Understanding Groundwater as a Source and Drought Supply

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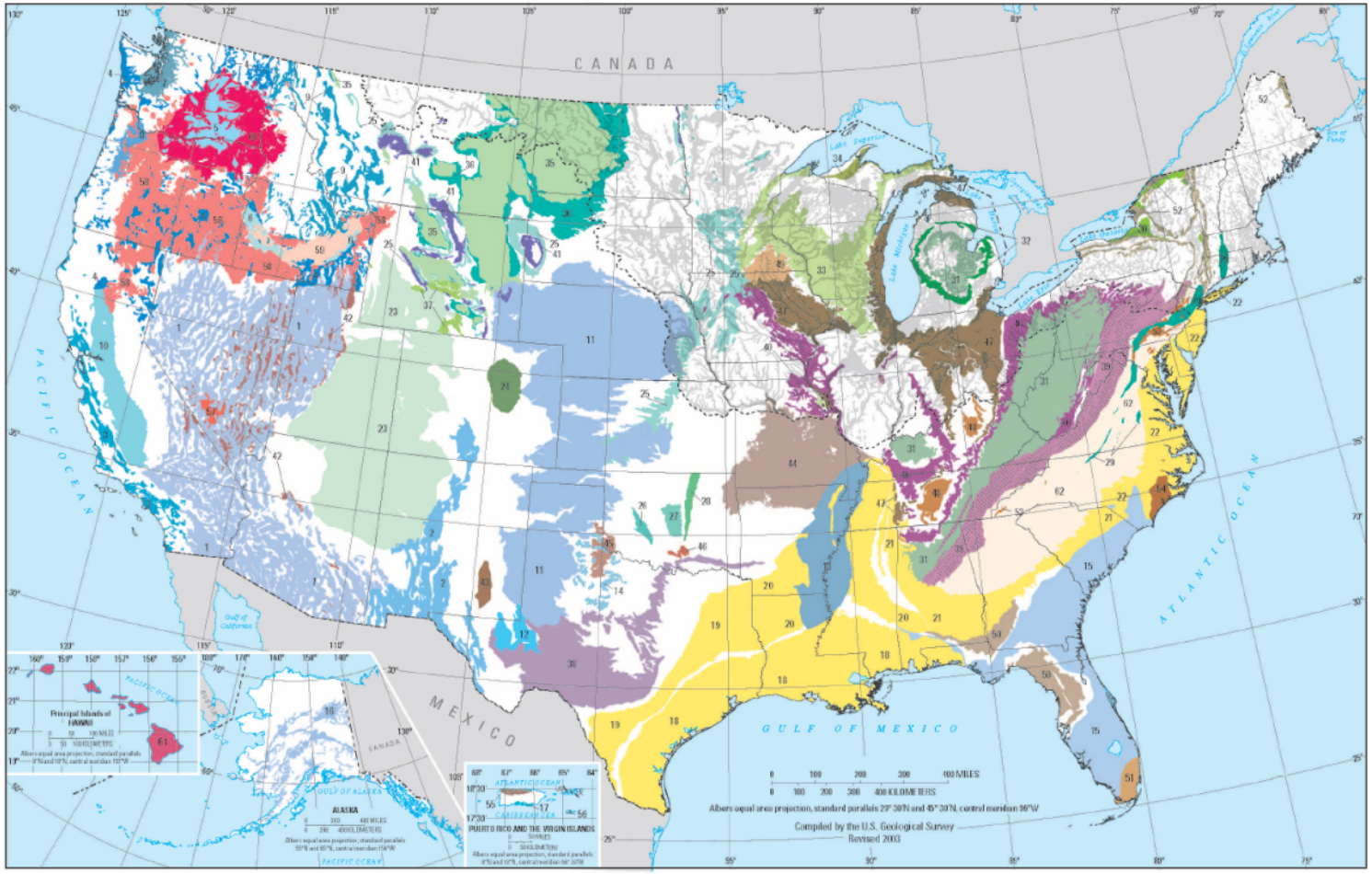
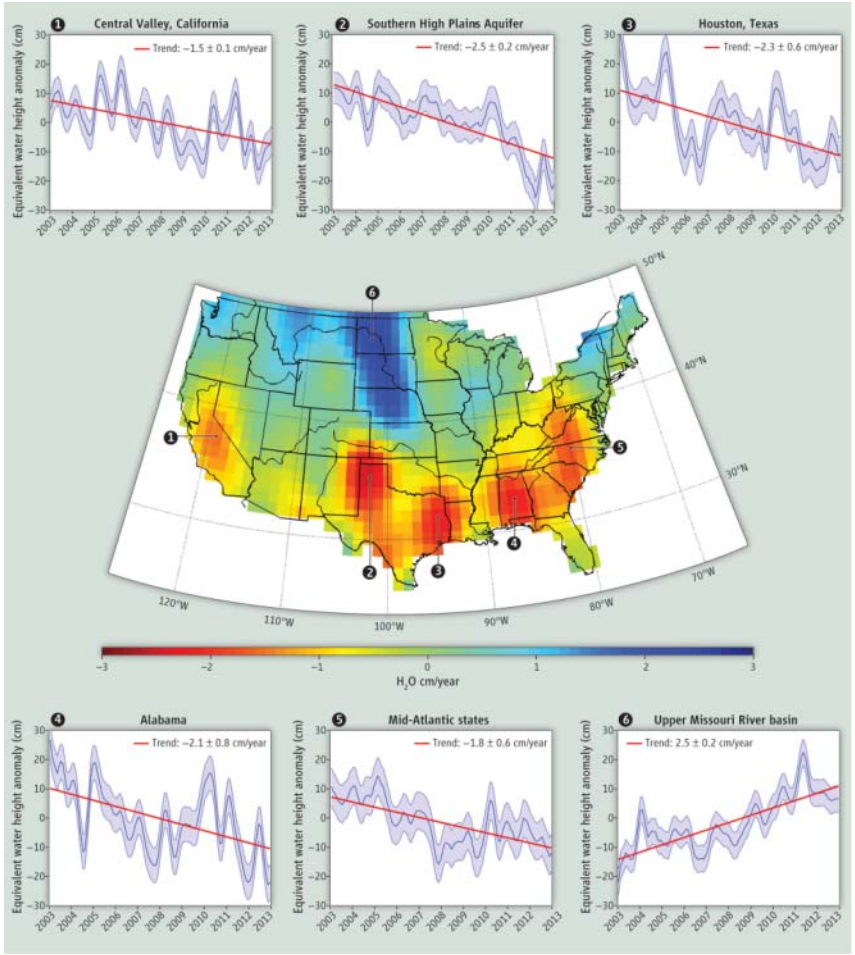
Principal aquifers of the United States



