

When You Drink The Water, Remember The Spring

2018 CA Specialty Crop Tour

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- University of Kentucky: PhD (2011-2015)
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- Optimizing regional and statewide vegetable production

Today's Presentation

Provides the facts about 1) where our water comes from in Central Valley, and 2) how agriculture (mainly crop production) accesses and uses it.

Water is Important for CA, Why?

Because California has/ranks/produces/supplies...

39.54 million population = 12% U.S. population.

5th largest economy globally if were a country.

Nation's leading agriculture > 50 years.

> 350 ag commodities, generating > \$ 47 billion.

> 1/3 country's vegetables and 2/3 fruit and nuts are grown in CA.

Ultra-Productive Central Valley



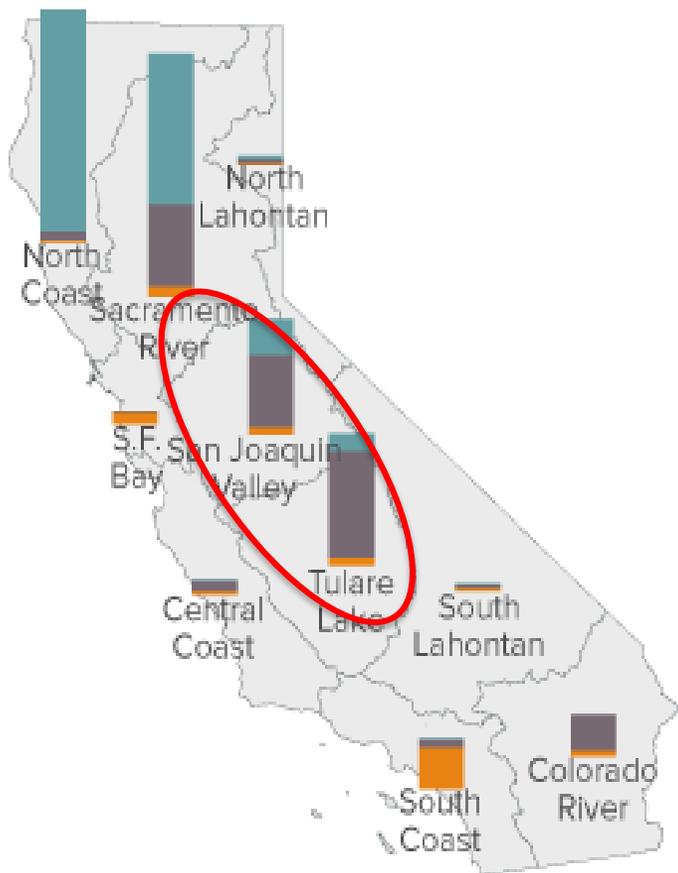
- Sacramento Valley and San Joaquin Valley
- 20,000 square miles: 50 miles wide x 400 miles length
- > 230 crops are grown, annual value = \$17 billion.
- < 1% of total farmland in U.S. produces 8% of nation's agricultural output.
- Total ag value: \$43.5 billion (data for 2013)
- Heavily relies on irrigation: 75% and 17% of irrigated land in California and U.S.

Source: USGS

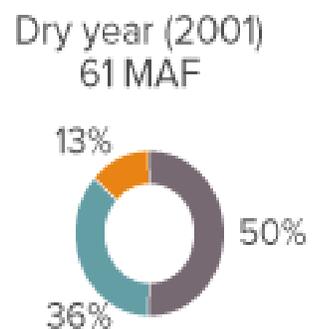
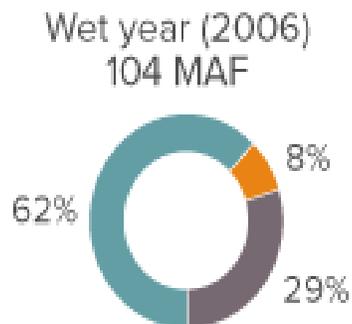
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Average annual applied water use (1998–2010)



Statewide applied water use, millions of acre-feet (MAF)



- Environment
- Agriculture
- Urban

Agriculture accounts for about 70%-80% of total water applied in central valley.

Almost all crops in central valley need to be irrigated.

Source: California Department of Water Resources (2013)



Rain-fed crops in other states need irrigation in California.

When using the water, we need to know the source. Where does the water come from?

Agricultural water usage in central valley relies on groundwater, surface water, and rainfall but to a small extent due to the unique Mediterranean climate.

Average Rainfall by Month: Modesto, CA (1888-2017, source: MID)

January	2.38"
February	2.05"
March	1.91"
April	0.97"
May	0.48"
June	0.10"
July	0.02"
August	0.03"
September	0.20"
October	0.63"
November	1.33"
December	2.10"

Typical Mediterranean climate lies most of rainfall during winter. Summer months are hot and dry.

