California Water Plan Plenary

October 29, 2013

Climate Change

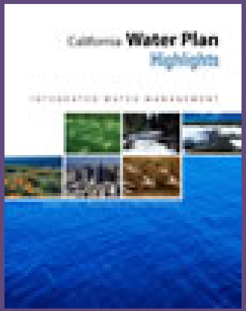
Elissa Lynn, Aaron Cuthbertson, Andrew Schwarz,

Qinqin Liu, Pete Coombe, Jennifer Morales

CA Department of Water Resources

California Water Plan, Update 2013

Climate Change Content

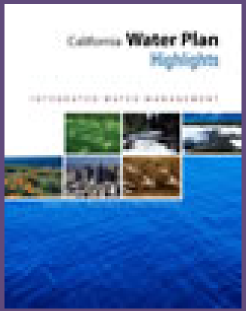


California Water Plan, Update 2013
Climate Change Content

- Volume 1: CA Water Today
  Statewide Adaptation and Mitigation

- Volume 2: Regional Reports

- Volume 3: Resource Management Strategies

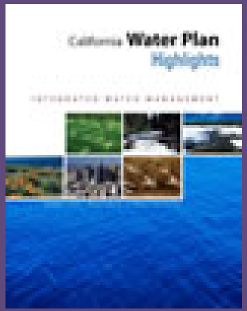


1:50 PM	WELCOME, AND INTRODUCTIONS And SESSION OVERVIEW	Elissa Lynn, DWR Climate Change Program
1:55	SUMMARY OF CLIMATE CHANGE CONTENT in CWP 1. Key Features of the Text 2. What is new/different from 2009 3. What has changed since the last draft 4. What public input has been received to date	Elissa Lynn, DWR Climate Change Program
2:00	CALIFORNIA WATER TODAY 1. Intro, Hydrology, SLR and Diagrams 2. Rain/Snow trends and Diagram 3. Impacts to Water Supply and Diagram 4. Water-Energy Nexus and Diagram DISCUSSION AND PUBLIC COMMENT	 Elissa Lynn, DWR Aaron Cuthbertson, DWR Andrew Schwarz, DWR Qinqin Liu, DWR
3:00	REGIONAL REPORTS 1. Mitigation/Energy Intensity and Diagrams 2. Adaptation DISCUSSION AND PUBLIC COMMENT	 Jennifer Morales, DWR Pete Coombe, DWR
3:30	RESOURCE MANAGEMENT STRATEGIES DISCUSSION AND PUBLIC COMMENT	Andrew Schwarz, DWR
3:45	Next Steps	All
3:50	ADJOURN	

California Water Plan, Update 2013

Climate Change Content

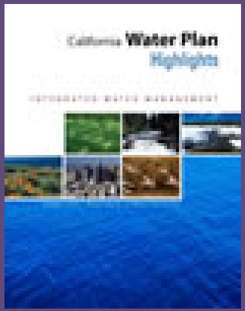
- What's new this year



California Water Plan, Update 2013

Climate Change Content

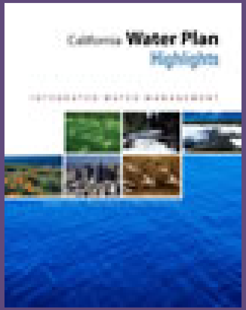
- What’s new this year
- Public Input received so far :
  - Climate Change Technical Advisory Group
  - Water Energy Subject Matter Experts