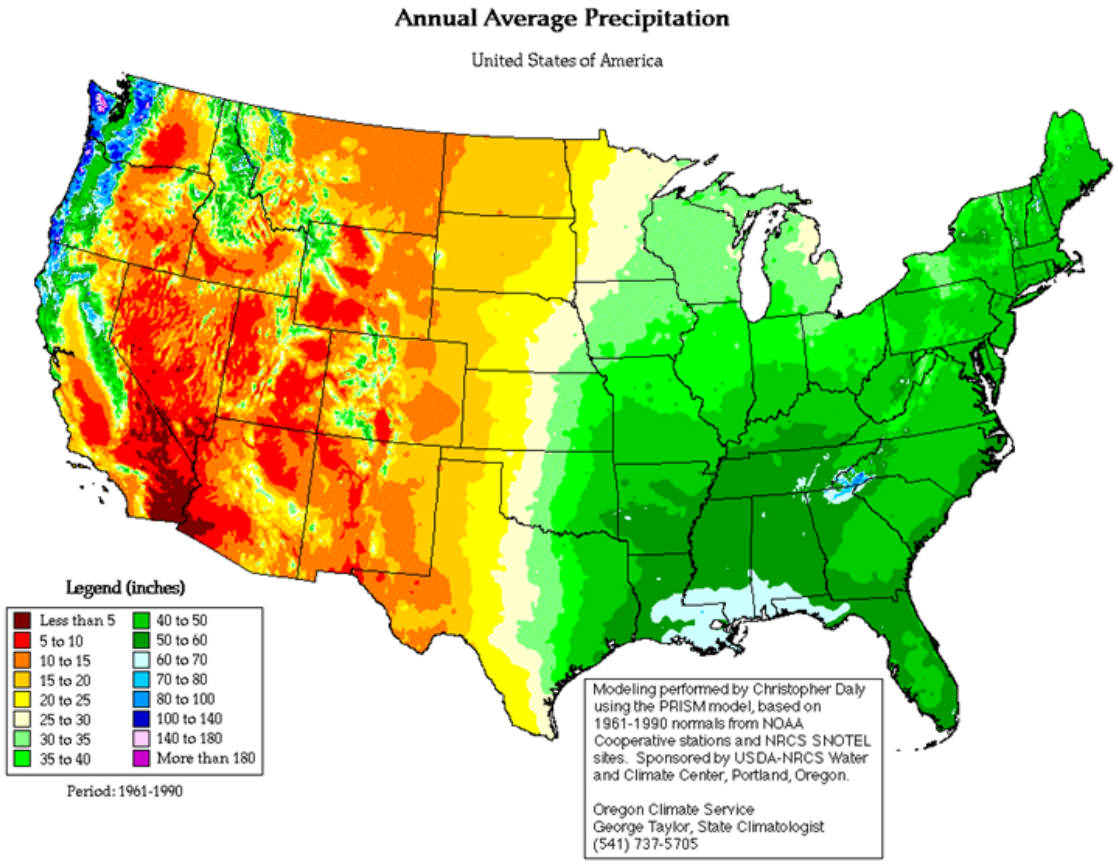
U.S. Geological Survey, 2003)

Change in Groundwater Storage: 2003 - 2012



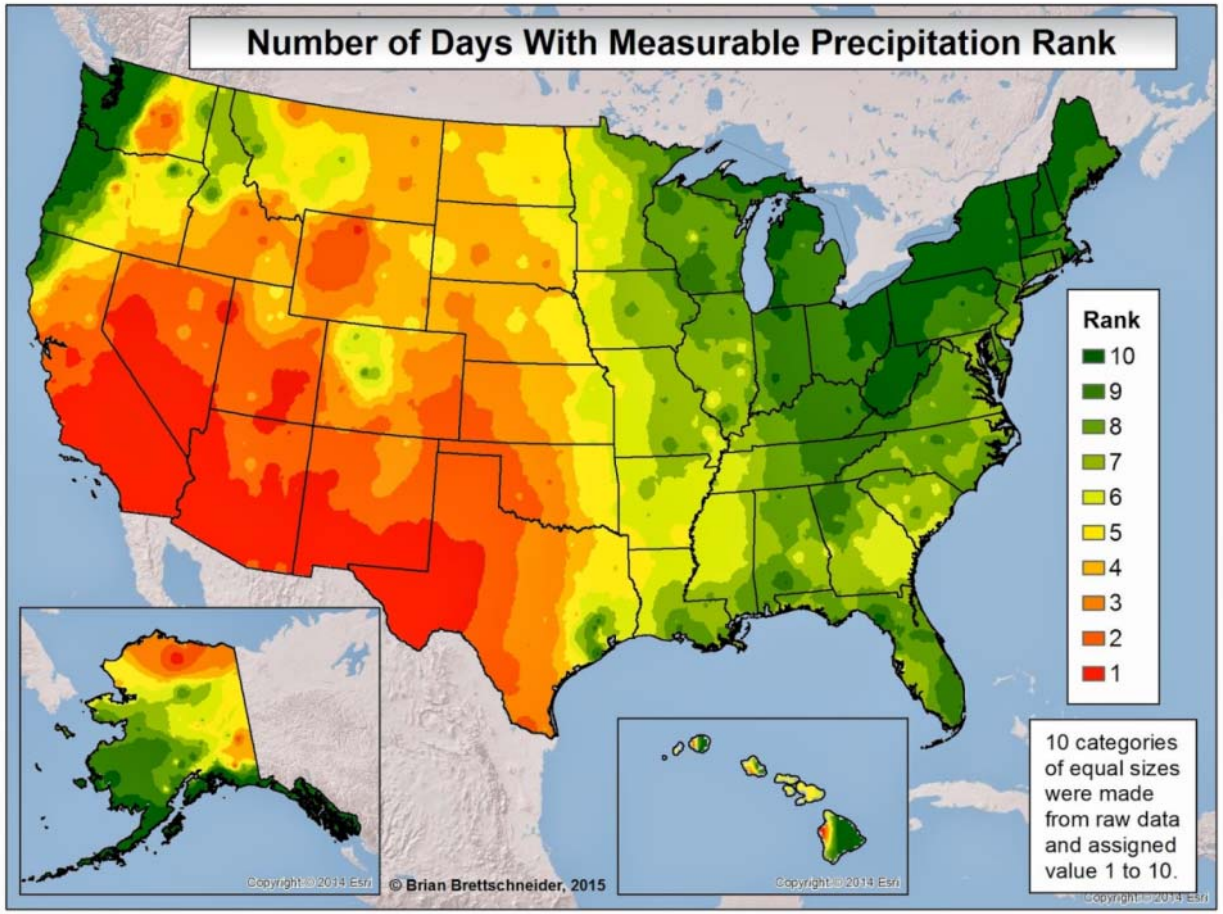
http://phys.org/news/2013-06-satellite-essential-future-groundwater-drought.html

