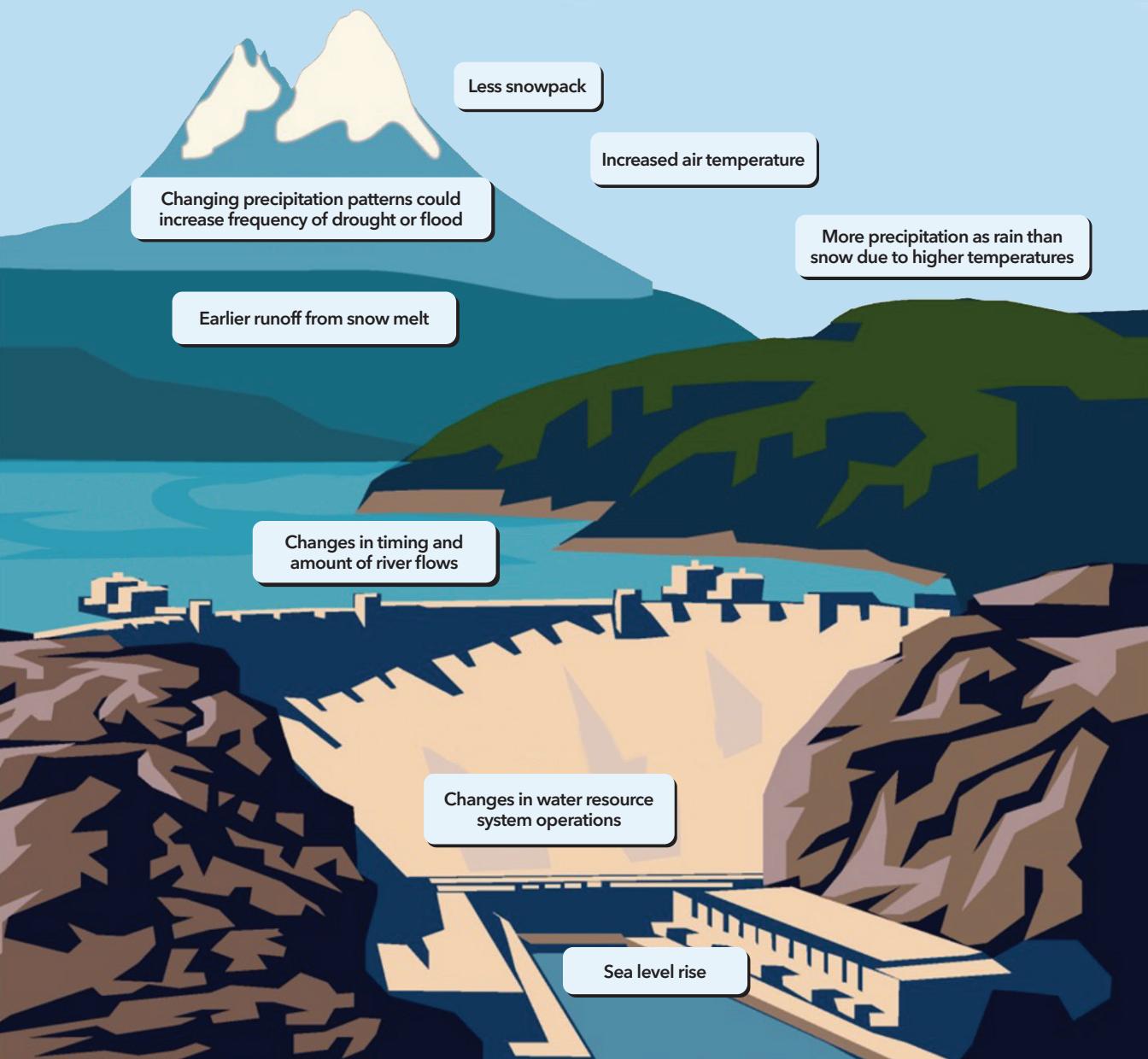


WATER SECTOR CLIMATE CHANGE VULNERABILITIES

Climate change is having a profound impact on California's water resources, as evidenced by lower water supply reliability, greater weather extremes, reduced snowpack, higher sea level, and changes in river flows. Further impacts include:



