Future Scenarios: Does California Have Enough Water to Survive to 2070?

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Why Future Scenarios?

WATER CODE - DIVISION 6. PART 1.5. CHAPTER 1. The California Water Plan [10004 - 10013]

10004.6. (a) As part of updating The California Water Plan every five … the department shall **conduct a study to determine the amount of water needed to meet the state's future needs** and to recommend programs, policies, and facilities to meet those needs. [emphasis added]

(c) …the department shall release a preliminary draft of the assumptions and other estimates … relating to all of the following:

(1) Basin hydrology, including annual rainfall, estimated unimpaired streamflow, depletions, and consumptive uses.

(2) Groundwater supplies, including estimates of sustainable yield, supplies necessary to recover overdraft basins, and supplies lost due to pollution and other groundwater contaminants.

(3) Current and projected land use patterns, including the mix of residential, commercial, industrial, agricultural, and undeveloped lands.

(4) Environmental water needs, including regulatory instream flow requirements, nonregulated instream uses, and water needs by wetlands, preserves, refuges, and other managed and unmanaged natural resource lands.

(5) Current and projected population.

(6) Current and projected water use for all of the following:

(A) Interior uses in a single-family dwelling.

(B) Exterior uses in a single-family dwelling.

(C) All uses in a multifamily dwelling.

(D) Commercial uses.

(E) Industrial uses.

(F) Parks and open spaces.

(G) Agricultural water diversion and use.

(7) Evapotranspiration rates for major crop types, including estimates of evaporative losses by irrigation practice and the extent to which evaporation reduces transpiration.

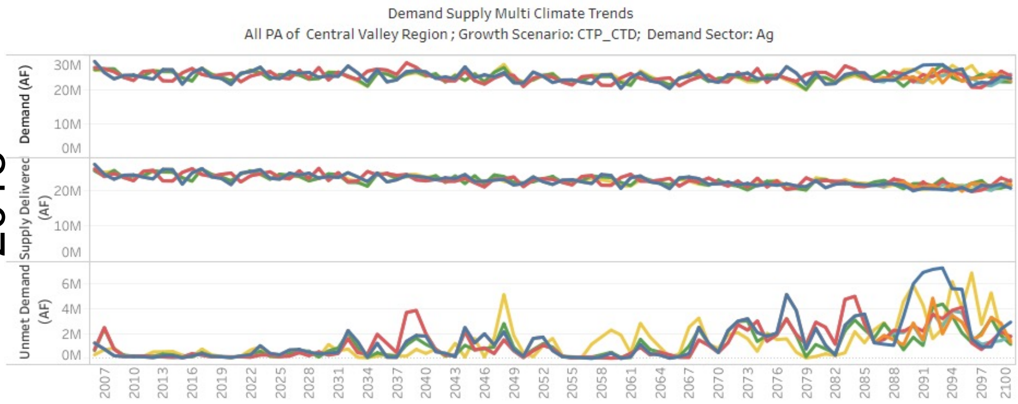
(8) Current and projected adoption of urban and agricultural conservation practices.

(9) Current and projected supplies of water provided by water recycling and reuse.

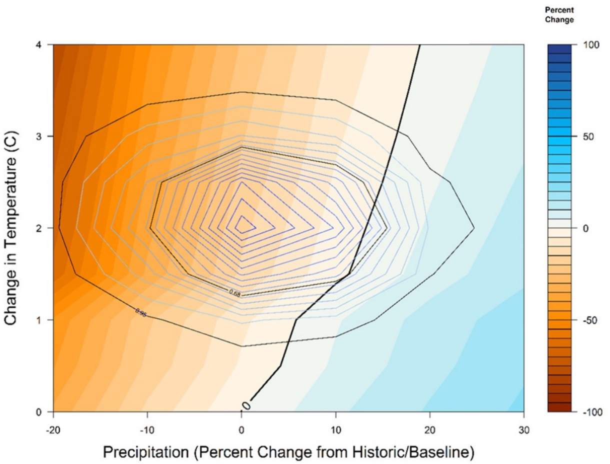
Analysis Technique

Decision scaling provides regional risk-based insights at current level (2020) and future conditions (2070)

2018

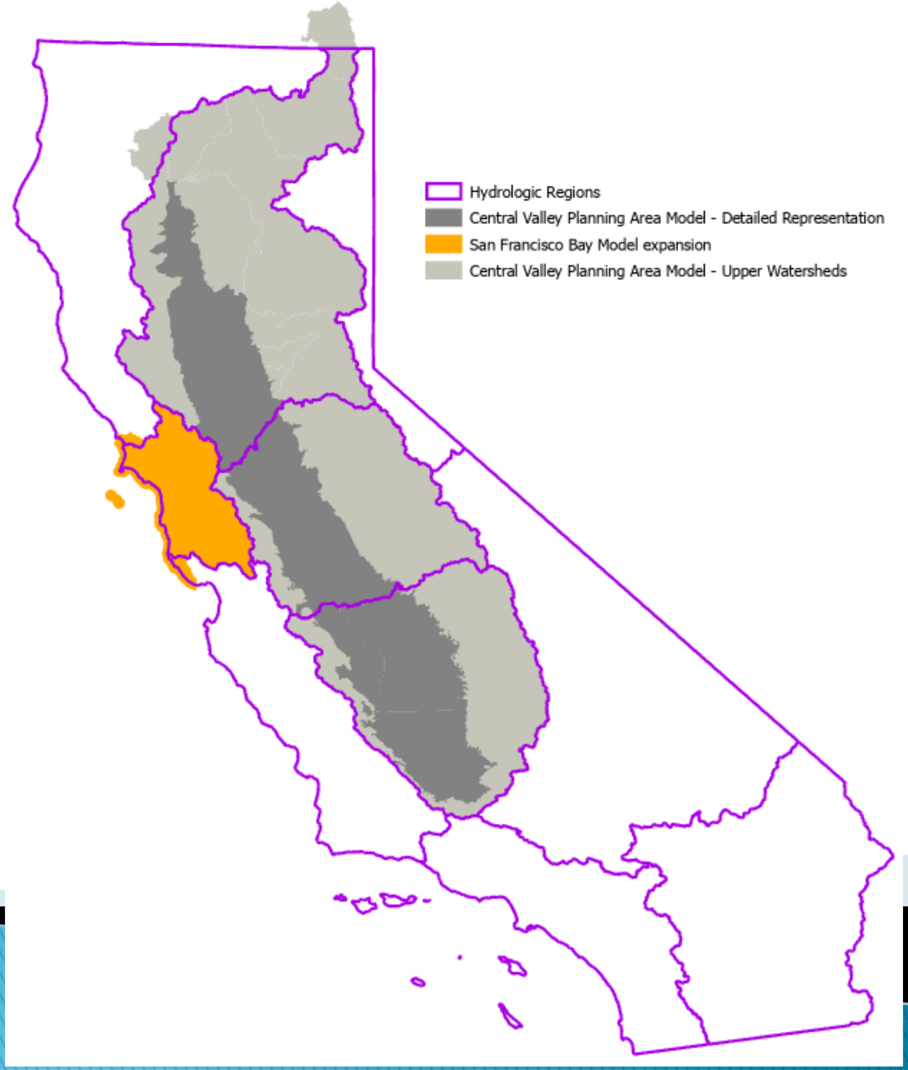


2023



Downscaled GCMs provided high level trend analysis from 2006-2100

Geographic Expansion



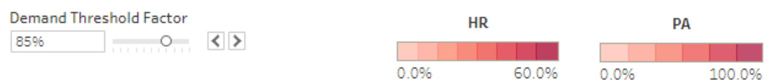
Exploring use of USGS HUC-8 Watersheds

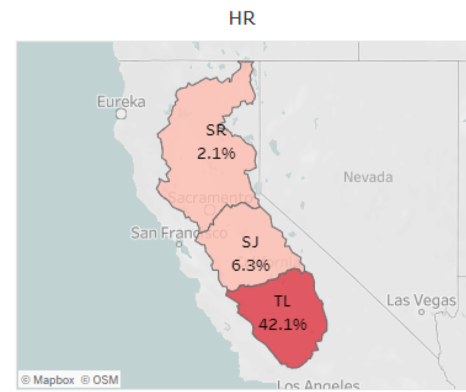
Delta Representation

Update 2023 includes:

- Delta Biological Opinions
- Coordinated Operation Agreement
- Sea level rise ANN used by Cal-SIM (1.8 feet) for 2070 dataset

Metrics





- Update 2018 included vulnerability metric based on the % of time a given demand threshold could be met

- Update 2023 intends to include 5 (or more) metrics:
  - End of water year surface water storage
  - Average Mar-Sep instream flow requirement buffer
  - Average surface water vs groundwater ratio
  - Frequency of meeting a prespecified demand threshold
  - Seasonal volume changes at control points

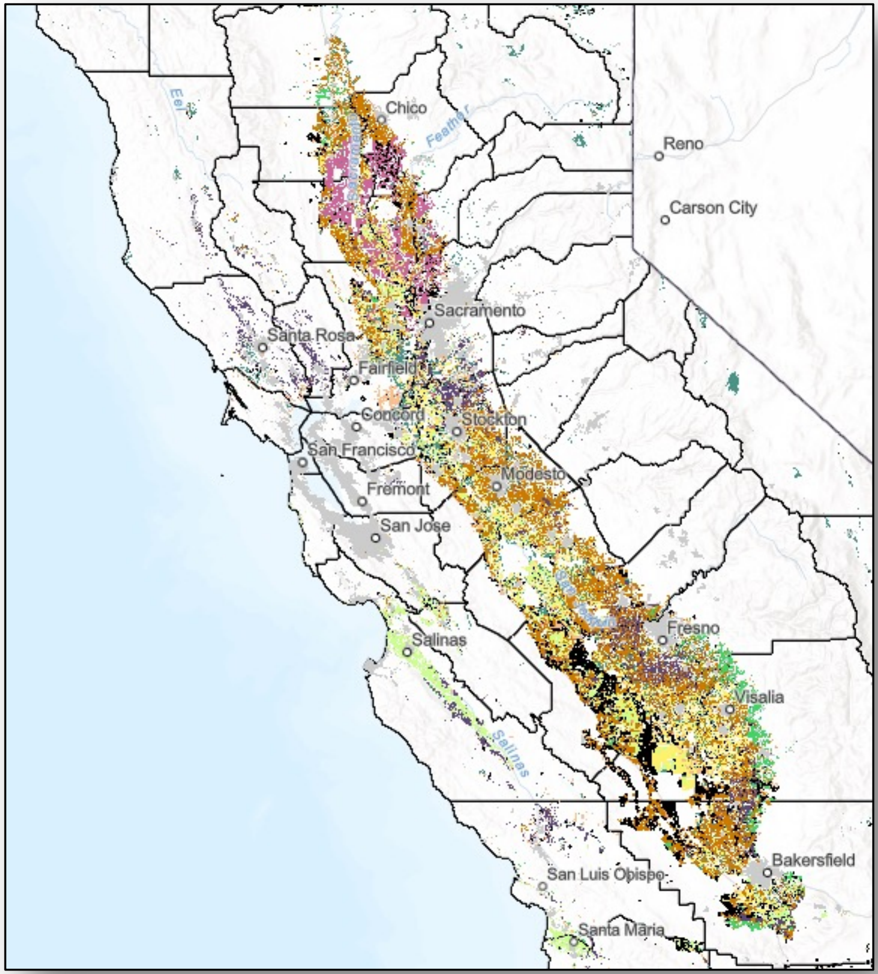
Land Use

Update 2018

- Native lands (NLDC 2006)
- Agricultural lands (county surveys)
- Projected future land use

