

# California drought has depleted water sources by 11 trillion gallons

Evan Blake

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A recent report by scientists at NASA's Jet Propulsion Laboratory (JPL) has found that the Sacramento and San Joaquin river basins in the Central Valley of California have been depleted by roughly 4 trillion gallons of water every year since 2011, as the state has been wracked by an ongoing three-year drought, considered to be the worst in over 1,200 years.

The NASA team estimates that 11 trillion gallons of rainfall are required to restore the rivers and groundwater aquifers to their pre-drought levels.

The two Central Valley river basins, which receive snowmelt from the Sierra Nevada mountain range, provide the bulk of the state's water, with roughly 85 percent used for agriculture and 15 percent for domestic and municipal purposes.

The staggering depletion of flows during this historic drought amount to more water than California uses for domestic and municipal purposes in a given year. It is twice as much as the Colorado River's annual flow, or one and a half times as much as the volume of Lake Mead, the largest reservoir in the United States. (See: California drought hits state economy, pushes US food prices higher)

NASA made its calculations using the Gravity Recovery and Climate Experiment (GRACE) satellite data, along with snowpack measurements from the Airborne Snow Observatory. JPL's Tom Painter said, "The 2014 snowpack was one of the lowest on record and the worst since 1977, when California's population was half what it is now."

The majority of the rivers' depletion stems from the expanded use of groundwater for agriculture during the drought. California's groundwater aquifers normally supply 40 percent of the state's water, but in 2014 they are estimated to account for 65 percent of all water usage. Water tables in parts of the Central Valley have

dropped 100 feet below historical lows, and groundwater pumping is expected to place further stress on the San Andreas Fault, increasing the likelihood of a major earthquake that would cripple the entire state. (See: One earthquake could leave two-thirds of Californians without drinking water )

The subsuming of water resources to the profit motive, and complete lack of governmental oversight or economic planning, has also depleted thousands of private wells across the state, particularly in the Tulare County basin of the Central Valley, home to most of the world's almond orchards. Concurrently, the race to drill ever-deeper wells has exacerbated the longstanding issue of pollutants that contaminate underground water.

Nitrates from fertilizers and septic tanks have been polluting groundwater for decades, so much so that an estimated 10 percent of Central Valley residents consume unsafe drinking water. As the water table has sunk during the drought, the concentration of nitrates has increased, posing a heightened danger to at-risk children, nursing mothers and the elderly.

Another recent study conducted by the National Oceanic and Atmospheric Association (NOAA) found that statewide precipitation in California during the last three winters "ranked the second lowest since official measurements began in 1895. Only the consecutive three-year period of 1974/1975 through 1976/1977 was drier."

The report notes that the drought began in 2011, when a "La Niña" formed a high pressure ridge off the West Coast. Instead of dispersing as it usually does, higher sea surface temperatures in the Western Pacific, along with other changes in the world's oceans, caused this high pressure ridge, nicknamed the "Ridiculously Resilient Ridge," to remain off the coast of California

for the following two years, bringing record low precipitation to the state.

These reports come amid a series of damaging storms that have impacted the state. Coming successively on December 1-2, December 11-12 and again on December 15-16, the storms, the result of an “atmospheric river” nicknamed Pineapple Express due to its origins in waters surrounding Hawaii, have brought several inches of rain throughout the state, along with snow storms in Oregon and Washington.

The high pressure ridge which had diverted the westerly jet stream northward to parts of Alaska and southward to Central America has partially dissipated in recent months, enabling the Pineapple Express atmospheric river to douse California with rain.

The storms have felled thousands of trees and power lines, caused dozens of car accidents, severe flash flooding, temporary power loss to more than a quarter million homes and businesses, coastal erosion along parts of the West Coast and the deaths of at least four people. In northern parts of the state, the storm produced hurricane-force winds of 78 miles-per-hour and 147 miles-per-hour gusts in the Sierra Nevadas, parts of which experienced blizzard conditions.

As the storms hit California, dangerous mudslides have caused serious damage throughout the state, in particular in regions burned by wildfires, as this year the state had one of its worst wildfire seasons on record. Beginning in September, the King Fire burned nearly 100,000 acres in El Dorado County and Placer County in the Sierra Nevadas, with 50,000 acres burned in one day. This region has been particularly hard-hit by mudslides, which in some cases have destroyed entire neighborhoods.

The NASA scientists noted that these recent storms are only a drop in the bucket on the path to replenishing the state’s water supplies. The director of the study, Jay Famiglietti, said, “It takes years to get into a drought of this severity, and it will likely take many more big storms, and years, to crawl out of it.”



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