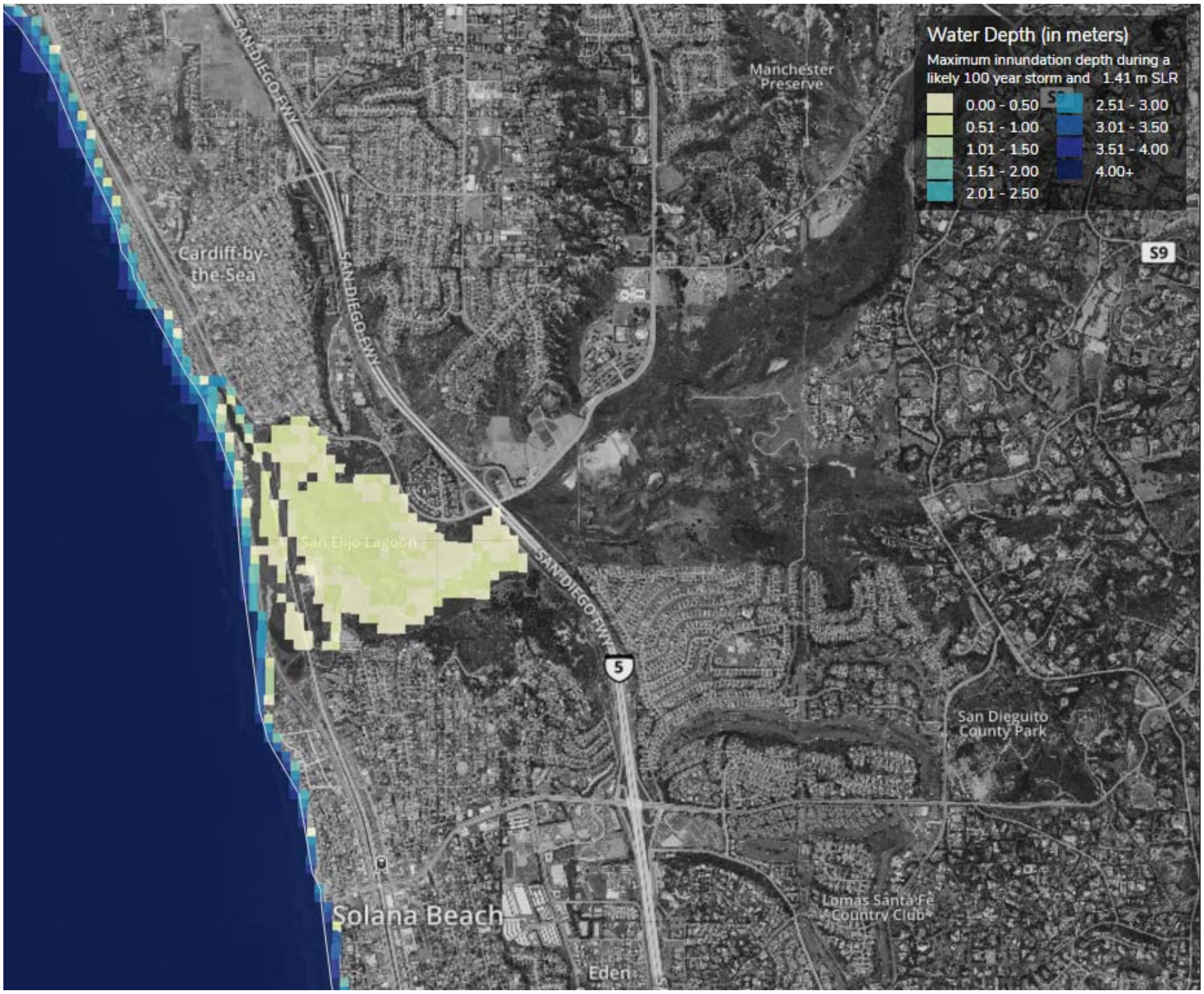
3.1.5 Sea-Level Rise

Another outcome of global climate change is sea-level rise. The average global sea level rose approximately seven inches during the last century. Assuming that sea-level changes along the California coast continue to reflect global trends, sea level along the State's coastline in 2050 could be 10-18 inches (0.25-0.45 meters [m]) higher than in 2000, and 31-55 inches higher (0.78–1.4 m) than 2000 levels by the end of this century (CEC 2012:9). According to the 2015 MHMP for San Diego county, sea levels measured in La Jolla show a 6-inch rise over the last century (OES 2014).

The county (including incorporated cities) currently has 7,498 residents—about one percent of the region's population—living in areas at risk of inundation from a 55-inch rise in sea level by 2100 (California Department of Public Health's Building Resilience Against Climate Change [CalBRACE] 2016). This rise in sea level will put these residents at risk of physical injury and property loss. Moreover, sea level fluctuates to higher-than-average levels due to high astronomical tides, wind, waves, and storm surge producing high sea-level events. Presently, the county coast experiences one hour of high sea levels per year on average; however, by 2030, high sea levels are expected to occur 12 hours per year on average and 62 hours per year by 2050 (OES 2014). Notably, only 1.64 square miles (1,050 acres) of unincorporated county land exists within the coastal zone, none of which contains coastline. As such, sea-level rise impacts to the unincorporated county would be substantially less as compared to the county as a whole (County of San Diego 2017a).

Using data provided by University of California, Berkeley, and the Institute of Civil Engineers, the Cal-Adapt tool provides mapping of areas of potential inundation with a combined 1.41-m rise in sea level and a 100-year storm event. The data includes dynamic spatial detail and incorporates real, time series water level data from past (near 100 year) storm events to capture storm surges and other hydrologic conditions. Sea-level rise in the county is shown in Figure 13.

