

Drought in California:

What did California learn and can teach others from its own experience

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With input from Charles Regnacq and Maria Milanes-Murcia

Is there an “optimal” amount of rain for California?

If California doesn't get rain this winter ...

Mark Koba

Saturday, 4 Oct 2014 | 10:19 AM ET

CNBC.com

Too much of a good thing

Storms, muddy Delta water lead to pumping cutbacks

December 15, 2014

USBR

Valley Public Radio

The recent storms that have hit Northern and Central California have much brought needed rain and snow to the state. But they also created a new problem for the operators of the massive pumps in the Delta that supply users in the San Joaquin Valley and Southern California — too much water.

The Drought Situation December 2014

Water Level in Major California Reservoirs December 31, 2014

<http://cdec.water.ca.gov/cdecapp/resapp/getResGraphsMain.action>

Northern Sierra Precipitation: 8-Station Index, December 31, 2014

http://cdec.water.ca.gov/cgi-progs/products/PLOT_ESI.pdf

What Did California and Californians do in response to the drought?

- Call for voluntary savings
- California voters approved a water bond that contains \$2.7 billion for new water storage
- Unilateral quest for water (wild west approach)
- Water savings ordinances by cities and utilities
- Revising water pricing schemes
 - Water Budget Rate System
- Introducing conservation incentives
- Water trade
- Legislation reform

