Economics of Declining Groundwater Levels: A Case Study for the Tulare Lake Basin, California

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Droughts in California
- Occur over annual, decadal and longer time scales
- 2014 and 2015 very dry and warm
- This drought had historically high water demands

A 200-year drought?
Evidence from tree rings shows that drought was historically much more widespread in the American West than now, while the 20th century was wetter than normal. Percentage of the West affected by drought from 800 A.D. to 2000:

Water Sources in California

<table>
<thead>
<tr>
<th>Basin</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sacramento</td>
<td>31%</td>
<td>69%</td>
</tr>
<tr>
<td>San Joaquin &amp; Delta</td>
<td>32%</td>
<td>68%</td>
</tr>
<tr>
<td>Tulare Lake</td>
<td>47%</td>
<td>53%</td>
</tr>
<tr>
<td>Central Valley</td>
<td>39%</td>
<td>61%</td>
</tr>
</tbody>
</table>

Groundwater Depletion, Especially in California’s Tulare Lake Basin
Higher Revenues and Employment in Fruits, Nuts and Vegetables

Cumulative Jobs and Revenues

Cumulative Irrigated Crop Area (1000 Acres)

2015 Estimated Agricultural Drought Impacts

<table>
<thead>
<tr>
<th>Description</th>
<th>Impact</th>
<th>Base year</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought water shortage (million acre-ft)</td>
<td>6.7</td>
<td>26.4</td>
<td>33%</td>
</tr>
<tr>
<td>Groundwater replacement (million acre-ft)</td>
<td>0.0</td>
<td>8.4</td>
<td>72%</td>
</tr>
<tr>
<td>Net water shortage (million acre-ft)</td>
<td>2.7</td>
<td>26.4</td>
<td>10%</td>
</tr>
<tr>
<td>Drought-related idle land (acres)</td>
<td>$40,000</td>
<td>9 million*</td>
<td>6%</td>
</tr>
<tr>
<td>Crop revenue losses ($)</td>
<td>$900 million</td>
<td>$40 billion</td>
<td>2.3%</td>
</tr>
<tr>
<td>Dairy and livestock revenue losses ($)</td>
<td>$350 million</td>
<td>$13 billion</td>
<td>2.7%</td>
</tr>
<tr>
<td>Costs of additional pumping ($)</td>
<td>$690 million</td>
<td>$780 million</td>
<td>75.5%</td>
</tr>
<tr>
<td>Net revenue losses ($)</td>
<td>$1.8 billion</td>
<td>54 billion rev. 3.3%</td>
<td></td>
</tr>
<tr>
<td>Total economic impact ($)</td>
<td>$2.7 billion</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Direct job losses (farm seasonal)</td>
<td>10,100</td>
<td>200,000*</td>
<td>5.1%</td>
</tr>
<tr>
<td>Total job losses</td>
<td>21,000</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

* NASA-ARC estimate of normal Central Valley idle land is 1.2 million acres.
* Total agriculture employment is about 412,000, of which 200,000 is farm production.

Groundwater is the Main Buffer During Droughts

Water Quantity and Quality Issues in Small Water Systems

Case study at the Tulare Lake Basin: A Survey Approach

Employed well completion reports and time series hydrographs of groundwater levels from DWR

Time Series Hydrographs to Groundwater

http://droughtimpacts.ucdavis.edu
Also see: Why California needs better groundwater management


This graphic depicts the extent of the dry wells, as identified and located by the Governor’s Office of Planning and Research and the 218th Groundwater Level Monitoring Wells. The dry wells are shown in red on a map of the Central Valley to highlight the impacts of the drought on groundwater levels. The concentration of pollutants is also shown, indicating areas with higher levels of contamination.
Idle farm land during 2015 drought in study area

A 44% increase in idle land in the skirts of the city limits
Source: Fallowing Area Mapping NASA, Forrest Melton
https://nex.nasa.gov/nex/projects/1372/

Preliminary Findings well survey work

- Overdraft increases energy costs due to head, efficiency or well costs
- Year to year increase in costs for deeper levels to groundwater slightly higher during 2012-2015 drought
- Dry wells or lack of access to groundwater will entail much higher costs, including well upgrade or replacement, higher cost surface water or fallowing.
- Dry wells, 10-20% agricultural, 20-30% domestic
- Well completion logs and groundwater elevation monitoring data are useful in quantifying effects of droughts and overdraft. The approach presented in this study could be extended to other critically overdrafted basins in the state.

A portfolio approach, surface and groundwater. Conceptual Model

Concluding Remarks on Groundwater and Droughts

- Groundwater remains the swing water source for droughts in California’s irrigated agriculture
- Climate change will likely bring similar and more frequent droughts
- Funding to manage groundwater is needed
- Creative tools like markets, water banking, and portfolio approaches can improve prospects for groundwater
- Water accounting to improve management
- Droughts and other crises force systems thinking
Thank you
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PPIC Public Policy Institute of California

CDFA California Department of Food & Agriculture

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