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

Josué Medellín-Azuara, Robert Gailey, Brad Arnold, Angela Kwon, Andrew Bell, Jay R. Lund

UCDAVIS CENTER FOR WATERSHED SCIENCES

International Groundwater Conference
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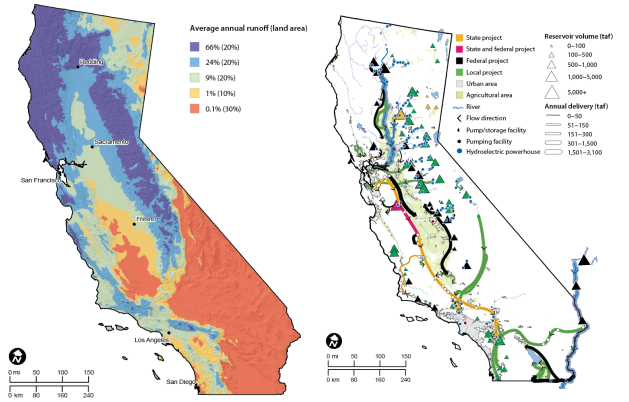
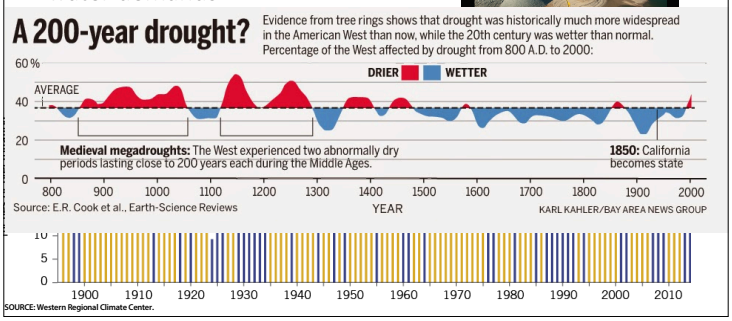
Water Resources in California



Hanak et al. (2011) Managing California's Water

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



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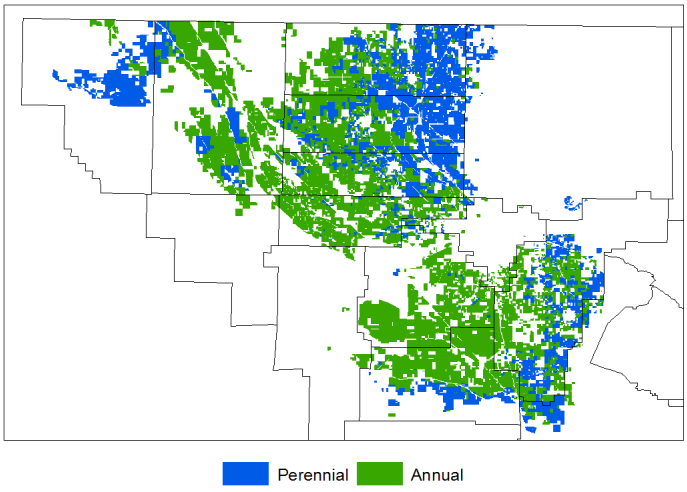
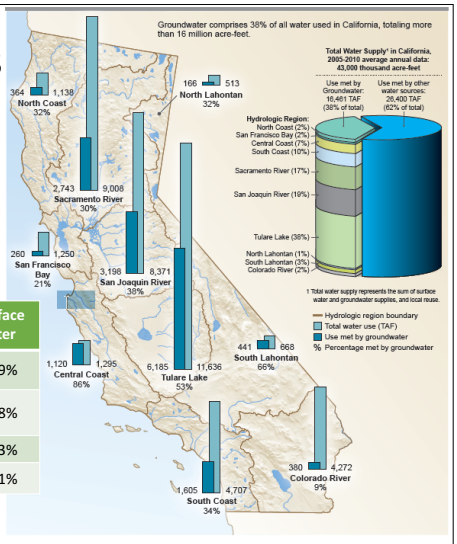


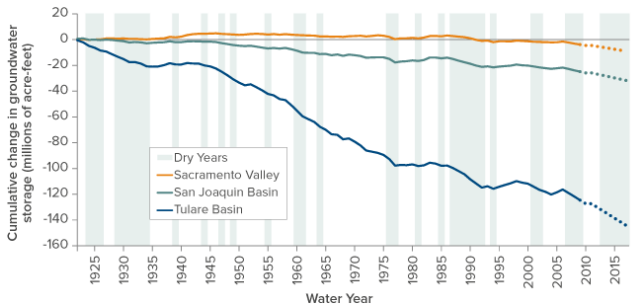
Water Sources in California

Irrigated Agriculture

Basin	Groundwater	Surface Water
Sacramento	31%	69%
San Joaquin & Delta	32%	68%
Tulare Lake	47%	53%
Central Valley	39%	61%

