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ALSO IN THIS ISSUE

Agricultural Groundwater Management in California: Possible Perverse Consequences?

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The sustainable management of groundwater resources for use in agriculture is a critical issue in California and globally. Increasing competition for water from cities and environmental needs, as well as concerns about future climate variability and more frequent droughts, have caused policy-makers to look for ways to decrease the consumptive use of water.

The recent rain notwithstanding, California is experiencing its third-worst drought in 106 years. From 1960 to the present, there has been significant deterioration in the groundwater level of the Central Valley of California, making current levels of groundwater use unsustainable. Groundwater management is particularly important in California as the state produces almost 70% of the nation's top 25 fruit, nut, and vegetable crops. Most crops in California come from two areas: the Central Valley, including the Sacramento and San Joaquin Valleys; and the coastal region, including the Salinas Valley, often known as America's "salad bowl." Farmers in both areas rely heavily on groundwater. Understanding the economics of sustainable agricultural groundwater management is particularly timely and important for California, as legislation allowing regulation of groundwater is being implemented gradually in California over the next several years.

Possible Perverse Incentives from Policy

Incentive-based water conservation programs are extremely popular policies for water management. Farmers can receive a subsidy for upgrading their irrigation systems; less groundwater is "wasted" through runoff, evaporation, or drift; marginal lands can be profitably retired; and farmers can choose whether to participate. However, such policies can have perverse consequences.

In many places, policy-makers have attempted to decrease rates of groundwater extraction through incentive-based water conservation programs. Between 1998 and 2005, the state of Kansas spent nearly $6 million on incentive programs, such as the Irrigation Water Conservation Fund and the Environmental Quality Incentives Program, to fund the adoption of more efficient irrigation systems. Such programs paid up to 75% of the cost of purchasing and installing new or upgraded irrigation technology, and much of the money was used for conversions to dropped nozzle systems. These policies were implemented under the auspices of groundwater conservation, in response to declining aquifer levels occurring in some portions of the state due to extensive groundwater pumping for irrigation.

In California, the State Water Efficiency and Enhancement Program (SWEEP) provides financial assistance in the form of grants to implement irrigation systems that reduce

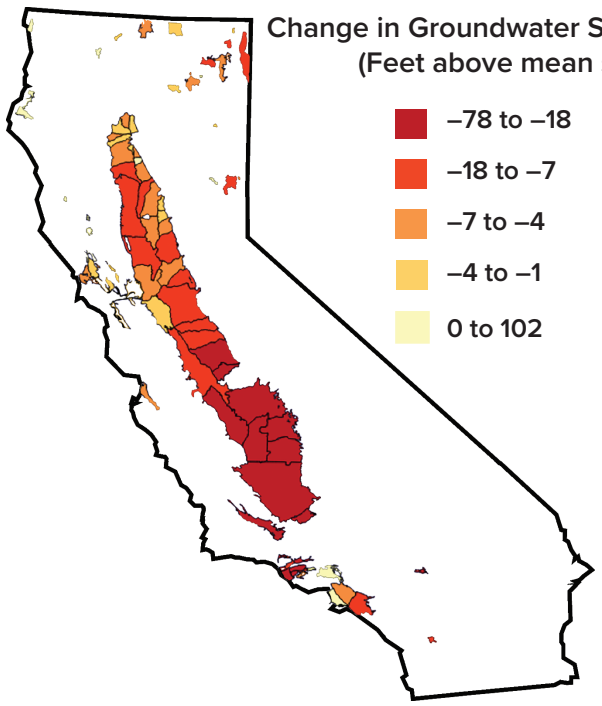

Figure 1. Decline in Groundwater Levels in California Since 2011, by Administrative Basin

Data source: California Department of Water Resources

greenhouse gases and save water on California agricultural operations, including evapotranspiration-based irrigation scheduling to optimize water efficiency for crops; and micro-irrigation or drip systems. San Luis Canal Company in the San Joaquin Valley offers $250 per acre to encourage the transition to pressurized irrigation systems.

Similarly, though funding for this order was not passed, under the Water and Energy Saving Technologies Executive Order B-29-15, the California Energy Commission, California Department of Water Resources, and California State Water Resources Control board were to provide funding for innovative technologies, including rebates for conversion from high-pressure to low-pressure drip irrigation systems.

However, although they are extremely popular policies for water management, we find that policies that encourage the adoption of more efficient irrigation technology may not have the intended effect. Irrigation is said to be "productivity enhancing"; it allows the production of higher-value crops on previously marginal land. Thus, a policy of subsidizing more efficient irrigation technology can induce a shift away from dry-land crops to irrigated crops. They may also induce the planting of more water-intensive crops on already irrigated land, as by definition, more efficient irrigation increases the amount of water the crop receives per unit extracted.