Monthly Average Reference Evapotranspiration by ETo Zone (inches/month)



Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	0.93	1.40	2.48	3.30	4.03	4.50	4.65	4.03	3.30	2.48	1.20	0.62	32.9
2	1.24	1.68	3.10	3.90	4.65	5.10	4.96	4.65	3.90	2.79	1.80	1.24	39.0
3	1.86	2.24	3.72	4.80	5.27	5.70	5.58	5.27	4.20	3.41	2.40	1.86	46.3
4	1.86	2.24	3.41	4.50	5.27	5.70	5.89	5.58	4.50	3.41	2.40	1.86	46.6
5	0.93	1.68	2.79	4.20	5.58	6.30	6.51	5.89	4.50	3.10	1.50	0.93	43.9
6	1.86	2.24	3.41	4.80	5.58	6.30	6.51	6.20	4.80	3.72	2.40	1.86	49.7
7	0.62	1.40	2.48	3.90	5.27	6.30	7.44	6.51	4.80	2.79	1.20	0.62	43.3
8	1.24	1.68	3.41	4.80	6.20	6.90	7.44	6.51	5.10	3.41	1.80	0.93	49.4
9	2.17	2.80	4.03	5.10	5.89	6.60	7.44	6.82	5.70	4.03	2.70	1.86	55.1
10	0.93	1.68	3.10	4.50	5.89	7.20	8.06	7.13	5.10	3.10	1.50	0.93	49.1
11	1.55	2.24	3.10	4.50	5.89	7.20	8.06	7.44	5.70	3.72	2.10	1.55	53.1
12	1.24	1.96	3.41	5.10	6.82	7.80	8.06	7.13	5.40	3.72	1.80	0.93	53.4
13	1.24	1.96	3.10	4.80	6.51	7.80	8.99	7.75	5.70	3.72	1.80	0.93	54.3
14	1.55	2.24	3.72	5.10	6.82	7.80	8.68	7.75	5.70	4.03	2.10	1.55	57.0
15	1.24	2.24	3.72	5.70	7.44	8.10	8.68	7.75	5.70	4.03	2.10	1.24	57.9
16	1.55	2.52	4.03	5.70	7.75	8.70	9.30	8.37	6.30	4.34	2.40	1.55	62.5
17	1.86	2.80	4.65	6.00	8.06	9.00	9.92	8.68	6.60	4.34	2.70	1.86	66.5
18	2.48	3.36	5.27	6.90	8.68	9.60	9.61	8.68	6.90	4.96	3.00	2.17	71.6

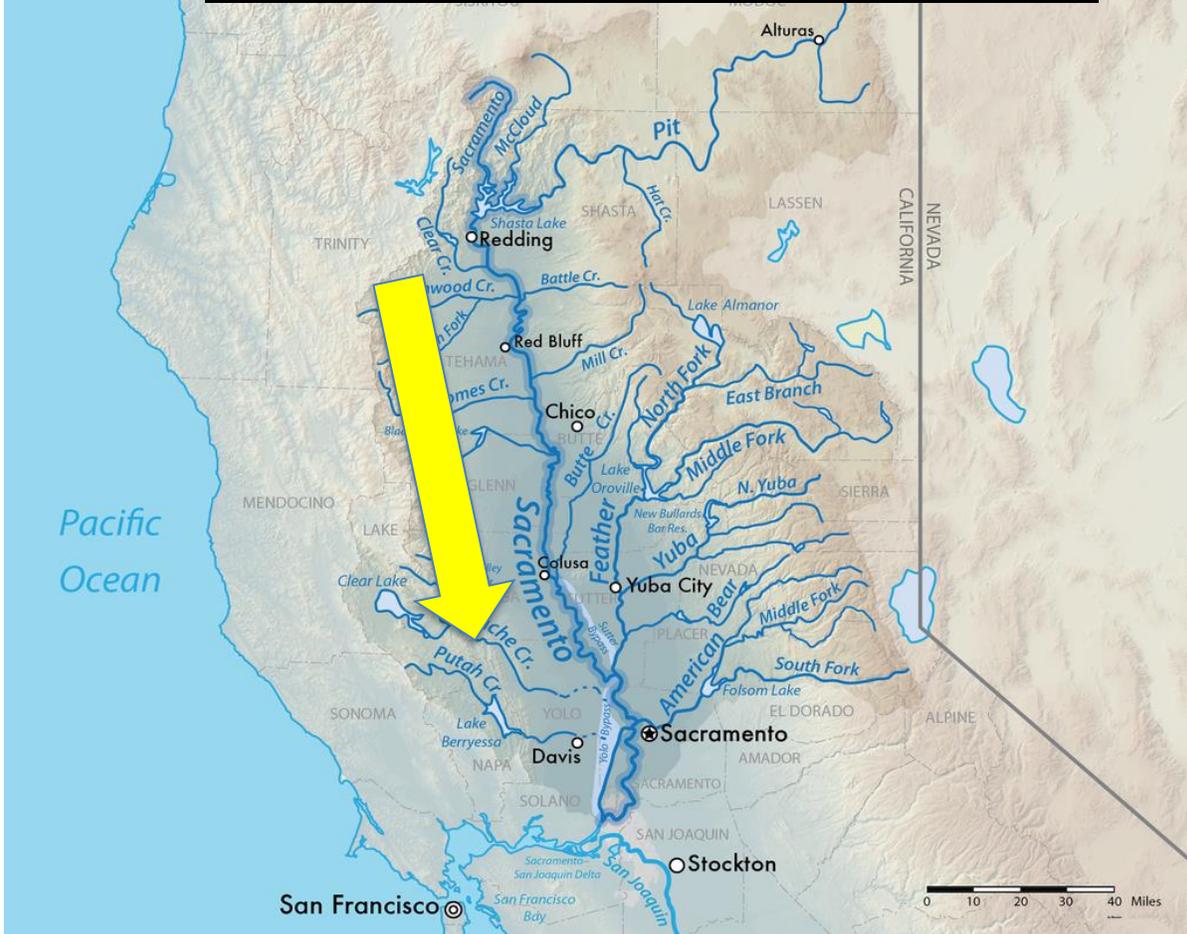
Source: State of California Department of Water Resources

Major growing seasons with no or very little rainfall plus the high monthly ET in summer limit the reliance of central valley agricultural production on precipitation.

