

Assessing Impacts of Climate and Socioeconomic Changes on Central Valley System Risk and Reliability

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Basin Study Program

- **Purpose**

- Work with state and local partners in 17 Western States to evaluate future water supply and demand imbalances in a changing climate

- **Basin Studies Include:**

- Assessments of the risks and impacts of climate change on water resources, and
- Development of adaptation strategies to address impacts to water supplies and demands
- Potential follow-on more detailed Investigations

SACRAMENTO & SAN JOAQUIN BASINS STUDY



Incorporates the entire watersheds of the Sacramento, San Joaquin and Tulare Lake Basins. Also includes portions of the Klamath-Trinity River watersheds

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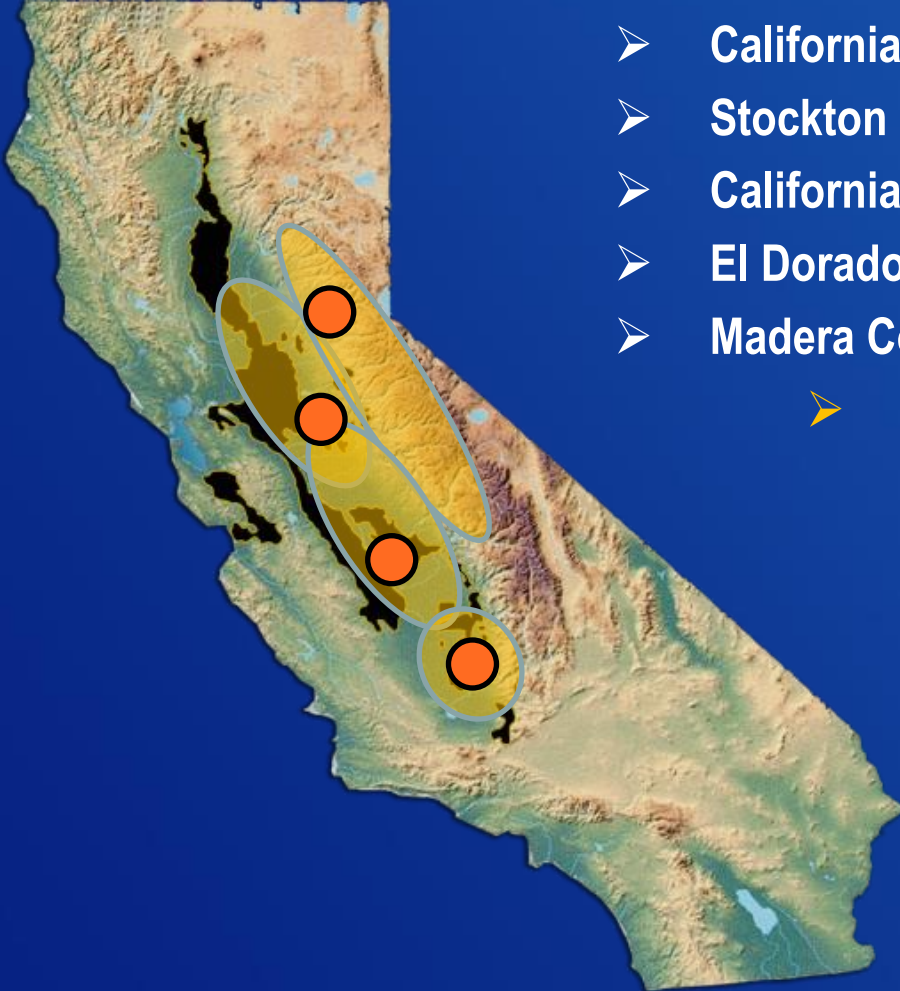
Geographic Coverage of Sacramento & San Joaquin Basin Study Partners:

➤ Reclamation's Cost-Share Partners include:

- California Dept. of Water Resources
- Stockton East Water District
- California Partnership for San Joaquin Valley
- El Dorado County Water Agency
- Madera County Resources Agency

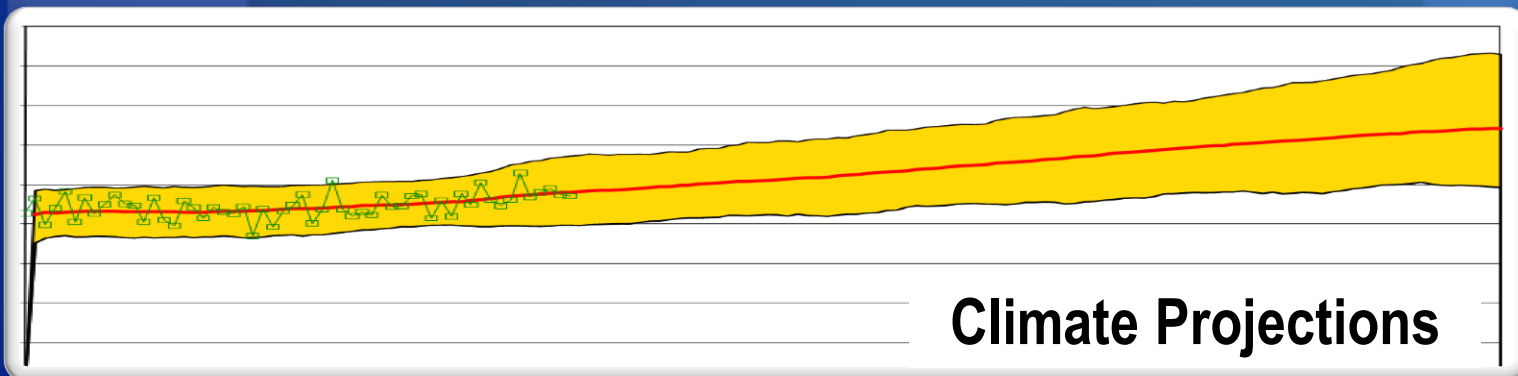
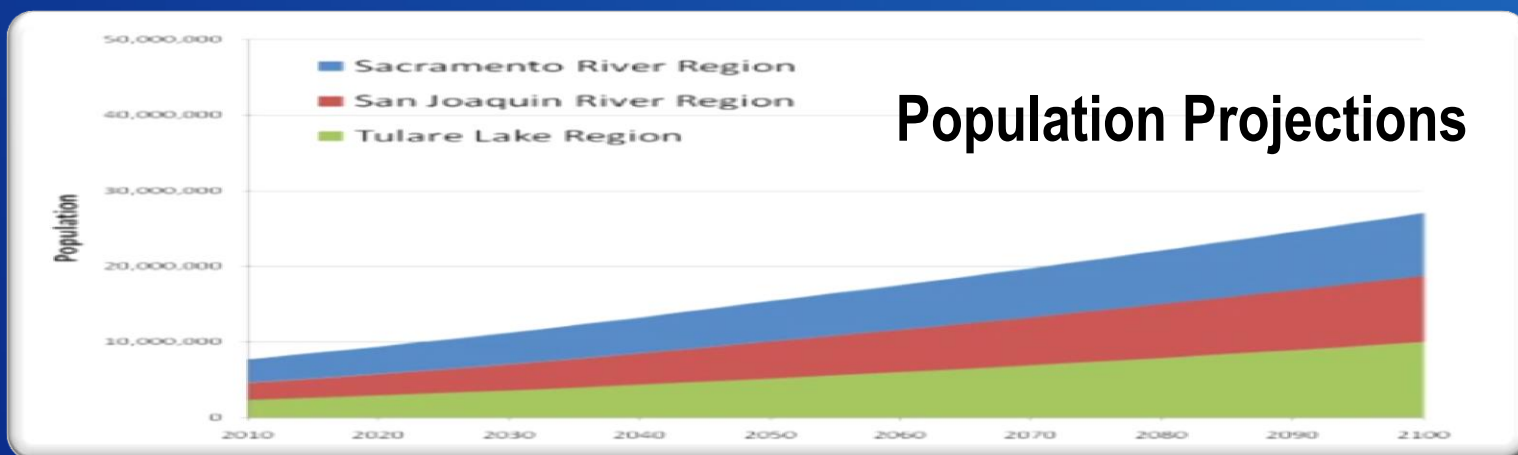
➤ Major Stakeholders:

- Friant Water Authority
- Mountain Counties Water Resources Association
- Northern California Water Association
- State Water Contractors
- San Luis & Delta-Mendota Water Authority

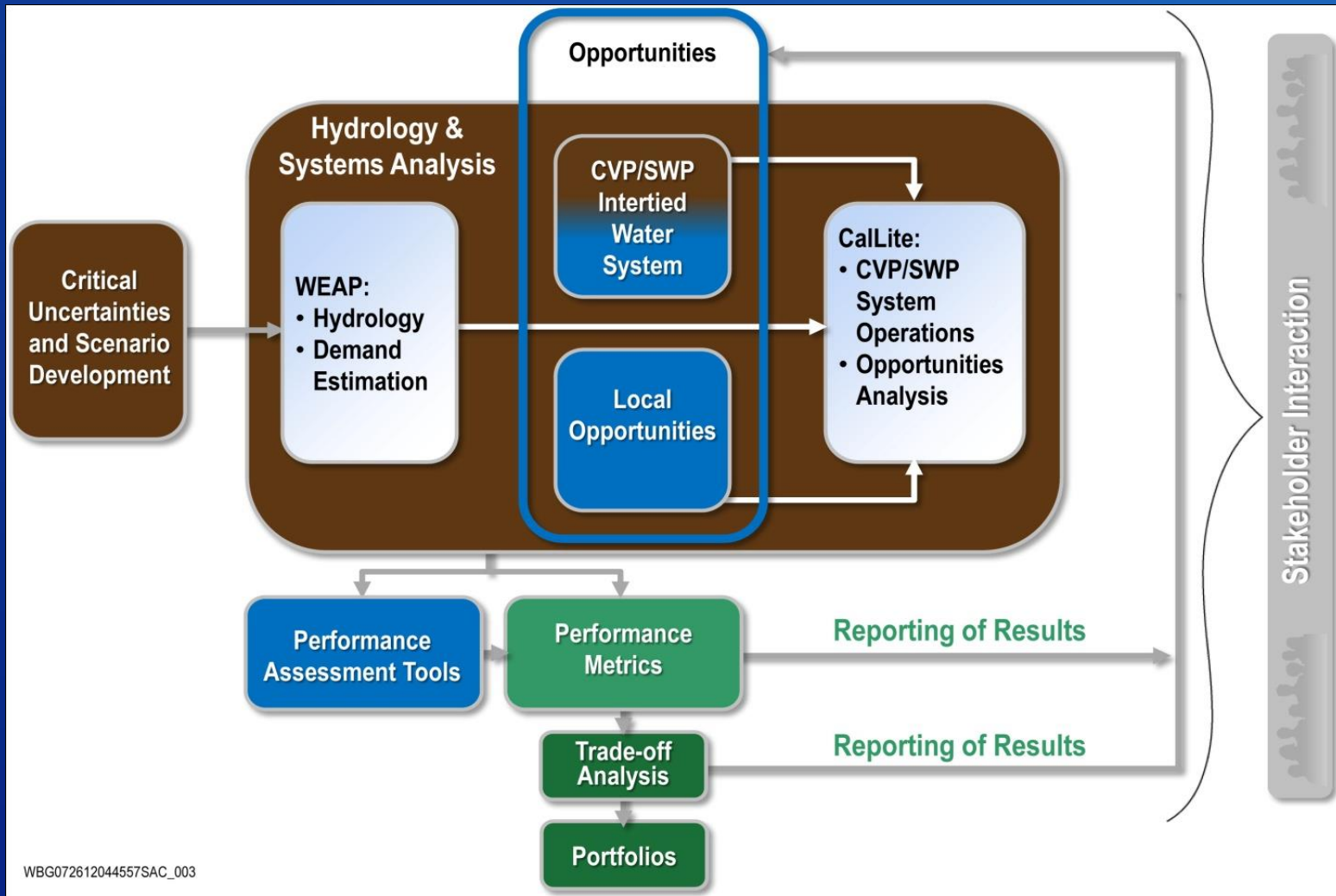


Representation of Climate and Socioeconomic Uncertainty

- Multiple scenarios bracket the range of uncertainty:



