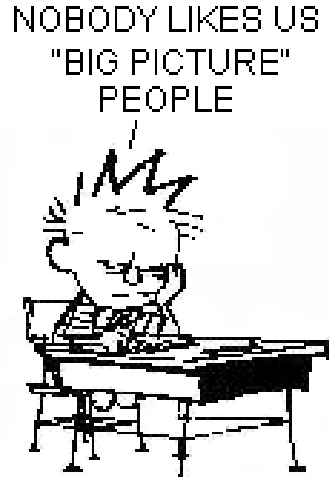
Water Storage in California



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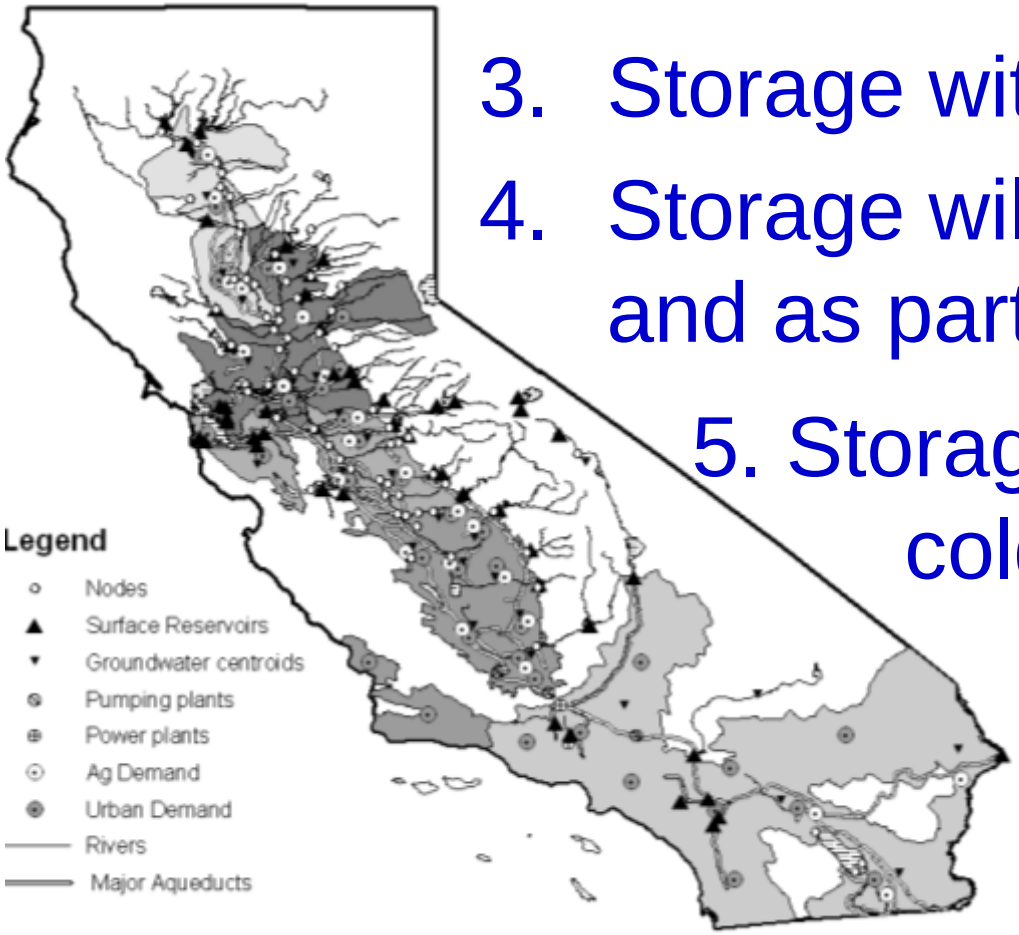
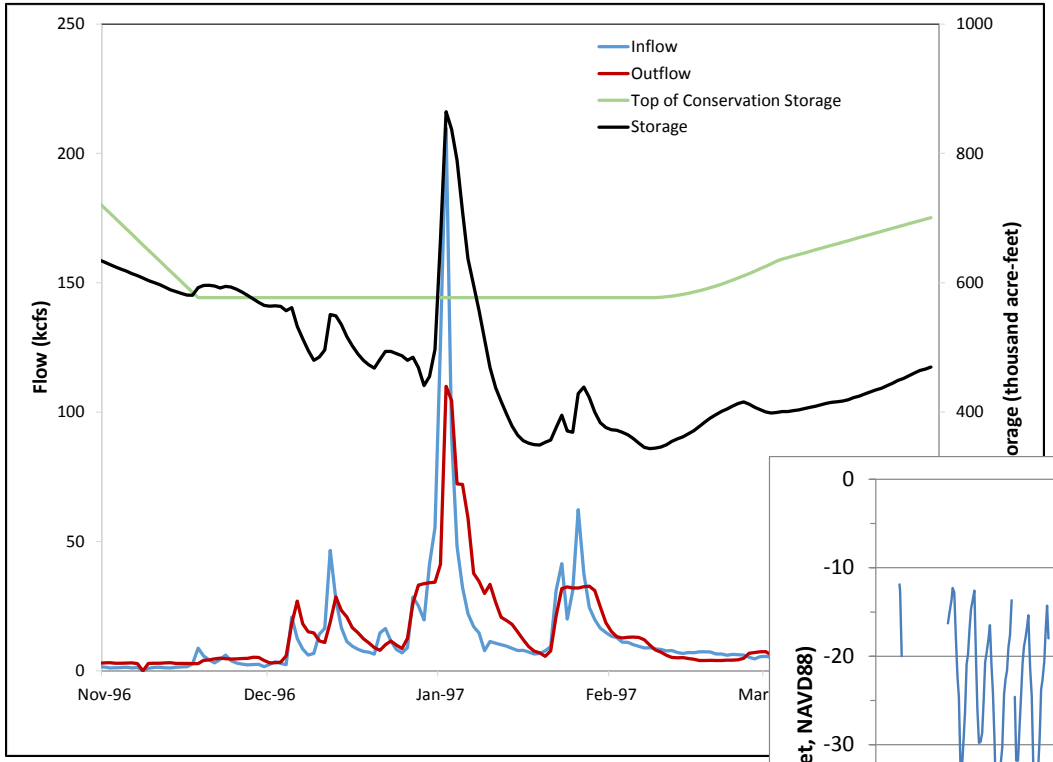
Main Ideas

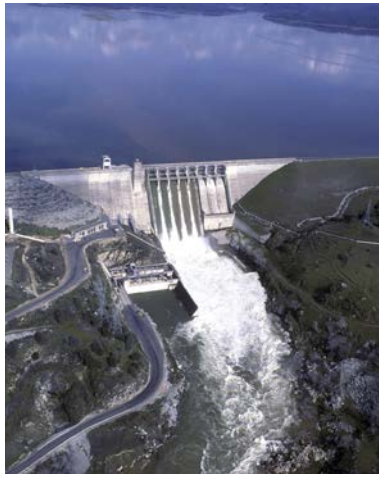
1. Storage is <u>part</u> of a system with inflows, conveyance, & demands
2. Not all storage is equal
3. Storage without water is useless
4. Storage will be used differently, and as part of a network
5. Storage decisions should be cold and calculating