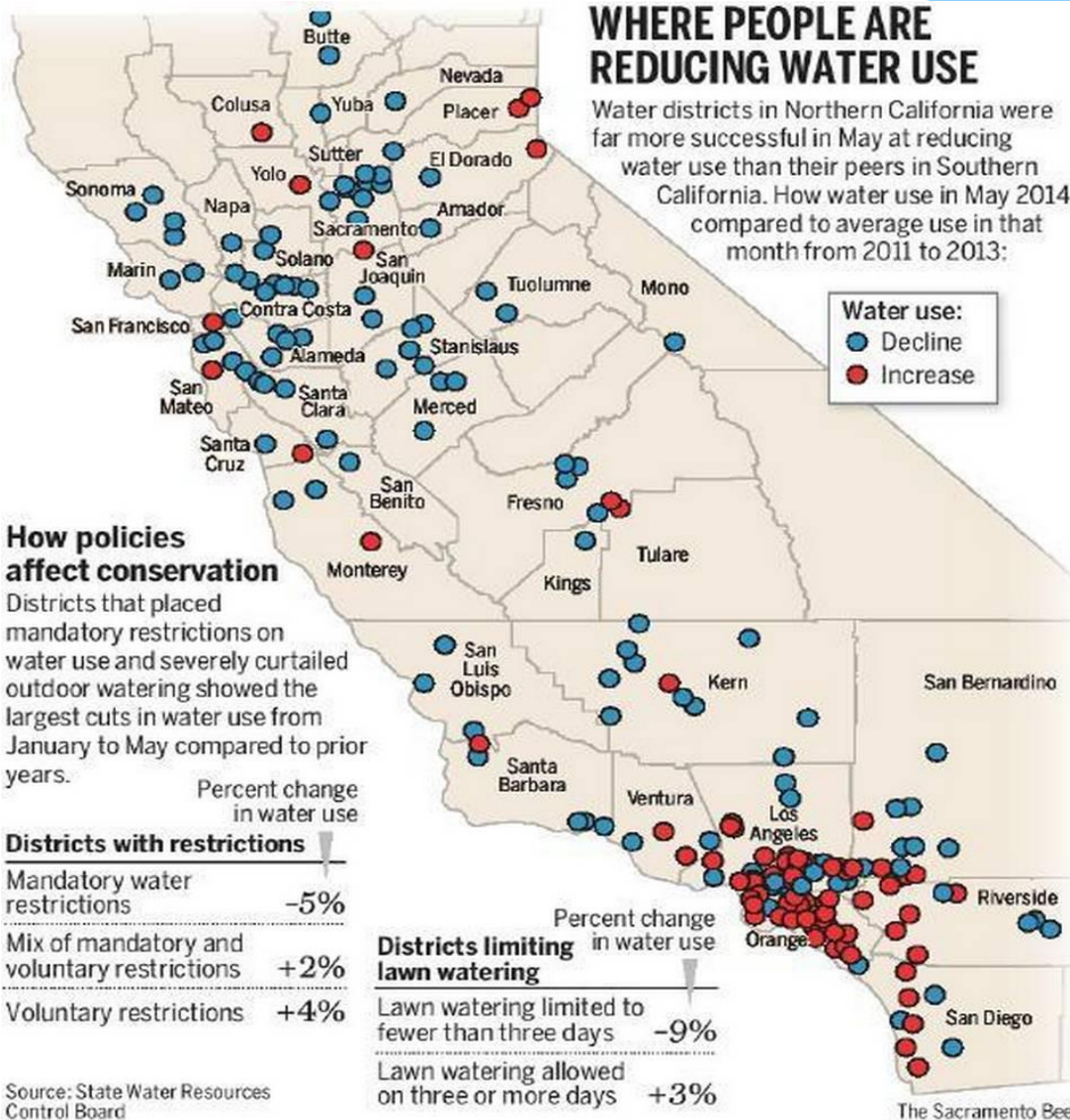
Voluntary cut in Water Use

- In January 2014, Gov. Jerry Brown urged Californians to voluntarily cut their water usage by 20% to help preserve the state's already limited supply during this severe drought.
- But sometimes, asking nicely doesn't work. Between January and May, water use was reduced by a measly 5%.
- Clearly, the voluntary approach isn't enough — water use is even up in some communities — and the state needs to take a harder line.

Source: LA TIMES July 14, 2014(<http://www.latimes.com/opinion/editorials/la-ed-water-conservation-20140711-story.html>)

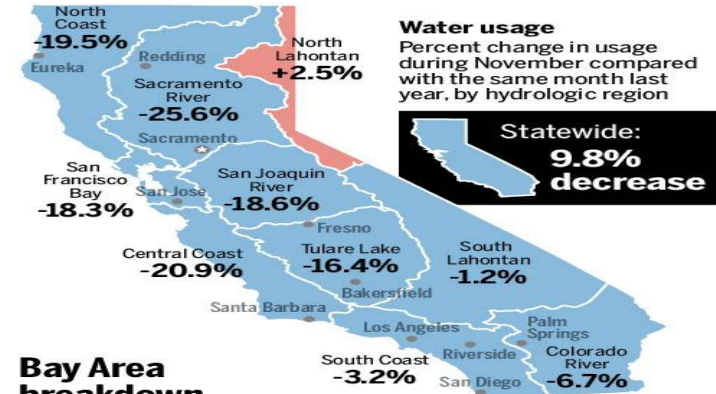
May 2014

November 2014



Who saved the most water

California cut water use by 9.8 percent in November compared with the previous November. Cities with tougher water rules and fines generally saved more, a new state report shows, and the north saved more than the south.



Bay Area breakdown

Percent change in usage during November, compared with the same month last year:

| | |
|---------------------------------------------------|--------|
| Alameda County Water District | -22.2% |
| American Canyon | -15.7% |
| Antioch | -18.0% |
| Benicia | -26.8% |
| Brentwood | -21.9% |
| Burlingame | -7.8% |
| California Water Service Co., Livermore | -23.9% |
| California Water Service Co., South San Francisco | -16.0% |
| Contra Costa Water District | -10.9% |
| Daly City | -17.0% |
| Dublin San Ramon Services District | -32.3% |
| East Bay Municipal Utilities District | -20.7% |
| Gilroy | -22.7% |
| Great Oaks Water Co. (San Jose) | -20.7% |
| Hayward | -3.2% |
| Hollister | 23.8% |
| Livermore Division of Water Resources | -25.9% |
| Marin Municipal Water District | -21.5% |
| Martinez | -17.4% |
| Millbrae | -3.9% |
| Milpitas | -15.8% |
| Morgan Hill | -41.6% |
| Mountain View | -26.8% |
| Napa | -20.4% |
| North Marin Water District | -39.3% |
| Palo Alto | -32.7% |
| Petaluma | -23.7% |
| Pittsburg | -14.4% |
| Pleasanton | -24.7% |
| Redwood City | -14.2% |
| San Bruno | -3.8% |
| San Francisco | -7.8% |
| San Jose | -18.3% |
| San Jose Water Co. | -18.0% |
| Santa Clara | -11.5% |
| Santa Cruz | -27.9% |
| Scotts Valley | -25.6% |
| Sonoma | -30.1% |
| Soquel Creek Water District | -24.4% |
| Suisun-Solano Water Authority | -21.6% |
| Sunnyvale | -20.0% |
| Other areas | |
| Sacramento | -20.6% |
| Fresno | -15.3% |
| Los Angeles | -6.9% |
| San Diego | -0.6% |