Figure 13: 1.41-Meter Sea-Level Rise Combined With a 100-Year Flood Event in San Diego County (CEC 2017k)



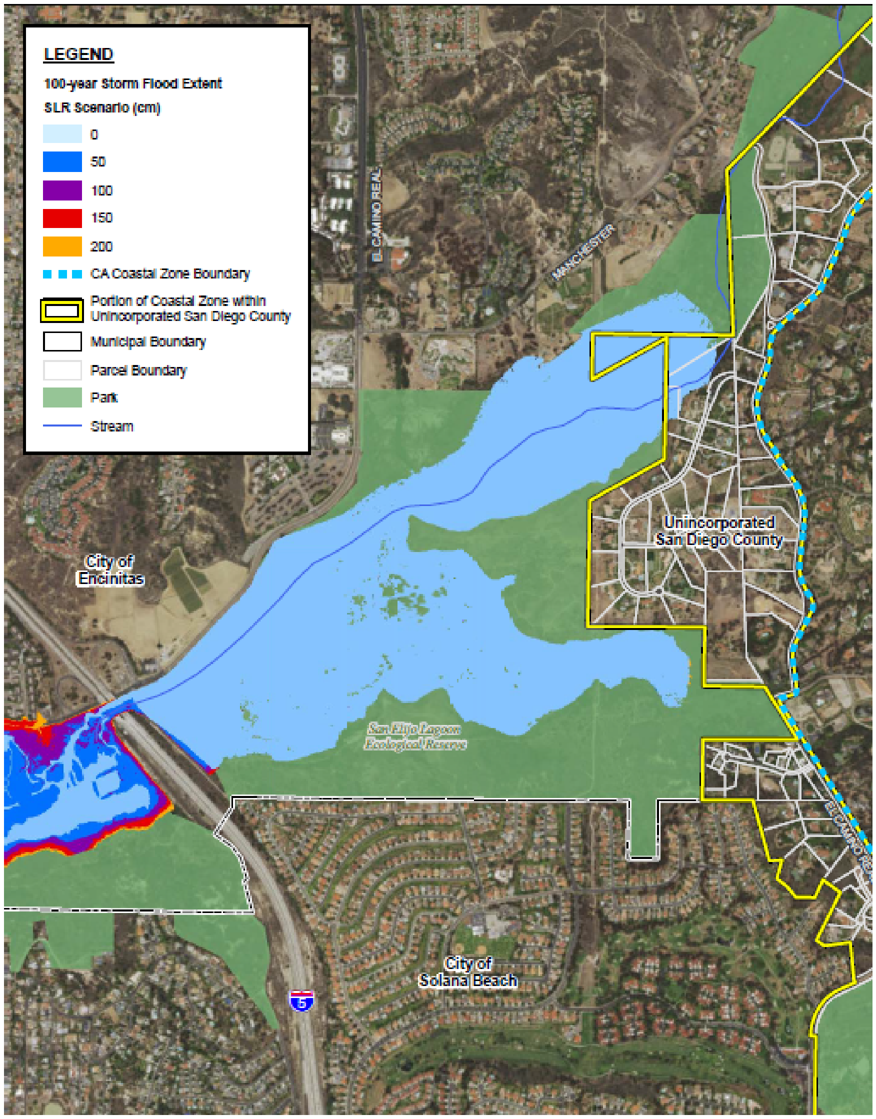
Future coastal and riverine flood risks may be magnified by the effect of future climate change. As sea levels rise, the frequency and magnitude of tidal flooding will increase. Higher sea levels may also exacerbate riverine flooding because higher water levels at the coast may impede drainage of freshwater discharge from lagoons and creeks. Other aspects of climate change, such as changes in storm frequency and intensity, may change the nature of coastal and watershed storm events in the future (CEC 2012).

The 2017 San Diego LCP is the primary document that governs land development in the unincorporated county's Coastal Zone. The county's Coastal Zone is a narrow strip of land defined by the Coastal Act. The unincorporated county's Coastal Zone is located east of Interstate 5, north of the city of San Diego, and east of the cities of Encinitas and Solana Beach, within the unincorporated community of San Dieguito. It is approximately 2 miles inland from the coast, encompasses approximately 1,050 acres (1.64 square miles), and does not contain any coastline (County of San Diego 2017a).

The LCP evaluated future exposure to combined coastal and riverine flooding using modeling results from the U.S. Forest Service's Coastal Storm Modeling System study for the San Elijo Lagoon Ecological Reserve, which is adjacent to the northwest boundary of the county's Coastal Zone and contains the portion of the unincorporated county considered to be coastal (Figure 14). The modeling evaluated combined flooding from a future 100-year coastal storm event with sea-level rise up to 2-meter and a likely coincident riverine discharge event. The modeling scenarios were intended to capture future flooding associated with a 100-year coastal storm event to account for freshwater discharge during a coastal storm (County of San Diego 2017a).

However, generally all existing development within the unincorporated county's Coastal Zone is located at an elevation above the predicted future limit of riverine and coastal flooding and is not vulnerable to direct impacts of sea-level rise.

Figure 14: 2-Meter Sea-Level Rise Combined with a 100-Year Flood Event in the San Elijo Lagoon Ecological Reserve (County of San Diego 2017a)



3.2 Steps 2 and 3: Sensitivity and Potential Impacts

The next two steps in the vulnerability assessment are discussed together because they are closely related. The second step in the vulnerability assessment involves using a systematic evaluation to identify structures, functions, and populations that may be affected in the county by projected exposures to climate change impacts. Using the APG's recommended sensitivity checklist, this assessment focuses specifically on resources in the county potentially affected by climate change that were identified in the Exposure section (Section 3.1) of this Chapter.

