



Santa Cruz County

Climate Vulnerability Technical Compendium

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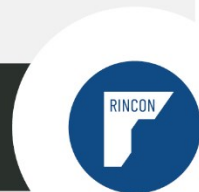


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Executive Summary

The Santa Cruz County Climate Vulnerability Technical Compendium provides detailed information on the vulnerabilities of sensitive community members, natural resources, managed resources, critical facilities, buildings, services, and infrastructure to climate change. This report is intended to provide analytical support to the Santa Cruz County Climate Action and Adaptation Plan (2022). Its key findings are intended to support the prioritization process for the selection of climate adaptation and resilience goals, strategies and objectives.

Climate change is a global phenomenon that is impacting local health, natural resources, infrastructure, emergency response, and many other aspects of society through the changes being experienced by climate conditions. Projections throughout this report were sourced from Cal-Adapt, an online tool that presents historic and modeled projections based on 10 different global climate models that have been localized. The data in Cal-Adapt is combined with additional information from California's Fourth Climate Change Assessment to model future changes in specific types of hazards within this report. Two separate Representative Concentration Pathways (RCP) from Cal-Adapt were used in this report (California Energy Commission 2021).

- RCP 4.5 is a medium emissions scenario where global emissions peak by the year 2040 and then decline.
- RCP 8.5 is a high emissions scenario in which global emissions continue to rise through the end of the twenty-first century unabated.

The climate projections, forecasted to mid-century (2035-2064) and end-century (2070-2099), indicate the following key changes in Santa Cruz County (California Energy Commission 2021):

- **Increasing temperatures.** Average maximum temperatures in Santa Cruz County are expected to rise between 3.2 degrees Fahrenheit (°F) (RCP 4.5) and 4.0°F (RCP 8.5) by mid-century and between 4.3°F (RCP 4.5) and 7.0°F (RCP 8.5) by the end of the century.
- **Increasing intensity of precipitation events and longer dry periods.** Maximum 1-day precipitation values are projected to increase between 0.2 inch (RCP 4.5) and 0.3 inch (RCP 8.5) by mid-century and between 0.3 (RCP 4.5) and 0.6 (RCP 8.5) by the end of the century. There is a projected increase of year-to-year variability with wetter days during periods of precipitation, but fewer total days with precipitation.
- **Decrease in coastal fog.** Coastal fog is projected to decrease between 12 and 20 percent by the end of the century.

Changes in temperature and precipitation are expected to amplify the frequency, duration, and magnitude of several other climate hazards. Climate change models project that Santa Cruz County is expected to experience the following by the end-century (California Energy Commission 2021).

- **Extreme Heat.** In Santa Cruz County, an extreme heat day occurs when the maximum temperature is above 90°F. The annual number of extreme heat days is projected to increase from 3 days to 19 days.

- **Drought.** Longer periods between rain events and an increase in the number of years with lower-than-average precipitation totals will increase the likelihood of drought conditions in the County.
- **Wildfire.** The decadal probability of a wildfire (the chance a wildfire will occur in a ten-year period) is projected to increase by 20 percent. A recent example of note is the CZU Lightening Complex Fire, which burned 85,509 acres and 1,490 structures across Santa Cruz and San Mateo Counties in August-September 2020, making it the twelfth most destructive Californian wildfire on record.
- **Landslides.** Susceptibility of landslides in Santa Cruz County is projected to increase as precipitation variability increases and wildfires increase in frequency, area, and severity. The recent example is during the winter of 2017 where landslides caused over \$100,000,000 in damage to our local road network.
- **Riverine and Stormwater Flooding.** Changes in precipitation patterns, may result in areas throughout Santa Cruz County experiencing more frequent and/or intense flooding, with the area of flooding potentially expanding.
- **Sea Level Rise.** The County is projected to experience up to 6.9 feet of sea level rise by 2100 with coastal storm impacts posing risk to multiple assets, including residences, commercial infrastructure, natural resources, and agricultural lands.
- **Air Quality.** Air quality within Santa Cruz County is projected to worsen due to increases in wildfires and average maximum temperature. Longer periods of drought may also lead dry and dusty conditions which can contribute to worsening air quality.

Populations, Assets, and Services at Risk

The Santa Cruz County Climate Vulnerability Technical Compendium describes the impacts climate change is expected to have on sensitive populations, assets, and services. Sensitivity is the degree to which a species, populations, natural systems, community, infrastructure, or other associated systems may be affected by changing climate conditions. Sensitive resources, infrastructures, populations, and services, as seen below, were identified as those that are most susceptible to climate change hazards.

Vulnerable Populations



- Individuals with high outdoor exposure
- Under-resourced individuals
- Individuals facing societal barriers
- Individuals with chronic health conditions or health related sensitivities

Managed Resources



- Agriculture
- Timber
- Forestry
- Rangelands

Natural Resources



- County parks
- Open spaces
- Forested land
- Critical habitat
- Rivers and streams
- Waterbodies
- Wetlands
- Wildlife

Buildings and Critical Facilities



- County buildings
- Education facilities
- Hospitals and residential medical care facilities
- Residential and commercial development
- Roadways and transportation facilities
- Fire stations
- Sheriff stations
- Airports

Services and Infrastructure



- Water services
- Wastewater
- Storm drainage and flood protection
- Solid and hazardous waste and recycling
- Fire services
- Emergency services
- Medical services
- Utilities and major utility corridors
- Transit facilities and services
- Roadways and highways
- Active transportation routes

Adaptive Capacity

Adaptive capacity is the ability to adjust to the consequences of climate change. Types of adaptive capacity include changes in behavior, resources, processes, and technologies. Santa Cruz County has existing plans, programs, and policies in place to help mitigate some of the impacts of natural hazards on the county's natural and managed resources, buildings, critical facilities, infrastructure, and services. Santa Cruz County also has some programs in place to mitigate impacts of extreme heat, drought, wildfire, landslides, flooding, and air quality on its vulnerable populations. A detailed summary of the County's adaptive capacity can be found in Appendix A: Adaptive Capacity.

Vulnerability Analysis

Understanding local climate risks and impacts allows communities to prepare for the future and focus resilience-building efforts where they will provide the greatest value. In this document, the vulnerability of identified populations and assets was evaluated based on a combination of their exposure, sensitivity, and adaptive capacity to identified climate hazards. Vulnerability is based on the combination of potential impacts and adaptive capacity, as identified in this Vulnerability Analysis. The results of the analysis details how climate change may impact vulnerable community members, natural resources, managed resources, critical facilities, buildings, services, and infrastructure in Santa Cruz County for which adaptation policies and programs should be developed and implemented to increase community resilience. The process generated low, medium, and high-risk ratings for populations and asset categories. The high-vulnerability scores are described below.

Vulnerable Populations



Extreme Heat, wildfire, and air quality have the potential to impact the greatest number of individuals county-wide. Outdoor exposure, access to resources, societal barriers, health related conditions, and age play significant roles in level of potential impact extreme heat, wildfire, and air quality have on vulnerable populations. These findings will support the efforts of County staff and stakeholders to tailor adaptation strategies to specific vulnerable populations and the climate changes they are most vulnerable to.

- **Extreme Heat.** An increase in the number of extreme heat days will exacerbate public health risks. The most at-risk populations include Individuals with high-outdoor exposure, under-resourced individuals, individuals facing societal barriers, and individuals with chronic health conditions are more likely to be more vulnerable to extreme heat than the general population.
- **Wildfire.** High populations of geographically isolated individuals in the county are located in wildfire risk zones. Individuals with high-outdoor exposure, under-resourced, individuals with chronic health conditions, and individuals facing societal barriers have been identified as having high risk to wildfire.

- **Riverine and Stormwater Flooding.** Areas located adjacent to the San Lorenzo River and south of Watsonville adjacent to the Pajaro River are at highest risk to riverine flooding. People experiencing homelessness, under-resourced individuals, and individuals facing societal barriers have been identified as having high risk to riverine and stormwater flood hazards.
- **Air Quality.** Individuals with high-outdoor exposure and individuals with chronic health conditions are particularly vulnerable to poor air quality. Outdoor workers and people experiencing homelessness are disproportionately vulnerable to poor air quality because they are predominantly outside and directly exposed to outdoor air pollutants. Individuals with chronic health conditions or health related sensitivities are at risk of developing or experiencing exacerbated health impacts from poor air quality. Children are extremely vulnerable to health impacts from poor air quality because their respiratory system has not fully developed yet. Seniors are vulnerable to health impacts from poor air quality because they are more likely to have underlying respiratory and/or cardiovascular conditions. Individuals with cardiovascular disease and individuals with asthma may experience severe health impacts if exposed to poor air quality.

Natural Resources



Natural resources in Santa Cruz County are highly vulnerable to extreme heat, drought, wildfire, and riverine and stormwater flooding. The county's natural resources provide a wide array of ecosystem services that supply the county with wide-ranging environmental, health, and well-being benefits. Ecosystems are complex and impacts from climate hazards are likely to trigger cascading risks in the county. The continued health of our natural environment as climate change impacts occur over time will play a central role in the resilience of Santa Cruz County residents.

- **Extreme Heat.** Wildlife under extreme heat conditions face impacts of heat stress and heat related illness, as well as disrupted reproductive cycles. Plants are more likely to experience heat stress and drying, species' habitat ranges may shift and be replaced with invasive species. Natural resources are highly exposed to extreme heat and warm nights.
- **Drought.** Impacts from drought involve risks associated with water scarcity and availability for reliant natural resources. Drought will disrupt habitats and the ability of wildlife to survive from dehydration and reliable food sources. There is a risk of generally stressed natural resources and unsupportable conditions for consistent stream flow. Declining stream flows will further threaten endangered aquatic species such as the California red-legged frog (*Rana draytonii*), Coho salmon (*Oncorhynchus kisutch*), Steelhead (*Oncorhynchus mykiss irideus*), and Tidewater goby (*Eucyclogogius newberryi*). Higher soil aridity will increase competition and depletion of young tree seedlings such as the coastal redwood. This may lead to forest thinning as new seedlings have less opportunities to survive the long dry and hot summer months as both temperatures increase and soil aridity becomes less favorable for supporting new tree growth.
- **Fog.** Decreasing coastal fog will have direct impacts on the resilience of our coastal redwood trees which serve as habitat for countless flora and fauna. The forest burned during the CZU Fire in 2020 is attempting to recover but reduced fog days will make it harder for burned mature trees, or saplings to thrive and recover. Fog patterns help keep ground habitat moist to support the ecosystems that thrive beneath the redwood canopy.

- **Wildfire.** The largest direct impacts to natural resources are caused by wildfires. There is direct mortality and loss of resources and wildlife from wildfire, as well as indirect mortality due to uninhabitable areas, loss of available food sources and seed bank. While many Indigenous communities have traditionally practiced cultural, or prescribed burns to manage forests, increased frequencies of fires can kill young plants and before they can produce seed, thereby reducing overall viability of ecosystems, especially in chaparral communities which cover the forest floors. The severity and frequency of wildfires can exacerbate these impacts further through habitat conversions, animal species die-offs, or vegetative communities no longer providing supportive habitat for dependent species.
- **Sea Level Rise.** Environmentally sensitive lands, including wetlands, riparian areas, woodlands, can be impacted by sea level rise and show limitations in their ability to shift habitat location (SC County CCC Vulnerability Report 2017). Saltwater intrusion into local groundwater resources is also a major threat from sea level rise. More than 100 acres of sand dune are currently susceptible to coastal erosion. Much of these resources are located in south Santa Cruz County between Rio Del Mar and the Pajaro River. The number of acres vulnerable to erosion may double by 2100. Nearly all of the creek and river mouth wetlands in Santa Cruz County are likely to be located within the coastal storm flood zone by 2030 (700 acres of habitat) and much of this fresh and brackish water habitat could be flooded each month by saline water due to rising tides by 2100. Some of these wetland areas are designated critical habitat.

Managed Resources



Managed resources in Santa Cruz County are highly vulnerable to extreme heat, drought, wildfire, riverine and stormwater flooding, and air quality. Climate hazard impacts on managed resources in the county can have severe cascading effects on the county's economy. Individuals and households who rely on managed resources for their economic livelihoods will be sensitive to these potential climate impacts.

- **Extreme Heat.** Extreme heat and warm nights can result in declines in crop yields because of heat stress and anomalous warmth during periods that are typically cooler. Declines in yields increases costs and ultimately decrease agriculture profitability. Livestock operations are potentially less viable during extreme heat events as livestock may suffer from heat related illness. Extreme heat can cause stress to trees which can increase mortality and decrease timber harvests.
- **Drought.** As precipitation levels vary and extreme heat dries out crops, the lack of water availability makes it difficult for farmers to satisfy irrigation demands for traditionally cultivated crops and pastures. Depleted water sources leave agricultural crops, timber, and livestock vulnerable to dehydration, pests, and disease. Drought intensifies wildfire risks and the ability to suppress fires, leaving agriculture and forest related production and recreation at high risk of loss. Climate change is likely to intensify California's already unpredictable rainfall patterns, leading to more uncertainty in the availability of water for agricultural production. The increased drought conditions could cause a shift in primary or secondary tree species in regions of the Santa Cruz mountains. We are already seeing the die-off of fir trees and some oak species and the CZU redwoods are struggling to recover.

- **Fog.** Decreasing coastal fog will have direct impacts on the resilience of our coastal redwood trees which serve as habitat for countless flora and fauna and provide economic value through managed forestry practices. The 80,000+ acres of forest burned during the CZU Fire in 2020 is attempting to recover but reduced fog days will make it harder for burned mature trees, or saplings to thrive and recover. The reduction in fog days could cause a shift in primary or secondary tree species in regions of the Santa Cruz mountains. We are already seeing the die off of fir trees and some oak species and the CZU redwoods are struggling to recover.
- **Wildfire.** Wildfire severity and frequency increases as extended dry periods and precipitation variability become more common. Wildfire is associated with direct loss of assets including timber, range and crop land, and recreational opportunities.
- **Riverine and Stormwater Flooding.** Increased turbidity and distribution of toxins during stormwater flooding can lower water quality for sensitive crops and livestock. Agricultural lands within the lower Pajaro Valley are less than 10 feet above the current mean sea level elevation, making them extremely vulnerable to the combined hazards of sea level rise, increased fluvial discharges and coastal wave induced flooding.
- **Air Quality.** The direct impacts of air quality on agriculture and forestry within Santa Cruz County is of primary concern to crop yield and livestock health. Both crop yield and livestock health are negatively impacted by worsening air quality as they are dependent on clean air for overall health and productivity. Increased air pollutants may cause stress and mortality to trees, impacting timber harvests.

Buildings and Critical Facilities



Buildings and critical facilities in the county are highly vulnerable to wildfire, riverine and stormwater flooding, landslides, and sea level rise. Vulnerability is highly dependent on location. Climate change is expected to amplify these identified risks for facilities in known hazard zones. It is likely that hazard zones will evolve over time, placing additional structures at risk. The potential changes in climate hazard risks are essential inputs for asset managers, land use planners, and capital planning efforts.

- **Wildfire.** Several of the county's buildings and critical facilities are located in moderate and High Fire Hazard Severity Zones and therefore are at risk to wildfire damage. The probability of a wildfire occurring increases in almost all of the county by the end of the century, which could lead to more facilities at risk of damage.
- **Riverine and Stormwater Flooding.** Flooding can cause structural damage due to flowing debris, saturation of building materials, and collapse of water-logged structures. High-velocity and high-pressure flooding may also cause structures to wash away. Several critical facilities and buildings are located in the Federal Emergency Management Agency designated floodplain and are at risk to damage. Critical facilities located in the San Lorenzo Valley, adjacent to the San Lorenzo River, and south of Watsonville, adjacent to the Pajaro River, are particularly at risk to flood damage.
- **Landslides.** Impacts to buildings and critical transportation facilities may occur in areas of the county with sloped hills, mountains, rivers, and coastal bluffs. Additionally, there is particular risk to buildings in and near areas prone to both wildfire and flooding, where post wildfire debris flows could occur. Landslides may cause physical and structural damage to impacted buildings and critical transportation facilities.

- **Sea Level Rise.** Buildings and critical facilities that are located in sea level rise inundation hazard zones in the county are at risk to structural damage from sea level rise and related coastal hazards. There are several critical sanitation facilities located in the county's sea level rise inundation zone.

Services and Infrastructure



Services and infrastructure in the county are highly vulnerable to wildfire, riverine and stormwater flooding, landslides, and sea level rise. They play a critical role in the County's ability to prevent, respond, and recover effectively from hazards. The electrical grid, in particular, will play a central role in the County's ability to address climate change. It will need to develop in a way that support's the County's electrification strategy while addressing its extreme heat and wildfire vulnerabilities. Electrical system reliability across our County is a critical element in our ability to build adaptive capacity for vulnerable community members, critical facilities, buildings, services, and infrastructure in Santa Cruz County

- **Extreme Heat.** The State level energy system has the potential to become overwhelmed by demand and result in rolling blackouts, or energy providers may conduct Public Safety Power Shutoffs (PSPS) to avoid impacts from electrical facilities during high fire conditions. Power outages have significant cascading impacts on communication networks, water conveyance, and vulnerable populations. These interdependencies indicate the importance of supporting efforts to reduce grid vulnerabilities, in order to protect the function of critical services (County 2021).
- **Wildfire.** Utility lines have the potential to be damaged in high-risk locations. Electricity distribution lines as well as natural gas lines are present in wildfire hazard zones in the county. Utility lines under certain high-wind conditions can also trigger wildfires through downed power lines. The electrical utility infrastructure in our County is being equipped with Enhanced Powerline Safety System (EPSS) technology which shuts off power to grid segments if there is a hazard is detected on the line to reduce utility ignited wildfires. This EPSS system has caused frequent outages in our high fire areas over the last 2 years and has also reduced ignitions from the utility lines. These regular grid reliability impacts can place members of our community at higher risk to other climate change negative outcomes. Increased frequency of wildfires can place strain on fire and emergency services. Evacuation routes could be disrupted during a wildfire event limiting emergency responders and ability for people to evacuate. As a result of wildfire, communities may be displaced and require temporary to long-term shelters. Displaced communities are already present in Santa Cruz County from recent wildfires. Subsequent wildfires may exacerbate existing impacts. Wildfires can destroy water system infrastructure and watershed impacts can decrease water availability and water quality for both natural and human uses.
- **Sea Level Rise.** Services and infrastructure, including critical transportation, water system, sanitation infrastructure, coastal highways, and infrastructure corridors are vulnerable to sea level rise and related coastal hazards. Sea level rise will likely impact county roadways and emergency services, which may have cascading impacts on utilities provisioning and communication networks.

1 Introduction

1.1 Report Overview

The Santa Cruz County Climate Vulnerability Technical Compendium provides detailed information on the vulnerabilities of sensitive community members, natural resources, managed resources, critical facilities, buildings, services, and infrastructure in Santa Cruz County to climate change. This document is intended to provide analytical support to the Santa Cruz County Climate Action and Adaptation Plan (2022). Its key findings are intended to support the prioritization of climate adaptation and resilience goals, policies, and implementation programs.

The document is composed of the following six parts:

1. **Section 1 Introduction** provides a background on climate change and Santa Cruz County, a lexicon of terms used throughout the report, and describes the methodology and key data sources used to prepare the Santa Cruz County Climate Vulnerability Technical Compendium.
2. **Section 2 Exposure to Climate Hazards** presents climate drivers, relevant climate hazards, historical hazard events, how hazards are expected to change, and includes figures mapping climate hazards across Santa Cruz County.
3. **Section 3 Community Assets and Services at Risk** identifies populations and assets most at risk to climate change.
4. **Section 4 Vulnerability Analysis** describes potential impacts to distinct aspects of the community, given their adaptive capacity. This section includes a score of low, medium, or high for each population group and asset.
5. **Section 5 Conclusion** presents the key findings of this report.
6. **Appendix A Adaptive Capacity** summarizes plans, policies, and programs that may help Santa Cruz County adapt to climate hazard events.

1.2 Background on Climate Change

This document evaluates how climate change is projected to impact vulnerable community members, natural resources, managed resources, buildings and critical facilities, and services and infrastructure in Santa Cruz County. This document is consistent with Government Code Section 65302 (as amended by Senate Bill 379), which requires California’s local jurisdictions to prepare a Climate Change Vulnerability Assessment as part of their local hazard mitigation plan within the jurisdiction’s general plan safety element. Understanding Santa Cruz County’s vulnerabilities to climate change provides a foundation to develop resiliency strategies and the required climate adaptation goals, policies, and implementation programs for the Climate Action and Adaptation Plan.

Causes of Climate Change

Climate change is caused by the addition of excess greenhouse gases (GHG) to the atmosphere, which traps heat near the earth's surface raising global average temperatures in what is referred to as the greenhouse effect. This increase in average temperatures across the globe affects sea level rise, precipitation patterns, the severity of wildfires, the prevalence of extreme heat events, water supply, and ocean temperatures and chemistry (National Aeronautics and Space Administration 2022). According to the Intergovernmental Panel on Climate Change (IPCC), GHGs are now higher than they have been in the past 400,000 years, raising carbon dioxide levels from 280 parts per million to 410 parts per million in the last 150 years (IPCC 2021). The dramatic increase in GHGs is attributed to human activities beginning with the industrial revolution in the 1800s, which represented a shift from an agrarian and handicraft-based economy to one dominated by industry and machine manufacturing (National Aeronautics and Space Administration 2022).

1.3 Santa Cruz County Snapshot

Santa Cruz County is located in the traditional tribal territory of the Awaswas peoples, one of eight divisions of the Ohlone American Indians of Northern California, who were known for their acorn-based diets and basket making and occupied present-day Davenport to Aptos for approximately 10,000 years (Dunn 2013). Santa Cruz County encompasses nearly 607 square miles of rugged coastline, mountains, and fertile farmland in the northwestern mountains of California (U.S. Census Bureau 2012). Neighboring counties include San Mateo County to the northwest, Santa Clara County the north and east, and Monterey and San Benito counties to the south. Steep mountainous elevations reach nearly 3,800 feet and descend into river valleys and beaches at sea level (Luther and Barrows 2010). The county comprises four incorporated cities, the largest being the city of Santa Cruz with a population of 62,956, followed by Watsonville (52,739), Scotts Valley (12,272), and Capitola (9,966). Just over half of all county residents live within the boundaries of these incorporated cities (137,933), the other nearly 50% live in the unincorporated county (132,927). Communities in the unincorporated county range from small and rural to urban or suburban. The county has four watersheds: the Pajaro River watershed, the San Lorenzo River watershed, the Soquel Creek watershed, and the Aptos Creek watershed. The San Lorenzo Valley watershed provides potable water supply to a majority of the county's population. Economic drivers include food production/processing with the highest value crops being berries, healthcare services, the University of California Santa Cruz, tourism, water-related recreation, local government, timber, and small private businesses, generating a \$75,957 per capita income for the county in 2020). Santa Cruz County has a total population of 270,861 full-time residents as of 2020 (U.S. Census Bureau 2020).

1.4 Lexicon

Several words and phrases are used throughout the plan to illustrate climate vulnerabilities within Santa Cruz County.

- **Adaptation.** The process of adjustment to actual or expected climate and its effects, either to minimize harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate (IPCC 2012).
- **Adaptive Capacity.** Santa Cruz County’s ability to increase resilience and adjust to the impacts of climate change (California Governor’s Office of Emergency Services [Cal OES] 2020).
- **Asset.** A resource, structure, facility or service relied on by a community.
- **Cascading Impact.** Climate caused impacts that compromise infrastructure or disrupt critical services (i.e., power supply or water conveyance) broadening the scope of impact past a single system to reliant subsystems and populations (Collins et al. 2019).
- **Climate Driver.** A change in the climate which acts as the main source of change for subsequent climate hazards. Climate drivers relevant to the County and discussed in this report are temperature, precipitation, and coastal fog.
- **Climate Hazard.** A dangerous or potentially dangerous condition created by the effects of the local climate (Cal OES 2020). Climate hazards of concern for Santa Cruz County are extreme heat and warm nights, drought, wildfire, landslides, riverine and stormwater flooding, air quality, and sea level rise.
- **Compounding Risk.** When two or more extreme events or average events occur simultaneously and increase the scope of impact or severity of the event; an additional risk brought about by increased frequency of events from climate change (Seneviratne et al. 2012).
- **Impact.** Effects on natural and human systems including effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate hazards and the vulnerabilities of the system or asset effected (IPCC 2012).
- **Mitigation.** An act or sustained actions to reduce, eliminate, or avoid negative impacts or effects (Cal OES 2020).
- **Resilience.** The capacity of an entity (an individual, a community, an organization, or a natural system) to prepare for disruptions, to recover from shocks and stresses, and to adapt and grow from a disruptive experience (Cal OES 2020).
- **Sensitivities.** The degree to which a species, population, natural system, community, asset, or other associated system would be affected by changing climate conditions (Cal OES 2020).
- **Vulnerable Populations.** Vulnerable populations experience heightened risk and increased sensitivity to climate change and have less capacity and fewer resources to cope with, adapt to, or recover from climate impacts (Cal OES 2020).
- **Vulnerability.** The propensity or predisposition to be adversely affected (IPCC 2012).