Source: State Water Resources Control Board BAY AREA NEWS GROUP

California Drought Spurs Groundwater Drilling Boom in Central Valley



7
Photograph by Spencer Millsap, National Geographic

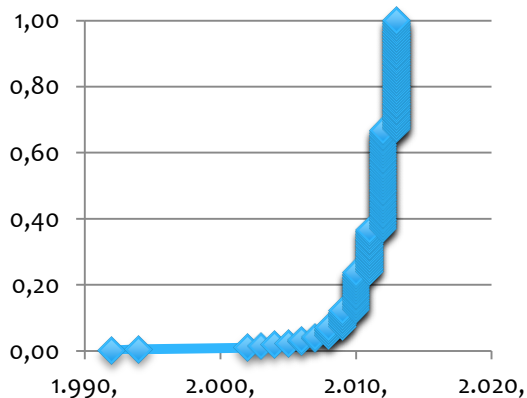
Water Saving Ordinances

- <http://www.acwa.com/content/drought-map>
- California Water Hogs
 - <http://www.nbclosangeles.com/investigations/California-Water-Officials-Drought-Conservation-278236801.html>

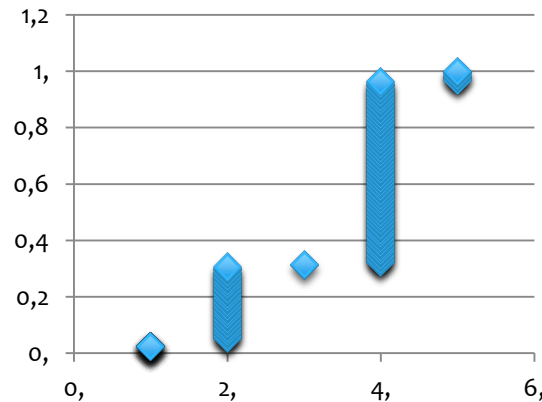
Revising Water Pricing Schemes

- AWWA Survey of 217 water utilities in California in 2013
 - Water Pricing schemes: “Other”; Uniform; Declining; Inclining; Budget
 - Years of adoption: 1992-2013
 - Water availability per consumer (CCF): 5-235

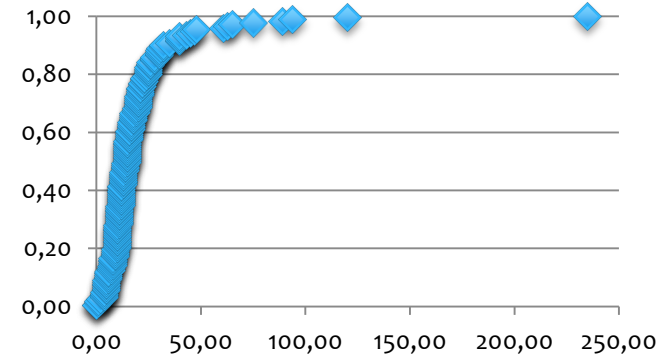
Year of adoption



Pricing schemes



Water availability

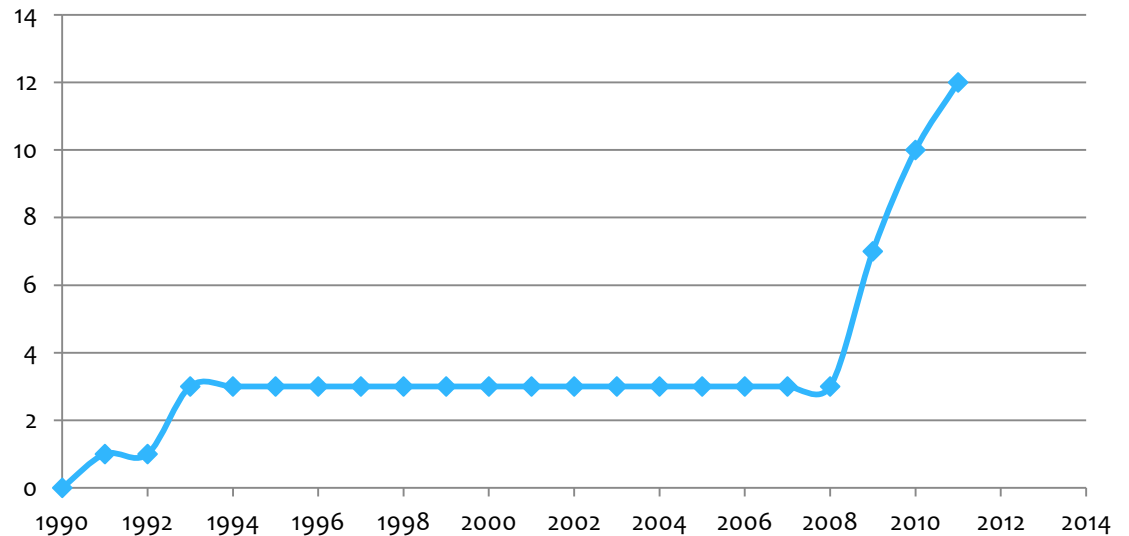


WBRS-Water Budget Rate Structure

Barr and Ash (2015); Dinar and Ash (2015)