Similarly, land and water conservation and retirement programs may not necessarily reduce groundwater extraction, although they are billed as such. An example of a land retirement program is the Conservation Reserve Program (CRP). The CRP was created by the federal government in 1985 to provide technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. These programs include payments to landowners to retire, leave fallow, or plant non-irrigated crops on their land. Such programs operate on an offer-based contract between the landowner and the coordinating government agency. The contractual relationship is subject to asymmetric information, and adverse selection may arise because the landowner has better information about the opportunity cost of supplying the environmental amenity than does the conservation agent. There is substantial evidence that farmers enroll their least productive, least intensively farmed lands in the programs while receiving payments higher than their opportunity costs, thus accruing rents. It is quite unlikely that an irrigated parcel, which requires considerable investment in a system of irrigation (which, in turn, enhances the productivity of the parcel), will be among a farmer's plots with the lowest opportunity cost and thus enrolled in the program. Instead, farmers may opt to enroll non-irrigated plots in the CRP program, which does not have any effect on the amount of irrigation water extracted.

In our previous study, which has been featured in such media outlets as the *New York Times*, the *Washington Post*, *Bloomberg View*, and AgMag Blog, as well as in a previous issue of *ARE Update*, we focus on incentive-based groundwater conservation policies in Kansas and find that measures taken by the state of Kansas to subsidize a shift toward more efficient irrigation systems have not been effective in reducing groundwater extraction. The subsidized shift toward more efficient irrigation systems has in fact increased extraction through a shift in cropping patterns. Better irrigation systems allow more water-intensive crops to be produced at a higher marginal profit. The farmer has an incentive to both increase irrigated acreage and produce more water-intensive crops.

We find similar results in our analysis of the effects of land and water conservation and retirement programs on groundwater extraction. Theoretically, we know that because the programs are offer-based, farmers will enroll their least productive land. Our empirical results support this conclusion; we find essentially no effect of land conservation programs on groundwater pumping, which occurs, by definition, on irrigated, and thus, very productive land.

Our result that increases in irrigation efficiency may increase water consumption is an example of a rebound effect, or "Jevons' Paradox," which arises when the invention of a technology that enhances the efficiency of using a natural resource does not necessarily lead to less consumption of that resource. William Stanley Jevons found this to be true with the use of coal in a wide range of industries. In the case of agricultural groundwater, we find that irrigation technology that increases irrigation efficiency does not necessarily lead to less consumption of groundwater. In particular, if demand is elastic enough, the higher efficiency technology operates at a lower marginal cost, and the higher efficiency technology increases revenue, then irrigation efficiency will increase applied water.

In California, SWEEP grant funds cannot be used to expand existing agricultural operations or to convert additional new acreage to farmland, which may limit how much a farmer can respond to the increased irrigation efficiency resulting from SWEEP grant funds to increase irrigated acreage. However, by lowering the marginal cost of irrigation, SWEEP grant funds may encourage farmers to continue irrigating more marginal lands. Furthermore, this increased efficiency may allow farmers to continue growing more water-intensive crops, even as groundwater becomes more scarce. Thus, SWEEP funds could make farmers in water-stressed locations less sensitive to existing price signals as groundwater becomes scarce, and may slow their adjustment to depleting groundwater stocks over the long term.

The California Department of Agriculture and the California Department of Water recently introduced a pilot program within SWEEP that incentivizes joint action by farmers and larger water suppliers to implement more efficient irrigation technology in return for an agreement to halt the use of groundwater for agricultural purposes. However, this program may be used most by farmers and water suppliers who rely relatively little on groundwater as a source. In this case, while irrigation may become more efficient, this may have little effect on groundwater use, the target of the policy. As a result, the costs of the program may unfortunately exceed its benefits.

Thus, when designing policies, policy-makers need to be wary of any potential unintended consequences. Incentive-based groundwater conservation programs are a prime example of a well-intentioned policy gone awry.

Conclusion

Incentive-based groundwater conservation programs are a prime example of a well-intentioned policy that may have perverse consequences, meaning that they may actually increase rather than decrease groundwater extraction. When designing policies and regulation, policy-makers need to be aware of the full range of implications of their policy, including any potential perverse consequences.

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For additional information, the authors recommend:

Sears, L., E. Bertone Oehninger, D. Lim, and C.-Y. C. Lin Lawell. (2016). The Economics of Sustainable Agricultural Groundwater Management: Recent Findings. Working paper, University of California at Davis. http://www.des.ucdavis.edu/faculty/Lin/CalAg_groundwater_paper.pdf

Lin, C.-Y. C. (2013). Paradox on the Plains: As Water Efficiency Increases, So Can Water Use. California WaterBlog. https://californiawaterblog.com/2013/08/13/paradox-on-the-plains-as-water-efficiency-increases-so-can-water-use/

Lin Lawell, C.-Y. C. (2016). The Management of Groundwater: Irrigation Efficiency, Policy, Institutions, and Externalities. *Annual Review of Resource Economics*, 8, 247-259.

Pfeiffer, L., and C.-Y. C. Lin. (2009). Incentive-Based Groundwater Conservation Programs: Perverse Consequences? ARE Update, 12 (6), 1-3.