The Need for Irrigation in the U.S.
Primary Water Source



http://www.wrcc.dri.edu/pcpn/us_precip.gif

The Need for Irrigation in the U.S.
Rainfed Agriculture Supplement



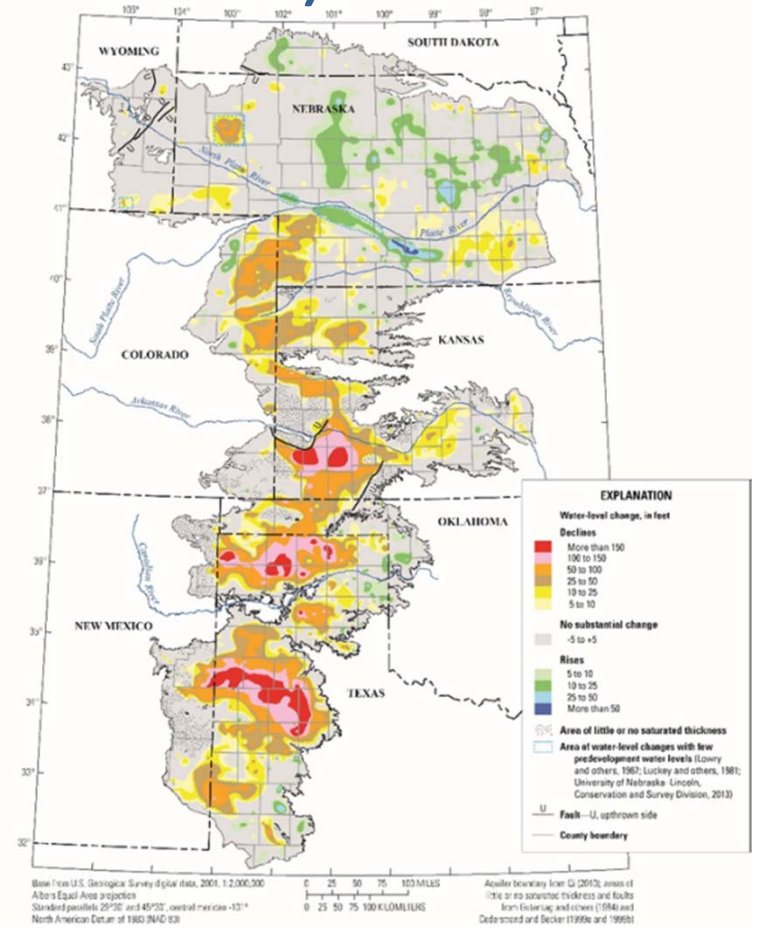
http://us-climate.blogspot.com/2015/03/dreary-weather.html

Water-level changes in the High Plains aquifer, predevelopment (about 1950) to 2013.

Groundwater as Primary Water Source

Groundwater Recharge Medium to Low to None

- Conjunctive Use Management
- Depletable Resource



McGuire, V.L., 2014, Water-level changes and change in water in storage in the High Plains aquifer, predevelopment to 2013 and 2011–13: U.S. Geological Survey Scientific Investigations Report 2014–5218, 14 p., http://dx.doi.org/10.3133/sir20145218.

High Plains Aquifer Use

- 2,000 – 15,500 Year Old Deep Water
- Largest Aquifer in North America
- 5 Million Acres Irrigated Lands 1949
- 35 Million Acres Irrigated Lands Today (14% U.S)
- Irrigation 90% of Withdrawals
- Alfalfa, cotton, corn, wheat, sorghum, soybeans
- Feeds 40% of feedlot cattle output in U.S.
- 1950 – 2060 Deplete 69% of Aquifer

McGuire, V.L., 2014, Water-level changes and change in water in storage in the High Plains aquifer, predevelopment to 2013 and 2011–13: U.S. Geological Survey Scientific Investigations Report 2014–5218, 14 p., http://dx.doi.org/10.3133/sir20145218.

