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Water for California Agriculture

Lessons from the Drought and New Water Market Reform

by David Zilberman, David Sunding, Richard Howitt, Ariel Dinar, and Neal MacDougall

Californians, much like residents of other western states, want more and more water for urban uses and in-stream water flows. Increased demand for urban and in-stream water, plus the severe 1987–92 drought, brought pressure on water institutions to change the state's archaic system of water rights and allocate water away from agriculture, the sector which uses the most water. Our research on the important San Francisco Bay/Sacramento-San Joaquin River Delta estuary (the "Bay/Delta") suggests that policy reforms to expand water markets and economic incentives for farmers and others can go a long way toward meeting the area's water needs and improving water quality at modest cost to agriculture and other sectors.

Water for California agriculture

The Sacramento and the San Joaquin Valleys join to form California's great Central Valley, an area which generates over 70 percent of the state's agricultural produce. Irrigation allows Central Valley farmers to take advantage of favorable soil and weather conditions to produce large shares of the nation's fruits and vegetables and obtain high yields in field crops such as cotton and alfalfa.

California's water system relies on a sophisticated network of water reservoirs and aqueducts. Much of the water used for irrigation in the Central Valley (or the Valley, for short) comes from snow melt of the Sierra mountains that lie to the north and east of the Valley and is carried by rivers and water projects to the farming areas (figure 1). Prior to World War II, growers in the Sacramento and east side of the San Joaquin Valleys established a network of private aqueducts and conveyance facilities to provide surface water for irrigation. During this period some municipalities, including San Francisco and Los Angeles, also developed their own water supplies. After the war, the federal and state governments completed two major public water projects—the Central Valley Project and the State Water Project—to provide water for irrigation in western and southern parts of the Valley and provide water to the cities in the south.

Agriculture consumes 70 to 80 percent of the state's developed water supply. Farmers irrigate nearly 200 crops with a variety of technologies. They use furrow and flood technologies on more than 50 percent of the land, sprinkler irrigation on 35 percent, and more efficient low-volume irrigation technologies (microsprinklers and drip) on 10 to 15 percent of the land. Differences in crop values, water requirements, irrigation efficiencies, and water supply conditions result in immense differences in the productivity of applied water. For example, the least productive 20 percent of water, used to produce hay with flood irrigation, produces only 2 to 3 percent of the value of the state's agricultural production. The most productive 20 percent produces about 60 percent of the value of agricultural production. Water reform that transfers the less productive water to urban and in-stream uses will be more efficient than reform that removes water used to produce high-value crops.

The response to the drought demonstrates that California farmers respond to financial incentives to conserve water and increase water use efficiency.

In most parts of the state, water is allocated according to the doctrine of prior appropriations. Under this doctrine, those who first put the water to beneficial use acquire the right to use the water (but can lose that right if not used) and generally cannot trade or market the water. The system of prior appropriations allocates most water in the north and the east sides of the Valley, but does not

provide adequate incentives to conserve water since its cost is very low.

