

Global warming basics for the Bay Area

A handout for 2020 King Tides walks

What is global warming? Since the late 19th Century, Earth's surface temperature has risen more than 2 ° F (1.2° C). The rate of warming is increasing. Overwhelming evidence shows that this is due to human activities that increase the atmosphere's content of greenhouse gases – mainly carbon dioxide but also methane, nitrous oxide, and others. By reflecting infrared energy back to the earth, these gases form a heat-trapping blanket that warms the earth.

This warming climate is undermining earth's systems in many ways, including melting glaciers and ice caps; loss of snow cover; changing patterns of rainfall, storms, and drought; sea-level rise due to both melting ice and expansion of warming sea water; and increasingly acidic ocean waters as the seas absorb more carbon dioxide.

What does global warming mean for the Bay Area? For the Bay Area, likely effects, some already evident, include stronger storms, longer and more extreme hot spells and droughts, more and fiercer wildfires, less fog (though trends in rainfall are uncertain), uncertain water supplies due to lessened and earlier snowmelt, and change and loss in plant and animal communities. As offshore waters become more acidic, marine animals from microscopic floating creatures to corals, clams, oysters, and crabs are finding it harder to form the shells they need.

Economic and public-health effects could range from dangerous heat waves and new epidemics; through decline of agriculture including wine-grape growing ; to destruction of infrastructure by storms, fire, and rising seas (especially because transportation, utilities, and industry are clustered along Bay Area shorelines). Low-income communities are particularly likely to suffer from effects from job loss to flooding of low-lying neighborhoods, more air pollution, and lack of cooling.

The most visible effects in the Bay Area are likely to come from sea-level rise. After rising about 8" since 1880, Bay Area sea level is expected to rise another ½ to 2 ft. by 2050 and 2 to 6 ½ feet by 2100 (up to 10 feet if the Greenland and Antarctic Ice Sheets melt quickly). The means increased flooding along shorelines as well as inland along tidal channels and in low-lying neighborhoods. San Francisco and Oakland airports, the Bay Bridge toll plaza, San Francisco's Ferry Building, Highway 37 across the North Bay are just a few landmarks likely to flood regularly without costly protections. Thousands more homes and businesses are in similar situations. Rising groundwater tables and salt infiltrating inland will bring other problems.

But oceans do not just rise quietly, like a filling bathtub. Most damage comes when high tides, storms, large waves, and heavy freshwater runoff coincide, accelerating erosion. Rising sea level can make these worse: Waves become more powerful as they move across longer stretches of deeper water. Coastal marshes that can tamp down wave battering are drowned. A 2019 study by US Geological Survey researchers estimated that these factors could about triple damage done by rising seas alone. Aside from beaches washing away and bluffs collapsing, and loss of many of our loveliest natural areas, coastal erosion could release pollutants buried in dozens of old landfills and capped industrial sites along the Bay shore.

To protect the people and places we love from challenges faced by sea-level rise, we will need all of the following:

- ***Slow climate change by reducing emissions of greenhouse gases:*** We can generate energy with sun, wind, tides, or other methods that produce little or no greenhouse gases. We can use low-emissions transportation and build to reduce transportation needs. We can improve energy efficiency of buildings, industry, and farming. We can reduce waste, avoiding both energy-wasting overproduction and methane emissions from burial in landfills . We can increase carbon storage (sequestration), in soil and plants or perhaps by as-yet-undeveloped engineered methods. We can take political action, for example with regulations, a carbon tax, or cap-and-trade programs. Significant effects will require collective action.

- ***Harden and build higher and drier:*** We can build, raise, or strengthen levees. We can build dams, gates, or locks to control tidal flows. We can strengthen bridges, docks, and seawalls against higher waves and storm surge, and strengthen and protect tunnels and pipes that are below high-tide levels. We can elevate building pads or other surfaces. This will cost billions and require unprecedented planning and cooperation.
- ***Accommodate:*** We can build floating buildings, docks, and bridges. We can build to accommodate floods, from building on piers to using ponds and permeable surfaces to manage floodwaters. We can accept that some roads, parks, etc. will be temporarily inaccessible.
- ***Maintain and increase tidal marshes and “living shorelines”*** that can absorb waves and surges. Coastal wetlands, such as salt marshes, also can capture and store carbon. We can provide corridors or move plants and animals deliberately to areas where they can survive. These efforts can ease or delay problems but cannot solve them.
- ***Move:*** We can move houses, roads, and critical infrastructure such as pipelines, railroads, and airports away from the Bay shore, low-lying areas that can flood, and areas that have subsided below sea level (mainly in the South Bay and Delta). History suggests that people will resist relocation.

