



WEST COAST DROUGHT

Water conservation policy to improve efficiency and increase water security in California.

Abstract

Water conservation throughout the entirety of California, even in non-drought periods, is essential to increase resiliency and security of water resources as climate variability and land-use change increases. Butte County, based on past hydrologic data, has a net positive water usage, meaning there would be no need for conservation based on the past. Current models, on the other hand, show that California is likely to have increasingly variable precipitation, which would have drastic effects on snowpack, surface water, and groundwater. Erring on the side of caution, California should prepare for the worst and begin tapering water use down 10% in the commercial sector and 20% in the urban sector, based on the proposed bills SB 606 and AB 1668.

Key Findings

- Climatic variability is on average increasing, with many different scenarios. Further variations between wet and dry years have significantly impacted water use in the state.
- It is important to look at land use change in California and how it has impacted water use in the state. There has been an increase in developed and urban land use, while agricultural land use has remained steady.
- Due to the diversity of California's counties, legislation should be passed at both the county and state level. For Butte county, policy can include the sale of water to other counties in need, and policy to update existing water technology (delivery and use). The new policies proposed by California should still be enforced given the uncertainty of the future climate although a gradual reduction might be best opposed to an outright cut in water use.



Figure 1: Lake Oroville during a time of drought (Mahoney, 2016).

Background:

From December 2011 to March 2017, the state of California endured one of the worst droughts since record-keeping began in the region, leading to legislation in 2018 in the form of bills SB 606 and AB 1668. These bills plan to have the state of California consistently in a mindset of water conservation even during years with no drought. Currently, SB 606 focuses on urban retail suppliers and reducing urban water usages as well as requiring servicers to publish water use data. AB 1668 focuses more directly on the users; commercial, industrial, institutional, or residential. Specifically, it establishes the goal to limit water usage to 55 gallons/day per person until 2025 and decreasing to 50 gallons/day person in 2020. In addition, this policy requires agricultural suppliers to create water management plans and annual water budgets.

Throughout the 21st century, California's water security has become increasingly threatened. Increased climate variability is driving up average temperatures beyond historical averages as well as decreasing annual precipitation. As shown by Figure 1 (below), recent years (2013-2015) have been unusually warmer and drier. With increased temperatures, snowpack levels

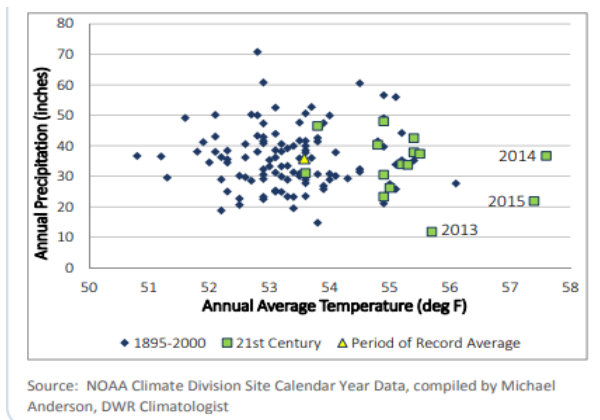


Figure 3: a visual for how hot the most recent years have been (California Department of Water Resources, 2017).

have decreased and as a result, water provided through snowmelt has decreased as well. Another significant factor threatening California water resources is land use change. As shown by Figure 2, developed land has increased over the past 20 years in Butte County. This increase in developed land demonstrates the statewide trend of population growth, resulting in

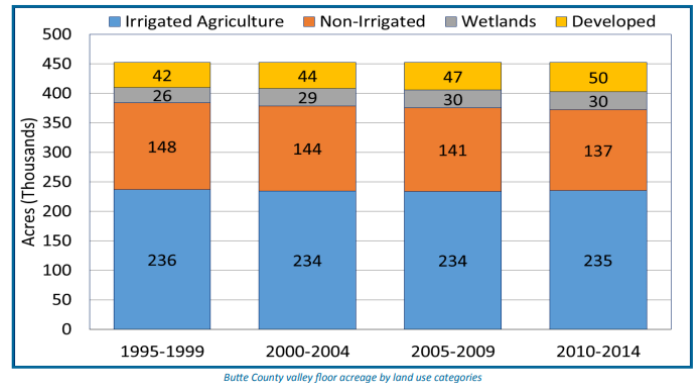


Figure 2: a visual for how land use has changed from 1995 to 2014 (Butte County Department of Water, 2016).

