The San Francisco Bay Area spans nine counties and 100 cities and towns with a population of more than 7 million people and a $750 billion economy (~30% of California’s total). The Mediterranean climate, with mild, wet winters and a warm, sun-drenched summer, supports extraordinary biological diversity and a thriving wine and dairy industry. This report examines the potential impacts of 21st century climate change on the physical climate, social systems and built environment, and natural and agricultural systems of the Bay Area. The geography of the region sets the stage for understanding how rising temperatures, changes in precipitation and fog, and rising sea levels will impact the region (section 1). We then examine projected impacts on social systems and infrastructure, from coastal flooding to wildfire and public health, with attention to the effects of social inequity on the vulnerability and resilience of local communities (section 2). Finally, we examine the impacts of climate change on biodiversity and open space conservation, and the effects on agriculture, with a focus on vineyards and rangelands (section 3). Where possible, we summarize proposed climate mitigation and adaptation strategies in a regional context to highlight potential actions and solutions necessary to meet these diverse challenges.

The impacts of climate change are already being felt in the San Francisco Bay Area and Northern California.

- Overall, the Bay Area’s average annual maximum temperature increased by 1.7°F (0.95 °C) from 1950-2005.
- Several studies suggest that coastal fog along the California coast, so critical to our Bay Area climate, is less frequent than before.
- Sea level in the Bay Area has risen over 20 centimeters (8 inches) in the last 100 years.
- The powerful 2015-16 El Niño, one of the three largest in the historical record, resulted in winter wave energy that was over 50% larger than the typical winter in the Bay Area, driving unprecedented outer coast beach erosion.
- The 2012-2016 California drought led to the most severe moisture deficits in the last 1,200 years and a 1-in-500 year low in Sierra snowpack. The 2012-2016
record low snowpack resulted in $2.1 billion in economic losses and 21,000 jobs lost in the agricultural and recreational sectors statewide and exacerbated an ongoing trend of groundwater overdraft.

These changes are projected to increase significantly in the coming decades over the region.

• Even with substantial global efforts to reduce greenhouse gas emissions, the Bay Area will likely see a significant temperature increase by mid-century. By the end of the century, the difference between lower and higher global emissions scenarios will make a major difference in how much Bay Area temperatures rise.

• Precipitation in the Bay Area will continue to exhibit high year-to-year variability - “booms and busts” - with very wet and very dry years. The Bay Area’s largest winter storms will likely become more intense, and potentially more damaging, in the coming decades. Under a high emissions scenario, average Sierra Nevada snowpack is projected to decline by nearly 20% in the next 2-3 decades, 30% to 60% in mid-century and by over 80% in late century.

• Future increases in temperature, regardless of whether total precipitation goes up or down, will likely cause longer and deeper California droughts, posing major problems for water supplies, natural ecosystems, and agriculture.

• California’s Fourth Climate Change Assessment projects median sea level rise between 0.74 m (RCP 4.5) and 1.37 m (RCP8.5) for 2100 along the California coast. However, recent science studies, using advanced models and ice sheet observations, suggest the possibility of extensive loss from Antarctic ice sheets in the 21st century — possibly producing sea level rise by 2100 that could approach 3 meters.

• Even with high levels of emissions reductions, research now suggests that at least 2 meters of sea level rise is inevitable over the next several centuries due to the lag of sea level rise in response to increasing global temperatures.

Changes in temperature, precipitation, and sea level rise will produce substantial impacts on Bay Area social systems and the built environment.

• The three-way relationship between land use, transportation infrastructure, and energy systems — all of which are vulnerable to climate impacts — is perhaps the most critical interdependence in determining the future growth and prosperity of the Bay Area.

• Future land use decisions will significantly influence the Bay Area’s efforts to address climate change, affecting building and transportation energy, urban water demand, and wildfire ignitions. For example, the critical lack of affordable housing in the core of the region is forcing households further south, north, and inland, with negative energy and environmental consequences. At the same time,
building energy demand is higher in inland regions (warmer summers/cooler winters) so reducing Bay Area energy consumption will strongly depend on where new housing and business growth are located.

• Much of the Bay Area’s transportation system — airports, roads, and railways — is concentrated along the bay where flooding from sea level rise and storm surge is a major vulnerability.

• The Bay Area electrical grid is vulnerable to power outages during wind and wildfire events while much of our natural gas transmission system is located along waterways and will be impacted by flooding from sea level rise and extreme storm events.

• Warmer summers will increase summer energy demand across the region, with the largest increase expected in coastal cities as air conditioning adoption grows there.

• Climate impacts — such as earlier melting of snowpack, increasing seawater intrusion into groundwater, increased rates of evapotranspiration, and levee failures or subsidence that contaminate Delta supplies — will affect both the quantity of water available and the quality of supplies.

