

**Climate Change Vulnerability Assessment
for the Sacramento County Climate Action Plan: Communitywide
Greenhouse Gas Reduction and Climate Change Adaptation
(Communitywide CAP)**

PREPARED FOR:

Sacramento County
Planning and Environmental Review
827 7th Street, Room 225
Contact: Todd Taylor, Associate Planner

PREPARED BY:

Ascent Environmental, Inc.
455 Capitol Mall, Suite 300
Sacramento, California 95814
Contact: Erik de Kok, AICP, Senior Project Manager

January 2017

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS III

1 INTRODUCTION 5

2 CLIMATE CHANGE ADAPTATION PLANNING PROCESS..... 5

3 VULNERABILITY ASSESSMENT..... 7

 3.1 Step 1: Exposure 7

 3.1.1 Increased Temperature..... 8

 3.1.2 Changes in Precipitation Patterns..... 13

 3.1.3 Increased Wildfires..... 21

 3.1.4 Increased Flooding..... 24

 3.1.5 Sea-Level Rise 25

 3.2 Steps 2 and 3: Sensitivity and Potential Impacts..... 28

 3.2.1 Increased Temperature..... 30

 3.2.2 Changes to Precipitation Patterns..... 33

 3.2.3 Increased Wildfires..... 35

 3.2.4 Increased Flooding..... 37

 3.2.5 Sea-Level Rise 39

 3.3 Step 4: Adaptive Capacity 40

 3.3.1 Adaptive Efforts Related to Increased Temperature..... 41

 3.3.2 Adaptive Efforts Related to Changes in Precipitation Patterns..... 45

 3.3.3 Adaptive Efforts Related to Increased Wildfires..... 48

 3.3.4 Adaptive Efforts Related to Increased Flooding..... 49

 3.3.5 Adaptive Efforts Related to the Sea-Level Rise..... 52

 3.3.6 Comprehensive Adaptive Efforts Related to Multiple Climate-Change Effects 53

 3.4 Step 5: Risk and Onset 55

4 REFERENCES 56

Figures

Figure 1	Climate Adaptation Planning Process Steps	6
Figure 2	Changes in Temperature in Sacramento County by 2099	9
Figure 3	Number of Extreme Heat Days under the Low-Emissions Scenario by 2099	11
Figure 4	Number of Extreme Heat Days under the High-Emissions Scenario by 2099	11
Figure 5	Counts of Heat Waves under the Low-Emissions Scenario by 2099	12
Figure 6	Counts of Heat Waves under the High-Emissions Scenario by 2099	12
Figure 7	Timing of Extreme Heat Days under the Low-Emissions Scenario by 2099	14
Figure 8	Timing of Extreme Heat Days under the High-Emissions Scenario by 2099	14
Figure 9	Urban Heat Island Index for Sacramento County	15
Figure 10	Change in Precipitation under the High- and Low-Emissions Scenarios by 2090	17
Figure 11	Change in Snowpack under the High- and Low-Emissions Scenarios by 2090	19
Figure 12	Increased Frequency of Wildfire under the Low- and High-Emissions Scenario	23
Figure 13	Effects of Sea-Level Rise in Sacramento County During a 100-Year Flood Event	27
Figure 14	Disadvantaged Communities in Sacramento County	29

Table

Table 1	Effects of Sea-Level Rise in Sacramento County during a 100-year Flood Event	26
Table 2	Risk and Onset for Sacramento County Climate Change Impacts	55

ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
AB	Assembly Bill
APG	California Adaptation Planning Guide
BRI	Business Resiliency Initiative
CalEPA	California Environmental Protection Agency
CAL FIRE	California Department of Forestry and Fire Protection
CAMP	Climate Action and Mitigation Practices
CAP	Climate Action Plan
CCAD	Consolidated Capital Assessment District
CDFA	California Department of Food and Agriculture
CDFW	California Department of Fish and Wildlife
CEC	California Energy Commission
CESA	California Endangered Species Act
CNRA	California Natural Resources Agency
CRCRC	Capital Region Climate Readiness Collaborative
CVFPD	Central Valley Flood Protection District
CVFPP	Central Valley Flood Protection Plan
CVP	Central Valley Plan
CWPP	Community Wildfire Protection Plan
DOE	U.S. Department of Energy
DWR	California Department of Water Resources
EDD	California Employment Development Department
ESA	Endangered Species Act
GHG	greenhouse gas
HDI	Heath Disadvantaged Index
HERO	Home Energy Renovation Opportunity
IBHS	Institute to Business and Home Safety
in	inches
IPCC	Intergovernmental Panel on Climate Change
km	kilometer
kV	kilovolt
LHMP	Local Hazard Mitigation Plan
m	meter
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
OEHHA	California Office of Environmental Health and Hazard Assessment
PACE	Property Assessed Clean Energy

PHI	Public Health Institute
MTP	Metropolitan Transportation Plan
REDI	Resilient Electricity Delivery Infrastructure
SacOES	Sacramento County Office of Emergency Services
SACOG	Sacramento Area Council of Governments
SAFCA	Sacramento Area Flood Control Agency
SCADA	supervisory control and data acquisition
SCS	Sustainable Communities Strategy
SCWA	Sacramento County Water Agency
SGA	Sacramento Groundwater Authority
SMAQMD	Sacramento Metropolitan Air Quality Management District
SMB	Small to Medium Business
SMUD	Sacramento Municipal Utilities District
SWP	State Water Plan
UARP	Upper American River Project
UHIE	Urban Heat Island Effect
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VOAD	Volunteers Organizations Active in Disasters
WAP	Weatherization Assistance Program
WFA	Water Forum Agreement

1 INTRODUCTION

This vulnerability assessment provides an overview of the primary and secondary threats associated with climate change, and identifies the ones most likely to affect Sacramento County. The findings of the vulnerability assessment will be used to develop climate adaptation strategies that address these threats, which will be included in the County's Climate Action Plan (CAP).

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

- ▲ rising sea levels due to thermal expansion of ocean water and melting of polar ice caps and sea ice, which can inundate low-lying areas exposed to tidal action and increase the severity of flooding risk;
- ▲ changes in the timing, severity, and amounts of rainfall and snowfall, leading to changes and greater variability in wet and dry periods that will affect water supply and flood risk;
- ▲ increased stress to vegetation and terrestrial and aquatic habitats, 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 community infrastructure; and
- ▲ increases in wildfire hazards.

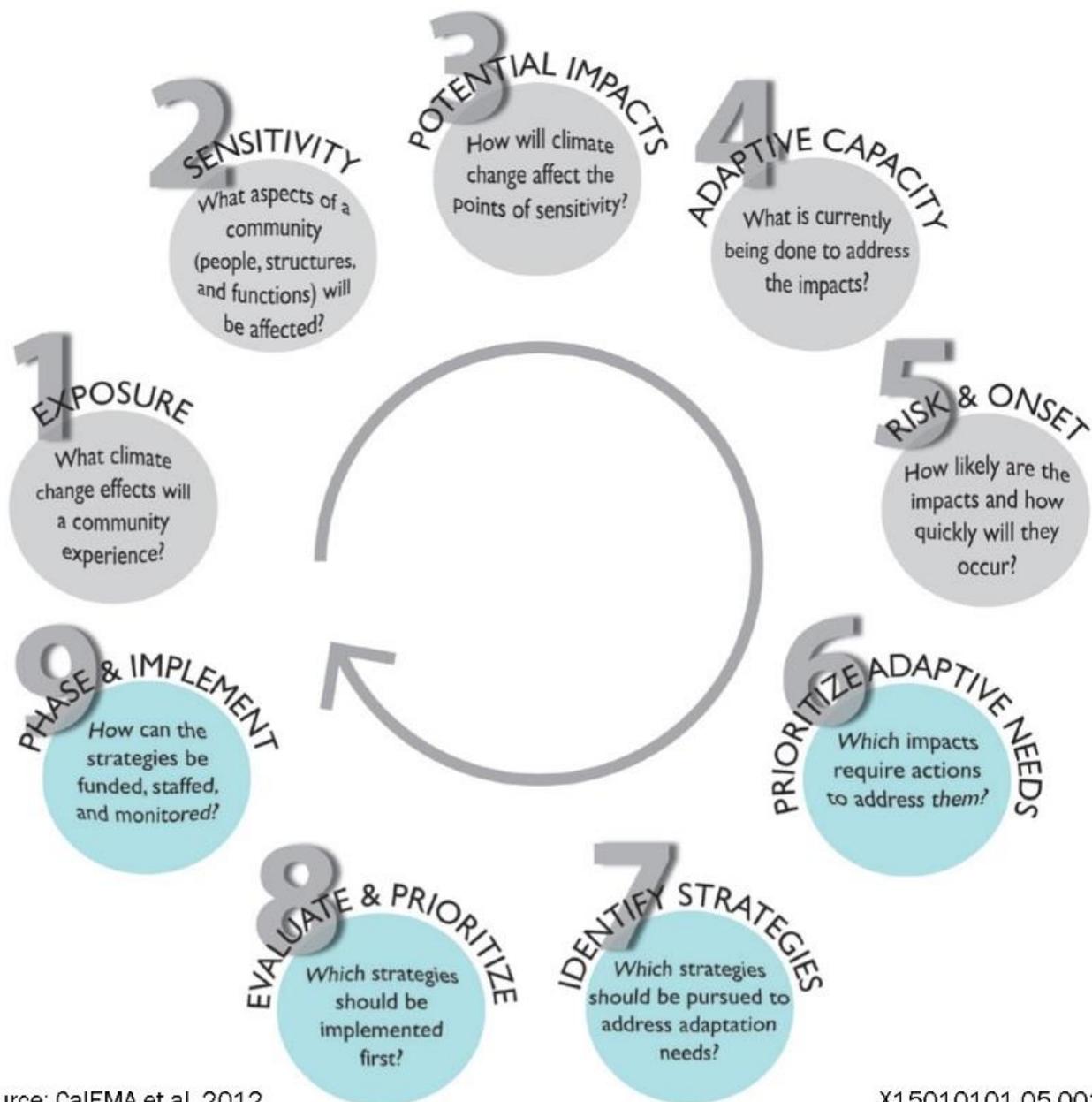
Over the long term, these changes create the potential for a wide variety of secondary consequences, including human health and safety risks, economic disruptions, diminished water supply, shifts in ecosystem function and habitat qualities, and difficulties with provision of basic services (California Natural Resources Agency [CNRA] 2012a:3). Locally, climate change is already affecting and will continue to alter the physical environment throughout the Central Valley and Sacramento County; however, specific implications of climate change effects vary with differing physical, social, and economic characteristics within the County. For this reason, it is important to identify the projected severity of climate change impacts on Sacramento County and ways the County can reduce vulnerability to them. Communities that begin to plan now will have the best options for adapting to climate change and increasing resilience (CNRA 2012a:4).

2 CLIMATE CHANGE ADAPTATION PLANNING PROCESS

The California Adaptation Planning Guide (APG) provides climate change guidance to cities, counties, and local governments. The APG 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 2012a:ii). As shown below in Figure 1, the climate adaptation planning process follows this sequence of steps:

- 1) Exposure: assessing exposure to climate change impacts.
- 2) Sensitivity: assessing community sensitivity to the exposure.
- 3) Potential Impacts: assessing potential impacts of the climate change exposure and sensitivities.
- 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 projection 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 implementation of strategies.
- 9) Phase and Implementation: establishing a phasing and implementation plan.



Source: CalEMA et al. 2012

X15010101 05 001

Figure 1

Climate Adaptation Planning Process Steps

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 they affect a community's health, economy, ecosystems, infrastructure, and socio-cultural stability (e.g., traditions, sense of place, values) (U.S. Department of Agriculture [USDA] 2011). The second phase of the process is adaptation strategy development. The vulnerability assessment phase helps communities understand climate change impacts, so that they can prepare effective climate adaptation strategies to increase resilience to climate change. Development of climate adaptation strategies will be included in the main body of the County's CAP.

3 VULNERABILITY ASSESSMENT

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

- ▲ Exposure: what climate change effects will a community experience?
- ▲ Sensitivity: what aspects of a community (i.e., function, structures, and populations) will be affected?
- ▲ Potential Impacts: how will climate change affect the points of sensitivity?
- ▲ Adaptive Capacity: what is currently being done to address the impacts?
- ▲ Risk and Onset: how likely are the impacts and how quickly will they occur?

Based on data provided by IPCC and research conducted by the State of California and its partner agencies and organizations, the effects of climate change are already occurring and will continue to occur in Sacramento County. These effects are identified and analyzed further below.

3.1 STEP 1: EXPOSURE

The first step in the vulnerability assessment is to identify the climate changes predicted for Sacramento County. For the purposes of this assessment, where predictive data exists, climate change effects are characterized for two milestone years: midcentury (2050) and end of century (2100). Historical data are used to set the baseline for describing the degree of change occurring by these two future dates.

The direct, or primary, effects of climate change analyzed for Sacramento County include:

- ▲ increased temperature,
- ▲ changes in precipitation patterns, and
- ▲ sea-level rise.

Secondary consequences, which could occur as result of one or a combination of these primary effects, are also analyzed. These include:

- ▲ increased frequency, intensity, and duration of extreme heat days and heat waves/events;
- ▲ loss of snowpack and decreased water supplies;
- ▲ increased wildfire; and,
- ▲ increased flooding.

To begin identifying these impacts, the APG encourages communities to use Cal-Adapt as a source of information to forecast 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. Cal-Adapt downscales global climate simulation model data to local and regional resolution under two emissions scenarios: the A-2 scenario represents a higher, future global greenhouse gas (GHG) emissions scenario, and the B-1 scenario represents a lower future GHG emissions scenario. Which scenario most closely resembles actual future conditions depends on the effectiveness of

programs implemented to reduce GHG emissions. While there has been progress on GHG emissions reduction and significant national, sub-national, regional and local efforts, overall anthropogenic CO₂ emissions have continued to rise at a rate that is anticipated to have major consequences worldwide (IPCC 2014). Because the degree of effectiveness of implemented programs is not yet known, results from both emissions scenarios are considered in this vulnerability assessment and distinguished, where possible.

Not all climate change effects within Cal-Adapt have data aggregated specifically for county-wide description. Cal-Adapt downscales most of its data to grid cells 12 kilometers (km) by 12 km in size (approximately 60 square miles), which cannot be easily aggregated for county-level evaluations, because the edges of the grid cells and county jurisdictional boundaries do not coincide. Twenty-eight grid cells are located entirely or partially within Sacramento County boundaries. For the purposes of this vulnerability assessment, where county-wide data are not available, this set of 28 grid cells is used for consistency in comparisons.

Cal-Adapt data describing future climate conditions for Sacramento County are summarized in the sections below.

3.1.1 Increased Temperature

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 GHG emissions scenarios (IPCC 2014:SPM-8). According to CNRA, downscaling of global climate simulation model data suggest that average temperatures in California are projected to increase 2.7 °F above 2000 averages by 2050 and, depending on emissions levels, 4.1-8.6 °F by 2100 (CNRA 2012b:2).

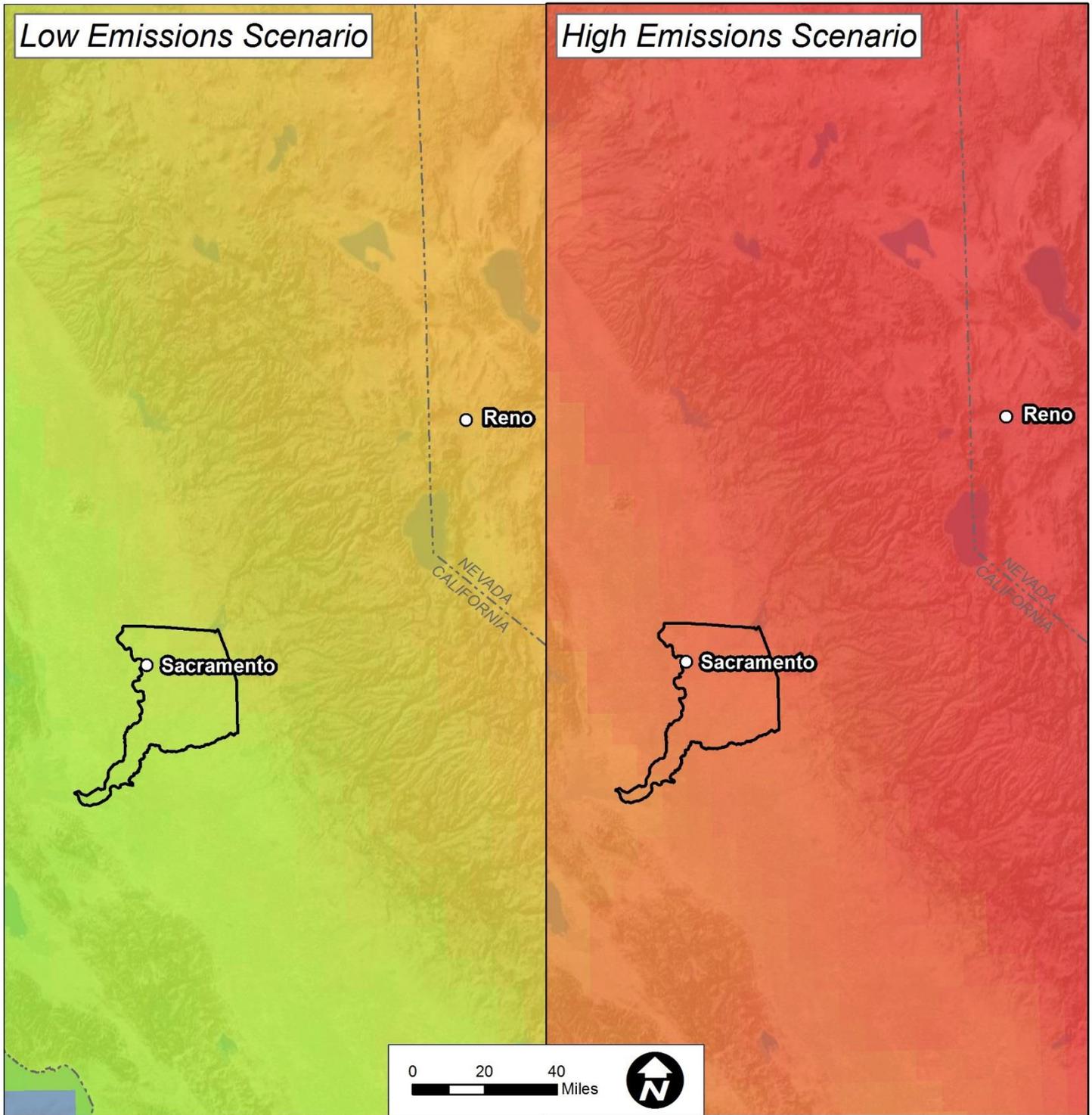
Figure 2 shows the projected change in average temperatures across Sacramento County under the low-emissions scenario and high-emissions scenario.

Annual average temperatures in Sacramento County are projected to increase steadily. Sacramento County's historical average temperature, based on data from 1961 to 1990, is 61.9 °F. According to Cal-Adapt, Sacramento County is projected to experience a temperature increase of 1.5 °F by 2050 and 3.5 °F by 2090 under the low-emissions scenario, and an increase of 4.1 °F by 2050 and 6.2 °F by 2090 under the high-emissions scenario, as compared to the 1961 to 1990 baseline period (Cal-Adapt 2016).

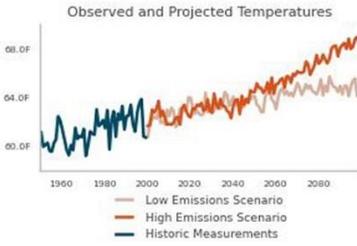
Sacramento County's annual average low temperature, based on historical data from 1961 to 1990, is 49.8 °F. Under the low-emissions scenario, annual low temperature is projected to increase 1.6 °F to 51.4 °F by 2099. The annual average low temperature under the high-emissions scenario is projected to increase 6.0 °F to 55.8 °F by 2099. Historically, the annual average high temperature is 73.1 °F. Under the low-emissions scenario, by 2099, annual average high temperatures are projected to increase 3.1 °F to 76.2 °F. Under the high-emissions scenario, annual average high temperatures are expected to increase 7.2 °F to 80.3 °F by 2099 (Cal-Adapt 2016).

EXTREME HEAT

Increased temperature is expected to lead to secondary climate change impacts, including increases in the frequency, intensity, and duration of extreme heat days and multi-day heat waves/events in California. Using Cal-Adapt's Extreme Heat tool, historical data from Sacramento County were used to project the change in frequency of extreme heat days, warm nights, and heat waves for the low- and high-emissions scenarios in 2050 and the end of century (2099). Historical data and projections are discussed below.



Legend



Source: Cal-Adapt (CNAP 2008)

Historical Average:	61.3°F
Low Emissions Scenario:	64.8°F +3.5°F
High Emissions Scenario:	67.5°F +6.2°F

Basemap: ESRI 2016
G15010101 05 005

Figure 2

Changes in Temperature in Sacramento County by 2099



Extreme Heat Days

Cal-Adapt defines the extreme heat day threshold for Sacramento County as 100 °F or higher. An extreme heat day is defined as a day between April through October where the maximum temperature exceeds the 98th historical percentile of maximum temperature based on daily temperature data from 1961 to 1990 (i.e., 100 °F). From the data collected from 1961 to 1990, Sacramento County has a historical average of four extreme heat days a year. Figures 3 and 4 show the number of days Sacramento County exceeded, or projected to exceed the area's extreme heat day threshold for each year from 1950 to 2099 under both emissions scenarios. Sacramento County is already experiencing an increase in the frequency of extreme heat days per year with a current average of eight to nine extreme heat days per year from 2010 to 2016 (Cal-Adapt 2016), including 18 extreme heat days in 2015.

Cal-Adapt data show a range of projected increases in the number of extreme heat days by 2099, all of which are at least four times the historical (1961-1990) average in both emissions scenarios. The projected annual average number of extreme heat days under the low-emissions scenario is approximately 15 days per year in 2050 and between 19 to 45 days per year at the end of the century. Under the high-emissions scenario, Cal-Adapt predicts that Sacramento County will experience 25 to 31 extreme heat days per year in 2050 and 50 to 67 days per year by 2099 (Cal-Adapt 2016).

In combination with extreme daytime heat, warm nights are also an important factor to consider. A warm night is defined as a day between April through October where the minimum temperature exceeds the average minimum temperatures between 1961 and 1990. Historically, Sacramento County has an average of four warm nights per year, with a threshold of 65 °F. Under the low- and high-emissions scenarios, the number of warm nights is expected to increase to an average of 12 to 33 nights by 2050 and 23 to 90 nights by 2099 (Cal-Adapt 2016).