Analytic Approach

For this report we used dynamic water allocation and an econometric model. The dynamic water allocation model used the marginal net benefits equation from the Ogallala aquifer exercise with some manipulation to make it work for the volume of groundwater in Butte County. The marginal net benefits were calculated and maximized assuming that there were 5.2 maf of groundwater in Butte County, there was no groundwater recharge, and that the benefits of extracting water this year were \$300 million based on agricultural gains. An interest level of 3.25% was used, representing a rate that is closer in line with current trends. Then separate curves were derived based on climate and policy data. The econometric model used data from David Sekler's book to derive a demand curve for urban water use in Butte County California. Sekler derived a percent change

increase in price (10%), followed by the respective percent decrease in quantity (11%) for water in different regions of California. We chose to use the percent change data for the Northern California region to better represent the values of Butte County. Using base data we found for both the quantity of water and the price per acre foot, we derived a demand curve using the percent changes in price and quantity found by Sekler. The proposed bills strives for a reduction of 20% for water used in the urban sector. First we calculated 20% of the current quantity then used that value to find a price for that amount of water using the demand curve. We later provide an example of a 10% reduction, which uses the same procedure mentioned previously.

Findings: Dynamic Efficiency

According to recent data, groundwater recharge rates (432 taf) exceed the extraction rates (411 taf). Given this, Butte County currently is in a groundwater surplus. These amounts are not exact though because we used deep percolation rates, which does not account for groundwater flow out of the county. After further reading, it was seen that wells in the region have all lowered substantially and the policies set forth will help support the future of the state, its agricultural economy, and help preserve natural surface waters. Looking towards the future, California is expected to have more variability in their weather, which could hugely affect the entirety of California and Butte County. With this being said, California will likely suffer a 30 year prolonged drought in the future, which will greatly affect groundwater reserves around the state. Allowing water to recharge the aquifer will be essential to ensure water security in Butte county and the surrounding areas in the future. Figure 3 depicts many scenarios and the effects on groundwater levels. The scenarios include, groundwater recharge based on past data, no groundwater recharge with extraction maximizing marginal net benefits, prolonged drought, hot and dry climate scenario, and hot and dry scenario with a policy intervention. Data for these curves was used from Colusa county reports, Butte county reports, and the worst predicted weather changes. We decided to go with the worst weather report to be cautious and proactive.

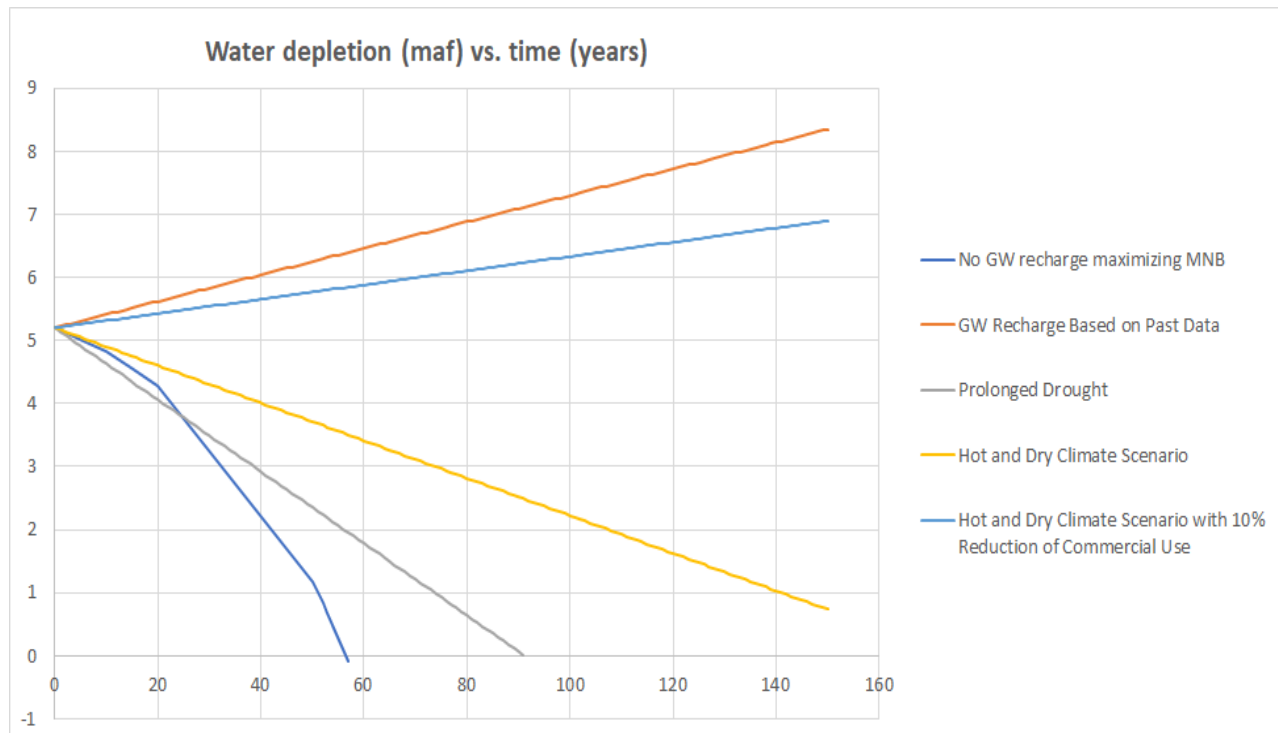


Figure 4: Water Depletion vs Time in Butte County, California (Created by Research team).