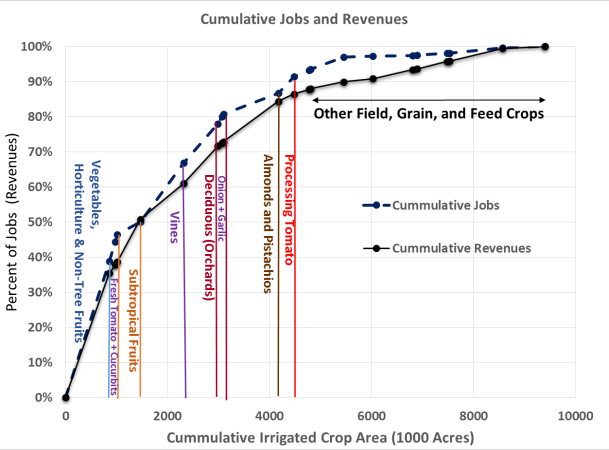


Groundwater Depletion, Especially in California's Tulare Lake Basin



SOURCE: What If California's Drought Continues? (PPIC, 2015), Figure 3.Data through 2009 from DWR; author estimates after 2009. Projections since 2009 may underestimate depletions since the onset of the latest drought (2012+)..

Higher Revenues and Employment in Fruits, Nuts and Vegetables



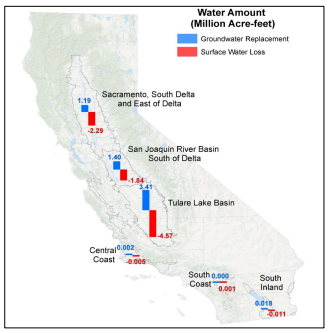
2015 Estimated Agricultural Drought Impacts

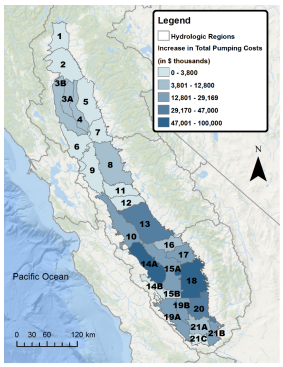
Description	Impact	Base year	Percent
Drought water shortage (million acre-ft)	8.7	26.4	33%
Groundwater replacement (million acre-ft)	6.0	8.4	72%
Net water shortage (million acre-ft)	2.7	26.4	10%
Drought-related idle land (acres)	540,000	9 million*	6%
Crop revenue losses ($)	$900 million	$40 billion	2.3%
Dairy and livestock revenue losses ($)	$350 million	$13 billion	2.7%
Costs of additional pumping ($)	$590 million	$780 million	75.5%
Net revenue losses ($)	$1.8 billion	54 billion rev.	3.3%
Total economic impact ($)	**$2.7 billion**	NA	NA
Direct job losses (farm seasonal)	10,100	200,000#	5.1%
Total job losses	**21,000**	NA	NA

* 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



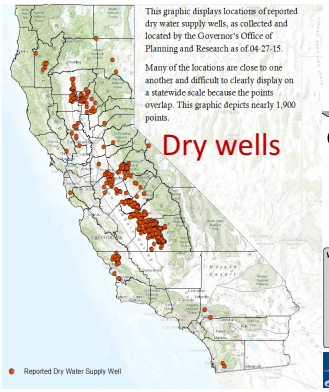


http://droughtimpacts.ucdavis.edu

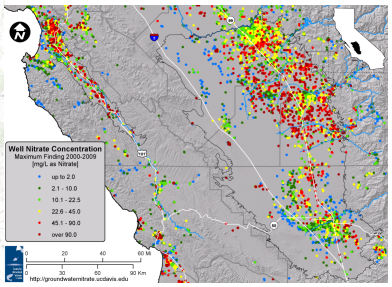
Also see: Why California needs better groundwater management

Medellin-Azuara et al. (2015) Hydrogeology Journal

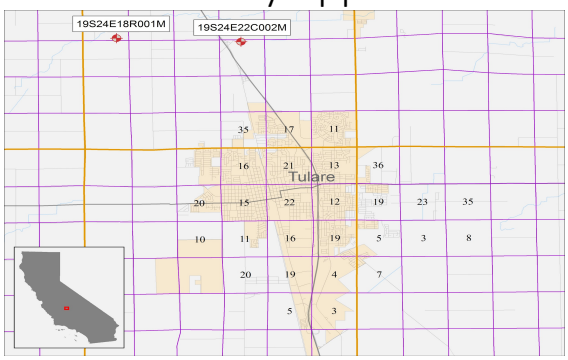
Water Quantity and Quality Issues in Small Water Systems