Update 2023

- Native Lands (NLCD 2016)
- Agricultural Lands (Statewide land use 2018)
- Projected future land use for urban only



	Future Scenarios update 2018	Future Scenarios update 2023
Analytical Approach	Scenario based approach using global climate change models to examine trends up to 2100	Decision scaling approach that examines system response to perturbations in temperature and precipitation
Spatial Coverage	Covers the Central Valley	Central Valley plus exploration of inclusion of SF Bay HR region
Delta Representation	Limited Delta representation	Includes Delta BiOps, coordinated operation agreement, and Sea level rise
Metrics	Includes a threshold-based quantification of reliability by region Example: can an agency meet water deliveries 90% of the time	Includes a suite of metrics including (among others): • End of water year surface water storage • Average Mar-Sep Instream Flow Requirement Buffer • Average surface water vs Groundwater ratio • Frequency of meeting a prespecified demand threshold • Seasonal Volume Changes at control points
Land Use	Native lands (NLDC 2006), Agricultural lands (county surveys), Projected future land use	Native Lands (NLCD 2016), Agricultural Lands (Statewide land use 2018), Projected future land use for urban only
Data Viewer	Includes an interactive data explorer to view different Global Climate Change model scenarios and their effects by region	Includes a visualization to explore response surfaces for different metrics by planning area

WEAP Application- Decision Scaling

(Water Evaluation And Planning Model)

An integrated water resources system planning model

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California Dept. of Water Resources

CWEMF 2022
Sacramento, California

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Planning

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- Why WEAP?
- Features
- What's New?
- Sample Screens
- Demonstration
- Publications
- History and Credits

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New Version of WEAP Available (2021.01)

Online, interactive, introductory training course
January 2022

Register now -- space is limited

Welcome to WEAP!

WEAP ("Water Evaluation And Planning" system) is a user-friendly software tool that takes an integrated approach to water resources planning.

Freshwater management challenges are increasingly common. Allocation of limited water resources between agricultural, municipal and environmental uses now requires the full integration of supply, demand, water quality and ecological considerations. The Water Evaluation and Planning system, or WEAP, aims to incorporate these issues into a practical yet robust tool for integrated water resources planning. WEAP is developed by the Stockholm Environment Institute's U.S. Center.

WEAP Highlights

WEAP Model
(Planning Tool)

- Current and future water supply and demand conditions; a time-step model.
- Very powerful in building future water scenarios under different population growth, socio_economic and climate change scenarios.
- Explores water management strategies (demand reduction, supply augmentation, pollution control).
- Long term water planning tool for water managers and governments.

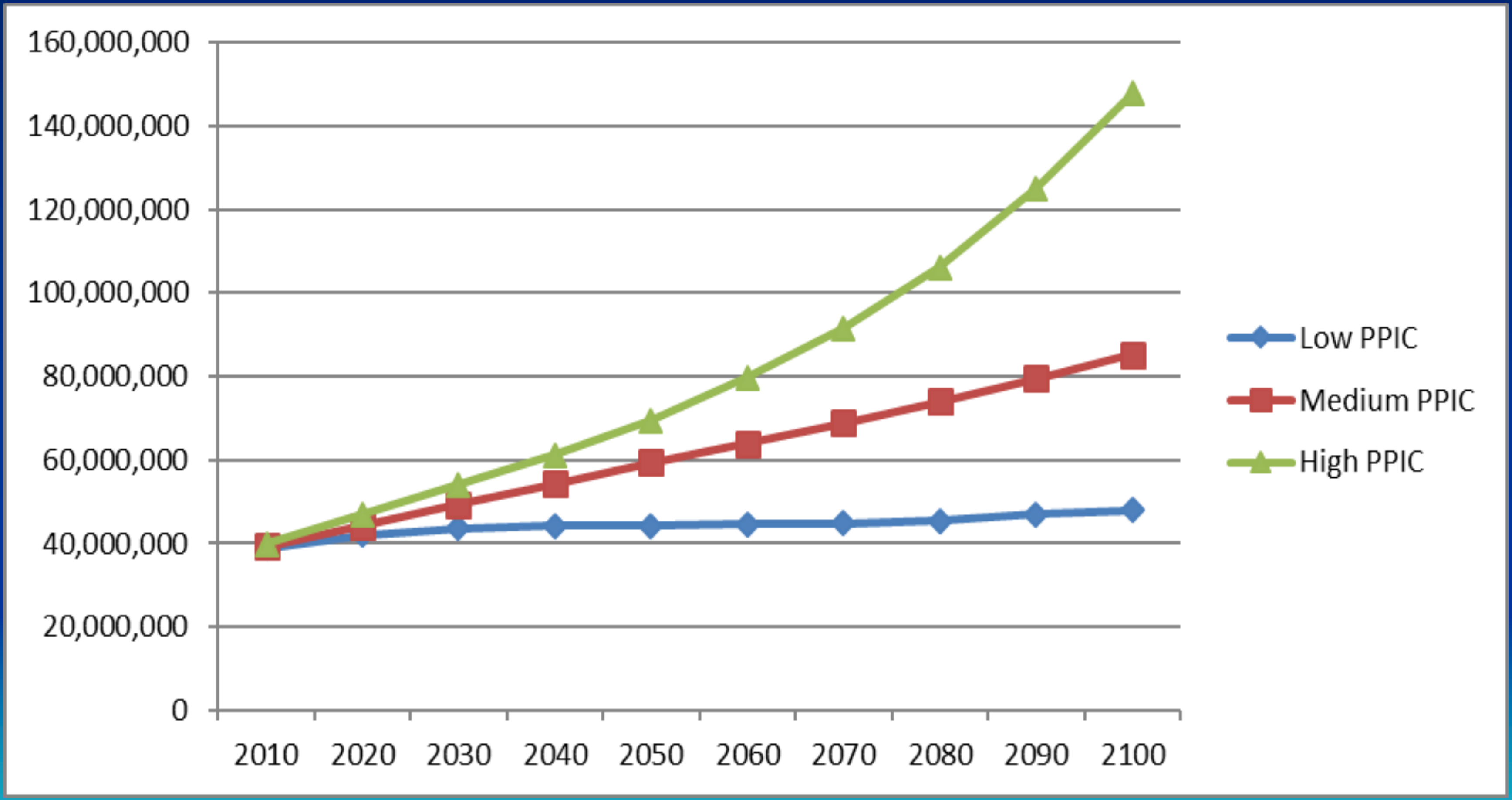
California Water Plan: Update 2018
Scenario Approach

- **California Water Code**: Quantify current and future water conditions (supply and demand) in California
- **Future Scenarios**: Two major external drivers:

  * Population and Urban Growth

- * Climate Change

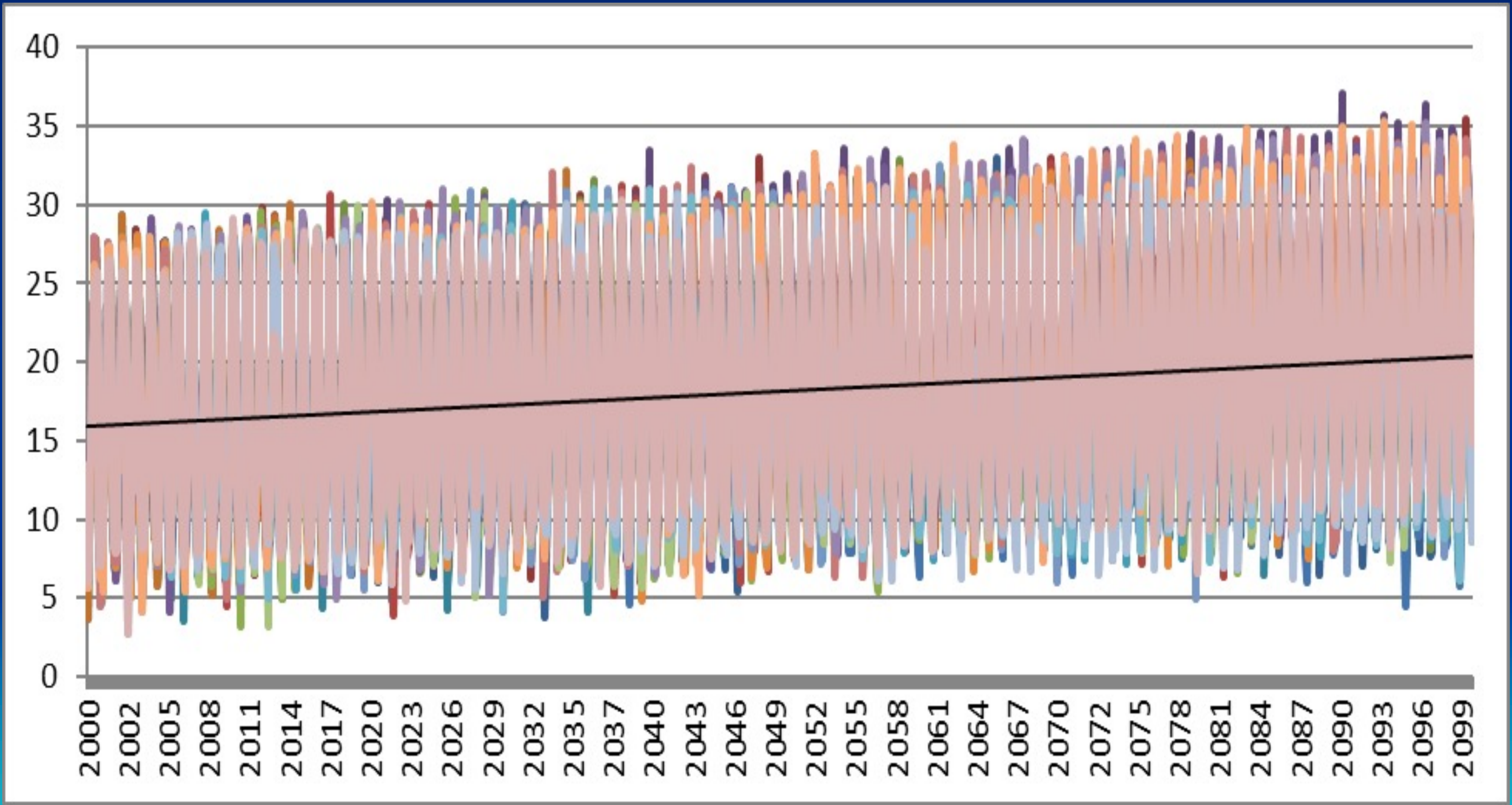
Population growth scenarios: Period 2010-2100



