Agricultural and Resource Economics
UPDATE
GIANNINI FOUNDATION OF AGRICULTURAL ECONOMICS • UNIVERSITY OF CALIFORNIA
V. 12 no. 3 • Jan/Feb 2009

Economic Impacts of Reductions in Delta Exports on Central Valley Agriculture

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We estimate the short run effects of environmental and drought induced reductions in Delta exports using a regional model of farmer decisions in California. Economic results are summarized in terms of losses in employment, revenues, and income. They indicate that current projections of reductions in Delta exports have significant impacts that are mostly concentrated among low-wage workers, but a South-of-Delta water market could mitigate these effects.

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California is currently experiencing its third major drought in the last 30 years. Droughts in California are a normal occurrence but this time state agriculture is facing an unprecedented crisis. Californians, acutely aware that water is the driving force and limiting variable for urban development and agriculture, have taken steps to prevent shortages. Irrigated agriculture reacted to the droughts in the mid-1970s and early 1990s with a combination of increased groundwater pumping, crop changes, better technology, and an emergency water market. When facing the drought of 2009, farmers have less of these coping mechanisms available and those that are available are not as effective as in the past.

According to the California Department of Water Resources (DWR) 70% of California's water runoff occurs north of the Bay Delta but 75% of California's agricultural and urban demands are to the south, leaving the Delta as a central hub for conveying California's water. More than simply a means of conveying water, the Delta is the largest estuary in the western United States and is home to a wide variety of unique wildlife. Unfortunately, three consecutive years of below average rainfall and an increased awareness of the effect of water exports on key native species has put significant strain on the ability to export enough Delta water to meet urban and agricultural demands. Further complicating the situation, recent legal decisions have clearly linked the well-being of Delta fish and farmers.

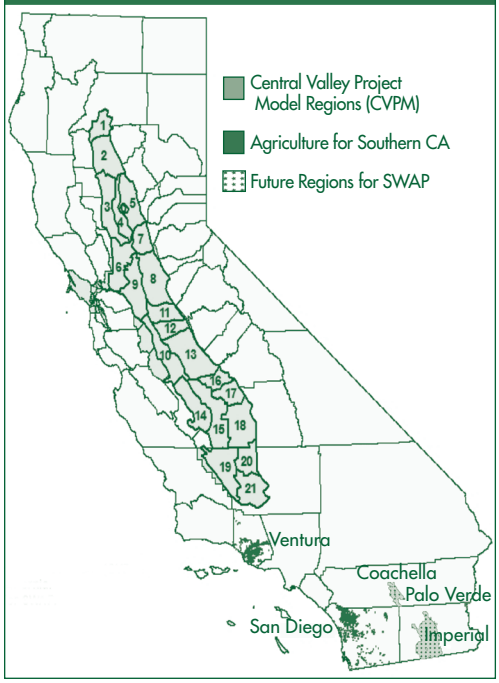
The current drought presents a situation that is unique relative to previous events for several reasons. During the drought of the early 1990s, farmers increased groundwater wells and rates of pumping. However, wells drilled in the 1990s are still operating and many aquifers have a limited capacity for even short run increases. Droughts always spur irrigation efficiency, but steady advances in technology over the past 15 years have made rapid improvements harder to achieve. Crop fallowing and changing cropping patterns were common responses in previous droughts, but this avenue of adjustment has been trimmed by increasing areas of perennial crops due to market growth. Reduced irrigation that stresses the crop is yet another short-term water management strategy, although the effectiveness is a source of contention in current literature. Stress irrigation depends on the timing of application which, in turn, depends on crop and soil specific characteristics. Additional limitations, as a result of recent legal rulings designed to protect endangered Delta fish, have further complicated matters by restricting Delta exports. The combined effect of these factors is one of "hardening" the demand for water and making it less flexible and price responsive.

