Can Increased Water Storage Reduce Water Price Variability in California?

Madeline Turland, Colin A. Carter, Bulat Gafarov, Jens Hilscher, and Katrina Jessoe

California's agricultural surface water prices exhibit extreme volatility over time because current water allocation systems and seasonal precipitation gaps create severe supply challenges, and this problem is only expected to get worse. This paper examines the potential for increased water storage to buffer these price spikes by carrying over excess wet-year water to mitigate dry-year scarcity. Our counterfactual analysis demonstrates that maintaining full reservoirs dramatically lowers price volatility. While expanding surface reservoirs is highly capital-intensive, utilizing excess floodwater for groundwater aquifer recharge offers a viable, cost-effective alternative to stabilize prices.

Approximately 7 million acres in California's Central Valley are farmed, making it one of the country's most productive agricultural regions. Nearly half of U.S. fresh vegetable production and more than three-quarters of nuts are produced in California. All these crops need irrigation. However, during a large part of the growing season there is virtually no precipitation, which is why California relies on stored water—groundwater, the snowpack, and large reservoirs, such as Lake Shasta and Lake Oroville. During times of low precipitation, these reservoirs are drawn down in order to meet increased irrigation demand.

Water is allocated through a series of water rights that may also be traded in California's surface water market. Trades typically involve a one-year lease for the water rights, which allows us to observe water prices.

During drought, water allocations are curtailed, and growers may try to turn to markets to procure water. Precipitation volatility has resulted in high surface water price variability over time, creating challenges for growers. The five-year drought from 2012–2016 saw water prices increase sharply. From 2011 to 2015, average water prices increased from $84 to $573 per acre-foot, adjusted for inflation. Another drought, from 2020 to 2022, also resulted in high surface water prices; from 2019 to 2022, prices increased from $156 to $538 per acre-foot (all in 2010 dollars).

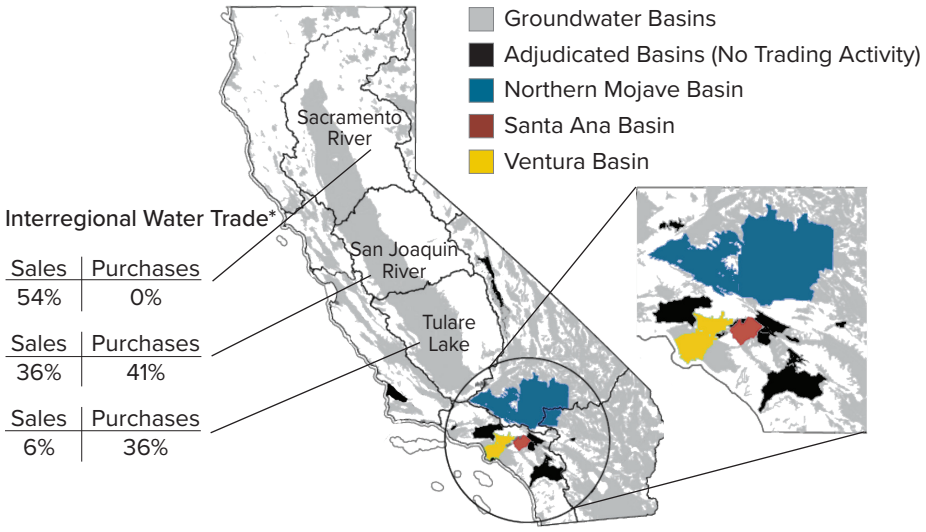
In this article, we explore the role water storage could play in reducing variability in water prices from one year to the next. Specifically, we ask if it is possible to reduce water price spikes caused by lower levels of precipitation. We present evidence that increased water storage can reduce this price volatility, while highlighting the distinct challenges to improving storage efficiencies.

A natural way to reduce price volatility is to store water in high rainfall years so it is then available during droughts. This should stabilize the water price over time. If water is scarce, then it is more valuable. Each additional acre-foot is worth a lot in a drought and very little when water is plentiful. Transferring water over time by storing it can equalize the marginal benefit, which should be reflected in prices. Water inventories are carried forward up to the point where expected price appreciation just covers the cost of storage.

Water Markets

There is a growing surface water market in California. Water is traded primarily within and across three hydrological regions—Sacramento River, San Joaquin River, and Tulare Lake (as shown in Figure 1).