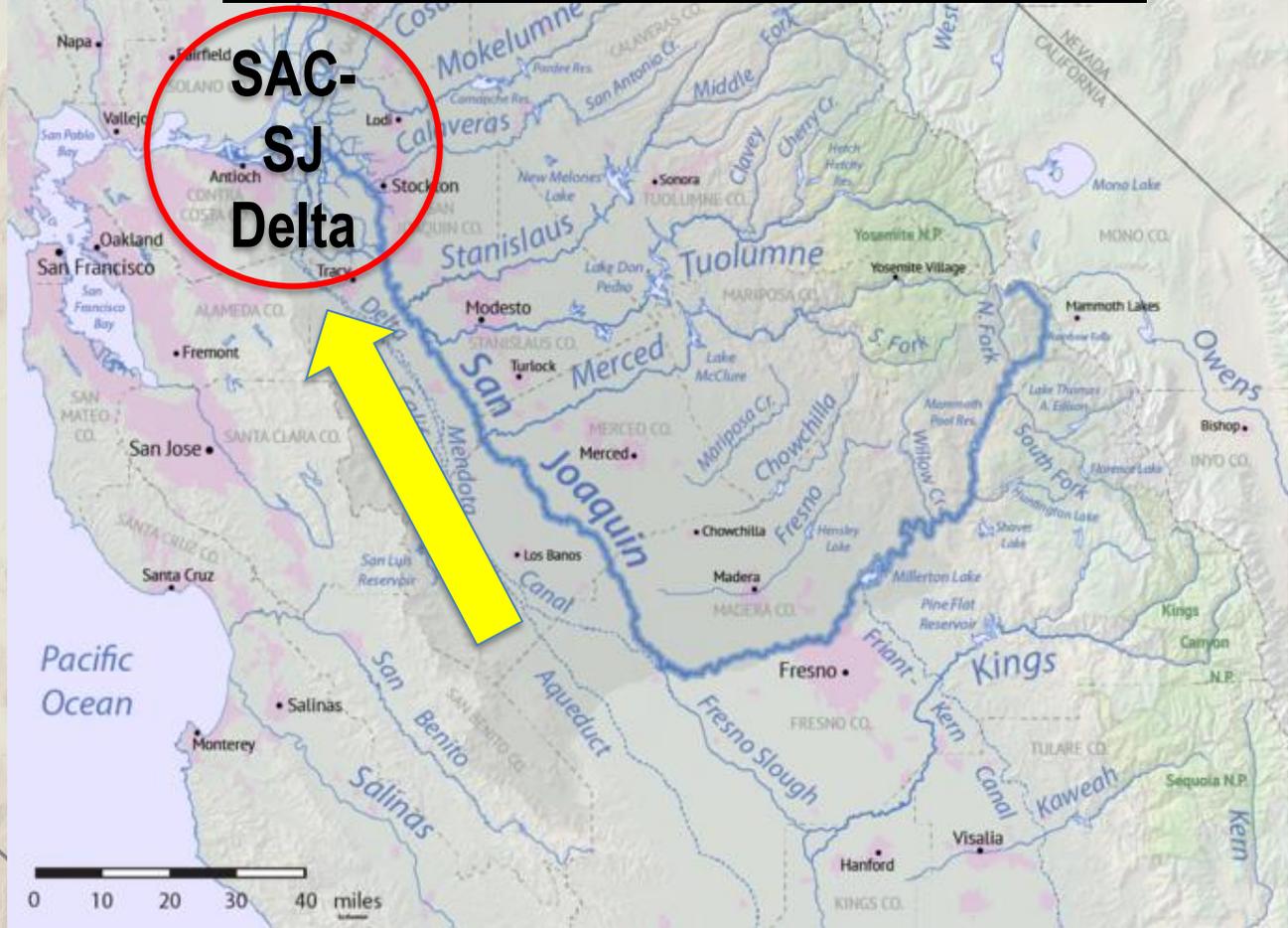
The central valley watershed (surface water) acts as a major water source for about 1/7 (1 million acres) of total irrigated acres (> 7 million acres).

Data from USDA 2012 Census of Agriculture

**Sacramento River Watershed
Flows south for 450 miles.**



**San Joaquin River Watershed
Flows northwest for 365 miles.**



Sacramento-San Joaquin Delta



Sacramento River

San Joaquin River

Significant water supply to Northern and Central California.

Sierra Nevada snowpack keeps feeding the central valley river systems.

