

# Cost of California's 2015 Drought Water Conservation Mandate

Mehdi Nemati, Steven Buck, and David Sunding

**As a result of the 2015 drought mandate, we calculate the consumer welfare losses to be \$203 million in Northern California and \$794 million in Southern California under observed reductions. Many urban water agencies complained that the mandated targets were arbitrary and likely to be more costly than an optimal policy. We find support for this view. In particular, we calculate that an efficient mandate would have resulted in a savings of nearly \$180 million for California households.**

The recent California drought was one of the most extreme on record, characterized by low precipitation and high temperatures. In response, Governor Jerry Brown mandated a 25% reduction in urban water use effective between June 2015 and February 2016. The California State Water Resources Control Board (SWRCB), was the agency responsible for implementing the order. The final regulation, however, set the highest percentage reductions on utilities with the highest water use. Under the SWRCB's adopted regulation, only urban water utilities serving more than 3,000 customers or delivering more than 3,000 acre-feet (AF) of water per year were required to reduce their customers' water consumption, with restrictions ranging from 4% to 36% of baseline usage.

We quantify the welfare consequences of these restrictions for residential consumers in Northern and Southern California. We compare our predicted welfare losses, which assume perfect implementation, to estimates of actual

welfare losses based on observed conservation reductions. Finally, we contrast these estimates to welfare losses under the efficient rationing regime.

## Methods

We evaluate welfare losses in the residential sector using a measure of consumers' willingness to pay (WTP) to avoid water supply restriction, which is similar to other recent work. Economists define welfare loss of a shortage as the difference between what consumers are willing to pay for the rationed commodity minus the marginal cost of supply. Figure 1 depicts a simple example with a linear demand curve.

We also assume a constant elasticity of demand and estimate the single family residential water demand elasticities for each urban water utility. Average welfare loss resulting from a supply restriction in each water utility service area is a function of the elasticity of demand in the service area, the initial water price prior to the supply restriction in the water utility, and the marginal cost of service in the water utility.

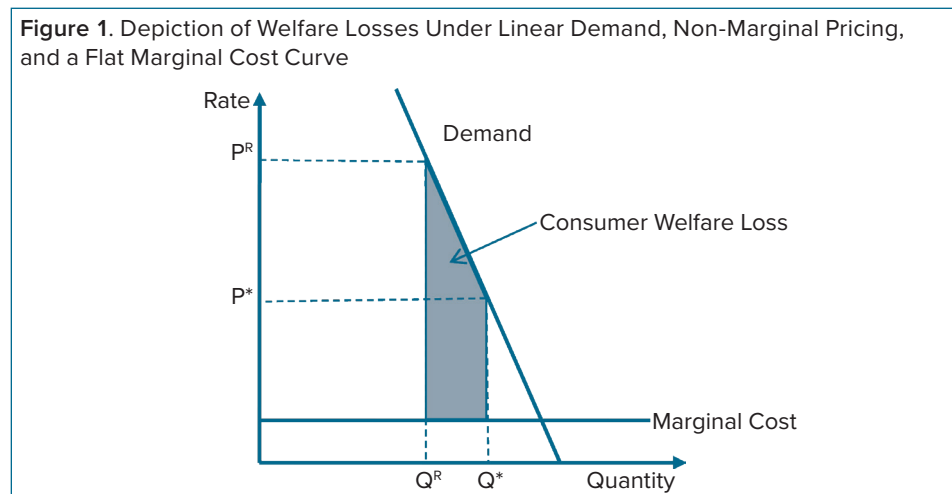
The residential demand estimation uses utility-level panel data on average

monthly water consumption and annual price, between January 2004 and December 2009, for single family residential consumers in California. The results of the residential water demand estimation indicate that the price elasticity of water demand in an urban water utility with a median household income of \$65,000 would be  $-0.19$ —meaning a 10% increase in rates would induce only about a 2% reduction in usage. Moving forward, we use results from this specification to estimate elasticities for the welfare loss calculations.

## Welfare Analysis

Welfare losses resulting from restrictions on residential water consumption in Northern and Southern California are quantified using consumption data from the year 2013 (the baseline period) encompassing 53 urban water utilities in California. Data are from the SWRCB, which calculates an estimate of residential water consumption by month for approximately 400 water utilities in California.