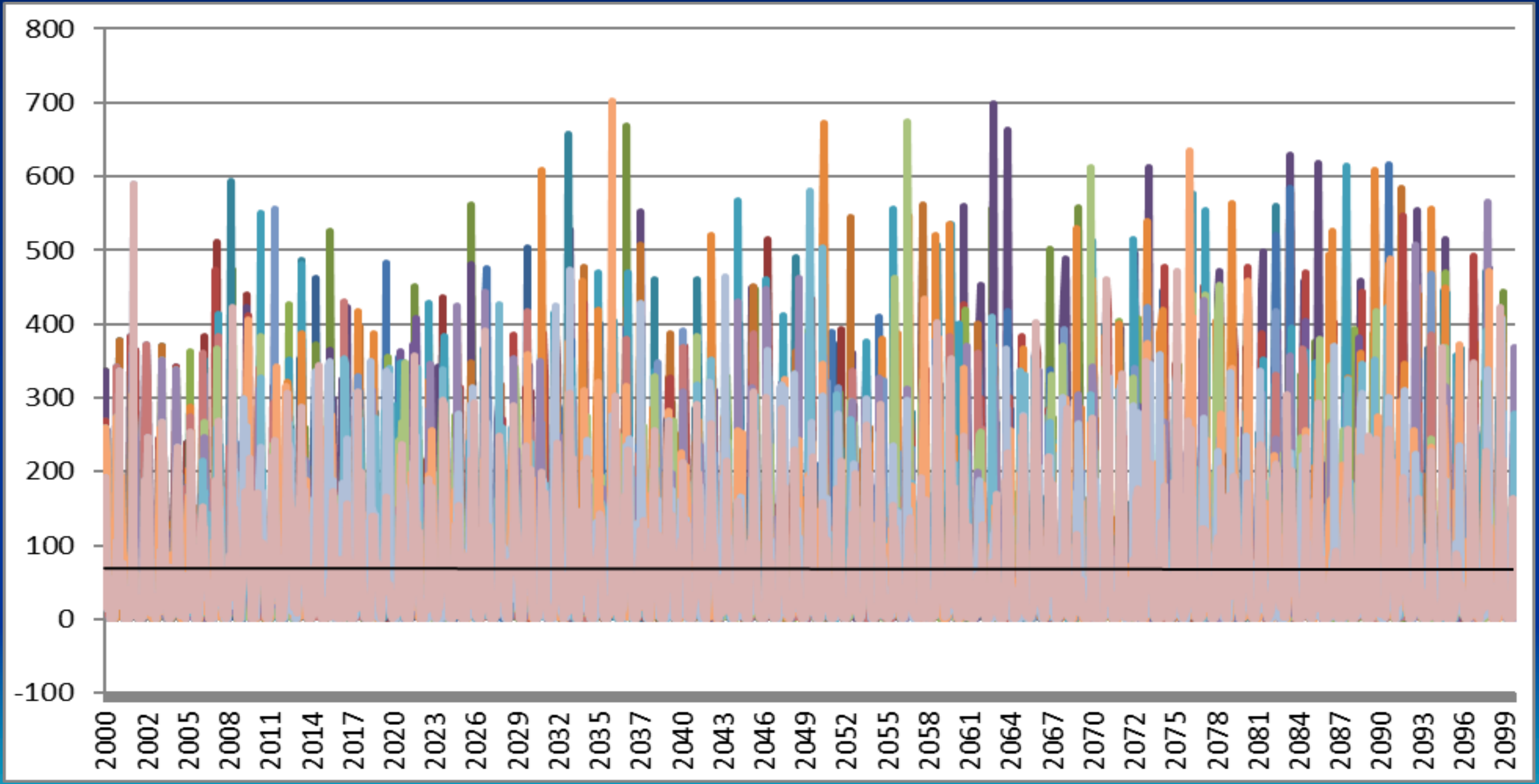
* 10 Global Climate Models (GCMs) x
* 2 Greenhouse Gas Emissions (GHGs) = 20 Climate Change scenarios

1. Access-1.0 x 2 GHGs (+4.5 w/m2, +8.5 w/m2)
2. Canesm2
3. Ccesm4
4. Cesm1-bgc
5. Cmcc-cm5
6. Cnrm-cm5
7. Gfdl-cm3
8. Hadgem2-cc
9. Hadgem2-es
10. Miroc5

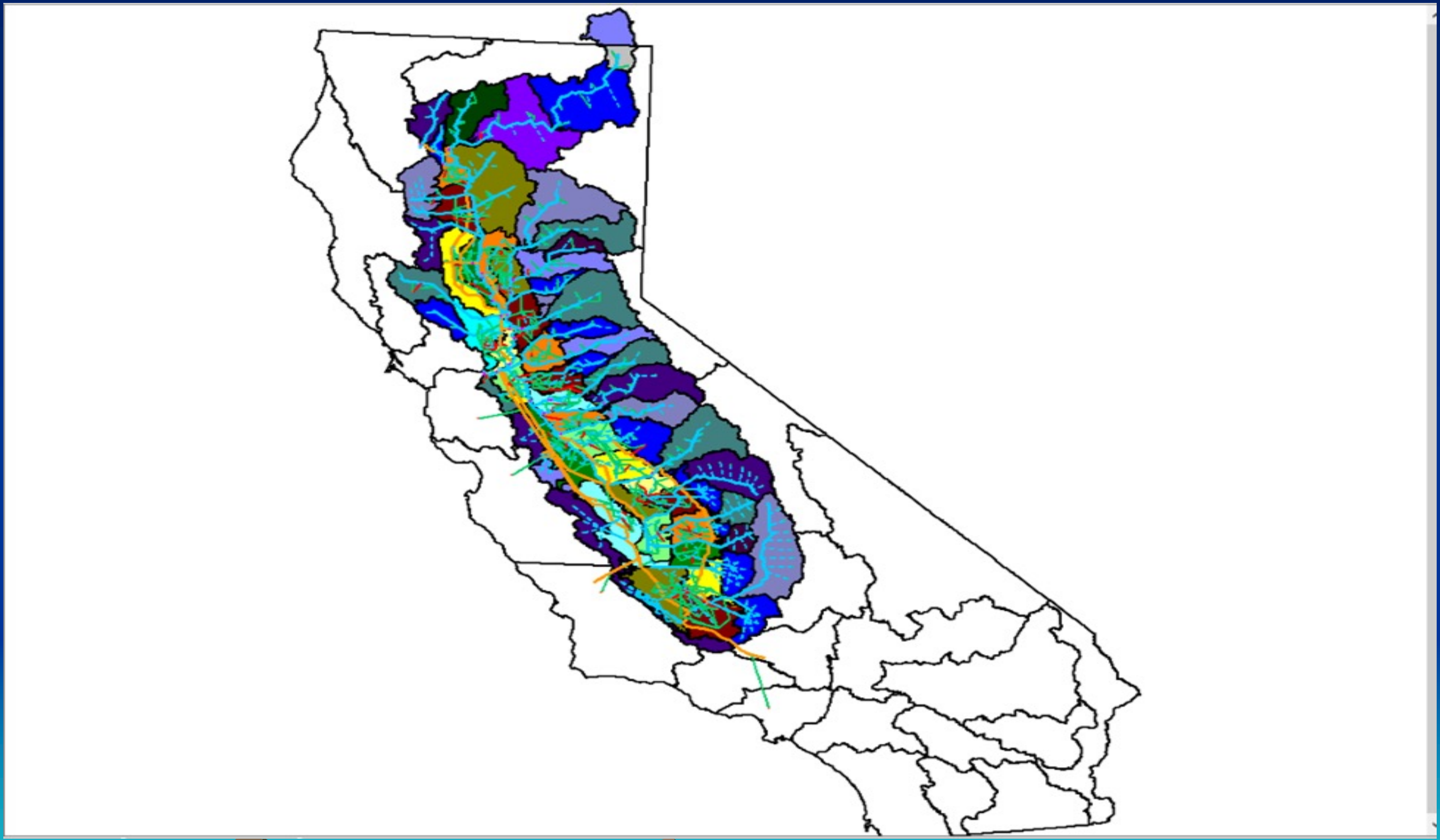
GCM Scenarios: Temperature (2000-2100)
Sample location: Sacramento

