northbay CLIMATE ADAPTATION INITIATIVE

Climate Ready North Bay

Fact Sheet Series



Climate Change in the North Bay

for residents of Marin, Sonoma and Napa counties



Inside Learn About:

Current Climate Trends

What to Expect for the Future

How We Can Be Prepared

Climate Change in the North Bay

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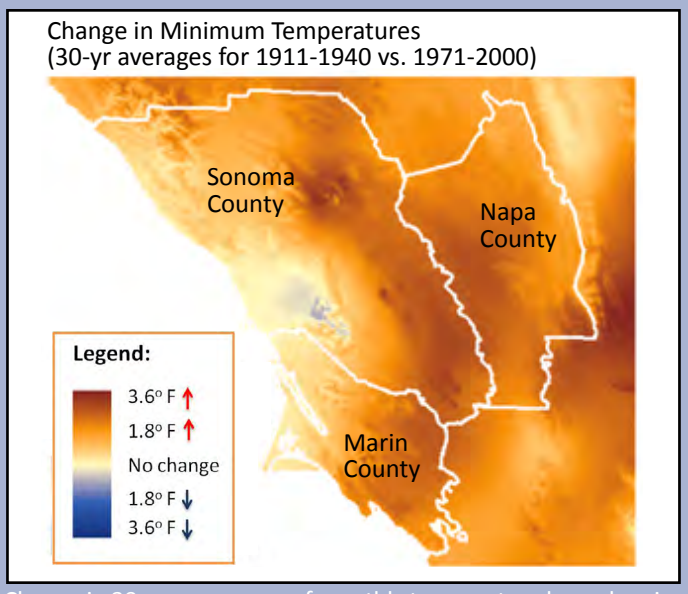
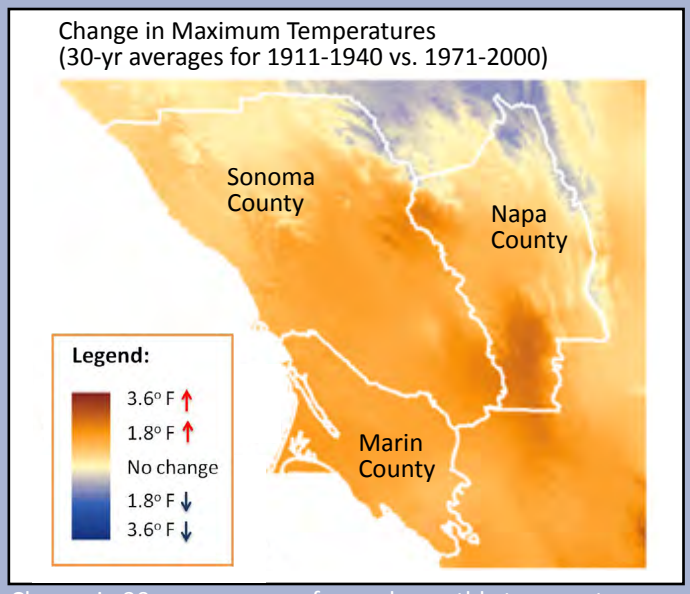
As over the rest of the globe, the climate in the North Bay region has already started changing in response to greenhouse gas emissions.[1] By looking at long-term weather station data, scientists have been able to confirm that our climate has warmed compared to the historical record.[2] Between 1911 and 2000, average maximum temperatures have increased approximately 1.0 °F while average minimum temperatures have increased approximately 1.7 °F.[3] The maps below depict changes in monthly maximum and minimum temperatures averaged over the last 30 years (1971-2010) compared to a pre-climate change period of the same duration (1911-1940). While some parts of the region (in blue) have cooled over this time period, *the overall warming trend (in orange) is clear across the region.*

Recent climate trends in the North Bay



Change in 30-year averages of monthly temperature lows showing an average warming trend for the region of approximately 1.7 °F



Change in 30-year averages for peak monthly temperatures, showing a warming trend for the region of approximately 1.0 °F

Maps produced from California Basin Characterization Model data (Flint and Flint, USGS) available on the California Climate Commons.

Why should we care?