For a baseline, we assume restrictions based on the SWRCB utility-level conservation standards. Under the



**Table 1.** Welfare Losses Under Uniform Restriction (25%) and Utility-Specific Restrictions from the SWRCB Conservation Program

Conservation Scenario	SWRCB Conservation Program	Observed Conservation	Conservation Under Efficient Rationing Regime
<b>Panel A: Northern California Utilities</b>			
Total Loss (\$ millions) [95% Bootstrapped C.I.]	\$106 [\$100–\$109]	\$203 [\$182–\$233]	\$38 [\$35–\$45]
Average Loss (\$/AF) [95% Bootstrapped C.I.]	\$6,107 [\$5,773–\$6,263]	\$6,082 [\$5,473–\$7,015]	\$2,653 [\$2,451–\$3,086]
Household WTP(\$/Month)	\$24	\$49	\$9
% Increases in Expenditures	44%	99%	18%
<b>Panel B: Southern California Utilities</b>			
Total Loss (\$ millions) [95% Bootstrapped C.I.]	\$873 [\$673–\$1,885]	\$794 [\$633–\$1,429]	\$766 [\$599–\$1,833]
Average Loss (\$/AF) [95% Bootstrapped C.I.]	\$2,680 [\$2,066–\$5,785]	\$2,534 [\$2,019–\$4,561]	\$2,306 [\$1,802–\$5,516]
Household WTP (\$/month)	\$29	\$27	\$26
% Increases in Expenditures	36%	33%	31%

Note: CI—Confidence Intervals; AF—Acre Feet; WTP—Willingness to Pay

SWRCB conservation program, water utilities are assigned to reduce their total consumption from June 2015 through February 2016 at rates between 4% and 36% based on historical consumption levels. Utilities in Northern California are generally in lower tiers of the SWRCB conservation program with a weighted average restriction of 16.2%. Utilities in Southern California have a weighted average restriction of 22.5%.

### Estimated Welfare Losses Under Perfect Compliance

Table 1 presents the results of estimated welfare loss calculations under perfect compliance with the SWRCB conservation program. Larger total losses in Southern California relative to Northern California are due to the larger population. In Northern California, the SWRCB conservation program indicates average welfare losses per acre-foot of \$6,107. In Southern California, average welfare loss per acre-foot of restriction is \$2,680 under the SWRCB conservation program. The second and fourth rows of Table 1 indicate the 95% confidence interval for each estimate.

Our data also allow us to express welfare effects in terms of household WTP. The fifth row of each panel illustrates the average household’s WTP to avoid the drought conservation mandate is \$24 per month in Northern California and \$29 per month in Southern California. Overall, these households’ WTP are sizeable when compared to baseline household water expenditures. As evidence, the last row of both panels illustrates households’ WTP measure in terms of the percentage increase in expenditures on the volumetric rate component of monthly water bills.

Households in Northern California have a WTP in terms of a percentage increase in monthly water bills of 44%. On average, households in Southern California would have been willing to increase water expenditures by 36% to avoid their mandated conservation programs. Overall, the anticipated welfare losses under perfect compliance with the SWRCB conservation program suggest aggregate losses of \$106 million for the 27 agencies we consider in Northern California and \$873 million for the 26 agencies in Southern California.

### Welfare Losses Under Observed Compliance

Interestingly, water agencies did not exactly meet their conservation targets, with some agencies under-complying and others exceeding their targets. In fact, recorded consumption for utilities in Northern California shows that 23 of 24 utilities exceeded the required cut-backs. On average, utilities in Northern California reduced water usage by 7% more than was required.

By contrast, only 8 of 25 utilities in Southern California met their conservation standard, and 9 of 17 missed their standards by more than 5%. On average, utilities in Southern California reduced their water usage by approximately 3% less than required.

Figure 2 shows the pattern of compliance for Northern and Southern California by plotting the mandated percent reductions versus observed percent reductions for each utility included in the welfare analysis. The 45 degree line defines perfect compliance; points above it indicate utilities that exceeded their conservation mandate, while those below it did not comply. The difference in compliance between Northern and Southern California is striking, though it is difficult to attribute to a single factor.

A natural driver of compliance may be the value on water, with customers who place a high value of water agreeing to conserve less. However, many utilities with large anticipated losses managed to comply with their targets, suggesting that other factors are at play. Another important feature of the drought mandate was that individual utilities could determine how they wanted to achieve the targets. Differences in compliance may be attributed to each utility’s method for achieving the standards. While individual utilities had flexibility regarding how to meet the standards, the SWRCB program also defined a

\$10,000 daily fine for not meeting the assigned targets.