Less snowpack

Increased air temperature

Changing precipitation patterns could increase frequency of drought or flood

More precipitation as rain than snow due to higher temperatures

Earlier runoff from snow melt

Changes in timing and amount of river flows

Changes in water resource system operations

Sea level rise

Temperature

In the Feather River watershed, where Lake Oroville reservoir is located, average annual temperatures have increased by about 2.3°F since 1980 and average annual minimum temperatures have warmed by 3.5°F, affecting rain and snow patterns.

Snowpack and Snow Water Equivalent

Average snow water equivalent, the amount of water stored in the Sierra snowpack on April 1st, has fallen by 11 percent since 1980, representing a fundamental change in the amount of water being stored in the snowpack and a significant change in the conditions that water managers are facing.

Weather Events

Climate models indicate we are likely to see larger and warmer storms, resulting in increased rainfall and flooding. While we have begun to observe such events in recent years, they have not yielded reliable supply, highlighting the short term, high intensity characteristics of these events.

Precipitation

In the Feather River watershed, the annual variability of precipitation has increased, with 40 percent more annual variability since 1980, leading to drier dries and wetter wets. California has always had high inter-annual variability of precipitation; however, this level of variability is higher than at any time in the last 1,100 years.

Runoff Timing

Warming temperatures have increased the proportion of precipitation that falls as rain. This leads to a higher elevation snowpack and less snowmelt for our water supply in the spring and summer. Additionally, this has led to an increase in peak flows of rivers earlier in the year.

Sea Level Rise

Sea level rise threatens coastal communities and the health of the Sacramento-San Joaquin Delta, the heart of California's water supply system. This could lead to flooding of low-lying areas, loss of coastal wetlands and other ecosystem impacts, saltwater contamination of drinking water, impacts on roads and bridges, and increased stress on levees.

Drought

California is facing a significant drought in the wake of one the driest and warmest periods ever on record. While droughts are a reoccurring feature of California's climate, increasing temperatures exacerbate the severity of dry conditions and are changing historical relationships among temperature, precipitation, and runoff. Climate change means that we will see more frequent and severe droughts in California.

Wildfire

Climate change is making conditions in California warmer and drier, leading to longer periods of drought and extending our wildfire season. Many of the largest and most destructive wildfires

in California have occurred in this century. These larger and more severe wildfires could lead to changes in runoff timing and water quality in watersheds affected by fire, such as the Feather River watershed.

Groundwater

Changes in precipitation, reduced snowpack, and more frequent droughts are likely to increase the demand on groundwater sources, risking overdraft, ground subsidence, and decreased water quality.

Flood

Communities throughout the state are threatened by the current and future effects of climate change on hydrology, such as increases in precipitation falling as rain instead of snow at higher elevations, extreme precipitation events fueled by atmospheric rivers, and runoff events that can exceed flood system design capacity.

Climate refers to conditions, such as temperature and precipitation, measured over an extended period of time. Most of California has a "Mediterranean climate," of hot, dry summers and mild, wet winters, and high annual precipitation variability.

Climate Change is caused by gases in the earth's atmosphere that trap heat like a blanket. Increasing emissions of carbon dioxide (CO₂) from the burning of fossil fuels and of methane (CH₄) thicken this blanket and increase earth's "greenhouse effect".