California Water Plan, Update 2013

Climate Change Content

- Volume 1: CA Water Today
  Statewide Adaptation and Mitigation

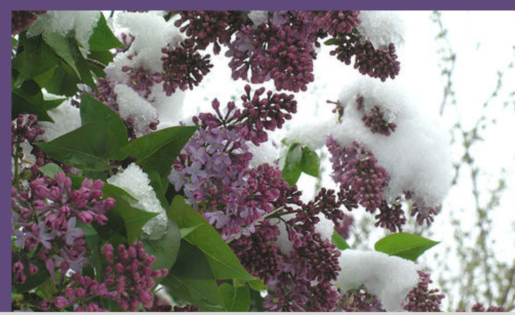


Recent Observations

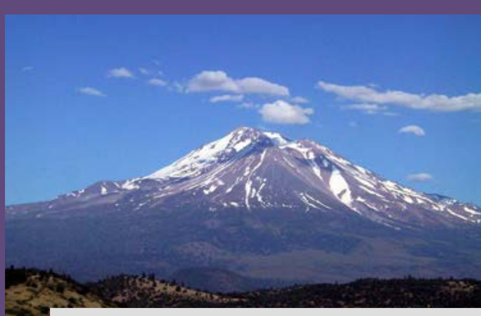
Warming Trend

Less snow/more rain; changing snow thresholds

Less Snowpack



Earlier greenup dates; more tree mortalities; enhanced wildfires

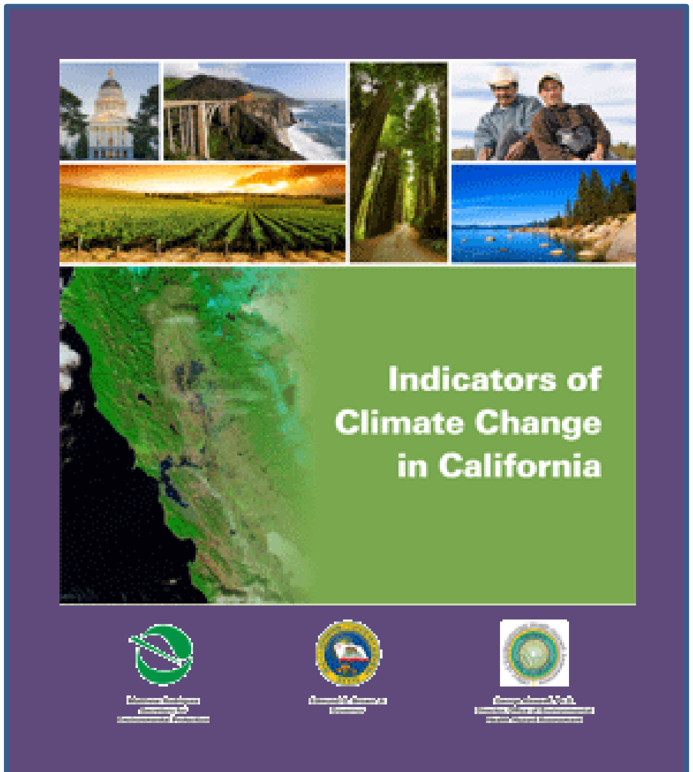


Earlier snowfed streamflow

Animals moving north

Mike Dettinger, USGS and SIO/UCSD

Indicators of Climate Change in California



Cal EPA and Health Hazards

36 indicators

- Decreasing spring snowmelt runoff
- Rising sea levels along the coast
- Shrinking glaciers
- Increasing wildfires
- Warming lakes and ocean waters
- Gradual migration of many plants and animals to higher elevations

What Does 4°F (2°C) Mean?

Sacramento
(avg. temp 61°F)

Bakersfield
(avg. temp 65°F)