The sensitivity checklist is organized into three main categories; Population, Functions, and Structures. The categories are described in more detail below:

- **Populations**: Includes both the general human population and segments of the population that are most likely to be sensitive or vulnerable to climate change impacts. This applies, particularly to non-English speaking or elderly populations who may require special response assistance or special medical care after a climate-influenced disaster, and disadvantaged communities.

- **Functions**: Includes facilities that are essential to the health and welfare of the whole population and are especially important following climate-influenced hazard events. These facilities include hospitals, medical facilities, police and fire stations, emergency operations centers, evacuation shelters, and schools. Transportation systems, such as airports, bridges, tunnels, roadways, railways (e.g., tracks, tunnels, bridges, and rail yards), and waterways (e.g., canals, seaports, harbors, and piers) are also important to consider. Lifeline utility systems such as potable water, wastewater, fuel, natural gas, electric power, and communications are also critical for public health and safety. Functions also include other economic systems such as agriculture, recreation, and tourism, as well as natural resources within a community, including various plants and animal species and their habitat.

- **Structures**: Includes the structures of essential facilities noted above such as residential and commercial infrastructure, institutions (i.e., schools, churches, hospitals, prisons, etc.), recreational facilities, transportation infrastructure, parks, dikes and levees, and water and wastewater treatment infrastructure. It also includes high potential loss facilities, where damage would have large environmental, economic or public safety considerations (e.g., nuclear power plants, dams, and military installations). This category also includes hazardous material facilities that house industrial/hazardous materials.

The third step in the assessment includes evaluating how these impacts will occur and how severe they may be (i.e., low, medium or high). Given that climate change exposures at the local scale are inherently uncertain, the APG recommends that communities conduct a qualitative assessment that describes the potential impacts based on the exposure (CNRA 2012:23). This assessment is not meant to be exhaustive and prescriptive, but is rather intended to provide a high-level view of potential impacts that could occur as a result of identified climate change exposures. Further evaluation and research would be needed to more precisely identify points of sensitivity and potential impacts, including specific facilities, structures, and areas of concern.

The population, functions, and structures in the county considered to be sensitive to climate change are itemized under the following headings followed by discussion of the potential climate-change related impacts to these sensitivities.

3.2.1 Increased Temperature and Frequency of Extreme Heat Events and Heat Waves

Based on the Low- and High-Emissions Scenarios, annual average temperatures in the county are projected to rise 5 to 10°F by 2099. Increased temperature can lead to secondary climate change impacts including increases in the frequency, intensity, and duration of extreme events and heat waves in the county.

Higher frequency of extreme heat conditions can cause serious public health impacts, increasing the risk of conditions directly related to heat such as heat stroke and dehydration (CNRA 2012:3). Exposure to excessive heat may lead to heat-related illnesses such as heat cramps, heat exhaustion, and heat stroke. Symptoms of heat exhaustion include weakness, nausea, vomiting, rapid heart rate, and extreme sweating, which results in loss of fluids and dehydration. The most serious reaction to extreme heat and heat stroke results in severe mental status changes, seizure, loss of consciousness, kidney failure, abnormal cardiac rhythm, and death (CalEPA 2013).

Higher temperatures also worsen air quality through increased air pollution, such as from ozone formation and particulate matter generation (e.g., from wildfire smoke), which poses a health hazard to vulnerable populations. Children, elderly, pregnant women, and persons with pre-existing chronic diseases are particularly susceptible to respiratory and cardiovascular effects from air pollution. Currently, the county (including incorporated cities) is home to approximately 217,000 children, or 7 percent of total population, and 340,000 elderly persons (i.e., 65 years or older), or 11 percent of total population (CalBRACE 2016). Elderly persons have a reduced ability to acclimatize to changing temperatures, and are more likely to live alone with limited mobility, which can exacerbate the risk of extreme heat. Those with Alzheimer’s disease and dementia are particularly susceptible due to an inability to notice rising temperatures and failure to stay hydrated or turn on the air conditioning.

Climate change-related increases in temperature pose significant challenges for achieving health equity, because populations that are socially and economically vulnerable often bear a disproportionate burden of climate effects. People with existing health issues, such as chronic diseases and mental health conditions; young children and the elderly; people experiencing homelessness; outdoor workers, and socially or linguistically isolated people are typically most vulnerable to the impacts of climate change.

Disadvantaged communities may also face greater challenges in dealing with extreme heat. Low-income populations may live in aging buildings with poor insulation, leading to higher costs associated with air conditioning. Upgrades to increase the efficiency of these homes may constitute a large portion of a person’s average income, thereby preventing homeowners from reducing costs related to energy usage. Some do not turn on air conditioning, because they cannot afford to pay the utility bill, and are unaware of assistance programs for low income households. They are also less likely to own cars that can provide mobility to avoid deleterious climate effects.

As shown in Figure 10 in Section 3.1.1 heat generated from the UHIE in the county is dispersed downwind of urbanized areas causing increases in daily temperatures in more rural and suburban areas of the county. Although higher temperatures generated by the UHIE are more pronounced in urbanized locations, the meteorology of the county dissipates this excess heat and air pollution inland towards the surrounding communities of Spring Valley, Sweetwater, Valle de Oro, and Jamul/Dulzura (CalEPA 2015). Further, the topographic characteristics of the county consisting of flat landscapes in the western coast that transition into foothills with moderate slopes in the east causes UHIE-related heat and air pollutants to become trapped. This phenomenon worsens air quality and results in higher energy demand and its associated financial costs.