Changing temperatures are already starting to impact our communities in terms of personal health and energy, water and land use. This is because climate dictates:

- The quantity and quality of our water supply and patterns of water demand
- Rates and patterns of commercial and residential energy use
- How and where farmers can grow crops
- Health risks for vulnerable populations including the very young and elderly

By raising awareness in our community about the impacts of weather variability in our own region, we can prepare for the future through effective long-term planning.

* Cover photo, top center: Julie Jedlicka, PhD and Matthew Poonamallee install a songbird nest in a Hopland, CA Vineyard. Photo by Laura Barrow.

1 Hansen, J et al., 2001. A Closer Look at United States and Global Surface Temperature Change. *J. Geophys. Res.*, 106, 23947-23963, doi:10.1029/2001JD000354.
2 Micheli, L et al., 2012. Downscaling Future Climate Projections to the Watershed Scale. *San Francisco Estuary and Watershed Science*, 10(4), jmie_sfews_11170.
3 USGS. Flint, L and Flint, A, 2011. California Basin Characterization Model (BCM) Downscaled Climate Surfaces. *California Climate Commons,* Petaluma, CA.

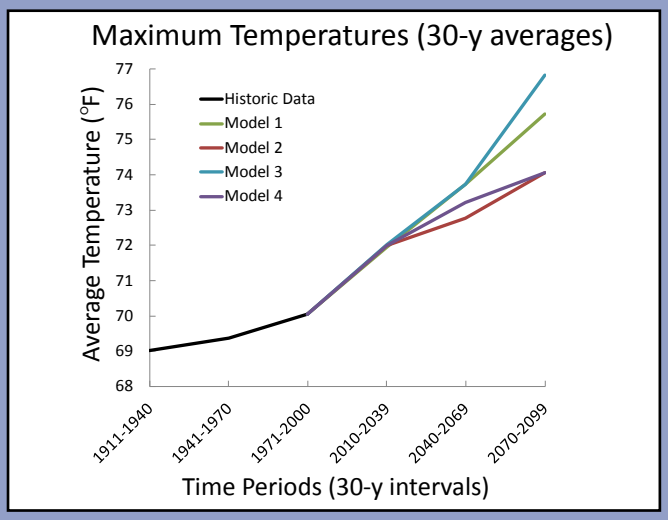
What Can We Expect For A Future Climate?

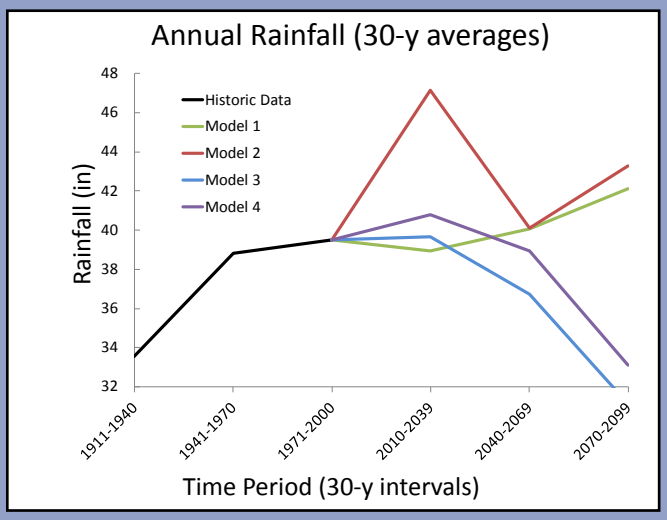
In 2007 the international scientific community released a set of future climate scenarios for the globe based on state-of-the-art computer models.[4]

Since their release, US Geologic Survey scientists have been downscaling these global climate models to assess potential impacts to our local area. The scenarios developed reflect a range of reasonable assumptions regarding future social and technological conditions, including whether or not we reduce greenhouse gas emissions.[5]

Depicted below are projections of temperature and rainfall using four future climate scenarios for our region. These models represent two different computer algorithms each combined with optimistic and pessimistic amounts of greenhouse gas reductions.

Regional temperatures and rainfall, 1911-2099





These graphs depict historical and potential future trends in 30-year averages of maximum temperatures and rainfall for the three-county North Bay region. Historical data is shown in black, while future scenarios created from four different global climate models are depicted in red, blue, green, and purple. While there is a consistent trend among models towards increasing temperatures across the region, the models show a range of possibilities for local rainfall in a changing future climate.