+7°F degrees makes Sacramento = Las Vegas, NV

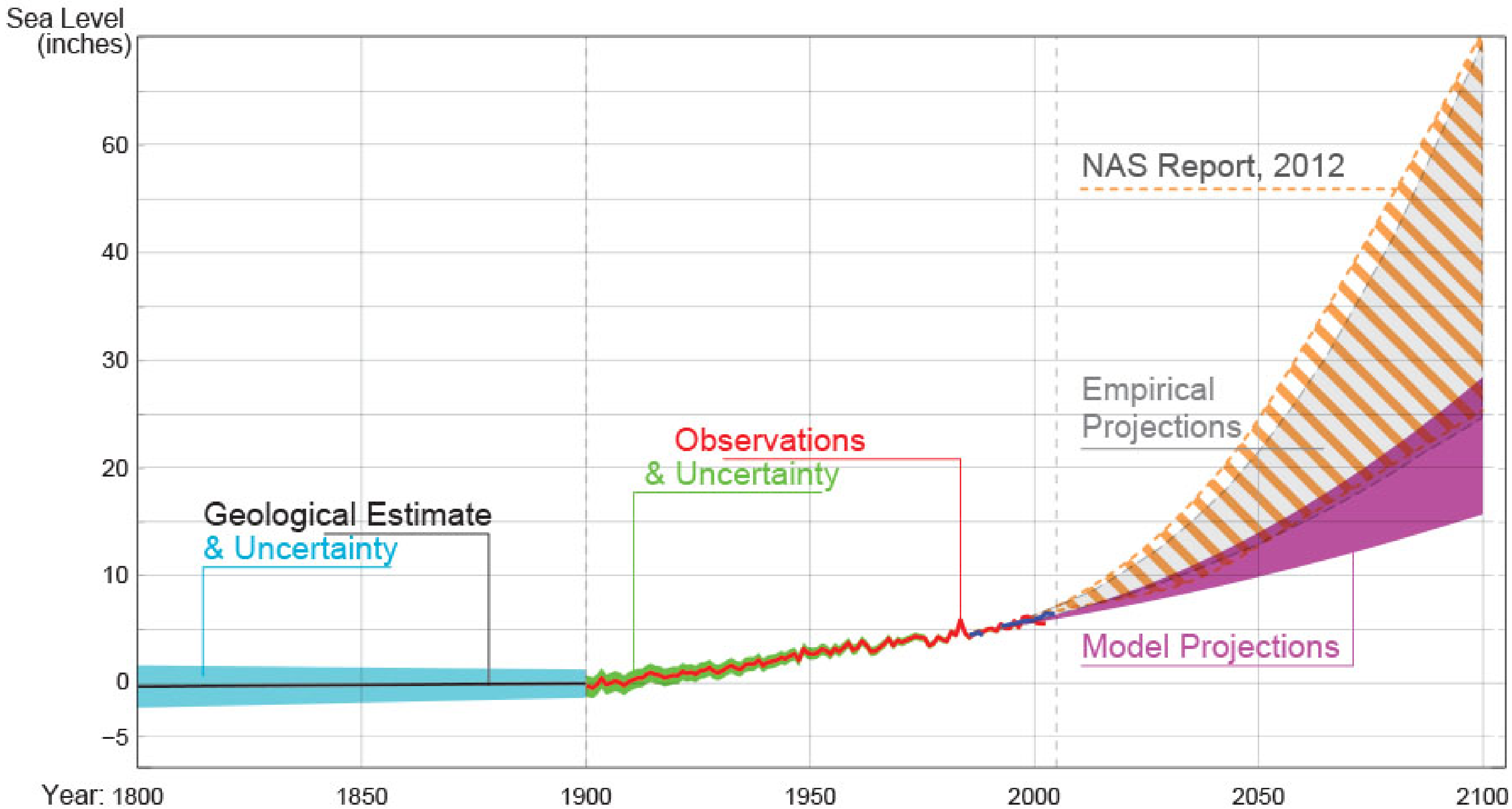
+12°F degrees makes Sacramento = Phoenix, AZ

Five Major Impacts to Water Resources in CA

- **Shift in runoff patterns resulting in more winter runoff and less spring and early summer runoff.**
- **Sea level rise with levee and salinity problems in the Delta and low coastal areas.**
- **Bigger floods due to larger winter rainflood producing areas and more water vapor in storms.**
- **Somewhat higher crop and landscape water needs.**
- **Water temperature problems for cold water fish like salmon and steelhead.**

