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Desalination Can Provide Relief to California’s Water Problem

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Policy Problem

Of the 50 states in America, California uses the most water of any state.[1] But California is facing a record-level drought, which has caused significant water shortages across the state. Of the 39 million people living in the state, 37.2 million residents are currently affected by drought.[2]

Glen MacDonald, a distinguished professor focusing on climate and environment at UCLA, identified three primary causes of California's growing water shortage problem. First, rising heat is causing increased evaporation.[3] 2022 currently ranks as the driest year in the past 128 years in California.[4] Second, years of agricultural and domestic extraction have caused the depletion of groundwater supplies and water table depths to fall. Third, the Colorado River, Southern California's primary water source, has declined in flow, and its massive reservoir system for water storage has significantly dropped.

In April 2022, Southern California water officials declared a water shortage emergency in response to the record-breaking drought conditions and imposed strict water restrictions on six million Southern California residents. Further bans were introduced in September of 2022 on four million LA County residents due to a leak in the Upper Feeder Pipeline, which delivers water from the Colorado River to Southern California.[5] Options to improve the water shortage problem in California have been put forth, such as building more dams and reservoirs to sustain supply or improving systems to capture runoff water. These solutions rely on existing freshwater supplies, snowpack, or rainwater, all of which are deficient in drought. Desalination offers a policy solution that provides a drought proof method for producing significant amounts of clean water. Desalination is a process by which salt is removed from water to make it potable. California currently has 12 desalination plants producing tens of millions of gallons of water daily. To further advance plans for desalination development along California's shores, developers must get past the California Coastal Commission (CCC). The CCC is an "independent, quasi-judicial state agency" composed of twelve voting members who regulate the coast, an area

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[1] Orobello, Christian, and Giuseppe T. Cirella. (2021). "Financialization of Water: Conceptual Analysis of the California Water Crisis." Frontiers in Environmental Science 9.

[2] Fleck, John., Kuhn, Eric. (2019). Science Be Dammed: How Ignoring Inconvenient Science Drained the Colorado River. United States: University of Arizona Press.

[3] MacDonald, Glen. (2015, June). "Beyond the Perfect Drought: California's Real Water Crisis." UCLA Institute of the Environment & Sustainability.

[4] "Current U.S. Drought Monitor Conditions for California." (2022). Drought.gov,

[5] Lin, Summer. (2022, September 6). "15-Day Watering Ban Begins for Parts of L.A. County." Los Angeles Times. Los Angeles Times.

larger than the state of Rhode Island.[6]

In 2022, the CCC voted 11-0 to reject building a new $1.4 billion desalination plant in Huntington Beach, which would have produced 50 million gallons of drinking water daily, enough for 400k California residents.[7] Desalination has two main criticisms. The first criticism of desalination is that the process is energy and cost prohibitive. The second is that desalination is harmful to the environment. Critics of the Huntington Beach plant cited both reasons in their opposition.[8]

Data

Despite high energy costs, desalination can reduce water's total energy footprint if the process replaces the energy-intensive process of importing water through aqueducts.[9] Desalination offers a viable alternative to water importation for Southern California, which contains only 25 percent of the state's available water south of Sacramento while requiring 80 percent of urban and agricultural water demands. In the greater Los Angeles area, 62 percent of the area's water supply is provided through importation across the California Aqueduct, Colorado River Aqueduct, and Los Angeles Aqueduct.[10]

An analysis of energy costs by the California Policy Center shows that water conveyance via aqueduct is slightly more cost-effective than desalination.[11] The energy cost of conveyance equates to 3,448 gigawatt-hours per million-acre feet of water delivered compared to 3,529 gigawatt-hours to produce 1 million acre-feet of desalinated seawater.[12] An "acre-foot" represents a water supply volume of approximately 326,000 gallons.[13]

The energy cost for California to desalinate 1.0 million acre-feet of seawater would consume just under one percent of the total electricity currently being generated in California in 2018.[14] That electricity use could be offset mainly by the energy use of the California Aqueduct, which would not be required to pump

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6 "Our Mission." (2022). California Coastal Commission. California Coastal Commission.