With respect to roadway infrastructure, prolonged exposure to extreme heat can exacerbate roadway degradation, as asphalt and concrete can deform at a faster rate under high temperatures, which results in pavement rutting and cracking that may present unsafe road conditions for motorists, bicyclists, and pedestrians. Bridges experience expansion and contraction as temperatures fluctuate, impacting the way expansion joints absorb movement and vibration over time. Extreme heat events may also increase the risk of rail track buckling. Overhead lines or catenary wires that supply power to light rail, tram, and streetcar systems could experience thermal expansion and lose tension, which would substantially reduce speeds (Sacramento Area Council of Governments [SACOG] 2015:22; California Department of Transportation [Caltrans] 2013).

Extended periods of extreme heat may lead to increased risk of power outages and blackouts. High temperatures decrease the efficiency of power transmission lines, while demand for electricity simultaneously goes up as operation of air conditioners and cooling equipment increases. This results in more frequent blackouts and could affect the operation of infrastructure (SACOG 2015:23; Caltrans 2013).

Further, utility companies such as San Diego Gas & Electric lose revenue during times of power failure and must bear the cost of repair expenditure and maintenance.

Prolonged periods of high heat will increase rates of evapotranspiration in plants and reduce the moisture content of soils causing increased demand for water for irrigation and landscaping. Additionally, extreme heat waves will exacerbate rates of evaporation in surface waters resulting in the loss of valuable water resources, which, as discussed in Section 3.1.2, will become less reliable as a direct result of climate change.

Temperature-related power failure can also adversely affect the quality of life in residential areas. In periods of high heat, loss of electricity inhibits cooling of inside areas resulting in a lack of refuge from dangerous heat. Further, economic losses may be incurred from refrigerated and frozen foods spoiling and an inability to communicate (e.g., telecommute) via internet or landline.

Outdoor recreation in the county may become a less desirable activity as temperatures increase. Extreme heat may deter county residents as well as potential tourists from engaging in outdoor physical activities (e.g., hiking, soccer, rock climbing). During periods of high heat, recreational users would be vulnerable to heat-related illnesses which could be exacerbated by physically demanding exercise. A decrease in recreational demand in the county could impact revenue for businesses that provide recreational activities, equipment and clothing.

Agricultural productivity depends on weather and a wide range of ecosystem processes that support productivity, which makes the sector vulnerable to shifts in climate conditions. As previously noted, outdoor workers such as agricultural workers, may be susceptible to extreme heat events. Further, the productivity of the county's agricultural industry is also dependent on the characteristics of California's Mediterranean climate (CNRA 2014:19). The most significant, overall outcome of warming temperatures as a result of climate change will be the likely reductions in yield of some of California's most valuable specialty crops (e.g., nuts, trees, fruits, and vegetables) due to changing fluctuations in temperature (e.g., night and day, seasonal changes) (CNRA 2014:24).

As the 12th largest farm economy compared to 3,000 other counties, the county supports the production of a wide range of farm commodities valued at approximately $1,701,777,000 in 2015. In 2015, the ornamental tree industries accounted for approximately $409,500,000, or 24 percent of the total value of agricultural production. Indoor flowering and foliage plants valued at $344,167,000, 20 percent of total. The county is also the number one producer of avocados; second producer of guavas, pomegranate, limes, and macadamias; and third in honey (San Diego County Farm Bureau 2015). Increases in temperature and moisture could impact the growing of crops, by causing late or irregular blooming and affecting yields. Livestock operations could also be subject to heat stress, which can result in reduced livestock pregnancy rate, increased length of time needed to meet market weight, and reduced milk production (CNRA 2014:24). Additionally, higher temperatures will alter the range of crop-damaging pests and microbial diseases, which could increase the susceptibility of certain crops to predation, increased spoilage, reduced nutritional content, and other damage. These will all contribute to a higher cost of food and contribute to more food insecurity. Warmer nighttime temperatures will also reduce or eliminate the required number of "chill hours" that specialty and other crops (e.g., nut and fruit trees) need to bud (Union of Concerned Scientists).

3.2.2 Changes to Precipitation Patterns

Increased average temperatures and a hastening of snowmelt in the Sierra Nevada, Rocky Mountains, and distant portions of watersheds could affect the flows of the State Water Project and the Colorado River which the county relies on. Reduced flow of fresh water, more persistent drought conditions, and increased water demands with population growth will likely affect the quality and quantity of water supplies.

Drought conditions can support the spread of vector-borne illness. Coupled with higher temperatures, reduced levels of precipitation restrict the flows of underground pipelines for water and wastewater diversion. This can result in unseen, stagnant pools of water that provide conditions for the breeding of mosquitoes and other vector carrying insects and arthropods, particularly in urban areas. An increase in the populations of these organisms may result in the spread of mosquito-borne illnesses, such as dengue fever, West Nile virus, and Zika virus. Vulnerable populations susceptible to these diseases include the elderly and people with compromised immune systems or chronic illness.

A reduction in surface water availability can result in an increase in dependence on groundwater supplies. As a result of intensified use of groundwater during recent drought periods, many of California's groundwater basins are already in overdraft conditions, with groundwater use exceeding the rate of groundwater recharge. Overdraft can lead to land subsidence wherein a gradual settling or sudden sinking of the earth's surface occurs. The effects of subsidence could impact houses and other structures such as transportation infrastructure, water well casing failures, and changes to the elevation and gradient of stream channels, drains, and other water transport structures (CNRA 2014:235). The county overlays 37 discrete groundwater basins, four of which are designated medium-priority basins under the SGMA.

In terms of agriculture, water supplies for agricultural irrigation could decrease and become more variable as a result of climate change. As the weather gets warmer with climate change, agricultural demand for water could intensify because during extreme heat conditions, water evaporates faster and plants require more water to stay cool (CNRA 2014:21). These combined effects will result in future water insecurity for agriculture, and may necessitate changes in agricultural practices.