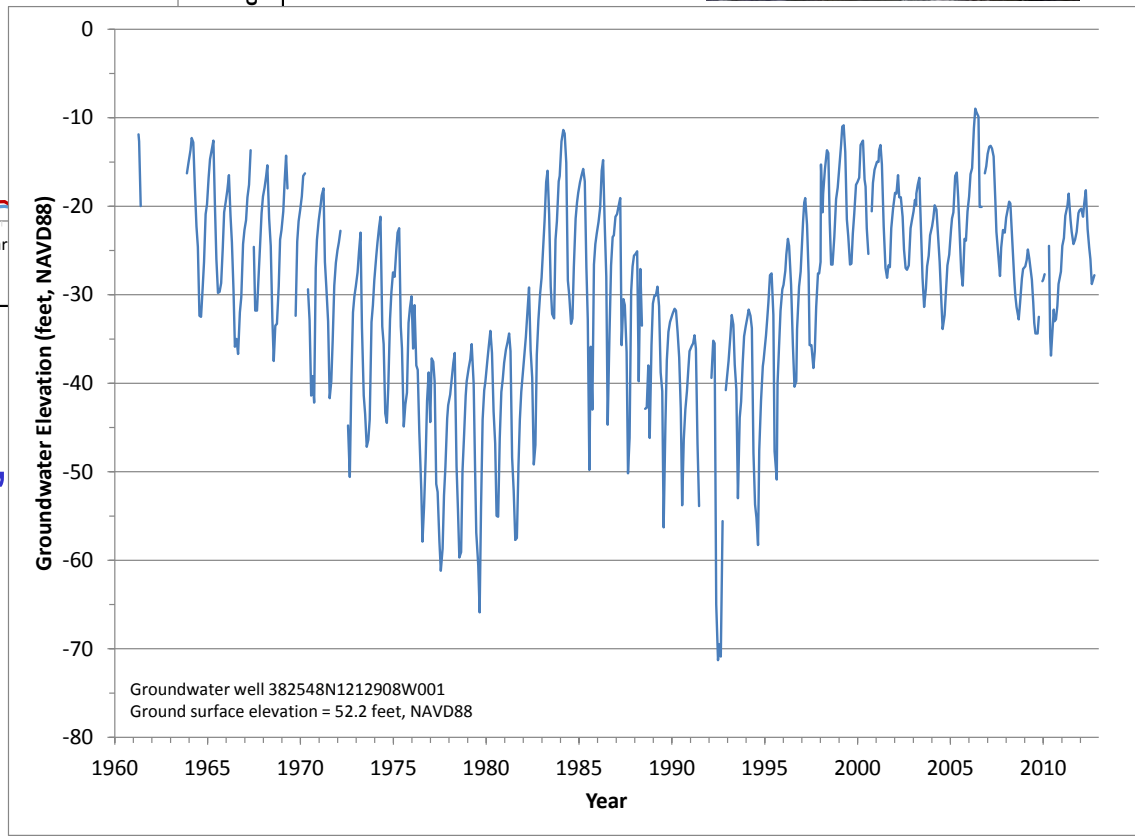
Storage moves water in time



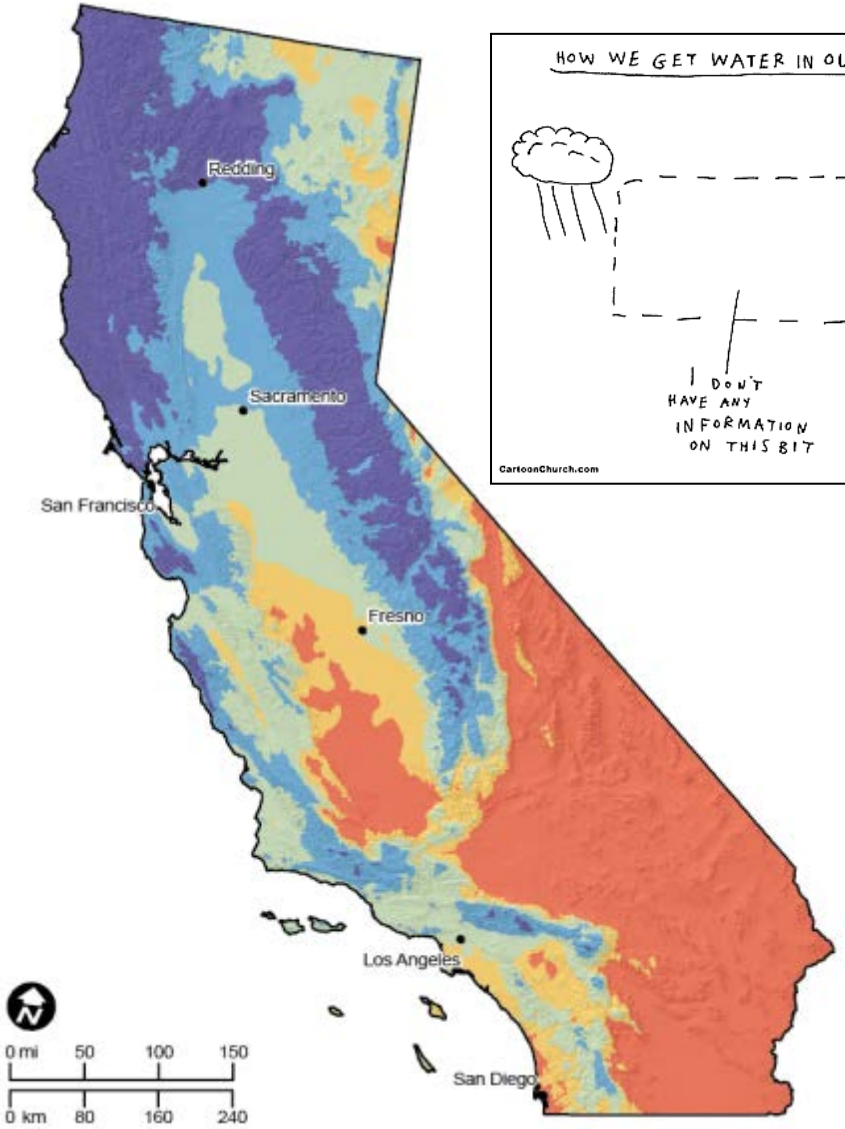
1997 flood storage at Folsom

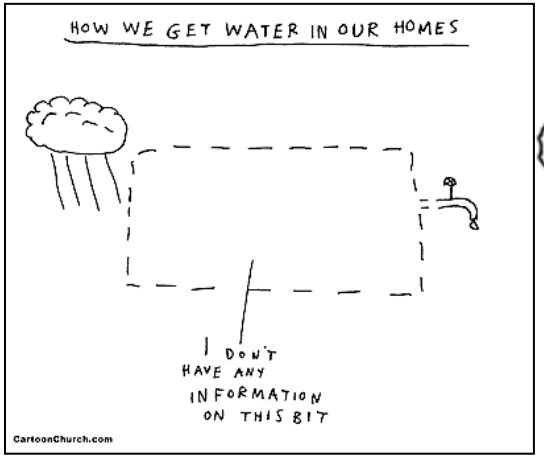