Figure 1. Surface Water and Groundwater Trading Areas in California

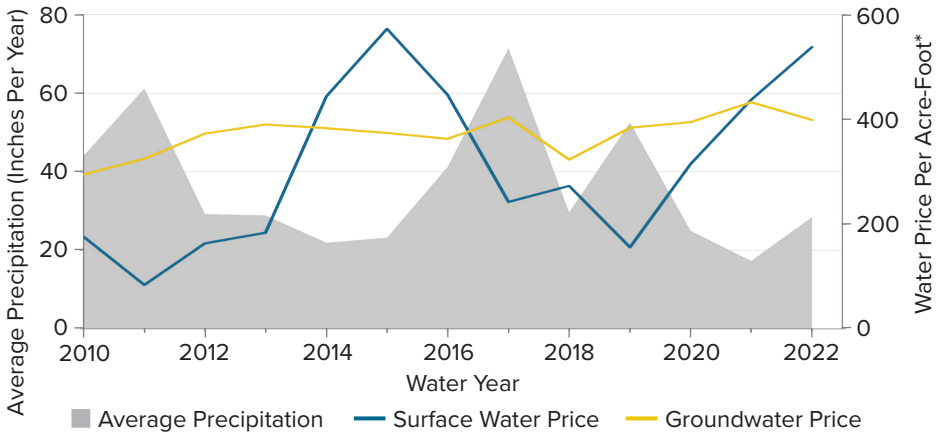


Source: Authors' construction based on data from West Water Research, LLC. Data from 2010–2022.
Note: This figure shows hydrologic regions and groundwater basins (those with the most trading activity are labeled). Adjudicated areas without notable trading activity are shown in black.
*Percentages reflect the proportion of total water sales with a buyer (or purchases with a seller) from a different region.

The surface water market is dominated by agricultural water users; 73% of buyers and 80% of sellers are agricultural users. The most common trade is a one-year lease. Most trades occur in May after the bulk of precipitation has fallen for the year, but before crops require irrigation. By then, farmers have a good idea of the total water supply and buy or sell as needed.

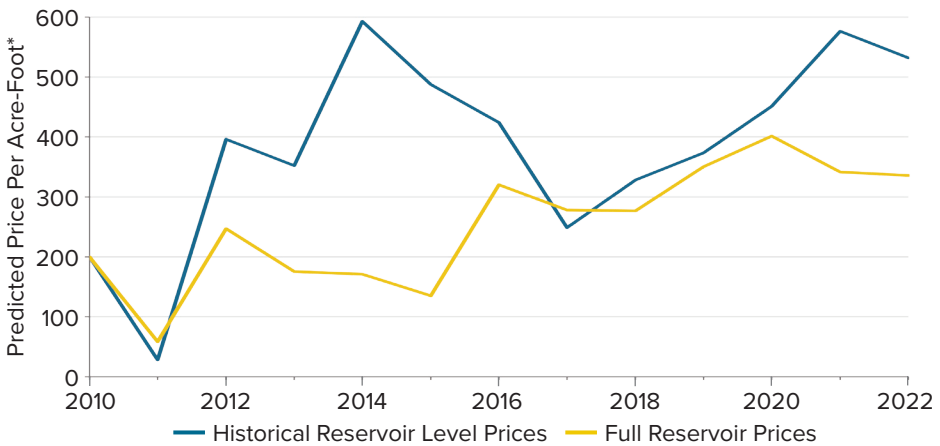
Figure 2 plots average annual precipitation, and the average price of surface water and groundwater per acre-foot (in 2010 dollars). The surface water price ranges from $84 to $573, a nearly sevenfold increase. Prices are high when precipitation is low, and they increase further when precipitation is low for several years in a row. In the 2011 and 2019 water years (October of the previous year to September), precipitation was high, and prices were low. During the following years, 2012 and 2020, precipitation dropped (52% in 2012 and 53% in 2020) and stayed low. In both cases, water prices initially increased, but by much less than in the later years of the drought. From 2011 to 2012, surface water prices increased from $84 to $164, and from 2019 to 2020, surface water prices increased from $156 to $315. As low precipitation continued, water prices kept going up, and reservoirs became depleted. This pattern implies that, with higher storage, water prices may not be as sensitive to changes in precipitation.

Figure 2. Average Annual Precipitation, Surface Water Price, and Groundwater Price



Source: Authors' calculations based on data from West Water Research, LLC and the California Data Exchange Center.
Note: The figure shows average precipitation, average surface water prices (based on one-year leases), and average groundwater prices from 2010 to 2022. *2010 U.S. Dollars.

Figure 3. Predicted Water Prices Based on Historical and Full Reservoir Inventory Levels*



Source: Authors' calculations based on surface water prices from West Water Research, LLC.
Note: We plot predicted California water prices when reservoirs are full, as well as predicted water prices based on the historical reservoir levels. *2010 U.S. Dollars.

Indeed, such an effect is present in groundwater markets. Groundwater markets exist in adjudicated basins, where water rights have been established. Because aquifers are so large relative to annual water extractions, they provide a nearly unlimited capacity to store water. As a result, price variability is much lower. Furthermore, the groundwater and surface water markets are not arbitraged, and this keeps groundwater prices more stable. Groundwater prices (shown in Figure 2) varied between $295 in 2010 and $432 in 2021, a much smaller range than $84 to $573 for surface water over the same time period.