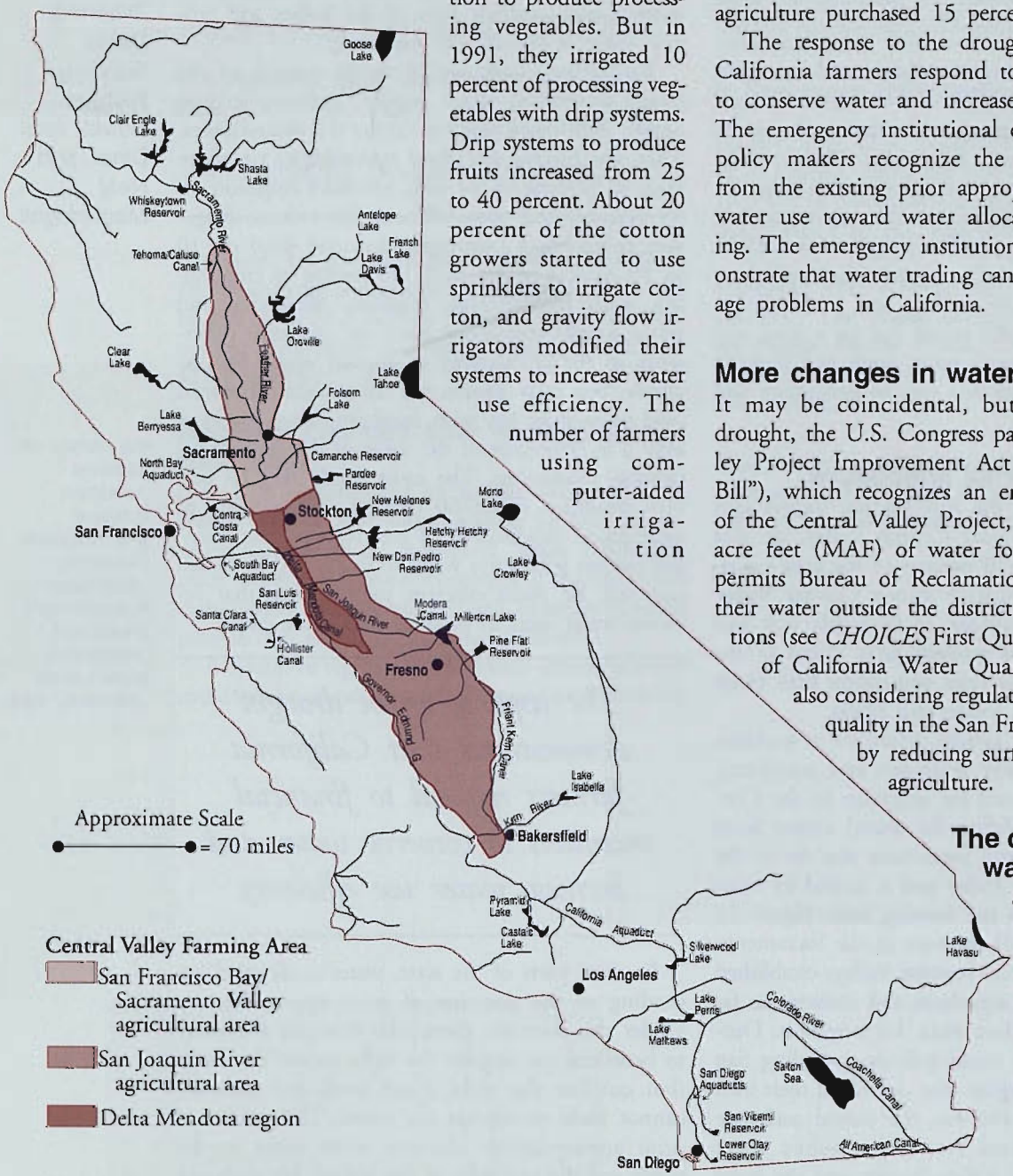
The drought improved irrigation and changed water institutions

California suffered a severe drought between 1987 and 1992 during which annual precipitation averaged less than 50 percent of normal. During the first two years of the drought, reservoirs maintained surface water supplies. As the drought continued, however, surface supplies dwindled and growers were forced to make a number of difficult choices.

Farmers replaced more than 50 percent of the surface water with more costly ground water supplies, and they dramatically increased the use of modern irrigation technologies. For example, before the drought, farmers used almost no drip irrigation to produce processing vegetables. But in 1991, they irrigated 10 percent of processing vegetables with drip systems. Drip systems to produce fruits increased from 25 to 40 percent. About 20 percent of the cotton growers started to use sprinklers to irrigate cotton, and gravity flow irrigators modified their systems to increase water use efficiency. The number of farmers using computer-aided irrigation scheduling doubled during the drought in some regions, and farmers and irrigation districts lined 114 miles of canals to reduce conveyance losses. Fallow land of the districts we surveyed doubled by the last year of the drought.

More importantly, the drought led to institutional changes. Seven water districts which received less water introduced increasing block-pricing schemes to encourage farmers to conserve water. Other districts introduced buy-back schemes which paid farmers a high price for the portion of their allotted water they chose not to apply. Moreover, the state created a water bank and purchased 825,000 acre feet of water for $125 per acre foot and sold 435,000 acre feet for $175 per acre foot. Water agencies used the Bay/Delta to store water. Metropolitan water districts bought 85 percent and agriculture purchased 15 percent of the water.