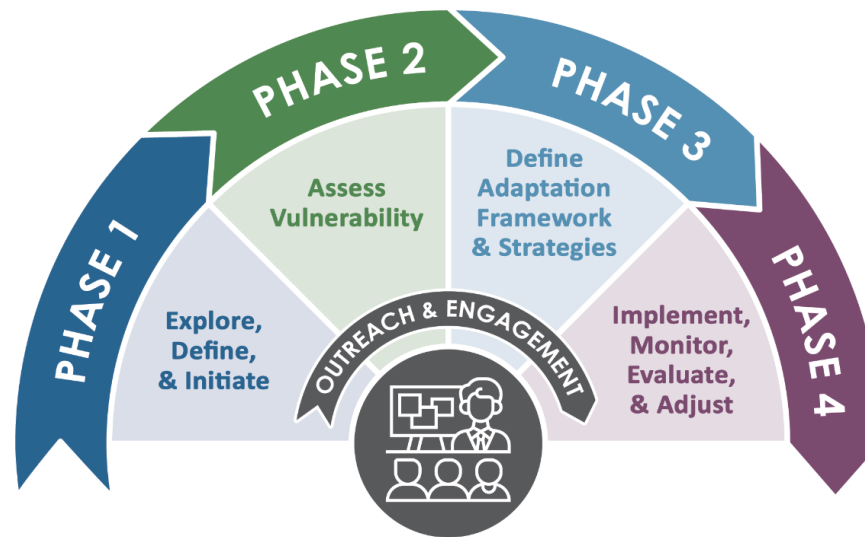
1.5 Vulnerability Assessment Methodology

The following section details state guidance, methods, and sources used in the production of this document.

California Adaptation Planning Guide Phases

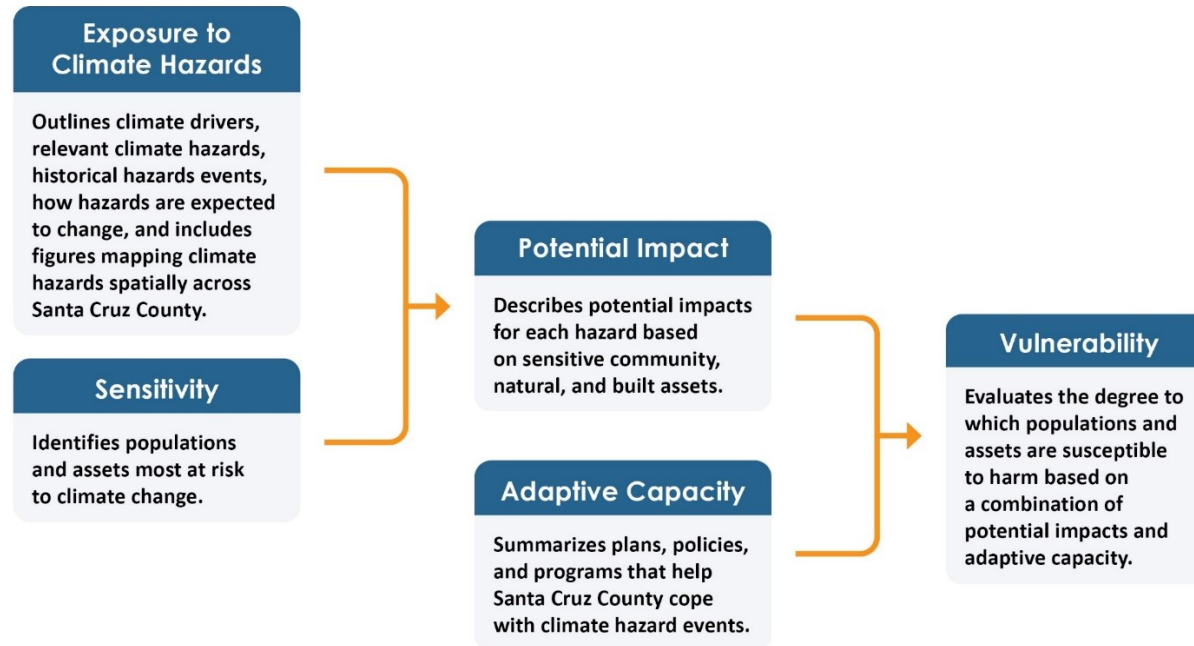
The Santa Cruz County Climate Vulnerability Assessment follows the vulnerability assessment process recommended by Cal OES, as documented in the *2020 California Adaptation Planning Guide* (Cal APG). The adaptation planning process outlined by the Cal APG consists of four phases, illustrated in the graphic below, with Phase 2 detailing the vulnerability assessment process (Cal OES 2020). The Santa Cruz County Climate Vulnerability Assessment is prepared consistent with Phase 2 of the Cal APG (Figure 1) and is composed of the following parts found in Figure 2.

Figure 1 California Adaptation Planning Phases to Assessing Vulnerability. Adaptation planning is comprised of four phases, which include defining the problem, assessing the vulnerabilities, developing adaptation strategies, and establishing an implementation plan.



Source: 2020 California Adaptation Planning Guide

Figure 2 Vulnerability Assessment Flow Diagram The vulnerability assessment follows the following steps: identify climate hazards of concern, identify sensitive assets and populations, assess potential impacts, summarize current plans, policies, and programs that help cope with climate hazard impacts, and evaluate the vulnerability of each population and asset.



Social Sensitivity Methodology

The presence of vulnerable populations in Santa Cruz County was identified based on the U.S. Census Bureau’s American Community Survey (ACS) and Center for Disease Control (CDC) PLACES health data. This report follows Cal APG’s methodology for identifying, grouping, and analyzing vulnerable populations. The Cal APG considers the potentially vulnerable populations in a community to include:

- Low income
- Homeless
- The unemployed or underemployed
- Seniors and young children
- Military veterans
- Non-white communities
- Renters
- Students
- Visitors and seasonal residents
- Outdoor workers
- Single female heads of households
- Undocumented immigrants
- Non-English speakers
- Tribal and indigenous communities
- Individuals with impaired health/disabilities
- Isolated individuals (e.g., no car or transit access)

This document identifies vulnerable populations, which are based on whether unincorporated census tracts in the county contain larger numbers of potentially vulnerable groups when compared with the statewide average. Santa Cruz County’s sensitive populations are described in the Vulnerable Populations section later in this report.

Vulnerability Scoring Methodology

Vulnerability scoring is an important step in the climate vulnerability assessment process because it identifies which assets and populations face the highest threat from climate hazards. This scoring methodology can aid in the prioritization of adaptation strategies and actions. The impact and adaptive capacity scores utilized in this document were developed using a qualitative methodology outlined in the Cal APG (Table 1). Impact and adaptive capacity scores were identified for each asset and population for each climate hazard. These impact and adaptive capacity scores and were combined into a matrix, as seen in Table 2 Vulnerability Score Matrix, to develop a vulnerability score. The range of potential vulnerability scores spans 1 through 5 with a score of 4 to 5 representing the greatest vulnerability.

Table 1 Impact and Adaptive Capacity Scoring Rubric

Score	Impact	Adaptive Capacity
Low	Impact is unlikely based on projected exposure; would result in minor consequences to public health, safety, and/or other metrics of concern.	The population or asset lacks capacity to manage changes; major changes would be required.
Medium	Impact is somewhat likely based on projected exposure; would result in some consequences to public health, safety, and/or other metrics of concern.	The population or asset has some capacity to manage climate impact; some changes would be required.
High	Impact is highly likely based on projected exposure; consequences to public health, safety, and/or other metrics of concern.	The population or asset has high capacity to manage climate impact; minimal to no changes are required.

Source: California Governor’s Office of Emergency Services 2020

Table 2 Vulnerability Score Matrix

Potential Impacts	High	3	4	5
	Medium	2	3	4
	Low	1	2	3
		High	Medium	Low
	Adaptive Capacity			

Source: California Governor’s Office of Emergency Services 2020

Key Data Sources

The following data sources and tools, many of which are recommended in the Cal APG, were used in preparation of this report.

- **U.S. Census, 2015-2019 American Community Survey** presents demographic data by census tract. U.S. Census data was used to identify the percentage of the Santa Cruz County population that corresponds to each vulnerable group.
- **Cal-Adapt** is an online tool that presents historic and modeled projections based on 10 different global climate models. The tool was developed and is maintained by the University of California with oversight from the California Energy Commission (CEC). This tool is used to present projection data related to minimum and maximum temperature, precipitation, extreme heat, warm nights, drought, and wildfire.
- **California’s Fourth Climate Change Assessment** was developed by the CEC and other State of California coordinating agencies to present up-to-date climate science, projections and potential impacts associated with climate change. The CEC and coordinating agencies developed nine regional reports to provide regional-scale climate information to support local planning and action. The Central Coast Region Report (2018) presents an overview of central coast-specific climate science, regional projections, specific strategies to adapt to climate impacts, and key research gaps needed to spur additional progress on safeguarding the Central Coast region from climate change. The Central Coast Region Report was used to understand regional changes that may affect Santa Cruz County both directly and indirectly.
- **The Santa Cruz County Local Hazard Mitigation Plan** presents information on existing processes and plans that address the County’s ability to prepare for climate change impacts and informed the adaptive capacity discussion of this report.
- **The Center for Disease Control’s (CDC) PLACES Health Data (2021)** details the burden and geographic distribution of health measures in Santa Cruz County and is used for health sensitivity indicators.

Data Limitations

The limitations of this report and its analysis stem from gaps and other shortcomings in the existing available data. Census data can overlook portions of the population (e.g., homeless populations, displaced individuals, undocumented immigrants, and visitors) and general demographic information may not identify the full extent of populations vulnerable to climate change (Cantwell 2021). Federal Emergency Management Agency (FEMA) 100-year and 500-year flood plains do not account for climate change projections; zones are instead based on historical information. The California Department of Forestry and Fire Protection (CAL FIRE) Very High Fire Hazard Severity Zones are based on vegetation, fire history, and terrain but also has similar limitations in not projecting fire zones into the future (Office of State Fire Marshall 2022). Extrapolating landslides and air quality hazard exposure data in the context of climate change is difficult and the estimates of exposure to these hazards are likely to be underestimated.

The data presented in **Cal-Adapt** tools are projections, or estimates, of future climate. The limitation in these projections is that the long-term behavior of the atmosphere is expressed in averages—for example, average annual temperature, average monthly rainfall, or average water equivalent of mountain snowpack at a given time of year. The averages discussed often downplay the extremes by which daily weather events

occur and when presented as an average, only show moderate changes within the climate. What is often lost in averages is that the frequency of extremes, like atmospheric river rainfall events and the number of drought years, may increase while low-moderate intensity weather events decrease through the end of the century. In instances of modeled precipitation projections, Cal-Adapt tools maintain an average similar to historic levels which does not account for anticipated fluctuations in extremes (CEC 2021).

1.6 Stakeholder Engagement

Incorporating stakeholder engagement into the development of the Santa Cruz County Climate Vulnerability Technical Compendium provides critical context for climate hazards of concern, vulnerable populations, services, and assets, and resilience efforts within the county. However stakeholder engagement should not be a one-time process. As implementation strategies are identified on-going community and stakeholder engagement will be critical to their success. The County is developing its CAAP in close partnership with a diverse set of Santa Cruz County departments and staff to facilitate shared ownership of adaptation priorities that center around key community concerns.

Workgroups Meeting

Santa Cruz County formed three workgroups to guide and support the CAAP development. Each workgroup brings unique expertise within Santa Cruz County. Incorporating this knowledge is critical in understanding the breadth of impacts, vulnerabilities, and existing adaptive capacity in the county.

- Community and Economy Workgroup
- Built Environment Workgroup
- Natural Environment Workgroup

Members from multiple departments are represented in the workgroups, including the following:

- Agricultural Commission
- Agricultural Extension
- County Administrative
- Environmental Health
- General Services
- Health Services
- Response, Recovery, and Resilience
- Parks
- Personnel
- Probation
- Public Works
- The County Sheriff's Office
- Workforce Development

The workgroups met together with Rincon Consultants, Inc. on July 22nd, 2022, to discuss initial findings regarding the county's climate exposure, sensitivity, adaptive capacity, and vulnerability. The workgroups provided feedback and information on recent experience recovering from and addressing climate change hazards. This assessment includes key findings from the workgroup meeting, which can be seen in the blue text boxes through the document.

2 Exposure to Climate Hazards

Climate change is a global phenomenon that can impact many aspects of society including public health, natural and managed resources, critical facilities, buildings, infrastructure, and services. Projected changes to the climate are dependent on location. The Cal-Adapt tool provides climate data for Santa Cruz County from global scale models that have been localized (downscaled) to 3.7-mile by 3.7-mile grids (CEC 2021). The data in Cal-Adapt is combined with information from the California Fourth Climate Change Assessment to model future changes in specific types of hazards in this document. Projections throughout this section are outlined by two separate Representative Concentration Pathways (RCP) (CEC 2021).

- RCP 4.5 is a medium emissions scenario where global emissions peak by the year 2040 and then decline.
- RCP 8.5 is a high emissions scenario in which global emissions continue to rise through the end of the twenty-first century.

Additionally, projections are forecasted to mid-century (2035 to 2064) and end-century (2070 to 2099) as 30-year averages to be compared to a modeled historical baseline (1961 to 1990) (CEC 2021).

This section presents information on temperature, precipitation, and coastal fog, which are characterized as climate drivers. The section then provides information on projections for natural hazards, including extreme heat, drought, wildfire, landslides, riverine and stormwater flooding, air quality, and sea level rise and related hazards, which result from changes to climate drivers.

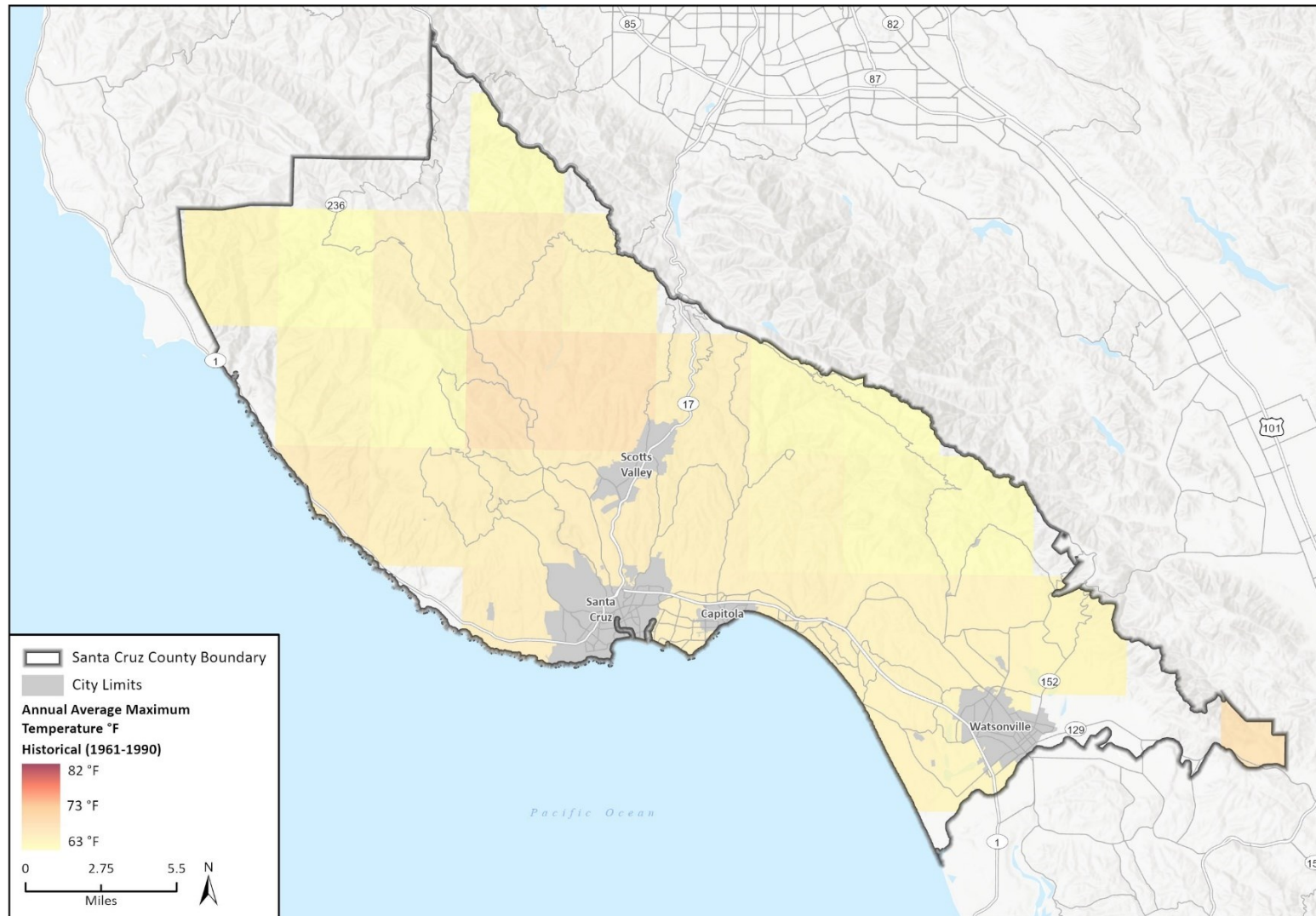
2.1 Climate Drivers

In Santa Cruz County, the climate drivers of concern include temperature, precipitation and coastal fog. All projections are taken from the Cal-Adapt Local Climate Change Snapshot tool and supplemented with the Central Coast regional information found in the California Fourth Climate Change Assessment (CEC 2021).

Temperature

Santa Cruz County has an average maximum temperature of 67.4°F and an average minimum temperature of 43.1°F (CEC 2021). The average maximum and minimum temperatures are expected to increase in the County with mid-century projections showing a 3.2°F (RCP 4.5) to 4.0°F (RCP 8.5) increase in temperature maximum and minimums (CEC, 2021). End-century projections show a 4.3°F (RCP 4.5) to 7.0°F (RCP 8.5) increase in the county. Temperature increases affect extreme heat and warm nights, drought, wildfire, and air quality. Global temperature increases cause ocean temperatures to rise which expands ocean waters. Glaciers, ice caps, and ice sheets melt from rising temperatures which further contribute to sea level rise (Langridge 2018).

Figure 3 Historical Average Maximum Temperature Across Santa Cruz County Historical average maximum temperature across Santa Cruz County ranges from 63°F to low 70s°F



Basemap provided by Esri and its licensors © 2022.
Additional data provided by CalAdapt, 2022

Vulnerability Assessment.aprx
Fig 4 Historical Average Maximum Temperature across Santa Cruz County

Figure 4 Mid-Century Average Temperature Across Santa Cruz County Historical average maximum temperature across Santa Cruz County ranges from high 60s°F to low 80s°F

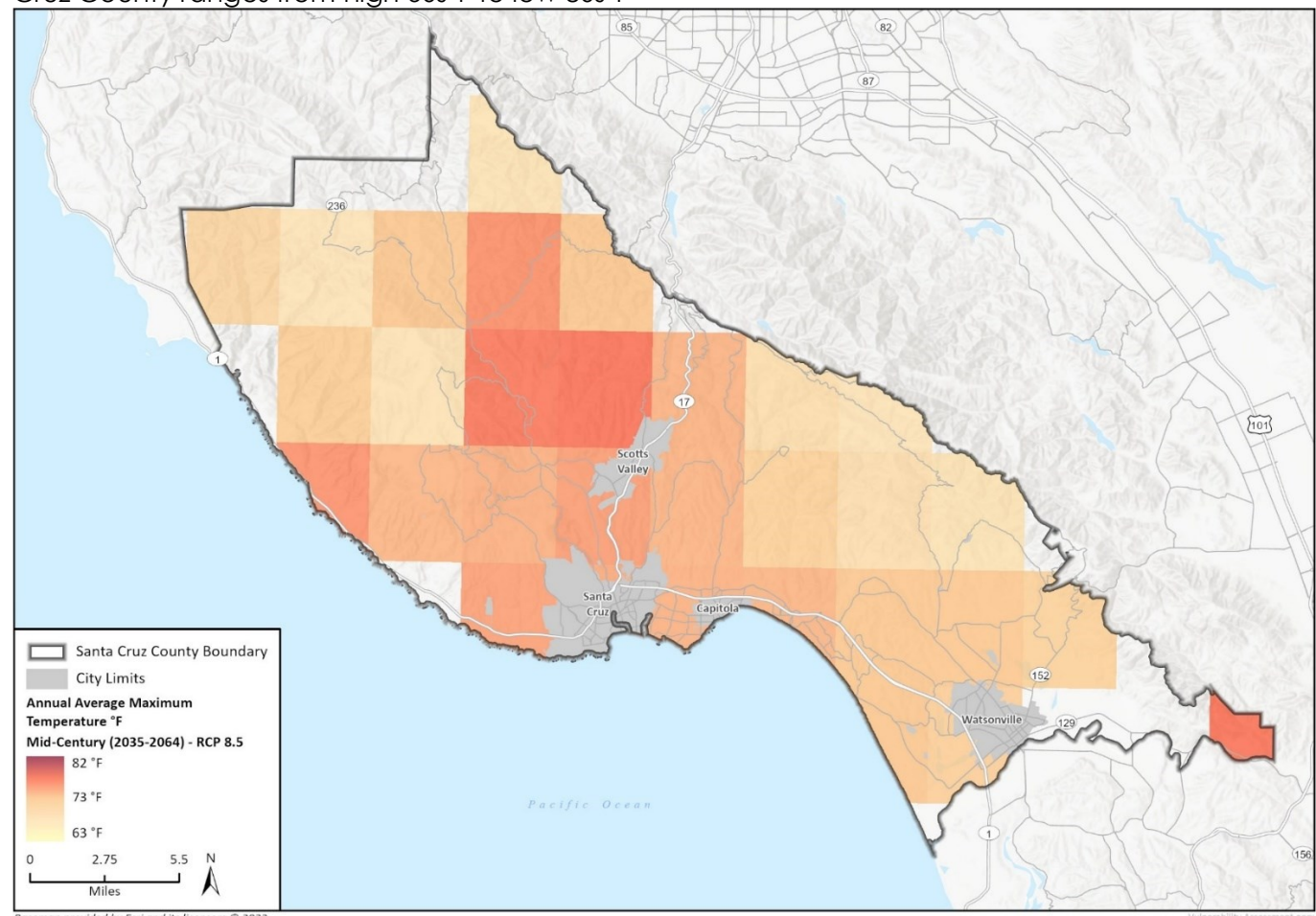
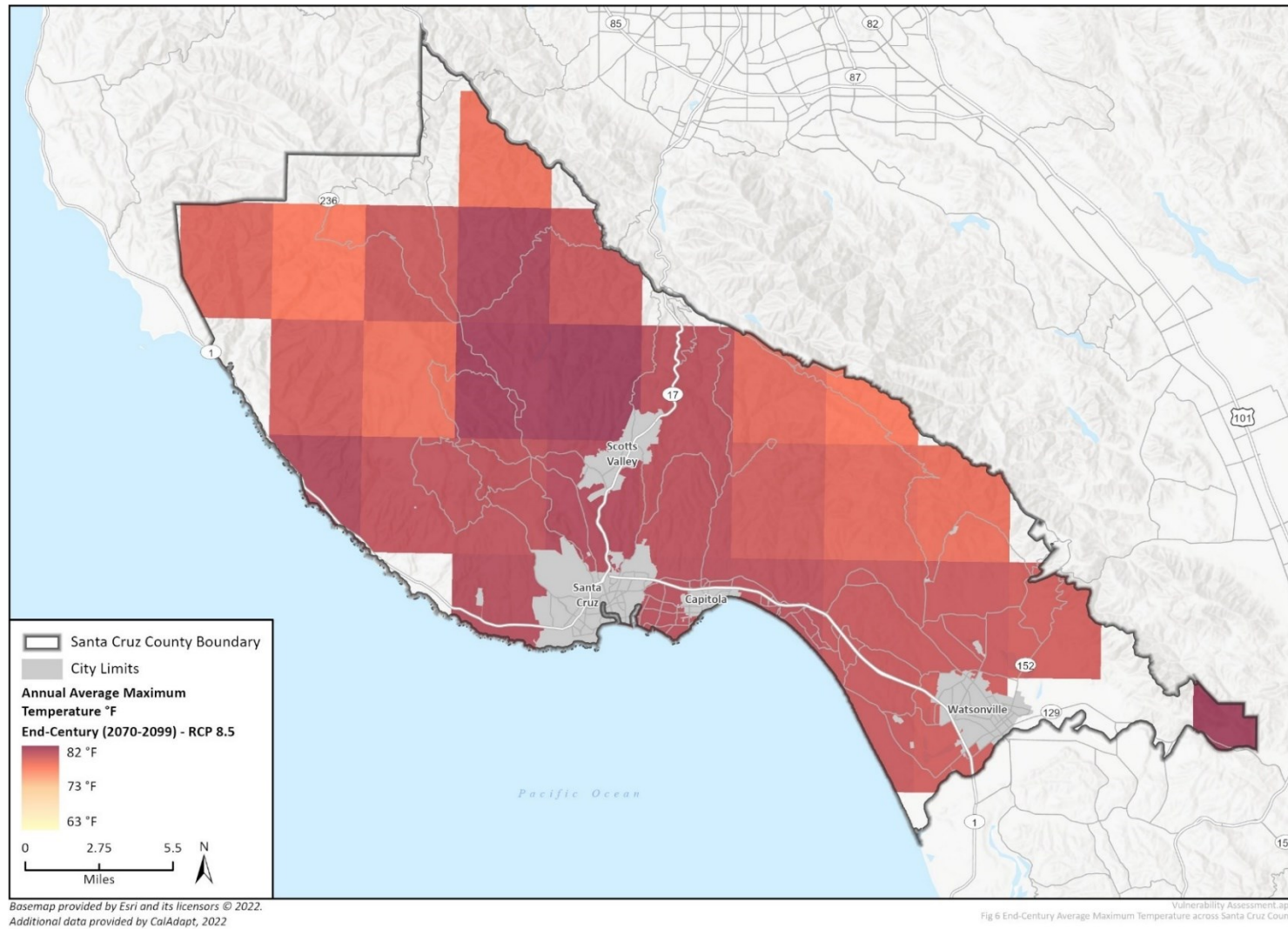


Figure 5 End-Century Maximum Temperature Across Santa Cruz County End-Century maximum temperature across Santa Cruz County ranges from mid 70s°F to 82°F




Precipitation

In the Central Coast of California, precipitation variability is expected to increase substantially (Langridge 2018). Santa Cruz County can expect longer and more frequent dry spells as well as an increase in the number of years with below average rainfall totals. As already observed in recent decades precipitation changes are largely observed as more extreme variability with intensely wet years followed by extreme droughts (Langridge 2018). Santa Cruz County has already experienced damaging extreme precipitation events in 2017 and again in 2021. It is projected that the wettest day every year will increase by up to 35 percent for some Coastal California locations by the end of the century under RCP 8.5 (Langridge 2018). Maximum 1-day precipitation values are projected to increase between 0.2 inch (RCP 4.5) and 0.3 inch (RCP 8.5) by mid-century and between 0.3 inch (RCP 4.5) and 0.6 inch (RCP 8.5) by the end of the century. Changes in precipitation are expected to affect wildfire, drought, fog, landslides, riverine stormwater flooding, and air quality.