- Irvine Ranch Water District (Calif) - 1991
- San Juan Capistrano Water District (Calif) - 1993
- Otay Water District (Calif)- 1993
- Centennial Water and Sewer District (Colorado)
- City of Castle Rock (Colorado)
- Eastern Municipal WD (Calif) - 2009
- City of Boulder (Colorado)
- Palmdale WD (Calif) - 2009
- Coachella Valley WD (Calif) - 2009
- Elsinore Valley WD (Calif) - 2010
- City of Corona (Calif) - 2010
- Rancho California WD (Calif) 2010)
- El Toro WD (Calif) - 2010)
- Moulton Niguel WD (Calif) - 2011
- Western Municipal WD (Calif) - 2011

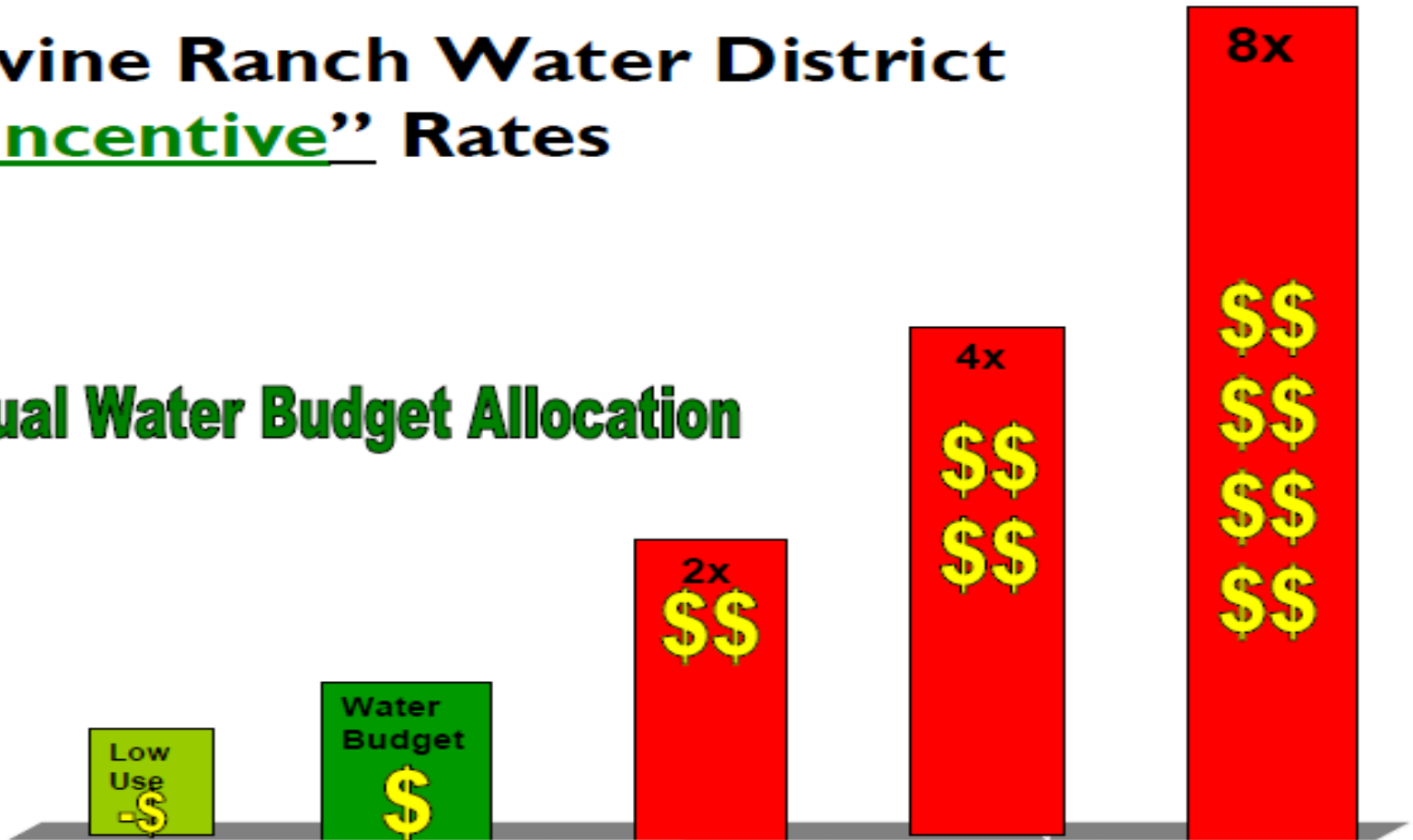
Number of utilities implementing WBRS



Water budget rate pricing structure

Irvine Ranch Water District “Incentive” Rates

Individual Water Budget Allocation



Residential rates (\$/ccf) in IRWD (effective July 1, 2011), EMWD and WMWD (effective October 1, 2011)