Global SLR Historic/Projected

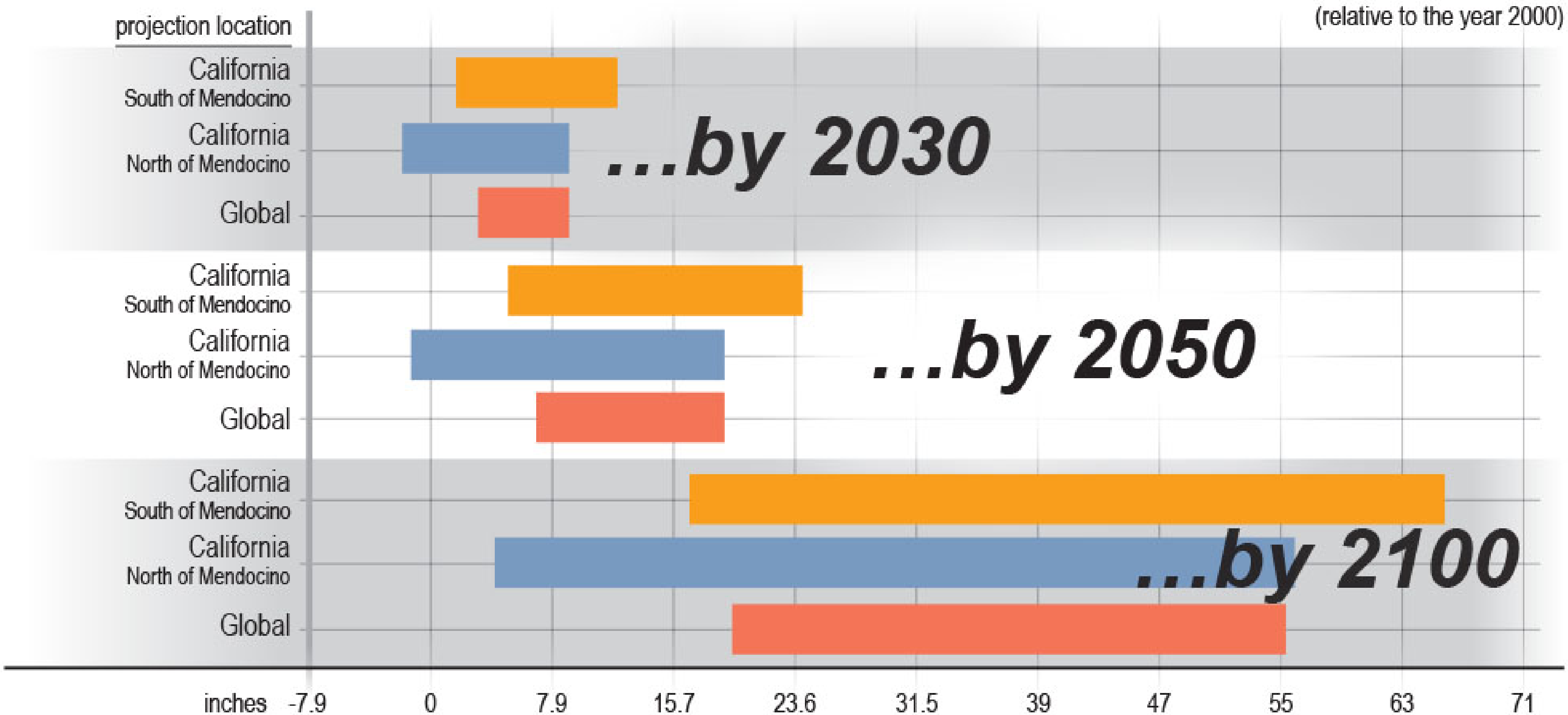
Figure 3-22 **Global Sea Level Rise: Historic and Projected**



Estimated, observed, and projected global sea-level rise from 1800 to 2100. The pre-1900 record is based on geologic evidence, and the observed record is from tide gages (red line) and satellite altimetry (blue line). Example projections of sea-level rise to 2100 are from IPCC (2007) global climate models (pink shaded area), semi-empirical methods (gray shaded area; Rahmstorf, 2007), and NAS report (yellow banded area, 2012). Reprinted with permission from "Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future," 2012, from the National Academy of Sciences, Courtesy of the National Academies Press, Washington, D.C.

West Coast vs. Global SLR

Figure 3-23 **West Coast and Global Sea Level Rise Projections**



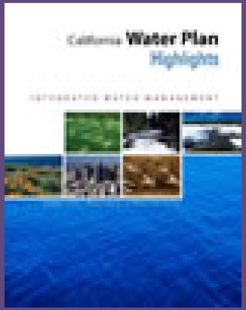
Reprinted with permission from "Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future," 2012, from the National Academy of Sciences, Courtesy of the National Academies Press, Washington, D.C.

Summary of regional projections of mean sea level rise from a National Academy of Sciences study (NAS, 2102), sponsored by California, Oregon, Washington, and three federal agencies. The highest observed values of sea level rise will occur during winter storms, especially during El Niño years when warmer ocean temperatures result in temporarily increased sea levels. Observed values can be much greater than the mean values shown here. For example, observed California sea levels during winter storms in the 1982-83 El Niño event were similar in magnitude to the mean sea levels now being projected for the end of the 21st century.