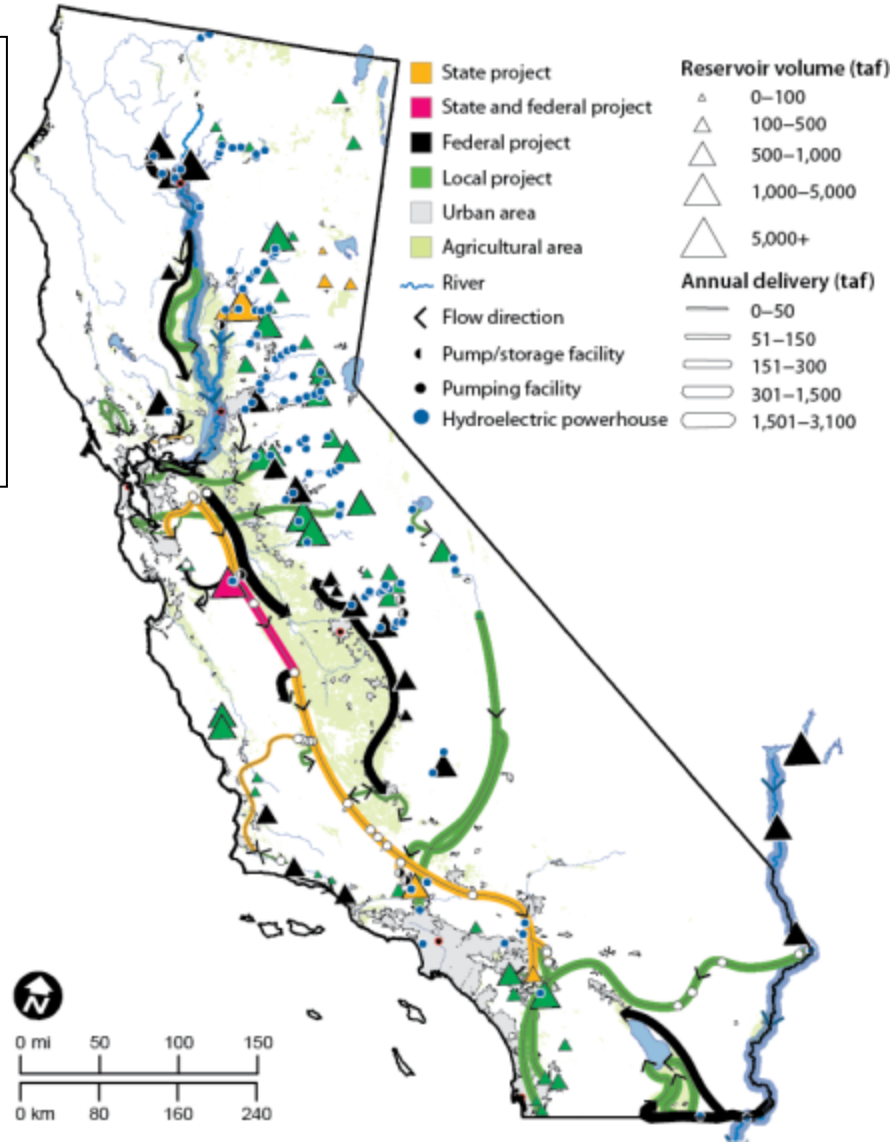
Seasonal and drought groundwater storage (Galt, CA)



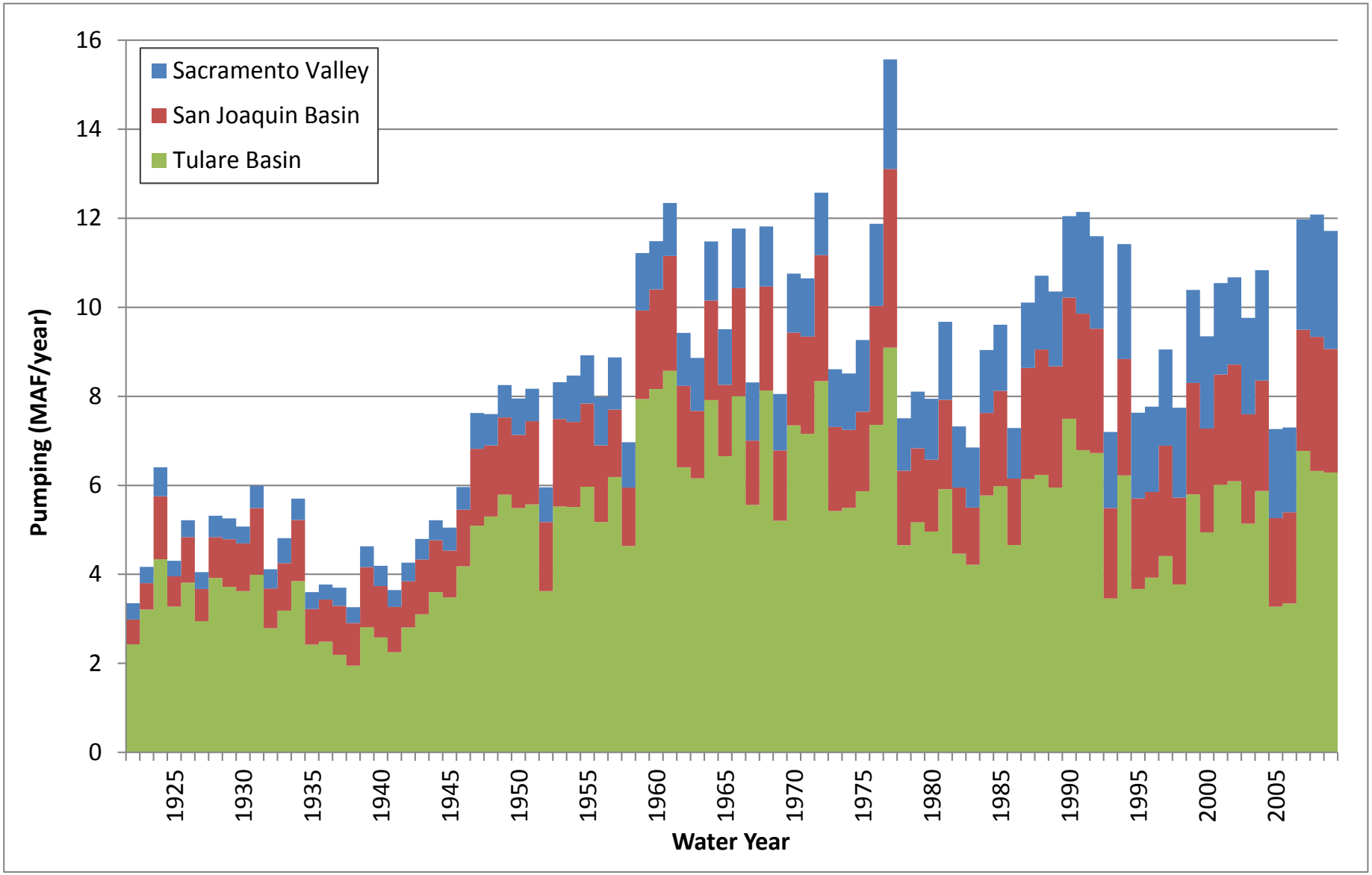
Storage works in an engineered statewide network