The two largest water storage and conveyance projects in California are the State Water Project (SWP) and the Central Valley Project (CVP) which pump water from the south part of the Delta that flows in from the north and across the Delta. Water inflows to the Delta are essential for sustaining native fish species such as the Delta Smelt and Chinook Salmon, and Delta exports are important for Central Valley agriculture and urban demands. In addition to legal restrictions on allowable exports, three consecutive drought years have reduced the level of Delta inflows to critical levels. Based on current data, 2009 Delta exports are projected to be zero for CVP water, and 10% of normal deliveries for SWP water. Furthermore, based on data from 1992, it is likely that regions on the east side of the Central Valley will realize reduced local surface supplies to about 75% of normal allocations. Total expected reductions in Delta exports are around 3.6 million acre-feet (maf), with an additional 800 thousand acre-feet in reductions of local supplies. Combined, these represent just under 30% of average Central Valley water use.

Using an Economic Model to Predict Drought Response

A modified version of the Statewide Agricultural Production Model (SWAP) is used to estimate the impacts of reduced Delta exports and other Central Valley water supplies. SWAP is calibrated against past farmer decisions and uses this to predict reactions to changed circumstances. The model implicitly assumes that farmers optimize their cropping decisions to maximize profits. Constraints on minimum regional corn silage production and perennial crop abandonment are included to be consistent with the regional dairy herd feeding requirements and farmers' reluctance to lose all but those perennial crops close to retirement. Drought impacts are summarized in terms of valley-wide economic losses. However, results from

Figure 1. Map of California CVPM Regions



SWAP allow for more detailed analysis of impacts both in terms of crop changes and fallowing, and also changes in the intensity of use of other inputs.

Agricultural regions in SWAP include 21 Central Valley Production Model (CVPM) regions as shown in Figure 1. Shaded areas indicate the 21 regions in addition to areas included in the model but outside of the valley. Central Valley regions, defined as regions 10 thru 21, represent the focus of this study. Regional irrigated crop production is classified into twenty crop groups which are defined using 2005 geo-referenced land use surveys and DWR land use data. Inputs to crop production include supplies, labor, land, and water. Water use is based on 2005 applied water data combined with 2000 regional water use proportions from DWR. The year 2000 is taken as a base because it represents the most recent normal water year data available from DWR. All input costs are in 2005 dollars to be consistent with land and input use numbers; model results are indexed to 2008 dollars.

As discussed previously, farmers are likely to respond in the short run through stress irrigation, increased groundwater pumping, and land use changes. The model allows for up to 15% stress irrigation across all crops. New groundwater wells have steadily increased over the last two drought years and are likely to continue to increase in the short run. However, the ability of farmers to pump additional groundwater depends on both its availability and the cost of pumping. Due to uncertainty in the ability of farmers to increase pumping in the short run, results are calculated for a range of groundwater pumping increases of 25, 50, 75, and 100%. All scenarios are analyzed with and without a South-of-Delta water market. Environmental regulations restrict voluntary water markets among districts and farmers south of the Delta.

Results

Results are summarized in terms of revenue loss, income loss, employment loss, and land use changes over the next year. Revenue losses for Central Valley farmers range from $1.2 to $1.6 billion for 2009, depending on farmer groundwater pumping response. Reductions in farm revenue are then combined with the results of a Central Valley regional economic model (REMI, http://remi.com/) and are used to generate estimates of the losses in income and employment. The combination of gross direct plus indirect income loss to the Central Valley is estimated to range from $1.6 billion to $2.2 billion. When converted into jobs lost in the Central Valley, model results show losses over a range of 60–80,000. In the case of a sustained drought, the increases in groundwater pumping and stress irrigation are unlikely to be sustainable and losses in revenue, employment, and income are expected to rise by 30 percent.

Total revenue losses across all regions in the Central Valley are summarized in Figure 2. Depending on the ability of farmers to increase groundwater pumping, gross revenue losses could range as high as $1.6 billion. It is important to note that the short run

model does not capture the effects of reduced levels of groundwater and, more importantly, results are in terms of gross revenues. Thus, they do not reflect the increasing costs of groundwater pumping as depletion occurs. As such, results should be viewed as a lower bound on plausible losses.

Employment losses are estimated in Figure 3 for alternative assumptions regarding the increase in groundwater pumping. This represents between 20–26% of total direct and indirect Central Valley agricultural employment in a normal year. The majority of these job losses will be to farm workers and employees of packing houses and processing plants. Farm workers are typically low-wage workers with few alternatives for other work. As such, job losses as a result of reduced Delta exports will be concentrated among a group poorly equipped to absorb the effects.