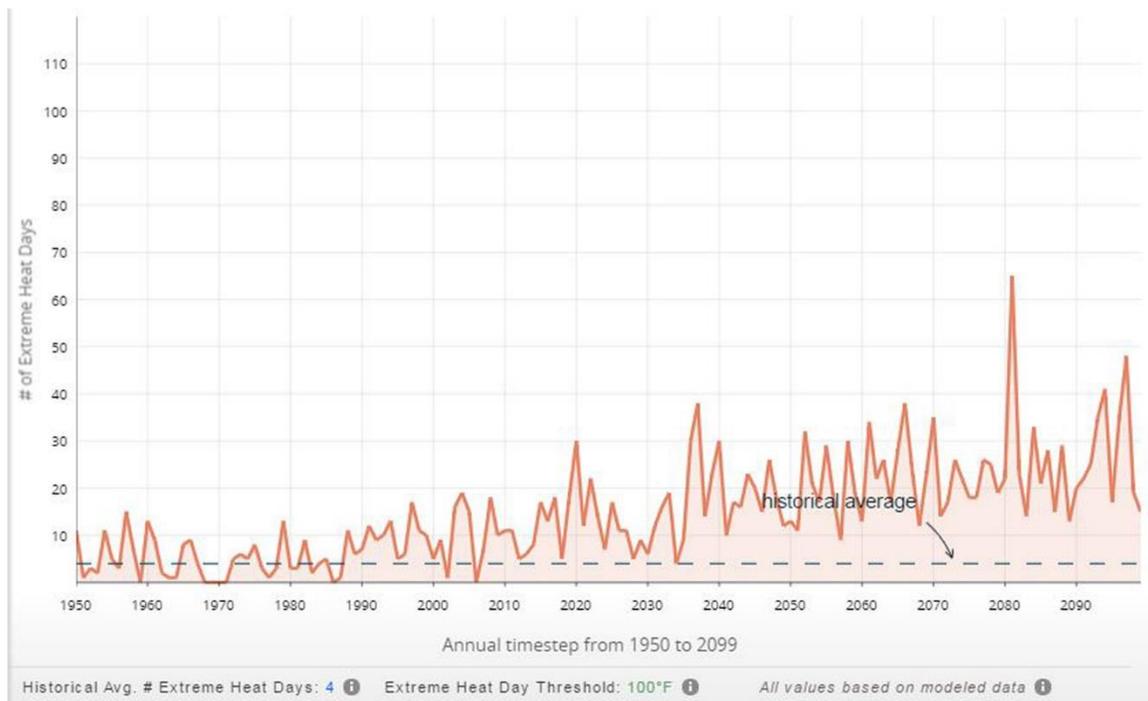
Heat Waves

When extreme temperatures are experienced over a period of several or more days, they are known as heat waves in some definitions, or heat events in others. The U.S. Environmental Protection Agency and Centers for Disease Control define extreme heat events as “periods of summertime weather that are substantially hotter and/or more humid than typical for a given location at that time of year.” Scientists expect climate change to lead to longer, more severe, and more frequent extreme heat events. According to Cal-Adapt, a heat wave occurs when the extreme heat day threshold (i.e., 100°F in Sacramento County) is exceeded for five or more consecutive days. This vulnerability assessment uses the Cal-Adapt term, heat wave, to describe current and projected future extreme heat conditions occurring over multiple days.

Figures 5 and 6 show the historical count of heat waves per year, and projected future heat waves in Sacramento County for each year between 1950 and 2099 under the low- and high-emissions scenarios. Each five-day period exceeding the extreme heat day threshold constitutes a counted wave; therefore, a 20-day heat wave would be shown as four counted events.

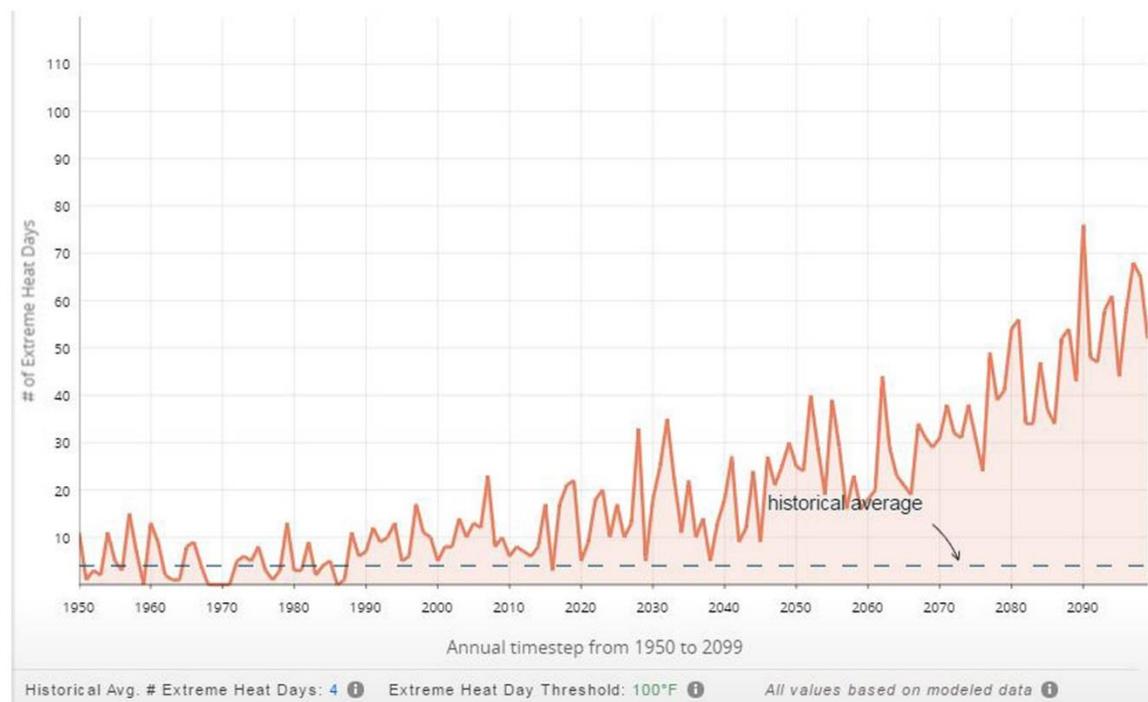
As shown in Figures 5 and 6, heat waves in Sacramento County have occurred at a rate of about one to two per decade between 1950 and 2000. The model projects an increase in frequency as the century progresses. Under the low-emissions scenario, Sacramento County would be expected to experience approximately three heat waves per year around the middle of the century, and up to four per year by 2099. The frequency in heat waves is projected to increase more substantially under the high-emissions scenario with an average of three to five heat waves per year occurring around 2050 and up to 12 per year at the end of the century (Cal-Adapt 2016).

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 7 and 8 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 Sacramento County graphed by time of occurrence in the period in which extreme heat days can occur (i.e., between April and October).



Source: cal-adapt 2016

Figure 3 Number of Extreme Heat Days under the Low-Emissions Scenario by 2099

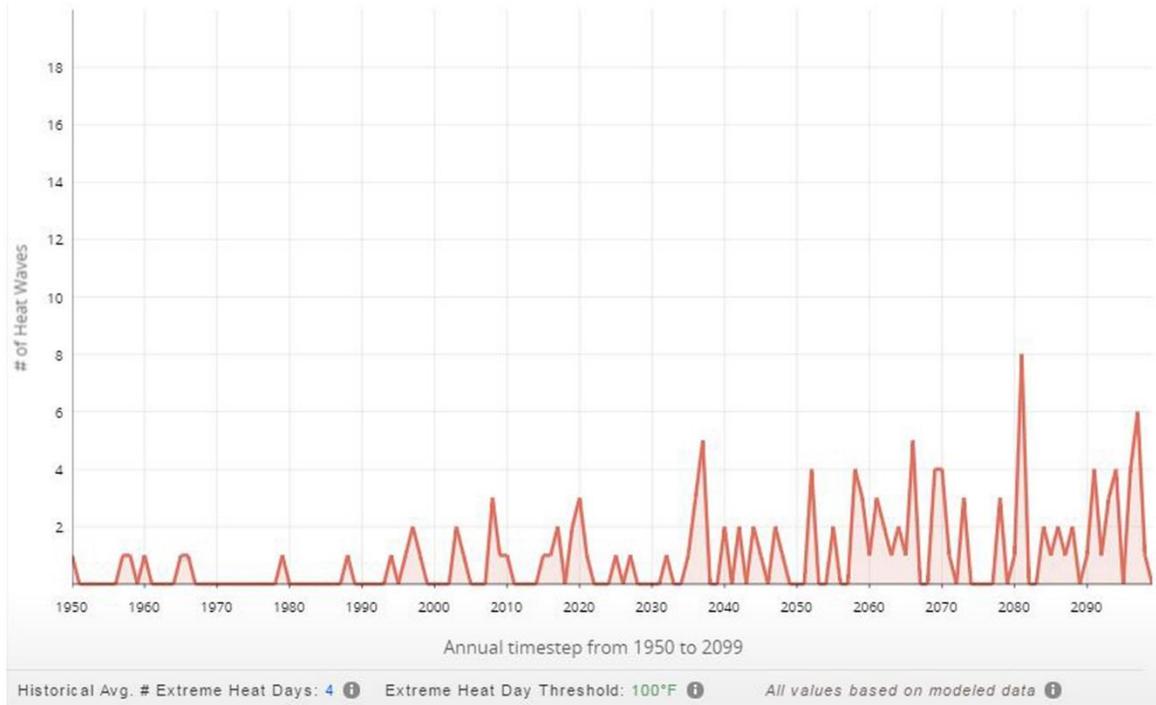


Source: cal-adapt 2016

X15010101.05.003

Figure 4 Number of Extreme Heat Days under the High-Emissions Scenario by 2099

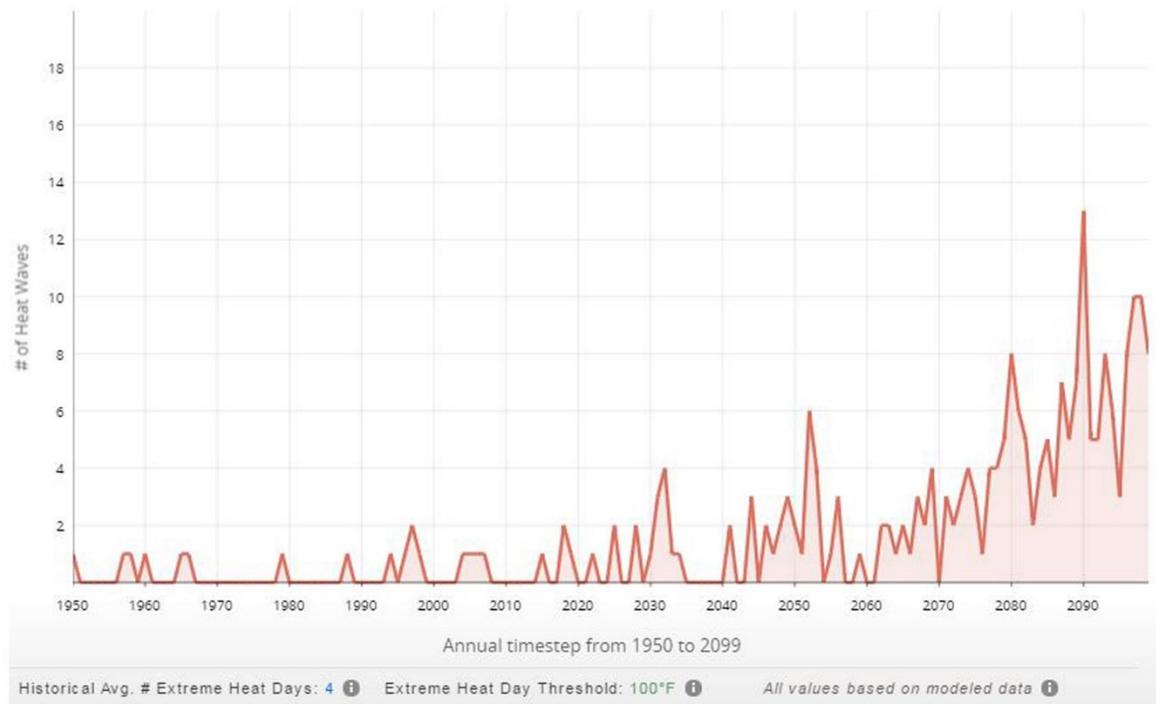




Source: cal-adapt 2016

A heat wave is defined as a period of five consecutive days that exceed the extreme heat day threshold.

Figure 5 Counts of Heat Waves under the Low-Emissions Scenario by 2099



Source: cal-adapt 2016

X15010101.05.004

A heat wave is defined as a period of five consecutive days that exceed the extreme heat day threshold.

Figure 6 Counts of Heat Waves under the High-Emissions Scenario by 2099



As shown in Figures 7 and 8, Sacramento County's extreme heat days historically occurred from late May/early June to late September. For both emissions scenarios, the model projects not only an increase in the frequency of extreme heat day threshold exceedances, but also their occurrence both earlier and later in the extreme heat season. In Figure 8 under the high-emissions scenario, longer sustained periods of extreme heat days would also result in more frequent and sustained heat waves earlier and later in the season towards the end of the century.

Urban Heat Island

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 °F, 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.

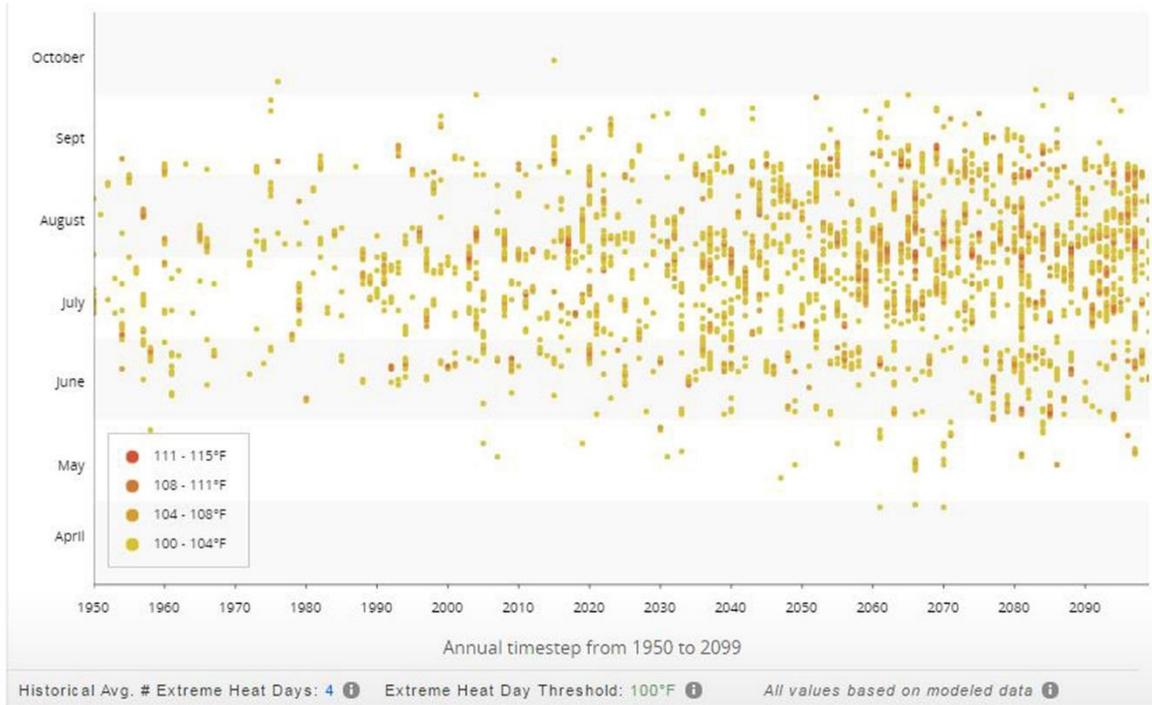
The effects of UHIE are heavily influenced by local wind patterns and can be distributed regionally. Assembly Bill (AB) 296 tasked the California Environmental Protection Agency (CalEPA) with defining UHIE, developing an index to track it, and producing a standard specification for sustainable or cool pavements. Pursuant to AB 296, CalEPA developed a study and 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 (°C) over a period of time (e.g., an area that experiences an increase of six degrees over the course of eight hours would have a UHIE index value of 48).

With respect to Sacramento County, UHIE-related impacts are dispersed by maritime wind patterns, locally known as the "Delta Breeze." These easterly winds are channeled from the ocean through the Delta into Sacramento County, and help disperse heat and air pollutants. As demonstrated in Figure 9, which displays Sacramento County's UHIE index developed by CalEPA, incremental increases in temperature are more pronounced in the northern portion of the County. These elevated temperatures occur due to the movement of heat originating in urbanized areas of Sacramento County (i.e., cities of Sacramento and Elk Grove) as a result of the wind patterns associated with the Delta Breeze.

3.1.2 Changes in Precipitation Patterns

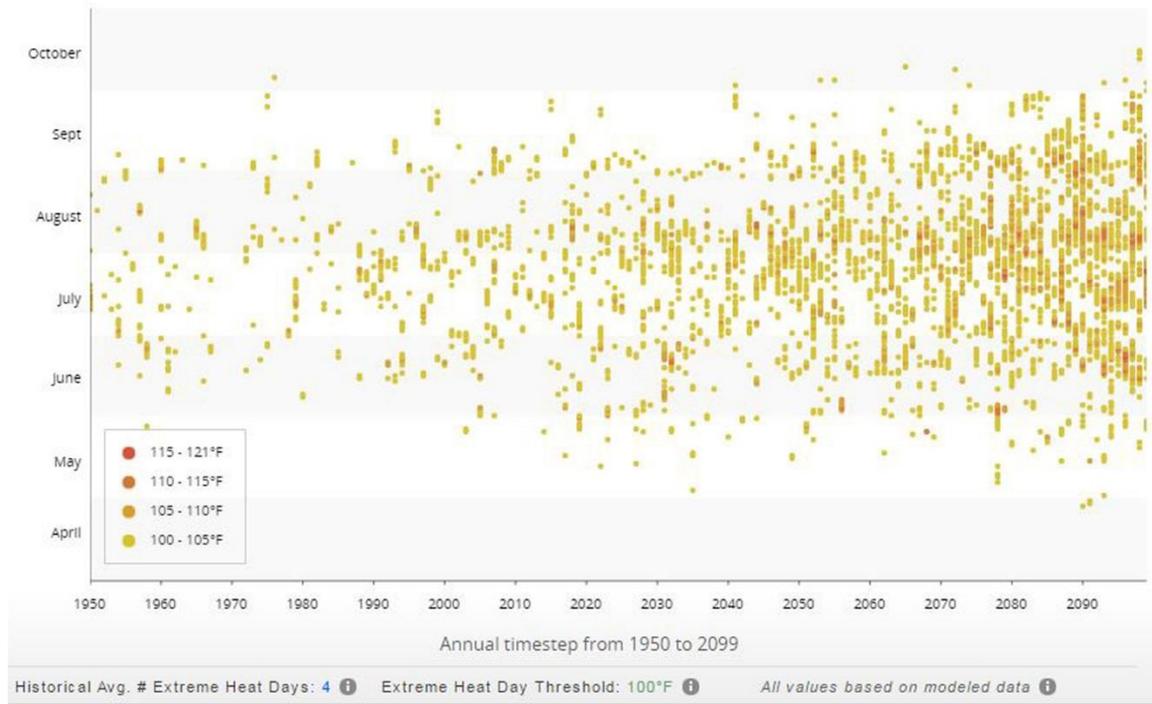
Global climate change will affect physical processes and conditions beyond average temperatures. As a result of climate change, historic precipitation patterns could be altered. Depending on location, precipitation events may increase or decrease in intensity and frequency, and are notoriously difficult to predict (Sacramento Area Council of Governments [SACOG] 2015:11). While projections generally show little change in total annual precipitation in California and trends are not consistent, even modest changes could significantly affect California ecosystems that are conditioned to historical precipitation timing, intensities, and amounts. Reduced precipitation could lead to higher risks of drought, while increased precipitation could cause flooding and soil erosion (CNRA 2014:25).

Cal-Adapt provides a historical annual average rate of precipitation of about 18 inches for Sacramento County. As shown in Figure 10, overall precipitation in Sacramento County is expected to decline over the course of the century, with annual averages decreasing more substantially under the high-emissions scenario.



Source: cal-adapt 2016

Figure 7 Timing of Extreme Heat Days under the Low-Emissions Scenario by 2099

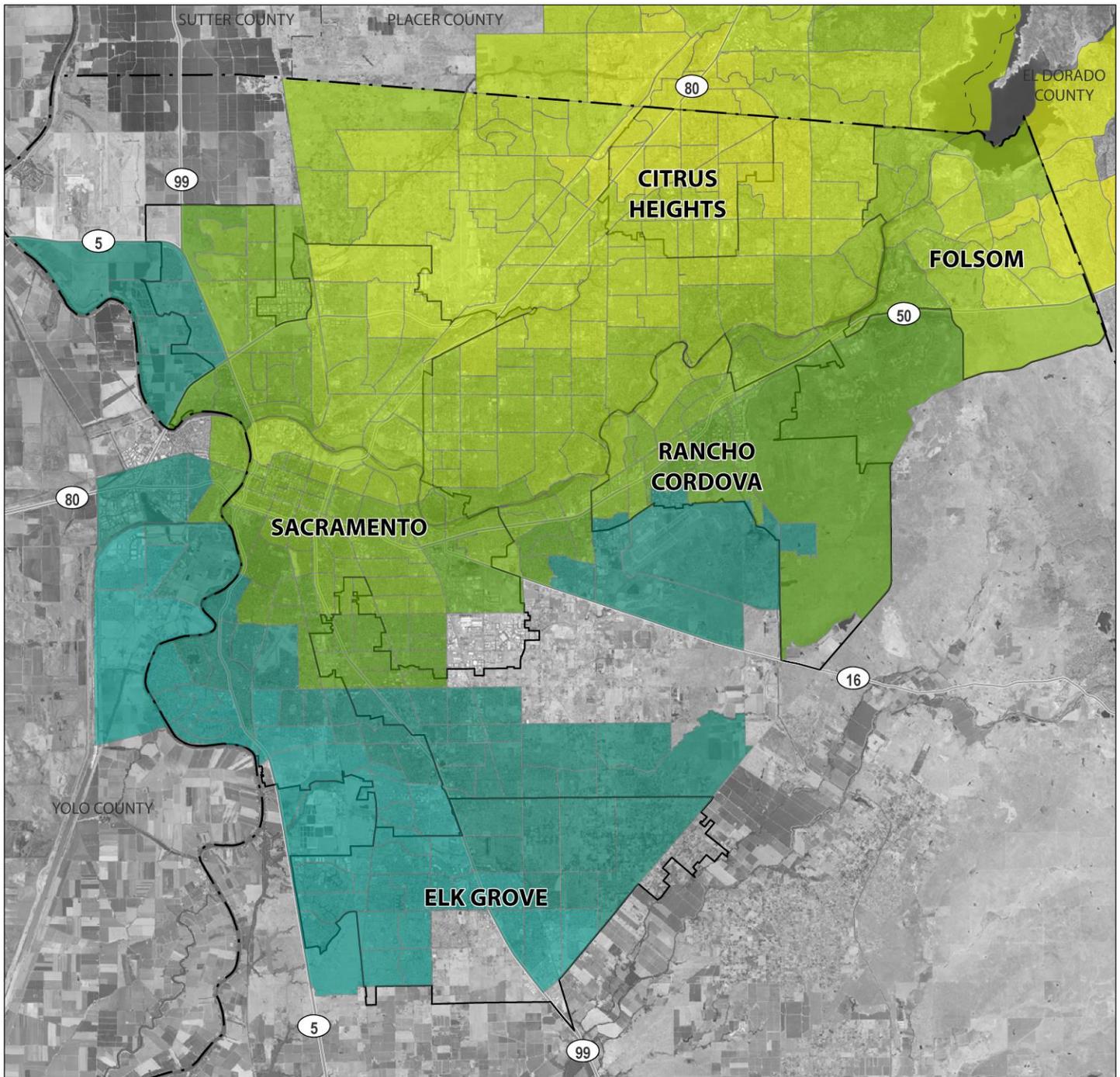


Source: cal-adapt 2016

X15010101.05.005

Figure 8 Timing of Extreme Heat Days under the High-Emissions Scenario by 2099





Legend

Urban Heat Island Index

0 - 10	51 - 60	101 - 110	151 - 160	201 - 210	251 - 260	Sacramento County City Limits
11 - 20	61 - 70	111 - 120	161 - 170	211 - 220	261 - 270	
21 - 30	71 - 80	121 - 130	171 - 180	221 - 230	271 - 280	
31 - 40	81 - 90	131 - 140	181 - 190	231 - 240		
41 - 50	91 - 100	141 - 150	191 - 200	241 - 250		

Note: The index is a measure of intensity over time (e.g., an increase of one degree over an eight hour period would equal eight degree hours as would an increase of two degrees over a four-hour period).