Changes in precipitation patterns will also alter stream flow and severely affect fish and amphibian populations during their life cycle (e.g., spawning, migration) in the San Diego River and its tributaries due to changes in timing and volume of flows. Reduced flow, combined with increased human demand may lower the availability of water for wildlife, especially fish and wetland species not designated as endangered or threatened under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA), while simultaneously increasing water temperatures, impacting fish and their habitat. While ESA- or CESA-listed species may, depending on location and watershed, be guaranteed certain levels of water flow, it would be expected that in watersheds wherein no species are listed, reduced flow levels may affect the populations of aquatic species. Further, precipitation changes may also alter the composition and structure of riparian communities along rivers in the county as well (California Department of Fish and Wildlife 2015).

3.2.3 Increased Wildfire Risk

Increased temperatures, changes in precipitation patterns, and reduced moisture content in vegetation during dry years associated with climate change are expected to increase the potential severity of wildland fires both within and beyond the boundaries of the unincorporated county. With a potential increase of 5 to 10 °F by 2099 under the Low- and High-Emissions Scenarios, vegetation in the county will lose moisture content. A changing climate is also expected to subject vegetation and forests to increased stress due to drought, disease, invasive species, and insect pests. These stressors are likely to make these forests more vulnerable to catastrophic fire (Westerling 2008:231).

The county is already at high risk of wildfire. The county contains high concentrations of Moderate, High, and Very High Fire Hazard Severity Zones (California Department of Forestry and Fire Protection [CAL FIRE] 2007). In 2010, 91 percent of county residents lived in Very High, High, and Moderate Risk wildfire areas as compared to the statewide average of seven percent (CalBRACE 2016; OES 2014 L4-93; County of San Diego 2014). Increased frequency and intensity of wildfires will directly affect the safety of populations living within or near wildland areas (i.e., wildland-urban interface) prone to wildfire. Closure of roadways and damage to transportation infrastructure during a wildfire may result in the isolation of rural and remote populations throughout the county. Reduced access to evacuation routes increases the danger associated with wildfire, with the potential to result in physical injury or death.

In addition to increased threats to human safety, the increased risk of catastrophic wildfire results in the release of harmful air pollutants into the atmosphere, which dissipate and can affect the respiratory health of residents across a broad geographical scope. Particulate matter (soot and smoke), carbon monoxide, nitrogen oxides, and other pollutants are emitted during the burning of vegetation, and can cause acute (short-term) and chronic (long-term) cardiovascular and respiratory illness, especially in vulnerable populations such as the elderly, children, agricultural and outdoor workers, and those suffering from preexisting cardiovascular or respiratory conditions.

Air quality will be directly affected by wildfire activity occurring within and beyond the boundaries of the county as these pollutants dissipate. Further, as future wildfires burn at higher intensity and burn for longer durations, periods of exposure to air pollutants will become more frequent and prolonged causing increased rates of acute and chronic respiratory and cardiovascular illness, and increased emergency room visits and hospitalizations.

While periodic fires originate from natural processes and provide important ecological functions, catastrophic fire events that cannot be contained or managed can cause serious threats to homes and infrastructure, especially for properties located at the wildland-urban interface (i.e., where residential development mingles with wildland area (CAL FIRE 2009). Damage to ecological functions may result as the risk of fire increases. When rain falls in burn scarred areas, there is a higher potential for soil erosion and mud flows into roads, ditches, and streams, which reduces water quality.

Wildfire can directly and indirectly damage important transmission lines and related facilities (e.g., hydroelectric generation facilities in remote locations) from heat, smoke, and particulate matter. Additional impacts to transmission lines in forested areas occur from indirect effects that wildfire can have on soil properties. Fires may breakdown soil structure, reduce moisture retention and capacity, and contribute to the development of impermeability, increasing an area's susceptibility to erosion or landslides (CEC 2012:15).

Further, wildfires often result in the closure of roadways and/or damage to transportation infrastructure resulting in reduced availability of recreational opportunities. Hiking and mountain biking trails, all-terrain vehicles and off-road vehicle trails (e.g., off-road motorcycle racing tracks), and camping sites in the county may become inaccessible or damaged from wildfire activity, thus impeding recreational use as well as the associated tourism revenue that may accompany it.

Additionally, as discussed above, wildfire activity results in the production of harmful air pollutants such as fine particulate matter, which can cause acute, and exacerbate chronic respiratory and cardiovascular diseases. During these periods, hospitals may incur additional strain on their resources to accommodate an influx in emergency room visits. This could result in longer waiting periods for emergency room patients if hospital resources reach their maximum capacity.

3.2.4 Increased Likelihood of Flooding

As discussed previously, average annual precipitation in the county ranges from 3 to 45 inches depending on location (i.e., highest in the mountains, lowest in the eastern desert). The central and eastern portions of the county are the most susceptible to flash floods where mountain canyons, dry creek beds, and high deserts are the dominant terrain. There are over 3,600 miles of flood-prone rivers and streams which threaten the safety of residents and over 200,000 acres of property in the unincorporated county and incorporated cities (County of San Diego 2007:4-31). In 2015, about 17,000 people and 7,000 residential and commercial buildings were located in the 100-year floodplain and approximately 20,000 people and 8,500 residential and commercial building were located in the 500-year floodplain in the county (OES 2014:4-81).

Increased flooding associated with climate change will not only stress human communities and infrastructure, but may also threaten the biodiversity that occurs along the streams and creeks in the county. Unlike natural flooding regimes, wherein seasonal flooding results in the deposition of useful sediment resulting in increased soil fertility as well as groundwater recharge, flash flooding could lead to the destruction of crops, erosion of topsoil, and deposits of debris and sediment to crop lands. Flash floods can result in unwanted submergence and/or excessive soil saturation of cropland (California Department of Food and Agriculture 2013).