Study Approach Overview

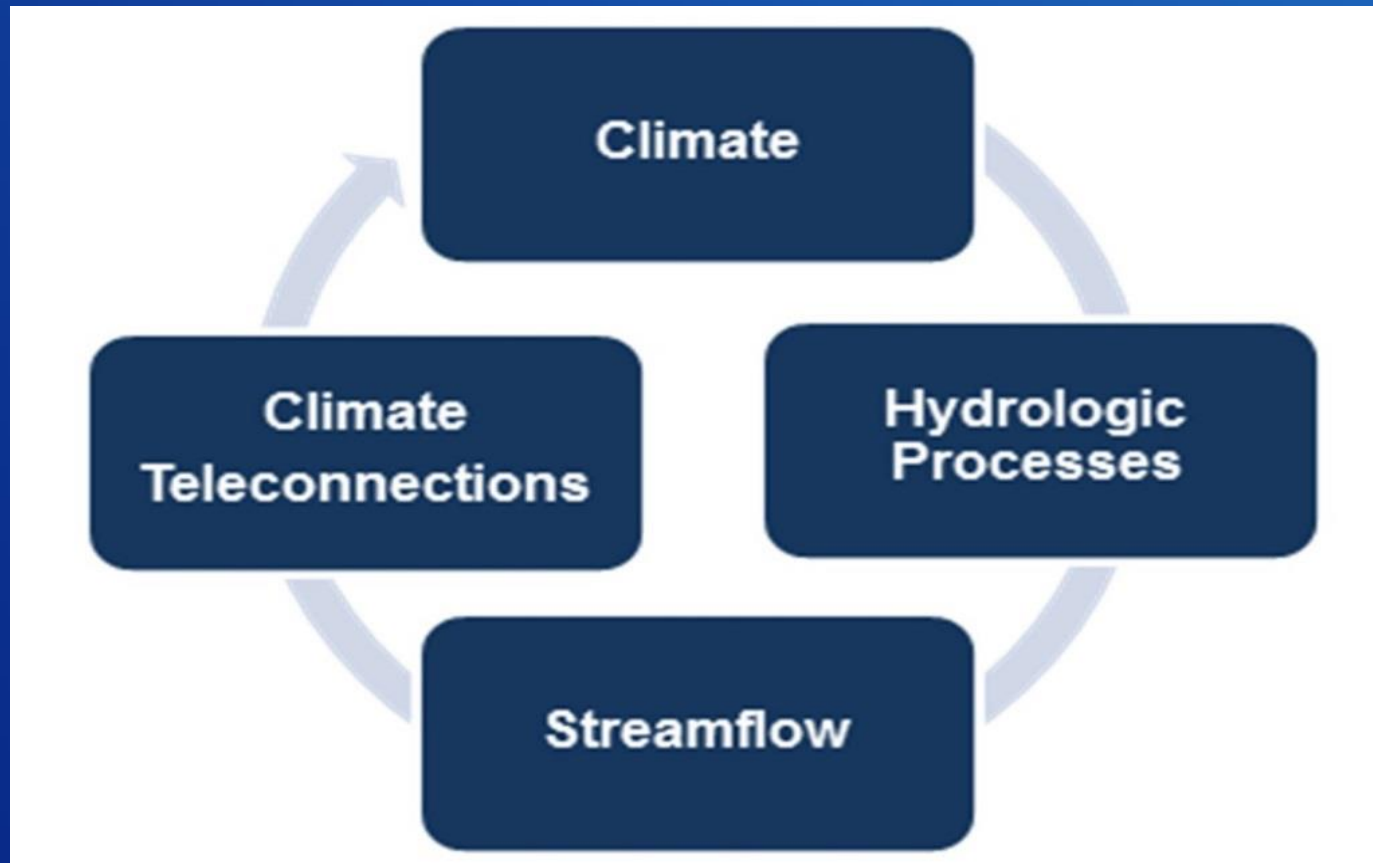


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Water Supply Assessment

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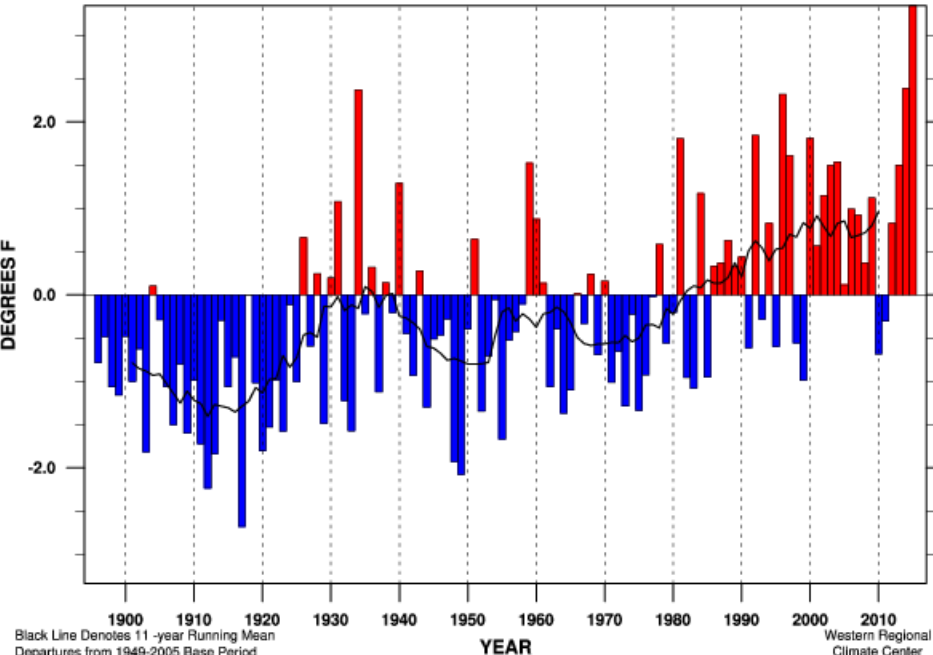
Types of Water Supply Indicators Used in the Study



Historical Climate Variability and Trends

1896-2015

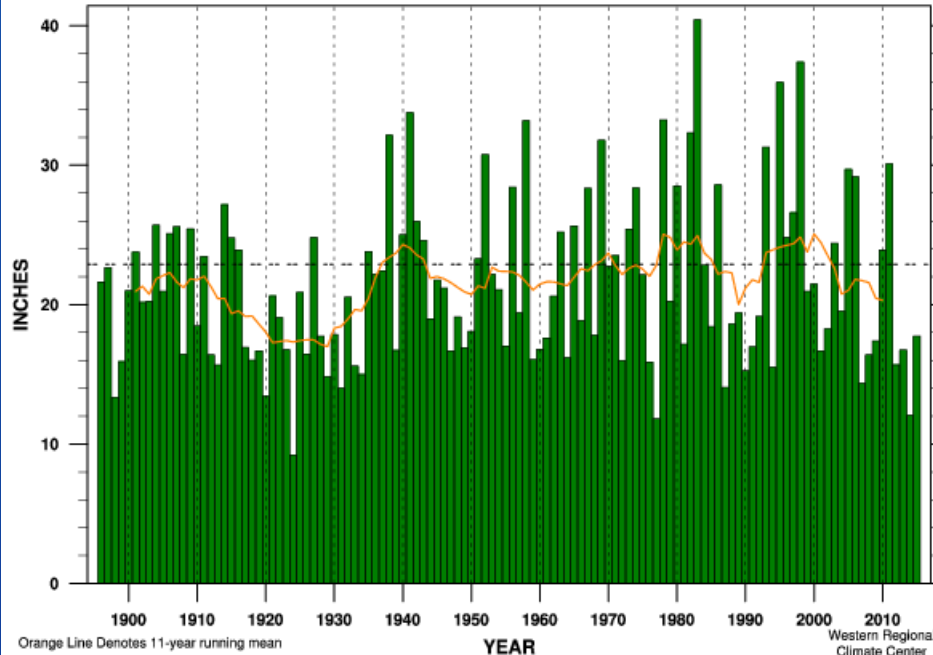
California Statewide Mean Temperature Departure Oct-Sep



Black Line Denotes 11-year Running Mean
 Departures from 1949-2005 Base Period
 Western Regional Climate Center

Linear Trend 1895-present	+ 1.72 ± 0.48 °F/100yr	
Linear Trend 1949-present	+ 2.90 ± 1.19 °F/100yr	
Linear Trend 1975-present	+ 4.05 ± 2.73 °F/100yr	
Warmest Year	59.4 °F (+ 3.3 °F) in 2015	MEAN 56.1 °F
Coldest Year	53.4 °F (- 2.7 °F) in 1917	STDEV 0.98 °F
Oct-Sep 2015	59.4 °F (+ 3.3 °F)	RANK 120 of 120

