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Drought, Jobs, and Controversy: Revisiting 2009

Richard E. Howitt, Duncan MacEwan, and Josué Medellin-Azuara

The effect of the 2009 water shortage on San Joaquin Valley agricultural jobs was a contentious topic which was exacerbated by conflicting job-loss estimates. In hindsight, econometric analysis of payrolls for employment and satellite data on crop fallowing have provided a clear measure of the extent of job losses in the San Joaquin Valley. However, droughts will occur again, and forecasts will have to be made. This paper presents the forecasts made, analyzes the reasons for differences in the forecasts, provides a final estimate of job losses, and draws insights for meaningful forecasts in the future.

Also in this issue

In 2009 California was in the third year of severe drought, and legal rulings had further limited water deliveries to agriculture in the San Joaquin Valley. Water users, farmers, and policymakers were interested in the effects of drought and additional water restrictions. Using data from state agencies, we forecasted the changes in agricultural production, revenue, and jobs due to water shortage in the San Joaquin Valley.

Beginning in January 2009, and followed by updates in May 2009, September 2009 and September 2010, a series of reports were released with updated acreage, revenue, and job-loss estimates. The dates of the reports were tied to updates in anticipated water deliveries released by the California Department of Water Resources (DWR) and United States Bureau of Reclamation (USBR).

In each report, the most recent estimates of announced State Water Project (SWP) and Central Valley Project (CVP) deliveries and groundwater pumping capacity were used to forecast the economic impacts of reduced water supply. As water deliveries increased, estimates of losses in agricultural acreage, revenue, and jobs were decreased. In other words, the water-cut scenarios were driving the job-loss forecasts.

Our January 2009 report contained a technical error, which we corrected as soon as it was brought to our attention by several colleagues, but has subsequently generated significant confusion. We want to clarify what this mistake was and how we corrected it.

We first used changes in agricultural water deliveries to forecast changes in irrigated acres and farm revenue using the Statewide Agricultural Production Model (SWAP). These losses in revenues were then combined in a regional input-output model to estimate job losses. An error occurred in this second step.

Our January 2009 estimates used the REMI input-output model, and we failed to notice that the “multiplier” used to translate losses in agricultural revenue into job losses was nearly double an acceptable value. In general, one million dollars in lost farm revenue translates into a range of 15 to 28 direct agricultural jobs lost. Our January 2009 estimate used 39 lost jobs per one million dollars in lost revenue. To correct this error, we purchased and calibrated a more transparent input-output model, IMPLAN, which we have used for all subsequent analysis.

In 2009 California was at the peak of the recession, and job-loss estimates generated significant attention. Adding to the confusion, preliminary monthly job surveys from the California Employment Development Department (EDD) showed agricultural employment in the San Joaquin Valley was largely unchanged between 2008 and 2009. Consequently, some partisan groups incorrectly stated that there were no jobs lost due to water shortage in the San Joaquin Valley.

There are two problems with using preliminary employment survey data to forecast job losses. First, the preliminary data are prone to survey error, which we have discussed in other reports, and are subject to revision. Although the initial estimates showed no change in jobs, the revised estimates, released nearly a year after the drought in 2010, showed 9,800 agricultural jobs lost in the San Joaquin Valley.

Second, and more important, a change in month-over-month employment across years does not provide a basis to assert causality, and is difficult to interpret due to the likely presence of confounding factors. Finally, we note that surveys are not useful in forecasting because they rely on observed (i.e., past) data.

Agricultural production forecasts using the SWAP model rely upon a deductive method to estimate production and revenue changes due to water shortage. When linked to a properly specified input-output model, job losses can also be forecasted. While the payroll data provide a valuable retrospective benchmark, they arrive too late to influence current water policy, which requires forecasts of job and income impacts in real time.

In this article, we review the job-loss estimates based on SWAP and IMPLAN model results, and compare them to EDD job-loss surveys, and show how changes in water deliveries changed forecasts. We conclude by discussing the usefulness of SWAP for forecasting drought effects and compare results to a recent econometric analysis.