Groundwater Aquifers of the Southeast

Groundwater as
Supplemental to Precipitation
Water Source (Increasing)

Groundwater Recharge
Significant

Conjunctive Use Management

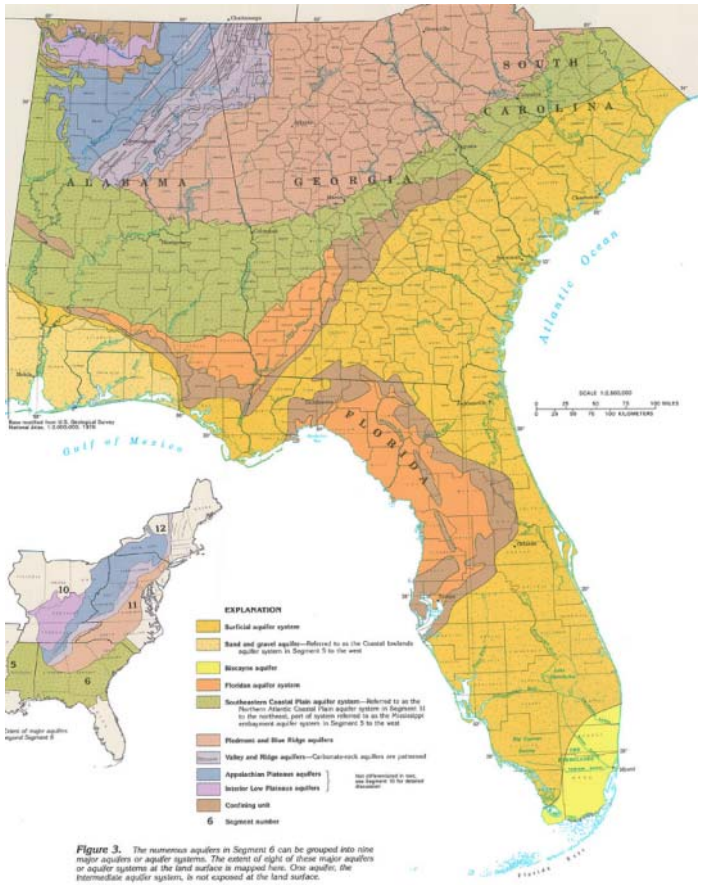
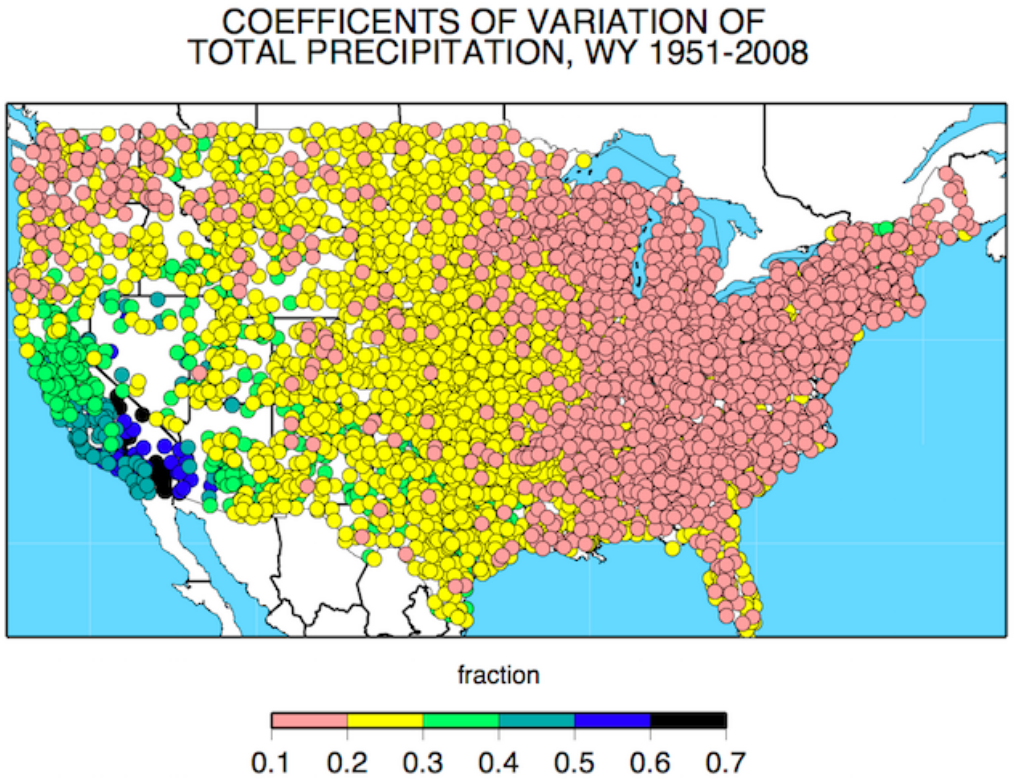


Figure 3. The numerous aquifers in Segment 6 can be grouped into nine major aquifers or aquifer systems. The extent of eight of these major aquifers or aquifer systems at the land surface is mapped here. One aquifer, the intermediate aquifer system, is not exposed at the land surface.