Source: California Environmental Protection Agency 2015

Figure 9

Urban Heat Island Index for Sacramento County



SNOWPACK

Changes in weather patterns resulting from increases in global average temperature could result in a decreased proportion and total amount of precipitation falling as snow. This phenomenon is predicted to result in an overall reduction of snowpack in the Sierra Nevada. Based upon historical data and modeling, under the low- and high-emissions scenarios as shown in Figure 11, the California Department of Water Resources (DWR) projects that the Sierra Nevada snowpack will decrease by 25 to 40 percent from its historic April 1st average of 28 inches of water content by 2050 and 48 to 65 percent by 2100 (DWR 2008:4, DWR 2013:3-64).

Surface Water

Water districts and municipal utilities in Sacramento County rely on snowmelt water as a key source of surface waters originating in the Sierra Nevada. The Sacramento, American, Cosumnes, and Mokelumne Rivers provide municipal, agricultural, and recreational uses to Sacramento County (Sacramento County 2011a). The flow-regimes of these rivers depend on spring and summer snowmelt in the Sierra Nevada. The ability of snowpack to retain water and release it gradually is fundamental to water supply planning in Sacramento County and throughout the watersheds of the Sierra Nevada.

The Sacramento and American Rivers flow through a regime of dams constructed to support the State Water Project and Central Valley Project. Shasta Dam comprises the principal storage facility in the Sacramento River system followed by Oroville Dam on the Feather River, the Sacramento River's largest tributary. Folsom Dam contains the American River's largest reservoir. These dams and reservoirs, combined with a network of smaller dams and canals, are designed to protect Sacramento from flooding while also helping to provide California with water security during droughts. Due to California's Mediterranean climate, much of the State experiences prolonged periods of drought during the summer months. Dams serve to enhance the natural capacity of California's river systems to support the water demand of California residents during dry months. Dams also provide flood protection for areas of the State located in floodplains; therefore, management of dams along the Sacramento and American Rivers must maintain a balance between storage and release priorities, particularly in periods of drought.

Pursuant to Section 9503 of the SECURE Water Act, the U.S. Bureau of Reclamation (USBR) is authorized to evaluate the risks and impacts of climate change in the Sacramento River Basin, which is detailed in the Sacramento and San Joaquin Climate Impact Assessment. The report provides an overview of the current climate and hydrology of the California Central Valley as well as projections of hydrologic changes that the Basin may experience as a result of climate change. The report projects a north to south trend of decreasing annual average precipitation throughout the 21st century. Additionally, the report predicts a shift to an increase in the rate of winter runoff and a decrease in precipitation falling as snow in winter months (USBR 2014). These shifts in precipitation patterns may result in an exceedance of surface water capacity earlier in the year. If flow rates exceed the capacity of reservoirs in the Sacramento and American river watersheds, fresh water would need to be released to accommodate river flow, which comprises a source of potable water which previously would have been stored in the Sierra Nevada snowpack. These conditions are already affecting summer water supply in the County.

Groundwater

Sacramento County lies over the north central portion of the California's Great Valley Groundwater Basin, which provides approximately 50 percent of all municipal and agricultural water supply in the County. Groundwater recharge occurs primarily from the American and Cosumnes rivers, with additional recharge from the Sacramento River and local streams. Groundwater stores are directly linked to surface water in the County and snowmelt in the Sierra Nevada; therefore, increased average temperatures and changes in the timing, amounts, and snow/rain form of precipitation could affect local aquifer recharge for groundwater supplies (Sacramento County 2011a). Groundwater use typically increases during droughts. Due to increased uncertainty in the amount and timing of water availability and the stress placed on aquifers during droughts, Sacramento County may face increased challenges in providing adequate groundwater supplies to meet future demand.

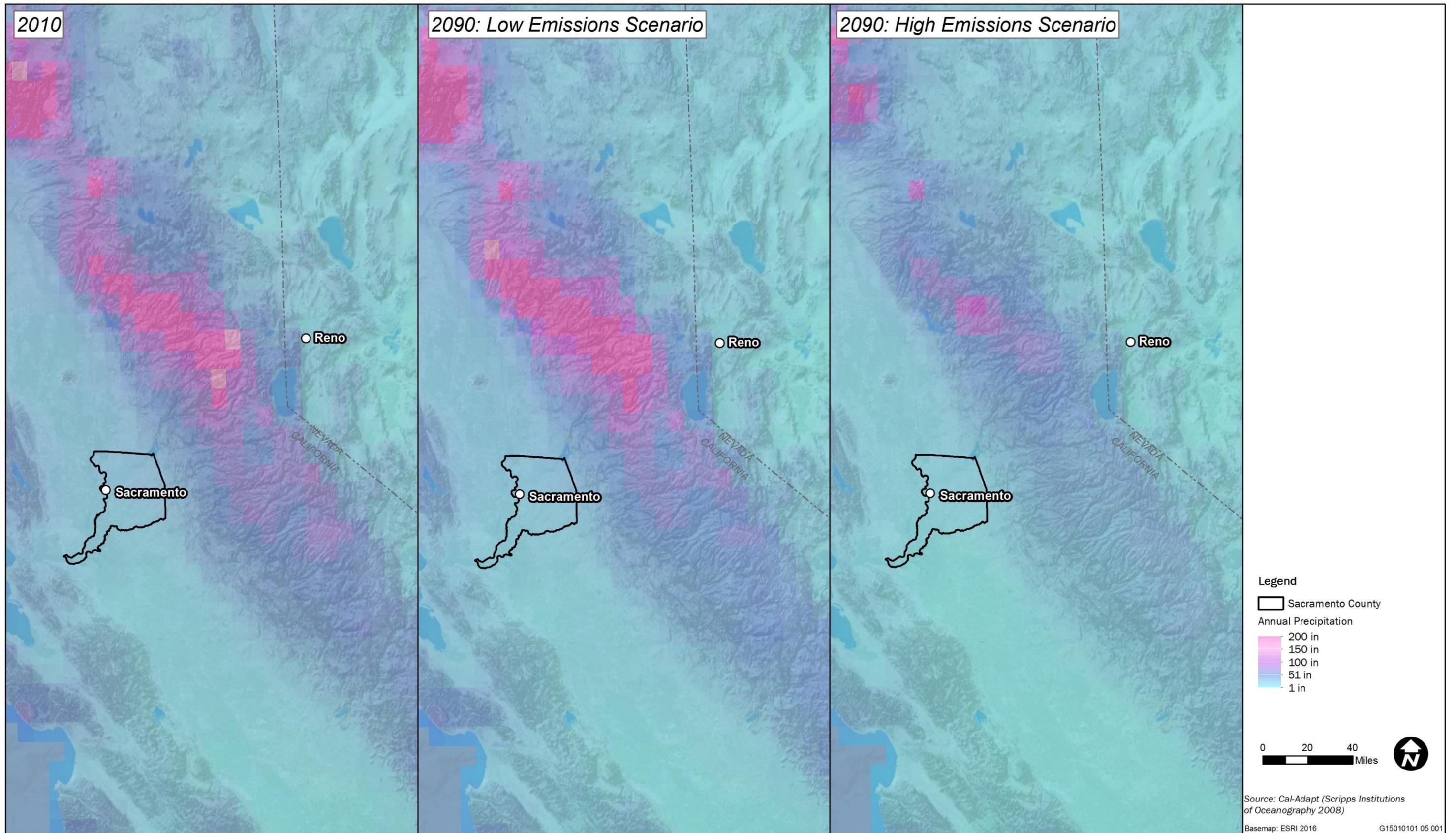


Figure 10

Change in Precipitation under the High- and Low-Emissions Scenarios by 2090

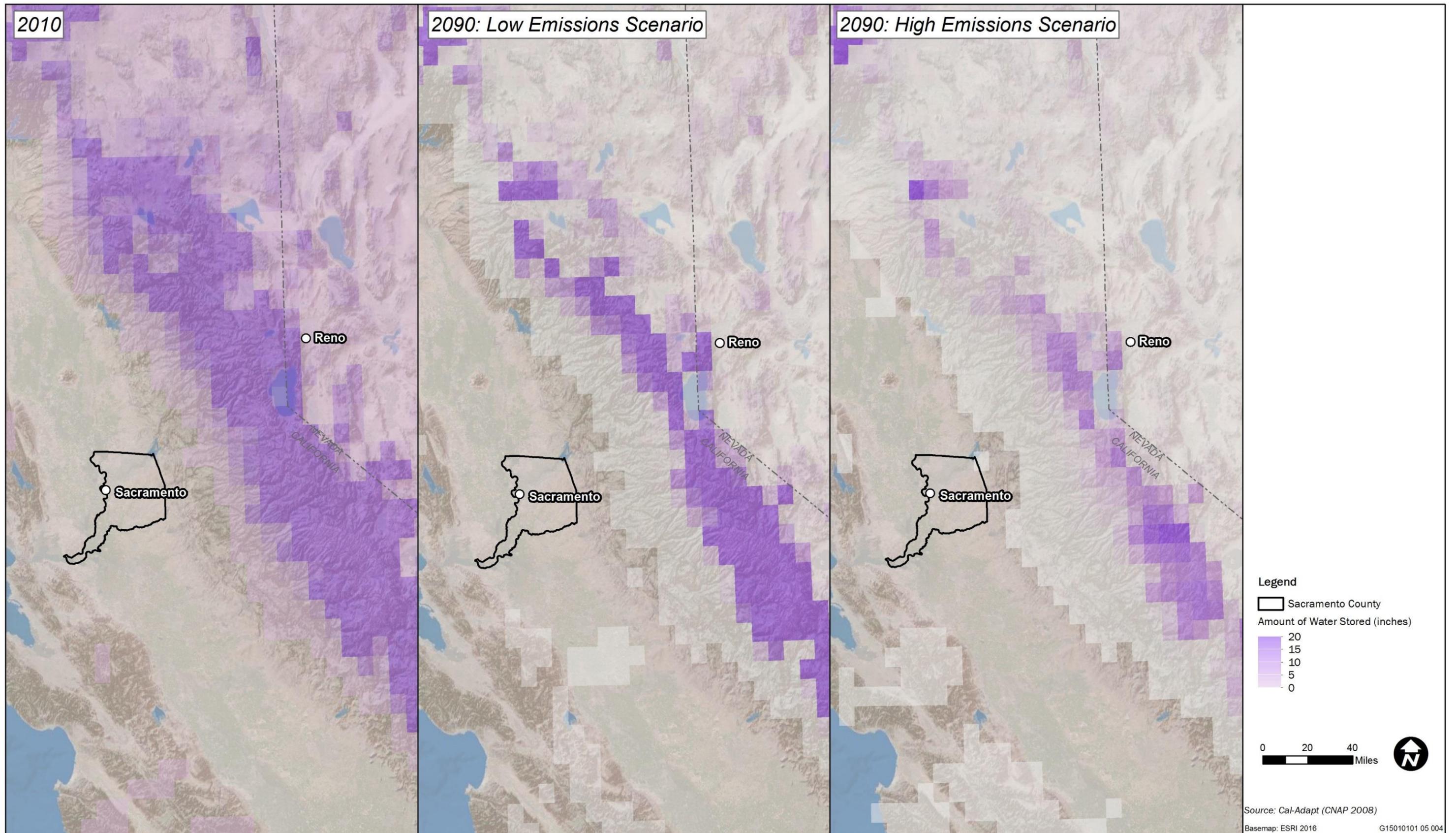


Figure 11

Change in Snowpack under the High- and Low-Emissions Scenarios by 2090

EXTREME STORMS

Changes in precipitation patterns may result in less-frequent but more extreme storm events. While Sacramento County is projected to experience an overall decrease in precipitation, the precipitation that will fall may have more intense characteristics, such as high volume of rain falling over a shorter period of time with stronger and more destructive wind patterns. These storms may produce higher volumes of runoff and contribute to an increased risk of flooding. Impacts associated with flooding are discussed in greater detail in Section 3.1.4, “Increased Flooding.”

3.1.3 Increased Wildfires

Rising temperatures combined with changes in precipitation patterns and reduced vegetation moisture content can lead to a secondary impact of climate change: an increase in the frequency and intensity of wildfires. 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 (CNRA 2012b:11). Increased temperatures will increase the rate of evapotranspiration in plants, resulting in a greater presence of dry fuels in forests creating a higher potential for wildfires (SACOG 2015:3).

Increased wild fire activity across the western United States in recent decades has contributed to widespread forest mortality, carbon emissions, periods of degraded air quality, and substantial fire suppression expenditures. Although numerous factors aided the recent rise in fire activity, observed warming and drying have significantly increased fire-season fuel aridity, fostering a more favorable fire environment across forested systems. On October 11, 2016, the Proceedings of the National Academy of Sciences reported that human-caused climate change has contributed to over half of the documented increases in fuel aridity since the 1970s and doubled the cumulative forest fire area since 1984. This analysis suggests that anthropogenic climate change will continue to chronically enhance the potential for western U.S. forest fire activity where fuels are not limited.

According to the Sacramento County 2016 Local Hazard Mitigation Plan (LHMP), wildfire and urban wildfire are an ongoing concern for the County. Generally, the fire season extends from early spring to late fall. Fire conditions arise from a combination of weather, topography, wind patterns, an accumulation of vegetation, and low-moisture content in the air. Urban wildfires often occur in areas where development has expanded into rural areas. In Sacramento County, grass fires and peat fires are the two main types of wildland fires of concern. Grass fires are an annual threat in the unincorporated county, especially within recreational areas, such as the American River Parkway. Peat fires are unique to the Sacramento-San Joaquin Delta where peat is subject to spontaneous combustion. Once started, these fires become very difficult to control. Peat can burn some distance underground even when the upper layers of peat are saturated with water over an extended period of time (Sacramento County 2016a).

There have been 46 recorded wildfires in Sacramento County from 1950 to 2008. The most damaging fire occurred in 1852 and destroyed approximately 90 percent of the City of Sacramento. The Sacramento County LHMP identifies wildfire hazard as “highly likely” to occur in the future but “limited” in geographic scope (i.e., less than 10 percent of the County area) and magnitude of severity (i.e., 10 to 15 percent of property damaged and causing treatable illness). Wildfire risk in Sacramento County is therefore considered a localized hazard with increased likelihood of occurrence in the western foothills as slopes gradually increase (Sacramento County 2016a).

The Sacramento Metropolitan Fire District (Metro Fire) Community Wildfire Protection Plan (CWPP) provides an overview of areas vulnerable to wildfire in Sacramento County, depending on the characteristics of the wildland urban interface (e.g., fuel models, structure density and arrangement), which can contribute to an area’s susceptibility to wildland fire. The CWPP assesses the potential effects on wildfire hazards associated with climate change. For example, the historic “fire season” (i.e., late spring, summer, early fall) is changing

or breaking down due to shifts in precipitation patterns combined with increased temperatures and a general drying out (e.g., reduced fuel moisture) of the Central Valley and Sacramento County. The CWPP predicts an overall increase in the frequency and intensity of wildfires as result of the changes associated with climate change. Rising temperatures, a reduction in the moisture content of fuel loads, and alterations in historic precipitation patterns will likely contribute to the rate of fires spreading and becoming more intense (Metro Fire 2014).

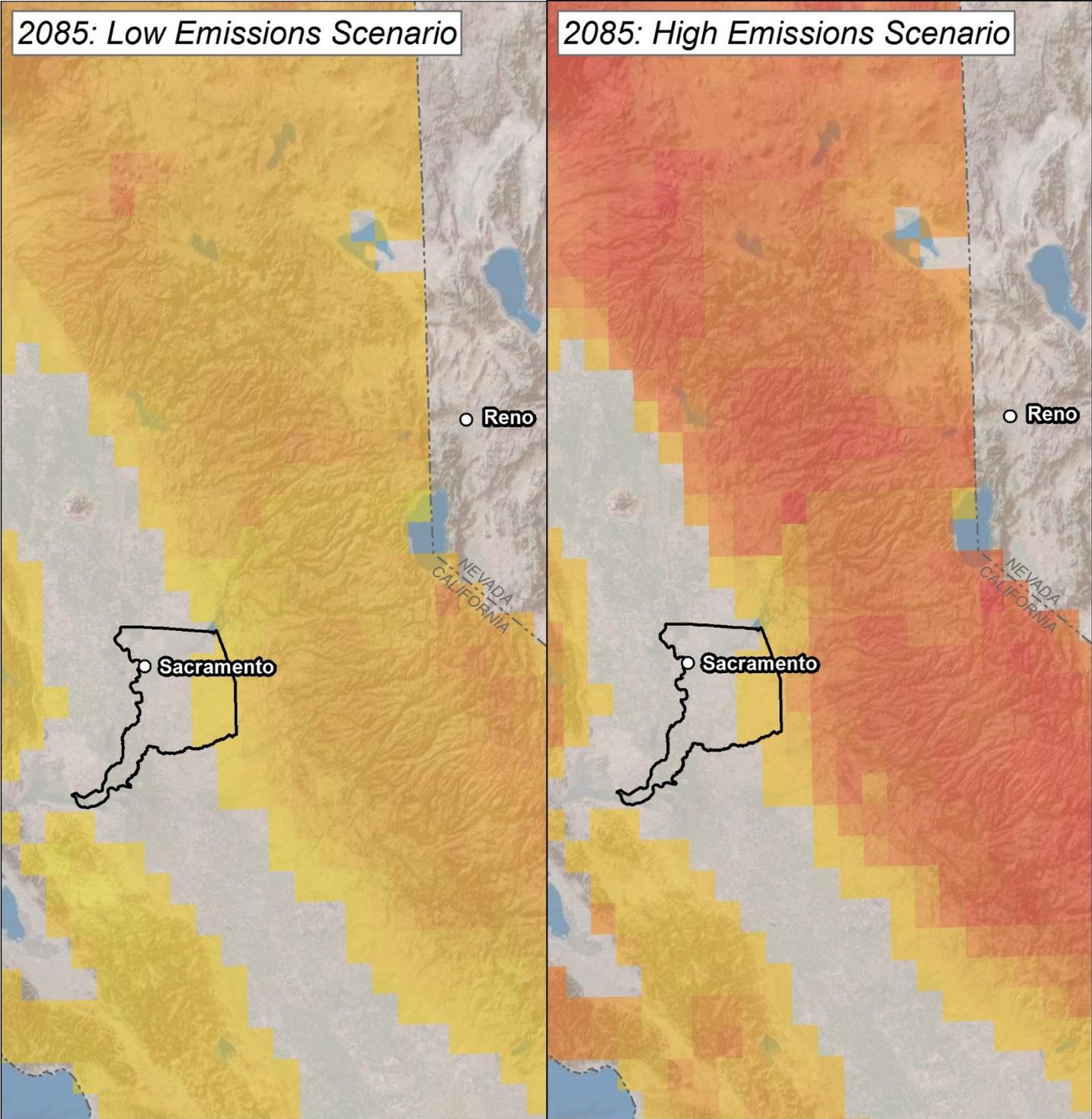
It should be noted that there is uncertainty surrounding projections for future wildfire risk. The projections contained in the Sacramento County LHMP and the Metro Fire CWPP are based on models that use a variety of factors that contribute to wildfire risk (e.g., topography, vegetation type). The variations in the parameters used in wildland fire models may produce contradictory results, as discussed below.

Cal-Adapt's wildfire tool predicts the potential increase in the amount of area burned for the year 2085, as compared to 2010 conditions. Figure 12 shows the increased wildfire risk for Sacramento County, which is concentrated in the east. Under the low-emissions scenario, fire risk relative to 2010 levels is 1 percent more likely in 2020, 13 percent less likely in 2050, and 33 percent less likely in 2085. Under the high-emissions scenario fire risk is 2 percent more likely in 2020, 14 percent less likely in 2050, and 33 percent less likely in 2085. Contrary to what is predicted in the Sacramento County LHMP, Cal-Adapt predicts that wildfire risk in Sacramento County will likely increase slightly in the near term, and subside during mid- to late-century (Cal-Adapt 2016).

As discussed above, wildfire models vary depending on the parameters used. Further, the contradictory predictions made by the Sacramento County LHMP and Metro Fire CCWP, and Cal-Adapt for future wildfire risk in Sacramento County demonstrates that the conditions to support wildfire are dependent on a variety of functions. In Sacramento County, precipitation patterns, high levels of heat, topography, and fuel load will likely determine the frequency and intensity of future wildfire. As Cal-Adapt does not account for landscape and fuel sources in its modeling, the data do not produce a comprehensive projection of wildfire risk in the County, leading to some inconsistencies with projections of the LHMP and CWPP. These projections serve as an indicator of the uncertainty of future risk. CEC and its collaborators are currently in the process of updating Cal-Adapt to reflect landscape.

Figure 12 illustrates the potential for increases in the severity of wildland fire beyond the boundaries of the County under the high- and low-emissions scenarios by the year 2085. As shown in Figure 12, the characteristics of the Sierra Nevada (i.e., steeper slopes) contribute to the region's susceptibility to more frequent and intense wildland fires. Fire activity in the Sierra Nevada region may damage water and energy infrastructure upon which Sacramento County relies.

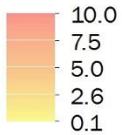
Further, wildfires within the Sierra Nevada and areas outside the County affect air quality in Sacramento County. Wildland fires produce substantial emissions of particulate matter (smoke, soot), which may cause adverse health effects including restricted breathing and aggravation of existing respiratory and cardiovascular diseases in the short-term, and alterations to immune systems and cancer from chronic exposure. Particulate matter from wildfire dissipates throughout the Central Valley degrading air quality conditions for short or extended periods of time. The duration of wildfire-related particulate matter in the County's air is linked to wind patterns originating from the Sacramento-San Joaquin Delta. As previously discussed, the phenomenon known as the Delta Breeze affects the severity of wildfire-related air pollution in Sacramento County by dispersing air pollutants through the Carquinez Straight into the northern portion of the Central Valley (Sacramento Metropolitan Air Quality Management District [SMAQMD] 2016). For example, during the summers of 2013 through 2015, several wildfire incidents occurred in Northern California that increased levels of particulate matter within Sacramento County.