California Statewide Precipitation Oct-Sep

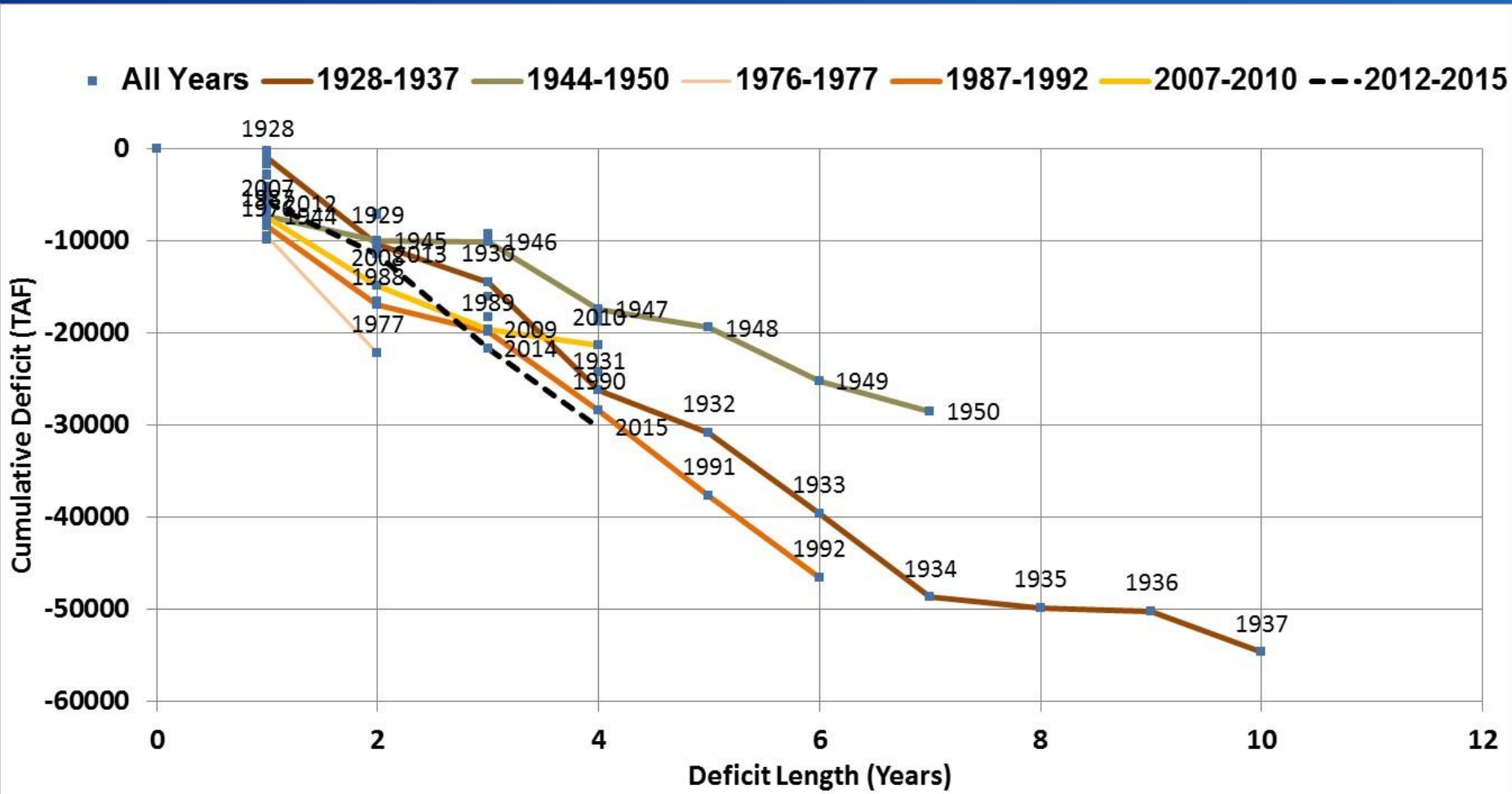


Orange Line Denotes 11-year running mean
 Western Regional Climate Center

Linear Trend 1895-present	+ 2.24 ± 3.05 in.	(+ 9 ± 13%) per 100 yr
Linear Trend 1949-present	- 2.60 ± 8.51 in.	(- 11 ± 37%) per 100 yr
Linear Trend 1975-present	-10.01 ± 20.41 in.	(- 43 ± 89%) per 100 yr
Wettest Year	40.44 in. (176%) in 1983	MEAN 22.90 in.
Driest Year	9.23 in. (40%) in 1924	STDEV 6.53 in.
Oct-Sep 2015	17.75 in. (77%)	RANK 41 of 120

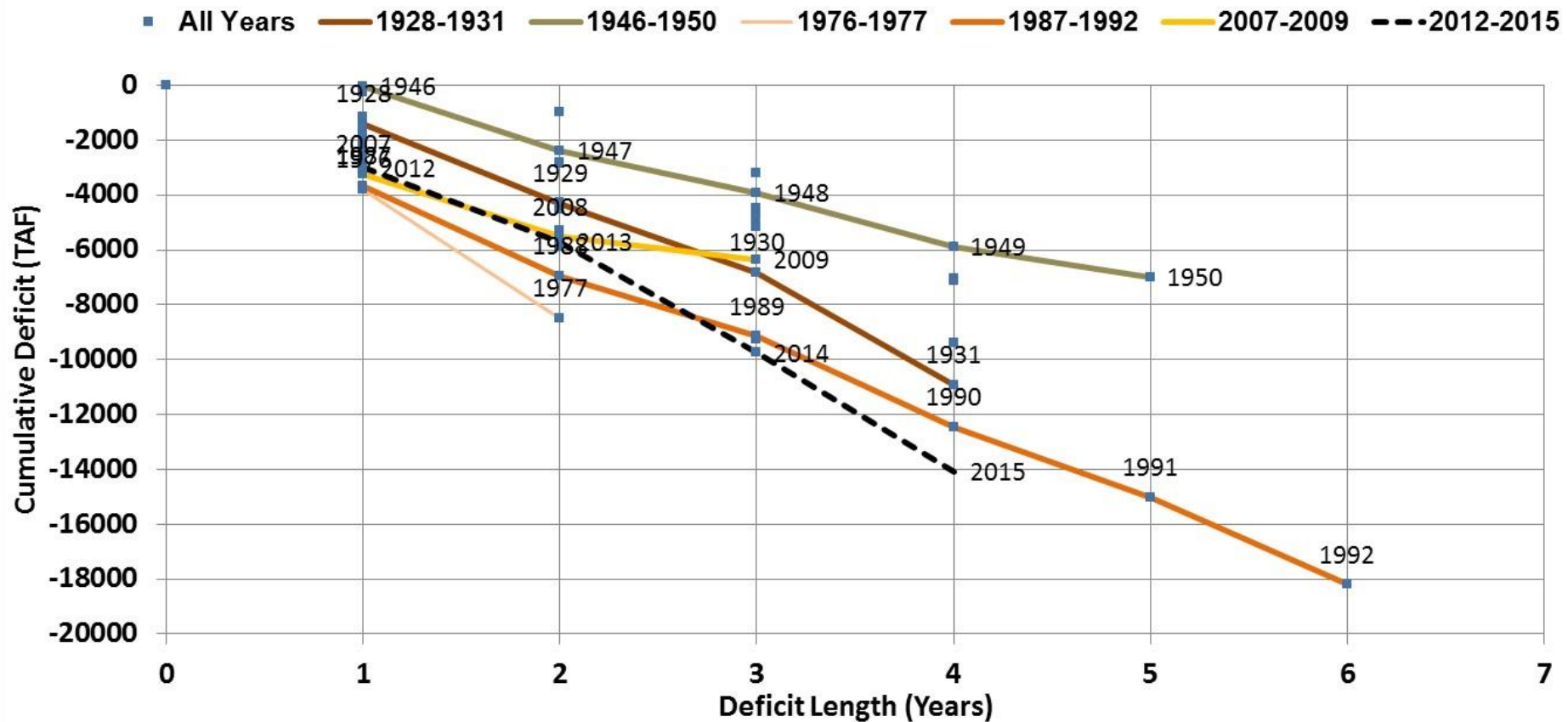
Historical Droughts: Cumulative Streamflow Deficits

Sacramento Valley 4-River Index



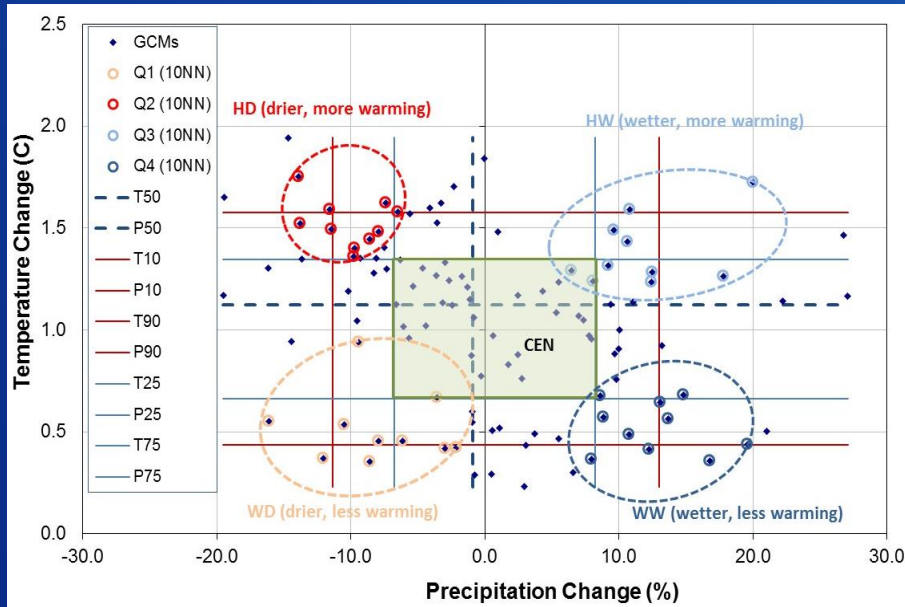
Historical Droughts: Cumulative Streamflow Deficits

San Joaquin Valley 4-River Index

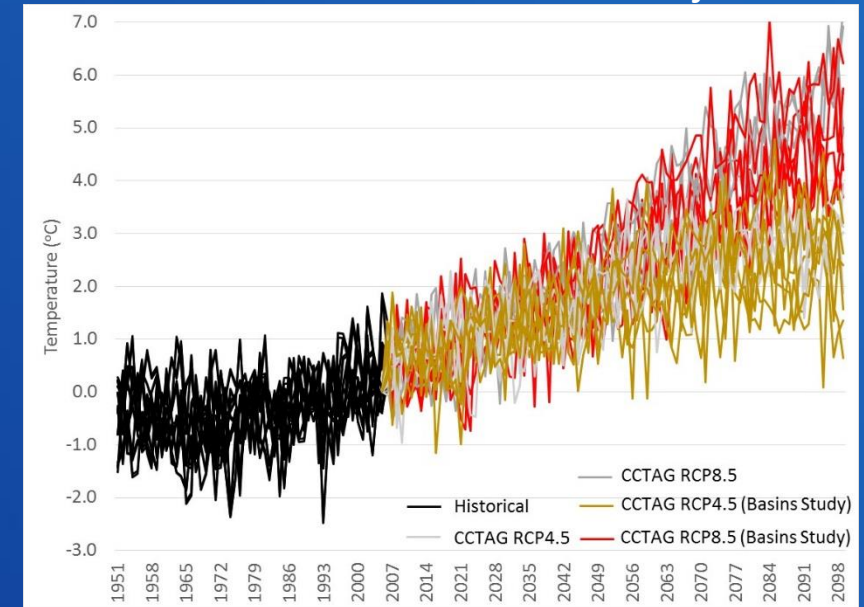


Climate Scenarios – Two Approaches

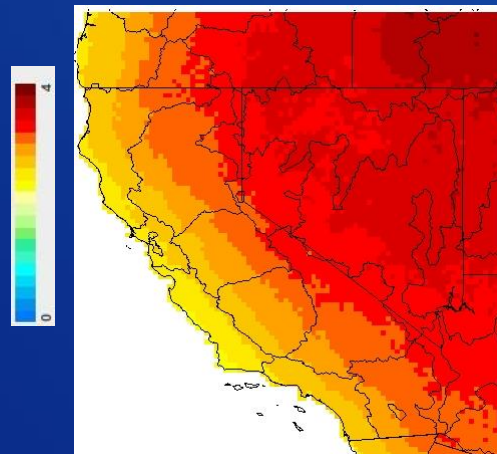
Ensemble-Informed Scenarios



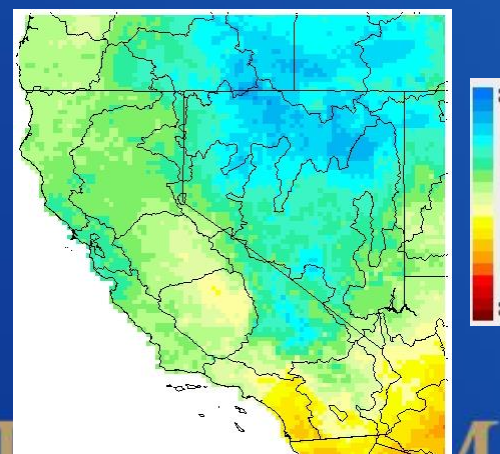
Individual Downscaled Climate Projections