The Need for Groundwater as a Long-term Source of Storage and Drought Relief



Source: Dettinger et al (2011

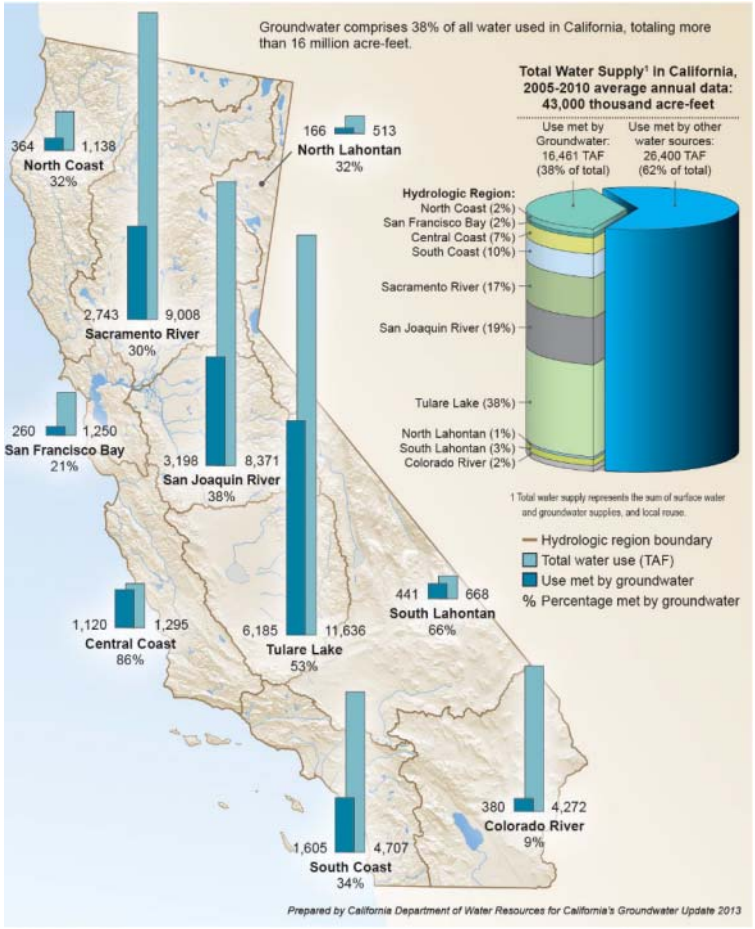
State Water Project
Federal Water Project
Local Water Project
N
Tule Lake
Clear Lake Reservoir
Trinity Reservoir
Shasta Lake
Whiskeytown Lake
Redding
Antelope Lake
Corning Canal
Tehama-Colusa Canal
Frenchman Lake
Lake Davis
Black Butte Lake
Lake Oroville
Stony Gorge Reservoir
New Bullards Bar Reservoir
East Park Reservoir
Lake Mendocino
Englebright Reservoir
Indian Valley Reservoir
Glenn-Colusa Canal
Lake Sonoma
Folsom Lake
Sacramento
Lake Berryessa
Putah S. Canal
Auburn Folsom South Canal
Camanche Reservoir
North Bay Aqueduct
New Hogan Reservoir
Mokelumne Aqueduct
Stockton
New Melones Lake
Contra Costa Canal
Hetch Hetchy Reservoir
Los Vaqueros Reservoir
Don Pedro Lake
San Francisco
Lake McClure
Lake Crowley
Lake Del Valle
Hetch Hetchy Aqueduct
South Bay Aqueduct
Delta-Mendota Canal
Pacheco Conduit
Madera Canal
Santa Clara Conduit
Millerton Lake
Tinemaha Reservoir
Pine Flat Reservoir
Hollister Conduit
San Luis Reservoir
Fresno
San Luis Canal
Los Banos Reservoir
Friant-Kern Canal
Lake Kaweah
Coalinga Canal
Hanford Reservoir
Lake Success
San Antonio Reservoir
California Aqueduct
Nacimiento Reservoir
Isabella Lake
Los Angeles Aqueduct
Cross Valley Canal
California Aqueduct Coastal Branch
Twitchell Reservoir
Quail Lake
Pyramid Lake
Antelope Valley
Lake Cachuma
Castaic Lake
Colorado River Aqueduct
Silverwood Lake
Santa Barbara
Lake Castaic
Bouquet Reservoir
California Aqueduct East Branch Extension
Los Angeles
Crafton Hills Reservoir
Lake Perris
Lake Mathews
Diamond Valley Lake
Coachella Canal
San Diego Aqueducts
San Vicente Reservoir
All American Canal
San Diego
Lower Otay Reservoir
Miles 0 25 50 100 200

Groundwater Use in California: 2005 – 2010 Average

Groundwater as Primary Water Source

Groundwater as Supplemental to Surface Water Supplies

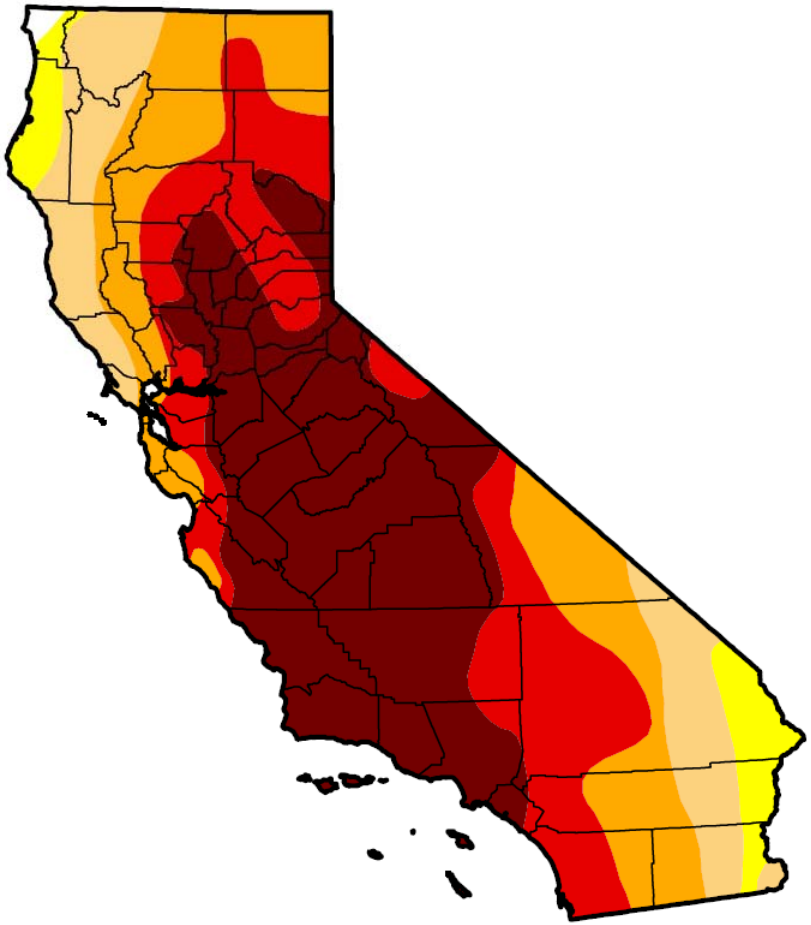
- Normal Year
- Drought Year



California Natural Resources Agency: Department of Water Resources (2015a) California's Groundwater Update 2013: A Compilation of Enhanced Content for California Water Plan Update 2013.