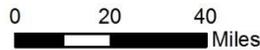
Legend

Sacramento County

Increase in Area Burned



Source: Cal-Adapt (UC Merced 2008)



Basemap: ESRI 2016
G15010101 05 002

Figure 12 Increased Frequency of Wildfire under the Low- and High-Emissions Scenario



According to a study performed by Climate Central, wildfires burning within 50 to 100 miles of a city generally caused air quality to degrade by 5 to 15 times normal conditions. On average, in the western U.S. there are now twice as many fires burning each year compared to the 1970s. A recent Yale University study predicts a substantial increase in the number of days that people in the western U.S. will be exposed to wildfire smoke by 2050. The number of people exposed to these “smoke waves,” or consecutive days with poor air quality due to wildfires, is projected to increase from 57 million currently to 82 million by 2050. The majority of people exposed are likely to be in northern California, western Oregon, and the Great Plains (Liu et al. 2016).

3.1.4 Increased Flooding

Climate change is likely to lead to changes in frequency, intensity, and duration of extreme storm events, such as heavy precipitation amounts with increased rainfall intensity. Further, increases in annual temperature may result in earlier and more rapid melting of the Sierra Nevada snowpack, which could lead to an increase in flow rate of surface waters in Sacramento County. These projected changes could lead to increased flood magnitude and frequency, and could place more pressure on Sacramento County with higher risk of damage to land, buildings, roads, and crops (IPCC 2007:14). While it is uncertain precisely how and to what extent climate change will affect flooding events in Sacramento County, it is reasonable to expect that an increase in flooding could have serious ramifications, because the area is already considerably vulnerable.

Sacramento County is susceptible to riverine flooding which can occur anytime from November through April. Riverine flooding generally occurs as result of prolonged rainfall, or rainfall combined with Sierra snowmelt and/or already saturated soils from previous rain events. Factors that directly affect the amount of flood runoff include precipitation amount, intensity and distribution, the amount of soil moisture, seasonal variation in vegetation, snow depth, and impermeability of surfaces due to land use decisions, development patterns, building and infrastructure material choices and project designs. Placement and integrity of existing levees and reservoir operation for flood control are also important factors. Intense storms may overwhelm local waterways, as well as threaten the integrity of flood control structures.

Historically, flooding has constituted the most frequent natural hazard experienced by Sacramento County. Due to the County’s relatively flat, low-lying terrain and numerous waterways Sacramento County is considered likely to experience severe flooding. Several rivers flow through the County including the Sacramento, American, and Cosumnes Rivers. The Sacramento and American Rivers, and numerous tributaries to the east, north, and west, flow toward the City of Sacramento. The watersheds of these two main rivers drain most of northern California and part of Oregon for a total of approximately 20,000 square miles. The Sacramento and American River flows are managed by USBR through the operation of Shasta and Folsom dams, both of which have flood control as important features of their operational rules. The Cosumnes River, which is not influenced by a flood-control reservoir, flows southwesterly through the southern portion of the County into the Sacramento-San Joaquin Delta region (Sacramento County 2016a).

When the Sacramento River reaches its peak capacity, the American River and other tributaries that flow into the Sacramento River cannot discharge at a normal rate. These conditions result in “backflows,” which can cause tributaries to overflow and flood local areas. The reach of Sacramento River closest to the Sacramento-San Joaquin Delta is also affected by ocean tides. High tides that occur simultaneously with high river flows could increase chances of flooding. To combat the natural tendencies for flooding in the Sacramento region, the American River and Sacramento River Flood Control Systems have been established with dams, bypasses, and levees to control high flows and potential inundation (Sacramento County 2016a). The construction of these control systems have greatly reduced the risks of flooding on the Sacramento River, though 20 floods have resulted in state and federal disaster declarations since 1950.

The characteristics of the Sacramento, American, and Cosumnes Rivers also contribute to the potential for Delta flooding to occur. The watersheds of these rivers converge at the Sacramento-San Joaquin Delta, and,

as agricultural interests continue to farm land and contribute to subsidence, levees in the Delta become more vulnerable to breaching (Sacramento County 2011a). As this land continues to subside coupled with the potential impacts of sea-level rise (discussed below), additional strain may be placed on the Delta levee system. In addition, catastrophic Delta flooding from levee failure may occur as result of a seismic event.

Flooding in the Delta will be dependent on the resilience of the existing levee system, which is undergoing deterioration due to several stressors beyond land subsidence. According to the U.S. Geological Survey, approximately 100 levee failures have occurred since the early 1890s (USGS No Date). Unlike levees which protect against intermittent periods of high volumes of water (e.g., flood), the Delta levees must provide consistent yearlong flood protection as a notable quantity of land in the Delta exists below sea level (Delta Stewardship Council 2013). The Delta levees experience erosion and sloughing due to river velocity and wind-driven, wave wash requiring on-going maintenance, which is often impeded due to lack of funding.

Creek flooding, or flash flooding, may also occur within the watersheds of the County's rivers. Flash floods occur in localized areas as a result of heavy rainfall on a relatively small drainage areas. These flood events are short-term in nature and generally occur in the winter and spring.

Sacramento County is also susceptible to experiencing localized, stormwater flooding wherein stormwater runoff exceeds the rate of drainage. Stormwater flooding occurs during periods of severe weather and unusually high amounts of rainfall, and on occasions where stormwater infrastructure is physically impaired or inadequate. This kind of flooding event typically occurs in urbanized areas with expanses of impervious surfaces.

The Sacramento County 2016 LHMP evaluates the likelihood of the County experiencing localized flooding (<100-year flood), 100-year floods, 200-year floods, and 500-year floods. The 100-year flood designation serves as the national minimum standard to which communities regulate their floodplains through the National Flood Insurance Program (NFIP) and refers to a flood with a one percent chance (i.e., one in one hundred) of occurring per year. Additionally, 200-year and 500-year flood events refer to a flood that has a 0.5 percent (i.e., one in two hundred) and 0.2 percent (i.e., one in five hundred) chance of occurring per year, respectively. According to the 2016 LHMP, Sacramento County is "Highly Likely" to experience localized flooding; hazards designated Highly Likely are predicted to have a nearly 100 percent chance of occurrence every year or at least every other year. The 2016 LHMP classifies the probability of future occurrences of 100-year floods as "Occasional," which means there is a predicted chance of one to ten percent that it will occur each year or has a recurrence interval of 11 to 100 years. For 200- and/or 500-year floods, the 2016 LHMP designates Sacramento County as "Unlikely," which suggests that Sacramento County is has a less than one percent chance of occurrences of 200-, and/or 500-year floods in then next 100 years (Sacramento County 2016a). More than 370 square miles of Sacramento County is within the 100-year floodplain and, in addition, many areas within the County have local flood hazard areas.

Flood events in Sacramento County are also tied to local meteorology. An atmospheric river known as the "Pineapple Express" brings warm air and rain from the Pacific Coast inland and can deposit large quantities of precipitation over short periods of time, which can lead to extensive flooding. The warm air also contributes to snow melt in the Sierra Nevada and further exacerbates flood potential (Sacramento County 2016a).

Detailed information regarding existing flood-related infrastructure projects in Sacramento County, as well as in-depth discussion of infrastructure and sites potentially vulnerable to flooding is discussed below in Section 3.2, "Steps 2 and 3: Sensitivity and Potential Impacts."

3.1.5 Sea-Level Rise

Another effect of global climate change is sea-level rise. The average global sea level rose approximately seven inches during the last century. Assuming that it continues to reflect global trends, sea level along the

California coastline could be 10-18 inches (in) (0.25-0.45 meters [m]) higher in 2050 than 2000 levels, and 31-55 inches higher (0.78-1.4 m) than 2000 levels by the end of this century (CNRA 2012a:9).

Sacramento County is located inland within the Central Valley of California. The southwestern portion of the County follows the course of the Sacramento River as it flows into the Sacramento-San Joaquin Delta. Using data developed by the University of California (UC) at Berkeley, Cal-Adapt depicts sea-level rise projections and existing storm-related flooding events using the 3Di hydrodynamic model, which incorporates a historical (100 years) water flow pathway framework that takes into consideration surface feature elevations to accurately identify flow connectivity and flood zones (Radke et al. 2016). Figure 13 shows the projected areas at risk for inundation of 0.00-4.00+ meters during a 100-year flood event combined with a 1.41 m rise in sea-level.

The southeastern portion of Sacramento County near the Delta is vulnerable to the influences of sea-level rise. Table 1, “Effects of Sea-Level Rise in Sacramento County during a 100-year Flood Event,” and Figure 13 illustrate the portions of Sacramento County that would be affected by a 1.41-m rise in sea level combined with a 100-year flood event.

Table 1 Effects of Sea-Level Rise in Sacramento County during a 100-year Flood Event

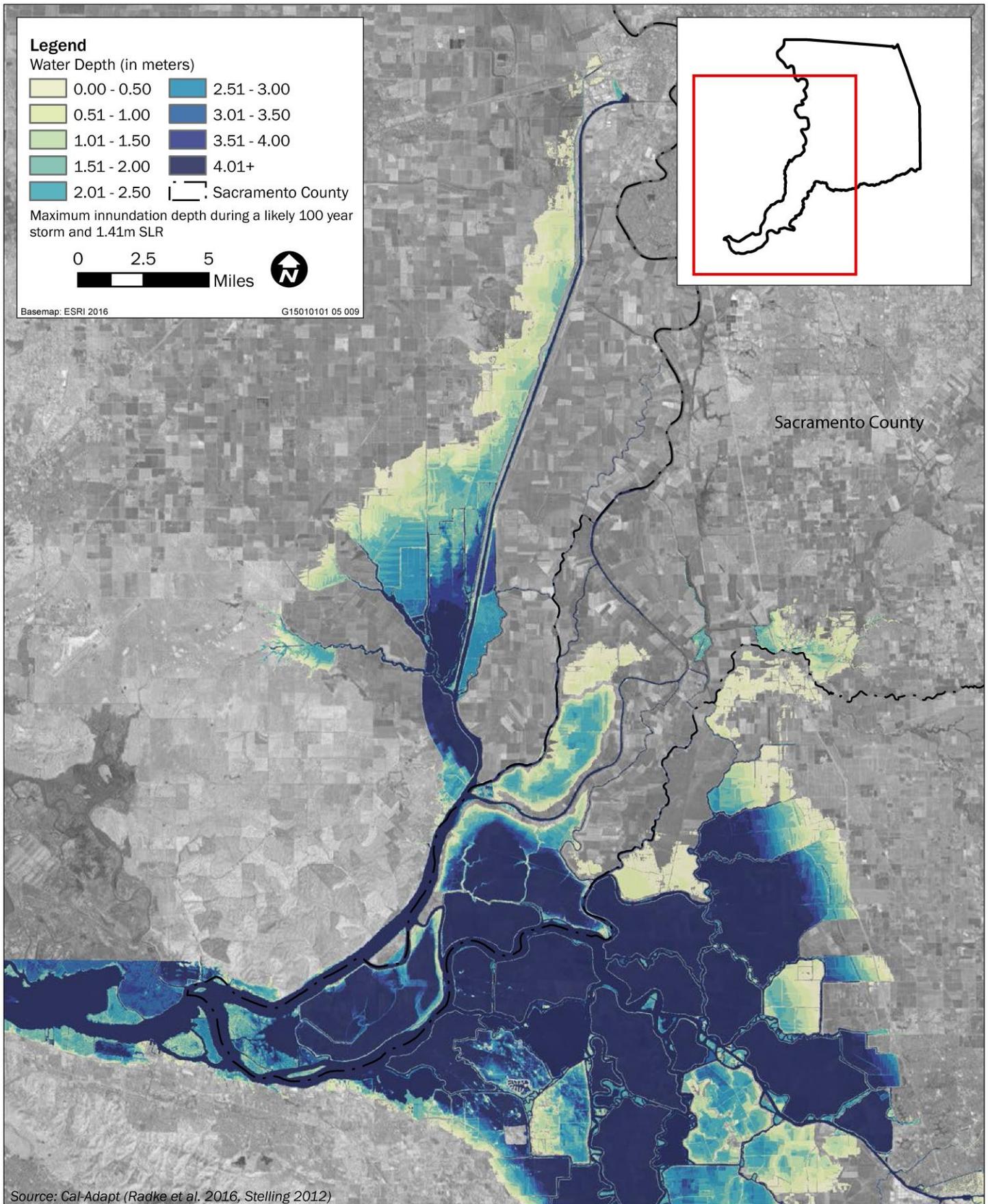
Water Depth (m) ¹	Potential Area Inundated (acres)
0.00-0.50	3,954
0.51-1.00	3,239
1.01-1.50	3,361
1.51-2.00	4,212
2.01-2.50	3,645
2.51-3.00	1,627
3.01-3.50	1,928
3.51-4.00	2,026
4.01+	27,027
Total	51,019

Notes: m=meters

¹ Maximum inundated depth during a 100-year flood event combined with a 1.41-meter rise in sea level.

Source: Radke et. al 2016.

Sea-level rise may place additional strain on the existing levee system within the Delta, which has already experienced flooding and high levels of erosion and damage since its foundation. Further, agricultural activity in the Delta has led to substantial subsidence and formation of “islands” located below mean sea level. Flooding in the Delta as a result of a breach in this levee system would have catastrophic consequences to Delta islands. Increased flow rate coupled with greater pressure from high sea levels may create conditions such that the integrity of the levee system cannot be sustained. Inundation of the Delta islands would result in the release of a massive quantity of sediments, as well as deposits of mercury from mining activities during the California Gold Rush. Such an event would severely damage water quality and severely impact the health of the Delta ecosystem as well as drinking water diverted for human consumption (Sacramento County 2016a).



Source: Cal-Adapt (Radke et al. 2016, Stelling 2012)

Figure 13 Effects of Sea-Level Rise in Sacramento County During a 100-Year Flood Event



Additionally, rising sea levels in the Sacramento-San Joaquin Delta may result in indirect effects associated with saltwater intrusion to the lower reaches of the Sacramento River. Increased municipal and agricultural demand for fresh water combined with rising sea levels in the Delta and reduced fresh water flows from a diminished snowpack may result in increased salinity further upstream in the Sacramento River. The salinity of the Delta and Sacramento River is determined by a function of freshwater outflow from the east and north, and ocean tides pushing in from the San Francisco Bay through the Carquinez Strait. The level of salinity is dependent on the combination of these variables, and, therefore, fluctuates depending on season, snowpack, tides, temperature, weather conditions, and human-related demand (Dettinger and Cayan 2003). Due to the fluctuations in the variables, the severity of saltwater intrusion into the Sacramento River as a result of sea-level rise is difficult to predict. It would be expected, however, that rising sea levels would introduce saltwater further upstream in the Sacramento River reducing the quality of fresh water supply (Sacramento County 2015a). Salt water intrusion from sea-level rise would be limited to the lower reach of the Sacramento River, and would not affect the water quality of the Mokelumne, American, and Cosumnes rivers.

3.2 STEPS 2 AND 3: SENSITIVITY AND POTENTIAL IMPACTS

The APG recommends that a vulnerability assessment be composed of five discrete steps; however, the next two steps in the vulnerability assessment are closely related and are thus discussed together. The second step in the vulnerability assessment involves using a systematic evaluation to identify populations, functions, and structures that may be affected in Sacramento County by projected exposures to climate change impacts and their degree of sensitivity. These determinations can be as simple as a “yes” or “no” answer. Using the APG’s recommended sensitivity checklist, this evaluation focuses specifically on resources in the County potentially affected by climate change that were identified in the Exposure section of this Chapter.

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

- ▲ **Population:** 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. In collaboration with California health departments across the state, the Public Health Alliance (PHA) has developed the California Health Disadvantage Index (HDI), which uses 27 economic, social, environmental, and health data indicators to illustrate which communities are considered the most and least disadvantaged. Sample HDI indicators include economic security, educational and employment opportunity, civic engagement, neighborhood quality, and premature mortality. Figure 14 depicts areas in the unincorporated County that are considered disadvantaged communities, according to the HDI (PHA 2016).¹
- ▲ **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 airways (e.g., airports and highways), 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.

¹ Other tools are available in California to help define disadvantaged communities, such as CalEnviroScreen (available at <http://oehha.ca.gov/calenviroscreen>). Both HDI and CalEnviroScreen include a broad range of social, economic and environmental indicators in indexing communities; however, they were created for different purposes and use different methods. HDI focuses on social determinants related to public health issues, whereas CalEnviroScreen tends to focus more on pollution burden in existing communities and was created for that purpose by CalEPA. HDI tends to capture a broader range of disadvantaged communities that are not defined as disadvantaged communities in CalEnviroScreen. Thus, using HDI in the context of a climate vulnerability assessment helps identify disadvantaged communities that may have lower levels of pollution burden, yet still may be considered to be disadvantaged for other reasons and thus may be vulnerable to climate change.

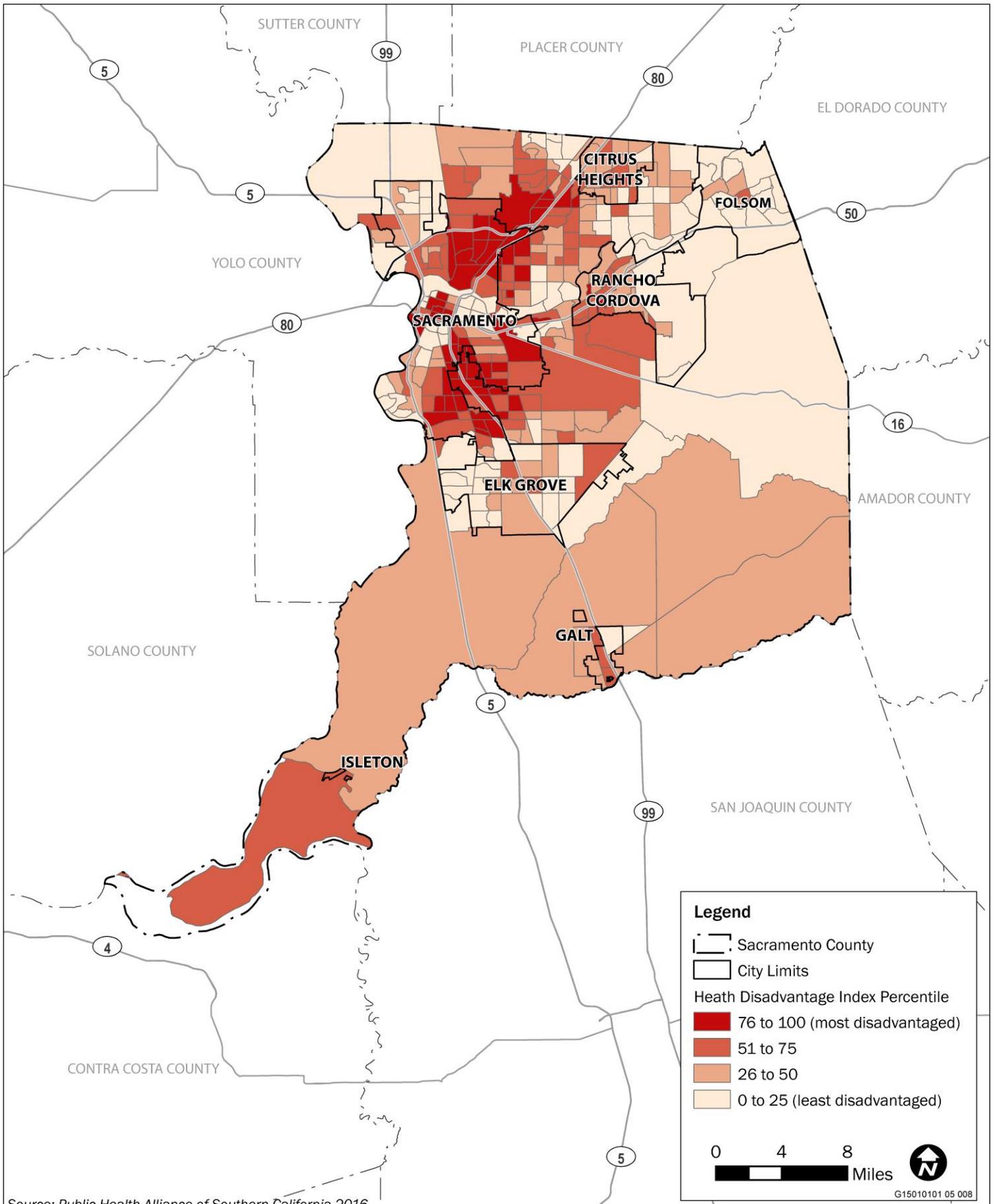


Figure 14

Disadvantaged Communities in Sacramento County



- ▲ **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 2012a: 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 Sacramento County considered to be sensitive to climate change are itemized under the headings below followed by discussion of the potential climate-change related impacts to these sensitivities.

3.2.1 Increased Temperature

Based on the high- and low-emissions scenarios, annual average temperatures in Sacramento County are projected to rise 3 to 6 °F by 2090. Increased temperatures can lead to secondary climate change impacts including increases in the frequency, intensity, and duration of extreme heat events in Sacramento County.

POPULATION

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 (APG 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, heat stroke, results in severe mental status changes, seizure, loss of consciousness, kidney failure, abnormal cardiac rhythm, and death (California Environmental Protection Agency [Cal EPA] 2013). From 2000 to 2013, a rate of 0.24 per 100,000 persons have died from heat-related illness in Sacramento County (English 2016). Applying this rate to Sacramento County's 2013 population of 1,462,000, the number of deaths is approximately three people.

Higher temperatures also worsen air quality through the 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, and persons with pre-existing chronic diseases are particularly susceptible to respiratory and cardiovascular effects from air pollution. Currently, Sacramento County is home to approximately 99,000 children, or 8 percent of total population, and 156,000 elderly persons (i.e., 65 years or older), or 13 percent of total population (CalBRACE 2015). Further, 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 (Census 2015). 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 in low-income areas, some of which are communities of color; people with existing

health issues, such as chronic diseases and mental health conditions; young children and the elderly; people experiencing homelessness; outdoor workers, including farmers; immigrants; some tribal nations; and socially or linguistically isolated people are most vulnerable to the impacts of climate change. These people are often in the same communities where residents are less likely to have air conditioning to cool homes or shade from trees in their neighborhoods, more likely to experience infrastructure limitations, more likely to have one or more chronic medical conditions, and less likely to own cars that can provide mobility to avoid deleterious climate effects.

Disadvantaged communities may 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. In 2014, of the approximately 240 people either taken to the emergency room or hospitalized for heat-related illness in Sacramento County, about 40 percent were African American, 30 percent white, 22 percent Hispanic, and 8 percent Asian (English 2016).