Source: Worldislandinfo.com

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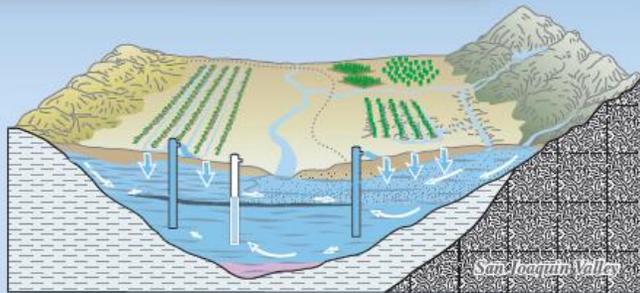
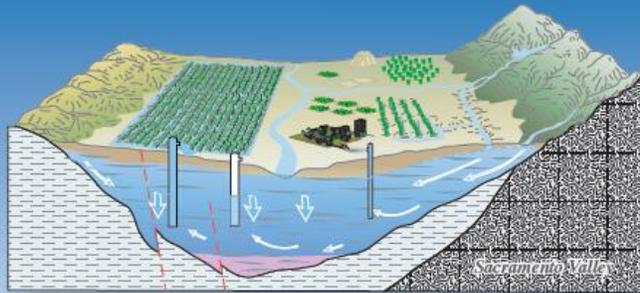
Groundwater is the most important source of supply for California agriculture, which accounts between 30% and 65% or more of total supply depending on level of drought.

Groundwater in Central Valley



GROUNDWATER RESOURCES PROGRAM

Groundwater Availability of the Central Valley Aquifer, California



Professional Paper 1766

U.S. Department of the Interior
U.S. Geological Survey

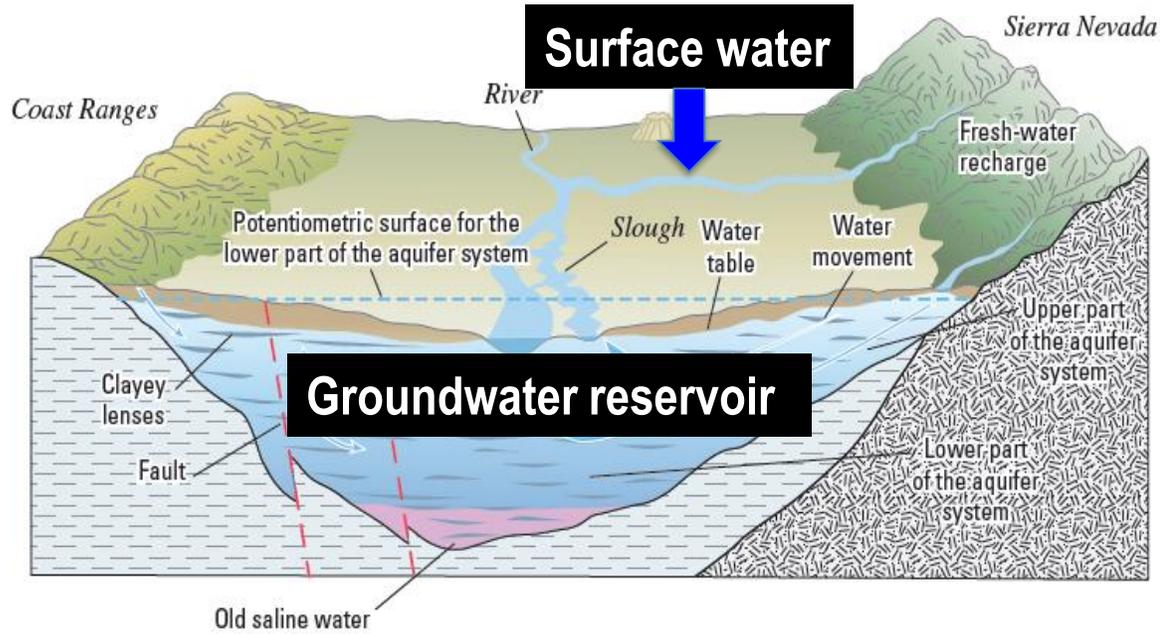
The largest groundwater reservoirs accessed by agriculture through pumping wells.

Runoff that seeps into the aquifer is the majority of supply.