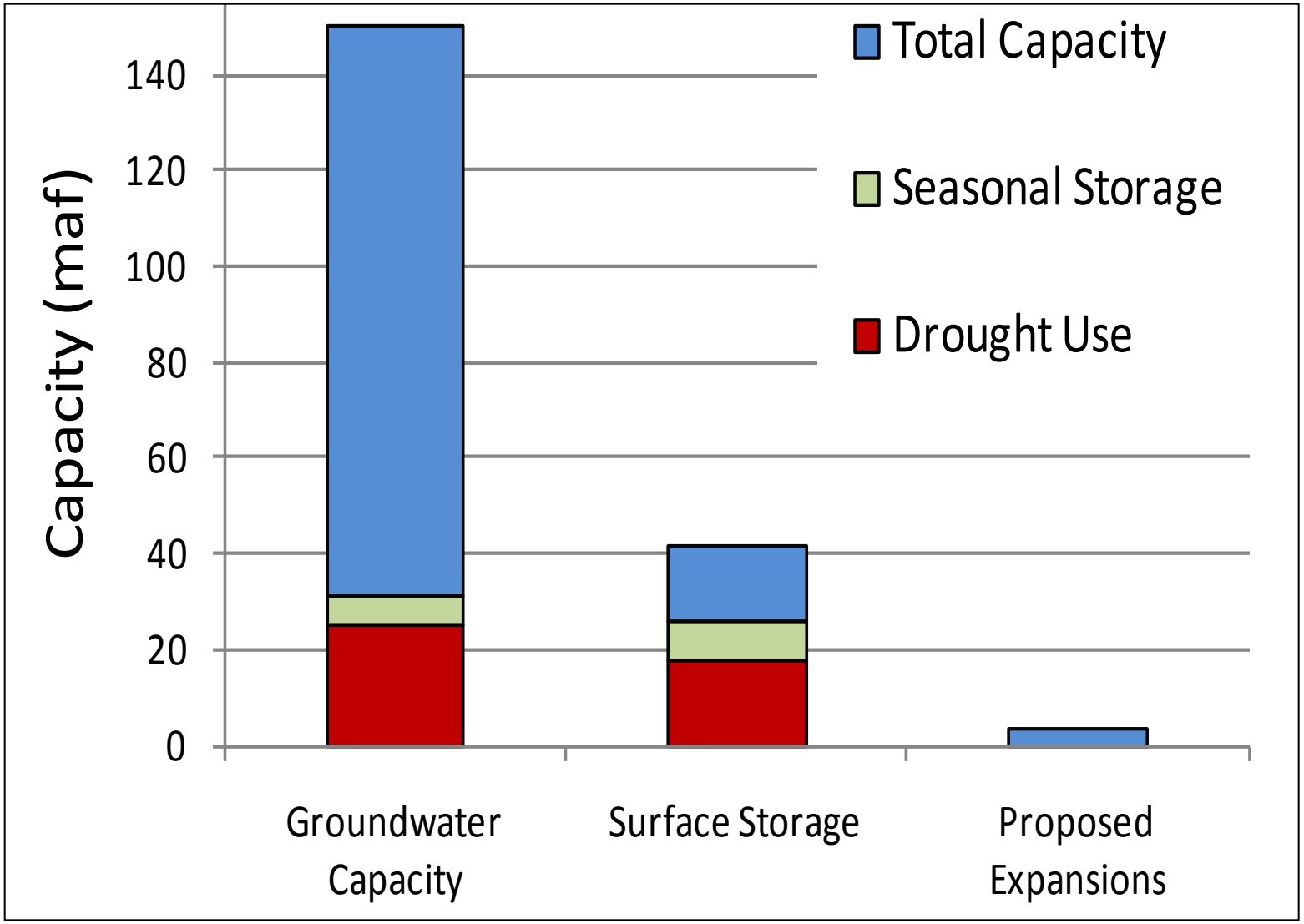


Historical Central Valley Pumping

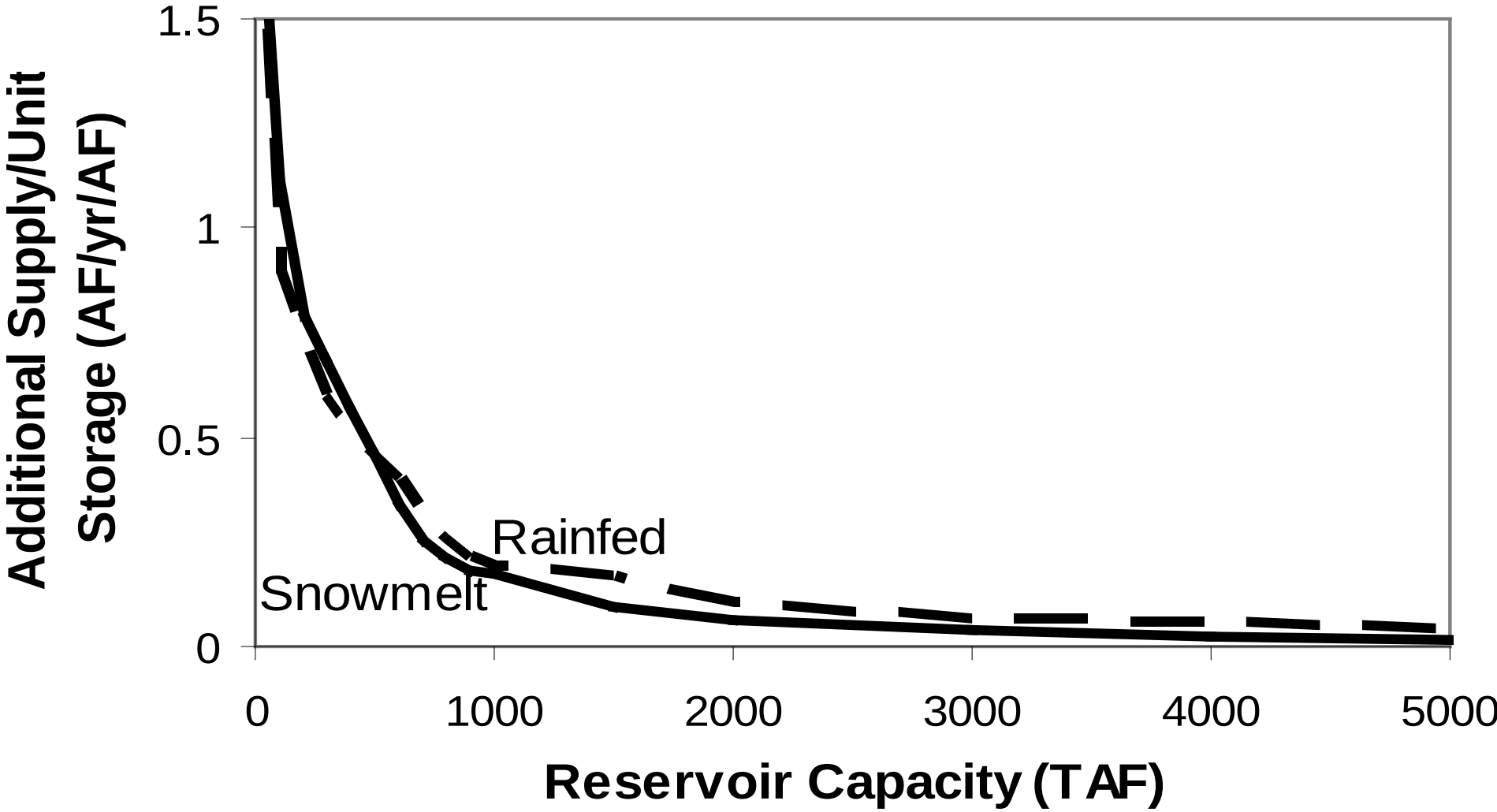


Source: C2VSIM simulations 2013 (TNC, 2014)

Water Storage Capacity and Uses in California



Not all storage is equal



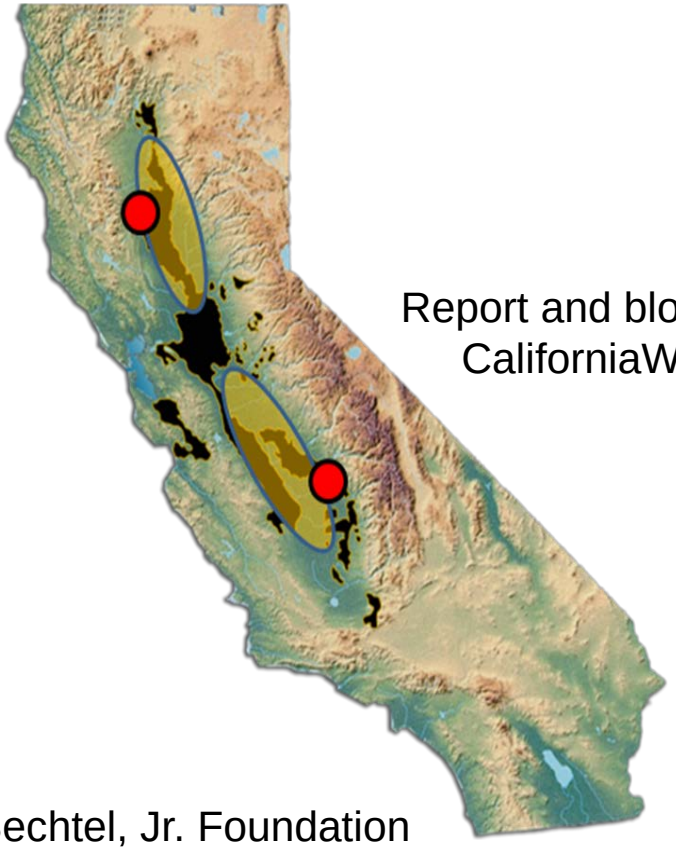
"With a larger reservoir, there is some increasing gain with further size, but in a diminishing ratio." - Alan Hazen (1914)