Temperature Change



Precipitation Change



Future Climate Projections

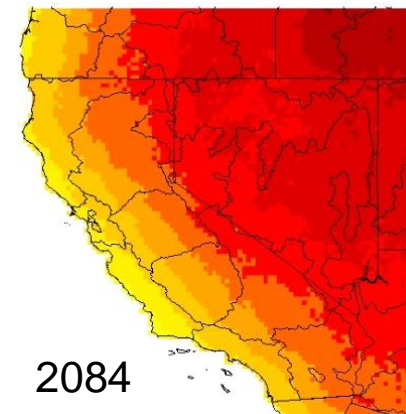
Projected Warming

- 2015-39: **+1.0 °C** (0.1-1.3 °C)
- 2040-69: **+2.0 °C** (1.0-2.9 °C)
- 2070-99: **+2.8 °C** (1.2-4.5 °C)

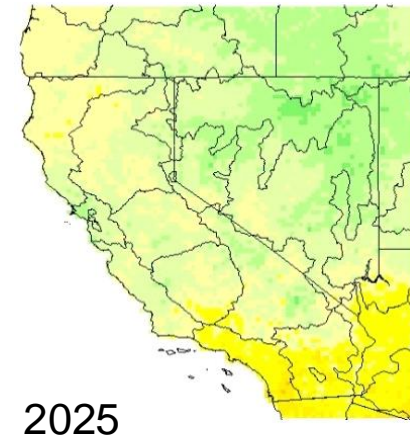
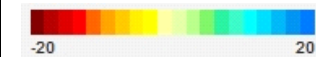
Temperature Change



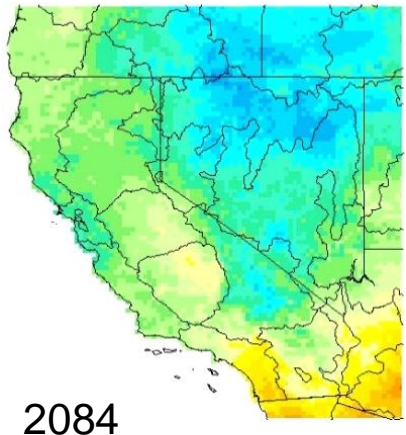
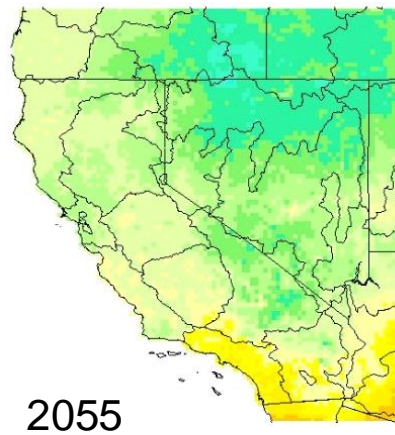
°C change



Precipitation Change



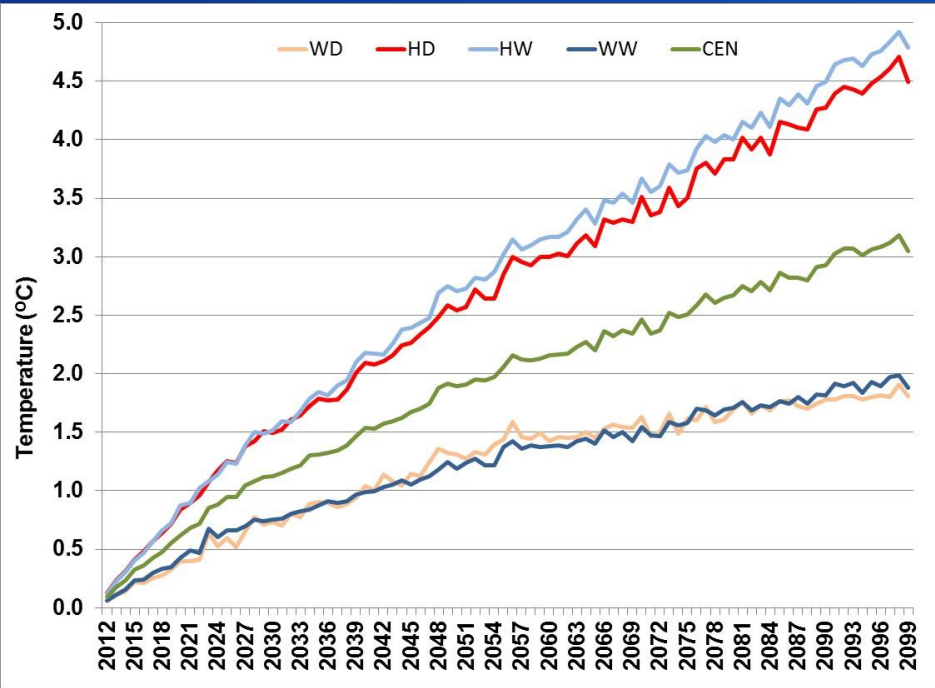
% change



Changes in Precipitation

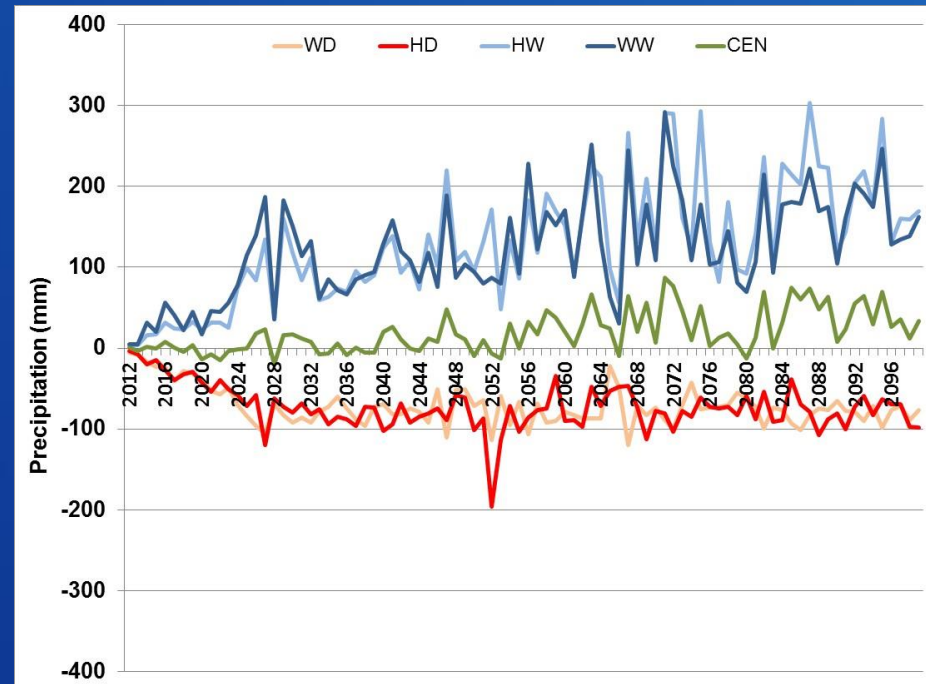
- 2015-39: **+0.1%** (-8% to 35%)
- 2040-69: **+2.1%** (-11% to 23%)
- 2070-99: **+3.9%** (-14% to 29%)

Transient Temperature & Precipitation Projections Sacramento River Hydrologic Region

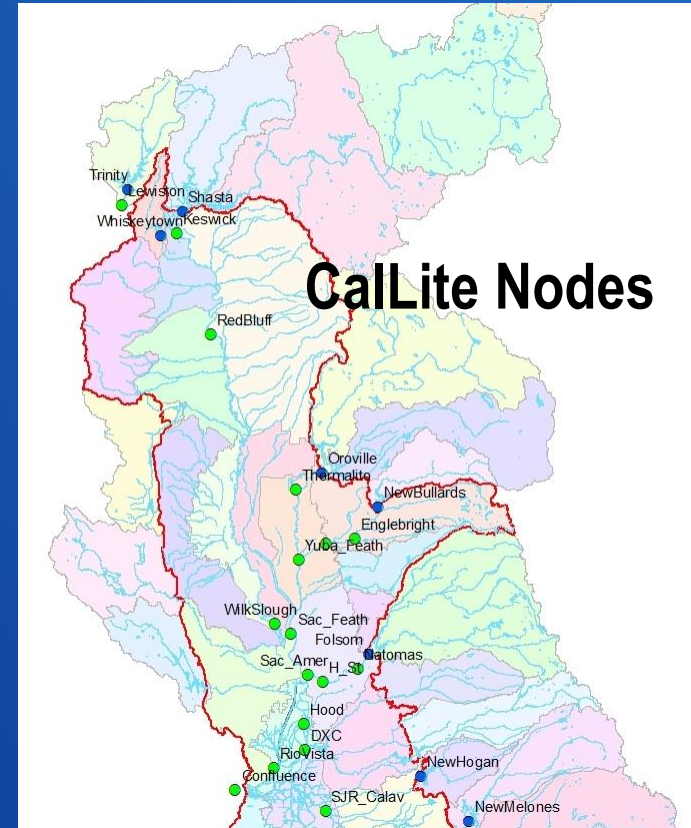
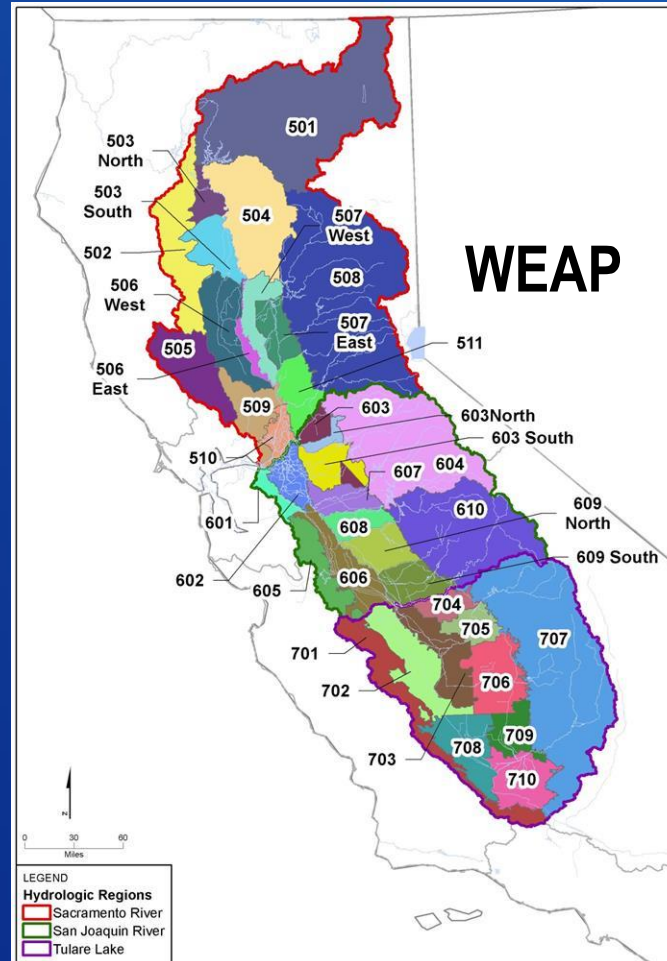
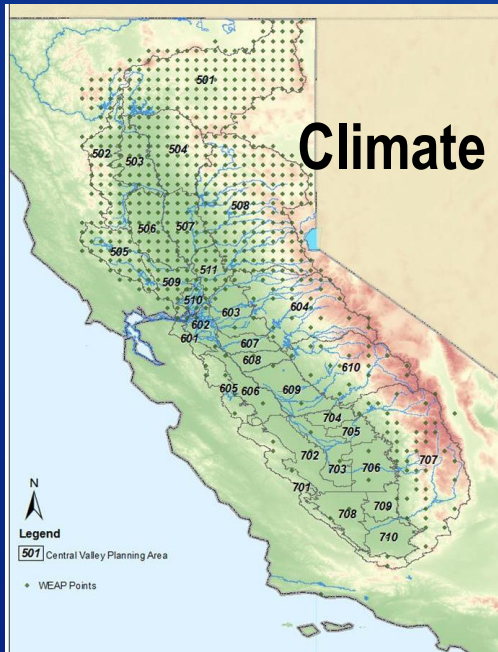