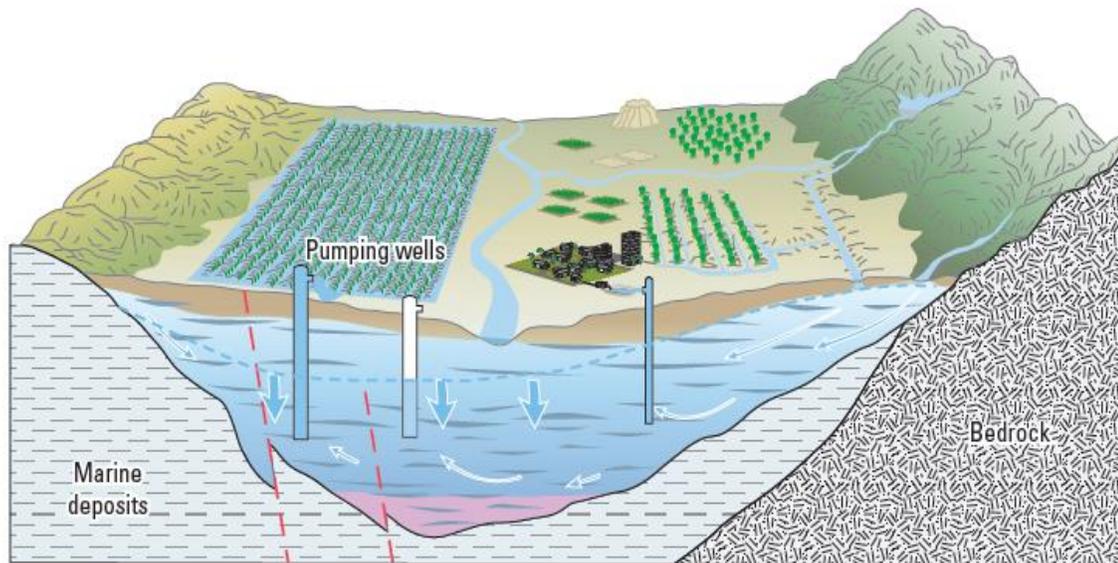
No state laws regulate groundwater management.

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Groundwater in Central Valley



Groundwater reservoir



Today, most land owners or the local water district carry the right of groundwater use in contrast to surface water use governed by California laws.

Overpumping of central valley groundwater occurs, somehow causing a crisis.

Pre- and Post-development of Sacramento Valley

Source: USGS

How the water is accessed to the agriculture in central valley?

Central Valley Project (CVP)

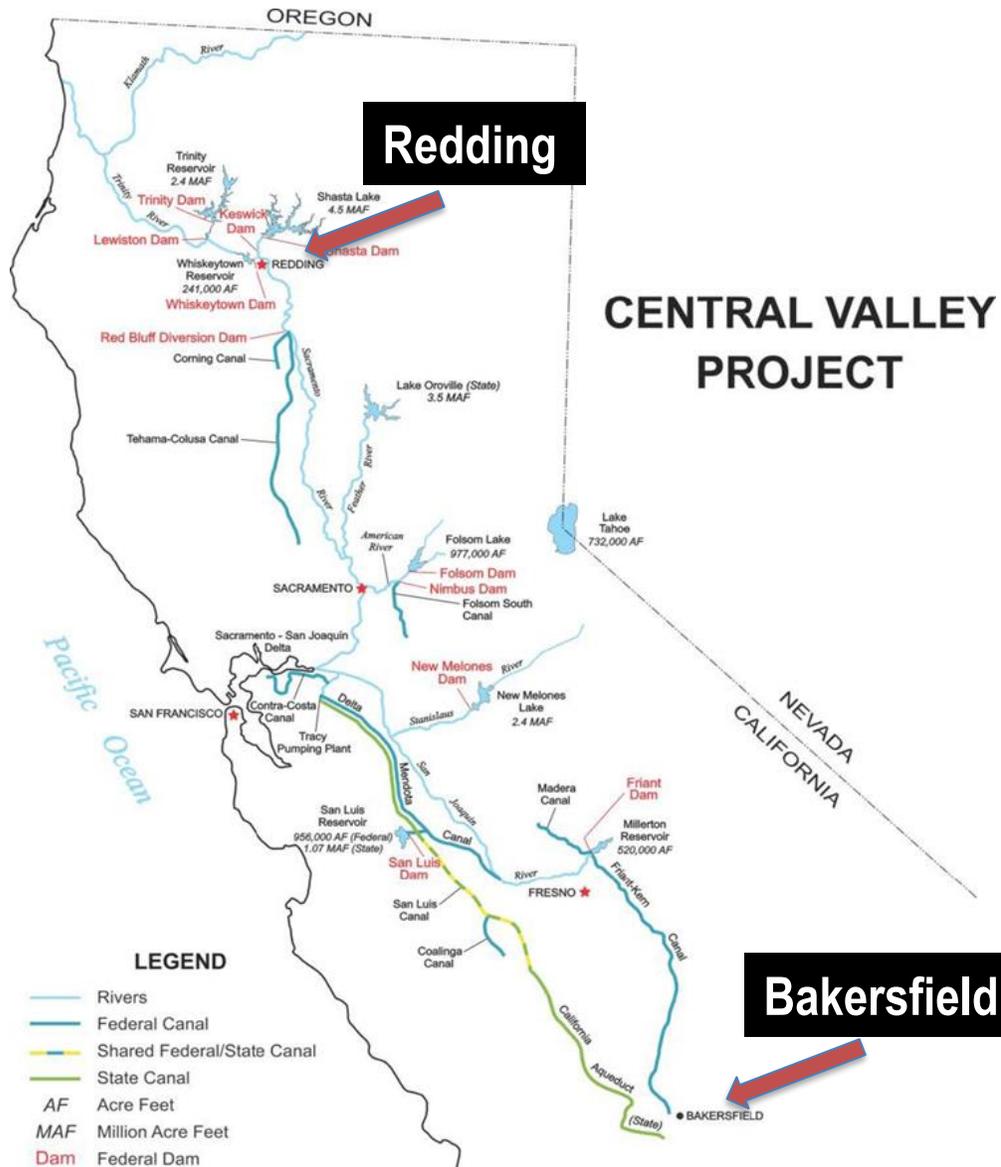


Background information

Impact

Friant Dam, Friant, CA
Source: Maven's Notebook

Central Valley Project (CVP)...