Storage being used differently

1. Cold water for fish
2. Pulse flows for habitat
3. Regional conjunctive use (Kern, Yolo, elsewhere)
4. Statewide conjunctive use (e.g., Sac Valley conjunctive use supplies water stored in Tulare for MWD)
5. Market motivations - Creativity isn't over yet.

Pilot Integrated Storage Analysis

- 4 storage programs
  - 2 groundwater storage
  - 2 surface storage locations
  - 2 maf capacity each
- CalLite screening model
  - Integrated hydrology
  - Intertied system



A Collaboration of:

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Ali Taghavi

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Anthony Saracino

Report and blog available at CaliforniaWaterBlog.com

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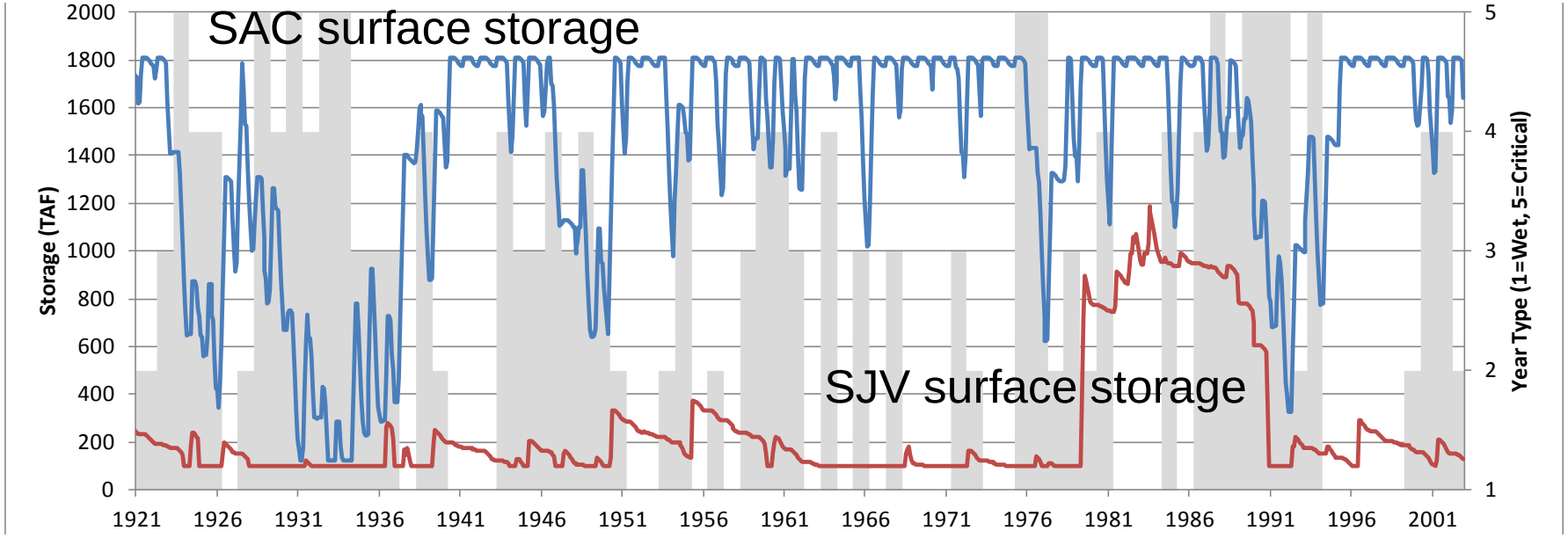
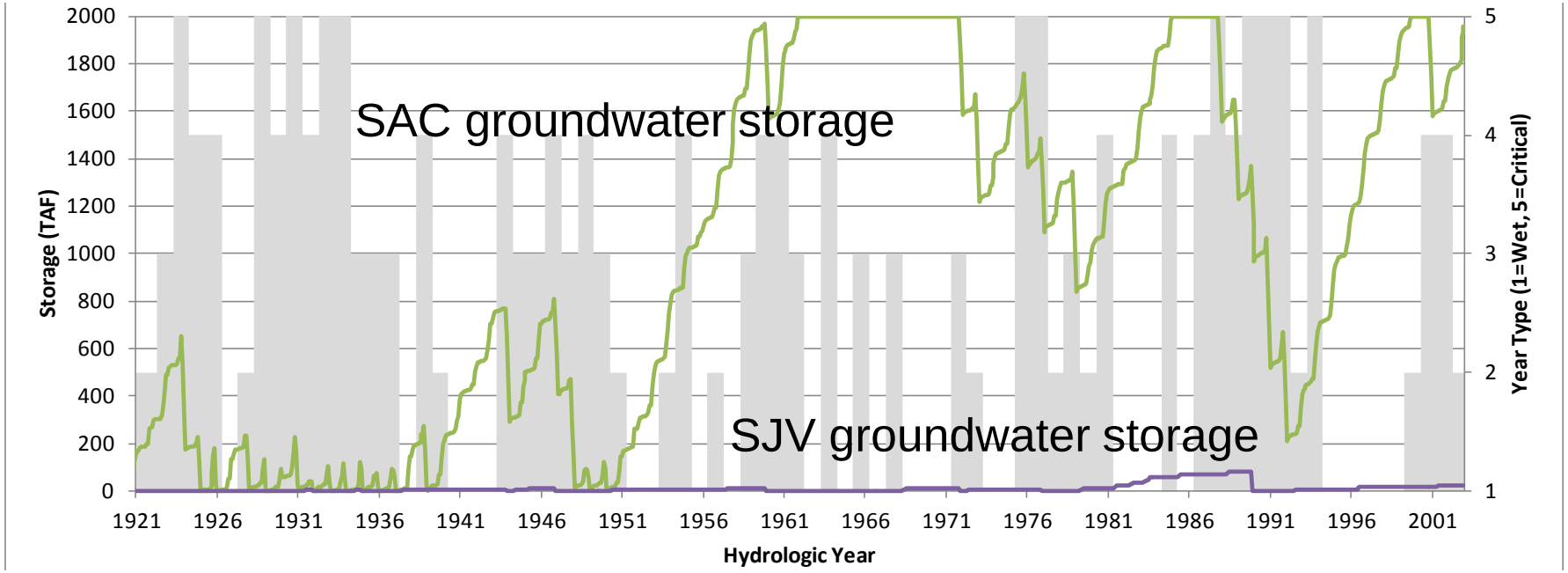
https://watershed.ucdavis.edu/files/biblio/Storage_White_Paper_20Nov2014.pdf