Central Valley income losses are estimated to be as high as $2.2 billion and are summarized in Figure 4. Using a different set of results from the REMI model, statewide income losses are estimated to be up to $2.8 billion. Income losses represent both direct and indirect effects and a sustained drought is expected to increase losses.

An important consideration for mitigating the impacts of drought and reduced Delta exports is setting up a functional voluntary market for water. Trades between regions north of the Delta and southern regions are unlikely, as Delta pumping will be infeasible at most times. However, a South-of-Delta water market is feasible and plausible under the projected conditions. To summarize the effects of a water market, Figures 5 and 6 (page 4) show expected reductions in total irrigated acres without and with water transfers. Land fallowing is significantly reduced with water transfers and effects are spread across regions more evenly. Allowing regions to transfer water enables it to flow to highest value uses first, which significantly reduces farmer revenue losses. Additionally, with a South-of-Delta water market, income, employment, and revenue losses are significantly reduced in affected regions. It is important to note that computer generated projections do not take into account the increased reluctance to sell water in a severe drought, and overestimate the ease with which water can be transferred east-west across the Central Valley. Accordingly, these results should be viewed as upper bounds on the likely effect of markets.

Figure 2. Projected Direct Farm Revenue Loss for 2009

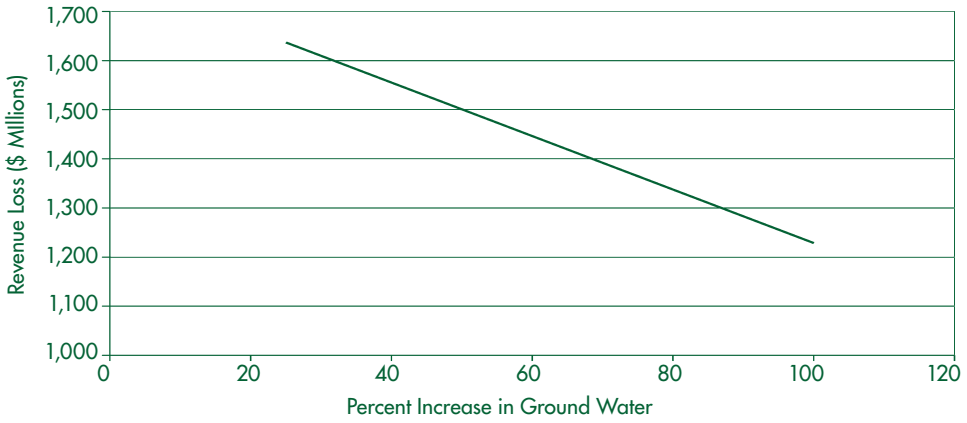


Figure 3. Projected Central Valley Employment Loss for 2009

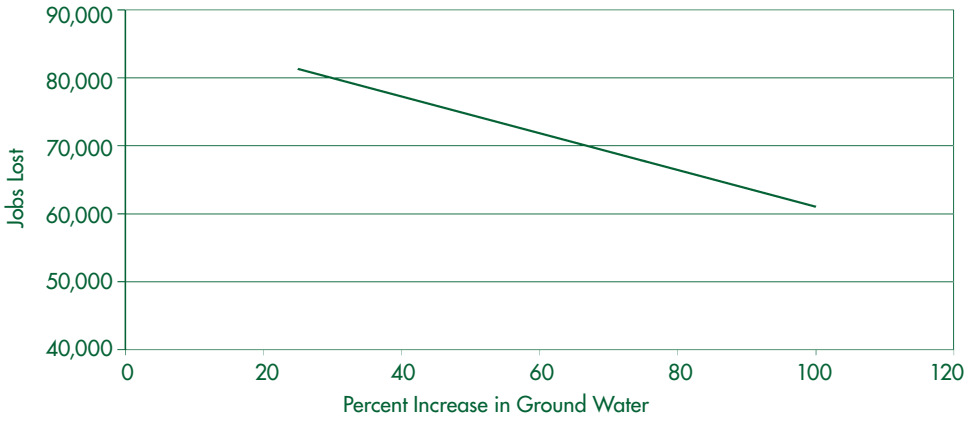
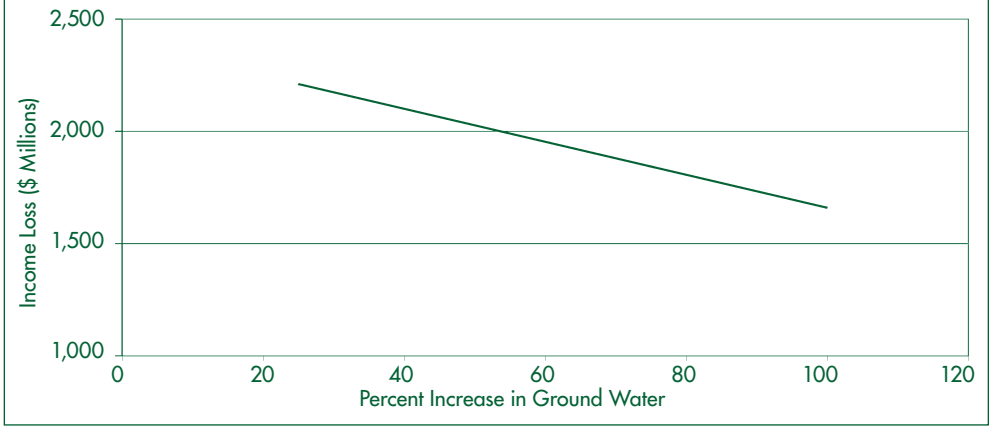