Forecasting Agricultural Production: An Overview of SWAP Estimates

SWAP is a mathematical model of California agriculture which exactly replicates a base year of input use and crop production. When faced with water shortages, farmers respond by fallowing land, deficit irrigating crops, pumping additional groundwater, and shifting to less water-intensive crops. All of these activities reduce agricultural profits. Additionally, groundwater is the most expensive source of water in most regions, thus additional pumping further reduces profits. Fundamentally, agricultural production modeling is based on a clear causal link between water and acres, and acres and revenue. Revenue is then linked to jobs using the IMPLAN input-output model.

We published four forecasts based on the SWAP and IMPLAN models, including three during the drought in January, May and September 2009, and a retrospective assessment in September 2010. We used the most accurate water-supply information available at the time, from the SWP and CVP, regional groundwater pumping capacities and regional local surface water supplies, to produce each forecast. We used this information to forecast the expected change in agricultural production and, as water deliveries increased and late season rains occurred, forecasts of impacts decreased.

The first forecast was released in January of 2009 by Howitt, MacEwan, and Medellin-Azuara. At the time, the best available data forecasted CVP and SWP deliveries of zero and 10%, respectively, with local surface supplies at 1991 levels. Data on groundwater pumping capacity was not available at the time, thus we ran the model over a range of capacities between zero and 100% pumping increases. The combined effect was an average total water shortage to the entire San Joaquin Valley of 29%. We estimated revenue losses in the San Joaquin Valley between $1.4 and $1.6 billion, with between 650 and 700 thousand acres fallowed. The corresponding estimate of job losses fell between 30 and 40 thousand.

Howitt, Medellin-Azuara and Mac Ewan released a second forecast in May of 2009, and a third forecast in September 2009 with more technical details. Between January and May, SWP and CVP water deliveries were increased from zero to 40% and 10% of normal, respectively. DWR completed an analysis of groundwater pumping capacity and found that some regions in the San Joaquin Valley could increase pumping, in the short term, by up to 400%—well in excess of previous estimates. The combined effect was a total water shortage to the entire San Joaquin Valley of 21%. We estimated revenue losses to be $710 million, with less than 450,000 acres fallowed. The corresponding estimate of job losses was 21,000.

Michael et al. released a fourth report in September of 2010. In this analysis, we had the luxury of observing the actual water-supply situation in 2009. The most striking finding was that over 500,000 acre-feet of known water transfers took place in 2009, which served to significantly offset some of the localized effects of the drought. Additionally, east-side local surface water supplies were higher than the anticipated 1991 levels due to late season rains. The combined effect resulted in water-supply reduction of 11%, about half of the best available predictions for the last forecast estimate in September 2009. As a result of the better-than-anticipated water supply, revenue losses, fallowed acres, and job losses were lower than previously forecasted. We estimated revenue losses of $370 million, with less than 270,000 acres fallowed. The corresponding estimate of job losses was 7,500.

An Overview of EDD Surveys

EDD uses a two-part process to collect farm employment data. During the year, they perform monthly surveys which are finally verified a year later when payroll data become available. Employment surveys serve as an important benchmark for retrospectively checking the accuracy of forecasts. Comparing monthly changes in jobs across years may estimate the change in employment, but not the reason why the number of jobs changed.