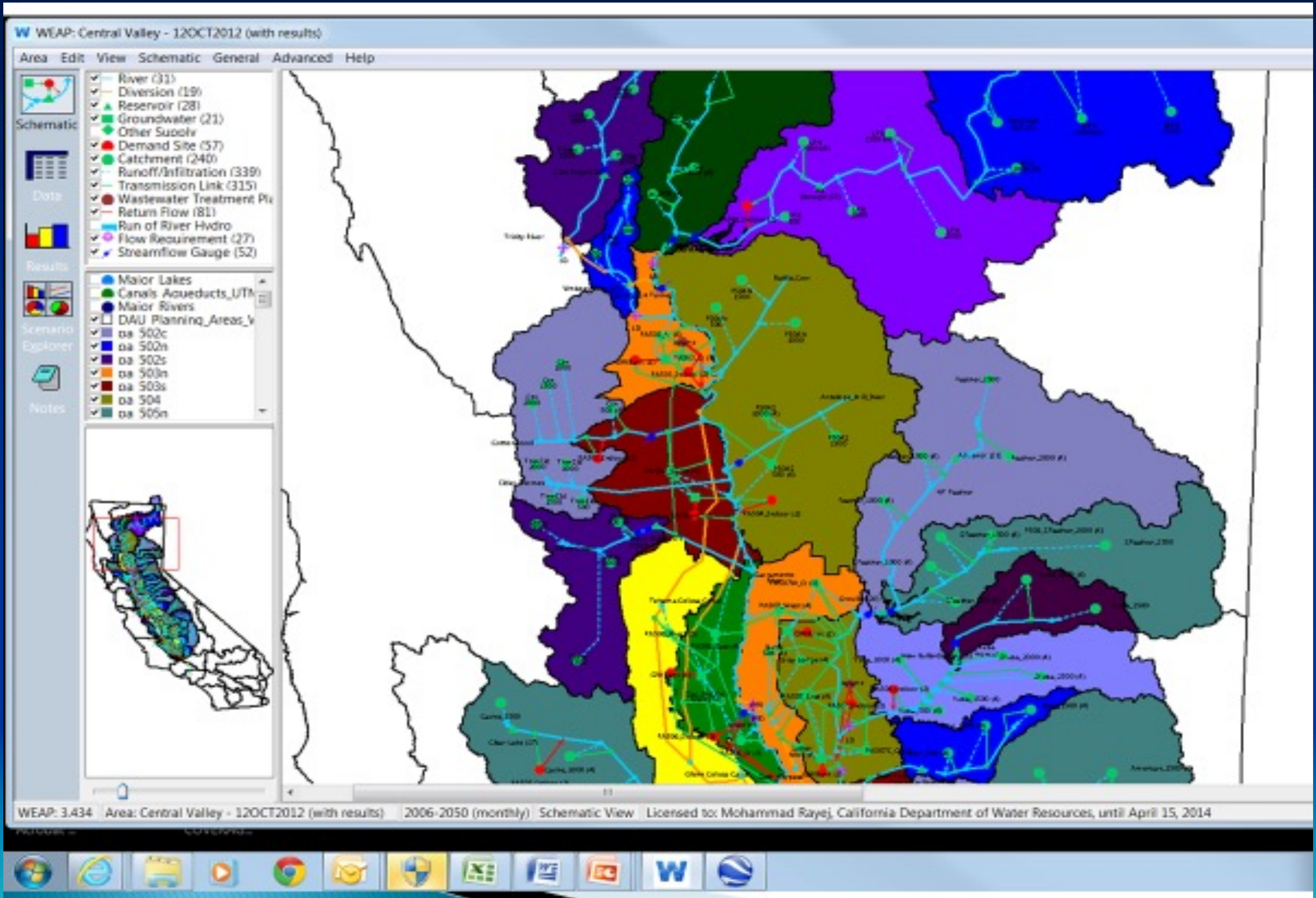


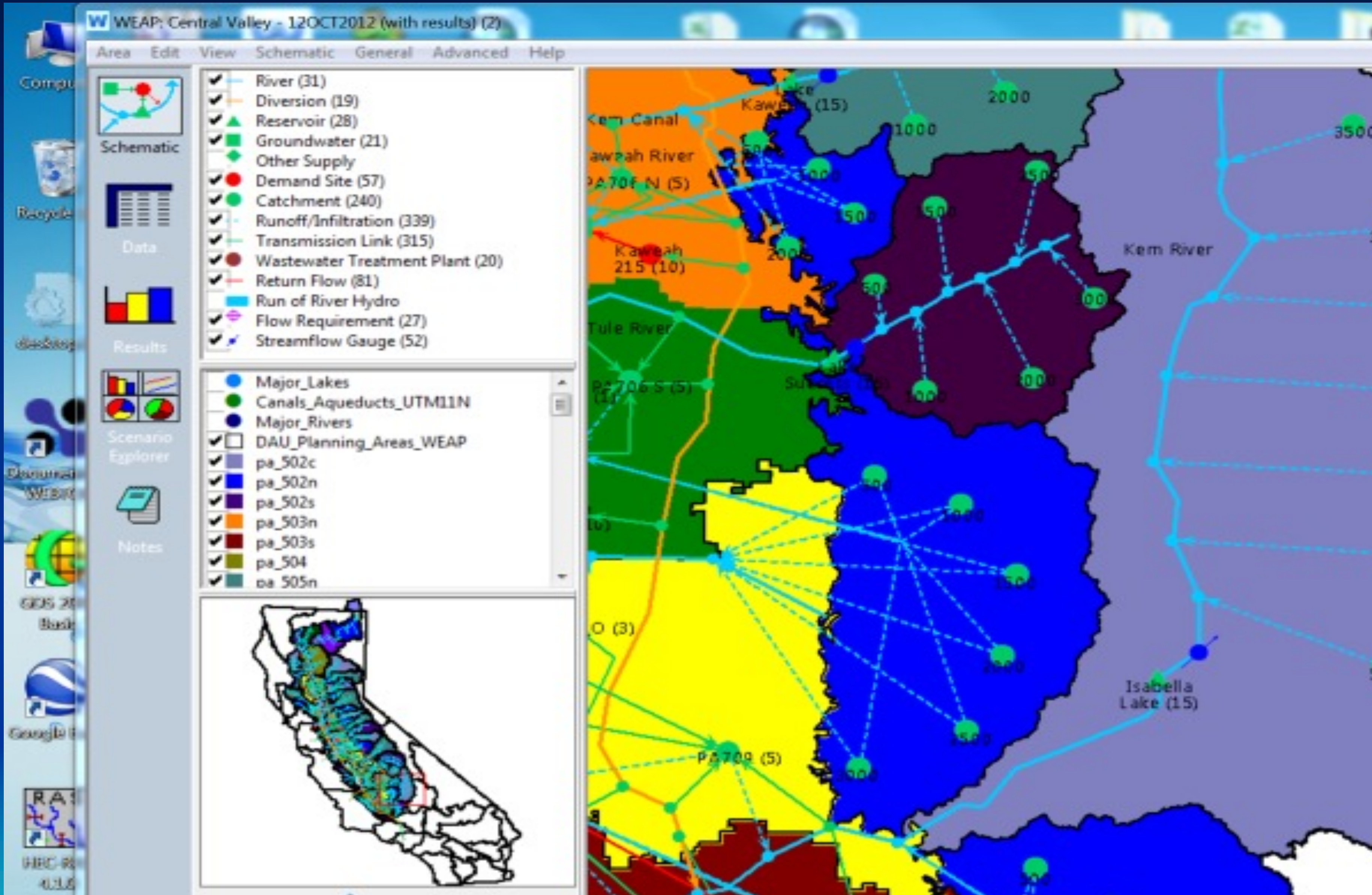
GCM Scenarios: Precip, mm (2000-2100)
Sample location: Sacramento



Application: Central Valley, California
California Water Plan 2018




WEAP: Central Valley - 12OCT2012 (with results)
Area Edit View Schematic General Advanced Help
Schematic
Data
Results
Scenario Explorer
Notes
River (31)
Diversion (19)
Reservoir (28)
Groundwater (21)
Other Supply
Demand Site (57)
Catchment (240)
Runoff/Infiltration (339)
Transmission Link (315)
Wastewater Treatment Pl
Return Flow (81)
Run of River Hydro
Flow Requirement (27)
Streamflow Gauge (52)
Major Lakes
Canals Aqueducts_UTN
Major Rivers
DAU Planning_Areas_V
pa 502c
pa 502n
pa 502s
pa 503n
pa 503s
pa 504
pa 505n
WEAP: 3.434
Area: Central Valley - 12OCT2012 (with results)
2006-2050 (monthly)
Schematic View
Licensed to: Mohammad Rayej, California Department of Water Resources, until April 15, 2014


WEAP: Central Valley - 12OCT2012 (with results) (2)
Area
Edit
View
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Advanced
Help
Schematic
Data
Results
Scenario Explorer
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River (31)
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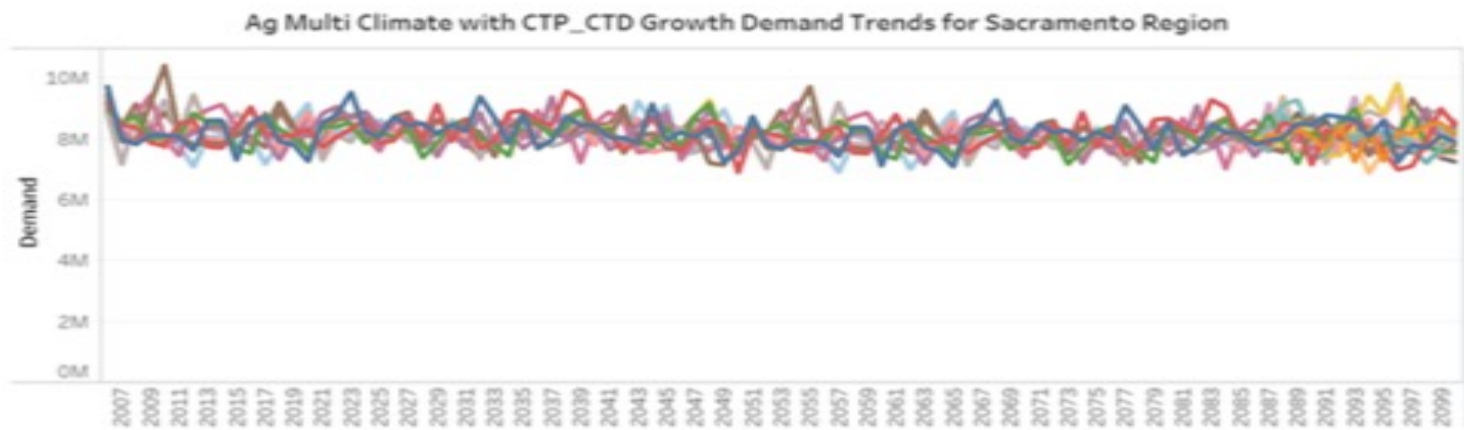
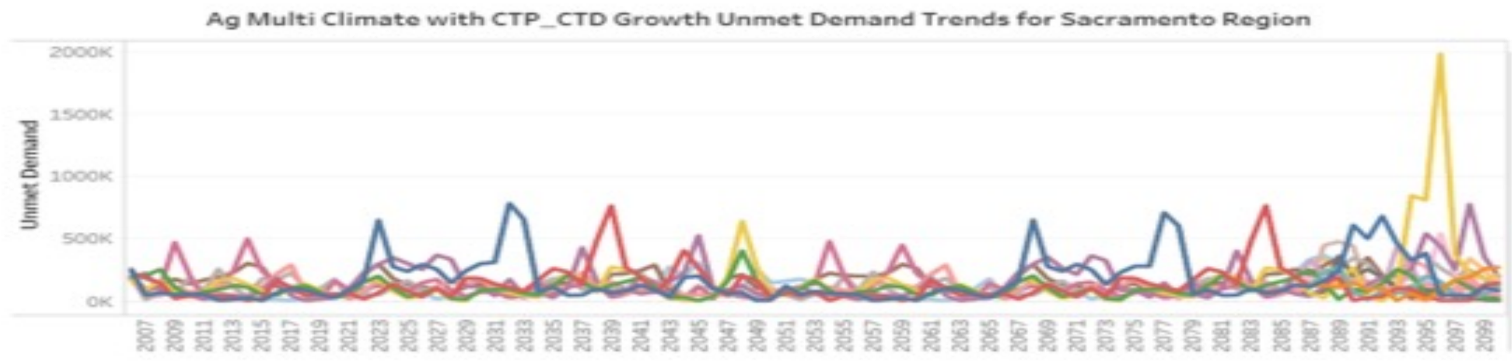
Run of River Hydro
Flow Requirement (27)
Streamflow Gauge (52)
Major_Lakes
Canals_Aqueducts_UTM11N
Major_Rivers
DAU_Planning_Areas_WEAP
pa_502c
pa_502n
pa_502s
pa_503n
pa_503s
pa_504
pa_505n
Kern River
Isabella Lake (15)
Tule River
PA709 (5)
2000
1000
3500

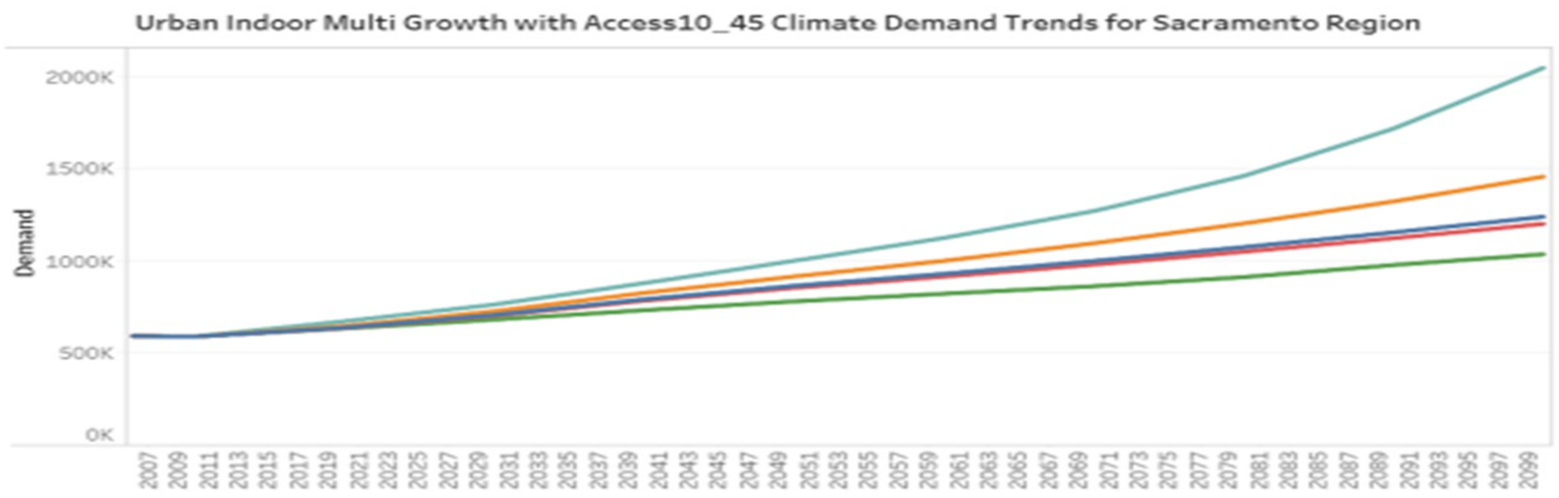
Sample scenario result
Ag Demand: Sacramento HR