Specifically, the prolonged drought data is based on real data showing an increase in groundwater consumption and decreased recharge rates. The hot and dry climate scenario accounts for a 7% decrease in groundwater recharge as well as a 5% increase in withdrawals. Lastly, the hot and dry scenario with a 10% reduction in commercial use accounts for a 7% decrease in groundwater recharge and a 10% reduction in withdrawals assuming the state regulates groundwater extraction with the new bill.

Findings: Econometric Model

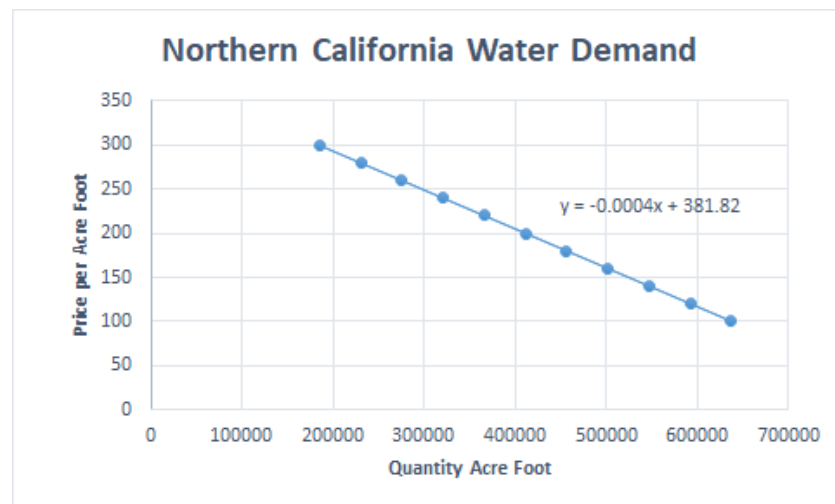


Figure 5: Northern California Water Demand (Created by Research team).

The new bills that California recently proposed, SB 606 and AB 1668, aims for a 20% reduction in urban water use by December 31st 2020. A 20% reduction sets the current extraction level of 411,000 acre feet to 328,800 acre feet. Using the demand curve above, an extraction level of 328,000 gives an estimated price of \$250.30 per acre foot. That is a \$50.30 increase to the current price of \$200 per acre foot. Given this increase, it may incentivise people to update their current water systems in order to increase efficiency thus reducing water usage and costs. It is unlikely that Butte County will outright increase the price to this estimate given the need for water by its people, thus other policy may be needed to reach the new consumption limit without having to raise price to this estimate.

Recommendations

Although the net change in groundwater storage is positive, it is recommended that Butte County begins to conserve water. Overtime, as the population of Butte County increases and climate change worsens, water demands will increase. In this case, a shift towards more efficient technology and water conservation practices will be needed in homes, commercial, industrial, and institutional facilities, which will help to lower the demand for groundwater over all. Policies on the county and state scale will

be needed to enforce such technological and institutional changes in the future when this occurs.

The majority of the counties in the state of California face greater water scarcity problems than Butte County. It is recommended that in the event of severe water scarcity or drought, that policy be implemented that allows for Butte County to sell water to Southern counties that need it the most if Butte County has a surplus of

water during that period. If new technologies are adopted, or groundwater continues to remain stable, Butte could profit from any excess or choose to save it depending on the scenario. Thus, a policy that conserves and allows the transfer of water should be implemented.

After conducting our analyses, we think that bills SB 606 and AB 1668 should be implemented given the uncertainty of the future climate. The ability to conserve water now is critical, even in areas where water may be plentiful to maintain a pristine ecosystem, a thriving agricultural economy, urban needs, and the recreation involved with California's waterways. California can lead the frontier of managing water scarcity for other states or even countries as the climate worsens over time. This leadership role can be fulfilled as long as the proposed policy is properly implemented and

preparation for the proposed limits are executed perfectly.

The current goal of the new legislation in California sets a goal of a 20% reduction in urban water use by late 2020. If the future policy put forth is implemented, it might be hard to manage and/or reach the set goal. A 20% reduction is quite a drastic cut if preparation is not taken seriously. It may be best for California to work its way up to the 20% goal. For example, they could set a goal of a 10% reduction by late 2019 that is then followed by the 20% reduction in late 2020 or push back the 20% enforcement date. Using the demand curve above, a 10% reduction gives an extraction rate of 369,900 acre feet and a cost of \$233.86 per acre foot. Although it is \$33.86 more per acre foot than the current cost, a gradual reduction in quantity used over the next few years will be easier to manage and implement.

Sources

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