1 ccf \cong 100 cubic feet or 748 gallons

| IRWD | | | EMWD | | | WMWD | | |
|-------------|---------------|-----------------|-----------|---------------|-----------------|-------------------|-------------------|-----------------|
| Tier | Rate (\$/ccf) | % of allocation | Tier | Rate (\$/ccf) | % of allocation | Tier | Rate (\$/ccf) | % of allocation |
| Low volume | 0.91 | 0-40 | Indoor | 1.483 | 0-50 | Efficient indoor | 1.77 | |
| Base rate | 1.22 | 41-100 | Outdoor | 2.714 | 50-100 | Efficient outdoor | 1.87 | |
| Inefficient | 2.50 | 101-150 | Excessive | 4.864 | 100-150 | Inefficient | 2.41 ^a | 100-125 |
| Excessive | 4.32 | 151-200 | Wasteful | 8.898 | 150+ | Excessive | 3.78 ^b | 125-150 |
| Wasteful | 9.48 | 200+ | N/A | N/A | N/A | Unsustainable | 4.67 ^c | 150+ |

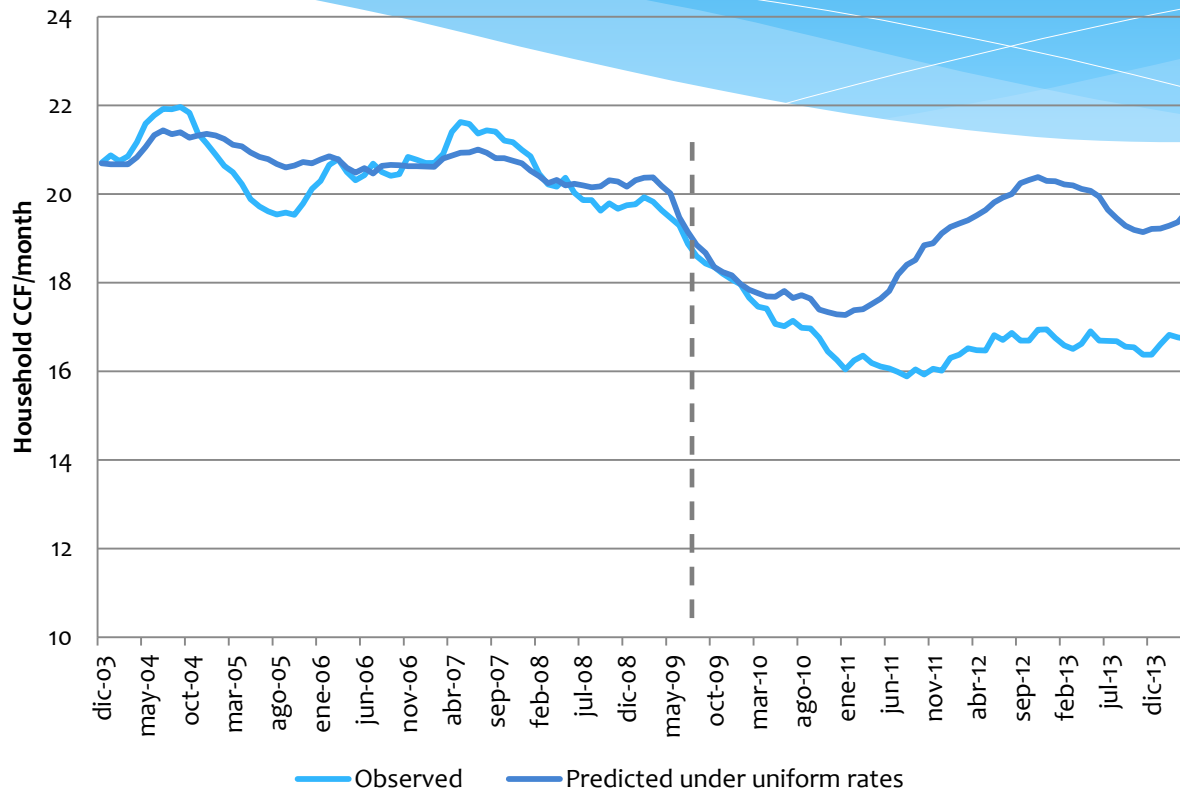
Water Conservation Programs for indoor and out door water use