Concentration of Pollutants

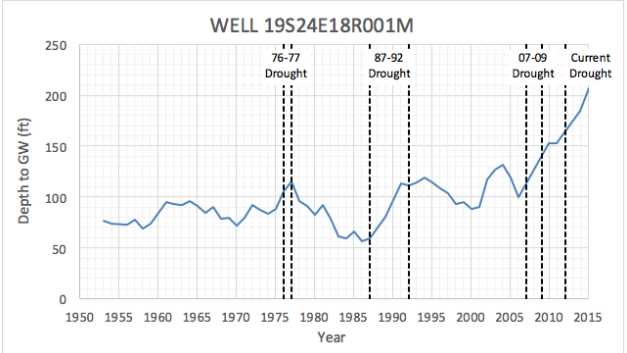


Case study at the Tulare Lake Basin: A Survey Approach



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

Time Series Hydrographs to Groundwater



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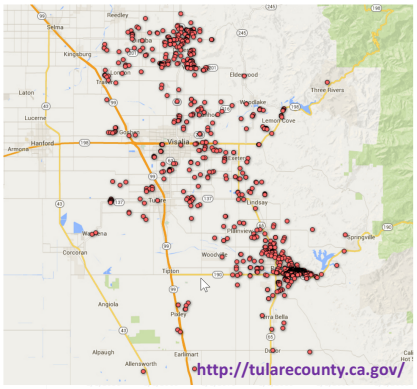
Week of September 21, 2015



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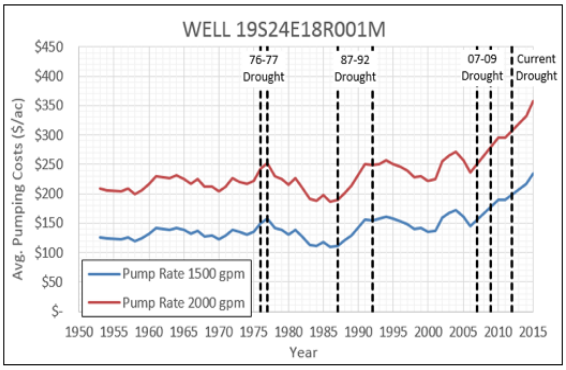
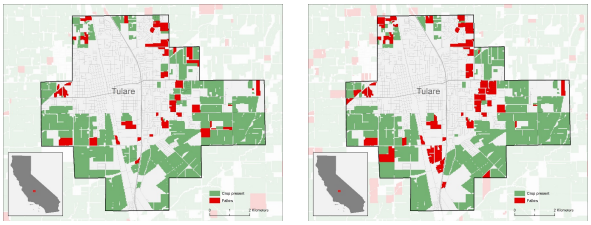
Preliminary Results: Costs



Average increase in cost ~$0.50/af –yr ~ $1.7/af yr during drought

Idle farm land during 2015 drought in study area



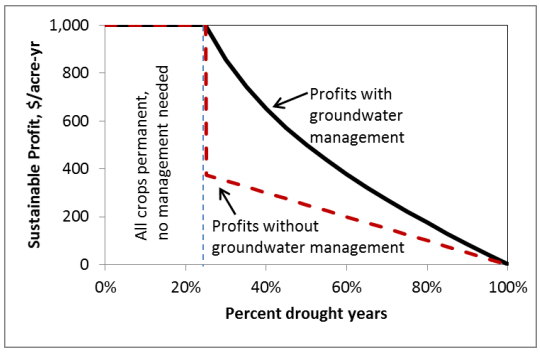
A 44% increase in idle land in the skirts of the city limits

Source: Fallowing Area Maping 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.

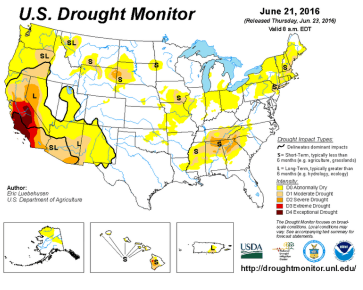
A portfolio approach, surface and groundwater. Conceptual Model



Lund et al. (2014). Why California Needs More Groudwater Management
http://californiawaterblog.com/2014/05/26/why-californias-agriculture-needs-groundwater-management/

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

jmedellin@ucdavis.edu

UC WATER
Security and Sustainability Research Initiative

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