Change in Temperature

Change in Precipitation

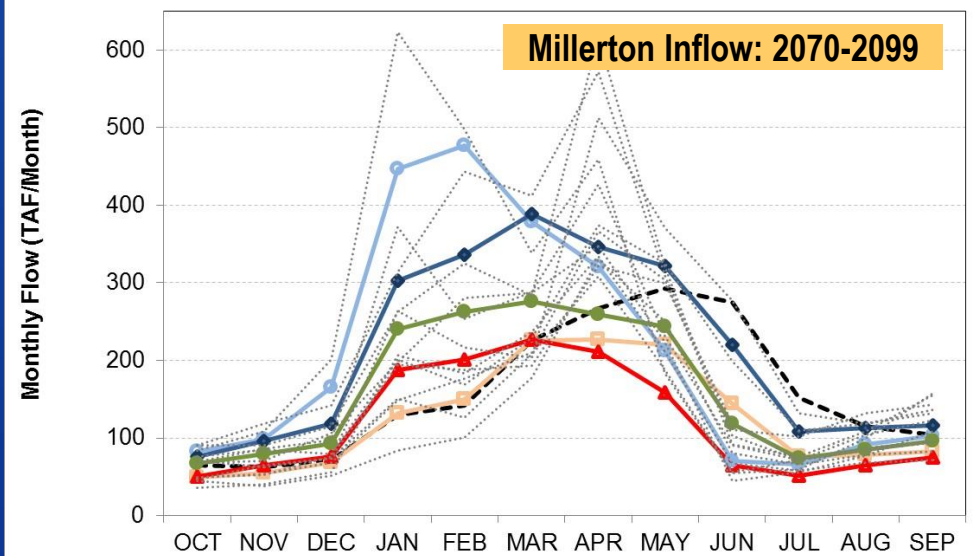
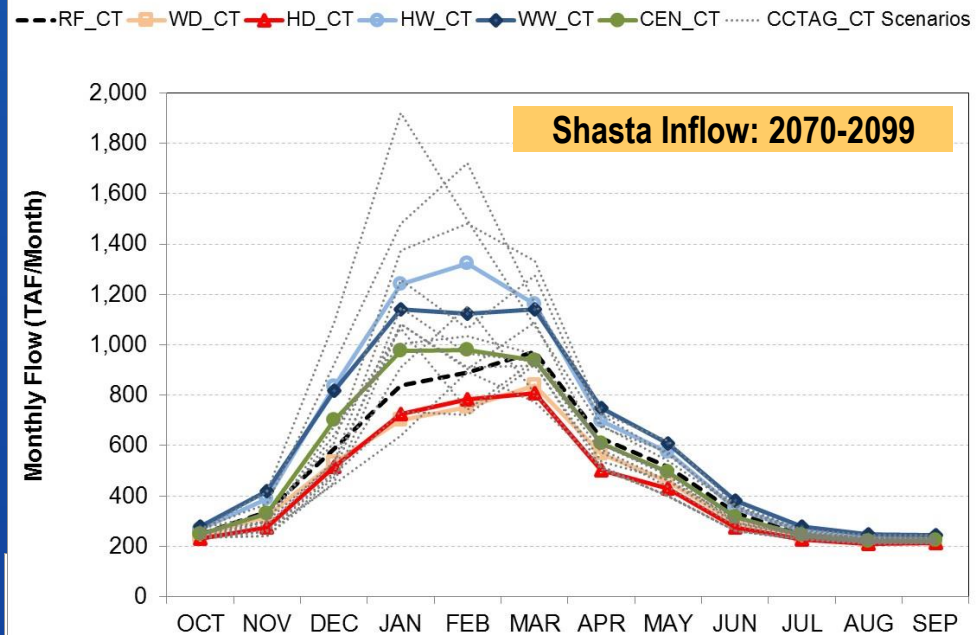
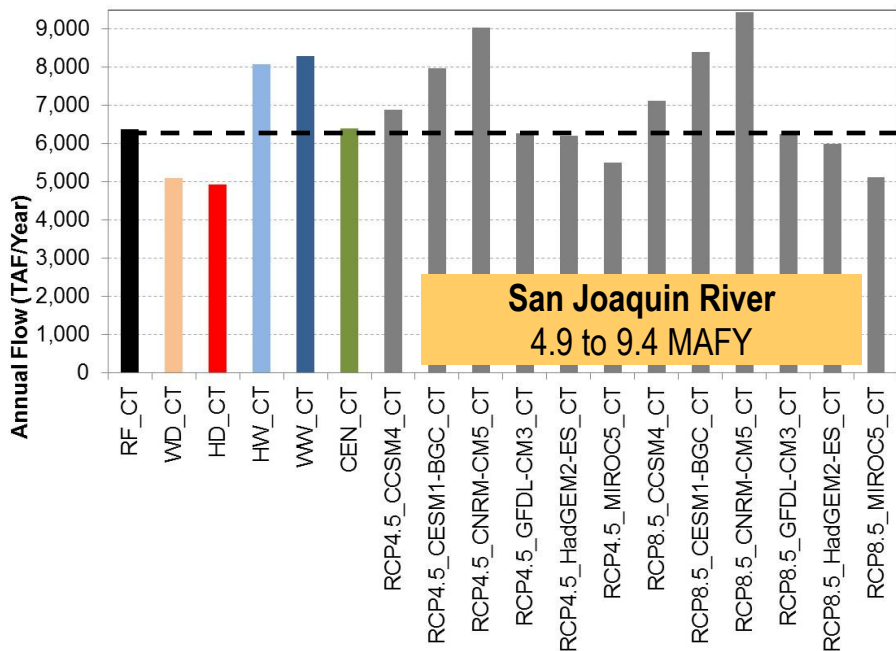
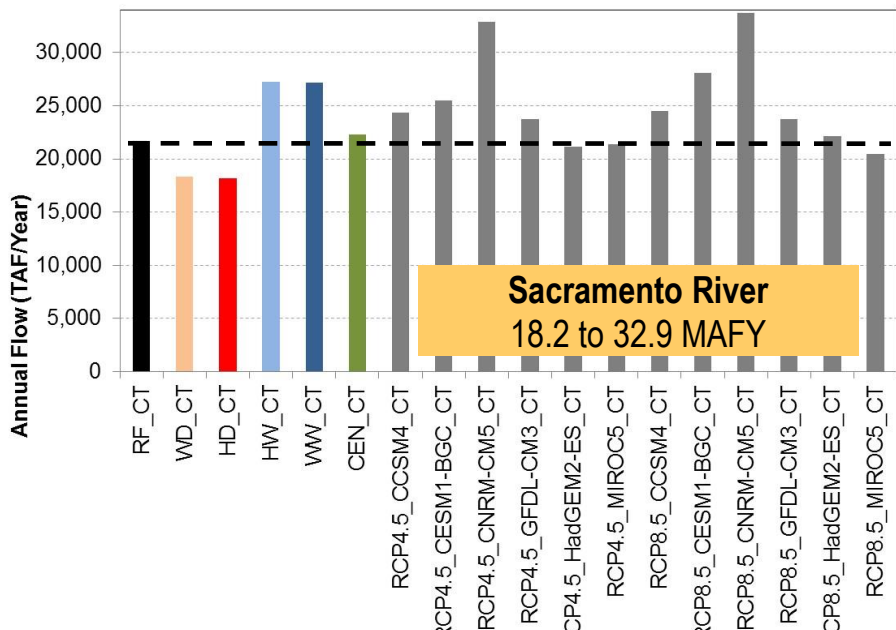


WEAP Hydrology into CalLite Nodes



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Projected Future Water Supply

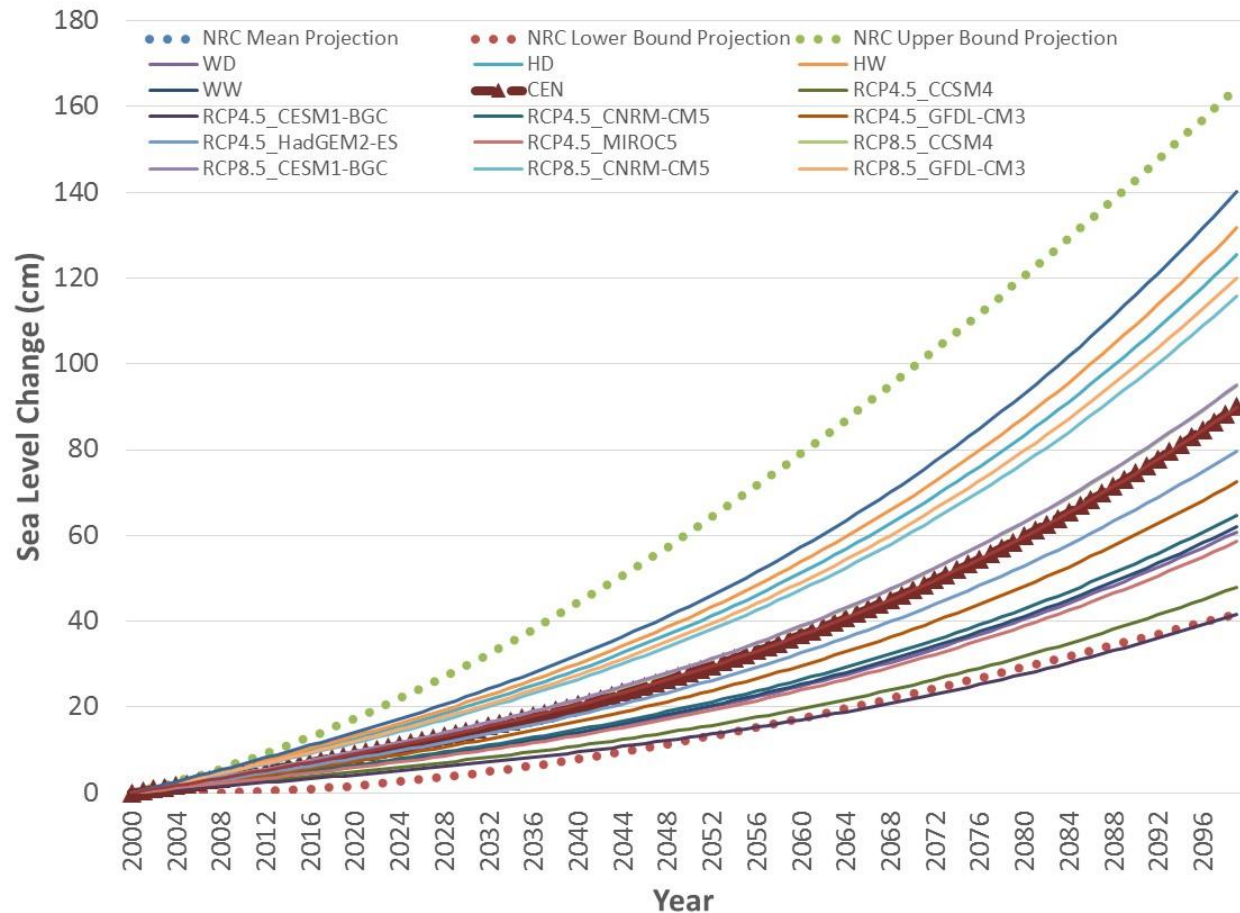


Projected Sea Level Rise

NRC Projections

Year	Mean Projection (in cm)	Lower Bound Projection (in cm)	Upper Bound Projection (in cm)
2030	14.4	4.3	29.7
2050	28.0	12.3	60.8
2100	91.9	42.4	166.5