7 Schaben, Allen. (2022, May 13). "Residents Celebrate as California Coastal Commission Rejects Plan for Huntington Beach Desalination Plant." Los Angeles Times. Los Angeles Times.

8 "Opposition to the Brookfield-Poseidon Huntington Beach Seawater Desalination Project." (2022, April) California Desal Facts. Stop Poseidon Coalition.

9 "PPIC Water Policy Center California's Water." (2018, November). California's Water. Public Policy Institute of California.

10 "Where Does My Tap Water Come From?" (2014). watertalks.csusb.edu. California State University, San Bernardino.

11 Ring, Edward. (2022, August 5). "The Abundance Choice – Part 11: The Desalination Option." California Policy Center. California Policy Center.

12 Ring, Edward. (2022, August 5). "The Abundance Choice – Part 11: The Desalination Option." California Policy Center. California Policy Center.

13 "What Is an Acre Foot?" (2023). North Marin Water District. North Marin Water District.

14 Ibid.

that 1.0 million acre-feet over the mountains if the water was desalinated locally.[15] In comparison, energy used by the State Water Project to transport water is the largest singe user of electrical energy. It accounts for 2 to 3 percent of all the electricity consumed in California to transport 2.5 million acre-feet of water to Southern California.[16] "California's water systems are uniquely energy-intensive due in large part to the pumping requirements of major conveyance systems which move large volumes of water long distances and over thousands of feet in elevation lift," according to an analysis by the American Council for an Energy-Efficient Economy.[17]

The fiscal cost of desalination is another issue raised. A 2016 report on alternative water supply and efficiency options in California from the Pacific Institute found that desalination was the most expensive water supply option compared to alternatives like stormwater capture projects or leak detection surveys.[18] To operate, desalination plants currently use 5 to 26 times as much work as the theoretical minimum of energy required.[19] The average cost of average electricity in California across all sectors is about 20¢ per kilowatt-hour (kWh). The energy needed to desalinate 1 cubic meter [1 cubic meter (m3) equals 1000 liters] of salt water is 0.86 kWh of energy.[20] Thus, theoretically, the cost of desalination could be reduced from 20¢ to anywhere from 4¢ to 0.77¢ per kilowatt-hour.

Market trends have shown the increasing cost efficiency of desalination as technology has progressed. Since the 1960s, the cost of desalinating water has decreased by approximately a factor of 10, according to Advision, a consulting firm focusing on resource energy and infrastructure challenges.[21] The approximate unit cost of US$10.00/m3 in the 1960s was reduced to less than US$1.00/m3 ($3.79 per 1000 gallons) in 2010.[22] The 2022 Global Water Summit reported that the desalination industry has now broken through the $0.50/m3 barrier, with expected costs likely to continue to reduce as desalination technology improves. Established desalination plants like California's Carlsbad desalination plant, which is its largest plant, producing 50 million gallons of water per day, are economically feasible. In

[15] Ring, Edward. (2022, August 5). "The Abundance Choice – Part 11: The Desalination Option." California Policy Center. California Policy Center.
[16] Wilkinson, Robert, and William Kost. (2006). "An Analysis of the Energy Intensity of Water in California." ACEEE.
[17] Ibid.
[18] Cooley, Heather, and Rapichan Phurisamban. (2016). "The Cost of Alternative Water Supply and Efficiency Options in California." Pacific Institute.
[19] Al-Karaghouli, Ali, and Lawrence L. Kazmerski. (2013, April 19). "Energy Consumption and Water Production Cost of Conventional and Renewable-Energy-Powered Desalination Processes." Renewable and Sustainable Energy Reviews.
[20] "Annual Average Electricity Price Comparison by State." Nebraska Department of Environment and Energy. Nebraska Department of Environment and Energy, 2022.
[21] "The Cost of Desalination." (2022). Advisian.
[22] Ibid.