Coastal Fog


In Santa Cruz County, summertime coastal fog reduces temperatures, increases water availability, and reduces evapotranspiration and respiration by plants. Fog moisture is transported from the ocean and can provide up to 33 percent of the water received by the neighboring ecosystems. In the county many native species, including coastal redwood trees and the ecosystems beneath their canopy, rely on high summertime fog frequency to maintain their habitat. In the case of salmonids, the moisture provided by fog events prevents streams from drying up, and therefore maintains their habitat throughout the summer. Agriculture depends on coastal fog to reduce summer temperature extremes and to reduce crop demand for water and




Coastal Fog

Summertime coastal fog in Santa Cruz County is expected to decrease, which will have many repercussions on natural and managed resources.


IMPACTS




**HABITAT
HEALTH**



**AGRICULTURE
PRODUCTIVITY**



**AIR
QUALITY**



**SUMMER
TEMPERATURES**

irrigation (Langridge 2018). Changes in air patterns, urban heat, and air quality all can cause changes in fog prevalence. Though future predictions of coastal fog remain uncertain, one mechanistic model projects a 12 to 20 percent reduction in California’s coastal fog occurrence (defined as when the cloud base is estimated to be below 400 meters) by 2070 (Langridge 2018).

2.2 Hazards

This section outlines projected changes for the following climate hazards:



Extreme Heat & Warm Nights



Drought



Wildfire



Landslides



Riverine and Stormwater Flooding



Air Quality



Sea Level Rise

Extreme Heat & Warm Nights

Extreme heat events are defined as days in which the daily maximum temperature exceeds the ninety-eighth percentile value of the historical average (CEC 2021). For Santa Cruz County, the threshold temperature is 90°F (CEC 2021). Increased frequency of extreme heat days can result in increased public health risks through an increase in heat-related and vector-borne illnesses. Particularly vulnerable populations include older adults, young children, and individuals with underlying chronic diseases. Santa Cruz County has historically been buffered by the impacts of extreme heat due to the colder marine and fog influence cooling down evening temperatures and tempering early to mid-morning temperatures. Warm nights will further exacerbate the risk of heat illness because they affect the body's ability to cool after a day of heightened temperatures. Most residents in Santa Cruz County are not equipped with air conditioning to address these events. Santa Cruz County has historically experienced 11 warm nights a year and is projected to experience a mid-century total of 46 nights (RCP 8.5) and an end-century total of 50 (RCP 4.5) to 90 nights (RCP 8.5) (CEC 2021). Extreme heat can also cause damage to roadways, overload electrical grid systems, and result in vegetation die-off or stress.

Extreme Heat & Warm Nights

Santa Cruz County is expected to experience an increase in the number of extreme heat days, from 3 days annually to 9 days by mid-century and 19 days by end-century.

IMPACTS

- CRACKED PAVEMENTS
- GRID OVERLOAD
- VEGETATIVE STRESS
- HEAT RELATED ILLNESS

WARM NIGHTS

Santa Cruz County is expected to experience an increase in the number of warm nights, from 4 nights annually to 46 by mid-century and 90 by end-century.

Drought

Climate change will increase the likelihood that low-precipitation years will coincide with above-average temperature years. Warming temperatures increase seasonal dryness and the likelihood of drought due to decreased supply of moisture and increased atmospheric demand for moisture as evaporation from bare soils and evapotranspiration from plants increases. The increased moisture loss from soils and vegetation amplifies dryness during periods without precipitation. In California’s highly variable climate setting, climate models project less frequent but more extreme daily precipitation, with year-to-year precipitation becoming more volatile and the number of dry years increasing (Langridge 2018). The duration of dry spells is projected to vary depending on which emissions scenario is used. Like precipitation patterns, some of the annual variability is obscured within 30-year averages. Despite this, the clear trend is for maximum lengths of dry spells to increase through the end of century (CEC 2021).

Drought can affect vulnerable populations as well as economic productivity throughout Santa Cruz County and is likely to exacerbate water affordability concerns, through the context of availability, for low-income populations. If groundwater levels drop too far during extended periods of drought, than wells may run dry. Many rural residents are on single well or small water systems that do not have water supply resiliency components built into their maintenance and operations plans. Vulnerabilities for natural resources can include stressed vegetation and habitat depletion(CEC 2018).

Drought

Extreme dry events are projected to occur more frequently, which will increase stress on water resources and the likelihood of drought conditions.

IMPACTS

- VEGETATIVE STRESS
- HABITAT LOSS
- WATER SCARCITY

PRECIPITATION CHANGE

There is a projected increase in year-to-year variability with more intense rain events but fewer total days with precipitation. Annual variability in precipitation will increase resulting in longer and more frequent multi-year periods of reduced water availability.

Wildfire

The occurrences of wildfires have increased significantly within California in frequency and intensity over the past two decades (Langridge 2018). Santa Cruz County is projected to experience increasing wildfire risk through the end of the century. An increase in temperatures and prevalence of drought conditions are projected to result in increased wildfire risk through decreases in ground and ladder fuel moisture levels. Wildfires in the Central Coast region are influenced by wind events, utility infrastructure, topography, humidity, fuel availability, and lightening or other severe weather (Langridge 2018). From 1948 to 2019, 15 wildfires were responsible for burning 61,455 acres in the County. The 2020 CZU Lightning Complex Fire burned a total of 85,509 acres and 1431 structures (County of Santa Cruz 2021).

There are many areas in the County categorized by CAL FIRE as Moderate, High, and Very High Fire Hazard Severity Zones, shown in Figure 6. There are several critical facilities within Moderate and High Fire Hazard Zones including schools and fire stations, sheriff stations, and hospitals. Several roads, highways and significant residential areas are also located within the county's fire hazard zones (County of Santa Cruz 2021). Some areas in the County that border fire hazard zones are considered wildland urban interface areas, which are zones of transition between open space and residential or commercial development. These areas are particularly at risk to damage because they often have significant quantities of vegetative fuels for fire near buildings and facilities that are vulnerable to fire (Langridge 2018). The County is projected to experience an increase in the decadal probability of wildfire by 20 percent by the end of the century (CEC 2021). Overall, there is a higher increase in decadal probability of wildfire under the high emissions scenario compared to the medium emissions scenario, as seen in Figure 7 and Figure 8. Wildfires can create risk of injury, death, or financial hardship if personal property is damaged as well

as phy
 vulner



Wildfire

Santa Cruz County is expected to experience an increase in the number of days with extreme wildfire risk, from 34 days annually to 68 days by mid-century and 96 days by end-century.

IMPACTS



**WORSENING
AIR QUALITY**



**POWER
DELIVERY
DISRUPTION**



**STRUCTURE &
PROPERTY
DAMAGES**



**PUBLIC HEALTH &
SAFETY RISKS**

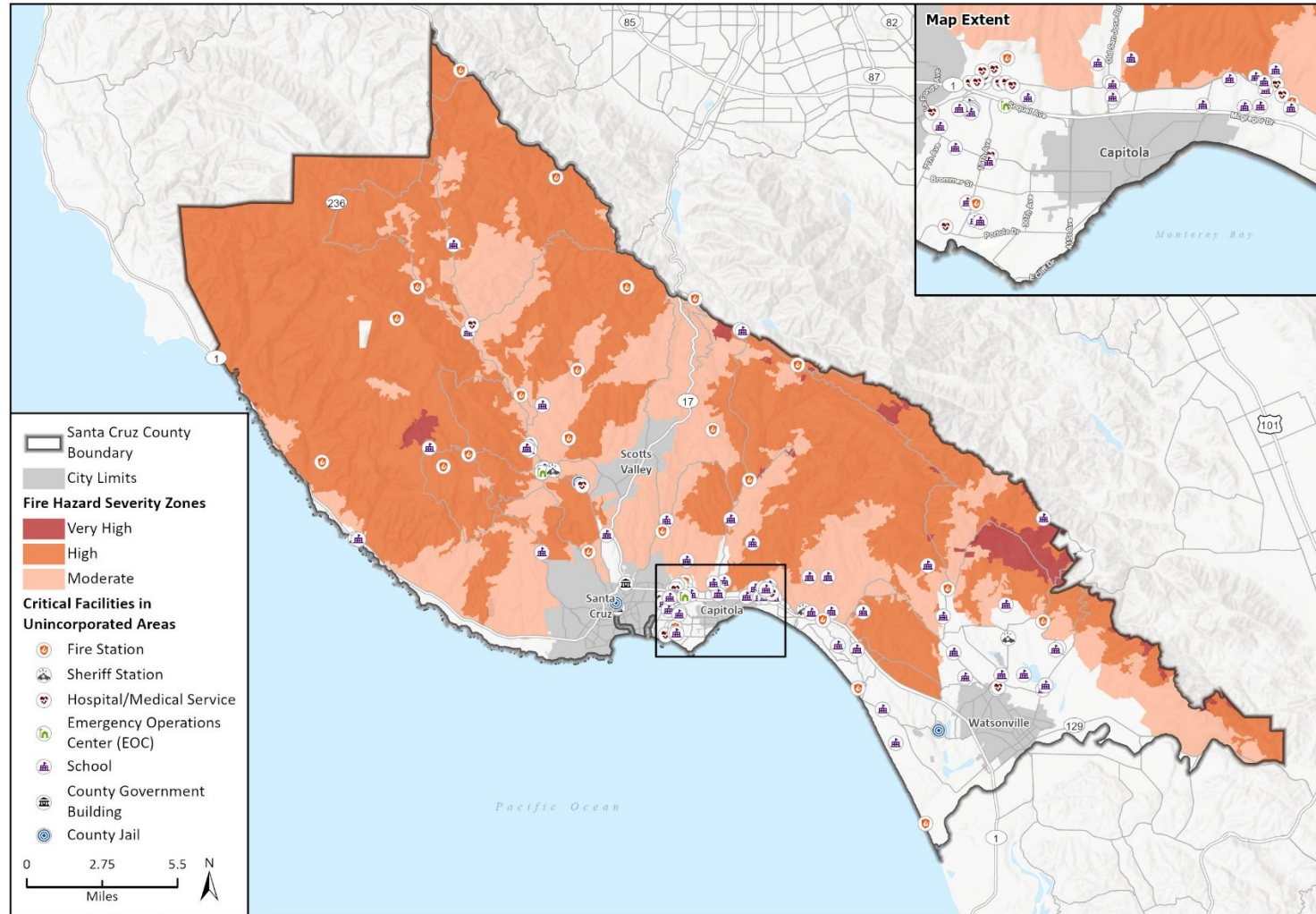


**HABITAT
LOSS**

HISTORIC WILDFIRES

In 2020, the CZU Lightning Complex Fire burned 85,509 acres in Santa Cruz County, making it the largest wildfire in the area on record since 1948.

Figure 6 Fire Hazard Severity Zones in Santa Cruz County Fire Hazard Severity Zones in Santa Cruz County range from moderate to very high and are located throughout most of the county.



Basemap provided by Esri and its licensors © 2022.
Additional data provided by CAL FIRE, 2008; Santa Cruz County Geospatial Data, 2022; Google My Maps, 2022.

Vulnerability Assessment.aprx
Fig 1 Critical Facilities and Fire Hazard Severity Zones in Santa Cruz County

County of Santa Cruz
Climate Vulnerability Technical Compendium

Figure 7 Change in Wildfire Risk (RCP 4.5) Santa Cruz County is projected to experience a decrease in wildfire risk in some areas of the county by end-century under the RCP 4.5 scenario

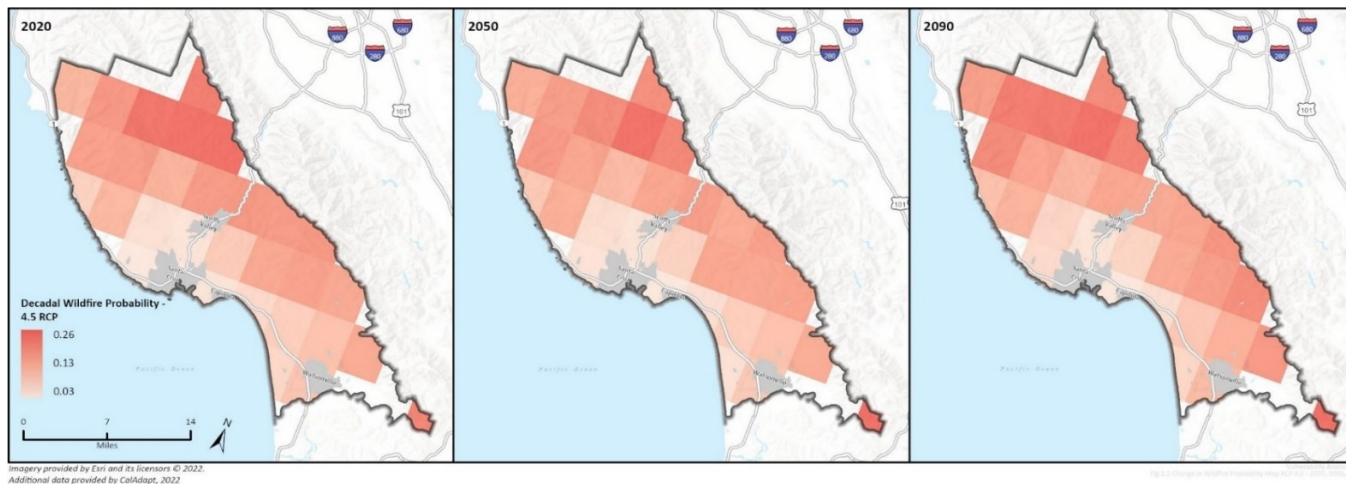
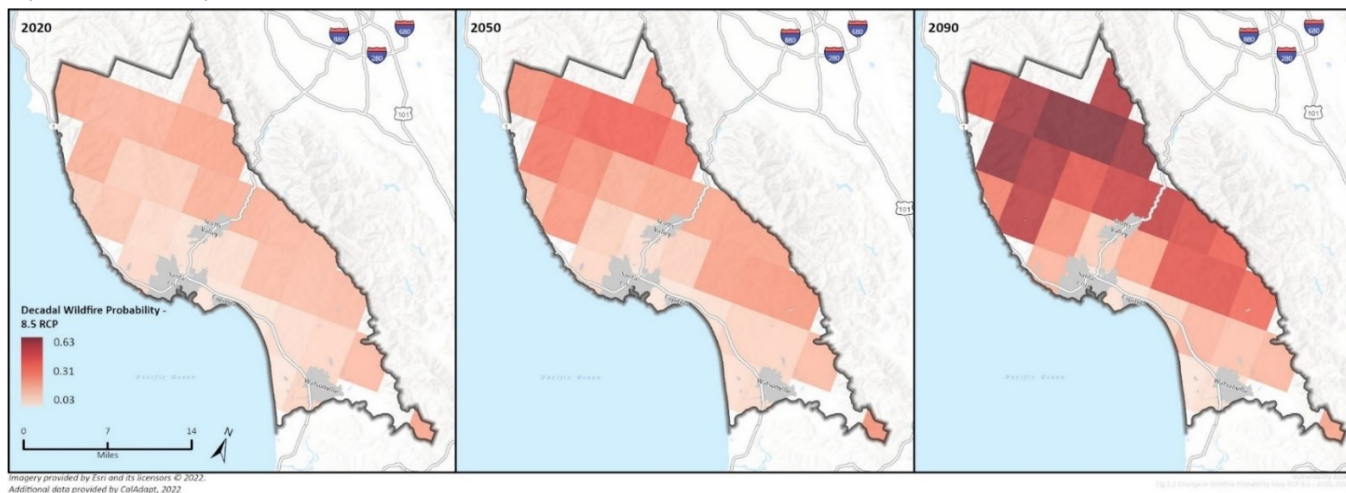


Figure 8 Change in Wildfire Risk (RCP 8.5) Santa Cruz County is projected to see an overall 20 percent increase in wildfire risk by end-century under the RCP 8.5 scenario



Recent Wildfire Event

Santa Cruz County workgroup members highlighted the CZU Lightning Complex fire as a recent severe and impactful climate hazard event. In August 2020, thousands of lightning bolts struck California, starting hundreds of fires in the state. The CZU Lightning Complex fire was initiated from lightning strikes on August 16, 2020. The CZU Complex fire burned through September 22, 2020, destroying over 1,400 buildings, over 86,000 acres across Santa Cruz and San Mateo counties, and killing one Santa Cruz County resident. Several historic buildings in the communities of Boulder Creek, Bonny Doon, Felton, and Swanton were damaged or destroyed from the fire. Big Basin Redwoods State Park also saw severe damage to its ecosystems and visitor's center. Over 70,000 residents were evacuated during the fire event (Santa Cruz County 2021).

Landslides

Susceptibility to landslides is expected to increase as the frequency and intensity of extreme precipitation events and wildfires increase in Santa Cruz County (Langridge 2018). Various factors increase landslide susceptibility in Santa Cruz County including storms, earthquakes, wildfires, erosion, stormwater management infrastructure, vegetation removal, grading, and other human activities. Areas of the county impacted by fires are especially prone to debris flow. Debris flow events are particularly dangerous because they often have little warning during severe storm events and are fast moving. Post-wildfire debris flows are likely to occur in burn scar for between 2-5 years after a wildfire, during significant rainfall events. According to U.S. Geological Survey (USGS) models, there is a very high probability of debris-flows occurring when there is a rainstorm in recently burned areas of the County. The Santa Cruz County Local Hazard Mitigation Plan vulnerability assessment details a wide range of critical facilities at risk to landslides within the County, but 90 percent of the structures are residential (County of Santa Cruz 2021).

Landslide likelihood in the county is based on a range from 1 to 10, with 10 being the highest susceptibility. As seen in Figure 10, susceptibility levels of 8 to 10, are common throughout the county. The regions with the highest susceptibility lie along the Northeastern boundary of the county, throughout the Sequel Demonstration State Forest and down into the Day Valley area. The data used in Figure 10 is from 2015 and therefore does not show the burn scars from the CZU Lightning Fire of 2020. In this region, between Highway 1 and Highway 9, surrounding Big Basin State Park, along East and West Waddell Creek, and along Big Creek, USGS debris-flow models project that there is between an 80 percent and 100 percent chance of a debris flow being triggered by a rainstorm within 3-5 years post-fire, as seen in (USGS 2022).



Landslides

Susceptibility of landslides in Santa Cruz County is projected to grow alongside precipitation changes and wildfire increases in frequency, severity, and acres burned.

IMPACTS



HABITAT
LOSS



PROPERTY
DAMAGE



EROSION



HUMAN
INJURY

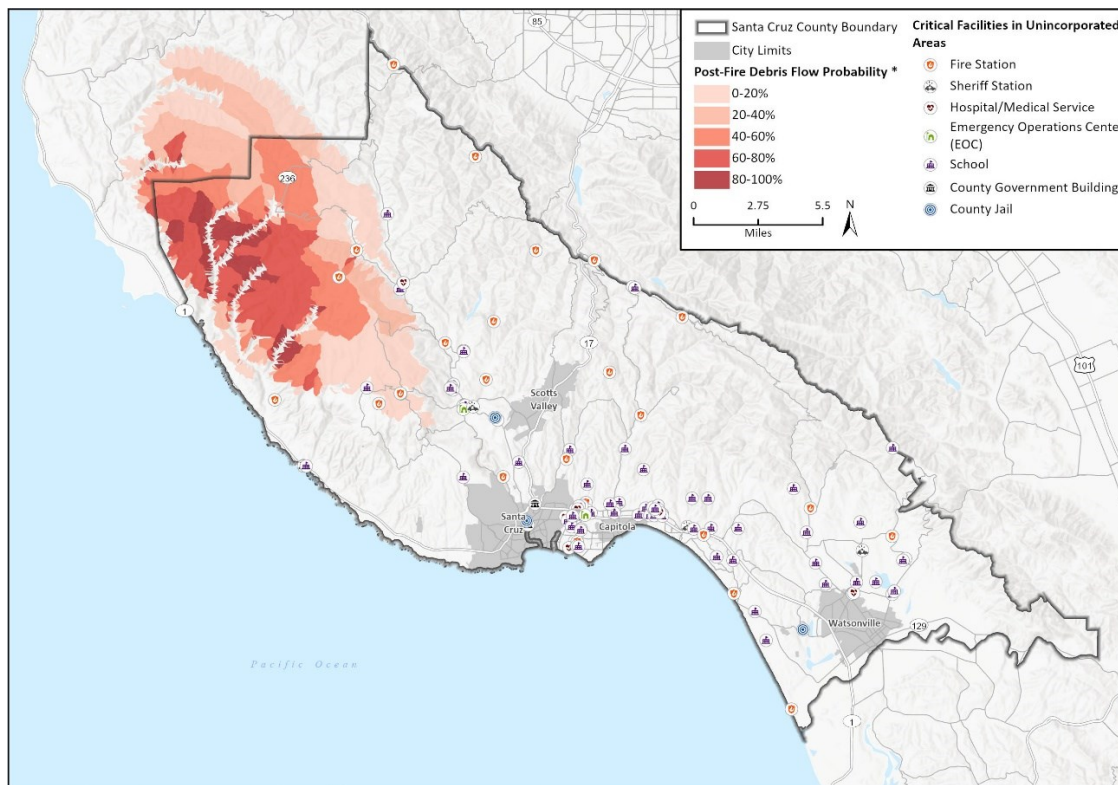
LANDSLIDE HAZARDS

Approximately 27,000 parcels and 8,000 structures are in landslide hazard areas in Santa Cruz County. Overall landslide risk in Santa Cruz has increased since the 2020 CZU Lightning Complex Fire.

Recent Post-Fire Debris Flow Risk

Areas burned by the CZU Lightning Complex fire have experienced heightened risk of debris flow and mudslides. Specifically, during recent heavy wind and rain events in January 2021 and October 2021, evacuation orders were issued to several areas in the Santa Cruz County communities of Ben Lomond, Boulder Creek, and Felton. January 2021 high debris flow risk evacuation orders affected just under 5,000 people (Williams 2021). Post-fire debris flow probability within the CZU Complex fire burn scar are shown in Figure 9.