• Wastewater treatment plants, historically located along bay shorelines where effluent discharge was convenient, are now highly vulnerable to future sea level rise. Rising bay water and groundwater levels will also increase salinity intrusion and subsurface flooding. Climate change will require improved stormwater management in the Bay Area as extreme storm events increase in size and frequency.

• Bay Area public health is threatened by a number of climate-related changes, including more extreme heat events, increased air pollution from ozone formation and wildfires, longer and more frequent droughts, and flooding from sea level rise and high-intensity rain events.

• High levels of socioeconomic inequity in the Bay Area create large differences in the ability of individuals to prepare for and recover from heat waves, floods, and wildfires. Financial resources as well as improved social structures are important to enhance community resilience and reduce these disparities.

• Heat waves pose increased health risks due to urban heat islands and lack of local experience and cooling infrastructure (air conditioning) in bayside cities. These risks are compounded for low-income communities.

• Natural infrastructure can play an important role in climate change adaptation, enhancing biodiversity and ecosystem services while reducing societal risks.

• While bayside communities are on the front lines for future flood risk, many may have limited ability or resources to pursue adaptation strategies. Without
inclusive engagement among communities, disparities in economic and political power will undermine regional solutions and leave communities acting independently, with highly variable results for resilience and community health.

Climate change will produce substantial impacts on Bay Area natural and managed resource systems.

- The future climate of the Bay Area will become less suitable for evergreen forests — redwoods and Douglas fir — and more favorable for hot adapted vegetation such as chaparral shrub land.

- The ability of vegetation to respond to the rapidly changing conditions in the 21st century is poorly understood. It is possible that vegetation will be increasingly “out of sync” with climate and vulnerable to heat and drought.

- The most threatening effect of climate change to Bay Area wildlife is the impact of rising sea levels on wetlands because of the limited potential for wetlands to move inland and become established. At the same time, less rainfall, more summer heat, and increased drought will hurt amphibians and reptiles, while heat and wildfires may negatively affect upland birds, mammals, amphibians, and reptiles. Some wildlife species may need to shift locations as the vegetation they inhabit transforms with a changing climate.

- The Bay Area’s mild climate and accessible open spaces are vital to the region’s quality of life. Regional conservation efforts, including coordinated open space protection design and implementation of landscape corridors, climate-smart conservation, and restoration practices, will enhance success in a changing climate.

- In the Bay Area, future fire activity will be driven by both changes in urban development and in climate. Land use planning, together with fire-safe building standards and near-building vegetation management, are important strategies for managing future fire risk to people and structures.

- Forests can play an important role in carbon sequestration. Fuel and fire management will be critical, as fire is the primary source of carbon loss from forests. Recently, carbon loss from fires exceeded carbon uptake by vegetation in California.

- Nearly every aspect of Bay-Delta ecosystems will be affected by climate change as a result of rising sea levels, increases in air temperatures, changes in precipitation, changes in sediment supply and more. All natural areas of the shore will need to adapt or transform.

- The interruption of natural processes over the past 200 years as the region has developed has decreased natural Bay-Delta resiliency. A dynamic, resilient ecosystem has become a rigid landscape with brittle features that will have
trouble adapting. New approaches that use natural shoreline infrastructure, like beaches, marshes, and mudflats, together with managed retreat where necessary, can create more resilient shorelines that respond well to changing conditions.

• Nearly 70% of California’s existing area of wine production will be vulnerable under future climate change projections by mid-century. Wine grape production in the Bay Area could be vulnerable to extreme temperatures and temperature-related water scarcity.

• The sensitivity of Bay Area rangeland vegetation to precipitation dynamics makes these ecosystems particularly vulnerable to climate change. Changes in rainfall regimes are also likely to affect plant production and associated patterns in soil carbon and greenhouse gas production. Grazing and rangeland management practices can play a significant role in enhancing soil moisture and belowground carbon sequestration. Current research highlights the potential role of compost together with grazing on California pasturelands as a targeted strategy to increase carbon sequestration.

A growing number of Bay Area local governments, regional agencies, nonprofits, and private sector stakeholders are taking actions that advance climate adaptation and resilience.

• Projects include comprehensive vulnerability assessments, plans for infrastructure improvements, new governance structures, and actual on-the-ground projects to address sea level rise, drought and other climate impacts.

• Examples include Resilient by Design: Bay Area Challenge, the Sonoma County Regional Climate Authority, Adaptation to Rising Tides, the Bay Area Regional Reliability Project, Bay Area Regional Health Inequities Initiative (BARHII), San Francisco Climate & Health Profile, RISer SF Bay, Marin County C-SMART, Sea Change San Mateo County, Climate Ready North Bay, and the San Francisco Bay Restoration Authority

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