What If Reservoirs Had Higher Capacity?

In our 2025 paper, we analyzed the effect of an extra inch of precipitation on surface water prices. We accounted for stored water levels (inventories), but importantly we also measured how the sensitivity of surface water prices to precipitation depends on the amount of water inventories. We found that the more water that is stored in large reservoirs, the smaller the effect on prices of a reduction in precipitation. These results mirror the patterns in Figure 2.

At the beginning of a drought period, inventories are high from the previous high-precipitation years. Water prices react to precipitation if inventories are high, but they react by more as the drought continues and inventories drop. Our findings therefore imply that the lower level of stored water in reservoirs (inventories) is an important driver of higher water prices in the later years of a drought.

What would happen to surface water prices if more water could be stored? In wet (high precipitation) years, there is excess water that cannot be stored in reservoirs because the capacity is simply not large enough. This water is therefore not available in dry years. We explore what might happen if excess water could be stored. For this counterfactual exercise, we assume that inventories are at their maximum level at the beginning of each year, i.e., that the reservoirs are full in every water year. This assumption proxies for the situation in which additional water storage capacity can capture previously lost excess water in wet years. We calculate predicted water prices based on regression results. Figure 3 shows predicted surface water prices under this scenario.

Over the sample period, the standard deviation of annual water prices with full reservoir levels (yellow line in Figure 3) is 100. For comparison, we also plot the predicted water price based on the actual historical reservoir levels (blue line in the figure). In that case, the standard deviation is 159. We note that the price spikes in response to the droughts beginning in 2012 and 2020 are dramatically weaker when assuming that sufficient storage can smooth price spikes (reservoirs are full in our counterfactual exercise). The more muted effect reflects the price stabilization of higher storage.

Our analysis implies that increasing storage capacity can be an effective way to mitigate water price volatility. Such a policy requires increased storage capacity to capture the additional water in wet years. Indeed, the proposed Sites Reservoir will capture Sacramento River water and add 1.5 million acre-feet of storage. It will be California's eighth-largest reservoir and the largest built since New Melones in 1979. Construction is targeted for substantial completion in 2034, at an estimated project cost of $8.1 billion in 2026 dollars.

However, building and managing large reservoirs is expensive and may not be cost-effective. Fortunately, there is another possibility: Underground aquifers are available for storage. Governor Newsom's Executive Order N-4-23, March 10, 2023, temporarily facilitated the use of floodwater for groundwater recharge, a policy measure that may reduce water price variability.

Conclusion

Precipitation volatility in California is likely to increase. Droughts will become more frequent and severe, and more precipitation will fall during wet years. In California, annual agricultural surface water prices rise significantly in low rainfall years to ration scarce supplies. This price volatility will hurt growers—particularly the extremely high prices growers will experience toward the later years of droughts. Further, when prices spike, and many growers are unable to irrigate their crops, they may have to fallow their land or remove fruit and nut trees. Increased storage, and the resulting stabilization of water prices, may save fruit and nut trees from premature removal during extended droughts.

The pronounced price volatility California growers—and indirectly consumers—experience stems in part from an underdeveloped market structure that has historically relied on administrative water rights rather than market-based mechanisms for resource allocation. If the water market matures and storage infrastructure expands, water inventories will help smooth price fluctuations over time. Intentional groundwater aquifer recharge using excess water in high precipitation years can be an effective tool to reduce surface water price variability.

Efforts to increase groundwater recharge are ongoing. In May 2026, the State Water Board reported that the $16 million Orestimba Creek Recharge and Recovery Project in Stanislaus County had already stored more than 9,000 acre-feet during its first wet season. Additionally, a recent proposal, California Assembly Bill 2026, seeks to streamline groundwater recharge permitting by allowing applicants to secure temporary permits before wet weather arrives. The bill also seeks to ease the transition to permanent permits, subject to environmental and water-quality safeguards.

Suggested Citation:
Turland, Madeline, Colin A. Carter, Bulat Gafarov, Jens Hilscher, and Katrina Jessoe. 2026. "Can Increased Water Storage Reduce Water Price Variability in California?" *ARE Update* 30(1): 9–11. University of California Giannini Foundation of Agricultural Economics.

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This work is supported by USDA NIFA award 2021-68012-35914.

For additional information, the authors recommend:

Turland, Madeline, Colin A. Carter, Bulat Gafarov, Jens Hilscher, and Katrina Jessoe. 2025. "Price Sensitivity to Precipitation and Water Storage in California." *Nature Sustainability* 8(12): 1505–1512. Available at: https://tinyurl.com/4jp7je32.