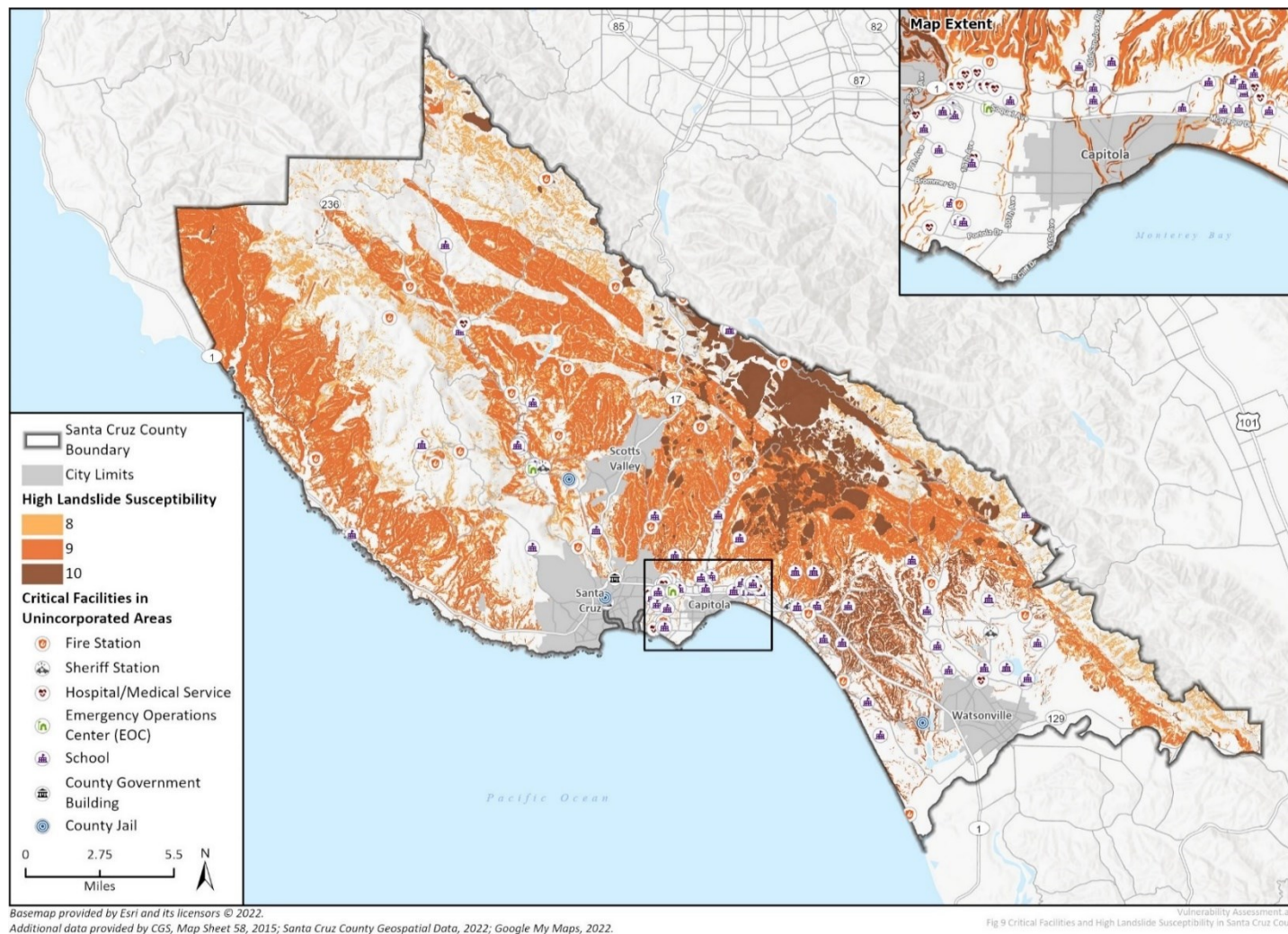
Figure 9 Post-Fire Debris Flow Probability -CZU Complex Fire Post-Fire debris flow probability ranges from 20 percent to 100 percent in the recently burned areas by the CZU Complex Fire



Basemap provided by Esri and its licensors © 2022. Additional data provided by USGS, 2020. Santa Cruz County Geospatial Data, 2022; Google My Maps, 2022.
* Likelihood of a debris flow (%) by drainage basin in response to the design rainstorm with a peak 15-minute rainfall intensity of 24 min⁻¹.

Fig X Critical Facilities and Post-Fire Debris Flow Probability in Santa Cruz County

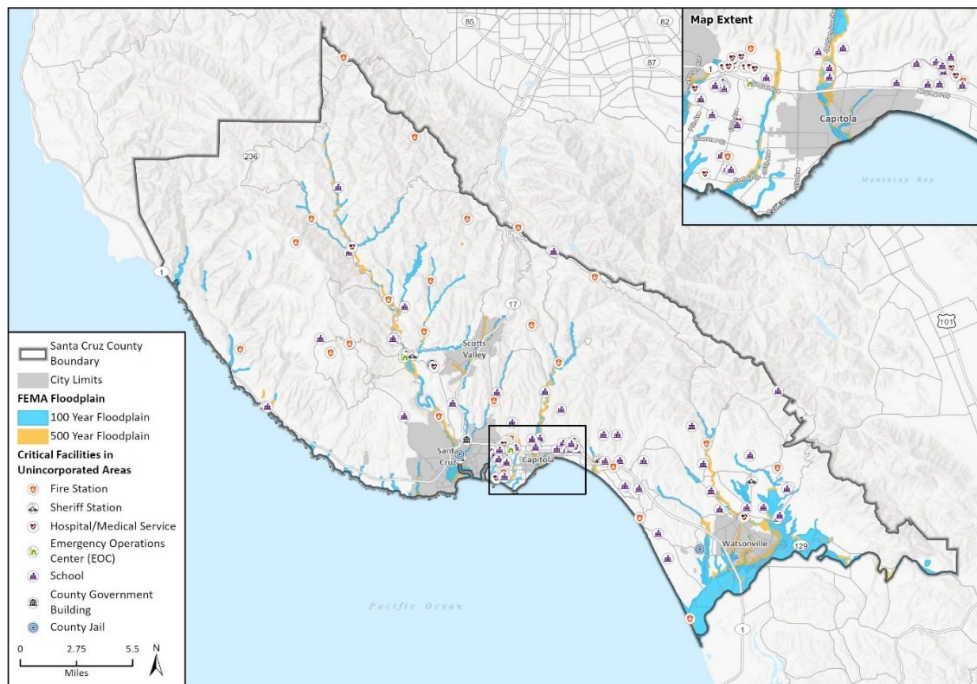
Figure 10 High Landslide Susceptibility in Santa Cruz County High landslide susceptibility areas are located throughout Santa Cruz County, particularly in mountainous and hilly areas.



Riverine and Stormwater Flooding

Low-lying areas throughout Santa Cruz County are expected to experience more frequent flooding as a result of climate change. Riverine flooding is projected to increase as precipitation extremes increase (CEC 2021). Figure 11 displays the 100-year and 500-year FEMA floodplains in Santa Cruz County. Stormwater systems may be overwhelmed more frequently as more extreme rain events occur, causing localized flooding which could impact properties and close streets. Data from the Santa Cruz County Local Hazard Mitigation Plan identifies over 2,000 1 to 4-unit residential structures, over 200 other habitable structures, and approximately 16,000 permanent Santa Cruz County residents living in flood hazard areas (County 2021). Several schools, fire stations, hospitals, and police stations are located within the flood plains, as shown in Figure 11. Flooding impacts create physical damage directly through inundation (Langridge 2018). Flooding can also trigger cascading impacts to power, water, and wastewater services and stormwater drainage infrastructure which may exacerbate public health concerns for vulnerable populations.

Figure 11 100-Year and 500-Year Floodplains Santa Cruz County 100-Year and 500-Year floodplains in Santa Cruz County are located along the coast and in areas adjacent to waterways.



Basemap provided by Esri and its licensors © 2022.
Additional data provided by FEMA, 2021; Santa Cruz County Geospatial Data, 2022; Google My Maps, 2022.

Map Extent
Capitola
Monterey Bay
Fig. 3 Critical Facilities and FEMA Floodplain in Santa Cruz County

Air Quality

In Santa Cruz County, good ambient air quality is typically maintained by the mountains and breezy coastal environment. However, the San Lorenzo Valley and other inland areas can experience poor air quality more frequently due to a lessening coastal wind influence and local topography (County 2021). Worsening air quality due to climate change can create respiratory issues for vulnerable populations and impact indoor areas without adequate air filtration systems. There are several types of air quality decline sources found below:

- **Dust.** Dry, dusty conditions also associated with drought and increased evaporation (Langridge 2018).
- **Smog.** Increases in ambient temperature can lead to higher rates of smog also referred to as ozone. Ground-level ozone specifically will be experienced at higher rates leading to raised cardiovascular and respiratory morbidity and mortality rates (California Department of Public Health [CDPH] 2014). Ground-level ozone has also been shown to have particularly disproportionate adverse impacts on populations experiencing homelessness and lower median income (Proceedings of the National Academy of Sciences of the United States of America 2021). Santa Cruz County is expected to experience increases in ozone concentrations in tandem with temperature increases.
- **Wildfire Smoke.** Temperature, severe wildfire conditions, and the area burned by wildfires throughout the state has increased and will continue to increase. Higher temperatures accompanied by an increase in the incidence and extent of large wildfires will lead to increased wildfire smoke and associated toxins and air pollution (Langridge 2018). Poor air quality can force school and business closures and limit healthy outdoor activity (County 2021).

Air Quality

Air quality is expected to worsen in Santa Cruz County due to extended droughts, more frequent wildfires, increased ambient temperatures, and variable natural filtrations of fog and wind.

IMPACTS

RESPIRATORY HEALTH PROBLEMS

VEGETATIVE STRESS

TYPES OF AIR QUALITY HAZARDS

DUST

SMOG

WILDFIRE SMOKE

Sea Level Rise

Sea level rise can negatively impact the coastal area of Santa Cruz County through related hazards including tidal inundation, coastal storm flooding, coastal erosion, and dune erosion. Tidal inundation occurs when sea level rises (due to storm events or climate change) and high tide events become co-occurrent, allowing water levels to reach higher points on beaches, and occasionally cause localized coastal flooding or our low-lying areas. Coastal storm flooding, also known as storm surge, refers to the phenomena of water rising to abnormal and unpredicted elevations during a storm. When coupled with high tide, storm surge can cause extreme flooding and coastal erosion. The Santa Cruz County coastline is dominated by sandstone cliffs which are susceptible to cliff erosion. When sea level rise in the County has the potential to negatively impact both private and public infrastructure including the wastewater treatment plant, sewer infrastructure, coastal transport infrastructure, critical facilities including fire stations and schools, the county jail, oceanfront residences, and commercial properties.

level rise causes waves to break against the base of the cliffs, it can cause the cliff face to become unstable and to erode. In Santa Cruz County, dunes provide protection to agricultural fields, residences, and commercial areas from sea level rise related hazards in the southern part of the County. When sea levels rise, dunes are not able to function naturally and can more easily be eroded, leading to more tidal inundation, slope stability for coastal bluff top development and coastal flooding (County 2017).

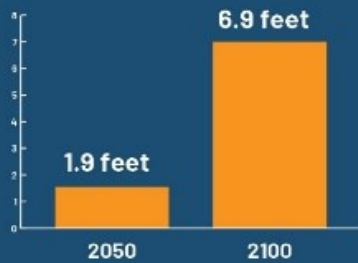
Sea level on the California Coast rose approximately 8 inches between 1900 to 2005, and climate change is expected to increase the rate of sea level rise dependent on the extent of warming temperatures (County 2021). As seen in



Sea Level Rise

The projected sea level rise within Santa Cruz County is expected to affect the community creating moderate to high vulnerability for all coastal assets by end-century.

IMPACTS



SEA LEVEL RISE RELATED HAZARDS

- Tidal Inundation
- Coastal Storm Flooding
- Coastal Erosion
- Dune Erosion

VULNERABLE ASSETS



AGRICULTURAL
FIELDS



BEACHES



RESIDENCES



COMMERCIAL
AREAS

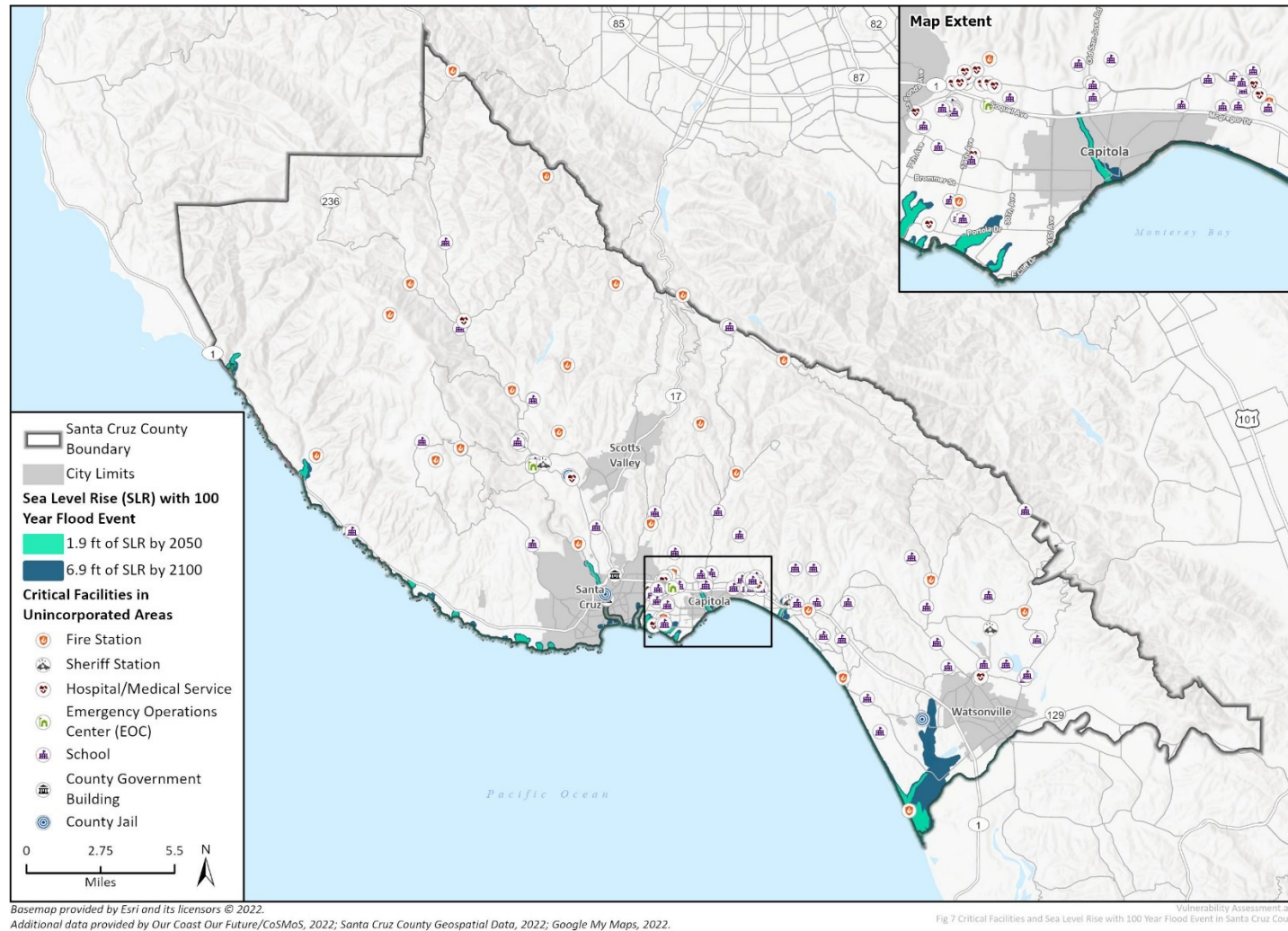


CRITICAL
FACILITIES



ROADWAYS

Figure 12 Sea Level Rise through 2050 and 2100 Santa Cruz County is expected to see 1.9 feet and 6.9 feet of sea level rise by 2050 and 2100, respectively



3 Community Assets and Services at Risk

Populations and assets are affected by climate change depending on their sensitivity to climate hazards. This section identifies sensitive populations and assets within Santa Cruz County. Potential impacts from the climate hazards of concern on sensitive populations and assets are presented in the Vulnerability Analysis. Assets are grouped in the following manner:



Vulnerable Populations



Buildings and Critical Facilities



Natural Resources



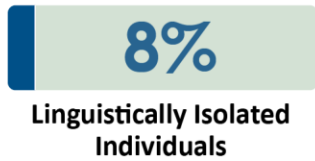
Infrastructure and Services



Managed Resources

3.1 Vulnerable Populations

While all people in our community will experience climate change, some may be disproportionately more affected than others. For example, older adults and young children may be more at-risk to heat illness during an extreme heat event. Many factors can influence sensitivity to climate hazards including an individual's health, age and ability, societal disadvantages, access to health care, economic opportunity, education and other resources, access to basic needs, and exposure to environmental stressors (Cal OES 2020). The most vulnerable populations experience a heightened risk to climate change and have fewer resources to adapt and recover from climate change impacts. Following guidance from the Southern California Association of Governments Adaptation Planning Guide, vulnerable population groups were identified for Santa Cruz County (SCAG 2020). Santa Cruz County has a number of vulnerable populations listed below that may disproportionately experience the impacts of climate change.



30%
Renters



11%
Outdoor
Workers



4%
Households
Without Access
to a Vehicle



23%
Single Female Head
of Households



9%
Individuals Without a
High School Degree



Households
Without a
Computer



Households
Without Broadband
Internet



Individuals
Without Health
Insurance



Unemployed
Individuals

\$103,000

Median Household
Income in Santa
Cruz County

27%



5%



Children

21%



Have
Disability

39%



Have
Asthma

13%



Have
Coronary Artery
Disease

6%



Military Veterans

Social Sensitivity Index Score

A social sensitivity index was created to understand where vulnerable population groups are present in concentrated numbers in Santa Cruz County. The social sensitivity index was developed using 25 data indicators. Each indicator represents a characteristic that increases a person's sensitivity to climate hazards. The indicators represent characteristics that increase a person's physiological sensitivity to climate hazards, the ability of an individual to prepare for, cope with or recover from climate hazards, or a combination of both. There are 11 categories of social sensitivity indicators, as seen below.

1. Age: seniors and children
2. Language and Nation of Origin: linguistically isolated, undocumented individuals
3. Occupation: outdoor workers, unemployed, military veterans
4. Education: individuals with educational attainment of less than 4 years of high school
5. Housing: people experiencing homelessness, displaced individuals, renters
6. Income: low income, single female heads of households
7. Race and Ethnicity: non-white communities, American Indians, Tribal and indigenous communities
8. Transportation: individuals without access to a vehicle
9. Access to Technology and Information: households without broadband internet, households without a computer, geographically isolated individuals
10. Health: individuals with disabilities, individuals with asthma, individuals with cardiovascular disease, individuals without health insurance
11. Non-Residents: visitors

The above indicators were used to assess the geographic spread and proportion of vulnerable populations within the County who may be disproportionately sensitive to climate hazards. Data for these indicators was obtained from the Census Bureau's ACS 2015-2019 and the CDC's PLACES Health Data. Each population type was identified as present in a census tract within unincorporated Santa Cruz County and given a score of 1 if the population indicator value exceeded the relative state average value (e.g., the statewide average for households without broadband internet is 13 percent, if the census tract had an average greater than 13 percent, it would receive a score of 1). If the population indicator equaled or was less than the state average value, a score of 0 was applied. Once each population type was scored for all unincorporated census tracts in Santa Cruz County, the scores were totaled. Low, moderate, and high social sensitivity rankings were assigned to each census tract depending on the total score (see Table 3). If a census tract had a score of 4 or less, the census tract was ranked as having a low social sensitivity. If a census tract had a score of 5-9, the census tract was ranked as having a moderate social sensitivity. Lastly, if a census tract had a score of 10-14, the census tract was ranked as having a high social sensitivity. Table 3 summarizes the social vulnerability scoring range for the unincorporated census tracts.

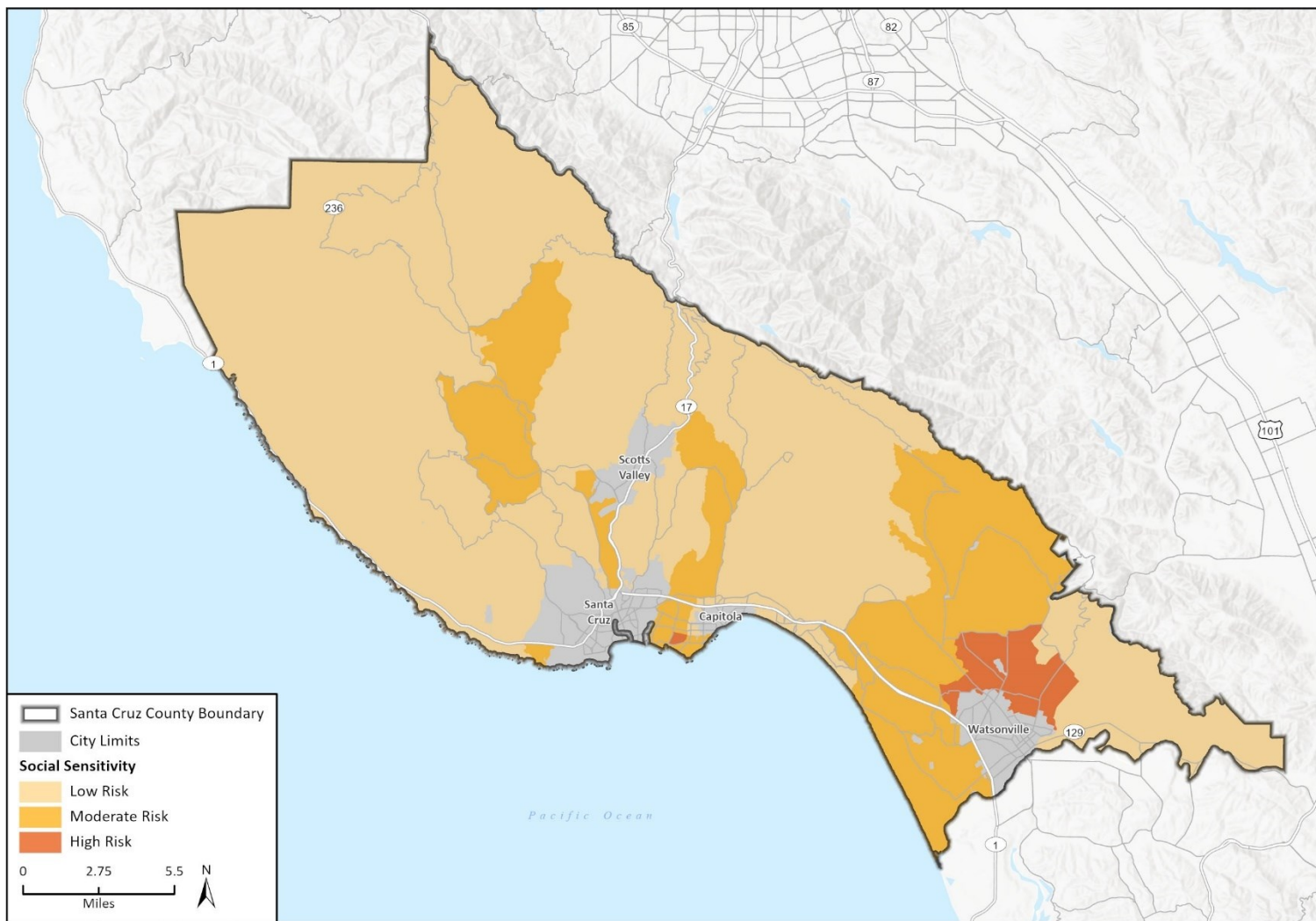
Table 3 Social Sensitivity Ranking

Social Vulnerability Rank	Score Range	Number of Census of Tracts
Low Risk	1-4	9
Moderate Risk	5-9	15
High Risk	10-14	11

Figure 13 displays social sensitivity in unincorporated Santa Cruz County by census tract. Overall, the majority of unincorporated Santa Cruz County is ranked as low or moderate social sensitivity, with some areas ranked as high. The most sensitive populations in the County are in the areas surrounding the city of Watsonville, north of the city of Soquel between Soquel San Jose Road and North Rodeo Gulch Road, and in some parts of the Live Oak region. Most moderate risk populations are in south Santa Cruz County, north of the City of Watsonville, with others located in the Ben Lomond and Scotts Valley areas.

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Figure 13 Social Sensitivity in Santa Cruz County Santa Cruz County populations have a range of low to high social sensitivity with communities around Watsonville scoring highest in social sensitivity.



Basemap provided by Esri and its licensors © 2022.
 Additional data provided by CDC, 2015; U.S. Census Bureau, 2021.