- The Southern California water \$mart rebate program
 - <http://www.socalwatersmart.com/index.php/qualifyingproducts>

Allocation-Based Pricing and Conservation Rebate Programs

Comparison of observed demand against model predictions

Vertical dashed line indicates the date when the water budget IBR price structure was implemented



Source: Baerenklau, Schwabe and Dinar, 2014

Allocation-Based Pricing and Conservation Rebate Programs

Rebate Programs

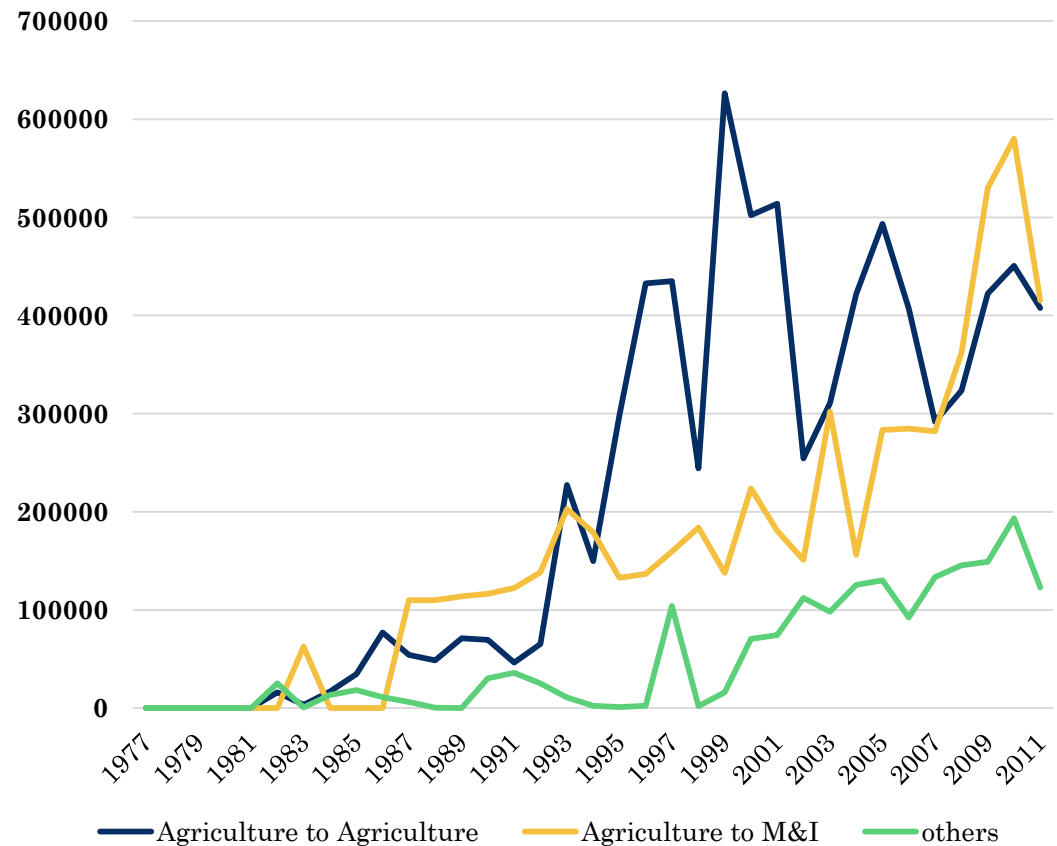
Water Use Pre- and Post-phase II Program Period

| | <u>Average Monthly Water Use (CCF)</u> | |
|--------------------------------------------------------|----------------------------------------|----------------|
| | <i>No Voucher</i> | <i>Voucher</i> |
| Pre (2010) | | |
| 3 month (July-Sept) | 20.08 | 26.13 |
| Post (2012) | | |
| 3 month (July-Sept) | 21.74 | 25.91 |
| Differences: Post(2012) – Pre(2010) | | |
| 3 month (July-Sept) | 1.66 (8%) | -0.22 (-0.8%) |
| Difference in Difference (Voucher – No Voucher) | | |
| 3 month (July-Sept) | -1.88 (-9%) | |

