

## Climate Vulnerability Indicators in the California Integrated Assessment of Watershed Health

### Overview

The California Integrated Assessment of Watershed Health includes an innovative index of the vulnerability of watersheds to a changing climate across the State. Projected changes in key parameters selected to identify climate trends related to water temperature, streamflow, snowpack and runoff are evaluated to map the relative vulnerability of watersheds to climate change. These climate change vulnerability maps can be used by State policy makers to incorporate climate change considerations are incorporated into every day programmatic decisions.

### Background

Climate change is significantly altering hydrological, runoff, and precipitation patterns in California, which challenges water supply, quantity, and even ecosystem functions. The resulting effects on streamflow, erosion patterns, and pollution loading to waterbodies have caused concern for long term effects on water quality. The Integrated Assessment of Watershed Health was created to identify healthy freshwater watersheds, as well as characterize relative watershed health to guide State protection initiatives. The main goals of the Assessment are to:

- 1) Integrate multi-disciplinary data to identify and quantitatively characterize the relative health of watersheds at various spatial and temporal scales;
- 2) Make watershed data and information readily available to a variety of state, federal, and local programs for watershed protection planning; and
- 3) Ensure a consistent, unified approach for comparing the health of watersheds across the State that would encourage interagency coordination.

A total of 23 indicators are used to characterize the relative health and vulnerability of California's watersheds. To combine this information for reporting and application, indicators are aggregated into 12 indices of watershed condition, stream health, and watershed vulnerability. Each index merges related indicators into an overall score that ranges from 0 to 1, with 1 representing the best condition in the State. The State uses several indicators and parameters identified as

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key for detecting climate change related trends. Overall, the Assessment helps determine the impacts of climate change by providing a framework to evaluate watershed health consistently across the State.

### Climate Change Condition and Vulnerability Indicators

The Assessment characterizes relative watershed health using a collection of indicators for watershed condition, stream health, and watershed vulnerability, which includes a specific focus on climate change related impacts. Climate change is considered in the Assessment in two ways. First, watershed condition is evaluated using several assessment parameters including water temperature, pH, conductivity, turbidity, and nitrate concentration. Second, the Assessment quantifies overall watershed vulnerability from a collection of indicators that characterize potential exposure to future climate, land use, water use, and wildfire risk (see box).

The Assessment specifically addresses climate change vulnerability based on projected changes in seven indicators (See box). Projections of future climate and hydrology acquired from [Cal-Adapt](#) were included to quantify the climate change indicators and characterize the vulnerability of California's watersheds to climate change. The *Cal-Adapt* tool assembles a variety of data sources to display climate

scenarios for California on a regional level and provide a general understanding of the types of changes that can be expected. The climate projection data can also be used by managers to conduct more localized vulnerability assessments.

## Integrated Watershed Assessment Indicators

### Condition

- Water Temperature
- pH
- Conductivity
- Turbidity
- Nitrate Concentration

### Watershed Vulnerability

- Climate Change
- Land Use
- Water Use
- Wildfire Risk

### Indicators of Climate Change Vulnerability

- Projected change in precipitation
- Projected change in mean temperature
- Projected change in minimum temperature
- Projected change in maximum temperature
- Projected change in snowpack
- Projected change in baseflow
- Projected change in surface runoff

Using the information generated from the Assessment, watershed vulnerability index maps are created on a state-wide scale to help managers identify areas with highest and lowest vulnerability for each climate related parameter, offering an approximation of the potential for aquatic ecosystem degradation due to climate change. (Figure 1) These maps are the main products of the Assessment, which can be used by both water management staff and policy makers to incorporate climate change considerations into every day programmatic decisions.

The data analysis and monitoring framework contained in the Assessment not only serve as a tool to help managers identify climate trends, but also incorporate climate change impacts and anticipated environmental stressors when detecting watershed needs. This effort also offers a general framework to better

quantify the physical, biological, and chemical integrity components and processes that states must consider when addressing water quality under the Clean Water Act. The [Healthy Watershed Partnership](#) is looking into building upon the framework established by the Assessment and plans to make the Assessment more robust for informing management decisions affecting California waterbodies. Overall, the Assessment serves as a model for including current and future impacts of climate change when performing watershed assessments. Using this approach, a state can prioritize watersheds for protection and restoration within the context of a changing climate.

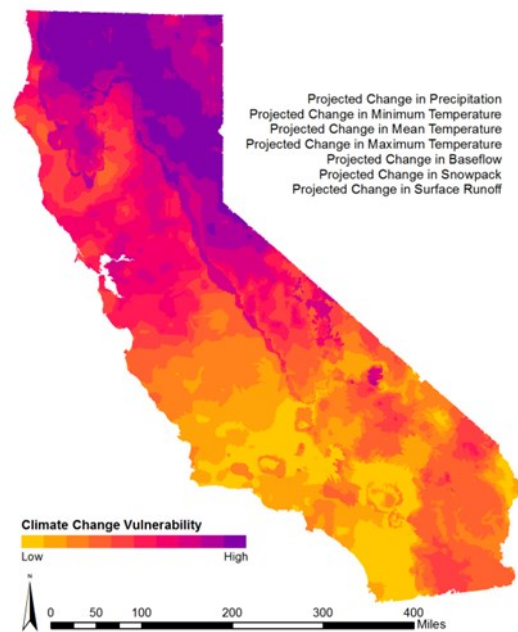


FIGURE 48. CLIMATE CHANGE VULNERABILITY INDEX SCORES.

**Figure 1.** A Climate Change Vulnerability Index map of California State that shows areas of low to high vulnerability based on projected changes in the seven indicators listed above.