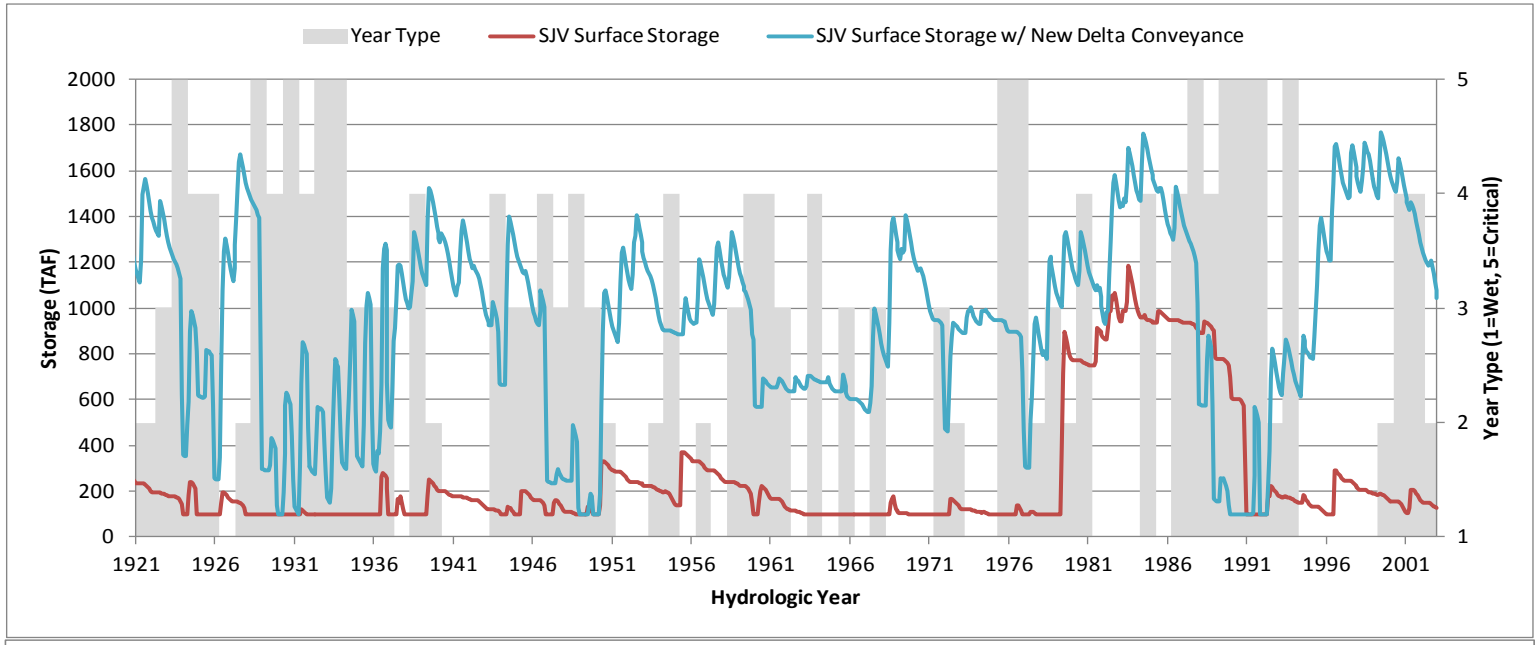
Ability to Use Additional Storage Today



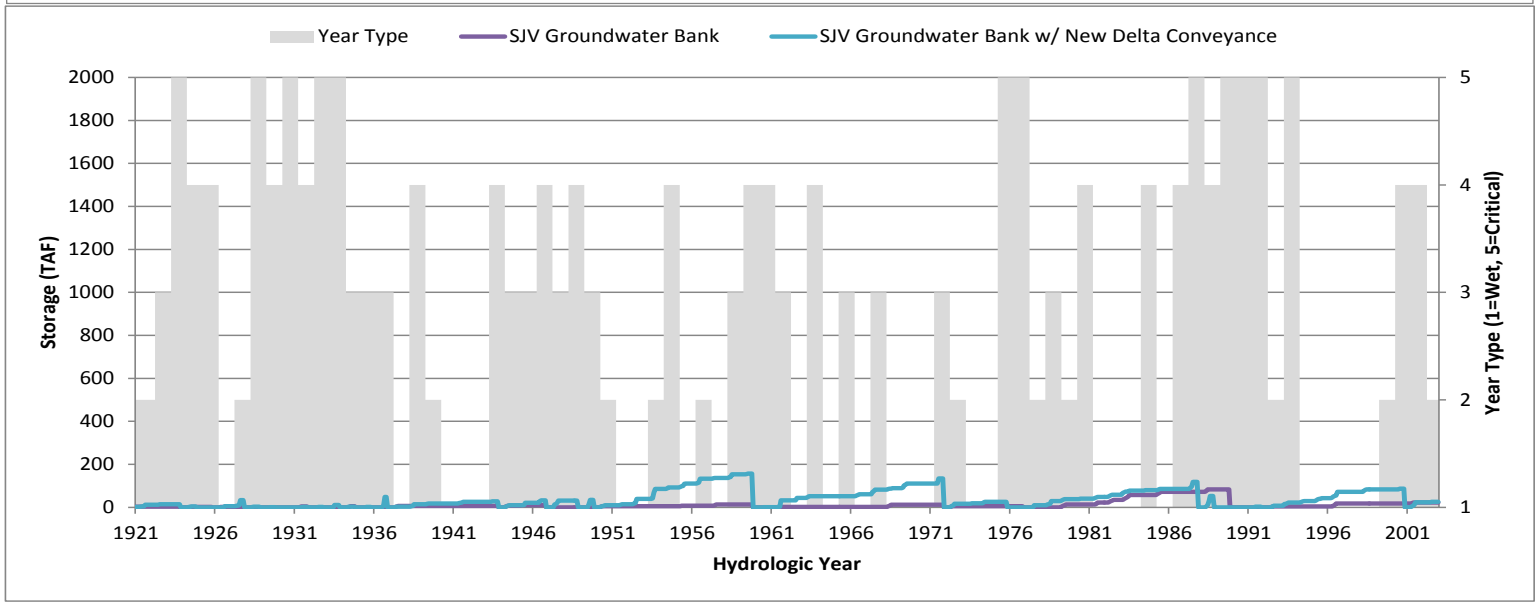


SJV Storage Utilization with BDCPish Delta Conveyance