Vulnerability Assessment.aprx
 Fig X Social Sensitivity in Santa Cruz County

3.2 Physical and Service-Related Assets

Santa Cruz County assets, as summarized in Table 4, were identified consistent with the asset grouping and list of assets detailed in the Cal APG based on information from the County of Santa Cruz Local Hazard Mitigation Plan and Santa Cruz County General Plan (County 2021, County 1994). A discussion of impacts to these assets is provided in the Vulnerability Analysis, along with figures identifying locations of assets in relation to climate hazards.

Table 4 Assets, Descriptions, and Asset Managers in Santa Cruz County

Asset	Type	Examples
Natural Resources	Biodiversity and Habitat	Nearshore reefs, rocky intertidal areas, sea caves, islets, offshore rocks, kelp beds, marine mammal hauling grounds, sandy beaches, shorebird roosting, resting and nesting areas, cliff nesting areas and marine wildlife or educational research reserves. Dune plant habitats. All lakes, wetlands, estuaries, lagoons, streams and rivers. Riparian corridors.
	Parks and Recreation	Santa Cruz Gardens County Park, Winkle Farm County Park, Chanticleer County Park, Jose Avenue County Park, Hestwood County Park, Twin Lakes County Park, Felt Street County Park, Brommer Street County Park, Coffee Lane County Park, The Hook County Park, East Cliff County Parkway, Pleasure Point County Park, Moran Lake County Park
	Surface Water	Corcoran Lagoon, Moran Lake, Pajaro River, Corralitos and Salsipuedes creek, San Lorenzo River; Aptos Creek, Scott Creek, San Vicente Creek, Valencia Creek, Soquel Creek, Branciforte Creek
	Critical Habitats	Aquatic habitat of the steelhead, Cojo salmon, monarch butterfly, long-toed salamander, California red-legged frog
Managed Resources	Agriculture	Berries, flowers, greens, and nursery stock, vegetables, apples, wine grapes, tree and vine fruit, livestock
	Timber	Commercial timberlands, primarily for Christmas trees and forest products
	Forestry	Public access for outdoor recreation, grazing lands, timber production, wildlife habitat and connectivity
	Rangelands	Beef cattle and calves, sheep, horses, and mules, irrigated and dryland hay (field crops)
Buildings and Critical Facilities	Commercial Buildings	City of Santa Cruz, Watsonville, Capitola, and Scotts Valley downtown and retail areas
	Industrial Facilities	Lumber yards, rock quarries, manufacturing
	Residential Buildings	Single-family homes mostly throughout the County (64.4%), while UC Santa Cruz infrastructure
	Hospitals	Dominican Hospital, Watsonville Community Hospital
	Healthcare Facilities	Youth centers, children’s services, support groups, physical therapy, massage and yoga, behavioral and mental health services, senior services, adult protective services

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Asset	Type	Examples
	Public Housing	Section 8 Services, senior affordable apartments
	Public Buildings and Institutions	Preschools, elementary districts, high schools, adult school, community day school, community college, University of California Cooperative Extension, after school programs
	Historic and Cultural Assets	Capitola Historical Museum, Santa Cruz Mountain Arts Center, Central Ranch, Northern Reach, Watsonville Reach, Mission Santa Cruz, Rancho San Andres Castro Adobe State Historic Property
	Government Buildings	Town and City Halls; County Jail; Sheriff's Headquarters
	Police and Sheriff Stations	Santa Cruz County Sheriff's Office
	Fire Stations	39 stations dispersed throughout the County
Infrastructure and Services	Airports	1 public airport in Watsonville and a few private airports
	Communication	Radio facilities, cellular and radio towers, fire cameras and lookouts, and repeaters
	Energy Infrastructure	Pacific Gas & Electric transmission lines
	Public Transit	Santa Cruz Metro/bus line; Amtrak train stations connecting to San Jose; Santa Cruz Trolley; Greyhound Santa Cruz
	Roads and Highways	1, 9, 17, 129, 152, and 236
	Solid and Hazardous Waste Management	Solid waste and transfer stations
	Wastewater Treatment/Water Supply/Water Suppliers	Sanitation Division of Santa Cruz County, Essential Operations, Inc, City of Santa Cruz Water Department, residential wells, Newell Creek Dam

4 Vulnerability Analysis

The following section outlines the impacts each climate hazard has on community assets and services, as identified in the Community Assets and Services at Risk section. Existing plans, policies, and programs that contribute to the adaptive capacity are summarized throughout. A detailed summary of the County's adaptive capacity can be found in Appendix A: Adaptive Capacity. An impact score and an adaptive capacity score is identified for each asset by climate hazard, along with an overall vulnerability score consistent with the scoring methodology described in the Vulnerability Assessment Methodology. Medium vulnerability scores will be reviewed and assessed during the August 17, 2022, Santa Cruz County workgroup meeting.

4.1 Vulnerable Populations

Overview

As climate change impacts continue to occur, virtually all populations in our community will be affected. However, some individuals are more sensitive and therefore, will be disproportionately impacted depending on the climate hazard and type and magnitude of sensitivity. Based on the social sensitivity map (Figure 13) provided in the Community Assets and Services at Risk section, the most sensitive populations in the county reside in the areas surrounding the city of Watsonville, north of Soquel Village between Soquel San Jose Road and North Rodeo Gulch Road, and in some parts of the Live Oak region. Most moderate risk populations are in south Santa Cruz County, north of the City of Watsonville, with others located in the San Lorenzo Valley and Scotts Valley areas. Some of these areas are projected to experience the highest extreme heat impacts in the County, as seen in Figure 4 and Figure 5. Particularly, the sensitive populations in south Santa Cruz County near Watsonville are located in the FEMA floodplain along the Pajaro River and are at risk of riverine and stormwater flooding, as seen in Figure 11. Most of the moderate and high areas of social sensitivity are located in fire hazard severity zones, as shown in Figure 6.

Vulnerable populations are grouped below according to a variety of social sensitivity indicators, as outlined in the social sensitivity score section in this assessment. Vulnerable populations were grouped based on potential exposure to climate hazards, access to resources to prepare, cope with, or recover from climate hazards, whether individuals face societal disadvantages, or if individuals have health conditions or health sensitivities that leave them vulnerable to climate hazards. Often individuals have characteristics that make them vulnerable in a variety of ways. However, for the purpose of this assessment, they were grouped based on the sensitivity that increases their risk the most. Compounding sensitivities are further explained for each vulnerable population in the grouping overviews and climate hazard impact sections.

Evacuation Challenges

Santa Cruz County workgroup members reported significant challenges during the CZU Complex Fire evacuations. Evacuations of geographically isolated communities proved logistically difficult and lacked organizational cohesion. Additionally, evacuation protocols lacked a systematic approach to designating and aiding vulnerable populations, including disabled individuals, older adults, and those with chronic health conditions, during the evacuation process. Therefore, these population groups experienced heightened health and safety risks during the wildfire event. Significant communication challenges also arose during the CZU Complex Fire evacuations. County residents who did not sign up for Code Red, the county's emergency communication platform, did not receive emergency or evacuations communications. Residents had to rely on social media or trusted community voice websites to get fire location updates and general information. Before the fire, there was no designated centralized resource for information, which caused general confusion and disorganization during evacuations (Santa Cruz County 2021).

Individuals with High-Outdoor Exposure

- People experiencing homelessness
- Outdoor workers
- Displaced Individuals
- Visitors

Sensitivity Overview

Outdoor workers and people experiencing homelessness face high-outdoor exposure, causing them to be more affected by climate hazards than the general population. Santa Cruz County outdoor workers are employed in a variety of fields including timber, agriculture, and construction. Santa Cruz County has also seen an increase in displaced individuals who have had to relocate due to recent wildfires in the region. Many of these individuals may currently live in substandard mobile or motor homes and tents and face high exposure to climate hazards. In addition, Santa Cruz County now has one of the highest per-capita homelessness rates in the state and a total of 2,167 people in 2019 (York 2021). Underhoused and unhoused individuals often suffer from high rates of respiratory conditions, mental illness, and other chronic health conditions and therefore are more subject to climate hazards (CDPH 2020). Santa Cruz County is also a popular tourist destination with many visitors to coastal beaches and the redwoods. Visitors are at risk because they may not receive warning during emergency events and are more likely to be unsure of how or where to receive help. Visitor deterrence, which could occur during and following climate hazards, would have a notable negative impact on the local economy (Gamble et al. 2016).

Potential Impacts

Extreme Heat

Outdoor workers, people experiencing homelessness, and displaced individuals are at risk to health impacts from extreme heat. Outdoor workers, including farmworkers, construction workers, roofers, and landscapers, are often subject to strenuous work conditions and are vulnerable during extreme heat events. People experiencing homelessness and displaced individuals are exposed to the health-related impacts associated with extreme heat because they have limited access to shelter and air conditioning. The primary health impacts to these populations are heat-related illnesses, such as heat stress, heat stroke, and dehydration, which can be life-threatening (CDPH 2020). Visitors are particularly at risk during extreme heat events because they may not be keyed into local heat warning communications and are less likely to know where to seek refuge.

Recent Extreme Heat Impacts

Santa Cruz County workgroup members highlighted the impacts recent extreme heat events have had on outdoor workers, displaced individuals, and people experiencing homelessness in the county. There is a lack of cooling centers and resources in the county to relieve outdoor workers, displaced individuals, and people experiencing homelessness from exposure to extreme heat conditions. Workgroup members noted that there is a growing concern regarding increase of heat related illness, particularly to individuals with high outdoor exposure.

Drought

Unless there are major water shortages in the county, individuals with high outdoor exposure are most likely not at disproportionate risk to drought.

Wildfire

Some outdoor workers, including firefighters and emergency personnel, may be exposed to hazardous work conditions during wildfire events and may become injured from smoke inhalation or burns. People experiencing homelessness and displaced individuals are particularly at-risk during wildfire events as they often suffer from respiratory conditions, mental illness, and chronic health conditions that may be exacerbated from physical contact with wildfire or poor air quality. People experiencing homelessness have limited access to shelter and do not have access to transportation to evacuate from smoke engulfed areas. (CDPH 2017). Displaced individuals or people experiencing homelessness living in public parks and open space areas are particularly at risk to wildfires and may face logistical obstacles when seeking to evacuate. Visitors may not have access to emergency public health warnings and may not know of appropriate evacuation routes or where to get emergency

evacuation information in the event of a wildfire. Additionally, wildfire risk may deter visitors, impacting Santa Cruz County's economy (Gamble et. al 2016).

Landslides

Landslide risk specific to people with high-outdoor exposure is relatively consistent with the general population. landslides susceptibility may deter visitors, which may have a negative impact on the economy (Gamble et. al 2016).

Riverine and Stormwater Flooding

Outdoor workers may be exposed to hazardous work conditions during severe sea level rise storm surge events and therefore, are vulnerable to health impacts (CDPH 2020). Many farmworkers in the county live on farm premises and will also be subjected to flood-related damages to their homes. People experiencing homelessness are disproportionately at risk to health impacts during flood events because they often live in flood hazard areas and do not have access to transportation to evacuate inundated areas. They may also have their personal belongings destroyed or damaged during a flood event (Ramin & Svoboda 2009). Impacts of flooding are likely to result in minimal impact to visitors (Gamble et. al 2016).

Air Quality

Outdoor workers, displaced individuals, and people experiencing homelessness are disproportionately vulnerable to poor air quality because they tend to spend most of the time outdoors and are therefore, directly exposed to air pollutants (CDPH 2017). These populations may experience exacerbation or development of respiratory diseases and conditions, such as asthma and chronic obstructive pulmonary disease, and respiratory infections, which in some cases may be life-threatening (Ramin & Svoboda 2009). Poor air quality events or conditions may deter visitors, impacting Santa Cruz County's economy (Gamble et. al 2016).

Sea Level Rise

Outdoor workers, particularly farmworkers working along the coastline, may be exposed to hazardous work conditions during sea level rise storm surge events and are vulnerable to health impacts (CDPH 2020). In Santa Cruz County, dunes provide protection to agricultural fields, residences, and commercial areas from sea level rise related hazards. When sea levels rise, dunes are not able to function naturally and can become eroded, leading to more tidal inundation and coastal flooding (Santa Cruz County 2017). Many farmworkers in the county live on farm premises and will therefore also be subjected to flood-related damages to their homes. Impacts of sea level rise are likely to result in direct impact to visitors, though disappearing beaches may deter or inhibit visitors, impacting the county's economy (Gamble et. al 2016).

Adaptive Capacity

There are existing plans, policies, and programs in place to help individuals with high-outdoor exposure mitigate and adapt to climate hazards particularly around extreme heat and wildfire.

- **Cal/OSHA Heat Illness Prevention Program:** aims to reduce the potential for heat illnesses by making workers within the county aware of heat illnesses, ways to prevent them, and actions to take if symptoms occur. The program specifically addresses vulnerabilities to outdoor workers (California State Department of Industrial Relations).
- =
- **Santa Cruz County Department of Public Works, Flood Control Division:** uses science-based information and technology to reduce flood risk and to inform emergency managers and the public of real-time flooding potential during storms.
- **Santa Cruz Office of Response, Recovery, and Resilience Evacuation Guidelines:** hosts a website which provides wildfire safety recommendations and evacuation guidelines for the residents of Santa Cruz County (Santa Cruz County 2022).
- **Santa Cruz County Community Emergency Response Team:** trains volunteers in basic first aid, light search and rescue, and small fire suppression, and are closely associated with Santa Cruz County Fire Department (County of Santa Cruz 2021).
- **County of Santa Cruz Master Emergency Services Plan:** provides guidance around response procedures in the event of a large-scale emergency or disaster in the unincorporated areas of the county. The plan provides recommendations on disaster response in jurisdictions both within and outside of the unincorporated areas of Santa Cruz County and acknowledges that emergency planning must consider outdoor workers (County of Santa Cruz 2015).

Vulnerability Score

Climate Hazard	Impact Score	Adaptive Capacity Score	Vulnerability Score
Extreme Heat/Warm Nights	High	Medium	4-High
Drought	Low	Low	3-Medium
Wildfire	High	Medium	4-High
Landslides	Low	Low	3-Medium
Riverine and Stormwater Flooding	Low	Low	3-Medium
Air Quality	High	Low	5-High
Sea Level Rise	Low	Low	3-Medium

Under-Resourced Individuals

- Low income
- Unemployed individuals
- Single female heads of household
- Individuals without health insurance
- Households without a computer
- Households without broadband internet
- Individuals with educational attainment of less than 4 years of high school
- Geographically isolated individuals
- Individuals without access to a vehicle
- Renters

Sensitivity Overview

Under-resourced individuals often do not have access or the ability to afford resources needed to prepare for, cope with, and recover from climate change impacts. Individuals who are unemployed, underemployed, housing insecure, or are low-income often face financial barriers when preparing for and recovering from climate change hazards. Individuals in these groups often live in homes that are less protected against climate hazards. Low-income individuals may not be able to take time off work to address health concerns either caused by or exacerbated by climate hazards. Geographically isolated individuals may face particular hardship because they may not have access to or may have to travel far distances to receive access to critical services and medical assistance.

Individuals with educational attainment of less than 4 years of high school have lower earning potential than those with a high school diploma and those with a 4-year college degree. These individuals are more likely to work in outdoor and/or labor-intensive environments (CDPH 2017). Individuals in this group are less likely to have access to transportation, healthcare, and other basic needs. Under-resourced individuals often lack the financial resources to evacuate from a climate hazard and/or find an affordable place to evacuate to.

Single female heads of households, defined by the U.S. Census as female householders with children under 18-years-old and no spouse/partner present, often face high levels of work-life conflict and financial hardship, which can make preparing for, coping with, and recovering from climate hazards difficult. They are also more likely to serve as the primary caretaker of children which can make evacuating during a hazard scenario difficult (Flanagan et al. 2011). Additionally, women's wages tend to be lower than their male counterparts. According to U.S. Census Bureau data, in 2020, women earned 84 percent of what men earned (Pew Research Center 2021).

Households without a computer or broadband internet may not receive emergency alerts or governmental guidance before or during a climate hazard event, making them particularly vulnerable in evacuation scenarios. According to national Census Bureau data, more than one in six people in poverty had no internet access in 2019. Low-income individuals are more likely to not have access to broadband internet, limiting their ability to work from home during hazardous climate conditions or access emergency information (U.S. Department of Health & Human Services 2021). Individuals without health insurance are more likely to have undiagnosed pre-existing health conditions which may make them more vulnerable to health impacts from climate hazards (Gamble et al. 2016). Individuals who rent housing have limited ability to weatherize their homes for hazard events. They also may not have temperature control in their housing units and generally experience a higher water and energy utilities cost burden than homeowners (Cooley et al. 2012).

Potential Impacts

Extreme Heat

Under-resourced individuals may not be able to pay for adequate air conditioning or fans, increasing their exposure to extreme heat. Geographically isolated individuals and those who do not have access to a vehicle may have trouble traveling to cooling centers or moving to temporary shelters during extreme heat event (Cooley et al. 2012). Under-resourced individuals are less likely to receive medical care for illnesses triggered or exacerbated by extreme heat. Households without a computer or broadband internet may not receive heat advisory warnings or governmental guidance, causing them to experience health impacts from extreme heat exposure (CDPH 2017).

Drought

During periods of prolonged drought, under-resourced individuals are more likely to experience the cost burden associated with increased water rates (Feinstein et al. 2017). Additionally, these individuals may struggle to access clean and affordable drinking water if they rely on wells in areas with declining groundwater levels, which may cause dehydration and/or exacerbate underlying health conditions and illnesses (Gamble et al. 2016). Droughts often trigger cascading economic impacts through the agricultural sector, decreasing job availability and leaving low-income individuals particularly vulnerable to financial hardships (Howitt et al. 2015).

Riverine and Stormwater Flooding

Under-resourced individuals may experience injuries or death from high-velocity flooding and are less likely to receive medical treatment (CDPH 2017). Individuals in these groups may experience cost burdens if their belongings and homes are damaged from floodwater inundation. Isolated individuals have limited or no access to a vehicle to evacuate flood hazard areas. Households without a computer or internet may not receive communications and emergency alerts to safely evacuate from hazard areas (CDPH 2020). Renters have limited control over home improvements that may protect against flood damage. Subsequently, they may experience economic and health impacts and a greater loss of

belongings than homeowners (Gamble et. al 2016). Additionally, they are less likely to have insurance to cover their belongings in the case of a flood event (County 2021).

Wildfires

Under-resourced individuals may experience injuries or death from smoke inhalation or burns and are likely to experience financial burden associated with medical treatment (CDPH 2017). These individuals may have their belongings and homes damaged by a wildfire. If this occurs, under-resourced individuals are likely to suffer from the cost burden associated with losses or damage. Households without a computer or internet may not receive communications and evacuations to safely evacuate from hazard areas. Isolated individuals are vulnerable during wildfires because they do not have access to a vehicle to evacuate. Renters have limited control over home hardening and improvements that may protect against fire and smoke. Subsequently, they may experience economic and health impacts and a greater loss of belongings than homeowners (Gamble et al. 2016).

Recent Wildfire Impacts

Santa Cruz County workgroup members highlighted that after the CZU Complex Fire burned through parts of the county, insurance companies have increased rates or, in some cases, stopped providing insurance to homeowners after the wildfire. Increasing rates pose significant cost burdens particularly to under-resourced individuals.

Landslides

Under-resourced individuals may have their belongings and homes damaged by landslide events. If this occurs, individuals in these groups are likely to suffer from the cost burden associated with losses or damage. Households without a computer or internet may not receive communications and evacuations to safely evacuate from hazard areas. Geographically isolated individuals and individuals without access to a vehicle are more vulnerable during wildfires because they may not have the ability to safely evacuate. Renters have limited control over home hardening and improvements that may protect against debris flow and related impacts. Subsequently, they may experience economic and health impacts and a greater loss of belongings than homeowners (Gamble et al. 2016).

Air Quality

Under-resourced individuals may be disproportionately impacted by poor air quality, because their housing may lack sufficient air filtration, and they may not be able to afford supplemental air filtration equipment (Gamble et al. 2016). Under-resourced individuals are more likely to live closer to sources of pollution and are less likely to live in areas with robust urban tree canopies, which filter air pollutants (American Lung

Association 2020). Individuals in these groups may experience the development or exacerbation of respiratory illnesses and are less likely to receive medical treatment (CDPH 2017).

Sea Level Rise

A majority of individuals who live in inundation zones are financially well positioned and therefore do not face disproportionate vulnerabilities associated with coping and adapting to sea level rise and associated impacts.

Adaptive Capacity

There are existing plans, policies, and programs in place to help under-resourced individuals adapt to climate hazards particularly around extreme heat, drought, and wildfire.

- **Santa Cruz County Health Service Agency Emergency Operations Plan Shelter Support Annex:** open and maintain cooling centers for county residents when temperatures are forecasted by the National Weather Service to exceed certain highs; low-income and unhoused individuals without access to air conditioning may benefit (County of Santa Cruz 2019).
- **Community Action Board of Santa Cruz County, Inc. Low Income Household Water Assistance Program:** offers a one-time payment to help low-income Santa Cruz County residents pay past due water or wastewater bills (Soquel Creek Water 2022).
- **Fire Safe Santa Cruz County:** runs several programs aimed at mitigating wildfire risk, including fire safety education, home safety preparation guidelines, educational public presentations on wildfire resilience strategies for students, and individual response programs for homeowners with financial need.
- **San Mateo-Santa Cruz Unit Strategic Fire Plan:** has goals and strategies that address specific planning for vulnerable populations including those in schools and nursing facilities as well as the older adult population. Additionally, the Resource Conservation District for Santa Cruz County has a no-cost chipping program to mitigate wildfire risk for homes in vulnerable areas (Cal Fire 2011).
- **Pacific Gas & Electric (PG&E) Community Wildfire Safety Program:** during public safety power shutoffs, implements vegetation management strategies, conducts system resilience improvements, and deploys innovative technologies that reduce wildfire risk; provides specific support for non-English speaking individuals, individuals with disabilities, low-income individuals, older adults, and those with chronic illnesses or health conditions (PG&E 2022).

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Vulnerability Score

Climate Hazard	Impact Score	Adaptive Capacity Score	Vulnerability Score
Extreme Heat/Warm Nights	High	Medium	4-High
Drought	Medium	Medium	3-Medium
Wildfire	High	Medium	4-High
Landslides	Low	Low	3-Medium
Riverine and Stormwater Flooding	Medium	Low	4-High
Air Quality	High	Low	5-High
Sea Level Rise	Medium	Low	2-Low

Individuals Facing Societal Barriers

- American Indians
- Communities of Color
- Hispanic or Latino
- Linguistically isolated
- Undocumented individuals

Sensitivity Overview

Individuals facing societal barriers are those that are directly impacted by the social and economic challenges that are ubiquitous in society. These challenges create educational, resource, economic, and health disparities that leave communities of color extremely vulnerable to climate change impacts (Baird 2008). Communities of color are more likely to live in high-hazard risk areas and less likely to be homeowners, which leaves them vulnerable to climate hazards. According to 2020 U.S. Census, 25% of unincorporated Santa Cruz County residents identify as hispanic or latino (of any race). Individuals that identify as hispanic or latino often face societal challenges, as described above for communities of color. In the county, many of these individuals face compounding risks associated with linguistical isolated and income barriers. Within the vulnerability analysis, potential impacts to hispanic and latino populations are discussed in the context of communités of color Undocumented immigrants often lack access to medical services, quality housing, and basic needs. Because these individuals are not citizens, they lack access to social and economic services that would allow them to prepare for, respond to, and cope with climate hazards. Individuals who are linguistically isolated have no or limited English-speaking ability. If evacuation and/or advisory notices, hazard preparedness material, or governmental

guidance is not provided in non-English versions, these individuals may not be able to prepare for, cope with, or recover from a climate hazard (Gamble et al. 2016).

Santa Cruz County is located on the ancestral lands of the Awaswas people of the Ohlone American Indians. The county has a rich human history that continues to this day with several tribal groups, such as the Amah Mutsun Tribal Band, having ties to the land (Hukill 2018). Approximately 5 percent of Santa Cruz County's residents identify as American Indian or Alaskan Native, compared to only 0.8 percent statewide. Not all county residents who identify as American Indian or American Indian have ties to tribal communities within Santa Cruz County. Most American Indians experience some degree of the implications of colonial violence, cultural erasure, and social marginalization, and as a result, they are more likely to be under-resourced and low-income (Lynn et al. 2011). In 2020, one in three American Indians across the United States were living in poverty (Northwestern Institute for Policy Research 2020). American Indians have lower health status and life expectancies compared to other populations due to a variety of factors including inadequate education, disproportionate poverty, cultural differences, and discrimination in the delivery or accessibility of health services. American Indians are also less likely to have health insurance, which may limit their ability to seek medical care for injuries or illnesses caused or exacerbated by climate change impacts (Indian Health Services 2019). American Indians are more likely to live in high-hazard risk areas and less likely to be homeowners, which leaves them vulnerable to climate impacts (Gamble et al. 2016).