Flooding could also release sewage and hazardous and/or toxic materials if wastewater treatment plants are inundated, storage tanks are damaged, and pipelines severed. Floods also cause economic losses through closure of businesses and government facilities, disrupt communications, disrupt the provision of utilities such as water and sewers, result in excessive expenditures for emergency response, and generally disrupt the normal function of a community.

Increases in the intensity of precipitation and stormwater runoff events will likely lead to increases in flash flooding. As roadways are exposed to a higher volume of water, pavement materials become susceptible to damage from the excess moisture. The most common form of pavement damage due to water is stripping, a process that separate the aggregates in pavement from the asphalt binder that holds them together. Another potential source of damage occurs when water infiltrates the pavement, either through voids or through cracks in the surface, then becomes trapped between two layers of asphalt. The forces that occur when traffic passes over these areas create intense hydraulic pressures that physically scour the asphalt from the aggregate (SACOG 2015:23; Caltrans 2013).

3.2.5 Sea-Level Rise

The unincorporated county is not vulnerable to sea-level rise, with less than one percent of the unincorporated county's total population considered at risk (CalBRACE 2016; County of San Diego 2014). Considering a 100-year flood event, a 1.41-m rise in sea level and other hydrodynamical factors, most of the land at increased risk for flooding is undeveloped.

As sea levels rise, the area and the number of people at risk due to flooding will also rise. Rising sea levels can overwhelm existing protection structures, putting those county residents living in vulnerable areas at increased risk (CEC 2012:6). Factors that increase vulnerability to the adverse impacts of flood events associated with sea-level rise include access to preparedness information, transportation, healthcare, and insurance. Key demographics associated with these vulnerabilities include income, race, linguistic isolation (i.e., non-English speaking), and residential tenure (CEC 2012:8). Language ability is an important factor in assessing vulnerability as emergency response crews may be unable to communicate with non-English speakers (CEC 2012:9).

Renters are also more vulnerable, as they are less likely to reinforce buildings and buy insurance because the decision to make major home improvements typically lies with the property owner. Additionally, disaster recovery services have often targeted homeowners, to the disadvantage of renters (CEC 2012:9).

3.3 Step 4: Adaptive Capacity

After identifying the points of sensitivity and the potential impacts of exposures, the next step is to look at the county's current adaptive capacity to address climate change. Step 4 involves determining what is or can be currently done in the county to address these challenges. Review of the County's existing local policies, plans, programs, resources, and institutions provides a good snapshot of the county's ability to adapt to climate change and reduce vulnerability (CNRA 2012:26).

The adaptive capacity of the county to respond to projected climate change impacts is analyzed in the following sections, based on identified exposures where possible. It is important to note that this review of local climate adaptation-related work offers a high-level perspective on the issue and is not meant to be all-inclusive. As more specific facilities, structures, and areas are identified in the future, additional review of adaptive capacity may likely be needed.

On a planning level, the County addresses current and future impacts related to existing natural hazards, as evidenced by the update of the County's MHMP in 2015. The MHMP identifies current hazard risks and mitigation strategies for flooding, sea-level rise, extreme heat, drought, earthquakes, and fires. Furthermore, the County's 2011 General Plan includes policies aimed at reducing local contributions to global climate change and encourages sustainable land development, mobility, water use, waste management, and energy use; best management practices; and ecological stewardship (County of San Diego 2011). It also covers vulnerable populations, including policies aimed at achieving more equitable outcomes for the growing low-income populations in the county, as well as its aging population that requires better access to public services and housing.

In addition to planning efforts, climate adaptation-related work occurring in the county includes, but is not limited, to the following:

Efforts Related to Increased Temperature and Frequency of Extreme Heat Events and Heat Waves

- The County of San Diego Health and Human Services Agency (HHSA) Public Health Services (PHS) prepared an Excessive Heat Response Plan (EHRP) in 2013 as an update to be previously prepared plan in 2008. The EHRP provides a framework and details the procedures for coordinating the preparedness and response efforts of HHSA to protect vulnerable persons from excessive heat. The EHRP also identifies the appropriate roles and responsibilities for addressing certain heat-related hazards (HHSA 2013).

- The San Diego County MHMP identifies extreme heat as a hazard to human health and infrastructure, particularly when effects are exacerbated by the UHIE. With increased temperatures related to climate change, the MHMP recognizes that there will be an increase in frequency, duration, and strength of heat waves in the coming decades.

- During periods of high heat, the County partners with local organizations to provide residents with cooling centers. Locations of cooling centers change year to year.

- The California Climate Change Center completed their *Climate Change-Related Impacts in the San Diego Region by 2050* report in August 2009. The report lists the vulnerabilities and projections of extreme heat in the county by the year 2050. The report includes recommendations to use demand management and local initiatives to combat climate change impacts (California Climate Change Center 2009).

- The County of San Diego PHS has partnered with a number of departments and agencies (e.g., the San Diego Council of Governments, CalBRACE) to address climate change and adaptation planning. Such strategies include (PHS 2015):

    - Building organizational capacity of PHS with guidance from the California Department of Public Health, and Office of Health Equity;

    - Coordinate, develop, and provide PHS general and division-specific, climate change training to increase knowledge, expertise, and resources to address the health impacts of climate change;

    - Promote local planning, land use, transportation, water, food, and energy policies that reduce carbon emissions, and support the design of healthy and sustainable communities;

    - Establish, improve, and maintain mechanisms for robust rapid surveillance of environmental conditions, climate-related illness, vulnerabilities, protective factors, and adaptive capacities; and

    - Inform the general public about potential health effects of climate change.