- passed in 1933.
- was a multi-purpose federal water management.
- aimed to supply urban and agricultural water for central valley (north to south), produce electrical power, and prevent flooding.
- started to construct facilities in 1938, Redding to Bakersfield, 400 miles+.
- now encompassed about 20 dams, 11 power plants, and 3 fish hatcheries.

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Central Valley Project (CVP)...

500

500 miles of canals transport water to where needs.

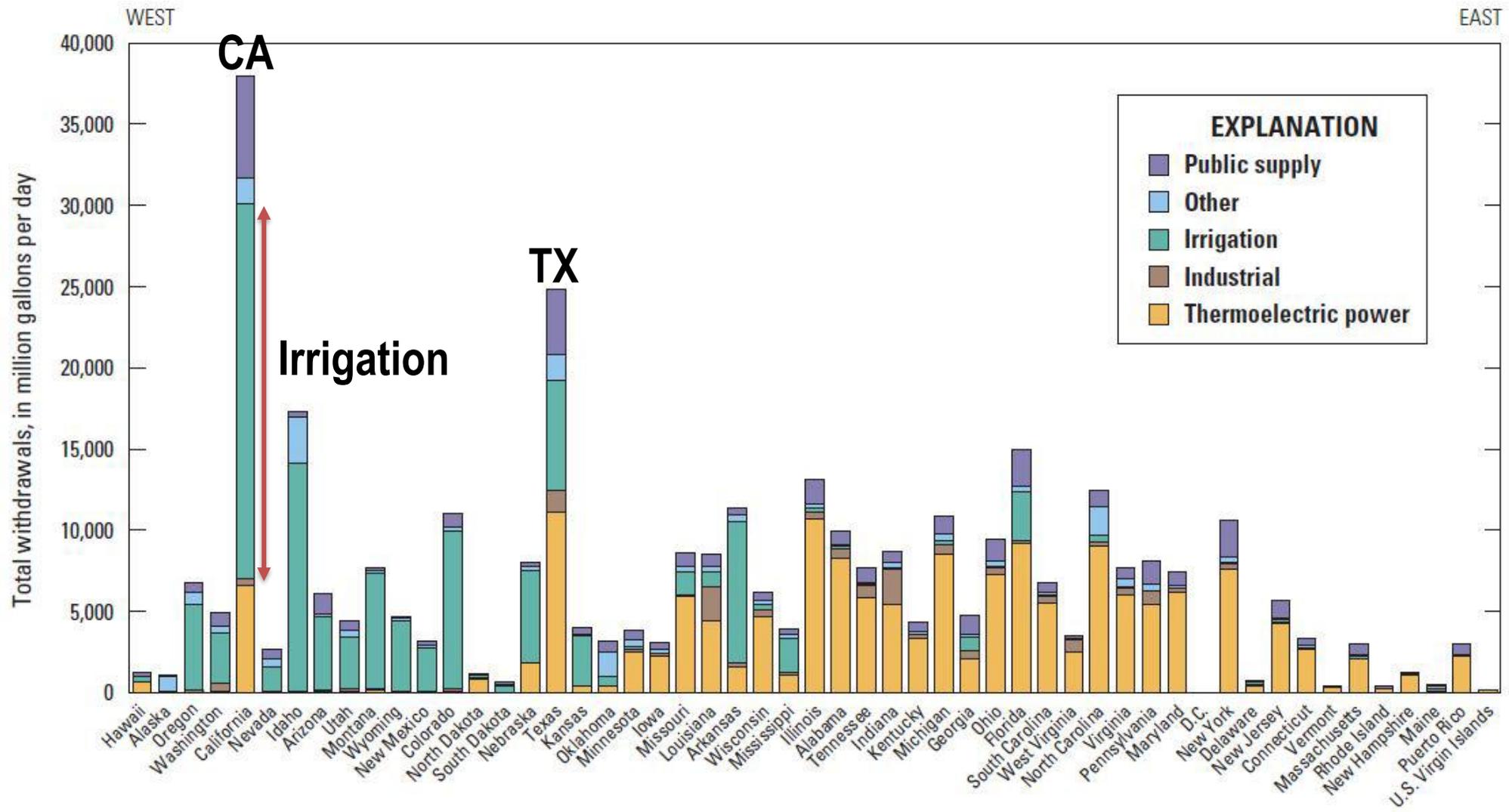
13 million,
5 million,
3 million

CVP stores 13 million acre feet of water and 5 million goes to irrigate 3 million acres of farmland.

250, 30

More than 250 contractors from about 30 counties in California had long-term agreements with CVP for water supply.