California Water Plan, Update 2013
Climate Change Content

- Volume 1: CA Water Today
  Rain/Snow Trends and Diagram

Aaron Cuthbertson



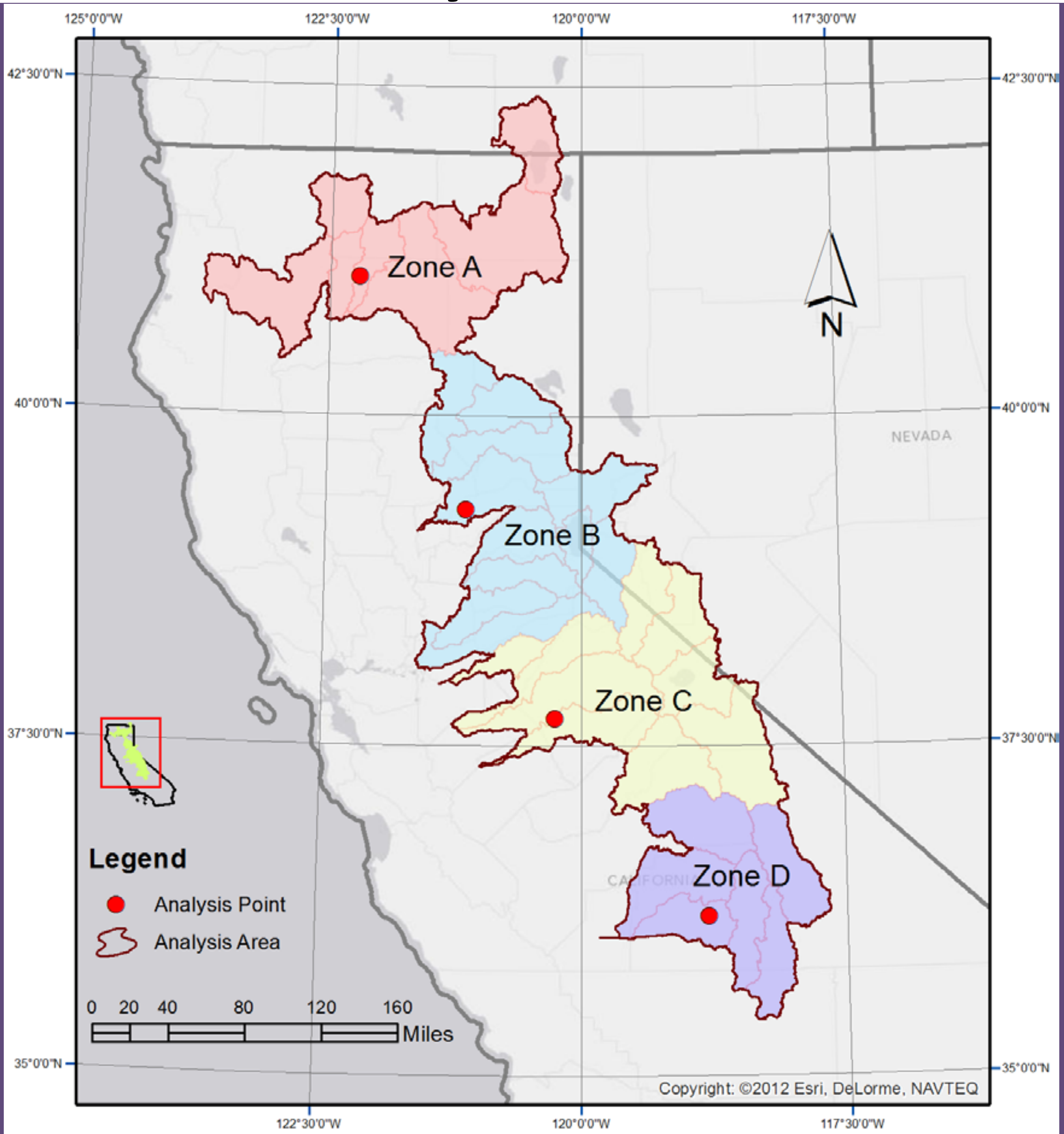
Questions

- **For the major watersheds of California,**
  - **Is the amount of precipitation falling as snow changing?**
  - **Can a time-series of the rain / total precipitation ratio be estimated?**
  - **Is there a significant trend in this estimate?**