Conversely, as shown in Figure 9 in Section 3.1.1, "Increased Temperature," heat generated from the UHIE in Sacramento 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 is more pronounced in urbanized locations, the meteorology of Sacramento County dissipates this excess heat and air pollution towards the surrounding communities of Antelope, North Highlands, Folsom, Roseville, Rocklin, and Granite Bay (CalEPA 2015). Further, the topographic characteristics of the County consisting of flat landscapes in the west that transition into hills with moderate slopes in the east causes UHIE-related heat and air pollutants to become trapped. This phenomenon reduces air quality and results in higher energy demand and its associated financial costs. Additionally, Sacramento County's economy includes a large agricultural industry that is supported by a sizeable outdoor labor force. According to the California Employment Development Department (EDD), the Sacramento Valley Region (i.e., Butte, Colusa, El Dorado, Glenn, Lassen, Modoc, Nevada, Placer, Plumas, Sacramento, Shasta, Sierra, Siskiyou, Solano, Sutter, Tehama, Yolo, and Yuba counties) employs approximately 23,000 outdoor laborers (EDD 2016). During an occurrence of an extreme heat wave or event, these workers are adversely affected by heat stress, which reduces productivity, and may lead to illness, disability, or death during exposure to extreme heat events (CNRA 2014:24).

In 2015, 0.18 percent (2,659) of Sacramento County's population was considered homeless. Of this total, 67 percent are considered unsheltered, or not enrolled in emergency shelters or transitioning housing programs (Sacramento Steps Forward 2015). Homeless populations are especially vulnerable to heat-related illnesses in periods of excessively high heat, as refuge from high temperatures may not be accessible. Further, homeless persons regularly using alcohol and/or drugs may experience exacerbated reactions to excessive heat.

FUNCTIONS AND STRUCTURES

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 (SACOG 2015:22).

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). Further, utility companies such as the Sacramento Municipal Utilities District (SMUD) lose revenue during times of power failure and must bear the cost of repair expenditure and maintenance.

Power failure as a result of climate change-related increases in temperature and prolonged heat waves may disproportionately affect the functions of small to medium businesses (SMBs) as compared to large businesses and corporations. The Capital Region (i.e., Sacramento, El Dorado, Placer, and Yolo counties) contains approximately 60,000 SMBs. About 96 percent of these SMBs support fewer than 50 employees and account for approximately 50 percent of the private sector within the Capital Region. SMBs are particularly vulnerable to power disruptions due to lack of capital and resources combined with a low number of operational facilities (typically one) (Valley Vision 2014). SMBs are less likely invest in back-up generators, improved insulation, and other infrastructural improvements to combat temperature-related disruptions.

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, “Changes in Precipitation Patterns,” 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 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.

Also, 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 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 noted above, 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 the 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).

Sacramento County supports the production of a wide range of farm commodities. In 2014, the wine, milk, and pear industries accounted for approximately \$131 million, \$76 million, and \$50 million, respectively (Sacramento County 2015b). Increases in temperature and moisture could impact the growing of wine grapes, pears, and other fruit and vegetable 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., almonds, fruit trees) need to bud (Union of Concerned Scientists n.d.).

Changes in temperature may also produce new agricultural opportunities for Sacramento County. Climatic shifts resulting in extended periods of high heat and warm nighttime temperatures provide an environment for crops that otherwise would not have been economically viable in Sacramento County's historic climate. A warmer climate will likely place economic pressure on the agricultural industry in Sacramento County to modify their practices and crop selection in response to such conditions (CNRA 2013). Indoor agriculture may become a more common practice to better control climate variables and exposure.

Rising temperatures will also affect natural resources in Sacramento County. Temperature-sensitive terrestrial plant and animal species exposed to higher temperatures may shift their existing ranges to higher latitudes and elevations, cooler coastal environments, or local microclimate refuges. Vernal pool ecosystems, in particular, are vulnerable to increases temperatures and prolonged periods of heat. High heat increases rates of evapotranspiration, reducing the inundation period of ephemeral pools and creating adverse conditions for the plant and animal species endemic to these environments (California Department of Fish and Wildlife [CDFW] 2015).

3.2.2 Changes to Precipitation Patterns

Increased average temperatures and a hastening of snowmelt in the Sierra Nevada and distant portions of watersheds, along with local and regional changes in precipitation and timing of runoff in local watersheds (e.g., Sacramento and American rivers; Morrison, Dry, Deer, and Laguna creeks), already are affecting both surface and groundwater supplies in Sacramento County. Over the past 100 years, April-July runoff in the Sacramento River basin has decreased by 23 percent, which indicates that a greater percentage of annual runoff in this major river system is occurring outside the traditional snowmelt season, likely as a result of earlier onset snowpack melting. Compounding this problem is the overall reduction in the amount of snowpack. If runoff shifts to earlier in the year, which has already begun to occur, runoff can flow into reservoirs when flood control dictates reservoir storage and release requirements affecting the amount of runoff that can be stored for future use, resulting in reduced storage (California Department of Food and Agriculture [CDFA] 2013:20). As a result, local water agencies serving unincorporated Sacramento County could struggle in the future to provide adequate water supplies to local residents and businesses. Water users could face shortages in normal or dry years if demand continues to increase.

POPULATION

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. As water flow decreases, the temperature of the water generally increases, the concentration of pollutants and contaminants in water may increase, and algae blooms can occur, all of which would degrade water quality and can carry illness producing bacteria. In October 2015, Sacramento County experienced algae blooms in the Sacramento River and posted hazard signs advising humans and animals to stay out of the water. Those relying on wells or groundwater may also face challenges in meeting water demands as rates of groundwater recharge decline (CalBRACE 2015). Although Sacramento County has yet to face a critical loss in water resources, it is possible that decreased snowpack, earlier snowmelt, and increased water demand associated with population growth could result in future water shortages wherein Sacramento County residents need to implement severe cutback strategies.

Further, reduced water flows, water diversion for agriculture, and warmer water temperatures from the Sacramento river and other California rivers that flow into the Delta are already impacting species like the delta smelt, Chinook salmon, white sturgeon, and other fish species listed as threatened or endangered under the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA), as well as the overall ecosystem.

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 (Capitol Region Climate Readiness Collaborative [CRCRC] 2014).

FUNCTIONS AND STRUCTURES

The steady stream of snowmelt provided by the Sierra Nevada snowpack provides hydropower generation, which supplies around 15 percent of electricity for the Sacramento region. A declining volume of snowmelt coupled with earlier periods of melting could have severe consequences for the region's hydro-electricity generation. The projected snow water equivalent (SWE) (i.e., the amount of water contained within the snowpack) is estimated to be reduced by approximately 70 percent of historical levels by the end of the 21st century (Pierce and Cayan 2012).

Further, larger, more intense storms as a result of climate change may affect the function of local businesses, especially SMBs. Power loss associated with extreme storms may disrupt communications and information technology systems, as well as back-up pumps and generators that power hospitals, drainage pumps, and other critical operations. As discussed previously under the heading, "Increased Temperatures and Frequency of Extreme Heat Waves and Heat Events," SMBs are more vulnerable to the effects of climate change due to limited resources and operational facilities as compared to large businesses and corporations (Valley Vision 2014).

Additionally, 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).

Sacramento County overlays the Sacramento and San Joaquin groundwater basins. According to DWR's Bulletin 118-80 prepared in 1980, both the Sacramento and San Joaquin basins have experienced "historical overdraft." Historical overdraft refers to a period between the 1950s and 1980s where groundwater extraction exceeded rates of groundwater recharge (DWR 1980). Since DWR's publication in 1980 and update in 2003, the sub-basins contained in Sacramento County (i.e., North American, Solano, Cosumnes) are not considered to be conditions of critical overdraft; however, a portion of municipal and agricultural water use in the County is reliant upon groundwater supplies. In addition, withdrawal pressure on regional groundwater increased over the last several years during the current drought when multiple local water agencies installed new groundwater wells, in many cases needing to drill deeper than they have in the past in order to reach water supply. If future groundwater use exceeds rates of replenishment due to reduced surface water supplies, Sacramento County could experience groundwater overdraft and subsequent land subsidence.

Reduced levels of river flow in the County's watersheds could also affect river-based economic and recreational opportunities. Lack of available water and a reduced salmon run has already impacted the fishing industry and those individuals who rely on fishing as their primary source of income. Lack of available river water will impede recreational fishing, rafting, camping, and backpacking, and swimming activities in the tributaries of the Sacramento, American, Cosumnes, and Mokelumne Rivers resulting in a potential loss of revenue for local businesses that provide equipment and tours related to these activities. Some individuals subsist on fishing as part of their food supply which could also be impacted.

In terms of agriculture, water supplies for agricultural irrigation could decrease and become more variable with risks of flooding expected to increase as a result of climate change. As discussed above, the timing of runoff and precipitation events combined with reaching reservoir capacity would result in dams releasing water to minimize flood risk. This would result in reduced water security for irrigation in the later, dryer months of the year (CNRA 2014:24). Additionally, 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 Sacramento, American, Cosumnes, and Mokelumne Rivers 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 ESA or 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 unincorporated County as well (CDFW 2015).

3.2.3 Increased Wildfires

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 fire both within and beyond the boundaries of the County. As discussed in Section 3.1, “Exposure,” the two most common types of wildfire that occur in Sacramento County are grass fires and peat fires. With a potential increase of 3.5-6.2 °F by 2100 under the low- and high-emissions scenarios, grasslands in the County will lose moisture content. Higher temperatures lasting even only one day will affect grass and other small-diameter fuels. Further, the amount of time (i.e., number of days and length of time in each day) in which there is a probability of ignition that reaches 90 percent or greater will also increase, which results in an expected greater number of wildfire ignitions. Additionally, as higher temperatures last for longer periods of time, dead fuels of wider diameter (e.g., twigs and sticks) will also become drier and contribute to increased wildfire intensity in the County. These conditions are predicted to lead to an increase in the total area burned by grassland fire, especially in the foothill areas in the eastern portion of the County, of which a section is designated a moderate Fire Hazard Severity Zone by the California Department of Forestry and Fire Protection (CAL FIRE) (Metro Fire 2014; CAL FIRE 2007). Grassland fires also ignite in open spaces and parkway areas, in particular the American River Parkway. Typically these fires are human caused and results can result in substantial habitat loss and severe economic impacts.

A changing climate is also expected to subject forests outside the County 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). Increased rate and intensity of wildfire in coniferous forests in the Sierra Nevada could adversely impact the populations, functions, and structures within Sacramento County.

POPULATIONS

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 (Valley Vision 2014b). With respect to Sacramento

County, populations at greatest risk of direct physical injury associated with wildfire are located in the southeast portion of the County (CalBRACE 2015).

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 (CRCRC 2014).

A study performed by Climate Central to assess the effects of wildfire and its associated emissions of air pollutants found that during periods of wildfire, depending on proximity, emergency room diagnoses for respiratory syndrome increased by 10 to 25 percent, and asthma diagnoses doubled (Climate Central 2013). Due to Sacramento County's location combined with the region's air patterns, Sacramento County residents can be subjected to degraded air quality from nearby and distant fires. It would be anticipated that more frequent and intense wildfires would produce harmful respiratory conditions that could aggravate chronic illnesses in susceptible populations as well cause acute illness in more resilient populations as well.

Air quality in Sacramento County will be directly affected by wildfire activity occurring beyond the boundaries of the County as these pollutants are transported to the valley and worsen air quality. 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.

FUNCTIONS AND STRUCTURES

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.

Beyond the boundaries of the County, climate change-related effects to wildland fire are predicted to have a more severe impact. The characteristics of the Sierra Nevada (e.g., forested with steeper slopes) contribute to the region's susceptibility to more frequent and intense wildland fires. The current drought has resulted in widespread tree mortality in Sierra Nevada forests, because of stress and increased susceptibility to insect infestation. Fire activity in the Sierra Nevada region may damage energy infrastructure upon which Sacramento County relies. According to SMUD's Climate Readiness Strategy, most of the increased wildfire frequency observed in the Sierra Nevada since the mid-1980s has been concentrated between 1,680 and 2,690 meters (5,512 and 8,825 feet) in elevation. Important transmission lines and hydroelectric infrastructure lie within this elevation range, and may be vulnerable to damage or temporary shutdown caused by wildfires. Further, even if direct damage does not occur to a transmission line from a wildfire, the transmission capacity of a power line can be affected by heat, smoke, and particulate matter (SMUD 2012).

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. These effects could impact the debris and sediment flows in watersheds in which SMUD generates or purchases hydropower, with uncertain impacts on infrastructure, generation capacity, and power availability. Excessive siltation or debris flow could diminish the water storage capacity of the reservoirs, resulting in the need for more frequent maintenance or special debris removal programs (SMUD 2012).

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, ATV 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 (Valley Vision 2014b).

Additionally, as discussed above, wildfire activity results in the production of harmful air pollutants such as PM_{2.5}, 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.

Healthy forests absorb carbon dioxide from the atmosphere and store it as carbon, helping to regulate our climate. The Sierra Nevada stores almost half of the state's total forest carbon - more than a billion metric tons. Overgrown forests are susceptible to drought, insect and disease outbreaks, and large, damaging wildfires - all of which can jeopardize carbon absorption and storage. One large, high-severity wildfire can undo much of the annual carbon storage benefits that our forests provide in a very short period of time. The initial pulse of emissions from a wildfire represents only a fraction of the total emissions that will come from the burn scar over the next few decades as the trees killed by the fire begin to decay.

3.2.4 Increased Flooding

Sacramento County is extremely vulnerable to flooding, which has caused the most disaster declarations, damage, and loss of life historically in the County (Sacramento County 2016a). Sacramento's history is filled with flood events dating back to 1861. Over the past few decades, the Sacramento region has experienced significant, sometimes devastating, flooding. The most notable recent flooding occurred in 1986, 1995, 1997 and 2006. The Sacramento Area Flood Control Agency (SAFCA) identifies Sacramento as having the nation's greatest metropolitan flood risk. While it is uncertain exactly how climate change will affect flooding events in Sacramento County, and to what extent, any increase in flooding is highly likely to have serious ramifications, because the area is already considerably vulnerable.

POPULATION

Flooding will most adversely affect populations living in 100-, 200-, and 500-year floodplains. As of 2011, if Folsom Dam were to fail, approximately 230,000 people in the unincorporated County would be subject to inundation. This number equates to about 50 percent of the total population of the unincorporated County (Sacramento County 2011a).

All Sacramento County residents living in flood zones will be adversely affected, if a flood event occurs; however, flooding-related impacts will likely disproportionately affect populations considered socially vulnerable. Social vulnerability is defined using a composite of proxy indicators, including age, race, health, income, and quality of the built environment. Low income status is considered the largest contributor to social vulnerability; therefore, households with insufficient financial reserves are likely to be disproportionately affected by a disaster such as flooding (Burton and Cutter 2008:142). Low-income populations generally suffer higher mortality rates and their homes sustain greater damage due to the housing stock and its location. Further, low income households may not be able to afford structural upgrades or flood insurance to mitigate the effects of flooding associated with dam failure or levee collapse (Burton and Cutter 2008:144). Low income households may also lack transportation and other resources to respond to or evacuate during a flood event.

Race, class, ethnicity, and immigration status are also drivers of flood-related social vulnerability as these may impose cultural and language barriers that affect residential locations in high-hazard areas, pre-disaster mitigation, and access to post-disaster resources for recovery. As of 2010, seven percent of Sacramento County's population was considered linguistically isolated (CalBRACE 2015). Further, physically and mentally

disabled individuals may not have the capacity to adequately respond to or evacuate during a flood event. In 2010, Sacramento County was home to 78,086 persons with cognitive disabilities and 91,100 persons considered physically disabled (CalBRACE 2015). Additionally, populations with limited mobility (e.g., dependent on public transportation, without a vehicle) are also considered more vulnerable to flood events because the ability to use sandbags or to evacuate is reduced. Further, educational status contributes to the social vulnerability of a population in that lower education typically coincides with poverty, over-crowding, unemployment, income inequality, and marginalization (Rafut et. al 2015:473). With respect to Sacramento County, areas considered at high risk of inundation from levee failure are home to significant clusters of persons of Hispanic origin and agricultural workers, which may contain one or several of the characteristics described above (Burton and Cutter 2008:143). High-risk populations are also vulnerable to localized flooding from older drainage infrastructure exceeding capacity and flooding streets and homes.

Flood events also contribute to the spread of disease and illness. Floodwaters uplift substances including dirt; oil; animal waste; and lawn, farm, and industrial chemicals and carry them downstream, contributing to degraded water quality in receiving streams. Stagnant flood pools can become breeding grounds for mosquitoes which may lead to an increase in vector-borne diseases. Also, buildings having experienced inundation may produce mold and mildew, which may cause acute respiratory illness in small children and the elderly. Populations that undergo flood events may also suffer from long-term mental health impacts associated with the trauma of losing one's home or irreplaceable keepsakes (Sacramento County 2016a).

FUNCTIONS AND STRUCTURES

One of the projected impacts of climate change is the increased likelihood of severe flooding capable of destroying streamside land, buildings, roads, and crops. Some of the levees adjacent to the Sacramento and American Rivers in rural areas were built as much as 150 years ago and were not constructed to current engineering standards. Levees protecting urban areas were built to withstand design floods. Prior to the storms that occurred in 1986, it was believed that the levees containing the Sacramento and American Rivers were of sufficient height and stability to protect the County from a 100-year or greater storm. Following 1986, DWR and the U.S. Army Corps of Engineers (USACE) have undertaken repairing and bolstering of the levees in the Sacramento River and American River flood control systems. DWR serves as the lead agency for the Sacramento-San Joaquin Erosion Repairs Program, and USACE is the lead agency for the Sacramento River Bank Protection Project, the PL 84-99 Rehabilitation Program, and the Calfed Levee Stability Program, all of which manage and maintain the levee systems currently, minimizing flood risk in the Sacramento Region (DWR 2011). Further, SAFCA is the joint agency that provides local flood protection along the American and Sacramento rivers.

According to the 2016 LHMP, Sacramento County contains 27 dams constructed for flood control, storage, electrical generation, and recreational purposes. Sixteen dams are rated as High Hazard indicating that a failure would result in loss of life; five as Significant Hazard, which suggests that failure could result in appreciable property damage; and 5 as Low Hazard meaning that failure would result in minimal property damage and unlikely loss of life. One dam was not rated (Sacramento County 2016a).

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 Sacramento 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, catastrophic flooding from levee overtopping could lead to the destruction of crops, erosion of topsoil, and deposits of debris and sediment to crop lands. Flash floods, stagnant (medium-length) floods, and deep-water (long-length) floods can result in unwanted submergence and/or excessive soil saturation of cropland (CDFA 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 (Sacramento County 2016a).

Extreme weather events, such as high-intensity storms, could weaken or collapse levees in the Delta and could breach Sacramento and American river levees especially where they have not yet been upgraded or do not meet the minimum NFIP requirements. Further, as peak flow patterns increase as a result of more rapid snowmelt, the levees currently protecting the Sacramento region from flooding events come under greater stress from long-term increases in peak, high-volume runoff. The increased pressure and flow of the Sacramento and American will exacerbate the Sacramento region's existing vulnerability to severe flooding (CRCRC 2014).

Increases in the intensity of precipitation and stormwater runoff events will likely lead to increases in localized 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 separates 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).

Flooding may result in closed roads and reduced access to many people trapped in their homes. Roadways can become clogged with vehicles restricting transportation. Further, for Sacramento County residents that are bicycle dependent, bike routes (e.g., American River Bike Trail) can be inundated limiting travel during flood events. Due to the impermeable characteristics of urbanized areas (e.g., concrete, asphalt) combined with the fact that portions of Sacramento County exist below the ordinary water line of the Sacramento River during certain periods of the year, flooding conditions could last for extended periods of time preventing residents from accessing key supplies, such as food, electricity, fuel, and potable water. Flooding may also inundate sewage systems causing back up and release of hazardous materials exposing people and animals to toxic substances.

Furthermore, floods can exacerbate bridge scour, which makes bridges weaker and less safe, and may require repairs or replacement. Electrical boxes and other facilities may also be inundated, disrupting service to infrastructure like traffic signals and light rail systems. Additionally, underground electrical infrastructure is considered more vulnerable to flooding as prolonged periods of inundations inhibit repairs. During fall storms, leaves wash into the drainage systems, further aggravating localized flooding throughout the region (SACOG 2015:24).

3.2.5 Sea-Level Rise

The majority of Sacramento County's land area is not vulnerable to sea-level rise, with approximately eight percent of the County's area considered at risk of inundation from a 1.41-m rise in sea level combined with a 100-year flood event (Cal-Adapt 2016). The low-lying land near the Sacramento River in the southwest corner of the County, including areas in the Delta and portions north near the City of Sacramento, are the primary at-risk areas (see Figure 14 in Section 3.1.5, "Sea-Level Rise"). Considering a 100-year flood event, a 1.41-m rise in sea level, and other hydrodynamic factors, the land at increased risk for sea-level related flooding encompasses 51,019 acres.

POPULATION

Residents in the unincorporated area that would be inundated by 100-year flood event under a 1.41-m rise in sea level are located in primarily low-density rural and agricultural areas. As depicted in Figure 13 in Section 3.1.5, "Sea-Level Rise," the portion of the County that would be most at risk would be the low-lying portions near the Delta. Using the California HDI developed by PHA (see Figure 12 in Section, "3.2 Steps 2 and 3: Sensitivity and Potential Impacts"), the populations at highest risk of flooding from a 1.41-m rise in sea-level during a 100-year flood event would fall within the range of 26 to 75 indicating a moderate level of disadvantage. Of the residents located within these vulnerable areas, those considered to be disadvantaged

face the greatest challenges in responding to or mitigating against flood events associated with sea-level rise due to low socioeconomic status, language barriers, educational status, social connection, political participation, shelter security, and limited mobility. These populations in Sacramento County will face greater challenges in preparing for, surviving through, or recovering from flooding disasters.

FUNCTIONS AND STRUCTURES

The portion of the County susceptible to sea-level rise will face a greater threat of flooding because of the aging levees in the Delta and predicted increase in storm intensity affecting the American and Sacramento River watersheds (see discussion under Section 3.2.4, “Increased Flooding”) (Curtis and Schneider 2011). With respect to areas outside the County, sea-level rise will likely affect the salinity of the Sacramento-San Joaquin Delta waters.

The salinity of the Sacramento-San Joaquin Delta has historically been extremely changeable. The salt content of the Delta ebbs and flows depending on the function of a variety of variables such as tides, storms, and river outflow. As California has developed, our freshwater demand has introduced an additional strain on the Delta that has affected water quality and ecosystem health. The Delta provides a freshwater source for the State Water Project (SWP) and the Central Valley Project (CVP), which diverts approximately two thirds of the State’s freshwater supply for agricultural and municipal purposes in Southern California (DWR 2008).