**How the water is used by
agriculture? Irrigate crops
through different systems.**



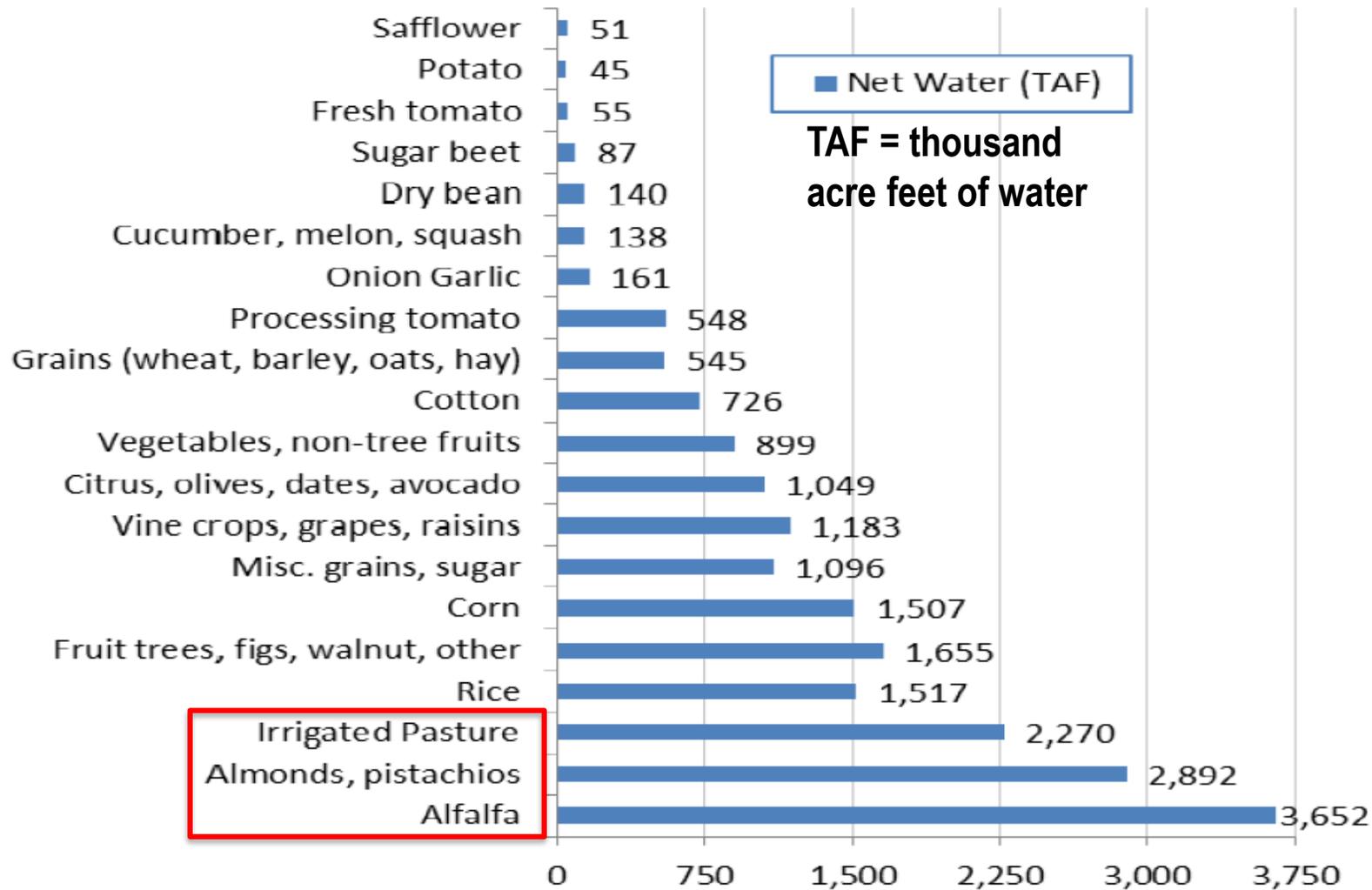
Total Daily Water Use by State in 2010 (Source: USGS)

Selected Crops	Number of Farms	Irrigated Acres Harvested	Average Acre-Feet Applied per Acre
Corn for grain or seed	489	152,261	3.4
Corn for silage or greenchop	1,583	363,651	3.1
Sorghum for grain or seed	42	10,305	1.9
Wheat for grain or seed	900	339,188	2.1
Soybeans for beans	—	—	—
Beans, dry edible	164	38,855	2.3
Rice	2,026	1,051,374	4.5
Other small grains (barley, oats, and rye)	334	77,523	1.8
Alfalfa and mixtures	2,412	664,318	3.8
All other hay (dry hay, greenchop, and silage)	2,212	437,280	2.8
Peanuts for nuts	—	—	—
All cotton	464	274,834	2.9
Land in vegetables	3,374	1,018,036	2.8
Sweet corn	113	28,420	2.5
Tomatoes in the open	1,036	283,287	2.7
Lettuce and romaine	261	197,716	2.5
Potatoes, excluding sweet potatoes	163	63,101	1.7
All berries	1,280	33,443	0.6
Land in orchards	31,859	2,576,601	2.7
All other crops (see text)	3,819	249,561	2.7
Pastureland, all types	3,786	433,570	2.0

Alfalfa is the most water-consuming crop after rice.

Irrigation Applied to Selected Crops in California (Data are 2013).

Source: USDA-Farm and Ranch Irrigation Survey.



Net water use (water consumed by the crop) = water applied – runoff and seepage.

Again, pasture crops and nut crops consume the most amount of water.

Net Water Use for Selected Crops in California (Data are 2015).

Source: California Water Blog.