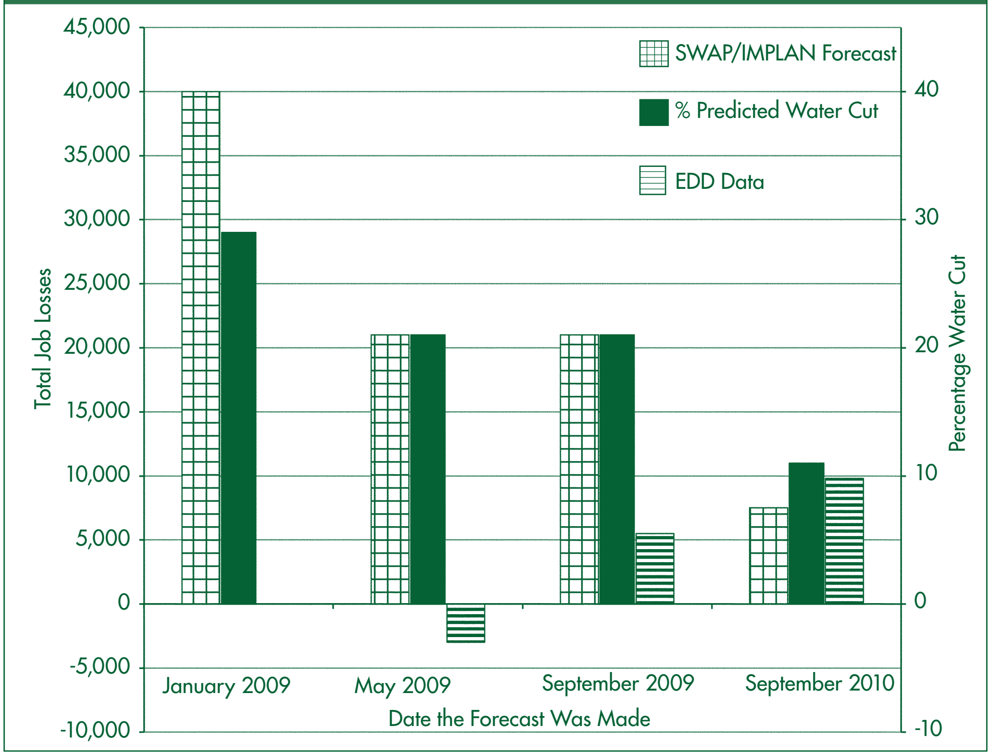
The California EDD releases monthly surveys of jobs across industries in California, and we focused on total agricultural jobs in the San Joaquin Valley. Initial survey releases showed significant positive job growth in agriculture during 2009, even when fallowing was increasing and the drought was anticipated to be worse than realized. EDD surveys are the product of a constant sampling procedure that is subject to significant bias if the sampling frame is changed by outside factors.

According to the EDD, if someone worked for an agricultural employer for any period, longer than one hour, during the week that contains the 12th day of the month, the EDD counts that person as an employed farm worker for that month. This method will work well, as long as there are no rapid changes in the pool of potential workers.

However, farm worker supply increased in 2009 due to a downturn in construction, and at the same time worker demand decreased due to drought, thereby increasing competition for existing agricultural jobs. Due to the seasonal nature of farm jobs, this translated into shorter periods of employment. For example, with extra workers available, a farm manager who might have hired one worker for three days may instead hire three workers for one day. Consequently, total employment as reported by EDD would increase from one worker to three workers for that week although, in reality, total farm work performed and wages paid could have decreased.

Initial survey data released by EDD, which showed an increase in San Joaquin Valley agricultural employment of 3,000 jobs between 2008 and 2009 during the growing season, were subsequently revised to show losses of 9,800 jobs during this period. Even with severe drought and an increase in fallowed acres, the initial EDD surveys were detecting job growth. This anomaly generated significant controversy, as partisan groups suggested that model-based estimates of job losses were false. It was not until September 2009 that the EDD released revised data showing 5,500 jobs lost in the San Joaquin Valley.

Figure 1. Summary of SWAP/IMPLAN Job Loss Forecasts and EDD Surveys by Forecast Date



Comparing EDD and SWAP Results and a Retrospective Assessment

SWAP is a method for forecasting drought effects on agriculture based on water supplies, whereas EDD surveys provide a useful retrospective benchmark. While the payroll data provide a valuable check, they come too late to influence current water policy which requires real-time forecasting of job and income impacts.