Warmer seasons, uncertain rainfall

Model results suggest that we should anticipate summer temperatures increasing by approximately 6 to 8 °F, on average, in our region by approximately the end of the century. These estimates are similar to temperature increases projected for the globe as a whole. In terms of rainfall, two of the scenarios above project lower precipitation in the future and two project higher precipitation. However all scenarios indicate more weather variability in the future compared to historical long-term averages, with a likelihood of an increase in the frequency and intensity of extreme events such as droughts and floods.[6]

4 IPCC, 2007. Climate Change 2007: Synthesis Report. Core Writing Team, Pachauri, R and Reisinger, A (eds.). IPCC, Geneva, Switzerland, 104 pp.
5 Same as reference 3.
6 Flint, L and Flint, A, 2012. Downscaling future climate scenarios to fine scales for hydrologic and ecological modeling and analysis. *Ecological Processes*, 1.

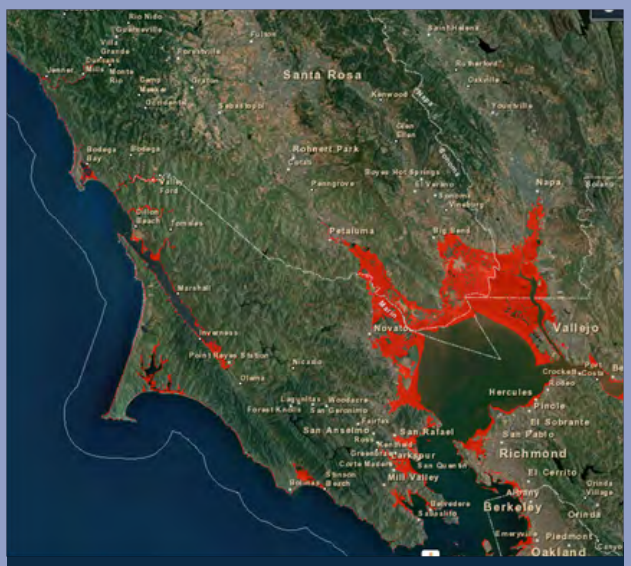
Rising tides

The tides of the ocean and bay bordering the North Bay region are projected to increase in elevation in response to increasing global temperatures. This sea level rise effect, which is anticipated to exceed 5 feet by the end of the century, will result in more frequent flood inundation of low-lying areas of the North San Francisco Bay Estuary (San Pablo Bay) shoreline and coastal regions of the region, with the greatest impact anticipated during winter storm events.[7,8] Flood risks will be greatest, as at present, where freshwater streams and rivers meet the estuary or the ocean. Sea level rise will cause flooding to occur more frequently and last for longer durations of time in regions shaded red in the map to the right.

Shorter winters, longer and drier summers, more extreme weather events

Our region is famous for its arid Mediterranean climate featuring an extended dry season from approximately April through November. Localized climate projections suggest that our climate is likely to become increasingly arid. Watershed models project potentially shorter, wet winters and longer, drier summers for our region. Whether we experience more or less rain during the wintertime, it is expected that more of it will arrive in extreme events, rather than spread out evenly over the wet season. Even with a wetter winter, measures of drought stress on soils in late summer are projected to increase approximately 10%.[9]

North Bay sea level rise



Shallow Coastal Flooding Areas

The red layer represents areas currently subject to shallow coastal flooding. A sea level rise of 3 feet is estimated to increase the number of days of flooding per year in these areas by a factor of 150.

Projected shifts in weather can trigger a cascade of effects including the following:

- Increased demand on surface water supplies, reduced groundwater recharge and stream flows[10]
- Change in forest vegetation from woody tree species to more shrubs and grasses[11]
- Changes in land suitability for agriculture, including appropriate crop varietal distributions[12]
- Increased fire risk due to more flammable vegetation and drier end of summer season conditions[13]
- Potential increases in pest and disease vectors due to reduced frost frequency[14]

Scientists are currently working on how to best estimate the secondary effects climate change may cause in our region.