Adaptive Capacity

The County's EHRP adopted in 2013 addresses the impacts of extreme heat. The EHRP both plans for extreme heat and designates specific government entities as the responsible parties for executive procedural actions. Further, PHS is currently engaged in evaluating the county's vulnerability to temperature-related health risks and plans to pursue additional adaptation planning to prepare the county for high heat associated with climate change. As the EHRP identifies appropriate procedures to combat extreme heat events and the MHMP recognizes extreme heat as a hazard for the county, the county is adequately prepared to deal with moderate occurrences of extreme heat; however, given that high heat days will occur more frequently and have a longer duration, the County will need to invest more resources into developing better strategies to combat this increasingly more common impact.

Efforts Related to Changes to Precipitation Patterns and Water Supply

- The County participates in the Home Energy Opportunity (HERO) Program, which is part of the Property Assessed Clean Energy Program. HERO helps homeowners reduce energy bills and decrease water consumption through special financing options, while also creating jobs for registered contractors in the county (San Diego Union-Tribune 2017).

- The County's Landscape Ordinance contains water conservation regulations for landscape design, with the intent to conserve water through promotion of the most efficient use of water in landscape design, while respecting the economic, environmental, aesthetic, and lifestyle choices of individuals and property owners. Implementation of the Ordinance is facilitated by the Water Efficient Landscape Design Manual (San Diego County Code Title 8, Division 6, Chapter 7, Section 86.701).

- SDCWA has several water conservation programs and incentives to help combat drought and other water supply issues. These include garden-friendly plant fairs, high-efficiency clothes washer rebates, artificial turf discount program, and others (SDCWA).

- The County of San Diego Department of Environmental Health (DEH) oversees several programs to reduce water usage and improve water quality. DEH provides guidance regarding installation of graywater systems, regulates the use of recycled water, and monitors the water quality at the county's beaches. DEH also provides useful information regarding protection against mosquitoes and other disease-carrying insects and animals (DEH 2017).

- The County's Watershed Protection Ordinance serves to protect water resource and to improve water quality by controlling the stormwater conveyance system and receiving waters, to implement and incent the use of best management practices to reduce adverse effects of pollutant stormwater discharge, and to comply with applicable state and federal laws (San Diego County Code Title 6, Division 7, Chapter 8, Section 67.801 et seq.).

- The *Climate Change-Related Impacts in the San Diego Region by 2050* report in August 2009 lists the vulnerabilities and projections of less predictable precipitation patterns and water insecurity in the county by the year 2050. The report includes recommendations to use demand management and local initiatives to combat climate change impacts (California Climate Change Center 2009).

Adaptive Capacity

The County and local agencies have several water conservation programs, including rebates for appliances and water saving devices, guidance on deployment of graywater systems, recycled water programs, and landscaping and watershed ordinances; however, the county is still currently vulnerable to water supply issues due to drought, increased temperatures, and other factors. The county will face challenges in providing sufficient water supplies in the future due to climate change effects, coupled with a growing population and increasing water demand. The State has identified four groundwater basins as medium-priority and are subject to the SGMA; however, none have been adopted at this time. Notably, groundwater does not constitute a major source of water for the county.

Efforts Related to the Increased Risk of Wildfire

- The County has adopted the 2016 California Fire Code and the 2016 California Buildings Standards Code in its 2017 Consolidate Fire Code to help reduce the county's risk of wildfire (County of San Diego 2017b). The County has provisions to help prevent the accumulation of combustible vegetation or rubbish that can be found to create fire hazards and potentially impact health, safety, and general welfare of the public. Provisions include ensuring that defensible spaces, which are adjacent to each side of a building or structure, are cleared of all brush, flammable vegetation, or combustible growth (County of San Diego 2017b).

- The San Diego Wildfire Education Project is an environmental education initiative to educate and motivate individuals most directly affected by fires in terms of understanding and monitoring the multi-faceted environmental recovery process, with emphasis on source and run-off pollution, watershed and habitat restoration, and species recovery. The Project also serves to develop grade-appropriate post-fire curricula to educated and engage students in grades Kindergarden-9th grade throughout the county (San Diego Wildfire Education Project 2004).

- The County has a Fire Safe Council that is active in minimizing the potential for wildfire damage. The Fire Safe Council receives federal grants from agencies like the U.S. Forest Service, Bureau of Land Management, and National Park Service. These funds provide Fire Safe Councils with grant money to pursue projects to reduce hazardous fuels, provide wildfire prevention education, and create risk assessments and community wildfire protections plans (CWPPs). Twenty-five communities within unincorporated county have an approved CWPP in place. CWPPs contains measures and recommendations to help enhance safety and reduce risk of damage to structures and watersheds. CWPPs allow communities to take action to protect lives, property, structures, and community livelihoods (Fire Safe Council 2017).

- The *Climate Change-Related Impacts in the San Diego Region by 2050* report lists the vulnerabilities and projections of increased wildfire risk in the county by the year 2050. The report includes recommendations to use demand management and local initiatives to combat climate change impacts (California Climate Change Center 2009).

Adaptive Capacity

The county is an area that is currently at high-risk for wildfires. While programs and policies in place show a current capacity to address risks, the county is still vulnerable to increased wildfires due to climate change. Increased temperatures and potential prolonged periods of drought will create a more wildfire-prone landscape. The county will need to continue to adapt to this projected increase.

Efforts Related to the Increased Likelihood of Flooding

- The County of San Diego Department of Public Works Land Development Division provides stormwater, flood control, map processing, and cartography for the county. The Engineering Services Division also provides flood control, wastewater, environmental services, and engineering and hydrology services.