Figure 1 summarizes the difference in SWAP forecasts, predicted water cuts, and EDD surveys tabulated by the date when each of the four forecasts was made. EDD initially estimated job growth during the drought. The final estimate was not available until months after the growing season and long after important policy decisions had to be made. In contrast, SWAP and IMPLAN forecasts of job losses were revised down as additional SWP and CVP water was available and additional groundwater pumping took place.

The reason the model forecasts differ is because the available water supply changed during the time intervals between forecasts. An important follow-up question is how well the SWAP model, or agricultural production modeling in general, does when accurate water-supply data are used in the model.

We reviewed crop acreage data, employment surveys, census data, water-transfer data, and satellite images available in September 2010 to retrospectively determine the actual effect of the 2009 drought. We found that the SWAP and IMPLAN models produced accurate measures of job

Table 1. Summary of Forecasts, Retrospective, and Realized Effects of 2009 Drought on San Joaquin Valley Agriculture

Date of Forecast	Combined % Drought	Revenue Loss	Acres Fallowed	Jobs Lost
January 2009	29%	$1,400m	675,000	40,000
May 2009	21%	$710m	450,000	21,000
September 2009	21%	$710m	450,000	21,000
September 2010 Retrospective	11%	$370m	270,000	7,500
Actual	–	$340m	285,000	9,800

impacts when driven by accurate water-supply data. More specifically, when known water transfers and increased east-side local water supplies were included, the SWAP model forecasts of acres and job losses were consistent with the best available data. Table 1 compares the results of the three forecasts and the retrospective analysis, with the actual outcomes.

In order to use EDD employment data to determine past agricultural job losses due to drought, it is necessary to perform econometric analysis. This allows the researcher to control for outside (confounding) factors and determine how many of the total jobs lost can be attributed to drought.

In a recent edition of *ARE Update*, Sunding, Foreman, and Auffhammer report the results of such an analysis. They find that the 2009 drought, compared to a base year of 2005, led to 5,000 direct agricultural jobs lost. When jobs lost in industries related to agriculture are added in, the econometric estimates are consistent with estimates from the SWAP and IMPLAN analyses.

Conclusion

When water supplies are cut due to drought or environmental considerations, policymakers and interest groups want timely forecasts of the impacts on regional employment and income. Such forecasts can be provided through analysis of agricultural production models like SWAP. The accuracy of such forecasts depends largely on the accuracy of water-supply forecasts that are input into these models.

Both the water-supply-based modeling and retrospective EDD employment surveys were in error when examining the impact of the 2008–09 drought. However, in future forecasts using the agricultural production models, it will be possible to improve accuracy by focusing more attention on the surface and groundwater supply estimates, and the prevalence of water trading. However, it is hard to see how the survey sampling approach used by EDD can be improved without substantial additions to their sampling budget.

In the retrospective analysis, we found that significant water transfers took place and local surface water supplies were higher than anticipated. Consequently, the early forecasts were based on data that indicated a drought worse than actually realized.

The key lesson from forecasting the 2009 drought is that agricultural production models require accurate estimates of water availability over the coming growing season. However, the severity of a drought changes over time and the true extent of effects are not known until months later. Even with this limitation, when accurate water estimates are input into production models the result is an accurate analysis of real-time effects. In other words, it's the water.

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Richard Howitt is professor and chair in the agricultural and resource economics department at UC Davis. He can be reached by e-mail at howitt@primal.ucdavis.edu. Duncan MacEwan is a Ph.D. student at UC Davis. Josué Medellín-Azuara is a project scientist in the civil and environmental engineering department at UC Davis.

For additional information, the authors recommend:

Howitt, R. E., D. MacEwan & J. Medellin-Azuara. 2009a. "Economic Impacts of Reductions in Delta Exports on Central Valley Agriculture."*ARE Update*, 12(3): 1-4. University of California Giannini Foundation of Agricultural Economics.

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