The response to the drought demonstrates that California farmers respond to financial incentives to conserve water and increase water use efficiency. The emergency institutional changes indicate that policy makers recognize the need to move away from the existing prior appropriation of governing water use toward water allocation based on trading. The emergency institutional changes also demonstrate that water trading can alleviate water shortage problems in California.



More changes in water institutions

It may be coincidental, but at the end of the drought, the U.S. Congress passed the Central Valley Project Improvement Act (the "Bradley/Miller Bill"), which recognizes an environmental mission of the Central Valley Project, allocates 0.8 million acre feet (MAF) of water for such benefits, and permits Bureau of Reclamation contractors to sell their water outside the district under certain conditions (see *CHOICES* First Quarter 1994). The State of California Water Quality Control Board is also considering regulations to improve water quality in the San Francisco Bay and Delta by reducing surface water supplies to agriculture.

The cost of less water for agriculture

Our recent study estimates the short-run costs of water supply reduction to Central Valley growers and to the state's economy. The study

recognizes the many ways to implement aggregate water supply reductions, including new rules to allow water sales. We use three different economic models to assess the effects of cuts in water supply on net farm income, state product (farm commodity sales plus secondary effects on the economy) and employment.

Under different scenarios, our studies allow for alternative ways to allocate irrigation water cuts. Some scenarios allow water trading among regions and others assume supply cuts distributed among regions proportional to current water use and without interregional trading.

As figure 2 demonstrates, the distribution of water cuts affects net farm incomes more than does the total amount of water taken. If rules allow water trading, and all Central Valley regions share an 0.8 MAF water cut (such as that required to meet environmental needs), annual net farm income declines by $10 million. A cut of 1.3 MAF reduces net farm income by $30 million. This loss is only about one percent of the net income of Central Valley Project farms. However, if rules disallow trading, and only growers in the Delta-Mendota area bear the entire 0.8 MAF or 1.3 MAF water cut, net annual farm income declines by $87 million or $145 million, respectively. Differences in water productivity among crops cause farm incomes to fall most when rules prevent water trading. If water authorities distribute water cuts among all Valley growers and water is traded, farmers can meet limited water availability by reducing acreage of only low-value crops. When water cuts all go to a small subregion, some land originally used for higher value crops must be fallowed.

Water supply cuts reduce gross state product by about twice the reductions in net farm income. Thus, an 0.8 MAF water cut reduces annual gross state product by $20 million if all growers share water cuts and rules allow water trading, but gross state product declines by $174 million if the Delta-Mendota regions bear all water reductions and rules prohibit water trading. The 1.3 MAF reduction causes gross state product losses of $55 million to about $300 million, depending on water allocation rules.

Differences in water productivity among crops cause farm incomes to fall most when rules prevent water trading.

The more liberal water allocation rules help maintain statewide employment in the face of reduced water supplies. The 0.8 MAF reduction causes a very modest 500 person-year employment loss, and the 1.3 MAF cut reduces employment by about 1,000 person-years, still less than 0.3 percent of state agricultural employment. The more restrictive water allocation rules result in much greater job loss. The 0.8 MAF reduction in water supply costs 4,000 person-years and the 1.3 MAF reduction in water supply costs 11,000 person-years.