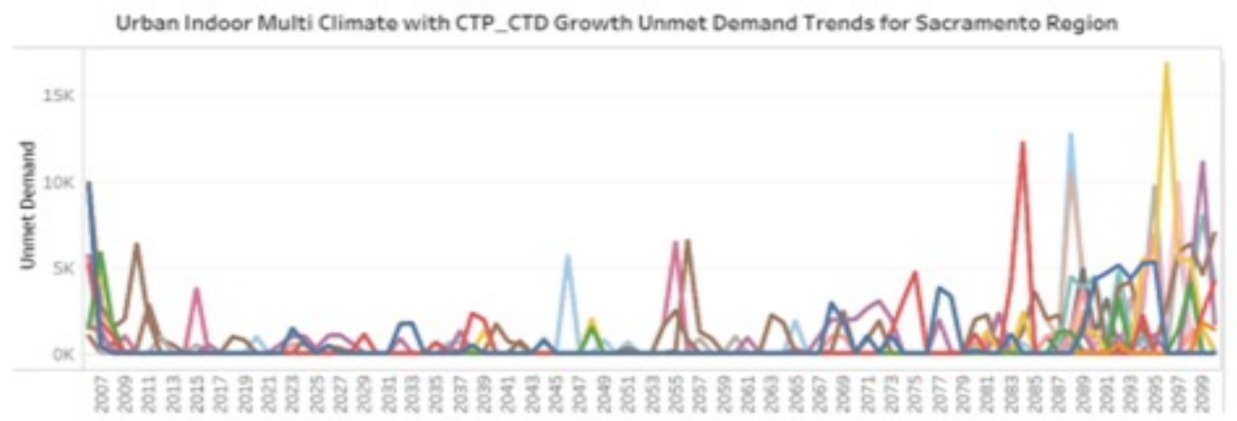
Sample scenario result
Ag Unmet Demand (shortage)



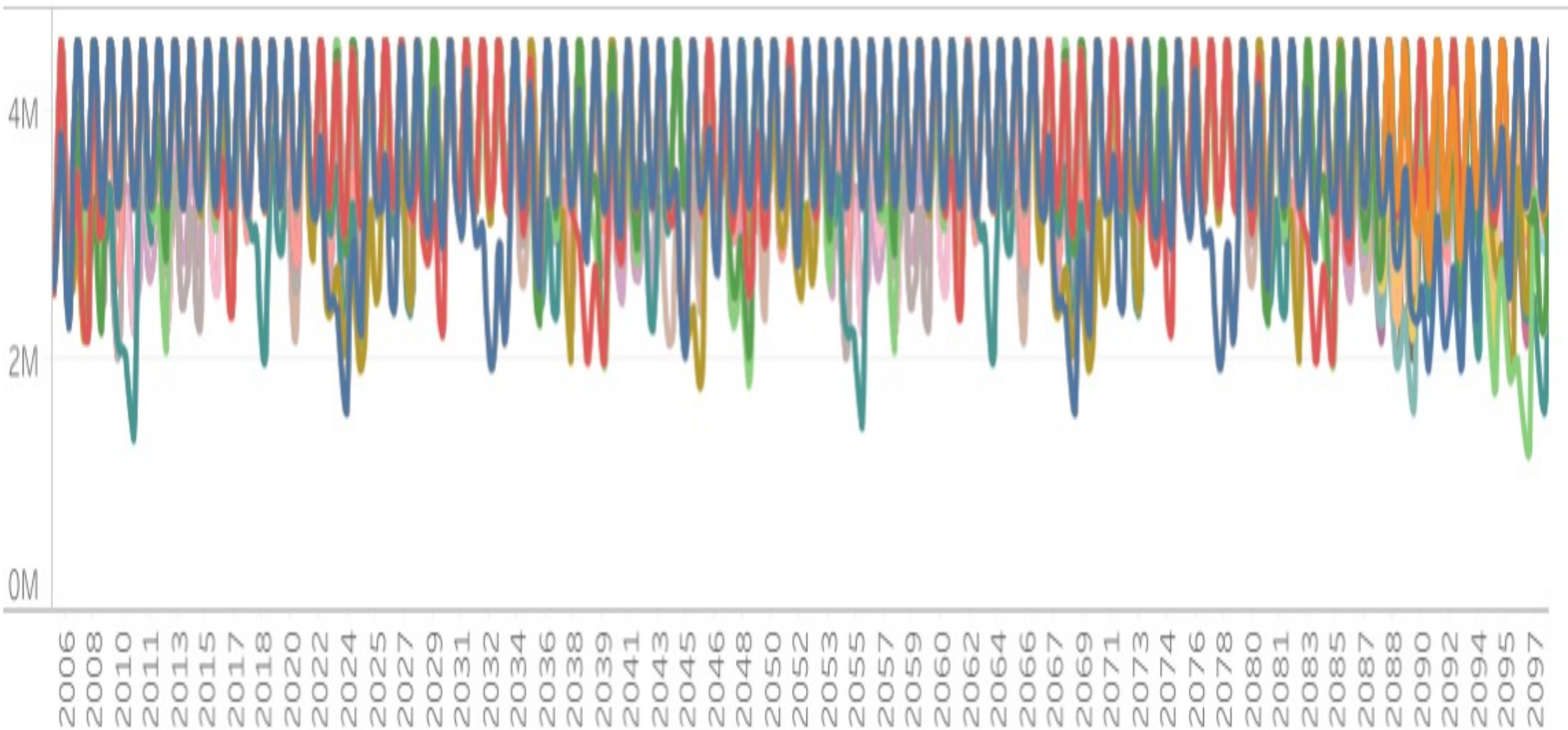
Sample scenario result
Urban Demand: Sacramento HR



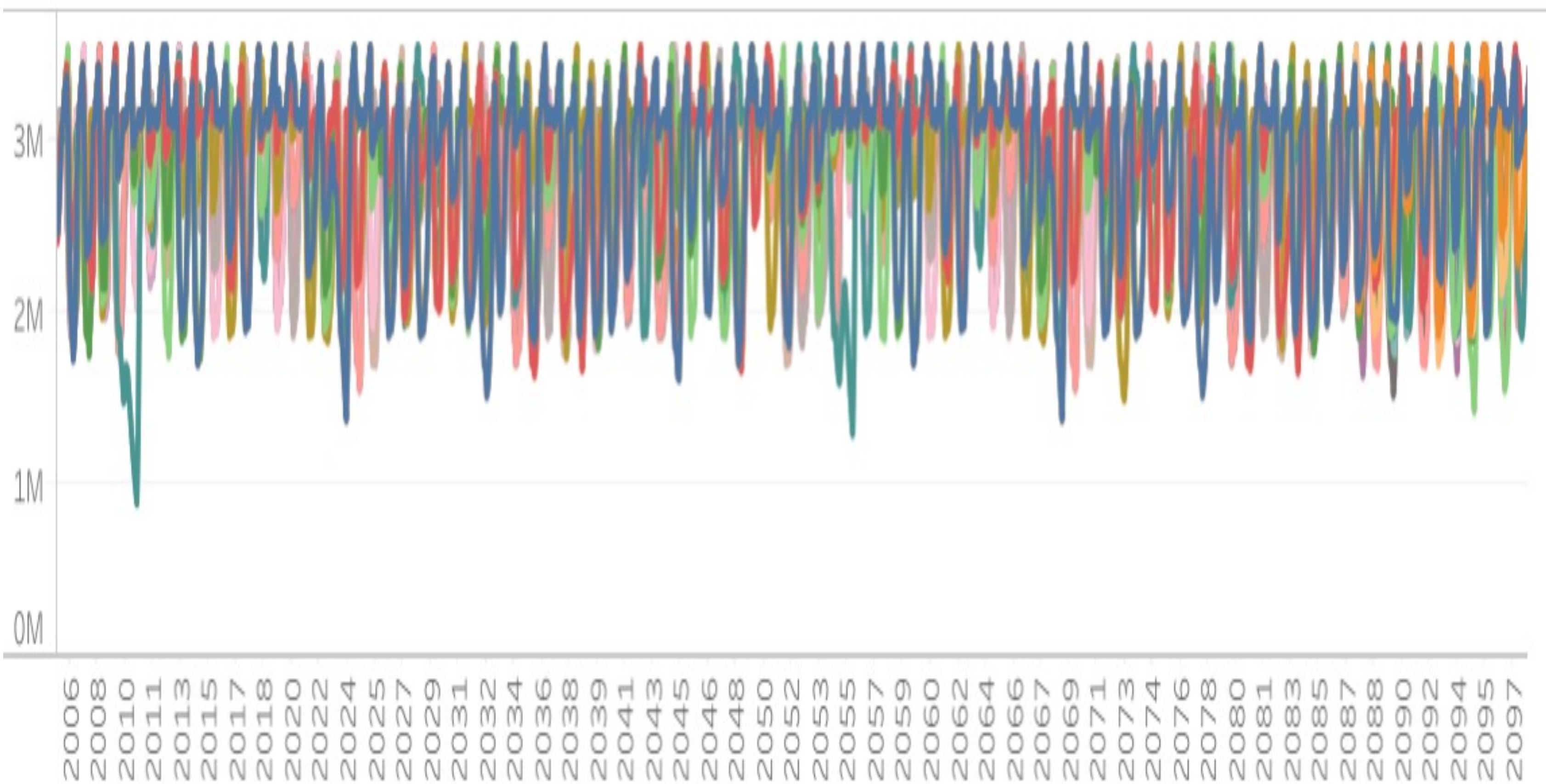
Sample scenario result
Urban Unmet Demand: shortage



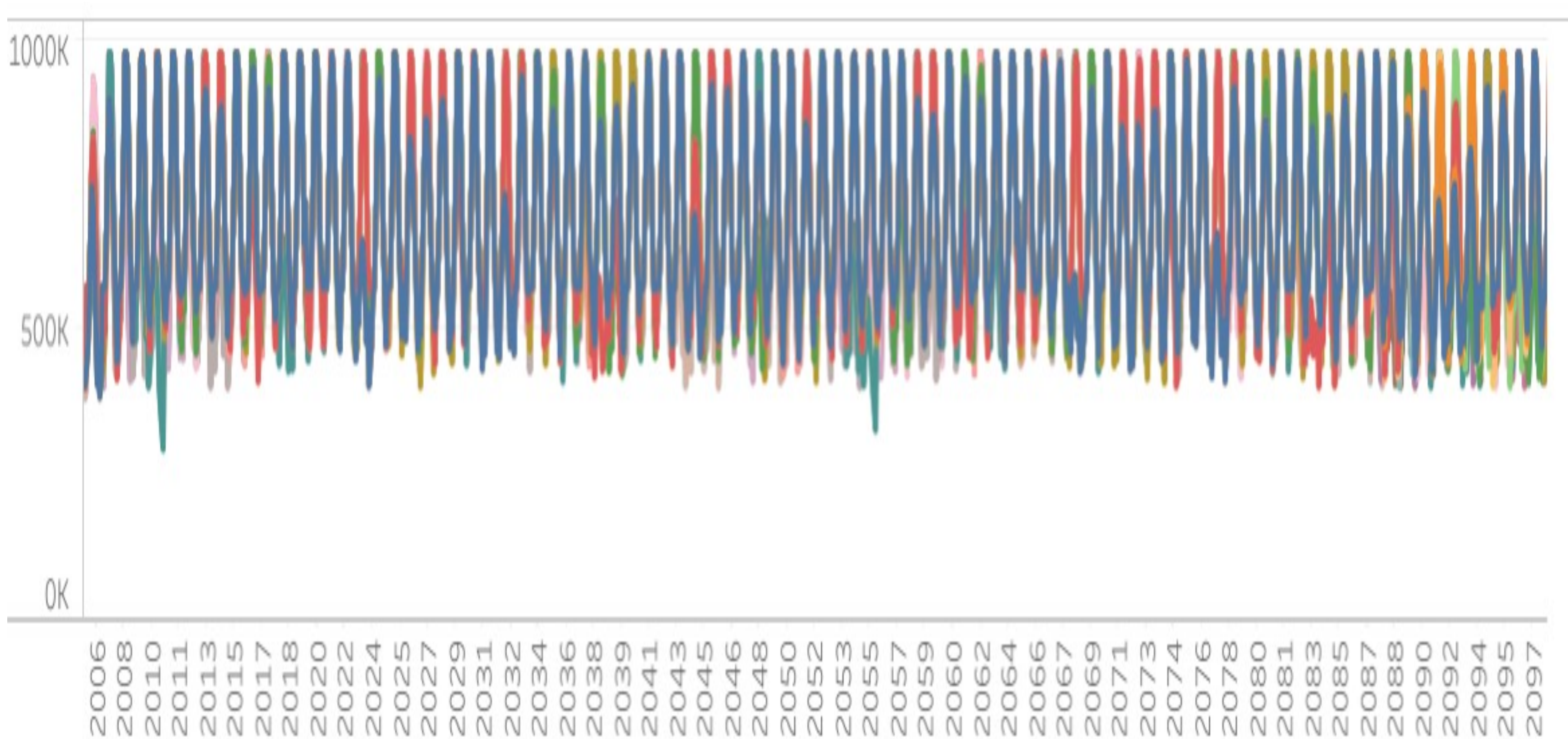
Shasta Reservoir Storage (MAF)