U.S. Drought Monitor

California



February 16, 2016

(Released Thursday, Feb. 18, 2016)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.29	99.71	94.69	81.82	61.40	38.48
Last Week *2/9/2016*	0.22	99.78	94.77	81.82	61.40	38.48
3 Months Ago *11/17/2015*	0.14	99.86	97.33	92.26	70.55	44.84
Start of Calendar Year *12/29/2015*	0.00	100.00	97.33	87.55	69.07	44.84
Start of Water Year *9/29/2015*	0.14	99.86	97.33	92.36	71.08	46.00
One Year Ago *2/17/2015*	0.16	99.84	98.10	93.44	67.46	41.20

Intensity:

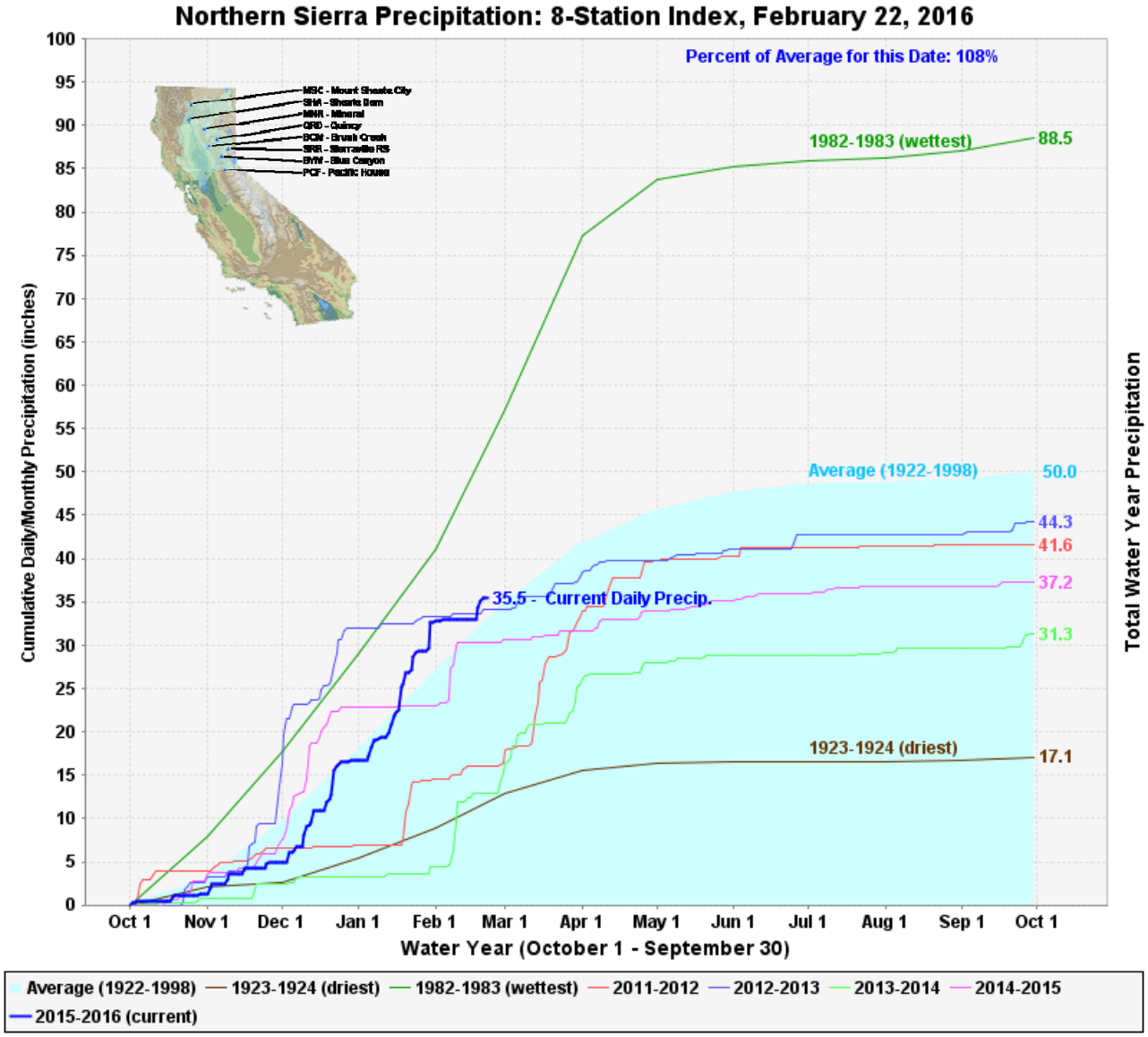
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Eric Luebehusen
U.S. Department of Agriculture

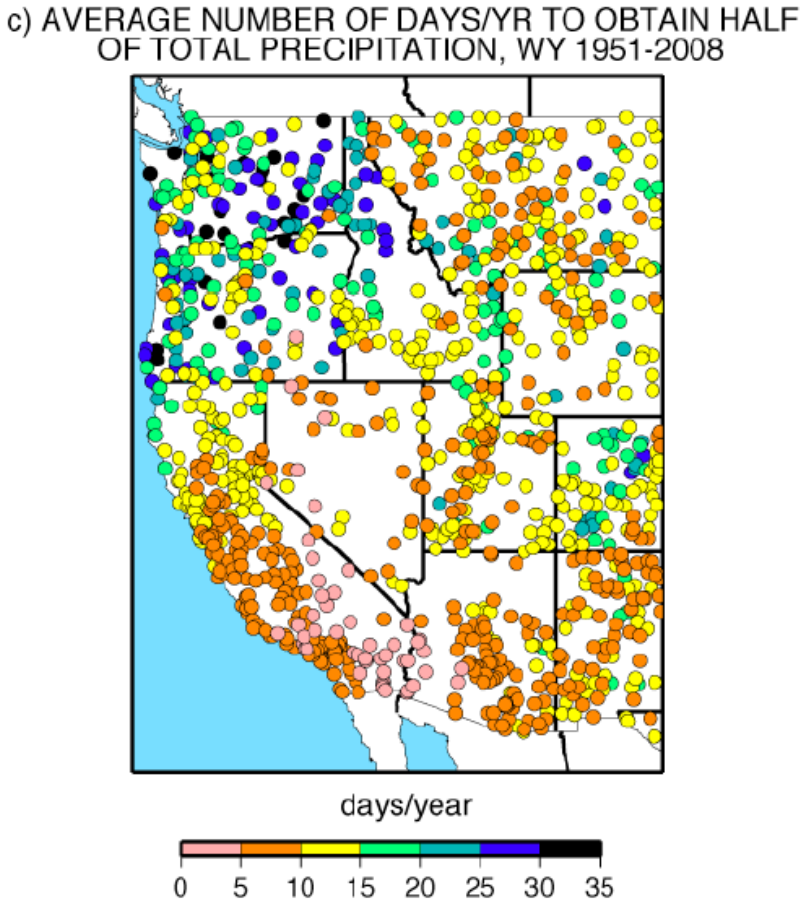
http://droughtmonitor.unl.edu/

University of California
Agriculture and Natural Resources | California Institute for Water Resources