As human-made canals were interconnected, approximately 60 islands have formed in the Sacramento-San Joaquin Delta, many of which are up to 20 ft below sea level as a result of agricultural practices and subsidence. In an effort to preserve water quality in the Delta, these islands are protected by about 1,100 miles of levees of varying age and stability. Climate change-related sea-level rise will likely increase pressure on fragile levees. If levee breach or failure occurs, it would pose a threat to water quality in the Delta (DWR 2008). In the case that a levee fails and an island is inundated, the inflow of water into the island would draw salt water deeper into the Delta. With such a large portion of the state relying on the Delta as a source of fresh water, levee failure in the Delta would disrupt water supplies throughout the state (Water Education Foundation 2016).

Saltwater incursion into the Delta has the potential to travel as far as the lowest reaches of the Sacramento River; however, given the complex and dynamic interactions that occur within the Delta (e.g., flow regimes, freshwater diversion, ocean tides) and the uncertainty of the atmospheric conditions in the end of the century, potential impacts to water quality in the Sacramento River are difficult to predict. Sea-level rise is unlikely to manifest up to 1.4 m until the end of the century, wherein temperatures may be higher, the flow rates of the Sacramento River may be less reliable, and human demand on the Delta may be greater. These conditions will continually interact and affect water quality in the Delta, and may have the potential to impact water quality in the Sacramento River.

3.3 STEP 4: ADAPTIVE CAPACITY

The next step in the Vulnerability Assessment process is to evaluate the adaptive capacity of the populations, functions, and structures as identified in Steps 2 and 3 to address climate change. Step 4 involves determining a community’s current ability to address the points of sensitivity and impacts associated with climate change. Review of the County’s existing local policies, plans, programs, resources, or institutions provides a good snapshot of the County’s ability to adapt to climate change and reduce vulnerability. Based on this information, adaptive capacity for a county can be rated high, medium, or low. High adaptive capacity indicates that sufficient measures are already in place to address the points of sensitivity and impacts associated with climate change, while a low rating indicates a community is unprepared (CNRA 2012a:26).

The adaptive capacity of unincorporated Sacramento County to respond to projected climate change impacts is analyzed below, based on identified exposure where possible. It is important to note that this review of local climate adaptation-related work offers an initial, high-level perspective on the issue and is not all-

inclusive nor site specific. As more specific facilities, structures, and areas are identified in the future, additional review of adaptive capacity would be valuable.

On a planning level, Sacramento County addresses current and future impacts related to existing natural hazards, as evidenced by the County's LHMP adopted in December 2004 and recently updated in December 2016. The 2016 LHMP identifies current hazard risks and mitigation strategies for climate change, flooding, levee failure, drought/water shortage, severe weather, and wildfires (Sacramento County 2016a). Furthermore, the County's General Plan 2005-2030, last amended in November 2011, includes policies aimed at reducing local contributions to global climate change and encourages sustainable building practices (e.g., Cool Communities programs, which emphasize building practices to reduce UHIE through incorporation of urban forests, rooftop gardens, and cool roofs and pavements), efficient use of resources (i.e., water, land, and energy), and ecological stewardship. The Human Services Element also includes goals to ensure that human services are available to all residents, and policies aimed to protect its aging population, which are more vulnerable to health-related effects of climate change impacts and require better access to public services and housing (Sacramento County 2011a). Further, effective September 2015 and updated in 2016, sustainable building practices were codified in the Sacramento County Zoning Code and apply to all land, buildings, structures, and uses thereof located within the unincorporated County (Sacramento County 2016b).

In addition to planning efforts, other climate adaptation-related work is ongoing in Sacramento County. These efforts are discussed in detail in the following sections.

3.3.1 Adaptive Efforts Related to Increased Temperature

Efforts occurring in Sacramento County to adapt to or reduce the impacts of extreme heat days and waves are summarized below:

- ▲ In 2012, Sacramento County adopted the Sacramento Operational Area Severe Weather Guidance as an annex to the Sacramento Emergency Operations Plan. The guidance describes operations during severe weather conditions such as excessive heat. The guidance defines excessively hot weather for 3 days accompanied by night time temperatures of 75 °F or more as a severe weather alert (Phase III), and a heat index of over 105 °F for more than 3 days with similar nighttime criteria as a severe weather emergency (Phase IV). Phase VI conditions initiate deployment of emergency services including mobilization of cooling centers, issuance of a Health Emergency, and increased public outreach to inform citizens of the availability of resources (Sacramento County 2012).
- ▲ The Sacramento County Office of Emergency Services (SacOES) provides community-wide information for how to stay safe during periods of extreme heat through their Sacramento Ready Program. The Program also designates public cooling centers in the event of a heat emergency. Cooling centers can include senior centers, community centers, shopping malls, churches, public pools, and other places that fit the appropriate criteria (Sacramento County 2016c).
- ▲ Sacramento County is participating in several Property Assessed Clean Energy (PACE) financing programs, including Ygrene and the Home Energy Renovation Opportunity (HERO). PACE programs help homeowners finance home energy and water efficiency upgrades and save money on energy and water bills through special financing options, while also creating jobs for registered contractors in the County (HERO Program 2016). By enabling homeowners to retrofit their homes and install upgrades, this program helps to build adaptive capacity by increasing home comfort and mitigating higher energy costs associated with increasing temperatures and extreme heat events and heat waves. It should be noted that PACE programs are only available to homeowners and cannot be used by renters or occupants of multi-family housing.

- ▲ The regional leadership organization, Valley Vision, has launched the Business Resiliency Initiative (BRI) to help reduce risks and economic impacts of potential disasters related to extreme weather, including extreme heat. BRI aids SMBs in preparing for the effects of natural disasters by helping develop adaptive capacity and manage risks from weather-related disaster threats. Through the BRI, Valley Vision and its partners stimulate wide-ranging leadership support from cross-sector stakeholders to aid SMBs build the capacity to handle weather-related crisis. BRI provides a toolkit of interventions, including five steps geared to developing a comprehensive plan to understand risk, assess your readiness, take action, test and update plans, and engage community partners.
- ▲ The U.S. Department of Energy (DOE) Weatherization Assistance Program (WAP) provides grants to states, territories, and Indian tribes to improve the energy efficiency of low-income homes. Recipients then contract with local governments and nonprofit agencies to provide weatherization services to low-income homes in need of energy upgrades (DOE n.d.). The California WAP program allocates funds to various local governments, which provide grants to the entities that apply for them. WAP-related upgrades (e.g., replacing windows, weather-stripping, insulating attics and water heaters) in Sacramento County are provided by various organizations such as the Community Resource Project, Inc. and GRID Alternatives. Increasing the affordability of energy appliances provides low-income residents the financial capacity to air condition their homes during times of high heat. The State Greenhouse Gas Reduction Fund (GGRF) also provided funding for weatherization, residential rooftop solar and tree planting in disadvantaged communities.
- ▲ Urban greening and urban forestry in Sacramento County are supported by numerous organizations and agencies. The planting of trees in urban areas reduces the impacts of the UHIE. Urban forestry involves the planting of trees to mitigate these impacts. Trees provide shade for homes, roadways, parking lots, and provide relief during periods of extreme heat. Further, ground-level ozone produced from excessive heat can be filtered by certain tree species, which improves local air quality (Nowak 2002). Tree coverage also reduces energy demand; the Sacramento Tree Foundation estimates that Sacramento County's current tree canopy saves 11.6 percent of the County's total annual energy usage (Sacramento Tree Foundation 2000). Efforts to plant trees are supported by the County, Pacific Gas and Electric (PG&E), SMUD, the Sacramento Tree Foundation, and other organizations. In 2015, the Sacramento Tree Foundation's Sacramento Shade program, funded by SMUD, delivered more than 10,000 shade trees to property owners, planted 2,537 replacement trees, enhanced 43.7 acres of habitat, and monitored and cared for 5,633 native trees totaling \$1,744,390 in expenses (Sacramento Tree Foundation 2015). Further, Sacramento County's 30K Trees Campaign has received funding from PG&E to promote the region's goal of planting 30,000 trees (PG&E Currents 2012).
- ▲ The County completed construction on its first green complete street in 2013. The County advanced climate resiliency in the 2015 update of the Zoning Code and Countywide Design Guidelines. Cool roofs, energy efficiency, walking and biking and urban greening were measures and elements included in the design guidelines. Urban greening measures include landscaping elements that improve air and water quality, provide shade during summer months and lowers temperatures reducing urban heat island effects (UHIE), which occur when city or metropolitan areas are significantly warmer than the general region due to land use and development patterns.
- ▲ Through their Cool Roof Incentive program, PG&E and SMUD offer rebates to their customers that qualify. The program uses a point system to evaluate the price of rebates, and incentives customers to upgrade their homes with cool roof measures (e.g., efficient insulation, water heaters). The rebates are not available for commercial land uses, but may be applied to single-family homes and multi-family buildings.
- ▲ The SMUD 2016 Climate Readiness Report lists several on-going or planned climate change-related initiatives that target increased resiliency to periods of extreme heat. Several initiatives will serve to improve Sacramento County's adaptive capacity across all sectors; however, specific initiatives, such as the Regional Urban Heat Island Initiative (to commence in 2017), will focus on reducing UHIE through identification of areas prone to UHIE and projected impacts on electrical load and health. The effort will

enable adaptive efforts (e.g., cool roofs and pavements, urban greening) to be targeted more effectively yielding the greatest benefit. The Initiative will be managed by CRCRC, SMAQMD, the Sacramento Tree Foundation, and local roofing industries and local governments (SMUD 2016).

POPULATIONS, FUNCTIONS, AND STRUCTURES

Given its climate and location, Sacramento County and its residents will be extremely vulnerable to the adverse effects of elevated temperatures as a result of climate change. As discussed previously in Section 3.2.1, “Increased Temperature,” the populations most likely to be endangered by extreme heat are seniors, infants and children, persons with pre-existing respiratory and cardiovascular illness, persons with dementia, outdoor workers, non-English speaking persons, persons with low incomes and limited mobility, and the homeless. To adapt to a hotter climate, these populations may require assistance from a variety of sources, including local governments, non-profits, and privately-owned businesses and organizations.

Adaptive capacity can be improved by informing and assisting individuals through proactive engagement in programs and services designed to mitigate the burdens and risks of high heat and heat events. SacOES and the County Department of Public Health provide information and education regarding methods to stay safe during extreme heat; however, the responsibility to use these methods ultimately lies with the individual. In 2016, Trinity Episcopal Cathedral, Rancho Cordova City Hall, E49 Corporation, Wackford Community Center, and others coordinated with Sacramento County to provide refuge for citizens during periods of extreme heat. These centers can provide refuge for hundreds of people a day. It should be noted, however, that the locations of cooling centers may change year-to-year depending on whether businesses or organizations volunteer to coordinate with SacOES. If Sacramento County continues to run, or expands the existing number of cooling centers, persons lacking refuge from the heat may choose to use these facilities. Alternatively, businesses may be receptive to individuals using their air-conditioned spaces as refuge from heat during business hours. Individuals can also make arrangements with friends, family members, or neighbors who have air conditioning during these events.

Further, the adaptive capacity of these populations can be increased through involvement in community programs to improve resiliency during periods of extreme heat. Individuals who own poorly-insulated housing may work with organizations receiving grants and financial assistance from the WAP to improve the efficiency of their homes for those who qualify based on income. They may also participate in the PACE program to finance energy efficiency, renewable energy, and water conservation upgrades to their homes. Implementation of SMUD and PG&E energy efficiency programs in rental housing may not be readily utilized since it requires cooperation of the building owner.

Agricultural workers are particularly vulnerable to heat-related illnesses because of their unavoidable outdoor exposure during work hours. California has passed legislation that entitles all workers, including persons without U.S. citizenship, to adequate wages and requirements for overtime pay, safe working conditions under the California Occupational Safety and Health Administration (Cal/OSHA), and rest and meal breaks. As extreme heat occurs more frequently, agricultural worker protection needs will evolve. The safety of agricultural workers may hinge upon the response of state regulations and the capacity of employers to monitor and adapt protection measures to extreme heat conditions.

Persons dependent on others (e.g., infants and children) or isolated persons (e.g., seniors, transportation limited) may not have the capacity to adapt to living in extreme heat. Persons dependent on caretakers or parents rely on these individuals to provide a safe environment from the effects of high heat. Further, seniors living alone, those with dementia or mental illness, the homeless, or persons without a reliable form of transportation and/or access to transit services may not have the resources to mitigate against heat, and are susceptible to heat-related illness such as heat exhaustion, heat stroke, or death.

As listed above, Sacramento County provides useful information regarding safety during extreme heat through the Sacramento Ready Program. Also, through the Sacramento Operational Area Severe Weather Guidance annex to the Sacramento Emergency Operations Plan, Sacramento County will be able to deploy a

plan to cope with extreme heat. To adapt to climate change-related periods of high heat, Sacramento County will need to continue to provide education regarding the risks of excessive heat through the Sacramento Ready Program available on the website www.SacramentoReady.org or by calling 2-1-1. The Sacramento Office of Emergency Operations, City and County of Sacramento, Volunteer Organizations Active in Disasters (VOAD), the American Red Cross and other agencies and organizations should continue to provide up-to-date information on available resources as well as update the Sacramento Operational Area Severe Weather Guidance periodically to reflect changes in the County and the climate.

As discussed in Section 3.2, “Steps 2 and 3: Sensitivity and Potential Impacts,” transportation infrastructure (e.g., roads, bridges, sidewalks) can be damaged from extreme heat events. Sacramento County’s budget includes repairing damages to structures, however an increase in the occurrence of significant damage due to climate changes would place additional strain on already limited financial resources and are not estimated in County transportation planning effort at this time. Further, existing efforts to build the urban forest canopy may provide some increase in shading throughout the unincorporated County, mitigating portions of transportation-related surfaces (e.g., asphalt) from excessive sun exposure. However, planting of shade trees alone may not be enough to fully mitigate potential damage from increased temperatures and extreme heat. The use of “cool pavements” and higher-albedo impervious materials on various surfaces are still not commonly used throughout the County. Further, existing space limitations and more compact building patterns may limit space available for tree planting and other greening efforts.

The County is an active member of the Capital Region Climate Readiness Collaborative (CRCRC). The CRCRC is a network designed to promote greater resilience and coordination at the regional and local level across the six-county Sacramento region (El Dorado, Placer, Sacramento, Sutter, Yolo, and Yuba Counties). The purpose of this collaborative is to help leaders from government, business, agriculture, academia, labor, and community groups come together – within and across market and jurisdictional boundaries – to share information and best practices, leverage efforts and resources, avoid duplication, identify critical needs and strategies, and develop funding strategies to meet those needs. The CRCRC works regionally and across the state with other similar collaboratives, under ARCCA (the Alliance of Regional Collaboratives for Climate Adaptation), to address climate change, understand and inform the region on best practices for resiliency and adaptation; in order to build strong, resilient, healthy, equitable, and sustainable communities across California. The CRCRC has identified heat as one of the major current and future climate risks facing the Capital Region and is in the process of formalizing a broad, multi-year initiative to reduce excessive heat pollution. Cool roofs, cool pavements and urban greening are key elements of this initiative.

Through its BRI, Valley Vision is providing the SMBs in the Sacramento County area with the resources to prepare for weather-related disasters, such as extreme heat. Extreme heat may cause power loss to businesses disrupting function and communications. According to the Institute for Business and Home Safety (IBHS), an estimated 25 percent of small to mid-sized businesses do not reopen following a major disaster. Further, 57 percent of small businesses have no disaster recovery plan as businesses of this size may be limited by time or resource constraints (Valley Vision 2014a). To adequately adapt to blackout periods related to extreme heat, SMBs must continue or initiate the process of developing strategies to combat the effects of this potential impact through BRI or an equivalent planning process.

ADAPTIVE CAPACITY RANKING FOR HIGH TEMPERATURES: MEDIUM

The Sacramento Operational Area Severe Weather Guidance appendix to the Sacramento Emergency Operations Plan addresses heat-related emergencies; however, adoption of the plan does not ensure comprehensive protection for all Sacramento County residents because County efforts cannot feasibly avoid all adverse heat effects. Further, the plan relies on individual accountability in that residents must engage government assistance, if needed.

The Sacramento County General Plan contains policies to promote cool community strategies to reduce human impacts of the UHIE. County policy is supplemented by regional efforts to sustain an urban canopy

throughout the urbanized areas of Sacramento County. The Zoning Code and Countywide Design Guidelines require landscape and other improvements that will further assist with reducing UHIE. These actions serve to mitigate the effects of high temperatures by reducing the UHIE and providing shade, which can be used as refuge in extreme heat. Additionally, the Design Guidelines also encourage cool roofs which have been proven to improve energy efficiency and reduce the urban heat island effect. Cool roofs can also be used in combination with solar panels and can reduce the amount of panels required on a home or business. SMUD & PG&E offer an incentive to cover the incremental cost of a residential cool roof, relative to a conventional roof, however the program is not widely used.

Sacramento County's participation in PACE programs and the WAP, with support from local utilities through energy efficiency rebates and financing, also enables homeowners to finance or obtain assistance to increase energy efficiencies and improve interior living conditions and comfort. Home energy assistance programs through local energy utilities also help reduce energy costs associated with periods of high heat. The Sacramento CAP Strategy and Framework document includes language to direct future support of these efforts as well.

As discussed previously, Sacramento County residents already experience injury and death from heat-related illness which will be exacerbated by global climate change. Due to its inland location, Sacramento County has a higher average of heat-related illness compared to California as a whole, and will require more extensive efforts to combat adverse heat effects. In consideration of the meteorology of Sacramento County, the County will continue to face challenges in protecting its residents from extreme heat.

The Sacramento Operational Area Severe Weather Guidance combined with the efforts of the programs discussed above provide Sacramento County with appreciable resources to reduce temperature-related climate change effects; however, given that residents of Sacramento County experience heat-related illness at present, the County will be required to invest more to improve its adaptive capacity as compared to other regions with cooler climates. Therefore, Sacramento County is given an adaptive capacity ranking of medium for increased temperatures.

3.3.2 Adaptive Efforts Related to Changes in Precipitation Patterns

Efforts occurring in Sacramento County to adapt to or reduce the impacts of changes in precipitation patterns are summarized below:

- ▲ Sacramento County adopted a Water Efficient Landscape Ordinance to the Sacramento County Code in 1990 consistent with the California Water Conservation in Landscaping Act of 1990. The Ordinance is intended to promote the conservation and efficient use of water in landscaping-related activities while recognizing that landscaping enhances quality of life in California. The County is currently in the process of updating the Ordinance to reflect the goals of Assembly Bill (32), the California Global Warming Solutions Act of 2006 (Sacramento County 2016d). As part of the Countywide Design Guidelines, all development must adhere to the landscaping guidelines that among many things require use of the River Friendly Landscape Guidelines.
- ▲ The Sacramento County Water Agency (SCWA), as well several of the other 21 active water purveyors operating within the county (e.g., California-American Water Company, Golden State Water Company), support programs and conservation activities intended to help water customers voluntarily conserve approximately 10 percent over time. These water agencies use incentive programs (i.e., turf rebates, water efficiency rebates, and home water audits) to aid customers in identifying ways to reduce water use. SCWA also enforces State Water Resources Control Board prohibited activities for water use and recommends a watering schedule for landscaping. On May 5 2015 the State Water Resources Control Board (SWRCB) approved their framework for achieving a 25 percent statewide reduction in urban water use. SCWA reduced its water use over 32 percent from June 2015 through February 2016 when compared to 2013. Sacramento County also recently implemented water metering to incentivize water

conservation throughout the County (Sacramento County 2016d). SCWA also runs a water waste prohibition program which increases customer awareness of wasteful water practices. County staff investigate public complaints and look for cases of water waste (Sacramento County 2011c).

- ▲ SCWA participates in the Sacramento Area Water Forum (Water Forum), a consensus-based, stakeholder process involving over 40 representatives of water purveyors, businesses, and environmental, and public interest groups in the region. The co-equal objectives of the Water Forum are to provide a reliable and safe water supply for the region's economic health and planned development through the year 2030 and to preserve the fishery, wildlife, recreational, and aesthetic values of the lower American River (Sacramento County 2011c).
- ▲ The Sacramento Groundwater Authority (SGA) oversees groundwater in Sacramento County north of the American River, and adopted a revised groundwater management plan in December 2014 in compliance with Water Code Section 10753.7. SGA has the authority to regulate groundwater within the County and the cities of Citrus Heights, Folsom, and Sacramento. The plan contains components of a Groundwater Sustainability Plan consistent with the Sustainable Groundwater Management Act (SGMA) of 2014 (SGA 2014). SGMA went into effect in January 2016, and is California's new comprehensive statewide groundwater management law designed to provide for local management of groundwater resources. Sacramento Central Groundwater Authority (SCGA) oversees the portion of Sacramento County from south of the American River to mid-stream of the Cosumnes River. SGA and SCGA are currently working on developing groundwater management plans that are tailored to the resources and needs of their communities that meet the requirements of SGMA and must be adopted by 2022. These plans will provide a buffer against drought and climate change, and contribute to reliable water supplies regardless of weather patterns. California depends on groundwater for a major portion of its annual water supply, and sustainable groundwater management is essential to a reliable and resilient water system. Groundwater in Sacramento County is also being regulated by other recently formed Groundwater Sustainability Agencies, such as Omochochumne Hartnell Water District and Sloughhouse Resource Conservation District.
- ▲ Sacramento County is also part of the Sacramento Stormwater Quality Partnership (SSWQP). The SSWQP is a multi-jurisdictional program made of Sacramento County and the incorporated cities of Sacramento, Citrus Heights, Elk Grove, Folsom, Galt, and Rancho Cordova whose purpose is to educate and inform the public about urban runoff pollution, work with industries and businesses to encourage pollution prevention, require construction activities to reduce erosion and pollution and require developing projects to include pollution controls that will continue to operate after construction is complete. SSWQP supports River-Friendly Landscaping, which entail gardening strategies to reduce water consumption, yard waste, and pollution. Another effort of SSWQP is to promote River-Friendly Carwashing and educate car-owners of the impacts of carwash runoff in residential areas.
- ▲ Sacramento County is participating in several Property Assessed Clean Energy (PACE) financing programs, including the county-wide Ygrene program and the Home Energy Opportunity (HERO) program. PACE programs help homeowners and business owners finance home energy and water efficiency upgrades and save money on energy and water bills through special financing options, while also creating jobs for registered contractors in the County (HERO Program 2016).
- ▲ Sacramento Regional County Sanitation District (SRCSD) has been providing a recycled water fill station since 2015. Residential and commercial customers can obtain recycled water from Regional San's Recycled Water Fill Station during the dry season (spring through early fall). Recycled water produced at the Sacramento Regional Wastewater Treatment Plant in Elk Grove can be used for watering lawns, gardens and landscaping, as well as dust control, and is available free of charge. Additionally, SRCSD is undertaking a monumental effort—called the EchoWater Project—to take our region's wastewater treatment to a whole new level. In 2010, Regional San was issued stringent new treatment requirements from the State of California required them to make the most significant upgrade to the wastewater treatment plant since its original construction. This new system, which must be in place by 2021-2023,

will produce cleaner water for discharge to the Sacramento River, as well as expanded opportunities for recycled water (e.g., for landscape, park and agricultural irrigation).