Source: Baerenklau, Schwabe and Dinar, 2014

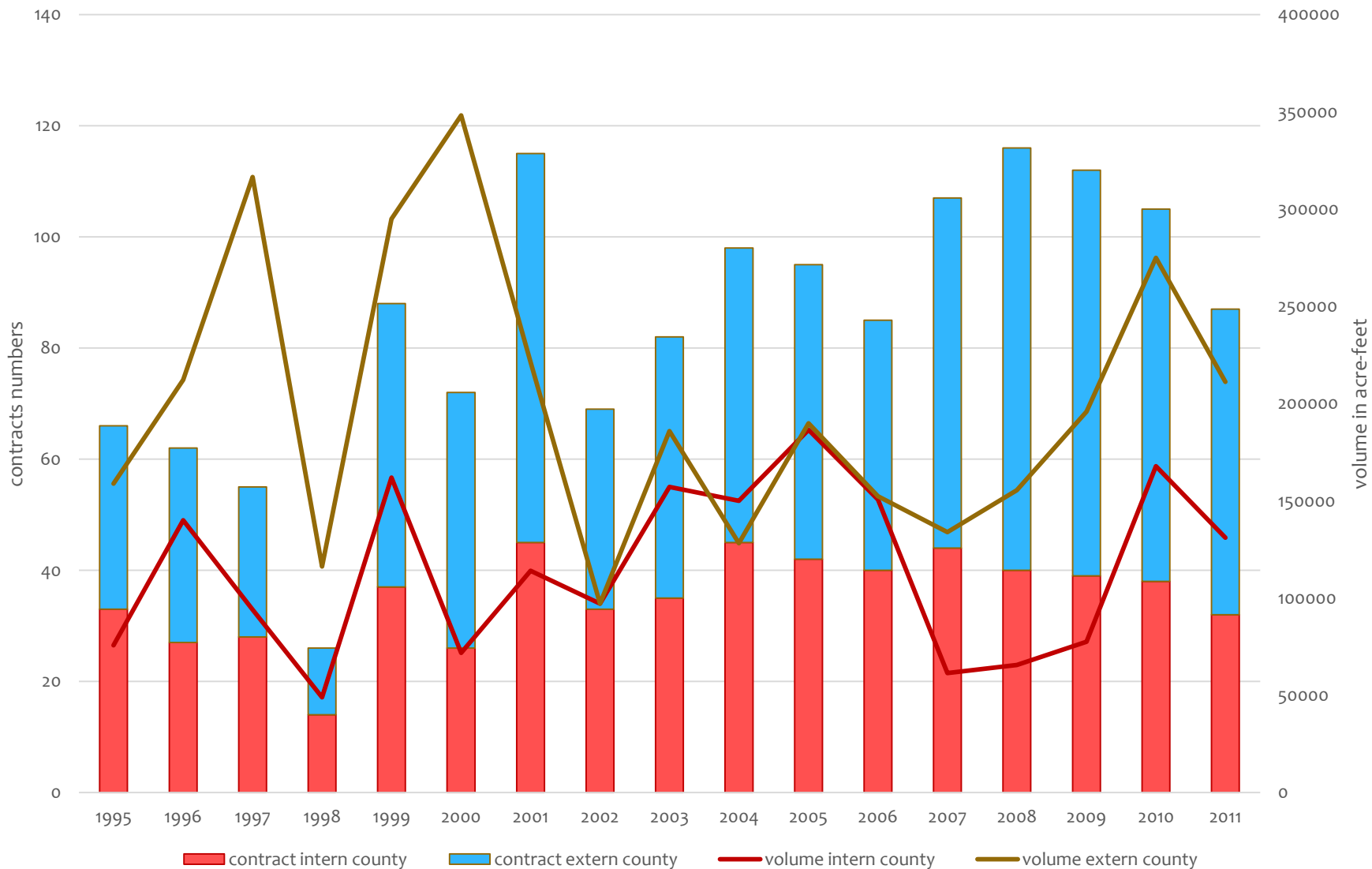
Why are there so few transactions?

- **Growing trend** this last decade,
- but water trading stays at a **low level** (3% of total water use).
- Important **bias toward proximity and intra-sectorial trade**



Data from Hanak (2003),
Additional data and Graph by
Regnacq, Dinar, Hanak
[RDH] (2015)

Volume of water transfers and number of contracts (short term leases only), 1995-2011



Groundwater Ordinances (30/58 counties)