Previous work

- Much previous work on
  - Runoff timing, magnitude
  - Snowpack
  - Total precipitation
  - Snow (or rain) to total precipitation ratios
  - This work looks at rain to total precipitation ratios for watersheds of the Sierra Nevada and southern Cascades in California

Analysis Area



Methodology

Combines:

- Temporally coarse, spatially fine precipitation and elevation data (PRISM) with
- Data product based on temporally fine, spatially coarse atmospheric data (NCAR/NCEP -> WRCC freezing level tracker)
- Linked by elevation (DEM)

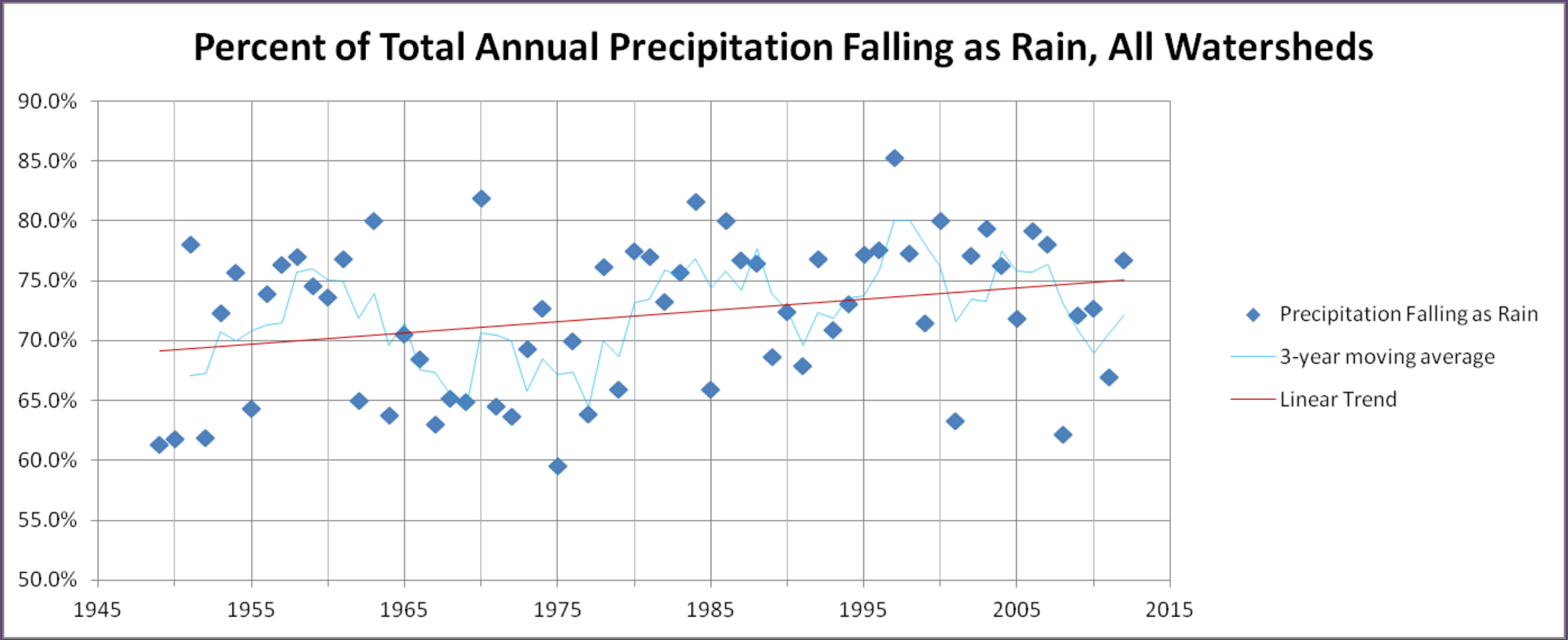
Methodology

Method results in:

- Time series of annual percent of total precipitation falling as rain for each analysis zone and the entire analysis region

- Time series spans from 1949 – 2012 water years

Results – Entire Analysis Area



Conclusions

- Analysis suggests that percent rain is increasing in state, particularly in northern watersheds
- Can we combine low resolution precip phase data with higher resolution precip data? Is there a way to validate the approach?
- What about interdecadal climate variability?