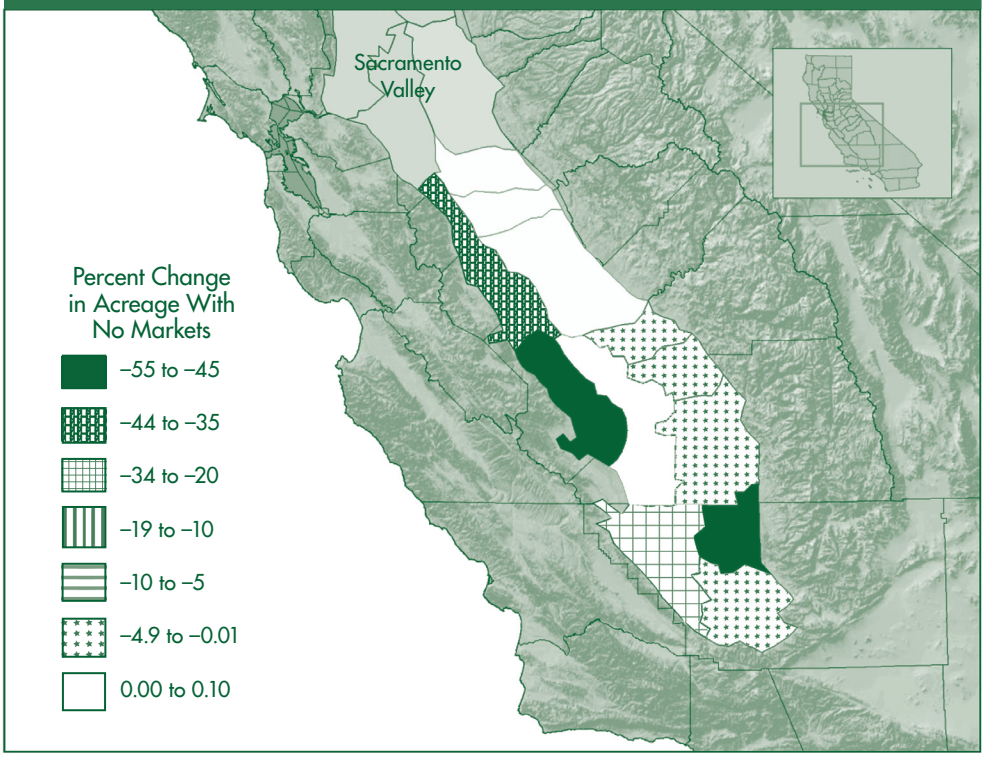
Figure 4. Projected Central Valley Income Loss for 2009



Conclusion

SWAP model results show that substantial reductions in available water from CVP and SWP deliveries, as well as reduced local supplies to the eastern regions, will severely reduce Central Valley income, employment,