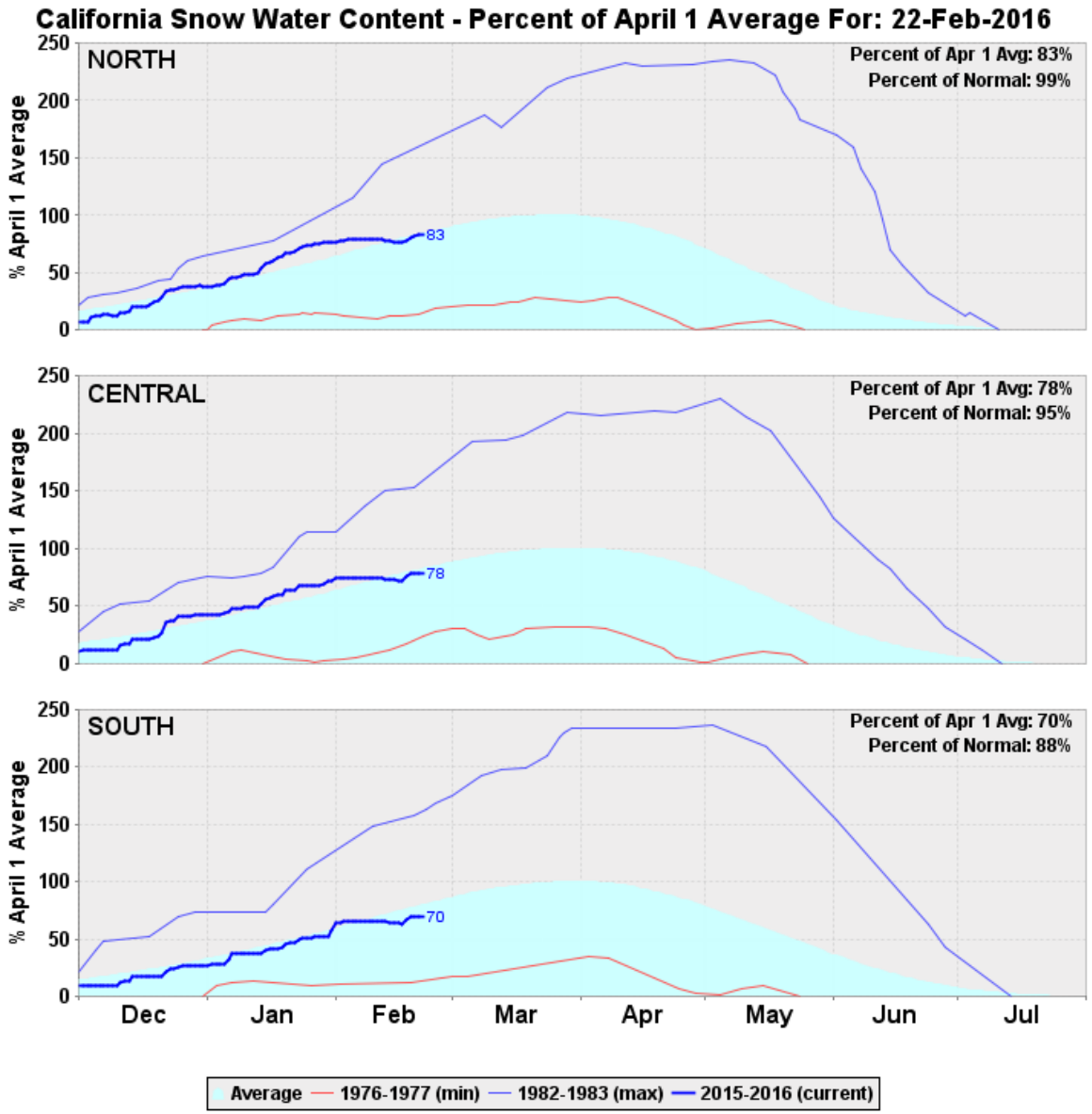


Source: http://www.water.ca.gov/waterconditions/waterconditions.cfm

The Importance of Large Storm Events



Dettinger et al, Water, 2011



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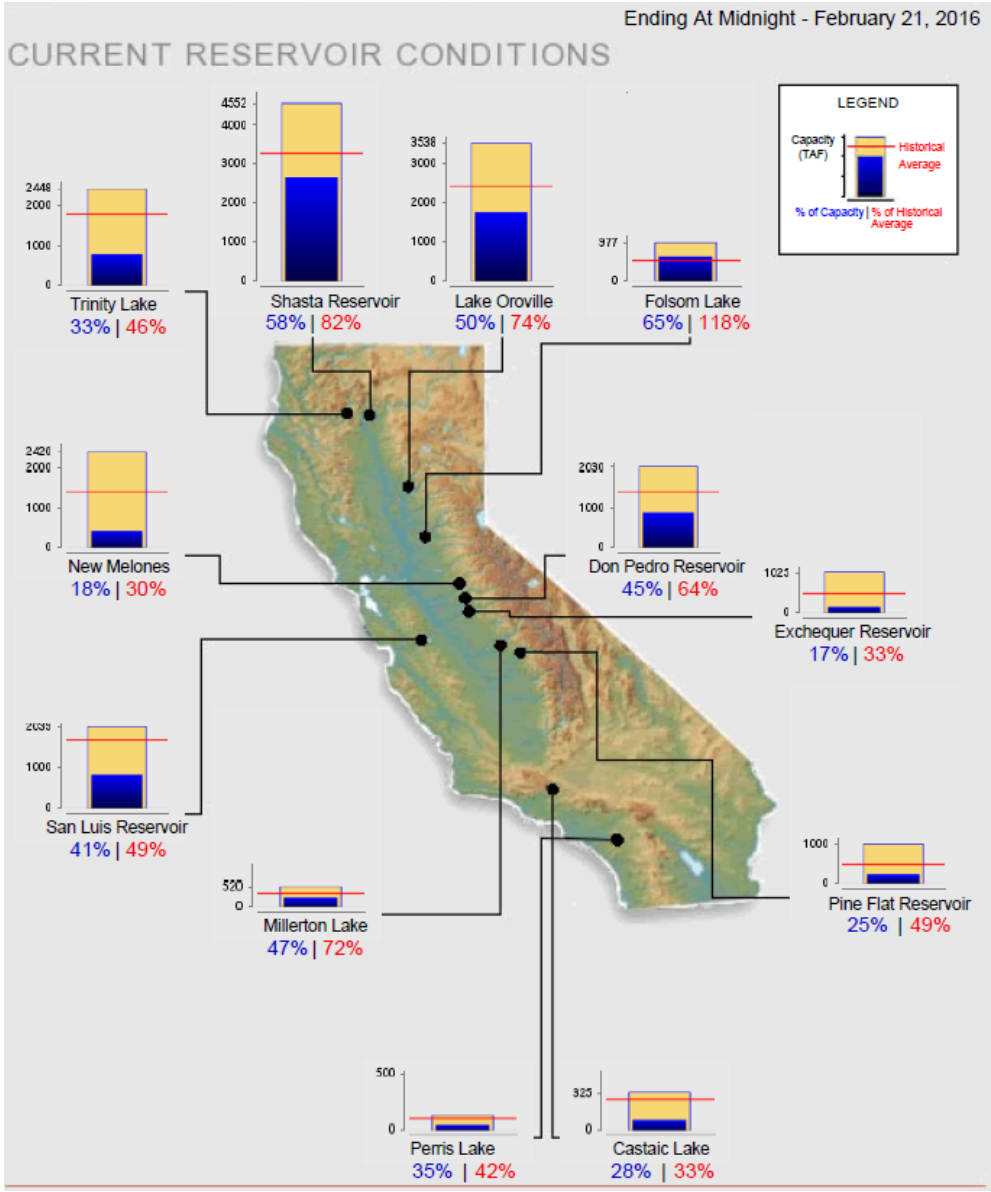


Source: http://www.water.ca.gov/waterconditions/waterconditions.cfm

The Importance of Groundwater for Drought Relief

- Groundwater Usage
  - Normal Year 38%
  - Drought Year 60%

2015 Estimated Drought Impacts

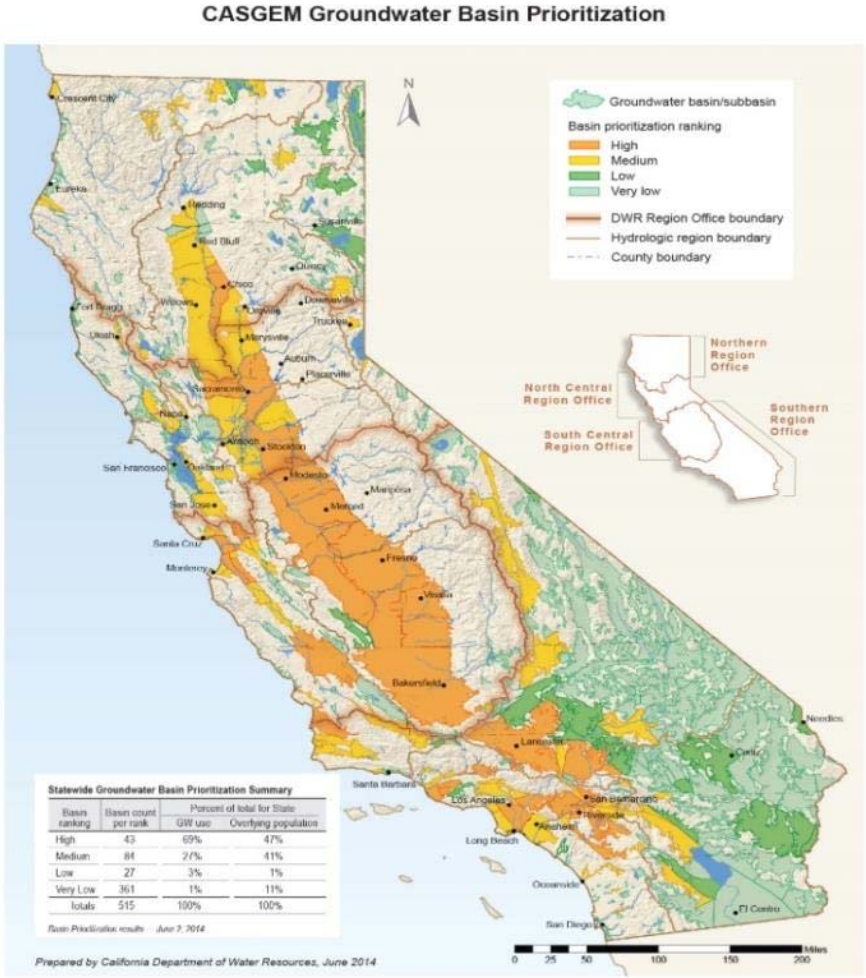
Drought impact	Loss Quantity
Water supply impacts, 2015 drought	
Surface water reduction	8.7 million acre-feet
Groundwater pumping increase	6 million acre-feet
Net water shortage	2.7 million acre-feet
Statewide agricultural impacts, 2014 drought	
Crop revenue loss	$900 million
Additional pumping cost	$544 million
Livestock and dairy revenue loss	$203 million
Total direct losses	1.8 billion
Total economic cost	$2.7 billion
Total job losses	21,000

Source: Howitt et. al., 2015

California Groundwater Management

- 2014 Sustainable Groundwater Management Act
  - Local Management with State Oversight
  - Sustainable Management Plans by 2020
  - Implemented by 2040

California Groundwater Management Basins



California Natural Resources Agency: Department of Water Resources (2015a) California's Groundwater Update 2013: A Compilation of Enhanced Content for California Water Plan Update 2013.

Thank You

Web: ucanr.edu/drought Twitter: @ucanrwater