Data – Precipitation Phase

- Obtained from WRCC North American Freezing Level Tracker, Monthly Percent Snow Tool

- Combines modeled data of precipitation and atmospheric temperature and elevation

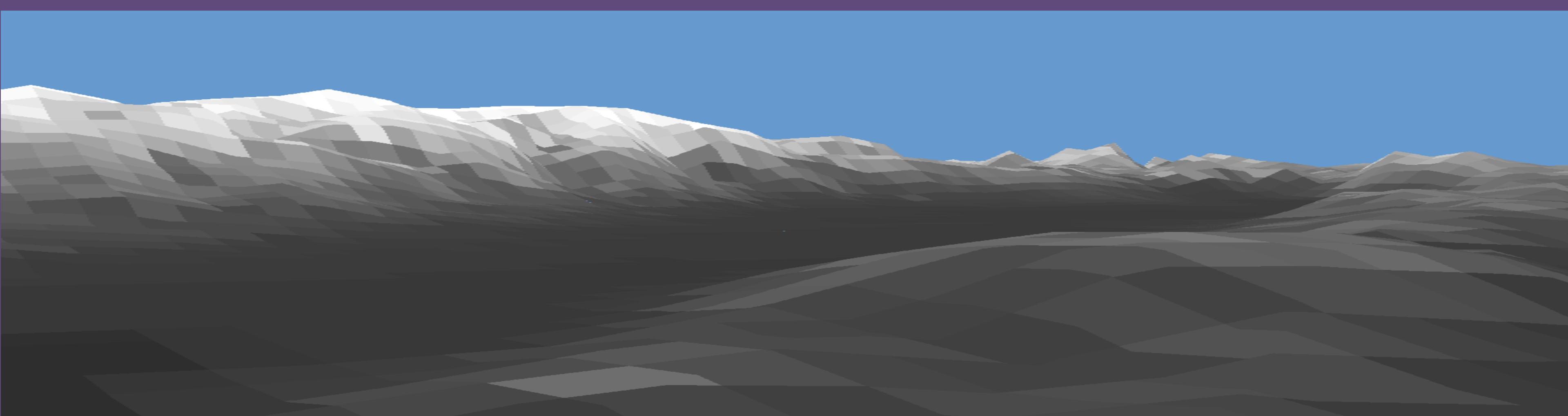
- Underlying data: NCAR/NCEP global Reanalysis Data
  - 6 hour increments
  - 21 levels of the atmosphere (0-4000m in 200m increments)
  - Coarse 2.5 degree Lat/long grid cell size

Data - PRISM Precipitation Data

- 2.5 ArcMinute Grid (about 2km)
- Monthly data calculated from 1896-2012
- This analysis uses Oct-Sept water years from 1949-2012, corresponding to the reanalysis period data