- OES coordinates the overall County response to disasters. OES is responsible for alerting and notifying appropriate agencies when disasters such as flooding occur, coordinating all agencies that respond, ensuring resources are available and mobilized in times of disaster, developing plans and procedures for response to and recovery from disasters, and developing and providing preparedness materials for the public. The 2014 San Diego County Emergency Operations Plan lists actions to respond to flooding events and delegates responsibility to the appropriate agencies and departments (OES 2014).

- The County Floodplain Management Plan (FMP) assesses the flooding hazards within the unincorporated areas of the county, summarizes current County programs, describes potential mitigation strategies, assesses the structural integrity of the county's dams and levee systems, and presents a plan for future action. The FMP is a living document and is reviewed by the County of San Diego Department of Public Works, Flood Control (County of San Diego 2007).

- The San Diego County Community Protection/Evacuation Committee assists the communities of the county in developing local plans with evacuation details. Community plans have been completed for the communities of Alpine, Boulevard, Campo/Lake Morena, Descanso, Fallbrook, Jamul, and Ramona.

- The *Climate Change-Related Impacts in the San Diego Region by 2050* report lists the vulnerabilities and projections of increased flood risk in the county by the year 2050. The report includes recommendations to use demand management and local initiatives to combat climate change impacts (California Climate Change Center 2009).

Adaptive Capacity

Levees and structures have been built to protect the county from a 100-year flood event and the FMP addresses structural weaknesses in flood infrastructure. Also, the 2014 San Diego County Emergency Operations Plan, combined with the completed evacuation plans for the communities previously listed, provides important details regarding flood protection and evacuation. However, evacuation plans have not been completed for all communities within the unincorporated county. The systems in place will need to be updated to account for potentially more intense storms coupled with sea-level rise.

Efforts Related to the Sea-Level Rise

- The County of San Diego LCP Land Use Plan governs land development in the unincorporated county's Coastal Zone. It is designed to preserve the environment of the Coastal Zone and to encourage the protection and restoration of its resources, while encouraging public enjoyment of its recreational opportunities. The LCP contains maps of areas vulnerable to sea-level rise combined with a 100-year flood event which advises future land use in the county (County of San Diego 2017a).

- The *Climate Change-Related Impacts in the San Diego Region by 2050* report lists the vulnerabilities and projections of sea-level rise in the county by the year 2050. The report includes recommendations to use demand management and local initiatives to combat climate change impacts (California Climate Change Center 2009).

Adaptive Capacity

The county (including incorporated cities) currently has 7,498 residents—less than one percent of the region's population—living in areas at risk of inundation from a 55-inch rise in sea level by 2100. Even fewer residents in the unincorporated county live within the coastal zone. As a result, the unincorporated county is not considered high risk for sea-level rise related impacts; however, more data and studies will need to be conducted as environmental conditions (e.g., emissions of GHGs) change in the coming years.

In conclusion, the County is committed to continuing efforts to reduce and address existing risks and future impacts as a result of climate change on a program level. With a number of ordinances and programs that cover a range of exposures, the County is equipped to handle current issues of flooding and water supply issues, but could still likely face increasing challenges as projected changes occur. Existing programs and adoption of the 2016 Consolidated Fire Code has helped to mitigate the high risk for wildfires, but the county is still vulnerable to current and future wildfires. The county will also need to continue to adapt to better address impacts from increased temperatures. However, the long-term vision identified in the County's planning documents demonstrate that the County is forward-thinking in its policy and mitigation development towards all exposures, and is positioned to maintain services in the face of climate change.

3.4 Step 5: Risk and Onset

The final step in the vulnerability assessment is to rank impacts based on the level of risk and the projected timeframe. Risk is the likelihood or probability that a certain impact will occur, which is an assessment that combines the estimated certainty of the science projecting the climate change impact and the certainty of the sector sensitivity. Certainty ratings are based on percent probability of global models created by IPCC (CNRA 2012:29). The timeframe in which the impact is most likely to occur (based on risk) can be categorized as:

- Current: Impacts currently occurring
- Near-term: 2020-2040
- Mid-term: 2040-2070
- Long-term: 2070-2100

Risk certainty has been provided based on the certainty of exposures estimated in Table 1. Onset designations have also been assigned.

Table 1 Risk and Onset for San Diego County Climate Change Impacts

Impact	Certainty Rating	Timeframe
Increased Temperature	High	Near-term
Increased Frequency in Extreme Heat Events	High	Near-term
Increased Frequency in Heat Waves	High	Near-term
Sea-Level Rise	High	Long-term
Changes to Precipitation Patterns	Medium	Near-term
Increased Wildfire Risk	Medium	Mid-term
Increased Flooding	Medium	Mid-term

The table shows that increased temperature, increased frequency in extreme heat days and waves, and sea-level rise are of high certainty rating. Temperature- and precipitation-related impacts are the most likely near-term climate change exposure facing the county and should be addressed and prioritized first in future adaptation planning efforts. Heat- and flood-related risk and the disproportionate burdens affecting vulnerable populations should be a part of the priority actions. With population increasing and water supply already strained in the county, future meteorology, snowpack, streamflow, and groundwater conditions should continue to be examined more closely with actions taken to enhance the conservation and management of water supply and storage. While sea-level rise has a high certainty rating and is already occurring, its onset isn't expected to occur until closer to the end of the century and the unincorporated county land area affected will be relatively small. Although sea-level rise has a high certainty ranking, the effects on the unincorporated county will be more limited than other climate risks. Addressing increases in wildfire risk has mid-term onsets and should be prioritized accordingly, given their widespread impact on the county.

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