DWR IS COMMITTED TO BUILDING RESILIENCY IN WATER MANAGEMENT BY PREVENTING, PREPARING FOR, AND ADAPTING TO CLIMATE CHANGE. ACTIONS COMPLETED SINCE DWR FORMALLY LAUNCHED ITS CLIMATE CHANGE PROGRAM IN 2009, INCLUDE:

Preventing Climate Change: Mitigation Actions

Mitigation for climate change refers to reducing greenhouse gas emissions. In 2012, DWR adopted [Phase I](#) of its Climate Action Plan and has consistently outperformed its greenhouse gas (GHG) reduction goals. For its achievements in GHG management and organizational leadership, DWR has won several national Climate Leadership Awards. Updated in 2020, DWR's current emissions reduction goals are:

- Mid-term Goal – By 2030, reduce GHG emissions to at least 60 percent below the 1990 level.
- Long-term Goal – By 2045, supply 100 percent of electricity load with zero-carbon resources and achieve carbon neutrality.
- In 2023, DWR will amend Climate Action Plan Phase I to meet recent legislative changes, such as Senate Bill 1203, which requires net-zero emissions of greenhouse gases for all state agency operations by 2035.

These goals will be achieved through several different strategies, including:

- Increasing the efficiency of State Water Project pumps and generators through replacement and refurbishment.
- Increasing the use of renewable energy to operate the State Water Project.
- Sequestering carbon through environmental restoration activities.

Understanding and Adapting to Climate Change

In 2018, DWR adopted [Phase II](#) of its Climate Action Plan by establishing a Department-wide policy for incorporating climate change impact analysis into its activities, including strategic planning documents, investment decisions, risk assessments, and infrastructure development.

In 2019, DWR produced a Climate Change Vulnerability Assessment of DWR owned and operated facilities and activities performed by DWR, as part of its Climate Action Plan [Phase III](#). The Adaptation Plan, released in 2020, prioritizes four key assets vulnerable to climate change impacts, all of which are critical to DWR's core function: staff safety; State Water Project (SWP); Upper Feather River watershed; and Landscapes (Ecosystems and Habitats).

For more information, see [DWR Hydroclimate Reports](#)





Building Resiliency in Water Management

DWR promotes adaptation strategies that ensure our water resources are resilient. What are some examples of multi-sector adaptations being led by DWR?

California Water Plan Update 2023:

The California Water Plan is the State's strategic plan for sustainably and equitably managing and developing water resources for current and future generations. The Plan focuses on future scenarios for climate change and includes adaptation strategies utilizing risk-based vulnerability assessments.

Central Valley Flood Protection Plan:

The Central Valley Flood Protection Plan is California's strategic blueprint to improve flood risk management in the Central Valley. The plan draws on the latest climate science and understanding to assess the effects of sea level rise and hydrological impacts to support a systemwide plan for the Central Valley.

State Water Project:

Current planning investigations in resiliency include the Delta Conveyance Project, which would help protect Delta water supplies from sea level rise and increase operational flexibility to protect fisheries. Also, new facilities being investigated at Oroville reservoir would allow SWP to resume energy storage and pump back operations while protecting downstream river temperatures for fish. Additionally, SWP has already contributed to the restoration of 1,500 acres of mountain meadow habitat in the Feather River watershed that provide water supply, flood, and ecosystem benefits in support of system resilience.

San Joaquin Watershed Studies:

DWR, with local and regional partners, are conducting cutting-edge climate vulnerability assessments and adaptation strategy evaluations for the tributary watersheds of the San Joaquin Basin, including Calaveras, Stanislaus, Tuolumne, and Upper San Joaquin watersheds. A similar pilot assessment for the Merced watershed has demonstrated that at a watershed scale, Flood Managed Aquifer Recharge (Flood-MAR) and related adaptation strategies such as Forecast Informed Reservoir Operations (FIRO), can effectively reduce vulnerabilities in the face of climate uncertainty, concurrently replenishing aquifers, reducing flood risk, and improving ecosystems in the San Joaquin Basin.

Real-Time Water Management Information and Decision Making:

Improving real-time water management relies on having more and better information so that forecasts can be used by operators to adjust to conditions on the ground. These forecast improvements provide benefits now and are even more important as climate changes continue to make California's hydrology even more extreme.



For more information, please contact the **Climate Change Program** at climatechange@water.ca.gov