Potential Impacts

Extreme Heat

Communities of color and undocumented immigrants often live in housing with insufficient protection from extreme heat events and limited or no affordable air conditioning. Linguistically isolated individuals may not be able to read heat advisory warnings or governmental guidance, potentially causing them to experience greater exposure to extreme heat (Gamble et al. 2016). The primary health impacts to these populations are heat-related illnesses, such as heat stress, heat stroke, and dehydration, which can be life-threatening (CDPH 2020). Undocumented immigrants may not have access to medical services to treat heat-related illnesses.

American Indians often live in housing with insufficient protection from extreme heat events and limited or no affordable air conditioning. American Indians may experience health impacts including heat-related illnesses, such as heat stress, heat stroke, and dehydration, which can be life threatening. (CDPH 2020).

Drought

Unless there are major water shortages in the county, individuals facing societal barriers are not expected to be at disproportionate risk to drought.

Wildfire

Communities of color communities and undocumented immigrants, and American Indians are more likely to live in wildfire hazard zones and in housing with insufficient protection against wildfire. Linguistically isolated individuals may not be able to read wildfire or smoke advisory warnings or governmental guidance, potentially causing them to experience greater exposure to smoke and/or wildfire. Individuals in these groups have may face systematic and/or cultural barriers to access resources to safely evacuate hazard areas (Gamble et al. 2016). Individuals in these groups may experience injuries or death from smoke inhalation or burns (CDPH 2017). Undocumented immigrants may not have access to medical services to treat injuries (Mendez et al. 2020).

Landslides

Linguistically isolated individuals may not be able to read landslide advisory warnings or governmental guidance, potentially causing missed critical evacuation information or limited ability to safely evacuate hazard areas (Gamble et al. 2016).

Riverine and Stormwater Flooding

Communities of color communities, undocumented immigrants, American Indians, and Tribal and indigenous communities are more likely to live in flood hazard areas and in housing with insufficient protection against riverine and stormwater flooding. Linguistically isolated individuals may not be able to read flood warning or governmental guidance, potentially causing them to experience greater exposure to flooding. Individuals in these groups may face systematic and/or cultural barriers when seeking to access resources needed to safely evacuate hazard areas (Gamble et al. 2016). Individuals in these groups may experience injuries or death from high-velocity flooding (CDPH 2017). Undocumented immigrants may not have access to medical services to treat injuries (Mendez et al. 2020).

Air Quality

Communities of color communities, undocumented immigrants, American Indians, and Tribal and indigenous communities are vulnerable to health impacts associated with poor air quality, in situations where housing lacks sufficient air filtration and they may not be able to afford supplemental air filtration equipment (Gamble et al. 2016). They may experience respiratory or cardiovascular health impacts and are less likely to have access to sufficient medical services for treatment (CDPH 2020). Undocumented immigrants are less likely to receive medical treatment for health impacts from poor air quality exposure (Mendez et al. 2020). Linguistically isolated individuals may not be able to read air quality advisory warnings or governmental guidance that are in English, potentially causing them to experience greater exposure to extreme heat (CDPH 2017). Tribal elders may have limited or reduced mobility, making it difficult for them to seek medical treatment or refuge from poor air quality.

Sea Level Rise

Populations in this group are less likely to live in coastal areas due to the high cost of living. Linguistically isolated individuals may not have access to non-English versions of communications and therefore may not be able to prepare for and cope with sea level rise (Cooley 2012). Individuals in these groups may face cultural barriers in accessing resources needed to safely evacuate or avoid sea level rise hazard areas (Gamble et al. 2016). Undocumented immigrants may not have access to medical services to treat flood related injuries (Mendez et al. 2020).

Adaptive Capacity

There are existing plans, policies, and programs in place to help individuals facing societal barriers mitigate and adapt to climate hazards particularly focused around wildfire.

- **PG&E Automated System:** communicates with customers in the county during power outages and notifies customers when power will be restored. PG&E provides translation assistance to non-English speaking individuals and the option to update language preference for Public Safety Power Shutoff (PSPS) alerts (PG&E 2022).
- **PG&E Community Wildfire Safety Program:** provides customer support during public safety power shutoffs, implements vegetation management strategies, conducts system resilience improvements, and deploys innovative technologies that reduce wildfire risk. The program provides specific support for non-English speaking individuals (PG&E 2022).
- **Climate Change and Health Profile Report Santa Cruz County:** identifies vulnerable populations including individuals living in rural areas, and non or limited English speakers (CDPH 2017).
- **County of Santa Cruz Master Emergency Services Plan:** acknowledges that emergency planning must consider individuals with limited or non-English speaking proficiencies (Santa Cruz County 2015).

Vulnerability Score

Climate Hazard	Impact Score	Adaptive Capacity Score	Vulnerability Score
Extreme Heat/Warm Nights	High	Medium	4-High
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Wildfire	High	Medium	4-High
Landslides	Low	Low	3-Medium
Riverine and Stormwater Flooding	High	Medium	4-High
Air Quality	High	Low	5-High
Sea Level Rise	Medium	Low	3-Medium

Individuals with Chronic Health Conditions or Health-Related Sensitives

- Seniors
- Children
- Military veterans
- Individuals with disabilities
- Individuals with asthma
- Individuals with cardiovascular disease

Sensitivity Overview

Individuals with chronic health conditions or health related sensitivities are socially and physiologically vulnerable to climate change impacts and hazards. Seniors and individuals with disabilities may have limited or reduced mobility, mental function, or communication abilities, making it difficult to evacuate during or prepare for a climate hazard event. They may also have medical needs for electricity which may be impacted during a public safety power shutoff or climate hazard event. Individuals in these groups are more likely to have pre-existing medical conditions or chronic illnesses that may exacerbate the risk of illnesses and medical problems from climate hazards. Individuals with disabilities often also experience societal barriers such as individuals with asthma and individuals with cardiovascular disease are more likely to experience health impacts from climate hazards because of pre-existing conditions or diseases. Seniors often face challenges regulating their temperature due to medications or underlying conditions related to age. Children are socially and physiologically vulnerable to climate hazards. They often have limited understandings of climate hazards and insufficient resources to independently prepare for and safely respond during a climate hazard event. Children, especially those 5 years and younger are reliant on their parental figures to ensure their health, safety, and wellbeing. Children also have vulnerable physical characteristics because they have not fully physiologically developed and are therefore more vulnerable to health effects of climate change impacts (Kenney et al. 2014). Military veterans may have been exposed to a variety of environmental, physical, and chemical stressors during military service which may have caused physiological or psychological health conditions, illnesses, or disabilities that make them particularly vulnerable to climate hazards (Olenick et al. 2015).

Potential Impacts

Extreme Heat

Individuals with chronic health conditions or health related sensitivities are particularly at risk to heat related illnesses during extreme heat events. Individuals with disabilities, seniors, and children may have difficulty affording or accessing air conditioning or traveling to cooling centers during extreme heat events. Extreme heat events can also trigger power outages which are particularly dangerous for individuals who

are electricity-dependent, either for their mobility, communication, or medical devices. Extreme heat conditions can exacerbate asthma, cardiovascular disease, certain disabilities, and other respiratory and cardiovascular conditions, potentially causing heat-related illnesses such as heat stress, heat stroke and dehydration, which can be life threatening (CDPH 2020). Children are still physiologically developing which means that they are less able to regulate their bodies during extreme heat events (Kenney et al. 2014).

Drought

Individuals with chronic health conditions or health related sensitivities do not currently have specific sensitivities to anticipated potential drought impacts that relate to their health conditions.

Wildfire

Individuals with chronic health conditions or health related sensitivities may experience injuries or death from smoke inhalation or burns (CDPH 2017). These populations are particularly at risk to respiratory health impacts associated with smoke inhalation of wildfire smoke pollutants. Seniors and military veterans are vulnerable to health impacts from wildfire smoke pollutants because they are more likely to have underlying respiratory and/or cardiovascular conditions and illnesses. Children may experience respiratory health impacts from wildfire smoke because their respiratory systems are not fully developed and are sensitive to stressors. Individuals with cardiovascular disease may experience severe cardiovascular health impacts if exposed to wildfire smoke pollutants. Individuals with asthma may experience severe respiratory health impacts such as difficulty breathing if exposed to wildfire smoke pollutants. Individuals with disabilities, children, and seniors may have difficulty evacuating from wildfires, increasing the risk of health impacts from wildfire smoke inhalation or fire burns (EPA 2022).

Landslide

Seniors, individuals with disabilities, and individuals with chronic health conditions or illnesses may be less able to safely evacuate landslide hazard areas.

Riverine and Stormwater Flooding

Seniors, individuals with disabilities, and individuals with chronic health conditions or illnesses may be less able to safely evacuate floodwater hazard areas.

Air Quality

Individuals with chronic health conditions or health related sensitivities are at risk of developing or experiencing exacerbated health impacts from poor air quality. Children are extremely vulnerable to health impacts from poor air quality because their respiratory system has not fully developed yet (CDPH 2017). Seniors and military veterans are vulnerable to health impacts from poor air quality because they are more likely to

have underlying respiratory and/or cardiovascular conditions. Individuals with cardiovascular disease and individuals with asthma may experience severe health impacts if exposed to poor air quality (EPA 2022).

Sea Level Rise

Seniors, individuals with disabilities, and individuals with chronic health conditions or illnesses may be less able to safely evacuate coastal hazard areas during storm surge or tsunami event.

Adaptive Capacity

There are existing plans, policies, and programs in place to help individuals with chronic health conditions or health related sensitivities mitigate and adapt to climate hazards particularly focused on extreme heat and wildfire.

- **PG&E Medical Baseline Program:** provides eligible customers with a medical need for electricity (for oxygen, dialysis, etc.) with extra notifications (i.e., calls, texts, or door-bell rings) in advance of a public safety power shutoff. Public safety power shutoffs may occur during an extreme heat event (PG&E 2021).
- **PG&E Self-Generation Incentive Program:** pays for all costs associated with procuring battery storage for eligible customers. Medical Baseline Program customers qualify for full benefits of the program (PG&E 2020).
- **San Mateo-Santa Cruz Unit Strategic Fire Plan:** identifies and prioritizes wildfire mitigation and recovery strategies aimed at reducing risk within the San Mateo-Santa Cruz Unit. The Plan has goals and strategies that address specific planning for vulnerable populations including those in schools and nursing facilities as well as the older adult population (Cal Fire2011).
- **PG&E Community Wildfire Safety Program:** provides customer support during public safety power shutoffs, implements vegetation management strategies, conducts system resilience improvements, and deploys innovative technologies that reduce wildfire risk. Provides specific support for individuals with disabilities, older adults, and those with chronic illnesses or health conditions (PG&E 2022).
- **Climate Change and Health Profile Report Santa Cruz County:** identifies vulnerable populations including children, older adults, individuals with chronic health conditions, and individuals living in nursing facilities, prisons, and college dorms (CDPH 2017).
- **County of Santa Cruz Master Emergency Services Plan:** acknowledges that emergency planning must consider individuals with disabilities, chronic health conditions, illnesses, older adults, children, pregnant, and those living in institutionalized settings (Santa Cruz County 2015).

Vulnerability Score

Climate Hazard	Impact Score	Adaptive Capacity Score	Vulnerability Score
Extreme Heat/Warm Nights	High	Medium	4-High
Drought	Medium	Low	2-Low
Wildfire	High	Medium	4-High
Landslides	Low	Low	3-Medium
Riverine and Stormwater Flooding	Medium	Medium	3-Medium
Air Quality	High	Low	5-High
Sea Level Rise	Medium	Low	3-Medium

4.2 Natural Resources

Overview



Natural resources within Santa Cruz County are diverse and expansive throughout the county. They include forested land, local parks, critical habitats, vegetation communities, rivers and streams, waterbodies, and wildlife. Nearly 69 percent of the county is comprised of forest habitat that stretches across the entirety of the county. Vegetation includes grassland, coastal scrub, coastal strand, coastal salt and freshwater marsh, riparian woodlands, redwood forests, and sandhills among many other communities (Santa Cruz NRCD, 2018). The Pajaro River watershed and the San Lorenzo River watershed provide critical food, water and shelter for wildlife and critical habitat for sensitive species (Santa Cruz County, 2022). Primary vulnerabilities for natural resources are associated with extreme heat and drought-related stresses, increasing wildfire frequency, direct species mortality, and loss of habitat. Compounding climate-related stress can cause wildlife to search for more conducive habitats, which are often where people tend to recreate, putting both wildlife and people at risk in these competing areas.

Potential Impacts

Extreme Heat

Natural resources are highly exposed to extreme heat and warm nights. Both mid- and end- of century projections depict dramatic increases in extreme heat days (CEC 2021). Wildlife under these conditions face impacts of heat stress and heat related illness as well as disrupted reproductive cycles, and compounding risks associated with early and extended seasonal temperature increases (Backlund 2008).. Timing of seasonal warmth may not overlap with food sources and extreme heat may stress dependent vegetation communities and wildlife (Dale 1997,

Hamerlynck 1995, Maclean 2011). Plants are more likely to experience heat stress and drying; species' habitat ranges may also shift and be replaced with invasive species. Some pests (such as the bark beetle) can proliferate more easily with warmer temperatures (Hamerlynck 1995), and some plants and animals ill-suited to the new warmer conditions may suffer increased mortality rates (CA 2022).

Drought

Impacts from drought involve risks associated with water scarcity and availability for reliant natural resources as well as aridification and increased water temperature due to water being shallower. Drought will disrupt habitats and wildlife abilities to survive from dehydration and reliable food sources. Extended or variable drought conditions affect the amount and duration water is available in ephemeral and permanent waters sources, impacting plants and wildlife dependent on those aquatic resources. Hydrologic modeling predicts reduced early and late wet season runoff for the end of the century which could result in an extended dry season and an increased risk of floods in the wet season. Summers are projected to be longer and drier in the future regardless of whether precipitation increases, decreases or is unchanged. As a result of precipitation pattern changes, water supply could be subject to increased variability, that is, reduced reliability, while water demand is likely to increase during the extended summers. Climatic water deficit is expected to increase as much as 30 percent between 2071 and 2100 (County of Santa Cruz Climate Action Strategy). Reduced water availability is likely to increase competition between natural resources and human water needs. Additionally, drought can increase reliance on groundwater resources, which are already depleted from over pumping particularly during extended drought periods. Groundwater decline and depletion can impact groundwater-dependent species and ecosystems by reducing available groundwater resources (Nelson & Szeptycki 2014). Drought will have increased impacts to Threatened and Endangered species such as California red-legged frog (*Rana draytonii*), Coho salmon (*Oncorhynchus kisutch*) (Central California coast ESU), Steelhead (*Oncorhynchus mykiss irideus*) (Central California Coast DPS), and Tidewater goby (*Eucyclogogius newberryi*), that are dependent on streams, rivers and wetland and already experiencing population declines due to habitat loss. Extended periods of drought can also reduce tree health and increase vulnerability to pest infestations such as the bark beetle.

Recent Saltwater Intrusion

Santa Cruz County workgroup members noted an increase of saltwater intrusion into coastal groundwater aquifers in the county, rendering portions of the aquifers unusable. Saltwater intrusion is the movement of saltwater into freshwater aquifers due to density and pressure gradients. Over-pumping of groundwater, which often increases during periods of extended drought, may lead to saltwater being drawn towards freshwater zones of an aquifers, leading to the intrusion of saltwater. Extreme droughts can also diminish the natural recharge of groundwater aquifers which can leads to increased risk of over-pumping of aquifers and potential saltwater intrusion. In the future, saltwater intrusion into local aquifers may be further exacerbated by sea level rise. The Pajaro Valley, Aptos, Seascape, and La Selva Beach are currently experiencing saltwater intrusion (Soquel Creek Water District 2022). Additionally, there are increasing levels of saltwater intrusion in local aquifers. Increased salinity in local aquifers has shifted inland three miles from the coast since the 1950s (Lachman 2018).

DECLINING STREAMFLOW

A primary contributor to stream flow declines is increasing amounts of evaporation from water sources and evapotranspiration plants during summer heat as a result of climate change. Increasing temperatures, and prolonged droughts will compound and worsen this condition. Groundwater over-pumping, which is often exacerbated during drought periods, can lead to the depletion of groundwater resources. This can have cascading impacts on local streams and rivers that receive water flow from groundwater resources (Nelson & Szeptycki 2014). Declining stream flows will further threaten endangered aquatic species such as the Coho Salmon. Freshwater habitats such as rivers and streams are particularly vulnerable to climate change. Projected changes in precipitation patterns, including an increase in precipitation variability and intensity, coupled with rising temperatures, will alter streamflow regimes and degrade water quality conditions for freshwater species (CEC 2018).

Wildfire

The largest direct impacts to natural resources are caused by wildfires. Direct mortality, loss of resources and wildlife from wildfire, as well as indirect mortality due to uninhabitable areas, loss of available food sources and seed bank (Backlund 2008) are all effects of wildfire. The severity and frequency of wildfires can exacerbate these impacts further through habitat conversions resulting in vegetation communities that no longer support the species using that habitat, and the landscape providing minimal alternative habitats (Bell et.al 1999, Stephenson et.al 1999, Coop et. al 2020). As discussed in the Hazards section, extreme wildfire risk days are projected to increase through the end of the century (CEC 2018). Some native vegetation communities within the County are dependent on wildfire for germination and structural health. However, these communities cannot survive too frequent or intense of fires, resulting in habitat conversion and loss of vegetation communities over time. Critical habitat areas projected to be impacted by wildfires include those belonging to the California red-legged frog, the Marbled murrelet, and the Zayante band-winged grasshopper, as seen in Figure 14.

Recent Wildfire Impacts

Santa Cruz County workgroup members noted watershed impacts from the CZU Complex Fire. The CZU Complex fire burned almost 20 percent of the San Lorenzo River watershed. Burned infrastructure and assets contribute to local water contamination through runoff, which can lead to negative impacts to local wildlife, including endangered steelhead and Coho salmon. After the wildfire, contaminants, including benzene and other volatile organic compounds (VOCs) have been found in drinking water samples in Santa Cruz County. Sedimentation runoff into local water sources has also increased after the wildfire, which has led to significant impacts on water quality and ecosystem health (The Resource Conservation District of Santa Cruz County 2021).

Landslides

An anticipated increase in precipitation during midwinter months (December and January) may lead to increased impact to roadways and residences from flooding and landslides (Flint, L.E., and Flint, A.L. 2012). Several notable landslides have occurred in Santa Cruz County in recent history. In February 2017, an atmospheric river event in the Santa Cruz Mountains triggered a landslide along Highway 17 and numerous other slope failures on County maintained roads (Santa Cruz County Climate Action Strategy). The likelihood of landslides occurring is determined by precipitation duration, intensity, accumulation and wildfire occurring sequentially (CA 2022). In the event of a landslide there is potential for loss of lands, habitat, and disruption of waterbodies in areas of debris flow. The susceptibility of natural resource lands in Santa Cruz County to landslides is less than other hazards such as wildfire but the risks around loss of topsoil and habitat conversions can increase the scope of impact. Wildlife and plants face a compounding risk when presented with landslide events.

Riverine and Stormwater Flooding

Flooding impacts are mainly caused by associated erosion and the detrimental effects flooding can have on water quality, especially to aquatic and fish species dependent on water quality for survival. Riverine and stormwater flooding will mostly affect sensitive species of plants and wildlife that are not upland based. Other impacts include damage from inundation within storm flooded areas such as habitats and lands around streams and waterbodies in the county. Poor water quality can impact the Monterey Bay National Marine Sanctuary, which was established and designated in 1992 for the purpose of resource protection, research, education, and public use. The Monterey Bay National Marine Sanctuary is the largest of thirteen marine sanctuaries administered by the United States Department of Commerce National Oceanic and Atmospheric Administration (NOAA) and it extends from Marin County to Cambria, encompassing nearly 300 miles of shoreline and 5,322 square miles of ocean, extending an average distance of twenty-five miles from shore.

Air Quality

The direct effects of air quality declines on natural resources relates to plant and wildlife health as increased air pollutants causes stress and mortality. Impacts from air quality can further impact natural resources since air quality declines correspond with other hazards such as wildfires (Manisalidis et al. 2020).

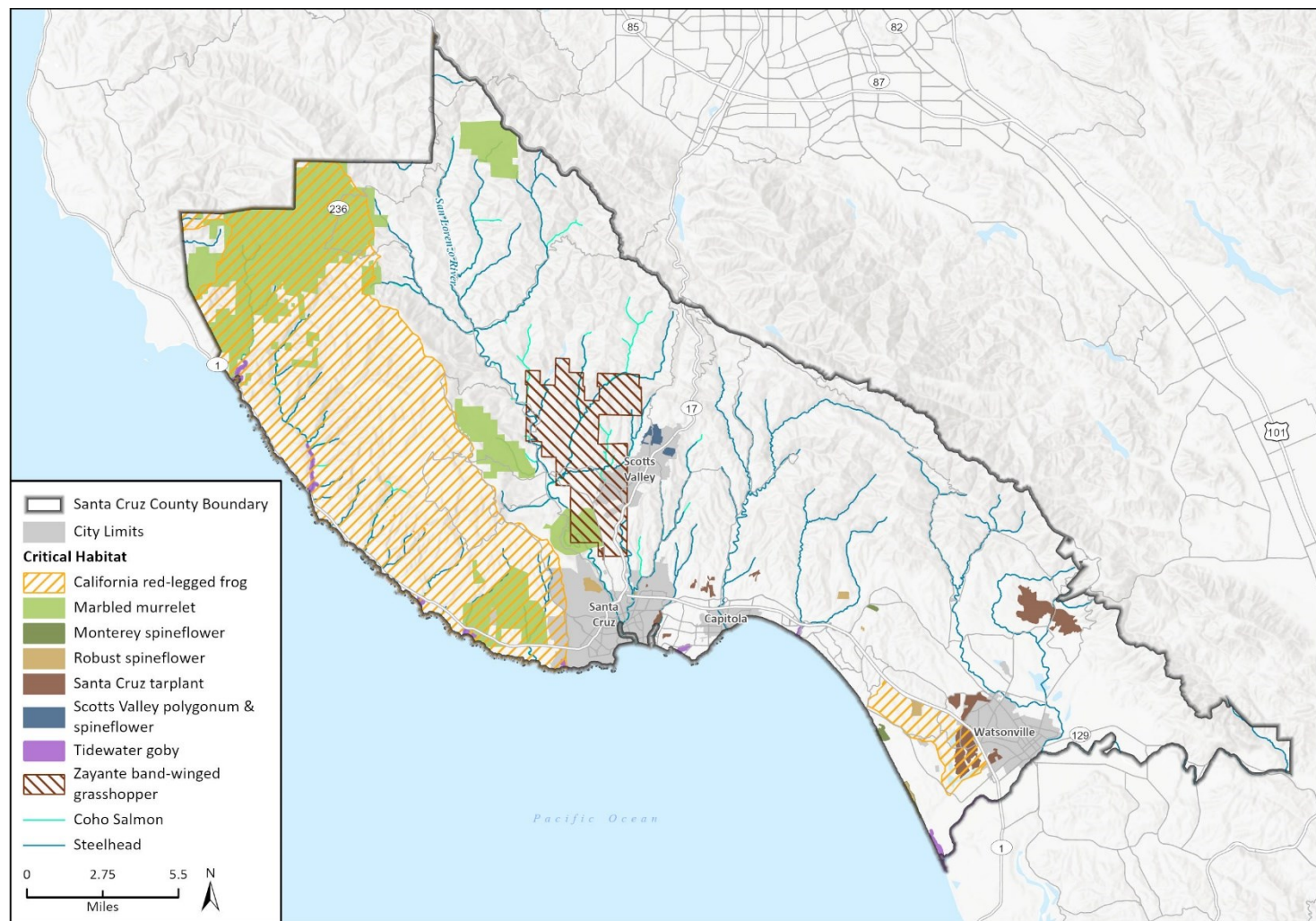
Sea Level Rise

The extent to which coastal inundation affects habitats, wildlife, and plants is large within Santa Cruz County. Impacts to natural resources are summarized in Table 5. Environmentally sensitive lands such as wetlands, riparian areas, and woodlands, are most affected by sea level rise and show limitations in ability to shift habitat location (SC County CCC Vulnerability Report 2017). More than 100 acres of sand dune are currently susceptible to coastal erosion. Much of these resources are located in south Santa Cruz County between Rio Del Mar and the Pajaro River. As seen in Figure 15, the number of acres vulnerable to erosion is projected to double by 2100. Though most of the County has boulder riprap or concrete seawalls to minimize damage to residences and infrastructure from cliff erosion, these types of engineering efforts are expensive,

address short-term risk, and can have adverse effects on natural habitats in coastal areas (County of Santa Cruz 2021). Nearly all of the creek and river mouth wetlands in Santa Cruz County are within the coastal storm flood zone by 2030 (700 acres of habitat) and much of this fresh and brackish water habitat will be flooded monthly by saline water by 2100 due to rising tides. Some of these wetland areas are designated critical habitat. Sea level rise may also increase contamination of the ocean and waterways as built structures are inundated, either temporarily or permanently. The Santa Cruz County Coastal Climate Change Vulnerability Report determines high vulnerability ratings for natural resources through the end of the century.