Range of Future Projections

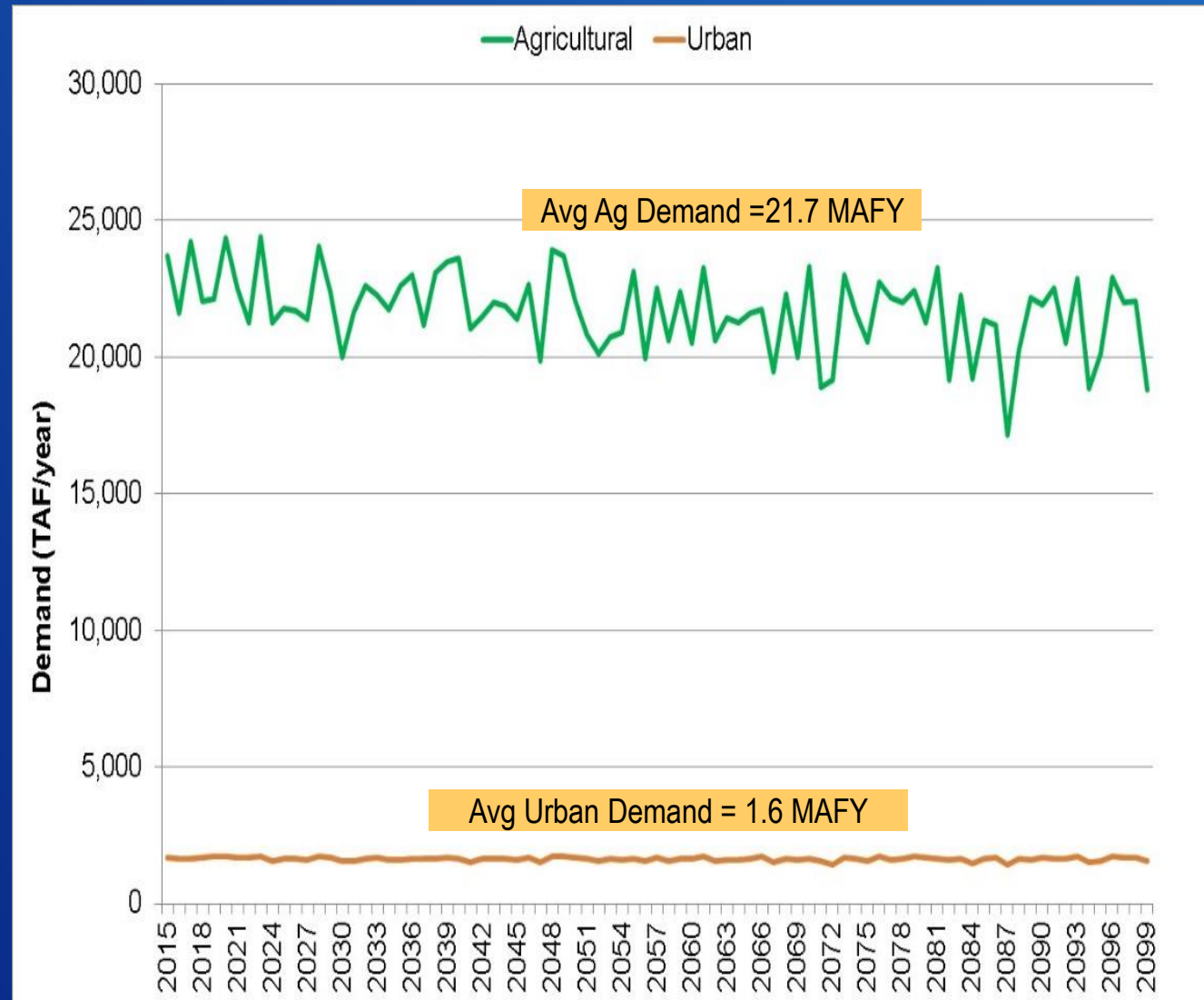


Water Demand Assessment

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Recent Historical Water Demands

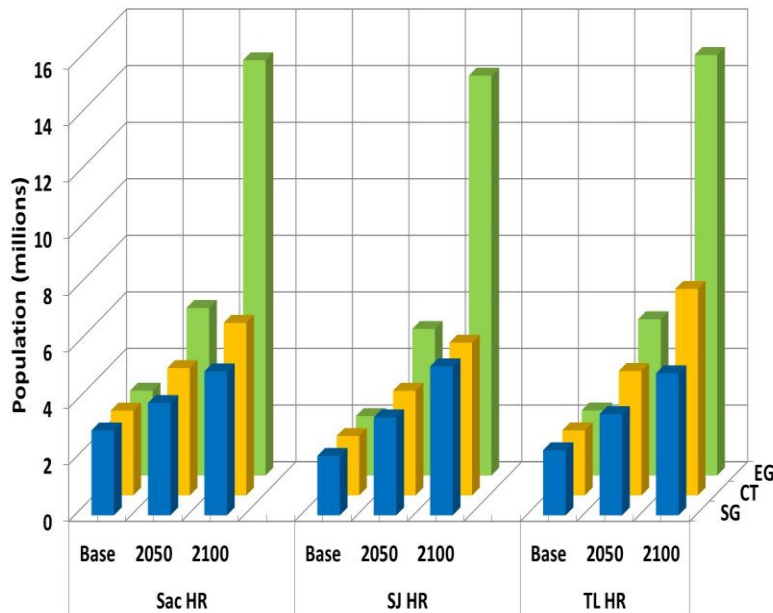
- Central Valley Simulated Annual Applied Water Demands



Socioeconomic Scenarios

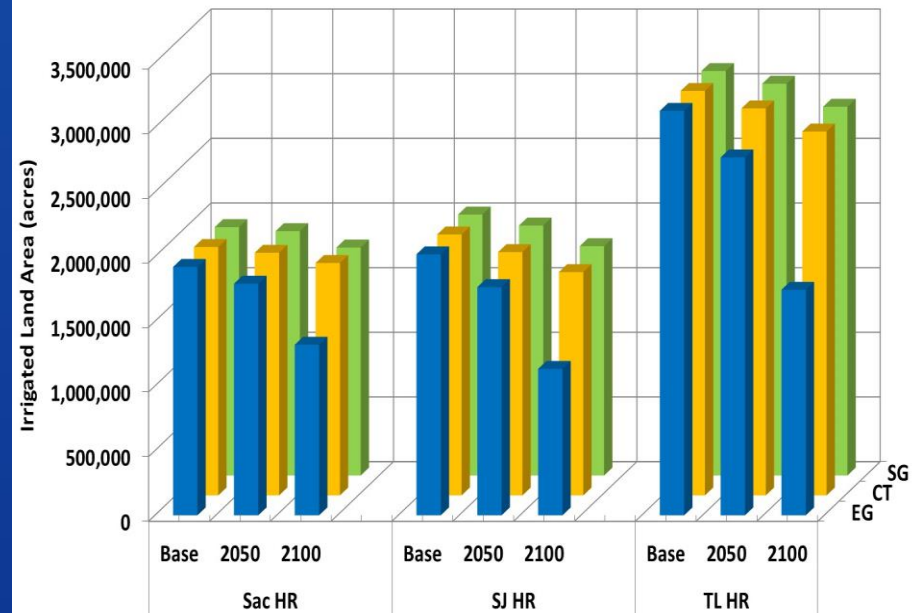
Population

Central Valley population projected to increase by 5 M by 2050 and 9 M by 2100 in Current Trends



Irrigated Land Area

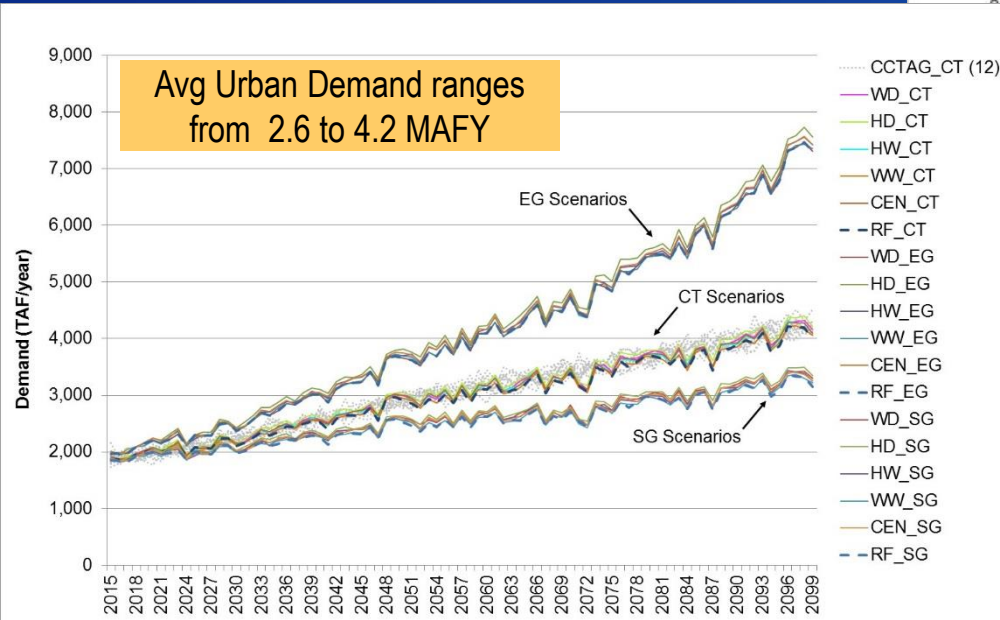
Irrigated acreage projected to decline by 300,000 acres by 2050 and 700,000 acres by 2100 due to urban growth in Current Trends