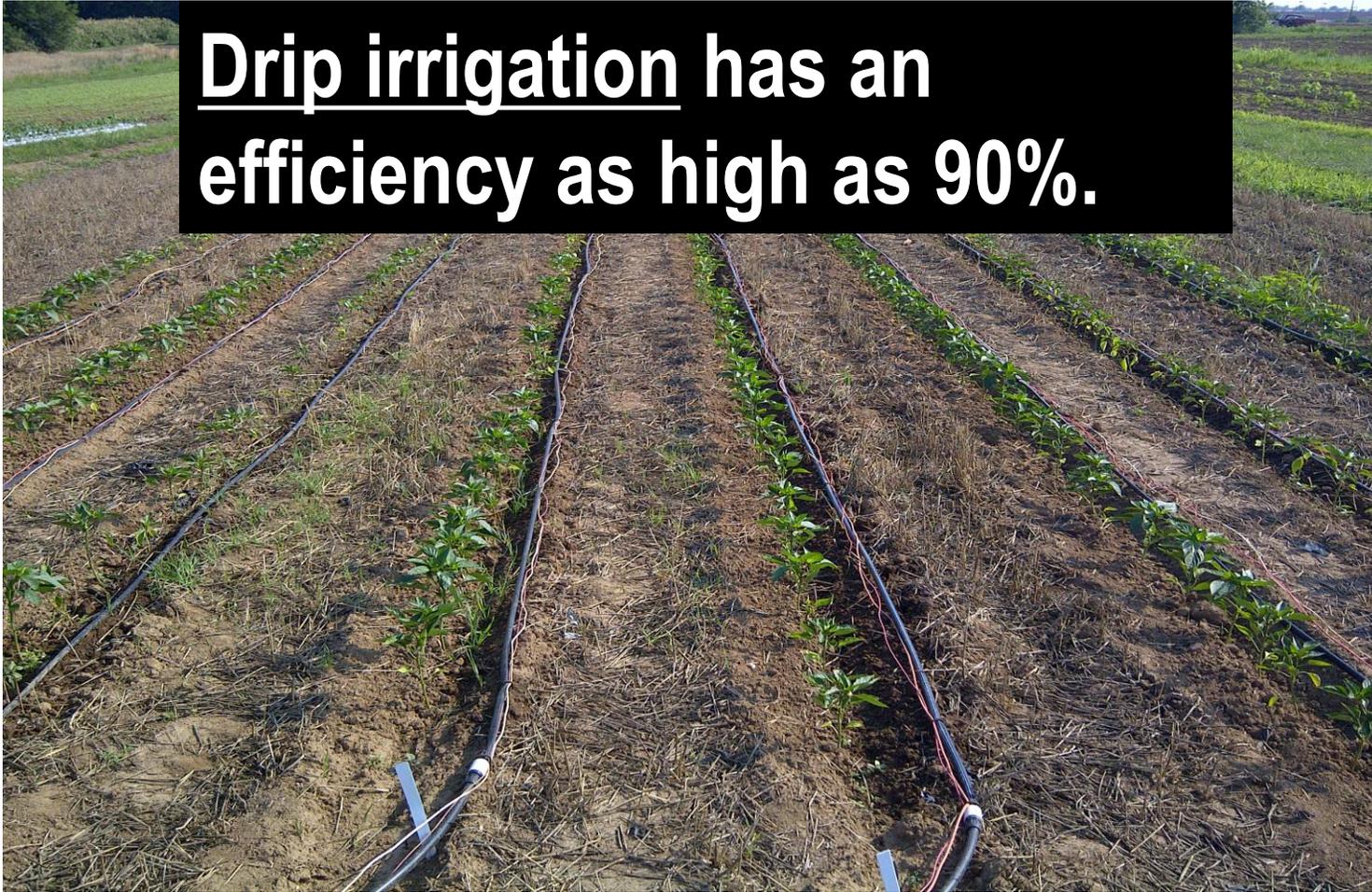
Furrow irrigation has an efficiency between 70%-75%.



Despite of low irrigation efficiency, furrow and flood irrigation still account for about 45% of all irrigated lands.

Irrigation efficiency: ratio of volume of water used to produce a crop to volume of water taken from a water source.

Drip irrigation has an efficiency as high as 90%.



Adoption of drip irrigation doubled in the past 25 years, now accounting for about 40% of all irrigated lands. It includes surface and sub-surface drip, and micro-sprinkler irrigations.

Trends in Irrigation Method in Central Valley, by Hydrological Region (2001 and 2010).

Hydrological Region	Furrow and Flood		Drip Irrigation		Sprinkler		Other	
	2001	2010	2001	2010	2001	2010	2001	2010
Sacramento River	56%	52%	20%	30%	21%	16%	3%	2%
San Joaquin River	54%	45%	35%	43%	8%	7%	3%	5%
Tulare Lake	57%	47%	36%	42%	6%	8%	1%	3%

Source: California Water Plan Update 2013, California Department of Water Resources.

Conclusions

Two major water source: groundwater and surface water.

Water supplies from north to south.

Central Valley Project contributes water access to central valley agriculture.

Drought drives growers to adopt drip irrigation for higher efficiency.

GOOD LUCK!

THANK YOU

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