2019, *Business Wire* reported that California's Carlsbad desalination plant was "financially strong." and the plant also received an upgrade in bond rating.[23]

The environmental critique of desalination has mixed evidence to support its claim. The biggest claim is that the salty brine released by desalination plants has a toxic effect on marine life. While some studies have shown that increased salinity can cause harm to the surrounding marine organisms, a study from several Australian universities contradicted that view and found that brine defusal had little impact on marine life.[24] The University of Arizona's Water Resources Research Center states, "Salt tolerant wetlands plants can thrive on concentrate from inland desalination and provide an ecosystem supporting marsh birds and other wildlife."[25] They argue that salty water can benefit some environments by providing salt-tolerant wetlands to thrive."[26]

Recommendation

Desalination is not a one size fits all solution. In areas like Northern California, where rainfall rates are much higher, desalination has no comparative advantage. However, desalination is a practical policy solution in many areas of Southern California that receive almost no rain and are experiencing significant drought. David Feldman, director of Water UCI at the University of California Irvine said that desalination could eventually provide "somewhere between 10% and half" of California's potable water."[27] Feldman provided the caveat that before this point could be reached would have to exhaust other less expensive and energy intensive options. However, Feldman recognized that desalinations remains the best path forward for some Californian communities, while in other communities it remains the second, third, or even last best option.[28]

Desalination plants vary by type. The Pacific Institute estimated in their 2016 report that the cost to desalinate for a small seawater desalination plant (a capacity of 10,000 acre-feet or less) ranged from $2,500 to $4,100 per acre-foot, with a median cost of $2,600 per acre-foot.[29] Large seawater desalination plants (a

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[23] "Credit Analysis Affirms Carlsbad Desalination Plant Is Financially Strong." (2019, October 8), Business Wire. Business Wire.
[24] "Desalination Plants Not Harmful to Marine Life, Long-Term Study Reveals." (2018, September 20). Australian Water Association. Australian Water Association.
[25] "Environmental Concerns Temper Enthusiasm for Desalination." (2011). University of Arizona Water Resources Research Center.
[26] Ibid.
[27] Smith, Hayley. (2022, November 7). "They Used to Call California Ocean Desalination a Disaster. But Water Crisis Brings New Look." Los Angeles Times. Los Angeles Times.
[28] Ibid.
[29] Cooley, Heather, and Rapichan Phurisamban. (2016). "The Cost of Alternative Water Supply and Efficiency Options in California." Pacific Institute.

capacity of more than 10,000 acre-feet) ranged from $1,900 to $2,300 per acre-foot, with a median cost of $1,900 per acre-foot.[30] In addition to having a more narrow cost range, the larger plants were estimated to produce more clean water for a lower price and are the preferable plant size for investment.

Desalination operates on economies of scale.[31] The larger the centrifugal pumps and recovery turbines are, the higher efficiency they will have, an important factor in reducing the total cost of clean water.[32] Proponents recommend California pursue investing in large desalination plants. Plants function using one of two types of technology: thermal (phase-change) processes and membrane processes or reverse osmosis (RO).[33] For seawater desalination, energy consumption and cost of the RO process is lower than thermal processes.[34] California policymakers should seek to outfit large desalination plants with reverse osmosis technology instead of the less efficient thermal processes. In October 2022, the CCC approved the Doheny Ocean Desalination Project. The plant is estimated to produce up to 5 million gallons of potable water per day using RO, according to the project's environmental impact report.[35]

Another desalination plant in Monterey Bay was approved by the commission in 2022. The Monterey Peninsula Water Supply Project will produce up to 9.6 million gallons of water per day using RO, estimated to cost around $322 million.[36] Since the Doheny and Monterey desalination plants are much smaller in size and capacity than the Huntington Beach plant, they will operate at lower economies of scale. Despite this, California needs to expand desalination capacities. The CCC should vote in favor of more desalination plants to diversify California's water supply but should also support the construction of larger plants like the Huntington Beach proposal. After rejecting the Huntington Beach proposal, of which the building company Poseidon Water sunk $100 million of its own funds, the CCC needs to increase public support for desalination or risk alienating companies from investing any additional money in desalination technology.

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[30] Ibid.