You can join in actions that will protect us:

- ***Reduce your carbon footprint – the amount of greenhouse-gas emissions you cause.*** You can estimate your household’s greenhouse-gas emissions and get ideas on reducing them with a carbon-footprint calculator, like these from the [Nature Conservancy](#) or [UC Berkeley](#). Many actions can help – including what you eat, how you garden, what and how much you buy, and how you deal with waste. But as the calculators show, for most households, the biggest effects are likely to come from housing and transportation. Possibilities include dense housing; good insulation and energy-efficient appliances; switching to green energy providers and/or solar power; and using an electric vehicle or transit, cycling, and walking. These changes by individuals add up – but they will not solve the problem.
- ***Support and work for candidates, laws, policies, plans, and funding that deal realistically with global warming.*** Most of the burden of dealing with sea-level rise is being left to local jurisdictions. Climate action plans are required in all cities. Your city’s clerk or Sustainability Committee/Commission can guide you to what your city is doing and how you can get involved. You can support city and county actions such as increasing housing density, adopting energy-saving building codes, reducing waste, and funding needed infrastructure.

Effective action will almost certainly require unprecedented regional cooperation, difficult tradeoffs, and large new funding sources. You can support and get involved in regional planning efforts. [Adapting to Rising Tides](#) is the Bay Conservation and Development Commission, Metropolitan Transportation Commission, and Association of Bay Area Governments effort to help with regional planning. [Resilient by Design: Bay Area Challenge](#) is a Rockefeller -funded effort aiming to spark innovation and local initiatives. The [San Francisco Bay Restoration Authority](#), funded by the voter-approved Measure AA levy, provides grants for restoration of natural areas that can help reduce effects of climate change or protect species. More-local efforts include Sea Change San Mateo County, Marin County C-Smart, and Climate Ready North Bay.

You can learn about, support, or seek to change state legislation and programs such as cap-and-trade and emissions targets, as well as related laws and policies dealing with varied areas such as water use and conservation, recycling, housing, and natural-resources management from wetlands restoration to wildfire preparedness and management. Much of this may be best done through organizations including the ones below

- **Support and volunteer with nonprofits.** Nonprofit organizations offer individuals many ways to contribute to the joint action we need to combat global warming. Work on climate initiatives ranges from public education and hands-on efforts like planting trees, through research and political and legal action on the state and federal levels. Here is a far-from-exhaustive list that can start you toward finding efforts that seem effective and meaningful: [350.org](#), [Asian Pacific Environmental Network](#), [Baykeeper](#), [Center for Biological Diversity](#), [Citizens Climate Lobby](#), [Communities for a Better Environment](#), [Ecology Center](#), [Environmental Defense Fund](#), [GRID Alternatives](#), [Natural Resources Defense Council](#), [Pacific Institute](#), [Save the Bay](#), [Sierra Club](#), [Sunwork](#), [Union of Concerned Scientists](#).

Citizen-science projects let individuals and groups contribute to knowledge and can lead to action. A giant, searchable catalog of projects is at [scistarter.org](#). The [California King Tides Initiative](#) involves citizens in photographing rising seas.

Where to learn more:

Maps: Several sets of maps let you explore likely effects of sea-level rise in the Bay Area (though none really deal with the combined effects of heavy rains, flooding streams, soil conditions, erosion, or buried toxics).

- [Adapting to Rising Tides Bay Shoreline Flood Explorer](#), perhaps the most recent and detailed, developed for agencies.
- [National Oceanic and Atmospheric Administration Sea Level Rise Viewer](#) (nationwide, zoom in); uses a slider to show flooding at up to 6 ft. of sea-level rise. Also data related to water depth, connectivity, flood frequency, socio-economic vulnerability, wetland loss and migration, and mapping confidence.
- [Our Coast Our Future \(OCOF\)](#), developed by Point Blue, USGS, and NOAA, covers most of urbanized California coast including San Francisco Bay, lets you explore by storm conditions as well as sea-level rise.
- [Surging Seas Risk Finder](#), developed by nonprofit Climate Central and Zillow, maps of areas below different amounts of sea level rise and flooding, down to neighborhood scale, matched with area timelines of risk, and searchable by parcels. The tool also provides statistics of population, homes and land affected by city, county and state, plus links to more data.

Reports and other information

- The Bay Conservation and Development Commission's [Adapting to Rising Tides](#), guidance for agencies dealing with climate-change challenges in the Bay Area.
- [California's Fourth Climate Change Assessment, San Francisco Bay Area Region Report](#), 2018: Most recent; work by prominent researchers funded by state agencies:
- [Preparing for Rising Seas: How the State Can Help Support Local Climate Adaptation Efforts](#), California Legislative Analyst, 2019/
- [Impacts of Sea Level Rise on the San Francisco Bay, 2012](#), Pacific Institute.
- The [California Landscape Commons Partnership's Climate Commons](#) has links to many reports and tools on all aspects of climate change in the state.
- Cal-Adapt, <https://cal-adapt.org/>, is a repository of datasets useful for research, developed by UC Berkeley

This handout is a work in progress. Please email f5creeks@gmail.com with corrections and suggestions.