Oroville Reservoir Storage (MAF)

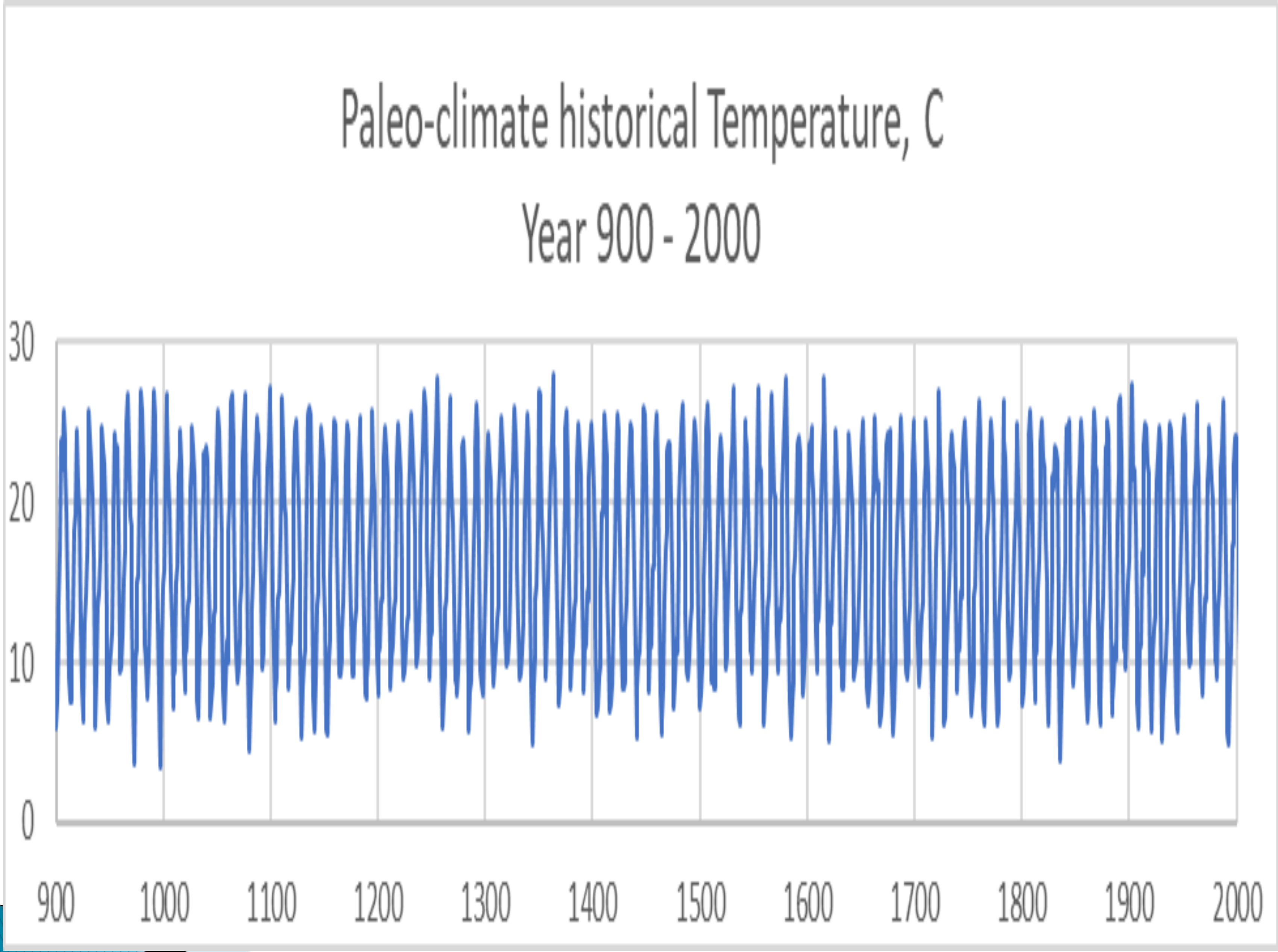


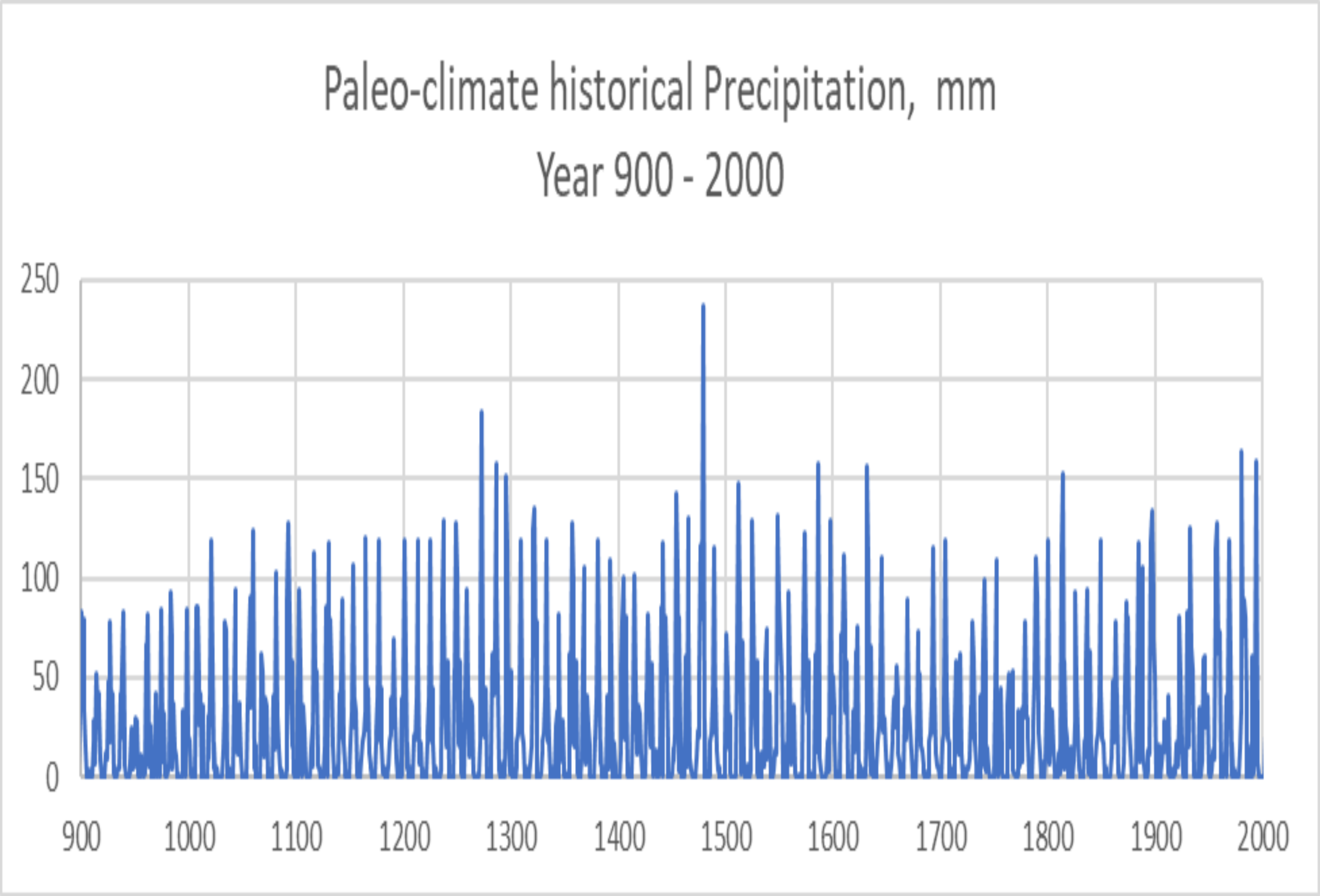
Folsom Reservoir Storage (TAF)



California Water Plan 2023
Decision Scaling Approach (D-S)
Pilot Study- Merced River

* Pilot study to test D-S application in WEAP
* Actual past historical climate, rather than downscaled GCM scenarios
- Perturb historical climate to any desired extreme conditions; hot/dry
- Develop extensive set of climate scenarios
- Evaluate system performance under extreme conditions; extended droughts


Paleo-climate historical Temperature, C
Year 900 - 2000
30
20
10
0
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000