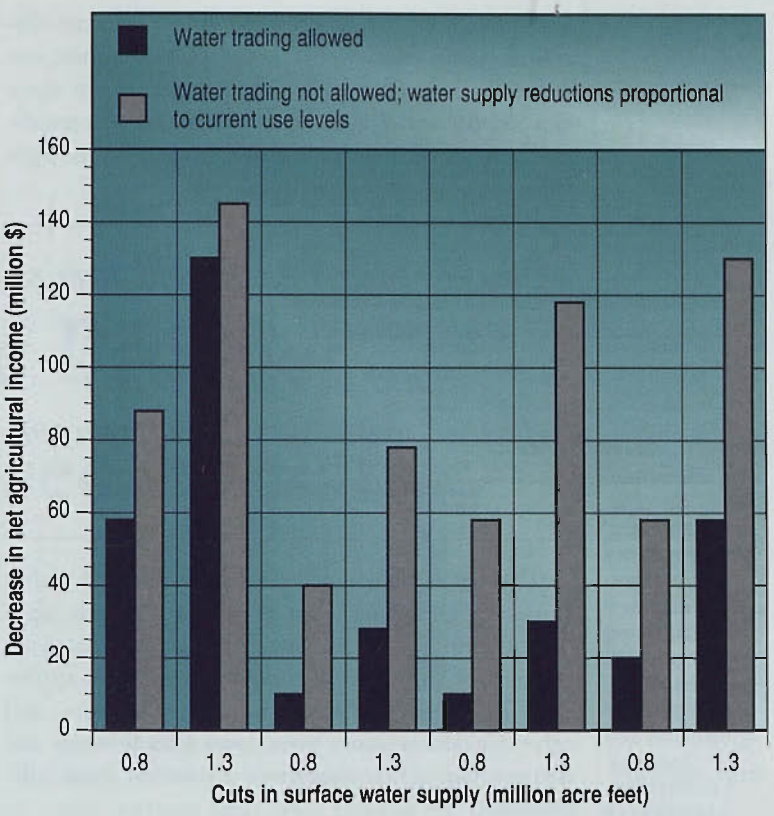


Figure 2. Decrease in net agriculture income caused by cuts in surface supply

Water lessons

California farmers respond to incentives and, as water becomes more scarce, farmers act to minimize their losses. The drought caused adoption of modern irrigation practices and water conservation strategies, a shift away from water-using crops to water-efficient crops, and increased reliance on ground water. Effective use of inventories (both of ground and surface water) helped to soften the impact of the drought; but as the drought continued, the state government created a new institution, the water bank, to facilitate water trading and further reduce drought costs. Water storage and trading mechanisms allowed California agriculture to survive and even prosper through a severe drought.

The costs of more limited water supplies depend critically on the extent of trading, and when rules limit trading, on how they distribute cuts

among regions. If government water agencies distribute water cuts over a wide region, farmers can reduce acreage of only low-value crops. But if agencies impose water cuts in only a limited geographical area, income losses increase because even high-value crops must be sacrificed.

Greater water trading will require improvements in conveyance facilities to assure fast and efficient water movement between different parts of the state.

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The water bank and the federal Central Valley Project Improvement Act (CVPIA) are early signs of a reform to extend market forces for managing water in California. However, the CVPIA applies only to Bureau of Reclamation contractors, and other California water users cannot trade water and do not face price incentives to use it more efficiently.

Much can be done to manage California's water even more efficiently. First, the institutional change currently underway should be expanded to allow water trading for all growers. For example, new laws might grant transferable water rights to encourage water rights holders to conserve water for trade. In areas where water districts hold water rights, water conservation and trade to higher value uses will be encouraged by assigning each grower a share in the district's supply. Districts can act as brokers to facilitate trade and help convey water. The state also needs ground water reform. More efficient use of ground water may require that government establish enforceable property rights in ground water aquifers.

Greater water trading will require improvements in conveyance facilities to assure fast and efficient water movement between different parts of the state. Existing water projects provide reasonable conveyance from the north to the south, but much of the accessible water goes to the east side of the San Joaquin Valley while demand is on the south side. A cross-valley canal may facilitate trade.

Finally, water trading will increase the value of water and provide incentives for conservation. While we expect modest water prices in normal years, they could increase substantially during drought years. The likelihood of price increases provides further incentive to construct new surface storage facilities and to devise ways to store water in the ground during wet years for pumping during dry years.

Public and private agencies designed and constructed water systems in California to promote the agricultural industry. Now, as water scarciry increases, the rules and mechanisms useful in the past should be changed to improve both farm and nonfarm welfare. Market mechanisms and efficient water allocation schemes can help solve perceived water crises without building new water supply projects. ◘

■ For more information

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