- ▲ The SMUD 2016 Climate Readiness Report list several on-going or planned climate change-related initiatives that target increased resiliency to periods of drought and extreme storm events. For example, in 2016, SMUD began the permitting, design, and construction of a recycled water interconnection and appropriate plant facilities at the Sacramento Power Authority (SPA) cogeneration plant through the County Recycled Water Reclamation Contract. The project will allow for the use of the Sacramento Regional County Sanitations District’s Title 22 recycled water for plant cooling and fire protection, saving millions of gallons of potable water per day (SMUD 2016).

POPULATIONS, FUNCTIONS, AND STRUCTURES

Drought

As listed above, Sacramento County has several programs in place to conserve municipal water supply. Sacramento County citizens can engage in rebate programs provided by SCWA and other water purveyors (e.g., Golden State Water Company, California-America Water Company), SMUD, and PG&E to improve the water efficiency of home appliances and replace water-demanding landscapes. Further, PACE financing programs can also help homeowners finance upgrades to their homes and landscapes to improve water efficiency along with energy efficiency. Deployment of these efforts can help to lower Sacramento County’s overall municipal water usage thereby helping ensure that Sacramento County residents continue to have a reliable source of potable water in the face of future dry years. Additionally, through the SCWA, citizens can report wasteful water usage.

Sacramento County’s involvement in the Water Forum provides an ongoing discussion of water demand and supply in the County. This process promotes the development of an integrated water system that functions on private and public stakeholder input. The Water Forum focuses on surface water diversion, groundwater management, habitat conservation and restoration, and adaptation to drier years. The efforts of the Water Forum provide Sacramento County with proactive actions to adapt to deviations in precipitation patterns. The Water Forum Agreement (WFA) was signed in April 2000, and contains the objectives of providing a reliable and safe water supply for the region’s economic health and planned development through the year 2030 and to preserve the fishery, wildfire, recreational, and aesthetic values of the lower American River (SFA 2014).

Further, groundwater in Sacramento County is regulated by SGA. The most recent groundwater management plan, adopted in 2014, details the SGA’s goals, objectives, and policies to sustainably manage groundwater in the County. The in-process Sustainable Groundwater Management Plans will further inform and adopt policies and actions that will provide a buffer against drought and climate change, and contribute to reliable water supplies. With the potential for precipitation patterns to become more erratic and less predictable, groundwater may become a more significant resource for County residents currently relying on surface water resources. To function in drier years, groundwater resources must be reliable and quantity and quality.

The Sacramento County Water Efficient Landscaping Ordinance also reduces municipal water use associated with irrigation (e.g., lawns), and is currently in the process of being updated to reflect the water conservation goals contained in AB 32. Further, Sacramento County recently implemented a water metering system, which acts as a financial incentive to reduce municipal water use on a customer-by-customer basis. The reductions from these efforts reduces demand on water supplies which will support the overall goal of maintaining adequate water supplies for the County in the event of a dry year or a period of dry years.

More Intense Storms

As discussed in Section 3.2, “Steps 2 and 3: Sensitivity and Potential Impacts,” the rate of damage to infrastructure is likely to increase as extreme storm events become more intense. The Sacramento County

budget would need to respond by allocating more funds accordingly to address repairs to damaged infrastructure; however, if funding is limited, implementation of repair work may be hindered.

ADAPTIVE CAPACITY RANKING FOR CHANGES IN PRECIPITATION PATTERNS: MEDIUM

Water conservation programs are helping to reduce water usage in Sacramento County, but the County is still currently vulnerable to water supply issues due to drought, changing surface water flow regimes, increased pressure on groundwater supplies, and other factors. Sacramento County may face challenges in providing sufficient water supplies in the future due to climate change effects, coupled with an increasing population and water demand. Sacramento County and the water purveyors working within the County will need to continue to explore additional options to address projected long-term changes in water availability through advanced conservation approaches, more integrated supply management of both surface and groundwater (i.e., conjunctive use), greater water recycling, and other means. Therefore, the adaptive capacity ranking for changes to precipitation patterns and water supply is medium.

3.3.3 Adaptive Efforts Related to Increased Wildfires

Efforts occurring in Sacramento County to adapt to or reduce the impacts of wildfire are summarized below:

- ▲ Sacramento County has adopted the 2013 California Fire Code, which incorporates the 2012 edition of the International Fire Code, which includes provisions to help prevent the accumulation of combustible vegetation or rubbish that can be found to create fire hazards and potentially impact the 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 (Sacramento County Municipal Code Title 17 Chapter 17.04).
- ▲ Metro Fire's CWPP provides the Sacramento area with a comprehensive plan that results in the protection of human life and reduction in loss of property, critical infrastructure, and natural resources associated with wildfire. Through the CWPP, Metro Fire implements strategies to prevent and combat wildfire within its jurisdictional boundaries (Metro Fire 2014).
- ▲ The American River Parkway (ARP) Plan, a legislatively adopted document, guides all uses and activities allowed in the 22-mile long American River Parkway. This Plan was adopted by the County, the City of Sacramento, and the City of Rancho Cordova, the Sacramento Area Flood Control District, and the State of California Legislature. Currently fire resilient landscape planting is occurring in the Bushy Lake area and star thistle removal is being done by the American River Parkway Foundation and their partners. The American River Parkway Foundation in collaboration with the County Regional Parks Department has proposed a project to develop an ARP Resource Management Plan (RMP). With funding, this RMP will support General Plan policies, and advances climate adaptation and greenhouse gas reductions. This RMP will coordinate with County and City departments and partners in reducing fire fuels, sustaining habitat, removing invasive species (in particular star thistle), advance fire resilient plantings/landscape, and amend the Parkway Plan as needed to support resource management and wildfire prevention.
- ▲ The SMUD 2016 Climate Readiness Report list several on-going or planned climate change-related initiatives that target increased resiliency to wildfire impacts. Commencing in 2017, SMUD will oversee a Forest Thinning, Stream and Revenue Flows Program in the Upper American River Project (UARP) reservoir system to establish specific forest thinning study areas for data collection, document baseline and post-treatment conditions, and evaluate results. The results will inform future cost/benefits associating with remote sensing technologies and forest management regimes (SMUD 2016).

POPULATIONS, FUNCTIONS, AND STRUCTURES

Damage to Infrastructure

Development in Sacramento County must comply with the 2013 California Fire Code, which includes standards to reduce the safety risks associated with fire. This includes the incorporation of 100 feet of defensible space, which limits the proximity of combustible vegetation to new structures. Prior to 2005, defensible space required clearance around homes and structures of 30 feet. Residents of buildings constructed prior to 2005 may be at higher risk for property damage associated with wildfire. Further, low-income residents living in aged buildings lacking the financial ability to either relocate to a safer, more modern building or upgrade their existing residence are at higher risk for fire-related injury; however, as discussed in Section 3.1, “Step 1: Exposure,” climate change-related increases in wildfire frequency and intensity will directly affect a small portion of County.

The Metro Fire CWPP provides the portions of Sacramento County within its jurisdiction with a plan to combat the effects of wildland fire. The CWPP serves to protect both people and structures from fire-related damage, and provides useful strategies to create an environment that is not conducive to ignition and spreading. The 2016 LHMP also recognizes wildfire as a potential hazard and contains strategies to mitigate impacts.

Reduced Air Quality

Wildfires occurring outside of the County can impair air quality in the Sacramento and San Joaquin Valley. Actions to reduce wildfire-related air pollution would need to be executed by state (e.g., CAL FIRE, California Air Resources Board) and local agencies (e.g., air quality management districts) with the authority to do so. SMAQMD takes actions to reduce exposure to harmful pollutants related to wildfire (e.g., PM) by implementing no-burn days during periods of poor air quality. SMAQMD also provides resources to educate the public on the status of air quality on a daily basis, provides alerts on poor air quality days, and provides educational material on the health effects of air pollution. CRCRC is working with Sierra Climate Action and Mitigation Partnership (CAMP) and others statewide on the urban-rural interface (Alliance of Regional Collaboratives for Climate Adaptation 2016). Sierra CAMP’s mission is to bring communities and decision-makers from a wide range of regions throughout California to make decisions regarding the future of the Sierra Nevada. Wildfires and forest management are critical components of this work that will help to protect and preserve the forests and contribute to improve water storage and management. The outcome of this work will inform where the State should make investments that will yield the greatest benefit.

ADAPTIVE CAPACITY RANKING FOR WILDFIRE: MEDIUM

In general, most of Sacramento County is not at high risk for wildfires. CAL FIRE designates a small portion of the eastern County as a moderate Fire Hazard Severity Zone (CAL FIRE 2007). Localized wildfire risks exist, such as where the natural areas of the American River Parkway abut urban communities. Plans and policies provide current capacity to address risks; however, the County is still vulnerable as climate conditions change. Climate change is projected to exacerbate current risk due to increased temperatures and changes in precipitation patterns. Further, despite the low risk for large wildfires to occur within most of the County, wildfires occurring beyond the County borders will likely affect the welfare and health of Sacramento County citizens (such as from smoke-influenced air quality degradation). The County will need to continue to adapt to reduce these effects. Therefore, the adaptive capacity for risks associated with wildfire is considered medium.

3.3.4 Adaptive Efforts Related to Increased Flooding

Efforts occurring in Sacramento County to adapt to or reduce the impacts of flooding are summarized below:

- ▲ SAFCA provides regional flood control for the Sacramento region including Sacramento County, the City of Sacramento, Sutter County, the American River Flood Control District, and Reclamation District 1000. Structures to control flooding (e.g., levees, dams, weirs, detention basins) have been built throughout Sacramento County along the Sacramento and American Rivers and their tributaries to protect against catastrophic flooding (SAFCA No Date). In August 2013, USACE judged the existing levee system as inadequate to meet the minimum NFIP requirements. SAFCA reviewed the affected levees and identified 10 miles of levees in need of improvements. In response, SAFCA established the Levee Accreditation Project as a means to meet the NFIP requirements and is engaged in upgrading levees along the Sacramento and American Rivers to achieve a valid status (SAFCA 2015).
- ▲ Several projects are underway to improve the capacity and flow of the American and Sacramento River levee systems. These include, but are not limited to, Mayhew Levee Improvement, Upper Levee Slope Protection, Sacramento Urban Area Levee Reconstruction Project, Folsom Dam spillway, and Sacramento Riverwall.
- ▲ In 2007, SAFCA formed a Consolidated Capital Assessment District (CCAD) to fund the local cost share for projects to protect Sacramento from extreme floods. Since then new Federal and State flood protection standards have been adopted that require additional improvements not anticipated by the CCAD. These additional improvements would address underseepage, erosion and encroachment issues that Federal studies have shown to be the most likely cause of levee failures. Without these improvements, the U. S. Army Corps of Engineers (Corps) has determined that many levees in Sacramento do not meet the current design standards to provide at least a 100-year level of flood protection. In order to fund the additional improvements, SAFCA proposed replacing the existing CCAD with a new assessment district (CCAD 2) that will increase annual assessments on homeowners by an average of about \$42 in order to meet the state's 200-year flood protection requirements by 2025; and improve the resiliency and structural integrity of the flood control system to provide more than 200-year protection over time. Property owners voted via a mail balloting process and approved in May 2016 the formation of CCAD 2 and the new assessment.
- ▲ The County is completing its first concrete-lined creek naturalization project on Cordova Creek, which flows into the American River. This project removed the concrete lined channel, pulled back the banks and added naturalization features, water quality plants, floodplain enhancements and habitat restoration. This urban greening project will serve as an example of how new community development will provide similar features that will add to climate resiliency.
- ▲ The Central Valley Flood Protection District (CVFPD) adopted a Central Valley Flood Protection Plan (CVFPP) in June 2012. The CVFPP guides California's participation in managing flood risk along the Sacramento River and San Joaquin river systems. The CVFPP proposes a system-wide investment approach for sustainable, integrated flood management in areas currently protected by facilities of the State Plan of Flood Control. The CVFPP must be updated every 5 years (CVFPD 2012).
- ▲ The Sacramento Countywide Design Guidelines require flood protection and drainage facilities to be designed to provide multiple public benefits wherever possible. Facilities shall include multi-purpose improvements consisting of recreation, the environment, storm water runoff, water reclamation, flood control, etc. Attractive joint use basins, such as parks (in addition to Quimby land dedication requirements) or parkways with trails that also convey stormwater to water quality basins or similar facilities and provide some water quality treatment are examples of desired multiple public benefit facilities.
- ▲ SacOES coordinates the overall countywide response to large scale incidents and disasters through its Sacramento Ready Program. The Sacramento County Evacuation Plan contains measures and strategies to ensure evacuations are handled smoothly. The Plan outlines the appropriate procedures for handling potential catastrophic flooding in the County and provides specific recommendations depending on location in the floodplain (Sacramento County 2008).

- ▲ The Urban Level of Flood Protection Criteria was developed in response to the requirements from the Central Valley Flood Protection Act of 2008, enacted by SB 5. “Urban level of flood protection” means the level of protection necessary to withstand a 200-year flood in any given year. The criteria were developed by DWR as a systematic approach to assist affected cities and counties within the Sacramento-San Joaquin Valley in making findings related to an urban level of flood protection before approving certain land-use decisions. In response to the passage of SB 5, Sacramento County adopted the Floodplain Management Amendments to their General Plan and Zoning Code on December 13, 2016. These amendments ensure compliance with SB 5 and establishing setback along levees, developing a flood emergency response plan, building design standards, and enhancing natural floodplain management.
- ▲ The USBR Sacramento and San Joaquin Basins Climate Impact Assessment evaluates the potential effects climate change may have on the Sacramento and San Joaquin river basins. The report uses a menu of models of varying parameters to project future water supply and demand combined with the effects of climate change to predict potential future conditions within the basins. These projections can be used to inform the decision-making process and enhance adaptation planning (USBR 2014).
- ▲ USACE has been implementing the Joint Federal Project at Folsom Dam and Reservoir. This includes an increased-capacity emergency spillway, flood gate improvements, and a three-foot dam and embankment raise for greater flood storage capacity. When completed, the flood protection capability of Folsom Dam and Reservoir will be enhanced for the lower American River (USACE 2007). Other planned or ongoing federally authorized projects include the Natomas Levee Improvement Project, American River Common Features, South Sacramento Streams Group Projects, and Sacramento River Bank Protection Program.
- ▲ The SMUD 2016 Climate Readiness Report list several on-going or planned climate change-related initiatives that target increased resiliency to flooding. For example, SMUD is executing a contract with DOE to receive grant funds from the REDI (Resilient Electricity Deliver Infrastructure) initiative as part of the Sacramento Resilient Initiative to improve grid resiliency by implementing smart grid technologies and strategies in the 100-year floodplain. The project includes installation and commissions of eight to ten automated 69 kilovolt (kV) switches within reinforced poles and supervisory control and data acquisition (SCADA) in selected flood prone areas and up to 20 low-voltage correction devices to demonstrate advanced conservation voltage reduction for peak load reduction on a select number of SCADA enabled substations (SMUD 2016).

POPULATIONS, FUNCTIONS, AND STRUCTURES

According to the 2004 LHMP, approximately 94,000 people in unincorporated Sacramento County live in the 100-year floodplain. These residents living in areas at high-risk for inundation from levee or dam failure have limited adaptive capacity to deal with flooding. Structural improvements to modify or elevate homes and other structures as well as the purchase of flood insurance can reduce the financial burden of recovering from flooding; however, these options are not universally acquirable. Low-income, mobility-challenged, and physically or linguistically isolated persons are particularly vulnerable. Ultimately, the safety of Sacramento County residents will be dependent on proper execution of evacuation procedures and durability of systems in place to prevent flooding. Localized and tributary flooding will also impact those living in near proximity to creeks and streams, as well as areas with constrained infrastructure (e.g. old, undersized infrastructure) that could back up when capacity is reached. The County continues to undertake projects to upgrade drainage infrastructure, however, residents need to be aware if they live in flood prone areas and make necessary accommodations in advance when access to their homes or businesses may be inaccessible.

The Sacramento County Department of Water Resources (DWR) has been educating residents on flood risk and preparedness for over ten years. This educational outreach is ongoing with multiple mailings and public events each year. DWR also reviews development projects for compliance with the County’s Floodplain Ordinance, which is more stringent in its regulations than the FEMA guidelines.

Sacramento County receives flooding protection services from USBR, USACE, CVFPD, and SAFCA. Due to its location and population, Sacramento County is considered one of the most vulnerable areas to inundation in the country. Sacramento's 2016 LHMP addresses the risks associated with flooding, and provides strategies to mitigate the hazard. According to the 2016 LHMP, approximately 1,100 facilities (e.g., daycare centers, schools, elderly care home, police stations) exist within the 100-year floodplain in the unincorporated County. SAFCA is involved in a continued effort to bolster and revitalize the Sacramento and American River Flood Control Systems and as levees age and deteriorate. Further, Sacramento County requires new development projects to develop drainage plans, comply with stormwater development/design standards to reduce potential for localized stormwater flooding, and conditions projects to retain drainage to their site in absence of a larger drainage plan.

Despite these efforts, Sacramento County will continue to be a high-risk area for severe flooding. As an area experiencing substantial growth, future flood events in Sacramento County have the potential to cause even greater damage as compared to current conditions. The Sacramento region recognizes that flood events (i.e., 100-year) constitute the greatest hazard facing the area; therefore, resources have been and continue to be invested in flood protection and management. However, given Sacramento County's high-risk status for severe flooding, more investments and restrictions of development may be necessary to provide more adequate protection.

ADAPTIVE CAPACITY RANKING FOR FLOODING: LOW/MEDIUM

While levees and structures have been built to protect the County from catastrophic flooding through SAFCA, this infrastructure has been constructed for protection from design floods based on the historic flow regimes of the County's rivers. Increases in the rate or changes in the timing of snowmelt associated with rising temperatures in the Sierra Nevada along with changes in the intensity of storm events may result in an exceedance of the capacity of dams and levees, and would increase Sacramento County's vulnerability to major flood events. Through SAFCA and its member entities, as well as federal agency support, Sacramento County will continue to invest in maintaining and bolstering flood-related infrastructure as it experiences greater pressures from sea levels rise, modified meteorology, and flow regimes change; however, despite these efforts, Sacramento County will face inherent challenges with flooding due to its location and characteristics (e.g., flood plain near sea level and at the convergence of two major river systems). Sacramento County will have to continue to invest in mitigation to prevent flooding to provide its residents with a moderate level of flood protection. It is likely that due to the increased uncertainty regarding flood regime in Sacramento County's watersheds, the County may never be able to achieve a high-level of flood protection; therefore, the adaptive capacity for risks associated with flooding is low/medium.

3.3.5 Adaptive Efforts Related to the Sea-Level Rise

As sea-level rise is considered a long-range climate change effect and Sacramento County is not a coastal community, adaptation and policy planning efforts related to sea-level rise have not yet occurred in Sacramento County.

POPULATIONS, FUNCTIONS, AND STRUCTURES

Sacramento County is not currently involved in proactive efforts that specifically focus on adapting to sea-level rise; however, as discussed in Section, 3.2, "Steps 2 and 3: Sensitivity and Potential Impacts," sea-level rise may contribute to the potential impacts of flooding in the County. Therefore, the adaptation strategies used by the County to reduce flood impacts can also mitigate the impacts of sea-level rise. For a more detailed discussion of the existing policies, plans, and investments Sacramento County is engaged in to combat flood events, see "Efforts Related to Increased Flooding."

ADAPTIVE CAPACITY RANKING FOR SEA LEVEL RISE: MEDIUM

Less than one percent of Sacramento County (22,800 persons) is located three feet below MHHW and is considered vulnerable to effects of a 0.88 m (34.6”) rise in sea level. As a result, the County has not implemented policies or plans that directly address this climate change impact; however, several efforts listed above under the heading “Efforts Related to Increased Flooding” would indirectly provide protection against this potential impact. Bolstering and maintenance of the Sacramento River Flood Control System would minimize the risk of inundation associated with sea-level rise. As the effects of sea-level rise in Sacramento County is inherently tied to flooding-related effects, the adaptive efforts discussed in Section 3.3.4, “Adaptive Efforts Related to Flooding,” can be applied to sea-level rise as well; therefore, the adaptive capacity ranking is medium.

3.3.6 Comprehensive Adaptive Efforts Related to Multiple Climate-Change Effects

As discussed above and throughout this document, Sacramento County supports numerous programs, policies, and plans focused on adapting to the potential effects of climate change. In addition to these efforts, Sacramento County invests in actions to mitigate the severity of a comprehensive list of climate change-related impacts.

- ▲ Sacramento County, through its operations, supports sustainability projects through its SacCounty Grows Greener projects, which funds and oversees various county-initiated green ventures including energy, waste and recycling, transportation, clean fleets, water, and agriculture and open space projects.
- ▲ Sacramento County enforces the State Green Building Standards Code to establish and encourage sustainable building construction practices having a positive environmental impact (Sacramento County Municipal Code Title 16, Chapter 16.04.030). The County also exceeds these standards by specifying that all new County-related buildings achieve a Leadership in Energy and Environmental Design (LEED) ranking of silver, or another alternative that achieves the same standard (Sacramento County 2011c). The Zoning Code and Countywide Design Guidelines require land uses, active transportation and development to be more sustainable, while advancing resiliency and health.
- ▲ Sacramento County is home to dozens of locally-based organizations focused on promoting sustainability, efficiency, and environmental stewardship. Water conservation, sustainable agriculture, and public outreach comprise a few of the resources areas currently being targeted by these organizations, and will play an important role in Sacramento County’s ability to adapt to climate change.
- ▲ Sacramento County is an active participant in the Sacramento Area Council of Governments (SACOG) which coordinates land use, transportation planning for the six county region, including programs that address the urban-rural interface. Pursuant to SB 375, SACOG maintains and updates the region’s Metropolitan Transportation Plan/Sustainable Communities Strategy (MTP/SCS) to include land use and transportation strategies to reduce GHG emissions from the automobile sector. Sacramento County will continue to participate in SACOG’s updates to the MTP/SCS, will implement transportation-related strategies, and encourage land use strategies designed to reduce mobile source GHG emissions.

POPULATIONS, FUNCTIONS, AND STRUCTURES

Through the above-mentioned programs, and others mentioned throughout this document, Sacramento County citizens can choose to take action to improve their resiliency to climate change effects. The efforts listed above provide Sacramento County with additional adaptation capacity across several impact areas. Not only does implementation of these efforts involve adaptation to climate change-related impacts (e.g., precipitation, temperature), they serve to reduce emissions of GHGs that contribute to the severity of these potential impacts. Through incorporation of sustainable development and environmental stewardship, GHG emissions can be reduced to avoid the projected impacts under a high-emissions scenario. These reductions

have co-benefits that improve the adaptive capacity of populations, functions, and structures by decreasing the severity of the impacts to be adapted to. For example, investments in planting trees to combat the UHIE would produce the co-benefit of increased carbon sequestration potential thereby lowering levels of GHGs in the atmosphere.