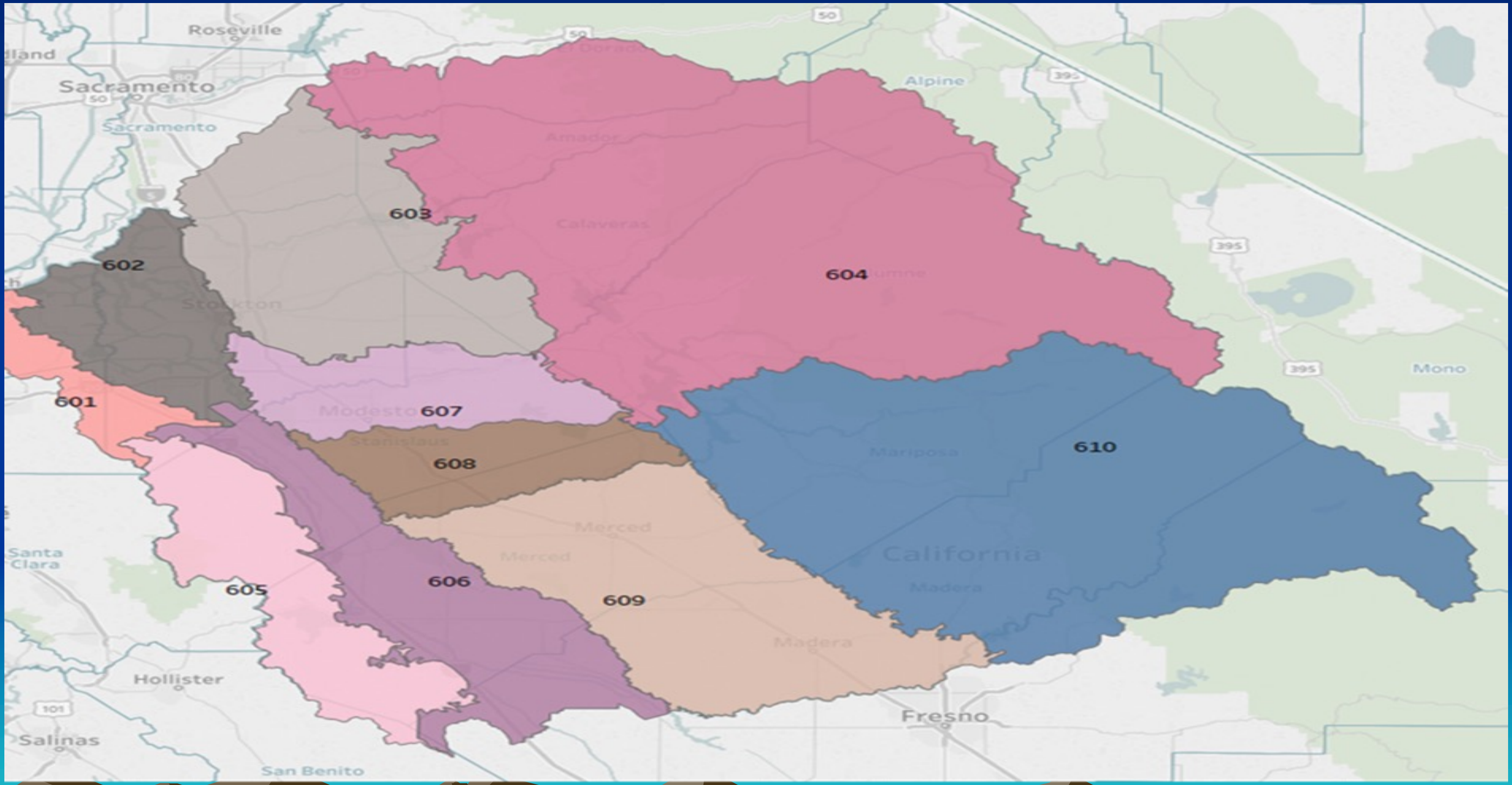

Paleo-climate historical Precipitation, mm
Year 900 - 2000
250
200
150
100
50
0
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000

Precipitation Change (%)

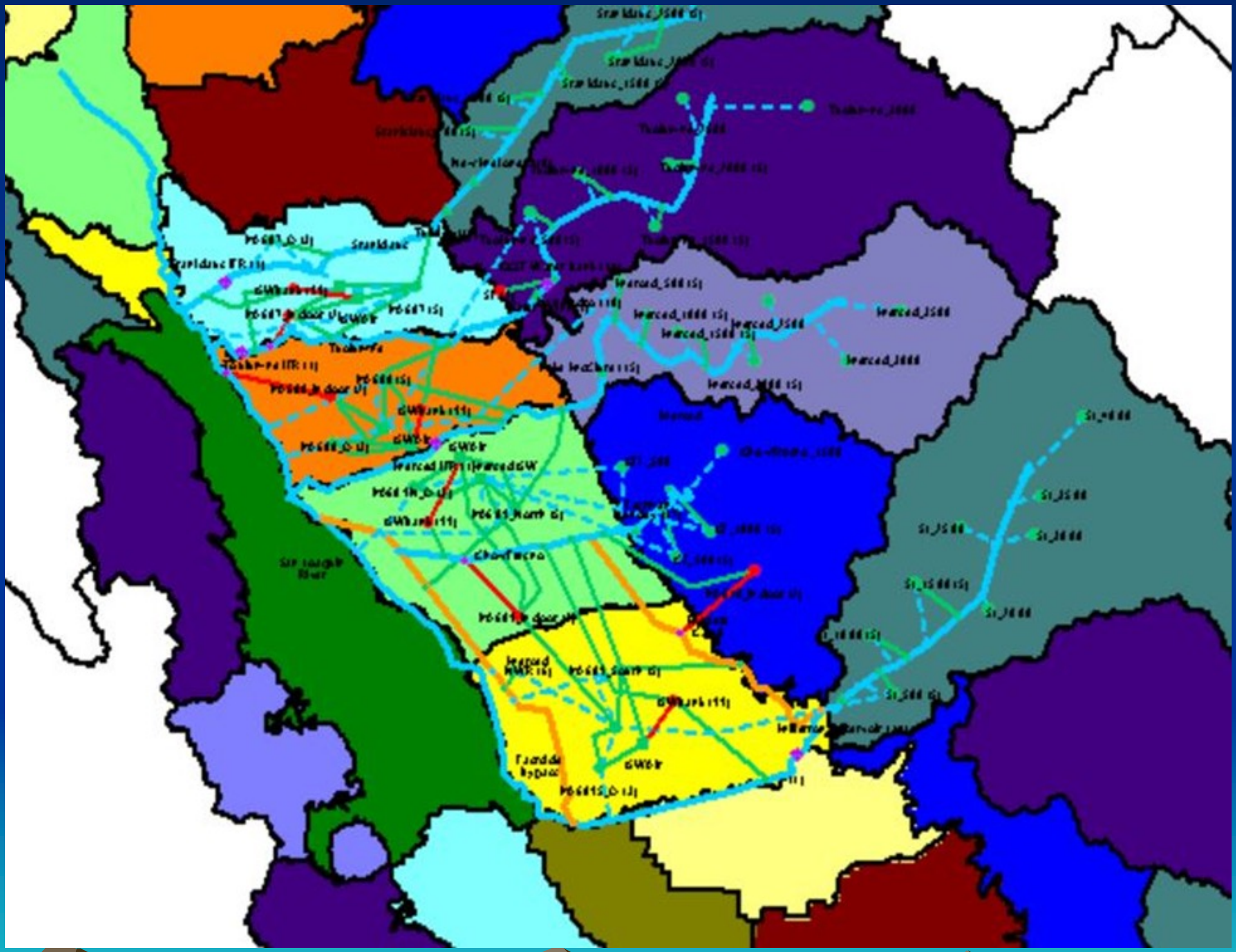
WEAP Pilot study: Decision-Scaling
63 Paleo-based climate scenarios

Temp (C)	-30%	-20%	-10%	0%	+10%	+20%	+30%
0	1 0, -30%	2 0, -20%	3 0, -10%	4 0, 0%	5 0, +10%	6 0, +20%	7 0, +30%
+ 0.5	8 +0.5,-30%	9 +0.5,-2%	10 +0.5, -10%	11 +0.5, 0%	12 +0.5,+10%	13 +0.5,+20%	14 +0.5,+30%
+ 1.0	15 +1.0,-30%	16 +1.0,-20%	17 +1.0, -10%	18 +1.0, 0%	19 +1.0,+10%	20 +1.0,+20%	21 +1.0,+30%
+ 1.5	22 +1.5,-30%	23 +1.5,-20%	24 +1.5,-10%	25 +1.5, 0%	26 +1.5,+10%	27 +1.5,+20%	28 +1.5,+30%
+ 2.0	29 +2.0,-30%	30 +2.0,-20%	31 +2.0,-10%	32 +2.0, 0%	33 +2.0,+10%	34 +2.0,+20%	35 +2.0,+30%
+ 2.5	36 +2.5,-30%	37 +2.5,-20%	38 +2.5,-10%	39 +2.5, 0%	40 +2.5,+10%	41 +2.5,+20%	42 +2.5,+30%
+ 3.0	43 +3.0,-30%	44 +3.0,-20%	45 +3.0,-10%	46 +3.0, 0%	47 +3.0,+10%	48 +3.0,+20%	49 +3.0,+30%
+ 3.5	50 +3.5,-30%	51 +3.5,-20%	52 +3.5,-10%	53 +3.5, 0%	54 +3.5,+10%	55 +3.5,+20%	56 +3.5,+30%
+ 4.0	57 +4.0,-30%	58 +4.0,-20%	59 +4.0,-10%	60 +4.0, 0%	61 +4.0,+10%	62 +4.0,+20%	63 +4.0,+30%

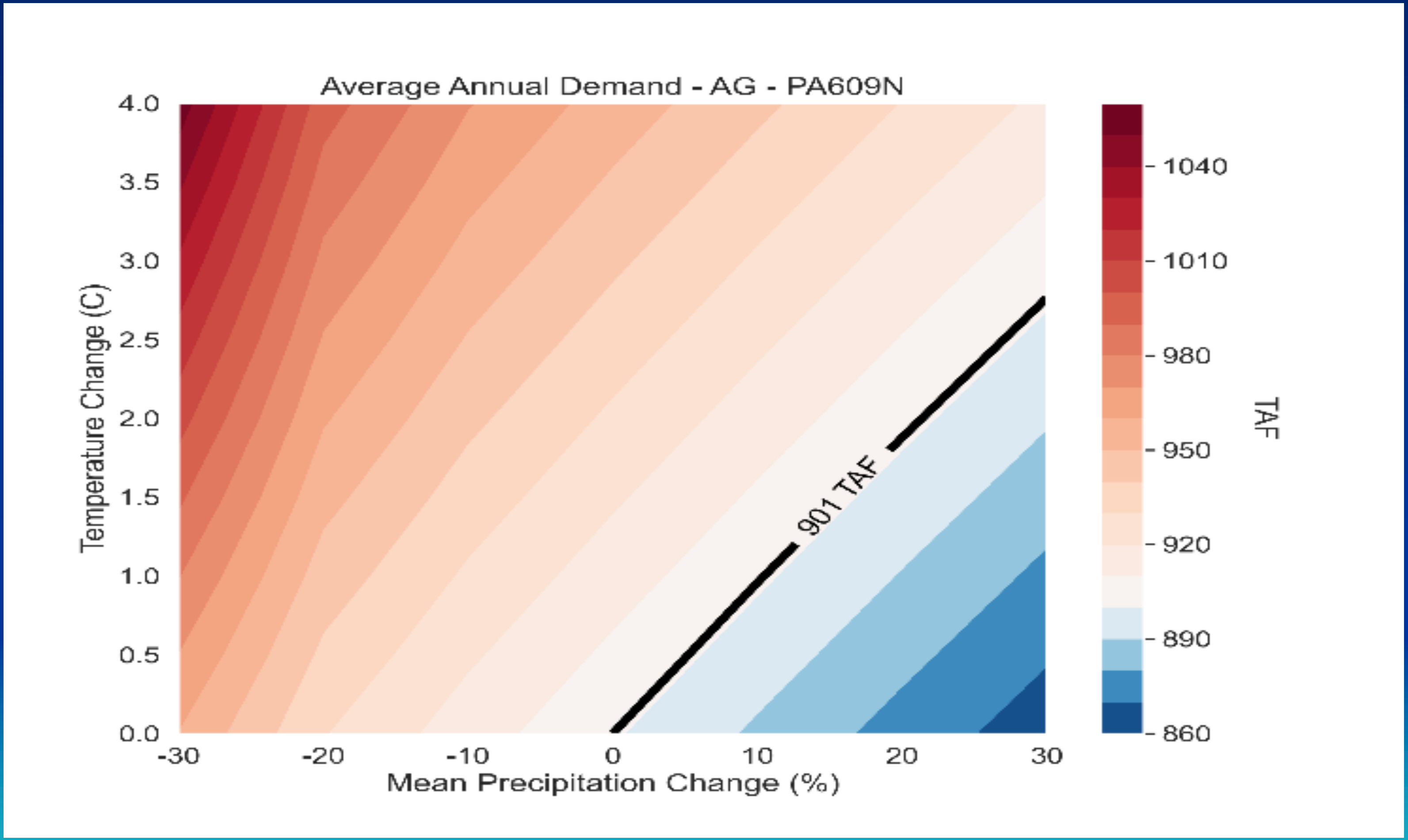
WEAP- Merced River Pilot Study (Paleo-Climate)