Milanes-Murcia and Dinar (2015)

| County | Groundwater Transfer Ordinance | Groundwater Management Program | Regional Coordination | Integrated Resource Management | Data Relating to Export | Substitution of Groundwater |
|----------------|-----------------------------------------------|--------------------------------|-----------------------|--------------------------------|-------------------------|-----------------------------|
| DWR Model | Groundwater Management Model Ordinance | | | | | |
| Alpine | Alpine County Code: 16.20 Groundwater | | | | | |
| Butte | Ord. No. 4034, Ch. 33A, Groundwater | | | | | |
| Calaveras | Ord. No. 2589, Ch. 16.12 Proof of Groundwater | | | | | |
| Colusa | Ord. No. 1115, Ch. 43 Groundwater Mang. | | | | | |
| Fresno | Ord. Code Tit. 14 Ch.14.03 Groundwater Manag. | | | | | |
| Glenn | Ord. Code Tit. 20 Ch 030 Groundwater Coord. | | | | | |
| Imperial | Ord. Code Tit. 9 Div. 22 Groundwater Ordin. | | | | | restrict |
| Inyo | Ord. No. 1004 Chap. 18.77 | | | | | |
| Kern | Ord. No. G-6502 Chap. 19.118 | | | | | |
| Lassen | Ord. Code Tit. 17 Groundwater | | | | | |
| Madera | Ord. Code Tit. 13 Chap. V Groundwater | | | | | Banking |
| Mendocino | Ord. N. 07-1 & Ord. Code Chap. 20.744 | | | | | |
| Modoc | Ord. Code Tit. 20 Groundwater | | | | | |
| Mono | Ord. Code Tit. 20 Chap. 20.01 | | | | | |
| Monterey | Ord. Code Tit. 15 Chap. 15.08 | | | | | |
| Napa | Ord. Code Tit. 13 Chap. 13.15 | | | | | |
| Sacramento | Ord. N. 1455 Tit. 6 Chap. 6.28 | | | | | |
| San Benito | Ord. Code Tit. 15 Chap. 15.05 | | | | | |
| San Bernardino | Ord. Code Tit. 3, D. 3 Chap. 6 | | | | | |
| San Diego | Ord. N. 7994 Tit. 6, D. 7, Chap. 7 | | | | | |
| San Joaquin | Ord. N. 4064 Tit. 5, D. 8 | | | | | |
| Shasta | Ord. Code Tit. 18 Chap. 18.08 | | | | | Conjunctive |
| Sierra | Ord. Code Part 8 Chap. 8.17 | | | | | |
| Siskiyou | Ord. Code Tit. 3 Chap. 19 | | | | | |
| Stanislaus | Ord. Code Tit. 9, Chap. 9.37 | | | | | |
| Tehama | Ord. Code Tit. 9 | | | | | conjunctive |
| Tuolumne | Ord. Code Tit. 13 Chap. 13.20 | | | | | |
| Ventura | Ord. Code D. 4, Chap. 8 | | | | | |
| Yolo | Ord. Code Tit. 10 Chap. 7 | | | | | |

The areas in grey means that the ordinance does not incorporate the specific aspect in the local legislation.

What affects water transactions among districts

RDH 2015

| Dependent var. Export | Model (I) | | Model (II) | |
|----------------------------|------------|---------|------------|---------|
| | coef | p-value | coef | p-value |
| <u>Logit regression</u> | | | | |
| Income Exporter | -0.1479555 | 0 | — | — |
| Income Importer | -0.3454272 | 0 | -0.444176 | 0 |
| Water Productivity Ratio | — | — | -0.1414065 | 0 |
| Water Scarcity Exporter | 0.1239186 | 0 | 0.1357973 | 0 |
| Distance between Districts | 0.8219476 | 0 | 0.7849441 | 0 |
| Same Project | -4.412185 | 0 | -4.285829 | 0 |
| Ordinace Exporter | 0.3592629 | 0 | 0.4646991 | 0 |
| Constant | 13.17101 | 0 | 11.87641 | 0 |
| <u>Poisson regression</u> | | | | |
| Income Exporter | 0.3057568 | 0 | — | — |
| Income Importer | 0.288305 | 0 | 0.6091691 | 0 |
| Water Productivity Ratio | — | — | 0.497319 | 0 |
| Water Scarcity Exporter | 0.0963553 | 0.083 | 0.0686285 | 0.142 |
| Distance between Districts | -0.0421077 | 0.27 | -0.0685812 | 0.050 |
| Same Project | 0.1829131 | 0.235 | 0.1058346 | 0.419 |
| Constant | -1.052287 | 0.237 | 0.9976489 | 0.182 |
| Prob>chi2 | | 0 | | 0 |
| adj McFadden R2 | | 0.279 | | 0.34 |
| fitted vs obs R2 | | 0.0041 | | 0.004 |

The New GW Legislation

- GOVERNOR BROWN SIGNS HISTORIC GROUNDWATER LEGISLATION
 - <http://gov.ca.gov/news.php?id=18701>
 - To be discussed probably in detail by Dan Dooley

The Big Transition

- * California is a water-scarce state and needs to have policy tools to deal with scarcity whether in drought years or otherwise.
- * The State of California and “Water agencies need to do more than just ticket violators. They need to make sure conservation is on the mind of every Californian.”