SJV surface storage



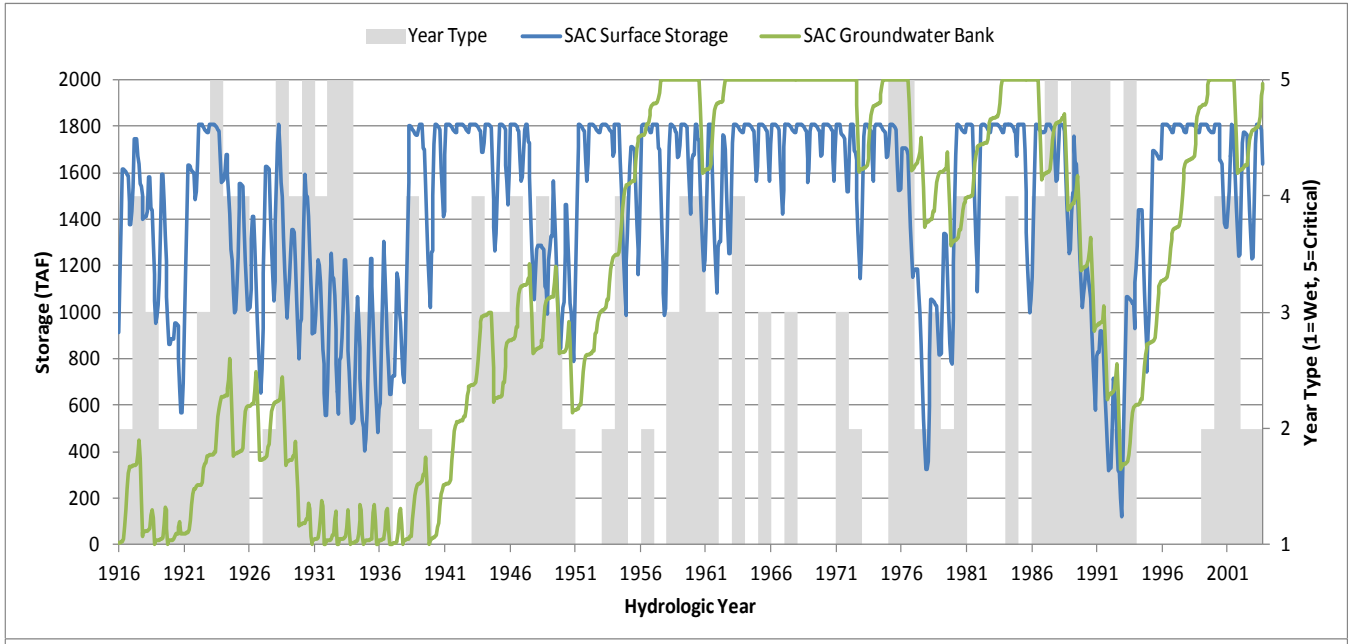
SJV groundwater storage



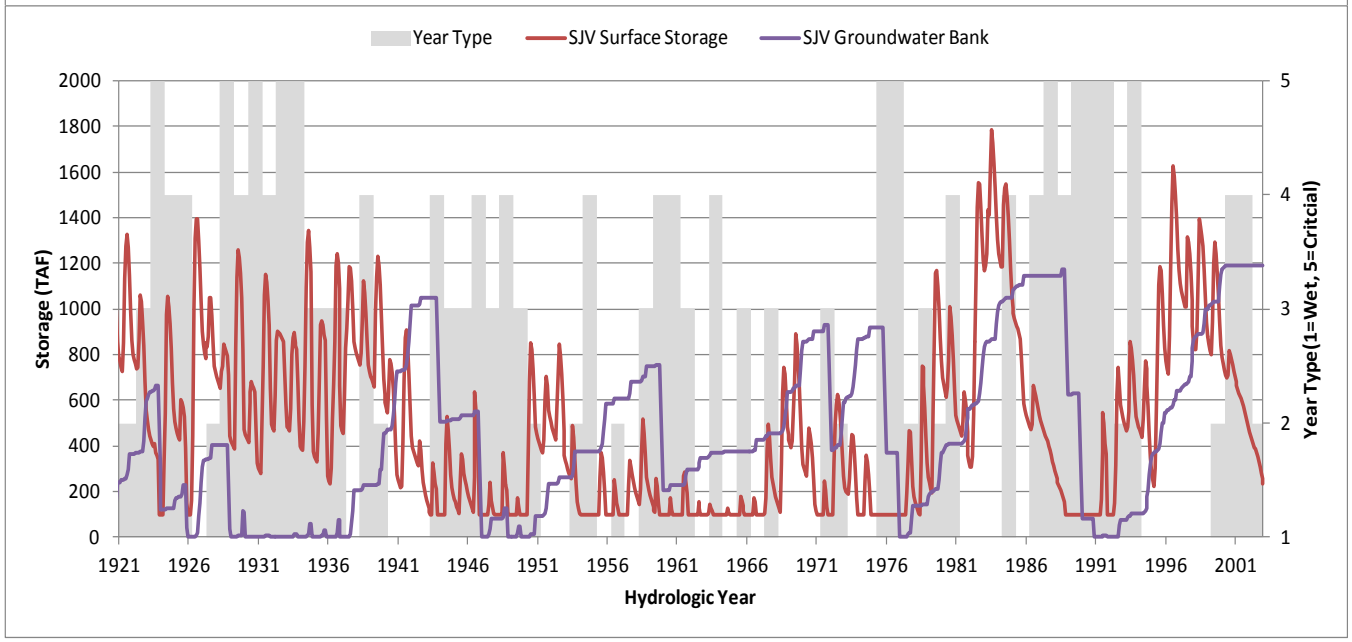
SAC storage utilization similar with additional Delta conveyance