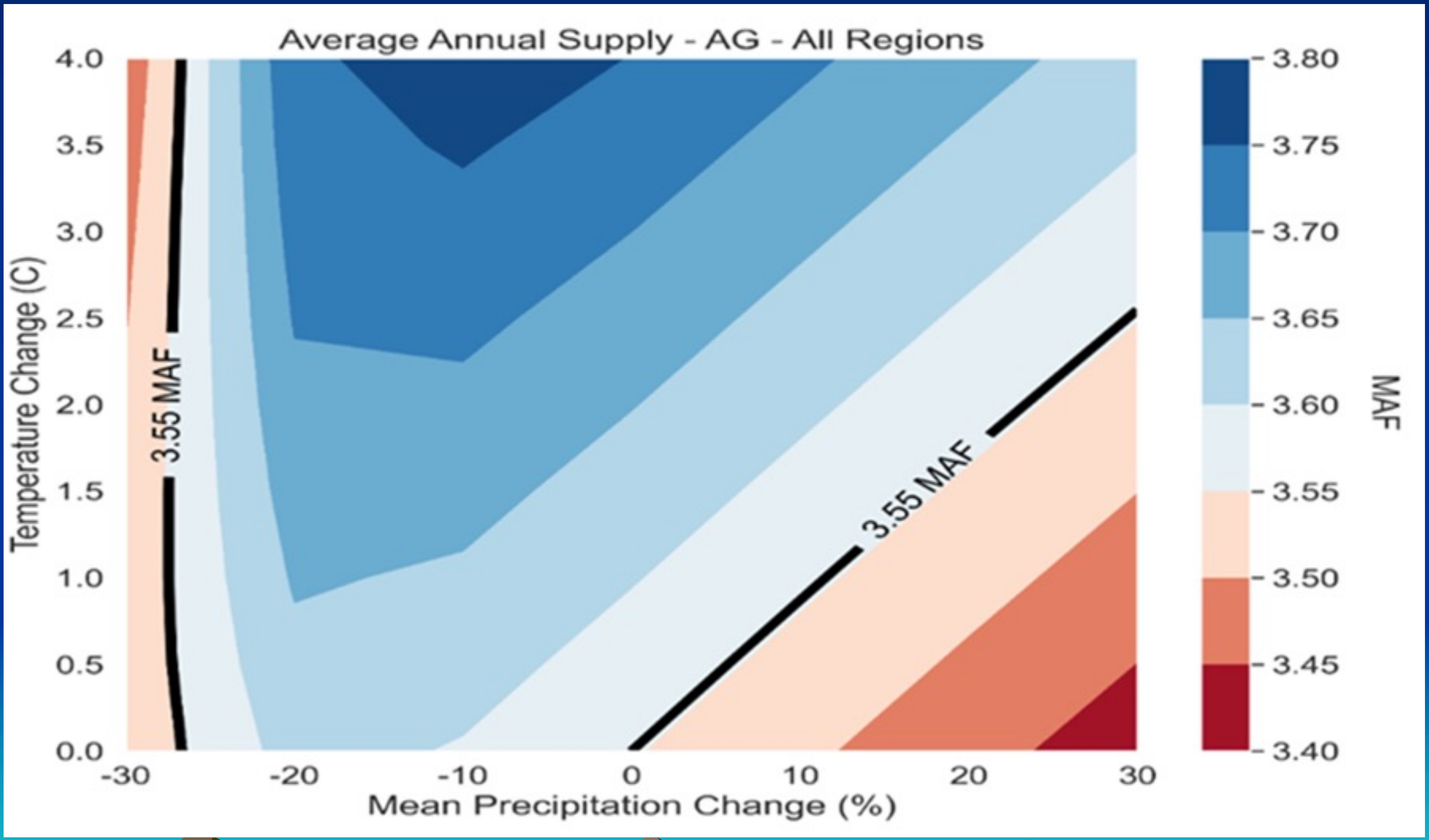
WEAP: Merced River watershed Pilot Study (Decision-Scaling)



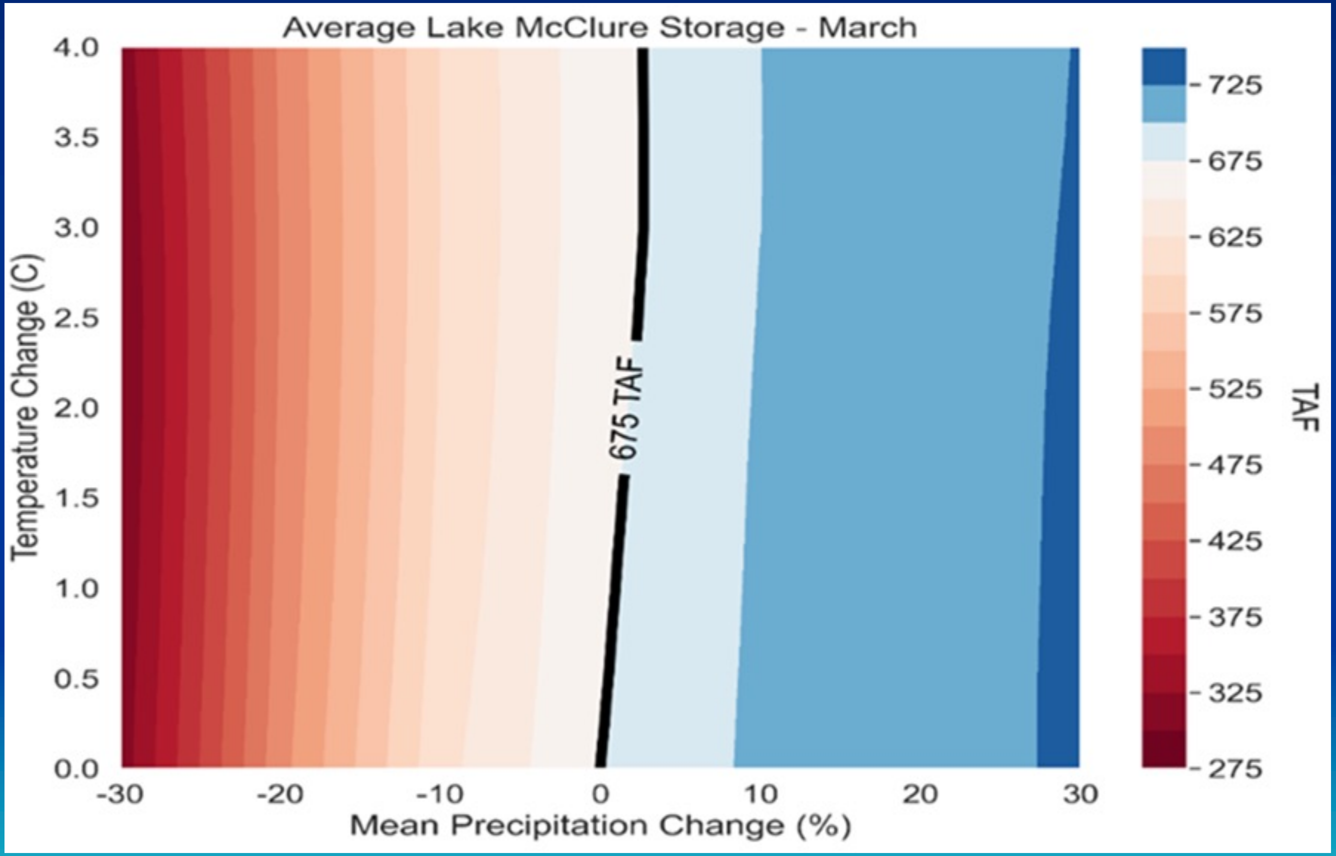
WEAP Pilot study: Decision-Scaling Ag demand response surface



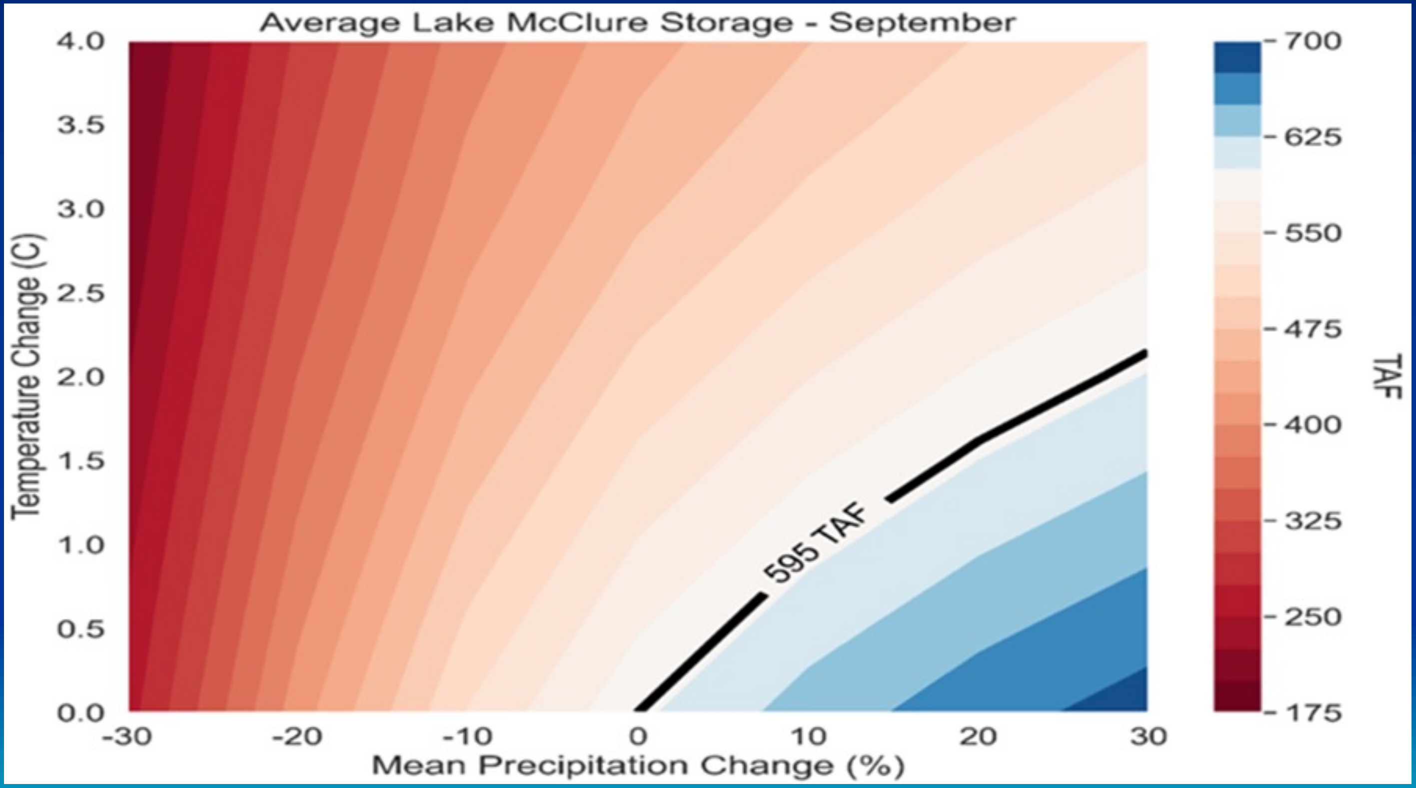
WEAP Pilot study: Decision-Scaling
Ag supply deliveries



WEAP Pilot study: Decision-Scaling Lake McClure storage- March



WEAP Pilot study: Decision-Scaling Lake McClure storage- September



WEAP and Decision-Scaling

Findings:

- Less CPU time with quick turn-arounds
- Less Input-Output processing for extensive climate scenarios needed in D-S application
- Less resource intensive in prepping the model
- As a coarse screening tool, WEAP can provide an initial estimate of system performance and vulnerabilities under extreme climatic conditions

Thank You!

Questions?