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Figure 14 Habitat areas containing threatened or endangered species in Santa Cruz County Santa Cruz County has a wide variety of habitat areas containing threatened or endangered species, particularly in the northwestern and central areas of the county.



Basemap provided by Esri and its licensors © 2022.
 Additional data provided by USFWS, 2021..

Vulnerability Assessment Layer
 Fig X Critical Habitat in Santa Cruz County

Figure 15 Dune and Wetland Habitat Vulnerable to Coastal Climate Change Hazards Santa Cruz County dune and wetland habitat will be increasingly vulnerable to coastal climate hazards by end-century

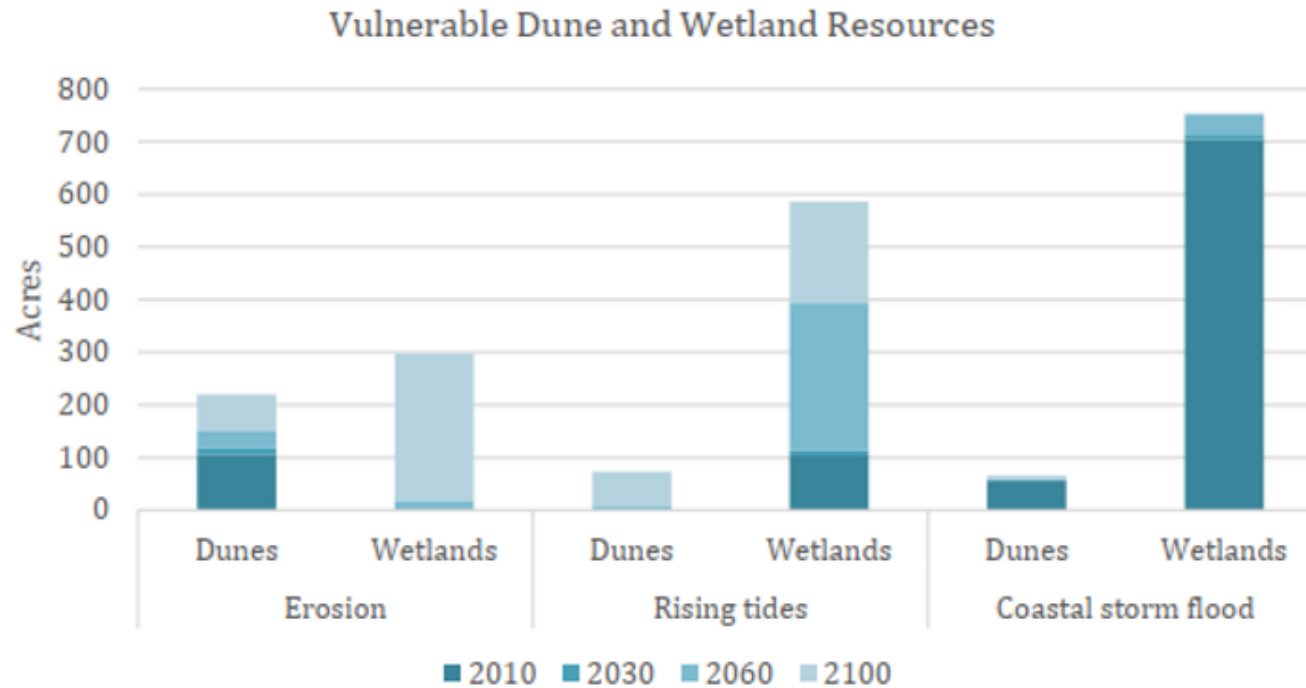


Table 5 Natural Resources Vulnerable to Sea Level Rise Parks, open spaces, recreational facilities, and natural resources in Santa Cruz County are vulnerable to sea level rise.

Parks, Recreation, and Public Access	Unit	Total
Parks	Acres	29,039
Beaches	Acres	179
Coastal Access Points	Count	70
Parking Lots	Acres	23
Coastal Trail	Feet	16,214
Natural Resources		
Dunes	Acres	1,429
National Wetlands	Acres	1,462

Source: SC County Coastal Climate Change Vulnerability Report

Adaptive Capacity for Natural Resources

There are existing plans, policies, and programs in place to help alleviate climate impacts on natural resources, particularly water conservation, flood control, and wildfire management. As one of the few counties with an approved Local Coastal Plan (LCP) and an Interim Programmatic Habitat Conservation Plan (IPHCP), there is a fair amount of existing capacity to manage the natural resources unique to the community. Since the last IPHCP update, understanding of the hazards has increased around insights to how climate change can create vulnerabilities for natural resources. The LCP which is supported by the Santa Cruz County Coastal Climate Change Vulnerability Report does offer insights on how sea level rise will impact natural resources as well as adaptation strategies in relation to climate change.

- **Santa Cruz County Flood Control and Water Conservation District:** provides funding and assistance for flood control projects on the Pajaro River, Salsipuedes Creek, and Corralitos Creek.
- **Santa Cruz County 2020 Water Resources Management Status Report:** includes relevant conservation and consumption data and recommendations for water conservation stages; considers the water demand and capacity for fire protection, thereby providing conservation benefits to ecosystems (County of Santa Cruz Environmental Health 2020).
- **Integrated Regional Water Management Plan:** includes strategies for water use, improved flood protection and stormwater management, and environmental stewardship, which benefit natural resources (IRWMP).

- **Santa Cruz County Department of Public Works, Flood Control Division:** uses science-based information and technology to reduce flood risk and to inform emergency managers and the public of real-time flooding potential during storms; works closely with Environmental Health on woody debris management in the watersheds of the Santa Cruz Mountains.
- **Santa Cruz County Community Wildfire Protection Plan:** identifies hazards and provides strategies to mitigate wildfire risk and restore healthier, more resilient ecosystems while protecting life and property (The Resource Conservation District for Santa Cruz County 2018).
- **San Mateo-Santa Cruz Unit Strategic Fire Plan:** identifies and prioritizes wildfire mitigation and recovery strategies aimed at reducing risk within the San Mateo-Santa Cruz Unit, leading to protection of natural resources within the Unit (Cal Fire. 2011).
- **Resource Conservation District of Santa Cruz County Forest Management Program:** Provides resources to public and private landowners to improve forest health, complete vegetation management and create defensible space.
- **PG&E Community Wildfire Safety Program:** implements vegetation management strategies, conducts system resilience improvements, and deploys innovative technologies that reduce wildfire risk (PG&E 2022).
- **County of Santa Cruz Local Hazard Mitigation Plan:** assesses hazards within the County and identifies mitigation strategies that reduce or eliminate long-term risks to people and property from those hazards. Climate hazards planned for include wildfire, flooding, coastal storm, drought, landslide, sea level rise, coastal storm damage, erosion, and beach loss, extreme storm events, extreme heat (County of Santa Cruz 2021).

Vulnerability Score for Natural Resources

Climate Hazard	Impact Score	Adaptive Capacity Score	Vulnerability Score
Extreme Heat/Warm Nights	High	Medium	4-High
Drought	High	Medium	4-High
Wildfire	High	Medium	4-High
Landslides	Medium	Medium	3-Medium
Riverine and Stormwater Flooding	Medium	Medium	3-Medium
Air Quality	Medium	Medium	3-Medium
Sea Level Rise	High	Medium	4-High

4.3 Managed Resources

Overview



Managed resources in Santa Cruz County include forest and agricultural related production. Much of the Santa Cruz Mountain Forest land in the county are temperate rainforests, made up of mixed evergreen forests and grasslands. Forests also serve as a public resource where residents and visitors can recreate outdoors in public areas. Strawberries, raspberries, and blackberries are the highest valued agricultural products in Santa Cruz County, with nurse crops vegetables, apples, wine grapes, timber, and livestock each providing significant additional value to the industry. Climate change impacts on managed resources in Santa Cruz County are related to the increasing variability of precipitation, making it difficult to meet irrigation demands for pastures and crop (Theodore 2018).

Potential Impacts

Extreme Heat and Warm Nights

Extreme heat and warm nights can result in declines in crop yields because of heat stress and anomalous warmth during periods that are typically cooler (Parker Et.al, 2020). Declines increase costs and ultimately decrease agriculture profitability. Livestock operations are potentially less viable during extreme heat events as livestock may suffer from heat related illness. Extreme heat can cause stress to trees which can increase mortality and decrease timber harvests (Teskey et al. 2015).

Drought

As precipitation levels vary and extreme heat dries out crop vegetation the lack of water availability makes it difficult for farmers to satisfy irrigation demands for crops and pastures. Depleted water sources leave agricultural crops and livestock vulnerable to dehydration, pests, and disease (Theodore 2018). In addition, forested areas that are open to the public may see an increase in closures due to risk of wildfire and unavailable water supply to fight fires, ultimately putting people at risk, and lessening the strength of outdoor recreational tourism in Santa Cruz County (WRTC 2011). Drought intensifies wildfire risks and the ability to fight fires, leaving agriculture and forest related production and recreation at high risk of loss. Additionally, as precipitation levels fluctuate, uncertainties in the timing and quantity of available water for agricultural production will arise.

Wildfire

Wildfire severity and frequency increases as extended dry periods and precipitation variability become more common. Wildfire is associated with direct loss of assets including timber, range and crop land, and recreational opportunities. As the number of wildfires increase in an area,

forest health diminishes, animal and livestock death are widespread, and wildlife diseases increase, rendering much of the forest landscape susceptible to secondary disease (NIDIS 2022).

Landslides

Much of the County's cropland is located in low lying and coastal areas, where landslide potential is not significant, and are therefore at low to moderate risk of related disruption or destruction (Santa Cruz County LHMP 2021). However, a significant amount of cropland, particularly along the coast surrounding Davenport and in the area surrounding the Byrne-Milliron Forest, are located in the Santa Cruz Mountains, where landslide risk is high and potential for crop loss is significant (see Figure 16).

Riverine and Stormwater Flooding

As many as 15,293 acres of agricultural land within the lower Pajaro Valley are less than 10 feet above the current mean sea level elevation, making them extremely vulnerable to the combined hazards of sea level rise, increased fluvial discharges and coastal wave induced flooding. By 2030, 1,272 acres of agriculture are predicted to periodically flood during winter storm events. The number of acres of farmland at risk of flooding will increase to 1,852 by 2060 and to 2,565 acres by 2100 (Santa Cruz County Climate Action Strategy). In addition, increased turbidity and distribution of toxins during stormwater flooding can lower water quality for sensitive crops and livestock (NCRP 2014). In particular, the farmlands located southwest of Watsonville are situated on a FEMA 100-year floodplain, which poses significant risks to yields as the likelihood of flooding events increases.

Air Quality

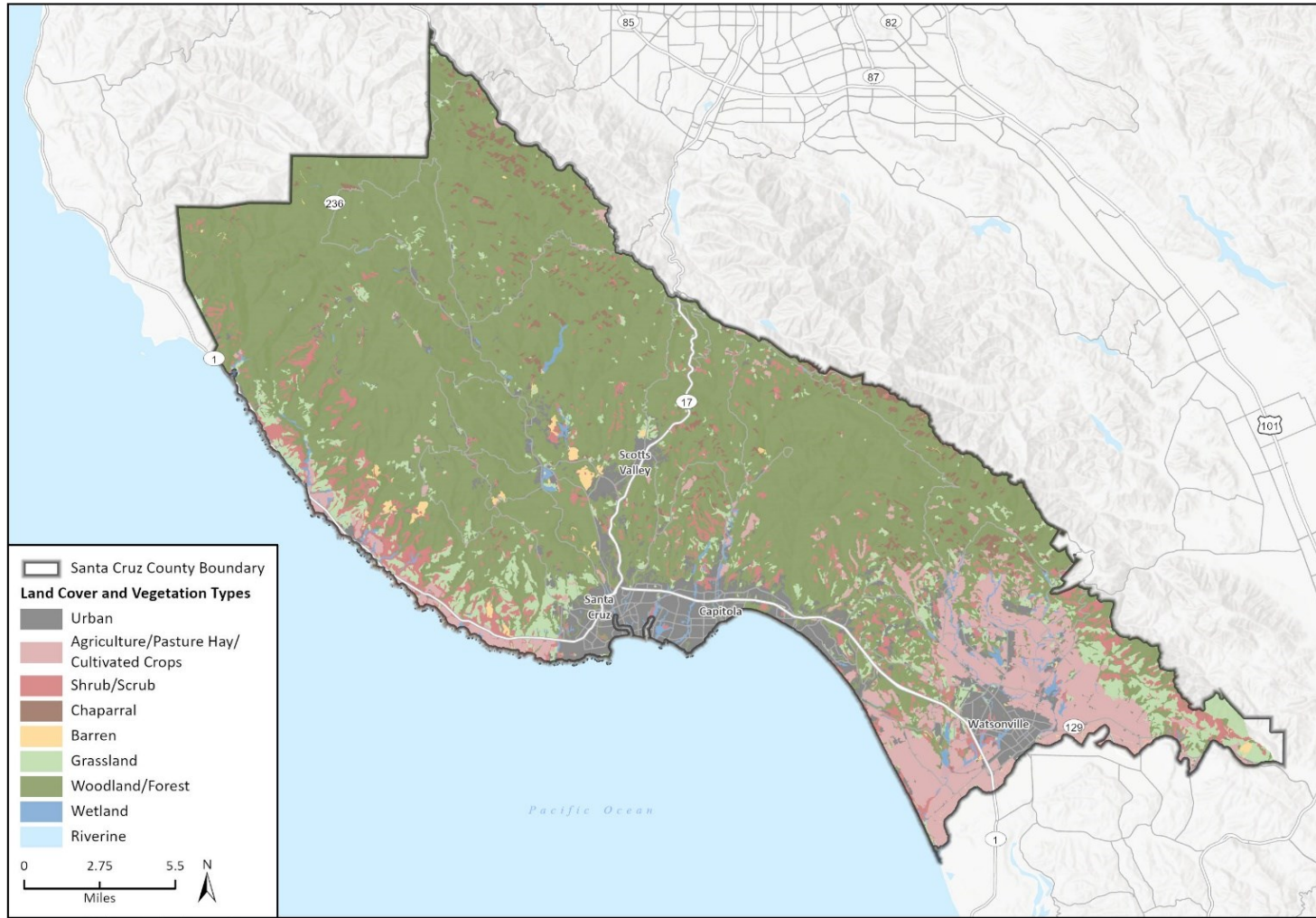
The direct impacts of air quality on agriculture and forestry within Santa Cruz County is of primary concern to crop yield and livestock health. Both are negatively impacted by worsening air quality as they are dependent on clean air for overall health and productivity. Specifically, particulate matter contains metal and organic compounds that have the greatest potential to affect plant growth and yields (CARB 2022b).

Sea Level Rise

In Santa Cruz County, dunes provide protection to agricultural fields, residences, and commercial areas from sea level rise related hazards. When sea levels rise, dunes are not able to function naturally and can become eroded, leading to more tidal inundation and coastal flooding. The farmlands located in the Pajaro Valley just inland from the Pajaro Dunes and north coast farmland near Davenport are particularly at risk (County 2017).

County of Santa Cruz
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Figure 16 Land Cover Types in Santa Cruz County Santa Cruz County has nine land cover and vegetation types with woodland/forest as the primary type.



Basemap provided by Esri and its licensors © 2022.
 Additional data provided by USDA Forest Service Region 5, 2008-2015.

Vulnerability Assessment.aprx
 Fig X Land Cover and Vegetation Types in Santa Cruz County

Adaptive Capacity

There are existing plans, policies, and programs in place to help alleviate climate impacts on managed resources, particularly surrounding wildfire. Many of the existing plans, policies, and programs in place are collaborative efforts at the local level, and it should be noted that many local entities may not have the staff or resources to fully implement strategies.

- **Integrated Regional Water Management Plan (IRWMP):** provides a framework for local stakeholders to manage this region’s water and water-related resources. Includes strategies for developing and implementing policies and projects to ensure sustainable water use, reliable water supply, better water quality, improved flood protection and stormwater management, essential for managed resource sustainability.
- **Groundwater Sustainability Plan for the Santa Cruz Mid-County Groundwater Basin:** details strategies to increase groundwater recharge capacity and drought resilience. The GSPs acknowledge future changing climate conditions as they outline strategies for ensuring groundwater supplies be sustainable by 2040.
- **National Resources Conservation Service:** helps America’s farmers, ranchers and forest landowners conserve the nation’s soil, water, air and other natural resources. All programs are voluntary and offer science-based solutions that benefit both the landowner and the environment.
- **Santa Cruz County Fire Code Chapter 7.92:** requires new construction located within State Responsibility Areas (SRA) to meet minimum uniform standards for emergency access, perimeter wildfire protection measures, private water supply reserves for emergency fire use, signing and building numbering, and vegetation modifications.
- **Santa Cruz County Community Wildfire Protection Plan (The Resource Conservation District for Santa Cruz County 2018):** identifies hazards and provides strategies to mitigate wildfire risk and restore healthier, more resilient ecosystems while protecting life and property.
- **Fire Protection Districts in Santa Cruz County:** provide fire and emergency services to unincorporated areas of Santa Cruz County, and has their own set of fire prevention programs, fire safety outreach and educational programs.
- **Resource Conservation District of Santa Cruz County Forest Management, Livestock, and Land Programs:** Provides resources to public and private landowners to improve forest health, complete vegetation management and create defensible space. The Livestock and Land program shares best management practices for landowners on conservation efforts, composting, drainage, manure management, and pasture management. The District provides specific financial and technical assistance to low-income individuals and non-English speakers.
- **Santa Cruz County Code of Ordinances: Geologic Hazards (Santa Cruz County 2022):** includes flood management regulations to minimize damage to public and private property caused by the natural physical hazards of floods, landslides, and coastal processes; and set forth standards for development and building activities that will reduce public costs by preventing inappropriate land uses and development in areas where natural dynamic processes present a potential threat to the public health, safety, welfare, and property.
- **County of Santa Cruz Local Hazard Mitigation Plan (County of Santa Cruz 2021):** assesses hazards within the County and identifies mitigation strategies that reduce or eliminate long-term risks to people and property from those hazards. Climate hazards planned for

include wildfire, flooding, coastal storm, drought, landslide, sea level rise, coastal storm damage, erosion, and beach loss, extreme storm events, extreme heat.

- **County of Santa Cruz Master Emergency Services Plan (Santa Cruz County 2015):** provides guidance around response procedures in the event of a large-scale emergency or disaster in the unincorporated areas of the County. The Plan provides recommendations on disaster response in jurisdictions both within and outside of the unincorporated areas of Santa Cruz County. Climate hazards planned for include flood, wildfire, extreme weather (strong storms, extreme cold, extreme drought, tule fog, high winds, and extreme heat), epidemics/pandemics, agricultural hazards, and dam failure.
- **United States Department of Agriculture’s (USDA) Disaster Assistance Programs:** offers several programs that provide coverage for agricultural producers to help them manage risk and protect their operations from climate hazards and disasters.
- **University of California Cooperative Extension – Santa Cruz County:** work as advisors, help farmers solve problems, support land stewardship initiatives, and facilitate partnerships with federal, state, county and private resources.

Vulnerability Score for Managed Resources

Climate Hazard	Impact Score	Adaptive Capacity Score	Vulnerability Score
Extreme Heat/Warm Nights	High	Low	5-High
Drought	High	Medium	4-High
Landslides	Low	Medium	2-Low
Wildfire	High	High	4-High
Riverine and Stormwater Flooding	High	Medium	4-High
Air Quality	Medium	Low	4-High
Sea Level Rise	Medium	Medium	3-Medium

4.4 Buildings and Critical Facilities

Overview



A jurisdiction's vulnerability increases when buildings and critical facilities are not designed, operated, and/or maintained to function effectively under extreme weather conditions or are in locations that can be damaged by extreme weather conditions. Climate change is expected to amplify extreme weather as described in the Hazards section. The following County buildings and critical facilities are particularly sensitive to climate change: county buildings, educational facilities, hospitals, residential and commercial development, fire stations, police stations, airports, and historical and cultural districts and landmarks. Vulnerabilities to this asset category primarily concern physical exposure and damages related to climate hazards.

Potential Impacts

Extreme Heat and Warm Nights

Extreme heat could impact occupants of buildings and critical facilities that are not adequately weatherized for increased temperatures. Increased frequency and severity of extreme heat events may lead to long-term impacts on the equipment located within the facilities and buildings in the county. High ambient operation temperatures may lead to a reduction of the lifespan for various electrical equipment (Water Utility Climate Alliance 2020).

Drought

Drought will have minimal impact on the physical structures of buildings and facilities across Santa Cruz County.

Wildfire

The structures and buildings that occupy wildfire hazard zones are at risk of structural damage from wildfires. There are several areas of the County that are classified as moderate and high severity wildfire zones, as shown in Figure 6. Cal-Adapt projections indicate that wildfire risk will increase most in Northeastern portion of the county in the Castle Rock State Park area and South towards Highway 17, which will put many buildings and facilities in these areas at high future risk (CEC 2021). There are several residential structures and critical facilities situated within moderate and high fire hazard zones in the county including schools, fire stations, sheriff stations, and healthcare facilities. There are at least two schools located in very high severity wildfire zones.

Landslides

Landslides occur throughout Santa Cruz County but is primarily along sloped hills and mountains, along streams, and on coastal bluff zones. Features in landslide hazard areas as outlined in the Multi-Jurisdiction Hazard Mitigation Plan encompass 27,176 parcels with 8,165 structures and 3 fire stations (County 2021). Landslide susceptibility for the county overlaps with wildfire hazard zones (CDOC 2021). Buildings and facilities within and below burned areas are at risk to damage from debris flows for several rainy seasons following a fire. Landslides can directly damage buildings and facilities by disrupting structural foundations either by deforming the ground on which an asset is located on or by physically impacting an asset (USGS 2008).

Recent Wildfire Event Impacts

Santa Cruz County workgroup members noted that the San Lorenzo Valley Water District sustained significant impacts to its services and facilities. Multiple assets and structures were destroyed, damaged, or contaminated, leading to service disruption to all customers in the District's service area. District facilities damaged in the fire include treatment systems, pumps, water quality monitoring equipment, intakes, and storage tanks. Over 7 miles of high-density polyethylene pipeline was melted and destroyed by the fire. The District's customers went without water services for several weeks after critical water assets were initially damaged (San Lorenzo Valley Water District 2022). Ultimate repair cost estimates are estimated to be between \$10 million and \$20 million. The District is still coping with water contamination and asset damage repairs in 2022 (Hagemann 2022).

Riverine and Stormwater Flooding

There is some risk of riverine and stormwater flooding to the physical structures outlined under this asset category. The location of floodplains in Figure 11 show risk along the San Lorenzo River, Bear Creek, Hare Creek, Zayante Creek, Soquel Creek, Corralitos Creek, the Pajaro River, and along the coastline that will impact critical buildings and facilities. The Multi-Jurisdiction Hazard Mitigation Plan identified the following features in FEMA flood hazard zones: 6,646 parcels, 4,061 structures, 2 schools, and 3 fire stations (County 2021). Additionally, some government buildings and the County Jail are in the flood zone along the San Lorenzo River and will likely be damaged in the case of a 100-year flood event. Flooding can cause structure damage due to flowing debris, saturation of building materials, and collapse of water-logged structures. High velocity and high-pressure flooding may also cause structures to wash away (Wilk 2018).

Air Quality

The impact of reduced air quality will have a similar limited effect as extreme heat on buildings and facilities. The ability to filter air will affect the subsystems, services, and populations that are reliant on the buildings and facilities, but the direct impact on structures is low.

Sea Level Rise

Physical damages to buildings and facilities brought about by coastal flooding are mainly related to structural damages--residential properties, coastal commercial industry, and some industrial facilities are at risk (County 2021).

Adaptive Capacity

There are existing plans, policies, and programs in place to alleviate impacts on buildings and critical facilities particularly surrounding wildfire and floods. It should be noted that many local entities may not have the staff or resources to fully implement strategies.

- **PG&E Automated System:** PG&E regularly communicates with customers in the county during power outages and notifies customers when power will be restored (PG&E 2022).
- **Santa Cruz County Coastal Climate Change Vulnerability Report:** provides greater detail on the risks to resources and assets within unincorporated Santa Cruz County from coastal climate change (Central Coast Wetlands Group 2017).
- **Santa Cruz County Department of Public Works, Flood Control Division:** uses science-based information and technology to reduce flood risk and to inform emergency managers and the public of real-time flooding potential during storms.
- **Santa Cruz County Community Wildfire Protection Plan:** Details the risk of significant wildfire within Santa Cruz County; identifies hazards and provides strategies to mitigate wildfire risk and restore healthier, more resilient ecosystems while protecting life and property (The Resource Conservation District for Santa Cruz County 2018).
- **County of Santa Cruz Local Hazard Mitigation Plan:** assesses hazards within the County and identifies mitigation strategies that reduce or eliminate long-term risks to people and property from those hazards (County of Santa Cruz 2021).