7 Cayan, D et al., 2008. Climate Change Projections of Sea Level Extremes Along the California Coast. *Climatic Change,* 87:57–73, doi: 10.1007/s10584-007-9376-7.
8 Knowles, N, 2010. Potential Inundation Due to Rising Sea Levels in the San Francisco Bay Region. *San Francisco Estuary and Watershed Science,* 8.
9 Same as reference 3.
10 Micheli, L et al., 2010. Adapting to Climate Change State of the Science for North Bay Watersheds: A Guide for Managers. North Bay Watershed Association, Novato, CA.
11 Cornwell, W et al., 2012. Climate Change Impacts on California Vegetation: Physiology, Life History, and Ecosystem Change. California Energy Commission, CEC-500-2012-023.
12 Ekstrom, J and Moser, S, 2012. Climate Change Impacts, Vulnerabilities, and Adaptation in the San Francisco Bay Area: A Synthesis of PIER Program Reports and Other Relevant Research. California Energy Commission, CEC-500-2012-071.
13 Krawchuk, M and Moritz, M, 2012. Fire and Climate Change in California: Changes in the Distribution and Frequency of Fire in Climates of the Future and Recent Past (1911–2099). California Energy Commission, CEC-500-2012-026/CEC-500-2012-026.
14 National Environmental Education Foundation, 2012. Climate Change and Health Fact Sheet.

What Are The Challenges We May Face?

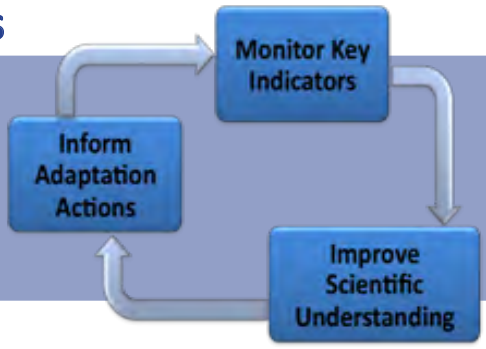
- Future weather patterns will be significantly different from those experienced over the past century
- Coastal ecosystems and human infrastructure will be at increased vulnerability to sea level rise inundation and storm induced flooding
- Rising temperatures and more unpredictable rainfall patterns will put increased pressure on our limited water resources and result in a more arid environment
- There will likely be increased risks of drought, flood, fire, and heat-related health emergencies

Working together, we can reduce risks and uncertainties

- By supporting world-wide reductions in greenhouse gas emissions, we can reduce the risks of warming climates
- New research will help us better understand the mechanics of winter storms and fog patterns which provide moisture and cool the land[15]
- By using the new climate scenarios available to us, local policy makers can start to take climate change into account in long-term planning for environmental protection, infrastructure, and human health

Real-time monitoring will help us minimize our risks

Scientists are working to reduce risks by monitoring the actual patterns of changing weather and its effects. We need to maintain the weather stations, stream gages, and other environmental sensors we already have in the North Bay and we need to improve the consistency, density, and coordination of these measurements across the region.



Sources of climate resilience

Climate resilience is defined as the ability of a landscape or community to adapt to climate change without sacrificing key attributes or functions. Our coastal location means we will continue to benefit from the cooling effect of the ocean on the land. The diversity of our microclimates in the valleys and mountains of the Coast Range is also an asset because there will remain relatively cool refuges for people and natural resources.[16] Our public institutions will boost our resilience if we can find ways to work together to prepare for the challenges which lie ahead.

Learn more

North Bay Climate Adaptation Initiative | www.northbayclimate.org
California Climate Change Portal | http://climatechange.ca.gov
San Francisco Bay Area Climate Action Portal | http://ca-ilg.org/sf-bay-area-climate-portal
The California Climate Commons | http://climate.calcommons.org

The North Bay Climate Smart fact sheet series is a project of the North Bay Climate Adaptation Initiative (NBCAI). NBCAI is a coalition of natural resource managers, policy makers and scientists working to identify and promote effective climate adaptation strategies that sustain the ecological and human communities of the North Bay watersheds. This document is also available at www.northbayclimate.org.

15 Ralph, F et al., 2006. Flooding on California's Russian River: Role of Atmospheric Rivers. *Geophys. Res.,* Lett., 33, L13801, doi:10.1029/2006GL026689.
16 The Resource Innovation Group, 2012. Toward a Resilient Watershed: Addressing Climate Change Planning in Watershed Assessments.

