## Estimating Economic Costs Droughts: Lessons Learned from California

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## Water Resources in California



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

## Droughts in California

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:



SOURCE: Western Regional Climate Center. Bars show inches above/below long-term statewide average precipitation (21.42 inches) based on water year (October–September) since 1896.

Ending At Midnight - April 25, 2017

## What about water conditions this year?





### Northern Sierra





## San Joaquin Valley



Total Water Year Precipitation





ries

## 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+)..

## Water Balances San Joaquin Valley

The San Joaquin Valley's water balance: sources and uses (1986-2015)





## Quantification Water Supply Shortage

- Surveys to about 100 irrigation districts mostly in the Central Valley expectations on deliveries
- Public announcements from the state and federal contract water projects
- Base water year 2010-2011



### Access to Groundwater



# Modeling Agricultural Production Decisions

- Inputs: Land, water, labor and supplies
- Self-calibration to base dataset
- Maximizes net returns to land and management
- Outputs: Input use and gross production, revenues and costs
- Statewide Agricultural Production Model (SWAP)

http://swap.ucdavis.edu



# Modeling Results: Groundwater is the Main Buffer During Droughts



Also see: Why California needs better groundwater management

#### Medellin-Azuara et al. (2015) Hydrogeology Journal

## Affected irrigated areas vary by crop and region. Field, grain, and feed crops are more vulnerable



## Higher Revenues and Employment in Fruits, Nuts and Vegetables



### Overall economic impact might seem small

Water supply, 2015 drought	Perc	ent Change	
Surface water reduction	8.7 MAF/yr	-48%	
Groundwater pumping increase	6.0 MAF/yr	72%	
Net water shGroundwater needs tight%Total fallow ( Crop revenue Additional grmanagement and irrigated area reductions are unavoidable5.8%2.6% 5.5%			
Livestock and dairy revenue loss	\$350 million		
7	5550 mmon	-2.8%	
Total direct costs	\$1.8 billion	-2.8%	
Total direct costs Total agriculture economic costs	\$350 minori \$1.8 billion \$2.7 billion	-2.8%	
Total direct costs Total agriculture economic costs Direct job losses	\$350 minori \$1.8 billion \$2.7 billion 10,100	-2.8% -2.5%*	

\*considering undocumented work force http://droughtimpacts.ucdavis.edu

## California Urban Water Systems Weathering Droughts

- So far...
  - Investments paid off
  - Regional cooperation
  - Conservation working
- Continued drought...
  - Supplies more constrained
  - Pricing restrictions (Prop 218) and affordability issues
  - Some challenges with conservation mandate
  - But economic impacts likely to remain small





18

Hanak, Ellen, Jeffrey Mount, Caitrin Chappelle, Jay Lund, **Josué Medellín-Azuara**, Peter Moyle, and Nathaniel Seavy. 2015. What If California's Drought Continues? Public Policy Institute of California.

# Water Quantity and Quality Issues in Small Water Systems





### **Concentration of Pollutants**



# Ecosystem risks with continued drought

Across the state fish are at risk of extinction with continued drought



- 18 fish at risk of extinction
  - Need for strategic flows, conservation hatcheries
- High waterbird mortality
  - Need for strategic wetland watering
- Severe wildfire risk, with some permanent losses of conifer forests
- More funding can help

## State and Federal Funds Drought

(Millions of dollars)	State	Feder al
Emergency community assistance	\$200	\$358
Impacted communities, workers (food, housing, training)	\$102	\$78
Safe drinking water systems	\$90	\$17
Technical guidance and planning	\$8	\$14
Feed subsidies for livestock producers	\$0	\$250
Emergency ecosystem support	\$66	\$67
Emergency fire protection	\$131	\$4
Water system investments	\$2,609	\$104
Total	\$3,006	\$534



## Lessons Learned

- 1. Every drought is different, droughts force system thinking
- 2. Agriculture robust due to groundwater and a diversified economy, water and land use reductions likely
- 3. California is Land of Extremes, climate change will likely bring similar and more frequent droughts
- 4. Groundwater is key, Sustainable Groundwater Management Act of 2014 offers some hope
- 5. Tools like markets, water banking, and portfolio approaches can improve prospects for water supply
- 6. Small water systems need help
- 7. Better water accounting and management of cutbacks

## Thank you

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- Further Readings
  - <u>Californiawaterblog.com</u>
  - Drought Impacts:
    - <u>http://droughtimpacts.ucdavis.edu</u>
  - What if the drought continues?
    - <u>http://www.ppic.org/main/publication\_q</u> <u>uick.asp?i=1160</u>
  - Futures of the San Joaquin Valley
    - <u>http://www.ppic.org/main/publication.as</u> <u>p?i=1224</u>
  - Forthcoming book futures of the San Joaquin Valley







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