[31] Drablos, Leif. (2004, November 12). "One Large Desalination Plant vs. Several Smaller Plants to Supply Water to an Area." Science Direct. Desalination Strategies in South Mediterranean Countries.

[32] Ibid.

[33] Al-Karaghouli, Ali, and Lawrence L. Kazmerski. (2013, April 19). "Energy Consumption and Water Production Cost of Conventional and Renewable-Energy-Powered Desalination Processes." Renewable and Sustainable Energy Reviews.

[34] Ibid.

[35] "Final Environmental Impact Report." (2019, June). Doheny Ocean Desalination Project. South Coast Water District.

[36] "Resource Issues: Desalination and Water Supply Project Details Monterey Peninsula Water Supply Project - #Noaa-NOS-2016-0156." (2016). Monterey Bay National Marine Sanctuary.

Implementation

When evaluating the effectiveness of water policy, two factors must be evaluated. The first factor is to evaluate if the public is getting adequate water. In a drought, water policy should be focused on meeting the minimum standards of water needed. In Monterey Bay, the site of the newly approved desalination plant, the 9.6 million gallons per day will be adequate to serve the supply of potable water available north to Santa Cruz, east to Salinas, and south to the Monterey Peninsula.

The second factor is a cost-benefit analysis to evaluate if the cost of the policy is an improvement over alternatives. In the case of California's water policy, desalination, and recycling water are the primary methods to drought-proof the water grid. Although health risks are low, public acceptance has been more resistant to recycling wastewater which the public views as a less pristine source than seawater since its derivative contains humans excrete and various toxins or pharmaceuticals.[37] Desalination is currently the more expensive option, but if the public is unwilling to accept the risks involved with increased wastewater recycling, desalination offers a viable path forward.

Desalination will cause prices to go up for Monterey Bay residents, with water estimated to be around $2,000 per acre-foot, putting costs around the same as water from the Carlsbad desalination facility. Though prices may rise, a cost-benefit analysis must also consider other project benefits. These benefits include increased use of renewable energy, improvement river flows, and habitats, restoration of the Seaside Aquifer, reduction of wastewater discharge to the Marine Sanctuary, and increased water reliability for the Monterey Peninsula.

By diversifying California's water options, California's water grid will be more resistant to earthquakes, a strength of desalination plants compared to far more susceptible aqueducts. Earthquakes cause ground motion and leaks in the hundreds of miles-long aqueduct system. The Pacific Institute's report found that leak detection surveys can reduce annual water losses by 260,000 gallons per mile surveyed, at an estimated cost of $400 per acre-foot. Desalination processes water and distributes it much closer to the demand reducing the risk of aqueduct leaks. In the short term, the cost of water may go up in some areas. As desalination technology improves in energy efficiency and desalination processes, the cost will continue to decrease. Though desalination will likely never entirely replace other forms of water recapture, conveyance, wastewater treatment, and groundwater pumping, California's immediate risk from drought needs relief through desalination.

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[37] Dolnicar, Sara, and Andrea I. Schäfer. (2009). "Desalinated versus recycled water: Public perceptions and profiles of the accepters." *Journal of Environmental Management 90,* no. 2.

Conclusion

California should seek to increase investment and construction of desalination plants along its coast. To this end, regulators of the California Coastal Commission should approve expanding desalination development rather than opposing new coastal builds. Desalination plants produce millions of gallons of clean drinking water annually by removing salt and other impurities from brackish water and seawater.[38] Though desalination is more expensive than other options, the process is far more reliable, especially during droughts, as it pulls from the nearly unlimited resource of ocean water.[39] Energy costs of desalination are currently competitive with those required to transport via the California Aqueduct. If further desalination is pursued and authorized, California may experience short-term price hikes in water prices. Still, through technological advancement, economies of scale, and improvement in energy efficiency, California can expect the long-term price of potable water to fall, equipping itself to meet public water demands.

[38] Robbins, Jim. "As Water Scarcity Increases, Desalination Plants Are on the Rise." Yale E360. Yale Environment 360, June 11, 2019.
[39] "PPIC Water Policy Center California's Water." California's Water. Public Policy Institute of California, November 2018.

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