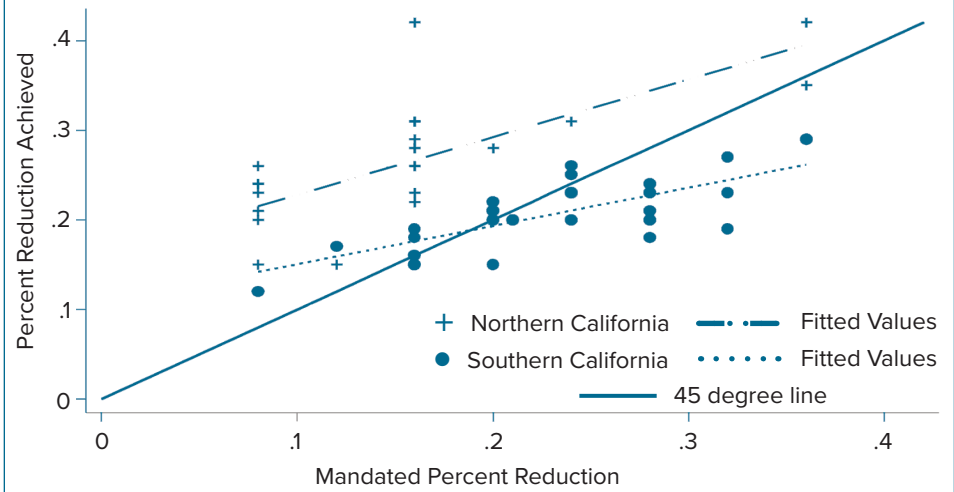
Many water districts offered rebate programs to encourage conservation during the drought. For example, city utilities, such as Menlo Park in Northern California, had attractive rebate programs during the mandate period for lawn replacement and offered a subsidized consultation on how to design drought-tolerant landscaping. These efforts included television and print advertising, as well as public information announcements available in social media.

In terms of actual welfare losses under observed imperfect compliance, in Northern California, estimates of average welfare losses per acre-foot by utility range from \$2,998 to \$15,710. In Southern California, estimates range from \$890 to \$6,638. A puzzling result is that utilities in Northern California, which have more inelastic demands than utilities in Southern California, tended to exceed their conservation standards, while those in Southern California tended to miss their standards.

Putting these numbers in perspective, the per household, per month results depend strongly on the household's utility and suggest that households in Northern California would have been willing to pay between \$12 and \$468 per month to avoid the observed conservation efforts in a non-drought period. In Southern California, the results suggest that households would have been willing to pay between \$5 and \$177 per month, depending on utility.

Finally, we calculate welfare results for an efficient mandate that achieves the same aggregate level of observed reductions. The final column of Table 1 presents these results. Welfare losses under observed reductions are comparable to the efficient rationing regime in Southern California. In Northern

**Figure 2.** Scatter Plot Showing Distribution of Mandated and Observed Percentage Reductions at Agency-Level for Northern and Southern California



California, there were significant inefficiencies. Overall, the efficient drought mandate would have reduced welfare losses by 18% relative to observed water conservation. This result suggests that the SWRCB staff could more effectively incorporate economic information into future drought conservation targets.

**Conclusion**

The estimated aggregate cost of the mandate for the 53 utilities considered in terms of lost consumer welfare resulting from observed reductions is an estimated \$997 million. The cost is \$203 million in Northern California and \$794 million in Southern California. These findings imply that Northern California households have a WTP of \$49 per month to avoid the observed reductions in water use. Households in Southern California have a WTP of \$27 per month to avoid the reductions in use resulting from the mandate.

The pattern of compliance with the SWRCB's conservation program presents a puzzle. Northern and Southern California households reduced their water usage by a similar percentage: 23.3% in the Bay Area of Northern California and 21.4% in Southern California. However, conservation

targets in the Bay Area were significantly lower than in Southern California in both absolute and percentage terms. On average, consumers in Northern California over-complied with the conservation mandate, while those in Southern California slightly under-complied. Future research may help to explain patterns of actual conservation during a drought and may shed light on whether the state should consider larger reductions in non-residential sectors.

**Suggested Citation:**

Nemati, Mehdi, Steven Buck, and David Sunding. "Cost of California's 2015 Drought Water Conservation Mandate." *ARE Update* 21(4) (2018): 9–11. University of California Giannini Foundation of Agricultural Economics.

**Authors' Bios**

Mehdi Nemati is a Ph.D. candidate, and Steven Buck is an assistant professor, both in the Department of Agricultural Economics at University of Kentucky. David Sunding is a professor in the ARE department at UC Berkeley. They can be reached by email at mehdi.nemati@uky.edu, steven.buck@uky.edu, and sunding@berkeley.edu, respectively.