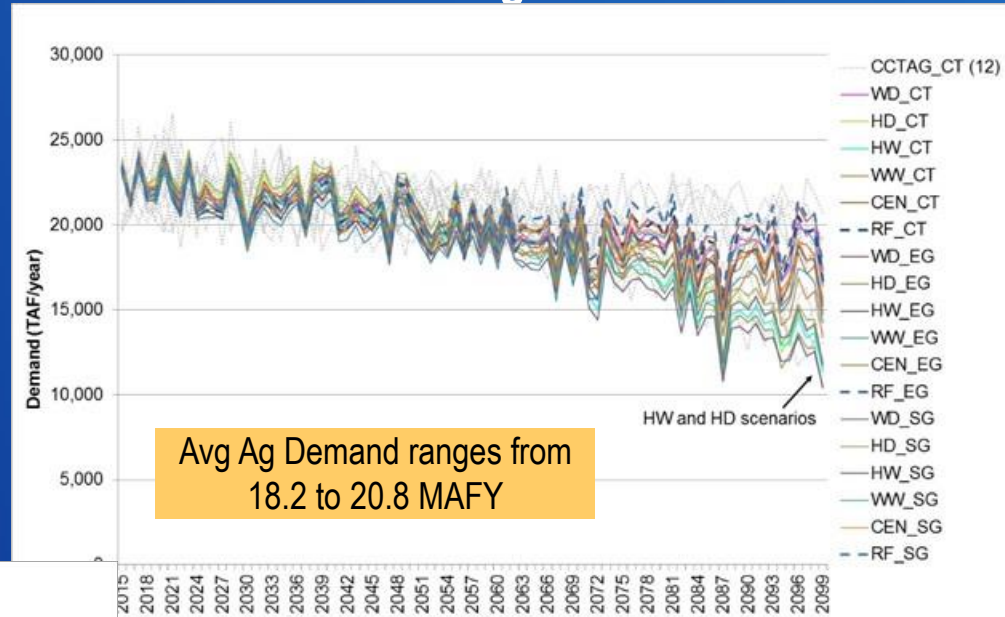
Projected Future Water Demands

- Central Valley Annual Applied Water Demands

Urban



Agricultural



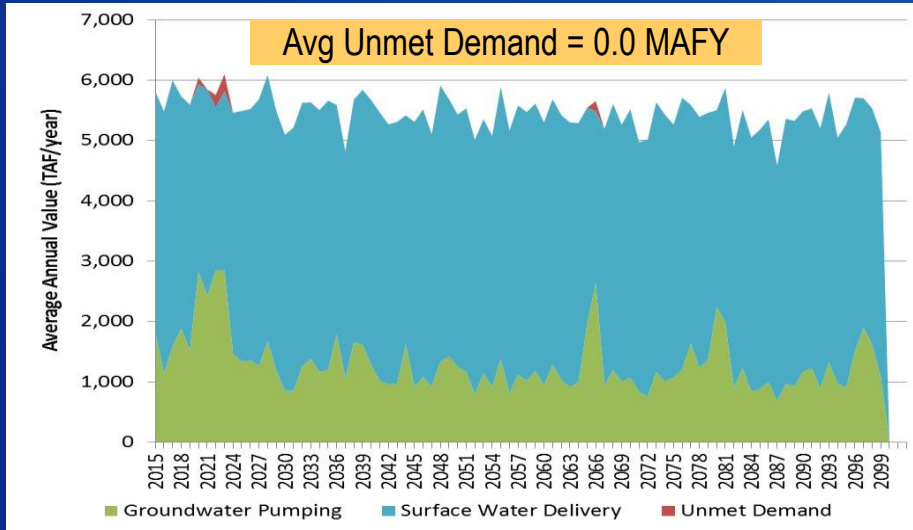
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System Risk and Reliability Assessment

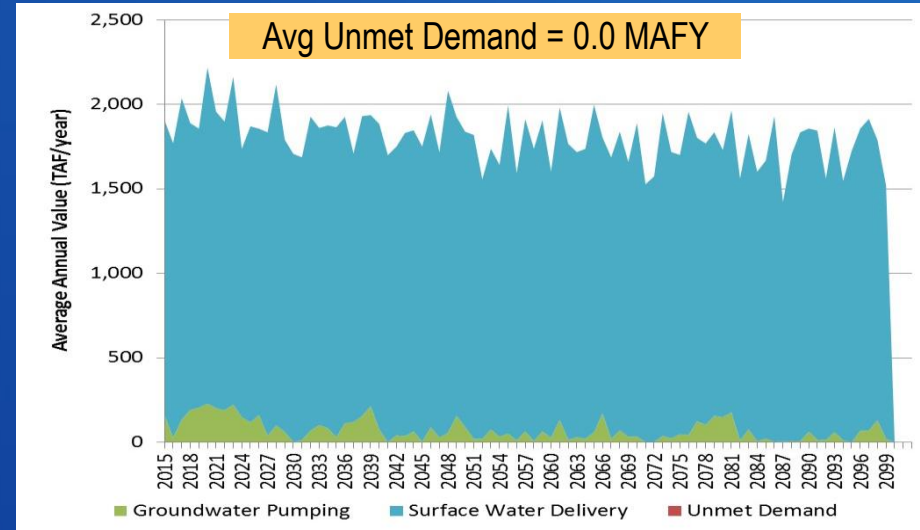
- **Impact Categories – required by Secure Water Act:**
 - Delivery Reliability
 - Water Quality
 - Hydropower
 - Flood Control
 - Recreation
 - Ecological
- **Impacts Assessment utilizes Indicator Metrics**