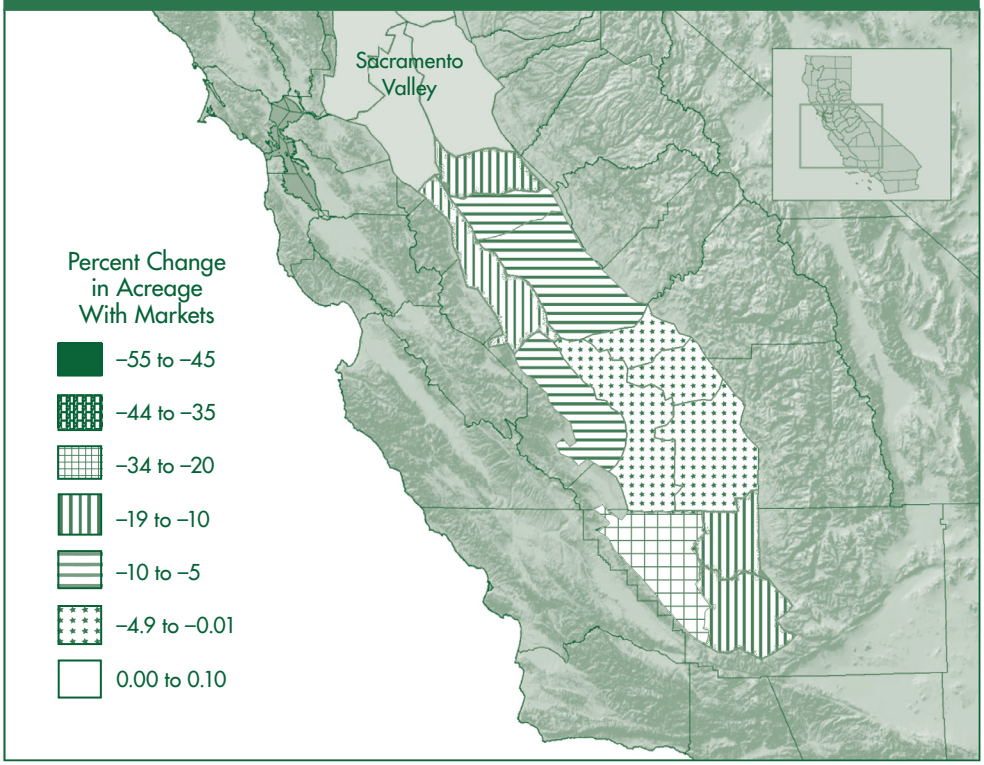
Figure 5. 2009 Change in Crop Acres with No Markets



revenues, and cropped acres. Under minimal increases in groundwater pumping, income loss to the Central Valley could be as high as $2.2 billion with 80,000 jobs lost. When measured on a statewide basis, the income losses rise to $2.8 billion in 2009, and the job loss to 95,000. Most of the unemployment impacts are concentrated among low-wage workers who have the least options for enduring the effects. In the long run, farm production costs are expected to rise by 30% and introducing a South-of-Delta water market could substantially reduce effects in some regions.

The projected drought impacts in 2009 are the result of a biological and hydrological crisis in the Central Valley of California. Both farmers and native fish depend on the Delta for water, and solutions to reconcile the needs of these two parties have been the focus of much research. Recent research on the role of the Delta includes short run options of regional water markets and fish habitat enhancement, and long-term solutions such as a peripheral canal. While water deliveries are uncertain in any given year and future droughts will occur, aligning the needs of the environment, farmers, and urban users is an important step for preventing future crises.

Figure 6. 2009 Change in Crop Acres with Markets



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For additional information, the authors recommend:

Howitt, R.E., N.Y. Moore, and R.T. Smith. *A Retrospective on California's 1991 Emergency Drought Water Bank.* Sacramento: California Department of Water Resources, 1992.

Howitt, R.E., K.B. Ward, and S.M. Msangi. "Appendix A: Statewide Water and Agricultural Production Model." In *Integrated Economic-Engineering Analysis of California's Future Water Supply*, A1–A11. University of California, Davis. http://cee.engr.ucdavis.edu/faculty/lund/CALVIN/Report1/.

Lund, J., E. Hanak, W. Fleenor, R.E. Howitt, J. Mount, and P. Moyle. *Comparing Futures for the Sacramento-San Joaquin Delta.* San Francisco: Public Policy Institute of California, 2008. www.ppic.org/content/pubs/report/R_708EHR.pdf.