Vulnerability Score for Buildings and Critical Facilities

Climate Hazard	Impact Score	Adaptive Capacity Score	Vulnerability Score
Extreme Heat/Warm Nights	Medium	Medium	3-Medium
Drought	Low	Medium	2- Low
Wildfire	High	Medium	4- High
Landslides	Medium	Low	4- High
Riverine and Stormwater Flooding	High	Medium	4- High
Air Quality	Low	Medium	2- Low
Sea Level Rise	High	Medium	4- High

4.5 Infrastructure and Critical Services

Overview

Within Santa Cruz County, there is a complex network of infrastructure and services that are vulnerable to climate change. Assets within this category include water services, wastewater, airports, emergency services, utilities, roadways, public transit lines, public transportation, and communication services. Natural gas and electricity services are provided by PG&E and distributed to Santa Cruz County residents through two major transmission lines. In addition, utility companies provide electricity, natural gas, water, and sewer services to residents, though residents not utilizing a community or municipal water provider depend on wells and/or surface water to meet their water needs. Wastewater and water supply infrastructure is provided by Santa Cruz County Sanitation District. Numerous pump stations and associated sanitary sewer infrastructure are in locations vulnerable to severe weather damage, as well as sea level rise. Overall vulnerabilities associated with this asset category involve structural preparedness and service reliability in the face of climate change. This section is mainly concerned with the cascading impacts that physical damages to buildings and critical facilities can have on services and infrastructure.

Potential Impacts

Extreme Heat and Warm Nights

As temperatures increase, roadways, active transportation routes, and railroads are vulnerable to damages through sustained heat such as buckled railroad ties and cracked surfaces (Water Utility Climate Alliance 2020). Additional impacts from extreme heat are associated with increased emergency service calls which could strain medical services. Electrical infrastructure may become overwhelmed by demand and result in blackouts, or energy providers may conduct power safety shutoffs to avoid impacts to electrical facilities. Power outages have significant impacts on communication networks, water conveyance, and vulnerable populations, and are a cascading impact of extreme heat events, which place additional strain on infrastructure and critical services (County 2021).

Drought

Drought can impact water reliability and water infrastructure. All emergency services depend on water, particularly firefighters, who rely on adequate water supply for fire suppression. Water providers within the county will encounter increased difficulty as drought decreases general service reliability. Drought impacts can create service strain for emergency and medical services. Cracked pavements from drought compounded with extreme heat affects roadways and transportation routes. Periods of drought will decrease the water supplies held within the county's reservoirs (County 2021).

Wildfire

There are some critical facilities such as police stations, medical facilities, fire stations, and government buildings, located in the high and very high fire severity zones shown in Figure 6 that are at risk of damage and destruction caused by wildfires. Damage to these facilities can lead to interrupted availability of critical and emergency services. Additionally, utility lines have the potential to be damaged in high-risk locations, resulting in oil and gas leaks and power outages. Utility lines under certain high wind conditions can also trigger wildfires through downed power lines (County 2021). Power safety shut offs in response to wildfire risk can affect service reliability of power. Increased frequency of wildfires can place strain on fire and emergency service capacity. Evacuation routes could be disrupted during a wildfire event limiting emergency responders and ability for people to evacuate as well.

Landslides

The 2020 CZU Lightening Complex Fire burned a total of 85,509 acres and left burn scars that are susceptible to landslides (County 2021). Landslide risk is high throughout most of the county, primarily along sloped hills and mountains, along streams, and on coastal bluff zones. Most of the county's roadways were constructed many years ago with little consideration to slope stability and will likely be affected by landslides in the future. Because utilities follow these roads, damage to roads may disrupt sewers, water systems, gas and electricity, as well as cable and telephone utilities (County 2021). Utility, water, and power outages have significant impacts on communication networks and may cause an augmentation of landslide events, which places additional strain on infrastructure and critical services.

Riverine and Stormwater Flooding

Impervious surfaces can impede the absorption of water and increase stormwater flooding in areas of the County. There is risk of damage from increased extreme precipitation events including erosion, washouts, and sinkholes. Storm drainage and flood protection services for the County may be impacted by these events. In flood events, water quality decreases, which may lead to cascading impacts such as limited availability for fire suppression.

Air Quality

Higher incidence of unsafe air quality caused by increased smog, dust and wildfire smoke can create general strain on existing critical services and infrastructure through increased rates of hospitalization and emergency and medical services (CDPH 2020).

Sea Level Rise

The SLR-related hazards that Santa Cruz County is expected to experience are significant. Critical services and infrastructure, including critical transportation, water systems, sanitation infrastructure, coastal highways, and infrastructure corridors are vulnerable to sea level rise and related hazards. When storms occur in tandem with high tides, flood conditions, specifically at the mouth of the Pajaro River and Aptos Creek,

are exacerbated and likely to cause damage to neighboring infrastructure. Sea level rise will likely impact the County's roadways and emergency services, which may have cascading impacts on utilities provisioning and communication networks.

Adaptive Capacity

There are existing plans, policies, and programs in place to alleviate impacts on buildings and critical facilities particularly surrounding wildfire and floods. It should be noted that many local entities may not have the staff or resources to fully implement strategies.

- **PG&E Automated System:** PG&E regularly communicates with customers in the county during power outages and notifies customers when power will be restored (PG&E 2022).
- **PG&E Enhanced Powerline Safety Settings:** helps prevent wildfires by automatically shutting power off when damage to a line is detected (PG&E 2022).
- **Operational Area Emergency Management Plan:** includes a planning, response, recovery, and mitigation approach to reduce the impacts of extreme heat, cold, and natural disasters (County of Santa Cruz 2015).
- **Santa Cruz County Community Emergency Response Team:** trains volunteers in basic first aid, light search and rescue, and small fire suppression, and are closely associated with Santa Cruz County Fire Department (County of Santa Cruz 2021).
- **County of Santa Cruz Master Emergency Services Plan:** provides guidance around response procedures in the event of a large-scale emergency or disaster in the unincorporated areas of the County. The Plan provides recommendations on disaster response in jurisdictions both within and outside of the unincorporated areas of Santa Cruz County. Climate hazards planned for include flood, wildfire, extreme weather (strong storms, extreme cold, extreme drought, tule fog, high winds, and extreme heat), epidemics/pandemics, agricultural hazards, and dam failure (County of Santa Cruz 2015).

Vulnerability Score for Services and Infrastructure

Climate Hazard	Impact Score	Adaptive Capacity Score	Vulnerability Score
Extreme Heat/Warm Nights	High	Medium	4- High
Drought	Medium	Medium	3- Medium
Wildfire	High	Medium	4- High
Landslides	Medium	Medium	3- Medium
Riverine and Stormwater Flooding	Medium	Medium	3- Medium
Air Quality	Medium	Medium	3 Medium
Sea Level Rise	High	Low	5- High

5 Conclusion

This report evaluates how climate change may impact vulnerable community members, natural resources, managed resources, critical facilities, buildings, services, and infrastructure in Santa Cruz County. The report provides a list of vulnerable population groups and assets for which adaptation policies and programs should be developed and implemented to increase community resilience. Vulnerability is based on the combination of potential impacts and adaptive capacity, as identified in the Vulnerability Analysis section of the report.

A list of asset categories with high vulnerability scores is provided on the next page.

- Individuals with high outdoor exposure have been identified as highly vulnerable to extreme heat, wildfire, and air quality hazards.
- Under-resourced individuals have been identified as highly vulnerable to extreme heat, wildfires, landslides, riverine and stormwater flooding, and air quality hazards.
- Individuals facing societal barriers have been identified as highly vulnerable to extreme heat, wildfires, landslides, riverine and stormwater flooding, and air quality hazards.
- Individuals with chronic health conditions or health-related sensitivities have been identified as highly vulnerable to extreme heat, and air quality hazards.
- Natural resources have been identified as highly vulnerable to many climate hazards including extreme heat, drought, wildfire, and sea level rise.
- Managed resources have been identified as highly vulnerable to extreme heat, drought, wildfire, flooding, sea level rise, and air quality hazards.
- Buildings and critical facilities in the county have been identified as highly vulnerable to wildfire, landslides, riverine and stormwater flooding, and sea level rise depending upon their location.
- Infrastructure and services have been identified as highly vulnerable wildfire and sea level rise depending on their location. Infrastructure and dependent populations may experience additional cascading impacts around power outages from downed utility lines, power safety shut offs and grid overload. All forms of power outages can affect how critical services are able to perform their needed functions during a hazard.

This report establishes a foundation for identifying adaptation policies and programs that can increase resilience in Santa Cruz County as part of the Climate Action and Adaptation Plan.

County of Santa Cruz
Climate Vulnerability Technical Compendium

Climate Hazard	Impact Score	Adaptive Capacity Score	Vulnerability Score
Individuals with High Outdoor Exposure			
Extreme Heat/Warm Nights	High	Medium	4-High
Wildfire	High	Medium	4-High
Air Quality	High	Low	5-High
Under-resourced individuals			
Extreme Heat/Warm Nights	High	Medium	4-High
Wildfire	High	Medium	4-High
Air Quality	High	Low	5-High
Individuals with chronic health conditions or health related sensitivities			
Extreme Heat/Warm Nights	High	Medium	4-High
Wildfire	High	Medium	4-High
Air Quality	High	Low	5-High
Individuals facing societal barriers			
Extreme Heat/ Warm Nights	High	Medium	4-High
Wildfire	High	Medium	4-High
Riverine and Stormwater Flooding	High	Medium	4-High
Air Quality	High	Low	5-High
Natural Resources			
Extreme Heat/Warm Nights	High	Medium	4-High
Drought	High	Medium	4-High
Wildfire	High	Medium	4-High
Sea Level Rise	High	Medium	4-High
Managed Resources			
Extreme Heat/Warm Nights	High	Low	5-High
Drought	High	Medium	4-High
Wildfire	High	High	4-High
Riverine and Stormwater Flooding	High	Medium	4-High
Air Quality	Medium	Low	4-High

Climate Hazard	Impact Score	Adaptive Capacity Score	Vulnerability Score
Buildings and Critical Facilities			
Wildfire	High	Medium	4- High
Landslides	Medium	Low	4- High
Riverine and Stormwater Flooding	High	Medium	4- High
Sea Level Rise	High	Medium	4- High
Infrastructure and Critical Services			
Extreme Heat	High	Medium	4- High
Wildfire	High	Medium	4- High
Sea Level Rise	High	Low	5- High

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Appendix A

Adaptive Capacity

Adaptive capacity is the ability to adjust to the consequences of climate change. This section summarizes the ways in which the County currently manages for the negative impacts of climate change. Types of adaptive capacity include adjustments in behavior, resources, and technologies. Santa Cruz County has actively taken steps to increase the county’s adaptive capacity. Existing policies, plans, programs, and institutions that increase the county’s resilience to climate change impacts are organized by climate hazard and listed in Table 6, Table 7, Table 8, and Table 9.

6.1 Extreme Heat and Warm Nights

Table 6 lists programs, plans, and policies that help communities become more resilient to an increase in extreme heat and warm nights.

Table 6 Program, Plans, and Policies to Manage Extreme Heat and Warm Nights

Existing and Planned Programs, Plans, and Policies	Objectives
Cal/OSHA Heat Illness Prevention Program (California State Department of Industrial Relations)	The program aims to reduce the potential for heat illnesses by making workers within the county aware of heat illnesses, ways to prevent them, and actions to take if symptoms occur. The Program specifically addresses vulnerabilities to outdoor workers.
Santa Cruz County Health Service Agency Emergency Operations Plan Shelter Support Annex (County of Santa Cruz 2019)	Santa Cruz County coordinates with local governments to open and maintain cooling centers for county residents when temperatures are forecasted by the National Weather Service (NWS) to exceed certain highs.
Pacific Gas & Electric (PG&E) Medical Baseline Program (PG&E 2021)	PG&E provides eligible customers with a medical need for electricity (for oxygen, dialysis, etc.) with extra notifications (i.e., calls, texts, or door-bell rings) in advance of a public safety power shutoff. Public safety power shutoffs may occur during an extreme heat event
Pacific Gas & Electric (PG&E) Self-Generation Incentive Program (PG&E 2020)	The PG&E Self-Generation Incentive Program pays for all costs associated with procuring battery storage for eligible customers. Medical Baseline Program customers qualify for full benefits of the Self-Generation Incentive Program.
Pacific Gas & Electric (PG&E) Automated System (PG&E 2022)	PG&E regularly communicates with customers in the county during power outages and notifies customers when power will be restored. PG&E provides translation assistance to non-English speaking individuals and the option to update language preference for PSPS alerts.

6.2 Riverine and Stormwater Flooding, Droughts, and Sea Level Rise

Table 7 lists programs, plans, and policies that help increase the community’s resilience to droughts and riverine and stormwater flooding.

Table 7 Programs, Plans, and Policies to Manage Riverine and Stormwater Flooding, Droughts, and Sea Level Rise

Existing and Planned Programs, Plans, and Policies	Objectives
Santa Cruz County Flood Control and Water Conservation District	The Santa Cruz County Flood Control and Water Conservation District (District) was established to provide funding for implementing proposed Army Corps of Engineers (Corps) flood control projects on the Pajaro River, Salsipuedes Creek, and Corralitos Creek. District staff coordinates with the Corps to ensure local needs are addressed; provides assistance to the Corps in project evaluation, as necessary, administrative, and engineering drainage services; and is responsible for the replacement, upgrade, and maintenance of drainage and flood control facilities in the levee system. The District provides administration and coordination of the Corps Pajaro River Flood Risk Reduction Project, and staff for the County’s participation in the Pajaro River Watershed Flood Prevention Authority.
Santa Cruz County 2020 Water Resources Management Status Report (County of Santa Cruz Environmental Health 2020)	Santa Cruz County develops an Annual Water Conservation Report that includes relevant conservation and consumption data and recommendations for water conservation stages for each District within the County for the relevant water year. The report considers the water demand and capacity for uses including human consumption, sanitation, and fire protection. The Report specifically mentions climate change in discussing approaches to manage for future drought conditions.
Santa Cruz County Coastal Climate Change Vulnerability Report (Central Coast Wetlands Group 2017)	This report is intended to provide greater detail on the risks to resources and assets within unincorporated Santa Cruz County from coastal climate change during three future time horizons (2030, 2060 and 2100). Risks to properties were identified using the ESA PWA Monterey Bay Sea Level Rise Vulnerability Study layers developed in 2014 using funding from the California Coastal Conservancy.
Integrated Regional Water Management Plan (IRWMP)	The Santa Cruz Integrated Regional Water Management (IRWM) program provides a framework for local stakeholders to manage this region’s water and water-related resources. The Santa Cruz IRWM Plan was developed in response to California’s IRWM planning initiative to promote an informed, locally-driven, and consensus-based approach to water resources management. The IRWM Plan includes strategies for developing and implementing policies and projects to ensure sustainable water use, reliable water supply, better water quality, improved flood protection and stormwater management, and environmental stewardship.
Community Action Board of Santa Cruz County, Inc. Low Income Household Water Assistance Program (LIHWAP) (Soquel Creek Water 2022)	LIHWAP offers a one-time payment to help low-income Santa Cruz County residents pay past due water or wastewater bills. LIHWAP helps pay overdue bills which accrued during any timeframe.

Existing and Planned Programs, Plans, and Policies	Objectives
Santa Cruz County Department of Public Works, Flood Control Division	The Flood Control Division uses science-based information and technology to reduce flood risk and to inform emergency managers and the public of real-time flooding potential during storms. Flood control engineering work is strongly focused on the Pajaro River and its tributaries. They coordinate with the County Planning Department on flood insurance needs in the County, and we work closely with Environmental Health on woody debris management in the watersheds of the Santa Cruz Mountains.
Groundwater Sustainability Plan for the Santa Cruz Mid-County Groundwater Basin	The Santa Cruz Mid-County Groundwater Agency formed in 2016 in order to implement California’s Sustainable Groundwater Management Act. The Groundwater Sustainability Plan for Santa Cruz’s Mid-County basin details strategies to increase groundwater recharge capacity and drought resilience. The GSPs acknowledge future changing climate conditions as they outline strategies for ensuring groundwater supplies be sustainable by 2040.

6.3 Wildfires, Landslides, and Air Quality

Table 8 lists programs, plans, and policies that help increase the community’s resilience to wildfires.

Table 8 Programs, Plans, and Policies to Manage Wildfire Impacts

Existing and Planned Programs, Plans, and Policies	Objectives
Santa Cruz County Fire Code Chapter 7.92	Santa Cruz County requires new construction located within State Responsibility Areas (SRA) to meet minimum uniform standards for emergency access, perimeter wildfire protection measures, private water supply reserves for emergency fire use, signing and building numbering, and vegetation modifications.
Santa Cruz County Community Wildfire Protection Plan (The Resource Conservation District for Santa Cruz County 2018)	Details the risk of significant wildfire within Santa Cruz County; identifies hazards, and provides strategies to mitigate wildfire risk and restore healthier, more resilient ecosystems while protecting life and property.
Santa Cruz Office of Response, Recovery, and Resilience Evacuation Guidelines (Santa Cruz County 2022)	The Santa Cruz County Office of Response, Recovery, and Resilience hosts a website which provides wildfire safety recommendations and evacuation guidelines for the residents of Santa Cruz County.
Fire Safe Santa Cruz County	Fire Safe Santa Cruz County is a non-profit group that runs several programs aimed at mitigating wildfire risk, including fire safety education, home safety preparation guidelines, educational public presentations on wildfire resilience strategies for students, and individual response programs for homeowners with financial need.

Existing and Planned Programs, Plans, and Policies	Objectives
San Mateo-Santa Cruz Unit Strategic Fire Plan (CAL FIRE et al. 2011)	The San Mateo-Santa Cruz Unit Strategic Fire Plan was collaboratively developed among various stakeholders, including federal, state, city, and county agencies, and is jointly managed by CAL FIRE, the Resource Conservation District of Santa Cruz County, San Mateo Resource Conservation District, and the US Fish and Wildlife Service. The Plan identifies and prioritizes wildfire mitigation and recovery strategies aimed at reducing risk within the San Mateo-Santa Cruz Unit. The Plan has goals and strategies that address specific planning for vulnerable populations including those in schools and nursing facilities as well as the older adult population. Additionally, the Resource Conservation District for SC County has a no-cost chipping program to mitigate wildfire risk for homes in vulnerable areas.
Fire Protection Districts in Santa Cruz County	Each of Santa Cruz County's 10 fire protection districts (Aptos-La Selva, Aromas Tri-County, Ben Lomond, Boulder Creek, Branciforte, Central, Felton, Pajaro Valley, Scotts, Valley, and Zayante), provides fire and emergency services to unincorporated areas of Santa Cruz County, and has their own set of fire prevention programs, fire safety outreach and educational programs
Resource Conservation District of Santa Cruz County Forest Management Program	Provides resources to public and private landowners to improve forest health, complete vegetation management and create defensible space. Also helps secure funding to implement and manage large-scale collaborative on-the-ground projects.
Pacific Gas & Electric (PG&E) Community Wildfire Safety Program (PG&E 2022)	PG&E's Community Wildfire Safety Program provides customer support during public safety power shutoffs, implements vegetation management strategies, conducts system resilience improvements, and deploys innovative technologies that reduce wildfire risk. The program provides specific support for non-English speaking individuals, individuals with disabilities, low-income individuals, the older adults, and those with chronic illnesses or health conditions.

6.4 Multiple Climate Hazards

Table 9 lists programs, plans, and policies that help increase the community's resilience to multiple climate hazards.

Table 9 Programs, Plans, and Policies to Manage Multiple Climate Hazard Impacts

Existing and Planned Programs, Plans, and Policies	Objectives
Shelter Support Plan (County of Santa Cruz 2019)	The Shelter Support Plan outlines temporary emergency relief to disaster victims in Santa Cruz County. The Plan acknowledges the need to provide shelter for all residents in the county including people experiencing homelessness and displaced individuals.
Operational Area Emergency Management Plan (County of Santa Cruz 2015)	The Santa Cruz County Operational Area Emergency Management Plan includes a planning, response, recovery, and mitigation approach to reduce the impacts of extreme heat, cold, and natural disasters. The planning phase calls for the initiation of a heat awareness campaign to launch at the start of the heat season, and natural disaster preparedness. In the next phase, a county-wide response to be triggered once the County Health Officer declares an emergency.

Existing and Planned Programs, Plans, and Policies	Objectives
Santa Cruz County Code of Ordinances: Geologic Hazards (Santa Cruz County 2022)	Chapter 16.10 of the Santa Cruz County Code of Ordinances, <i>Geologic Hazards</i> , includes flood management regulations to minimize injury, loss of life, and damage to public and private property caused by the natural physical hazards of floods, landslides, and coastal processes; and set forth standards for development and building activities that will reduce public costs by preventing inappropriate land uses and development in areas where natural dynamic processes present a potential threat to the public health, safety, welfare, and property, to assure that potential buyers are notified of property located in an area of special flood hazard, and to assure that those who occupy areas of special flood hazard assume responsibility for their actions.
Santa Cruz County Community Emergency Response Team (CERT) (County of Santa Cruz 2021)	The CERT program trains volunteers in basic first aid, light search and rescue, and small fire suppression, and are closely associated with Santa Cruz County Fire Department. CERT volunteers may assist neighbors and other emergency personnel in times of emergency, and support evacuations along with other responsibilities.
Pacific Gas & Electric (PG&E) Climate Change Vulnerability Assessment and Resilience Strategies (Pacific Gas & Electric 2016)	The Climate Change Vulnerability Assessment and Resilience Strategies Report evaluates how key climate hazards (i.e., flooding, severe storms, sea level rise, subsidence, drought, wildfires, and extreme temperatures) have the potential to impact PG&E's assets and services, including disadvantaged communities' reliance on the delivery of continuous power, PG&E outlines its approach to engagement, emergency preparedness, and response planning. The Plan acknowledges the need to support disadvantaged communities and preferentially consider disadvantaged communities for grant funding.
Climate Change and Health Profile Report Santa Cruz County (CDPH 2017)	The Report details climate projections and related climate hazards, climate-related health risks, and the populations in Santa Cruz County that are most vulnerable to climate change impacts. The Report identifies vulnerable populations including individuals living in rural areas, children, older adults, non or limited English speakers, low income, outdoor workers, individuals with chronic health conditions, households with no car, adults educated less than high school, households with no air conditioning, and individuals living in nursing facilities, prisons, and college dorms. Climate hazards planned for include extreme heat, poor air quality/air pollution, wildfire, severe weather, extreme rainfall, flood, sea level rise, climate changes impacts on agriculture, drought, and climate change impacts mental and physical health.
County of Santa Cruz Local Hazard Mitigation Plan (County of Santa Cruz 2021)	The Plan assesses hazards within the County and identifies mitigation strategies that reduce or eliminate long-term risks to people and property from those hazards. Climate hazards planned for include wildfire, flooding, coastal storm, drought, landslide, sea level rise, coastal storm damage, erosion, and beach loss, extreme storm events, extreme heat.
County of Santa Cruz Master Emergency Services Plan (Santa Cruz County 2015)	The County Office of Emergency Services developed the Emergency Service Plan to provide guidance around response procedures in the event of a large-scale emergency or disaster in the unincorporated areas of the County. The Plan provides recommendations on disaster response in jurisdictions both within and outside of the unincorporated areas of Santa Cruz

Existing and Planned Programs, Plans, and Policies	Objectives
	County. Climate hazards planned for include flood, wildfire, extreme weather (strong storms, extreme cold, extreme drought, tule fog, high winds, and extreme heat), epidemics/pandemics, agricultural hazards, and dam failure. The Plan acknowledges that emergency planning must consider individuals with disabilities, chronic health conditions, illnesses, limited or non-English speaking proficiencies, older adults, children, low income, those experiencing homelessness, transit dependent, pregnant, and those living in institutionalized settings.
Santa Cruz County Emergency Operations Center (Santa Cruz County 2022)	The County’s Emergency Operations Center coordinates with the Santa Cruz County Office of Response, Recovery, and Resilience, medical centers, and other county agencies to lead response and recovery planning in the event of a large-scale public health threat in Santa Cruz County, including extreme heat, wildfire, severe weather, and natural disaster events. The program’s webpage does not provide resources for vulnerable populations.
United States Department of Agriculture’s (USDA) Disaster Assistance Programs	The USDA offers several programs that provide coverage for agricultural producers to help them manage risk and protect their operations from climate hazards and disasters. Assistance programs include the Agricultural Risk Coverage (ARC) and Price Loss Coverage (PLC) programs, Dairy Margin Coverage (DMC) program, Noninsured Crop Disaster Assistance Program, the Crop Insurance Program, Emergency Loan Program, and Disaster Set-Aside Program. The USDA programs help farmers protect and recover from drought, wildfire, and winter storms.