Storage Use with Delta Conveyance & Integrated Ops

SAC storage



SJV storage



Integrated operations greatly expands use of SJV groundwater

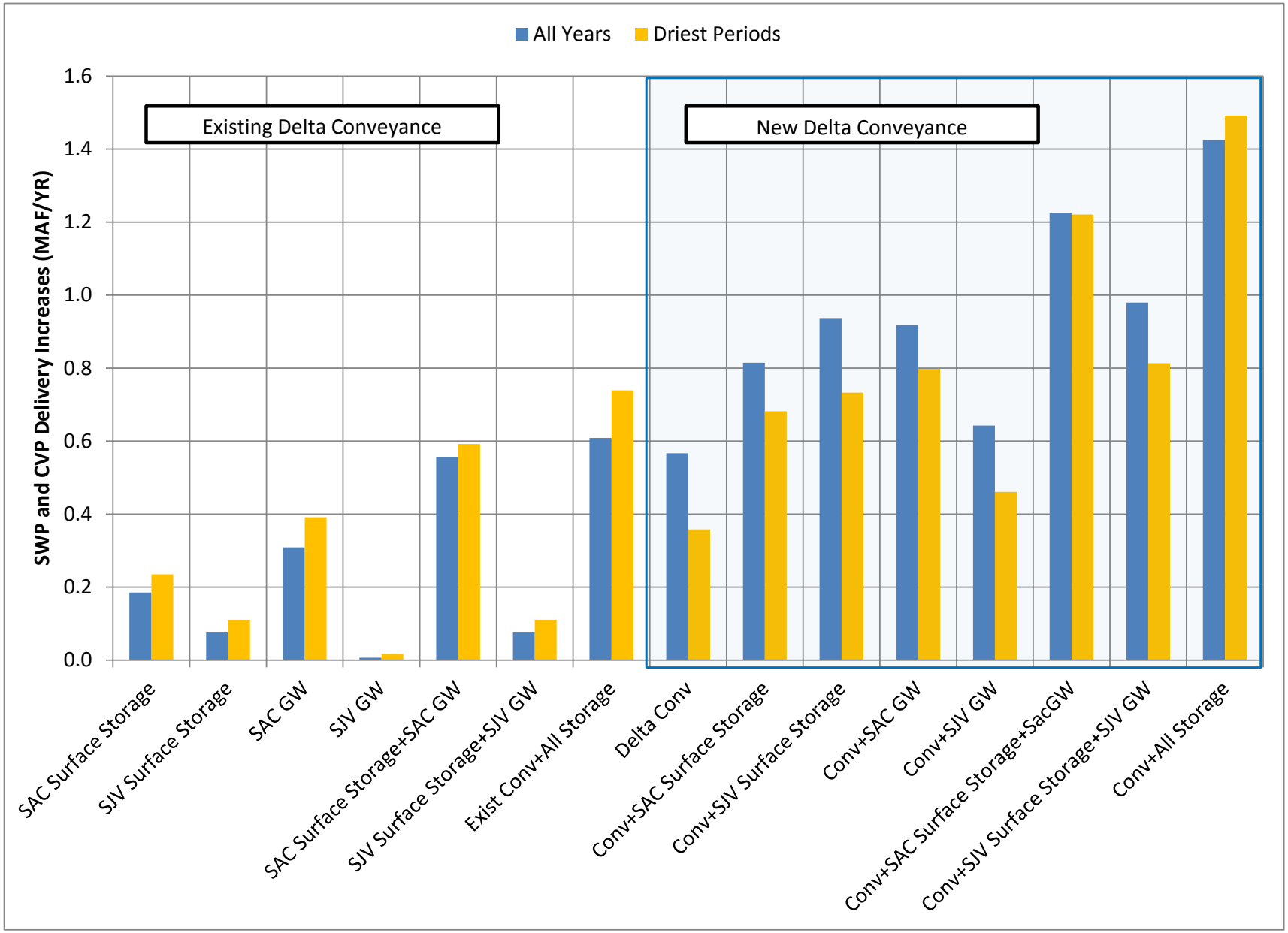
Total Storage Utilization

Storage	Existing Delta Conveyance	Integrated SW and GW Operations w/ Existing Delta Conveyance	New Delta Conveyance	Integrated SW and GW Operations with New Delta Conveyance
Sacramento Valley				
Surface Storage	1.8 maf (1.8 maf)	1.8 maf (1.8 maf)	1.8 maf (1.8 maf)	1.8 maf (1.8 maf)
Groundwater	2.0 maf (2.0 maf)	2.0 maf (2.0 maf)	2.0 maf (2.0 maf)	2.0 maf (2.0 maf)
San Joaquin Valley				
Surface Storage	1.2 maf (800 taf)	900 taf (100 taf)*	1.8 maf (1.5 maf)	1.4 maf (1.0 maf)
Groundwater	< 50 taf (<50 taf)	<200 taf (<200 taf)	<200 taf (<100 taf)	1.1 maf (1.0 maf)
Total				
Total Storage Utilization	5.0 maf (4.6 maf)	4.9 maf (4.1 maf)	5.8 maf (5.4 maf)	6.3 maf (5.8 maf)

More than 5-6 maf of additional storage cannot be filled, due to insufficient streamflow.

Water Delivery Improvements With Integration

In terms of Increased Deliveries South of the Delta



Value of added storage capacity ($/af-yr) CALVIN model

Ragatz, 2013	Historical climate				Warmer, drier climate			
	0% urban conservation		30% urban conservation		0% urban conservation		30% urban conservation	
Reservoir	Full exports	No exports	Full exports	No exports	Full exports	No exports	Full exports	No exports
Claire Engle	3	3	3	3	39	30	32	32
Shasta	8	8	8	8	67	34	51	34
Oroville	15	11	13	10	78	18	66	17
N. Bullard's Bar	18	17	17	17	156	19	90	19
Folsom	13	10	11	9	153	20	85	15
Pardee	2	5	1	1	14	32	20	41
New Melones	9	10	9	10	3	3	3	5
Hetch Hetchy	6	7	5	7	7	6	5	7
New Don Pedro	8	9	8	8	4	3	4	5
Millerton	6	95	5	62	37	120	56	33
Pine Flat	6	95	5	62	20	103	51	95
Kaweah	56	457	47	379	269	263	225	254
Success	49	403	42	340	361	361	308	357
Isabella	4	46	1	15	32	76	32	5
Grant Lake	52	116	44	76	0	0	0	0

Conclusions

1. Storage is <u>part</u> of a system with inflows, conveyance, & demands
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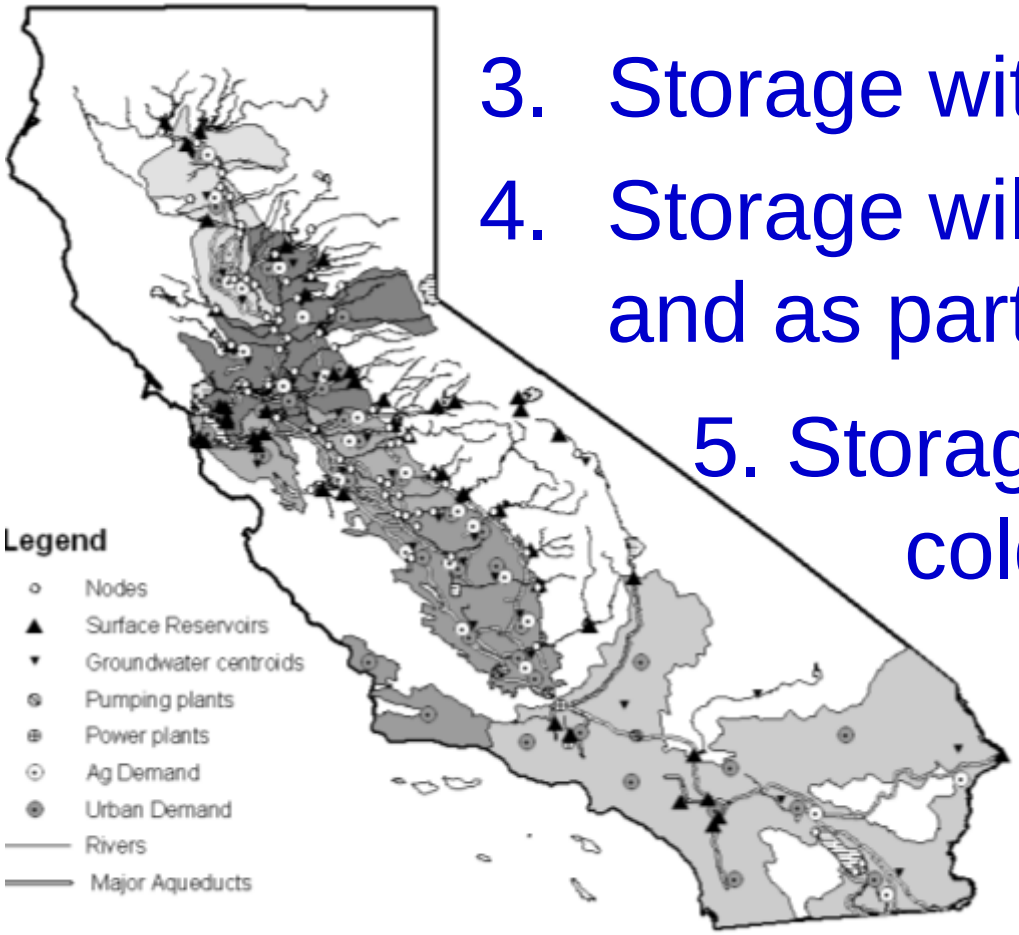

Further Reading

Krieger, J.H. and H.O. Banks (1962), “Ground Water Basin Management,” *Cal. Law Review*. V. 50:56

Lund, J., A. Munévar, A. Taghavi, M. Hall, and A. Saracino, “Integrating Storage in California’s Changing Water System,” Center for Watershed Sciences, UC Davis, November 2014

Lund, J.R. (2011), “Water Storage in California,” CaliforniaWaterBlog.com, Posted September 13

Ragatz, R.E. (2013), “California’s water futures: How water conservation and varying Delta exports affect water supply in the face of climate change,” Master’s thesis, UC Davis

Connell-Buck, C.R., J. Medellín-Azuara, J.R. Lund, and K. Madani, “Adapting California’s water system to warm vs. warm-dry climates,” *Climatic Change*, Vol. 109 (Suppl 1), pp. S133–S149, 2011

Views of Storage at 50%

1) Pessimist – The glass is half empty
2) Optimist – The glass is half full
3) Engineer - The glass is too big
4) Flood control engineer - The glass should be 40% larger
5) Water supply engineer – I prefer a larger glass
6) Dam safety engineer - The glass needs a larger spillway
7) Delta engineer – Can you pump out my glass?
8) Delta engineer - Why is water rising outside of my glass?
9) Environmental engineer - I wouldn’t drink that stuff
10) Water marketing engineer – I’ll buy water to fill my glass