Unmet Demands by Region in Current Trends – no Climate Change

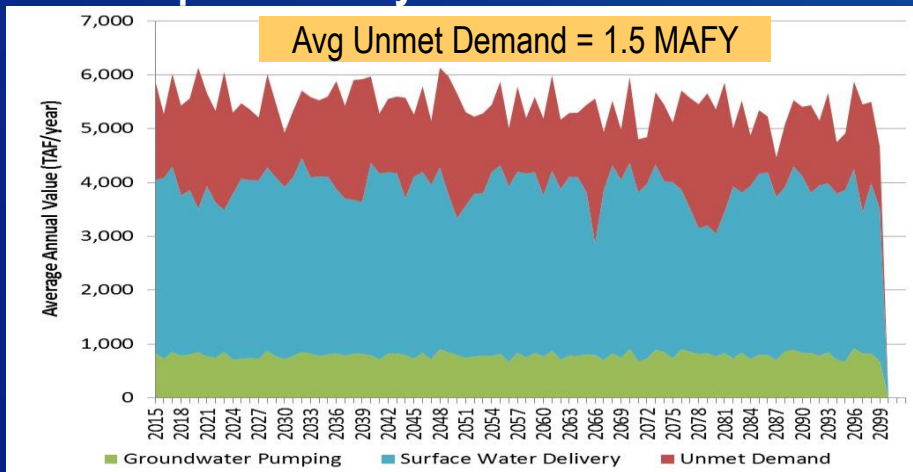
Sacramento-River System



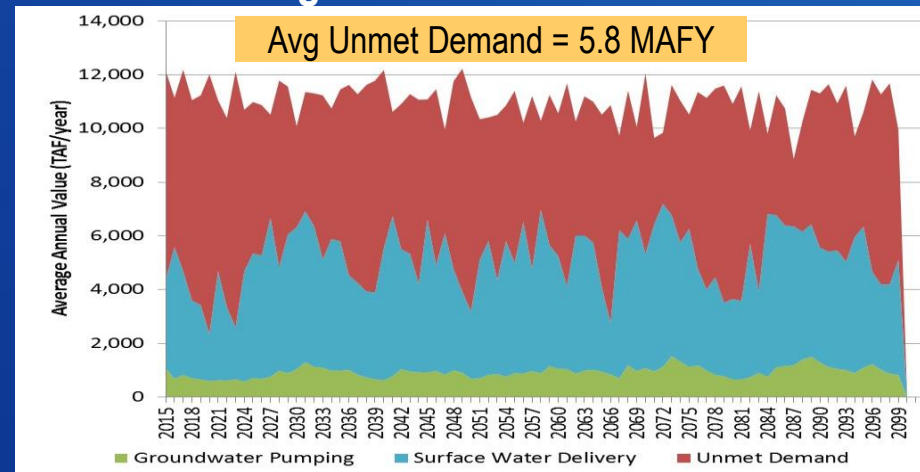
Eastside Streams and Delta



San Joaquin River System

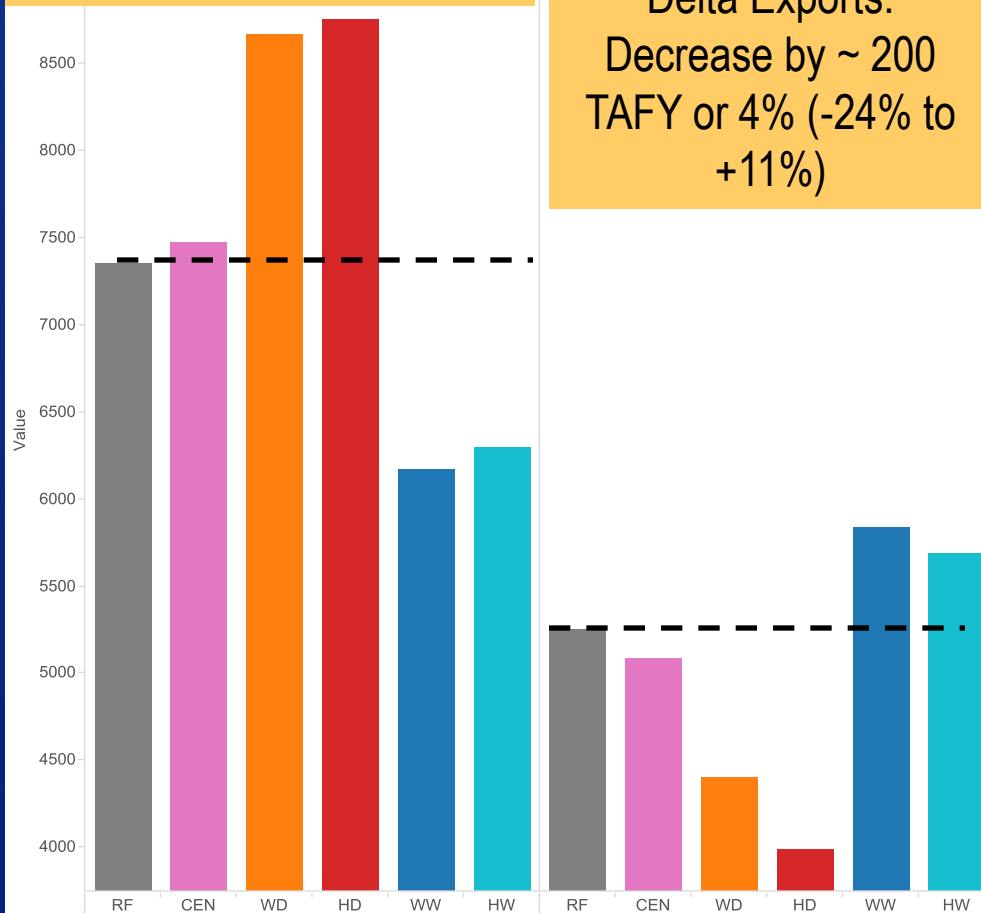


Tulare Lake Region



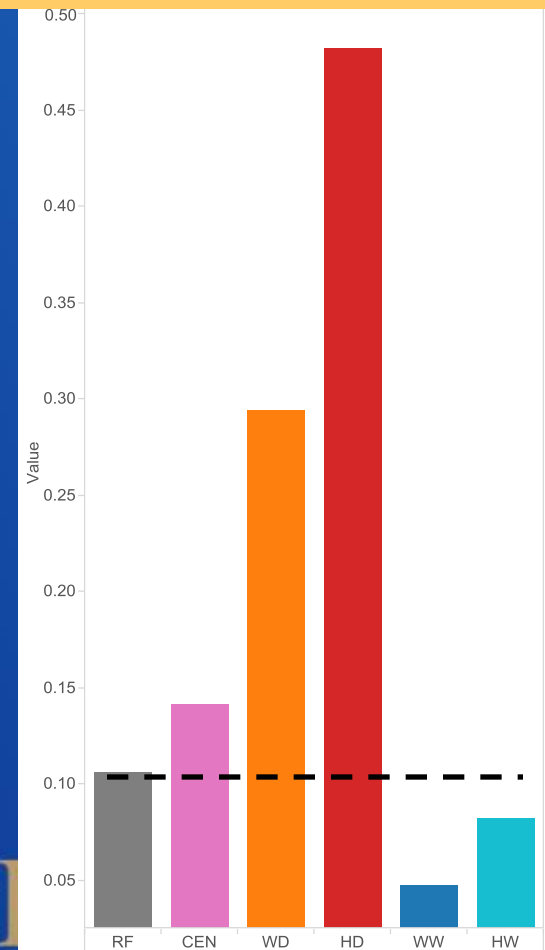
Delivery Reliability - Climate Impacts

CV Unmet Demand:
Increase by ~100 TAFY
(-1.4 MAFY to +1.2 MAFY)



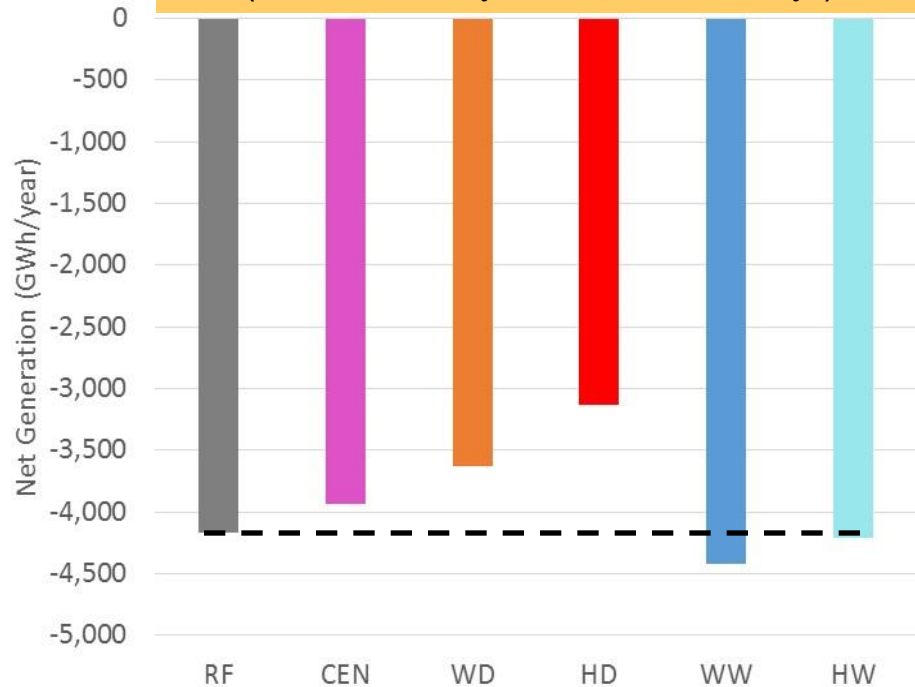
Delta Exports:
Decrease by ~ 200
TAFY or 4% (-24% to
+11%)

Shasta September Storage (% Yrs
less than 1.9 MAF)

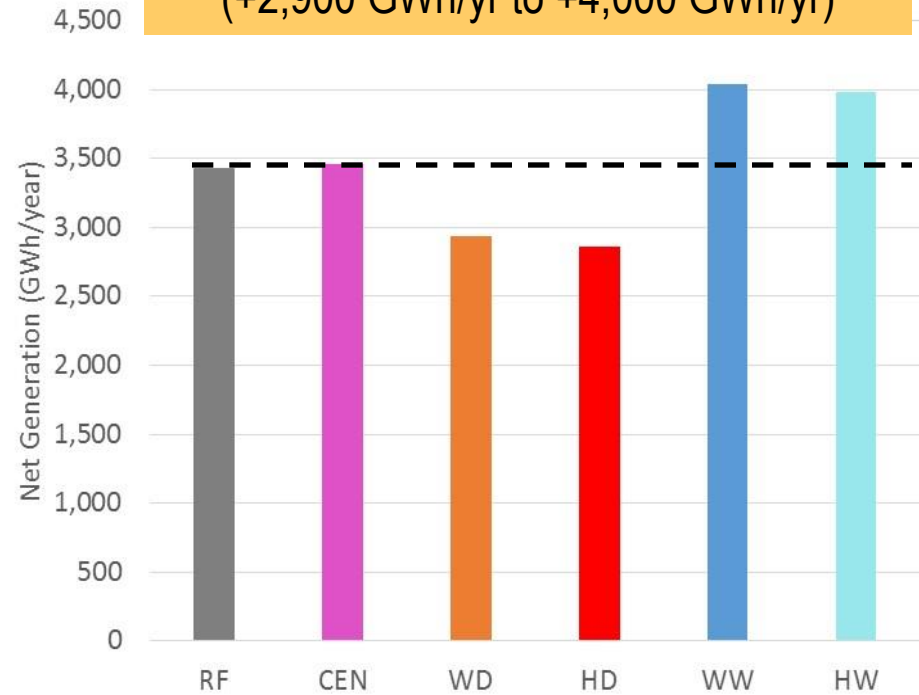


Hydropower - Climate Impacts

SWP System
(-3,100 GWh/yr to -4,400 GWh/yr)

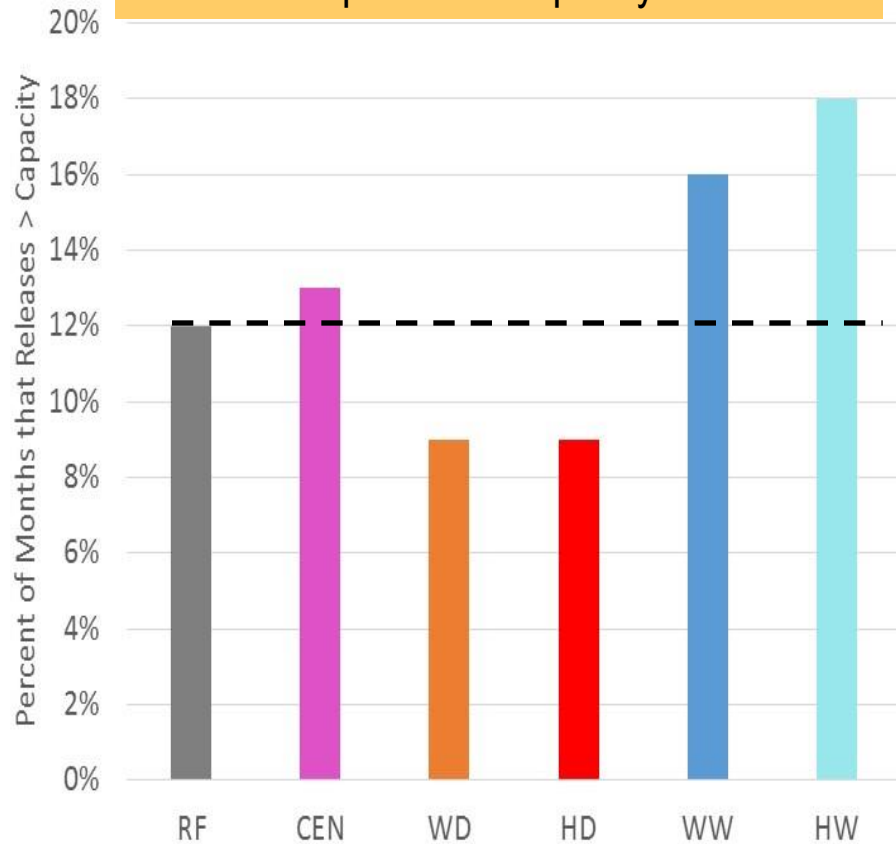


CVP System
(+2,900 GWh/yr to +4,000 GWh/yr)

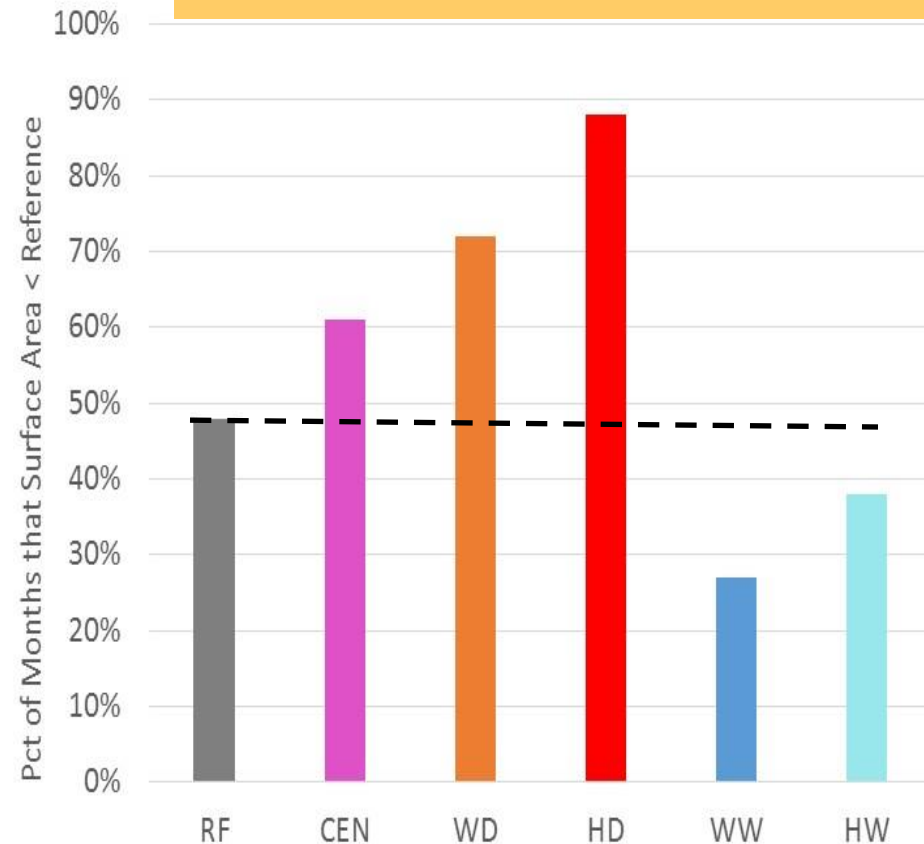


Flood Control and Recreation - Climate Impacts

Flood Control: % months Keswick flow > penstock capacity



Recreation: % of months Shasta surface area < reference value



Ecological - Climate Impacts