ADAPTIVE CAPACITY RANKING FOR COMPREHENSIVE MITIGATION: HIGH

Sacramento County supports initiatives, projects, and organizations that help address issues of sustainability and climate adaptation. With organizations that educate the public and foster collaboration for long-term environmental sustainability, the County is finding ways to change behaviors and practices. Furthermore, by adopting and complying with the 2013 Green Building Standards, future development in Sacramento County will be more efficient and emit fewer GHGs than previous development. Additionally, through the 2015 Zoning Code, the County set development standards that allows a variety of approaches to design that preserves or establishes a sense of place for each community, but does so in a healthy, safe and sustainable manner. Sacramento County is setting a standard for reduced energy use, increased sustainable building materials, active transportation, mixed land uses/infill development, clean fleets and fuels, and conservation of water and more. These efforts, however, will need to be expanded and continually deployed throughout the County and deeper into the community to address future impacts attributed to climate change. Residents and businesses will need to follow actions led by the County to reduce GHG emissions and to adapt to the changing climate. Assuming that these projects continue to be funded and equitably distributed, Sacramento County will be well equipped to mitigate the severity of potential climate change effects; therefore, the adaptive capacity is high.

As mentioned above, the County is an active member of CRCRC, which works across multiple sectors to advance resiliency across the region and the state. CRCRC aided the County in the preparation of the 2016 LHMP and this Vulnerability Assessment. CRCRC works regionally and across the state with other similar collaboratives, under the Alliance of Regional Collaboratives for Climate Adaptation (ARCCA), to address climate change, understand and inform the region on best practices for resiliency and adaptation to build strong, resilient, healthy, equitable, and sustainable communities across California.

To conclude, Sacramento County is committed to continuing efforts to reduce and address risks and impacts resulting from climate change through multiple programs. With a number of ordinances and programs that cover a broad range of climate exposures, Sacramento County has a medium-level capacity to handle current issues of water supply, wildfire, temperatures, and flooding, but will face increasing challenges as projected climate changes occur. Further, the County needs to adopt a more comprehensive strategy to address the impacts of extreme heat events, which have already affected the County and its vulnerable populations. The long-term vision identified in the County's planning documents demonstrates that the County is forward thinking in its policy and mitigation development towards all climate exposures. Further, completion of this vulnerability assessment can increase awareness of the risks and impacts associated with climate change as well as key areas where improvements can be made. This effort will add to the County's capacity to carry out further planning and implementation of adaptation actions, increasing Sacramento County's adaptive capacity as policy, planning, and future development continues to unfold.

To maintain its adaptive capacity, it is important that existing efforts in Sacramento County should be integrated, expanded, and evaluated to explore how well they are serving to increase the County's readiness for the current climate, as well as climate trends and future impacts. On an ongoing basis, specific monitoring and assessment approaches for climate readiness strategies should be explicitly integrated into existing and future community plans and development or infrastructure projects in a way that provides for public health, safety, livability, equity, and prosperity in Sacramento County.

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 in which impacts would occur (i.e., onset). Risk is the likelihood or probability that a certain magnitude/extent/scale of a potential impact will occur. For the purposes of this analysis, risk is determined by a combination of the estimated certainty of the science projecting the climate change impact and the certainty of the sector sensitivity. Certainty rankings are based on percent probability of global models created by the IPCC (CNRA 2012a: 29). The timeframe in which the impact is most likely to occur (based on risk) can be categorized as:

- ▲ Current: Impacts currently or imminently occurring (2016-2020)
- ▲ 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 Step 1 in Table 2 below. Onset designations have also been assigned.

Table 2 Risk and Onset for Sacramento County Climate Change Impacts

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

The table shows that increased temperature, increased frequency in extreme heat days and waves, sea-level rise, and increased flooding are of high certainty rating. Temperature- and precipitation-related impacts are the most likely near-term climate change exposure facing Sacramento 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 County land area affected will be relatively small. Although sea-level rise has a high certainty ranking, the effects on the County will be more limited than other climate risks. Addressing increases in wildfire risk have mid-term onsets and should be prioritized accordingly.

4 REFERENCES

- Alliance of Regional Collaboratives for Climate Adaptation. 2016. *The Urban-Rural Connection*. Available: <http://www.arccacalifornia.org/initiatives/the-urban-rural-connection/>. Accessed: November 23, 2016.
- Burton, Christopher and Susan L. Cutter. 2008 (August). *Levee Failures and Social Vulnerability in the Sacramento-San Joaquin Delta Area, California*. Natural Hazards Review. Pp 136-149. Available: https://www.researchgate.net/profile/Christopher_Burton3/publication/228756947_Levee_failures_and_social_vulnerability_in_the_Sacramento-San_Joaquin_Delta_area_California/links/00b4953c3a884f3878000000.pdf. Accessed: August 4, 2016.
- CAL FIRE. See *California Department of Forestry and Fire Protection*.
- Cal-Adapt. 2016. *Climate Tools*. Available: <http://cal-adapt.com/tools/>. Accessed: June 15, 2016.
- CalBRACE. 2015 (December). *Public Health Planning for Climate Change Adaptation in California*. Available: http://www.cdph.ca.gov/programs/Documents/VARreportSection2_Sacramento_12-21-2015.pdf. Accessed: September 21, 2016.
- Cal EPA. See *California Environmental Protection Agency*.
- California Department of Community Services and Development. 2015 (August). *Weatherization Assistance Program for Low-Income Person 2015 State Plan and Application to the U.S. Department of Energy*. Available: <http://www.csd.ca.gov/Portals/0/Documents/State%20Plans/2015%20DOE%20State%20Plan%208-6-15%20-%20FINAL.pdf>. Accessed: August 24, 2016.
- California Department of Fish and Wildlife. 2015. *California State Wildlife Action Plan 2015 Update: A Conservation Legacy for Californians*. Available: <https://www.wildlife.ca.gov/SWAP/Final>. Accessed: September 20, 2016.
- California Department of Food and Agriculture. 2013. *Climate Change Consortium for Specialty Crops: Impacts and Strategies for Resilience*. Available: <https://www.cdfa.ca.gov/environmentalstewardship/pdfs/ccr-report.pdf>. Accessed: August 24, 2016.
- California Department of Forestry and Fire Protection. 2007. *Fire Hazard Severity Zones in State Responsibility Areas: Sacramento County*. Available: http://frap.fire.ca.gov/webdata/maps/sacramento/fhszs_map.34.pdf. Accessed: August 3, 2016.
- _____. 2009 (March). *Homeowners Checklist: How to Make your Home Fire Safe*. Available: http://www.fire.ca.gov/communications/downloads/fact_sheets/Checklist.pdf. Accessed: August 3, 2016.
- California Department of Water Resources. 1980. *Ground Water Basins in California: A Report to the Legislature in Response to Water Code Section 12924*. Available: http://www.water.ca.gov/pubs/groundwater/bulletin_118/ground_water_basins_in_california__bulletin_118-80_/b118_80_ground_water_ocr.pdf. Accessed: November 9, 2016.
- _____. 2008. *Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water*. Available: <http://www.water.ca.gov/climatechange/docs/ClimateChangeWhitePaper.pdf>. Accessed: June 15, 2016.
- _____. 2011. *Levee Repair—Levee Repair Projects*. Available: <http://www.water.ca.gov/levees/projects/>. Accessed: June 21, 2016.

- _____. 2013. *California Water Plan Update 2013: Investing in Innovation and Infrastructure*. Available: <http://www.water.ca.gov/waterplan/docs/cwpu2013/Final/Oa-Vol1-full2.pdf>. Accessed: June 21, 2016.
- California Employment Development Department. 2016. *Agricultural Employment in California*. Available: <http://www.labormarketinfo.edd.ca.gov/data/ca-agriculture.html>. Accessed: August 23, 2016.
- California Environmental Protection Agency. 2013 (October) *Preparing California for Extreme Heat*. Available: http://www.climatechange.ca.gov/climate_action_team/reports/Preparing_California_for_Extreme_Heat.pdf. Accessed: September 21, 2016.
- _____. 2015 (April). *Creating and Mapping an Urban Heat Island Index for California*. Available: <http://www.calepa.ca.gov/UrbanHeat/Report/Report.pdf>. Accessed: December 23, 2016.
- California Health Care Foundation. 2016. *California's Uninsured: Coverage Expands, but Millions Left Behind*. Available: <http://www.chcf.org/~media/MEDIA%20LIBRARY%20Files/PDF/PDF%20C/PDF%20CaliforniaUninsured2016.pdf>. Accessed: November 7, 2016.
- California Natural Resources Agency. 2012a. *California Adaptation Planning Guide*. Available: http://resources.ca.gov/docs/climate/01APG_Planning_for_Adaptive_Communities.pdf. Accessed: June 15, 2016.
- _____. 2012b. *Our Changing Climate 2012: Vulnerability and Adaptation to the Increasing Risk from Climate Change in California*. Available: <http://www.energy.ca.gov/2012publications/CEC-500-2012-007/CEC-500-2012-007.pdf>. Accessed: June 15, 2016.
- _____. 2013. *Climate Change Consortium for Specialty Crops: Impacts and Strategies for Resilience*. Available: <https://www.cdffa.ca.gov/environmentalstewardship/pdfs/ccc-report.pdf>. Accessed: November 9, 2016.
- _____. 2014. *Safeguarding California: Reducing Climate Risk—An Update to the 2009 California Climate Adaptation Strategy*. Available: http://resources.ca.gov/docs/climate/Final_Safeguarding_CA_Plan_July_31_2014.pdf. Accessed: June 15, 2016.
- _____. 2016. *Safeguarding California: Implementation Action Plan*. Available: <http://resources.ca.gov/docs/climate/safeguarding/Safeguarding%20California-Implementation%20Action%20Plans.pdf>
- Capital Region Climate Readiness Collaborative. 2014 (November). *Climate Change Risks and Solutions for the Capital Region*. Available: <http://www.climate readiness.info/wp-content/uploads/2014/04/Sacramento-Climate-Change-Risks-Nov-2014.pdf>. Accessed: August 2, 2016.
- CDFA. See *California Department of Food and Agriculture*.
- Central Valley Flood Protection District. 2012.
- Climate Central. No Date. *Sacramento and Stockton Face Biggest Sea Level Rise Threat in California: Host State's Largest City Population on Low-Lying Lands*. Available: <http://www.climatecentral.org/pdfs/SLR-CA-SS-PressRelease.pdf>. Accessed: August 25, 2016.
- _____. 2012. *Sea Level Rise and Coastal Flood Risk: Summary for Sacramento California*. Available: http://ssrf.climatecentral.org.s3-website-us-east-1.amazonaws.com/Buffer2/states/CA/downloads/pdf_reports/Town/CA_Sacramento-report.pdf. Accessed: August 25, 2016.

- _____. 2013. *Wildfires and Air Pollution: The Hidden Health Hazards of Climate Change*. Available: <http://assets.climatecentral.org/pdfs/WildfiresAndAirPollution.pdf>. Accessed: November 9, 2016.
- CNRA. See *California Natural Resources Agency*.
- CRCRC. See *Capital Region Climate Readiness Collaborative*.
- Curtis, Katherine J. and Annemarie Schneider. 2011 (April). *Understanding the Demographic Implications of Climate Change: Estimate of Localized Population Prediction under Future Scenarios of Sea-Level Rise*. Springer Science and Business Media, LLC. Available: https://www.researchgate.net/profile/Annemarie_Schneider/publication/227203534_Understanding_the_demographic_implications_of_climate_change_Estimates_of_localized_population_predictions_under_future_scenarios_of_sea-level_rise/links/004635351a192319d4000000.pdf. Accessed: August 4, 2016.
- CVFPD. See *Central Valley Flood Protection District*.
- Delta Stewardship Council. 2013. *The Delta Plan: Ensuring a Reliable Water Supply for California, a Healthy Delta Ecosystem, and Place of Enduring Value*. Available: http://deltacouncil.ca.gov/sites/default/files/documents/files/DeltaPlan_2013_CHAPTERS_COMBINED.pdf. Accessed: December 22, 2016.
- Dettinger, Michael D. and Daniel R. Cayan. 2003 (February). *Interseasonal Covariability of Sierra Nevada Streamflow and San Francisco Bay Salinity*. *Journal of Hydrology*, 277, pp. 164-181.
- DOE. See *U.S. Department of Energy*.
- DWR. See *California Department of Water Resources*.
- EDD. See *California Employment Development Department*.
- HERO Program. See *Home Energy Renovation Opportunity Program*.
- Home Energy Renovation Opportunity Program. *HERO Financing Makes Sense*. Available: <https://www.heroprogram.com/ca/sacramentocounty/>. Accessed: August 3, 2016.
- Intergovernmental Panel on Climate Change. 2007. *Fourth Assessment Report*. Available: http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml. Accessed: June 15, 2016.
- _____. 2014. *Climate Change 2014 Synthesis Report*. Available: <http://www.ipcc.ch/report/ar5/wg1/>. Accessed: June 15, 2016.
- IPCC. See *Intergovernmental Panel on Climate Change*.
- Liu, Jia Coco, Loretta J. Mickley, Melissa P. Sulrpizio, Francesca Dominici, Xu Yue, Keita Ebisu, Georgiana Brook Anderson, Rafi F. A. Khan, Mercedes A. Bravo, and Michelle L. Bell. 2016 (October). *Particulate Air Pollution from Wildfires in the Western U.S. Under Climate Change*. *Climate Change* 138:655-666.
- Metro Fire. See *Sacramento Metropolitan Fire District*.
- Nowak, David J. 2002. *The Effects of Urban Trees on Air Quality*. USDA Forest Services, Syracuse, Ny. Available: http://www.nrs.fs.fed.us/units/urban/local-resources/downloads/Tree_Air_Qual.pdf. Accessed: August 24, 2016.

- Pacific Gas and Electric. 2012 (April). *Sacramento: PG&E Helps Fund Green Initiatives, Plant Trees*. Available: <http://www.pgecurrents.com/2012/04/05/sacramento-pge-helps-fund-green-initiatives-plant-trees/>. Accessed: November 10, 2016.
- PG&E. See *Pacific Gas and Electric*.
- PHA. See *Public Health Alliance*.
- Pierce and Cayan. 2012. "The Uneven Response of Different Snow Measures to Human-Induced Climate Warming." *Journal of Climate*. 26, 4148-4167.
- Public Health Alliance. 2016. *Health Disadvantage Index for California*. Available: <http://www.phi.org/news-events/1038/new-interactive-index-tool-gives-snapshot-of-health-disadvantages-in-california-communities>. Accessed: November 11, 2016.
- Rafut, Samuel, Eric Tate, Christopher G. Burton, and Abu Sayeed Maroof. 2015 (September). *Social Vulnerability to Floods: Review of Case Studies and Implication for Measurement*. International Journal of Disaster Risk Reduction. Pp. 470-486.
- SACOG. See *Sacramento Area Council of Governments*.
- Sacramento Area Council of Governments. 2015. *Sacramento Region Transportation Climate Adaptation Plan*. Available: <http://www.sacog.org/sites/main/files/file-attachments/fullplanwithappendices.pdf/>. Accessed: June 15, 2016.
- Sacramento Area Flood Control Agency. No Date. *SAFCA Mission Statement*. Available: <http://www.safca.org/>. Accessed: August 3, 2016.
- _____. 2015. *SAFCA Levee Accreditation Project*. Available: http://www.safca.org/documents/Levee_Certification/2015.06_FEIR_NoArea_Streams/residentquestionandanswers.pdf. Accessed: September 29, 2016.
- Sacramento County. 2008 (November). *Sacramento County Evacuation Plan: An Annex to the County Emergency Operations Plan*. Available: <http://www.sacramentoready.org/Documents/Sac%20County%20Evac%20Plan%20COMPLETE-FINAL%20111808.pdf>. Accessed: August 3, 2016.
- _____. 2011a. *Sacramento County General Plan of 2005-2030*. Adopted December 15, 1993. Available: http://www.per.saccounty.net/PlansandProjectsIn-Progress/Documents/General%20Plan%202030/2030%20General%20Plan%20Adopted%2011.9.11_sm.pdf. Accessed: May 31, 2016.
- _____. 2011b. *Sacramento County Multi-Hazard Mitigation Plan Update*. Adopted December 2004. Available: <http://www.sacoes.org/EmergencyManagement/Documents/Chapter%204%20Risk%20Assessment.pdf>. Accessed: June 7, 2016.
- _____. 2011c (November). *Sacramento County Climate Action Plan: Strategy and Framework Document*. Adopted November 9, 2011. Available: http://www.ca-ilg.org/sites/main/files/file-attachments/sac_030843.pdf. Accessed: August 24, 2016.
- _____. 2012 (April). *Sacramento Operational Area Severe Weather Guidance: An Annex to the Sacramento Operations Plan*. Available: <http://www.sacramentoready.org/Documents/Sacramento%20Severe%20Weather%20Guidance.pdf>. Accessed: August 24, 2016.
- _____. 2014. *Community Health Status Report 2014: A Description of the Health Status and Mortality Experience of Sacramento County Residents*. Available:

<http://www.dhhs.saccounty.net/PUB/Documents/Disease-Control-Epidemiology/RT-HealthStatusReport2014Final.pdf>. Accessed: November 7, 2016.

_____. 2015a (April). *Climate and Health Profile Report Sacramento County*. Available: https://www.cdph.ca.gov/programs/Documents/CaIBRACE%202015CHPR/CHPR067Sacramento_County11-1-15.pdf. Accessed: June 8, 2016.

_____. 2015b. *Sacramento County 2014 Crop & Livestock Report*. Available: <http://www.agcomm.saccounty.net/Documents/CropandLivestockReports/2014Report.pdf>. Accessed: July 27, 2016.

_____. 2016a. 2016 Local Hazard Mitigation Plan. Available: <http://www.waterresources.saccounty.net/stormready/Pages/Hazard-Mitigation-Planning-Committee-2016-Plan-Update.aspx>. Accessed: January 3, 2016.

_____. 2016b. *Sacramento County Zoning Code*. Available: [http://www.per.saccounty.net/LandUseRegulationDocuments/Documents/Zoning%20Code%20Final%20Adopted%20July%202015/Updates%20to%202015%20Zoning%20Code/Amended%20July%202016/Zoning%20Code%20Effective%20September%202015%20\[Amended%2007-08-16\].pdf](http://www.per.saccounty.net/LandUseRegulationDocuments/Documents/Zoning%20Code%20Final%20Adopted%20July%202015/Updates%20to%202015%20Zoning%20Code/Amended%20July%202016/Zoning%20Code%20Effective%20September%202015%20[Amended%2007-08-16].pdf). Accessed: November 9, 2016.

_____. 2016c. *Sacramento Ready: Heat*. Available: <http://www.sacramentoready.org/Emergencies/Pages/Heat.aspx>. Accessed: August 2, 2016.

_____. 2016d. *Sacramento County Water Agency*. Available: <http://www.waterresources.saccounty.net/scwa/Pages/WaterConservation.aspx>. Accessed: August 3, 2016.

Sacramento Metropolitan Air Quality Management District. 2016 (March). *CEQA Guide: Introduction and Air Quality*. Adopted December 2009, Revised May 2011, June 2014, November 2014, June 2015. Available: <http://www.airquality.org/ceqa/cequguideupdate/Ch1IntroAQFINAL.pdf>. Accessed: July 8, 2016.

Sacramento Metropolitan Fire District. 2014 (June). *Community Wildfire Protection Plan*. Available: <https://metrofire.ca.gov/phocadownloadpap/CWPP/appacwpp.pdf>. Accessed: July 19, 2016.

Sacramento Municipal Utilities District. 2012 (November). *Climate Readiness Strategy Overview and Summary Findings*. Available: http://www.hackingsolar.org/library/images/a/a5/SMUD_Climate_Readiness_Report_2012.pdf. Accessed: June 16, 2016.

_____. 2016 (November 16). *Draft Action Plan to Address Climate Risks*. Not currently publicly available.

SAFCA. See *Sacramento Area Flood Control Agency*.

Sacramento Tree Foundation. 2000. *State of the Trees Report: A Call to Action for the Sacramento Region*. Available: http://sactree.com/assets/files/state_of_the_trees/state-of-trees.pdf. Accessed: November 9, 2016.

_____. 2015. *2015 Annual Report: Transforming Neighborhoods, Transforming Lives*. Available: http://sactree.com/assets/TF%20Annual%20Report%202015_4web.pdf. Accessed: November 9, 2016.

SMUD. See *Sacramento Municipal Utilities District*.

- Union of Concerned Scientists. No Date. *Global Warming and California Agriculture*. Available: http://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/ucs-ca-agriculture2.pdf. Accessed: August 24, 2016.
- USACE. See *U.S. Army Corps of Engineers*.
- USBR. See *U.S. Bureau of Reclamation*.
- USDA. See *U.S. Department of Agriculture*.
- USGS. See *U.S. Geological Survey*.
- U.S. Army Corps of Engineers. 2007 (May). *Record Decision Folsom Dam Safety and Flood Damage Reduction Join Federal Project*. Available: http://www.usbr.gov/mp/nepa/documentShow.cfm?Doc_ID=2716. Accessed: September 29, 2016.
- U.S. Bureau of Reclamation. 2014 (September). *West-Wide Climate Risk Assessment: Sacramento and San Joaquin Basins Climate Impact Assessment*. Available: <http://www.usbr.gov/watersmart/wcra/docs/ssjbia/ssjbia.pdf>. Accessed: July 7, 2016.
- U.S. Census. 2015. *QuickFacts: Sacramento County*. Available: <http://www.census.gov/quickfacts/table/PST045215/06067>. Accessed: July 26, 2016.
- U.S. Department of Agriculture. 2011 (August). *Social Vulnerability and Climate Change: Synthesis of Literature*. Available: http://www.fs.fed.us/pnw/pubs/pnw_gtr838.pdf. Accessed: June 21, 2016.
- U.S. Department of Energy. No Date. *Weatherization Assistance Program*. Available: <http://energy.gov/eere/wipo/weatherization-assistance-program>. Accessed: August 24, 2016.
- U.S. Geological Survey. No Date. *Sacramento-San Joaquin Delta-the Sinking Heart of the State*. Available: <https://pubs.usgs.gov/circ/circ1182/pdf/11Delta.pdf>. Accessed: December 22, 2016.
- Valley Vision. 2014a (December). *Business Resiliency in the Capital Region*. Available: http://valleyvision.org/sites/files/pdf/business_resiliency_in_the_capital_region_0.pdf. Accessed: September 20, 2016.
- _____. 2014b (November). *Business Resiliency Initiative El Dorado County Wildfire: Too Close to Home*. Available: http://valleyvision.org/sites/files/pdf/edc_learning_paper_nov_2014_1.pdf. Accessed: September 20, 2016.
- Water Education Foundation. 2016. *Sacramento-San Joaquin Delta Levees*. Available: <http://www.watereducation.org/aquapedia/sacramento-san-joaquin-delta-levees>. Accessed: August 4, 2016.
- Westerling, A.L. and B.P. Bryant. 2007. *Climate Change and Wildfire in California*. Available: http://ulmo.ucmerced.edu/pdf/files/08CC_WesterlingBryant.pdf. Accessed: August 3, 2016.
- Wilson, Paul. 2016. *Presentation: Extreme Heat Events*. Presented in October 2016. Presentation materials available: http://www.climate readiness.info/wp-content/uploads/2016/10/02_heat_localgovt_10_16.pdf. Accessed: November 11, 2016.