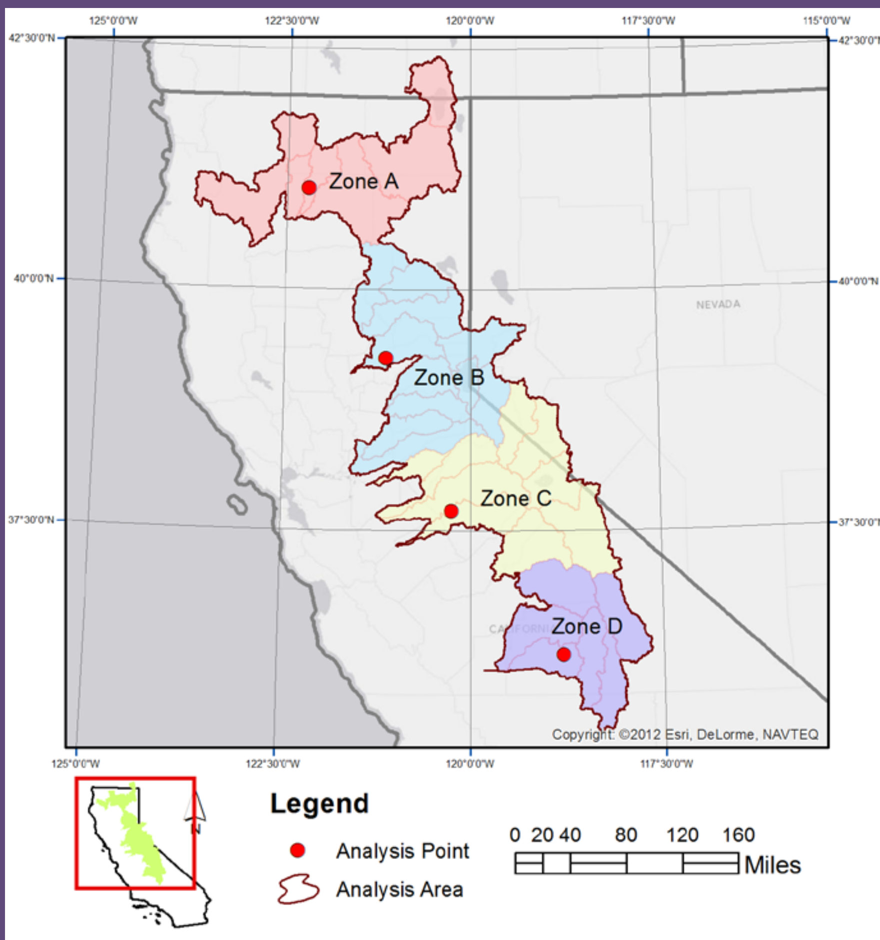
Data - Elevation

- 2.5 Arcminute Lat/long grid
- Coincides with PRISM monthly precipitation grid data
- DEM ‘binned’ to divide elevations into 21 elevation bands

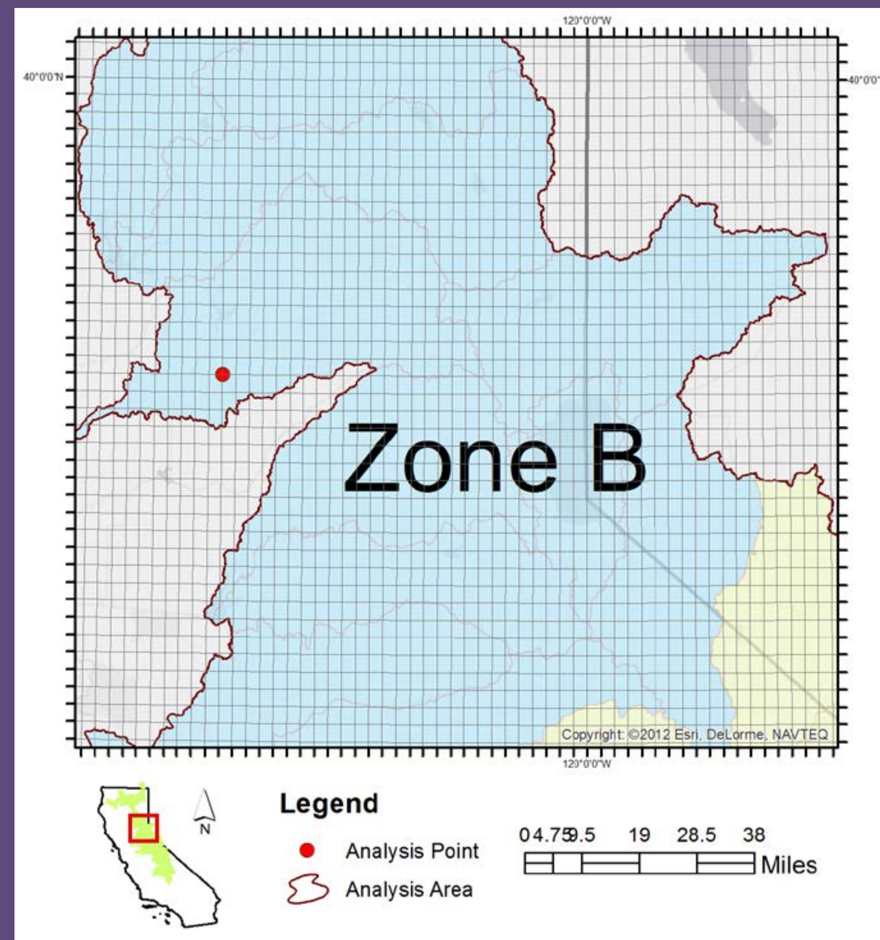


Data

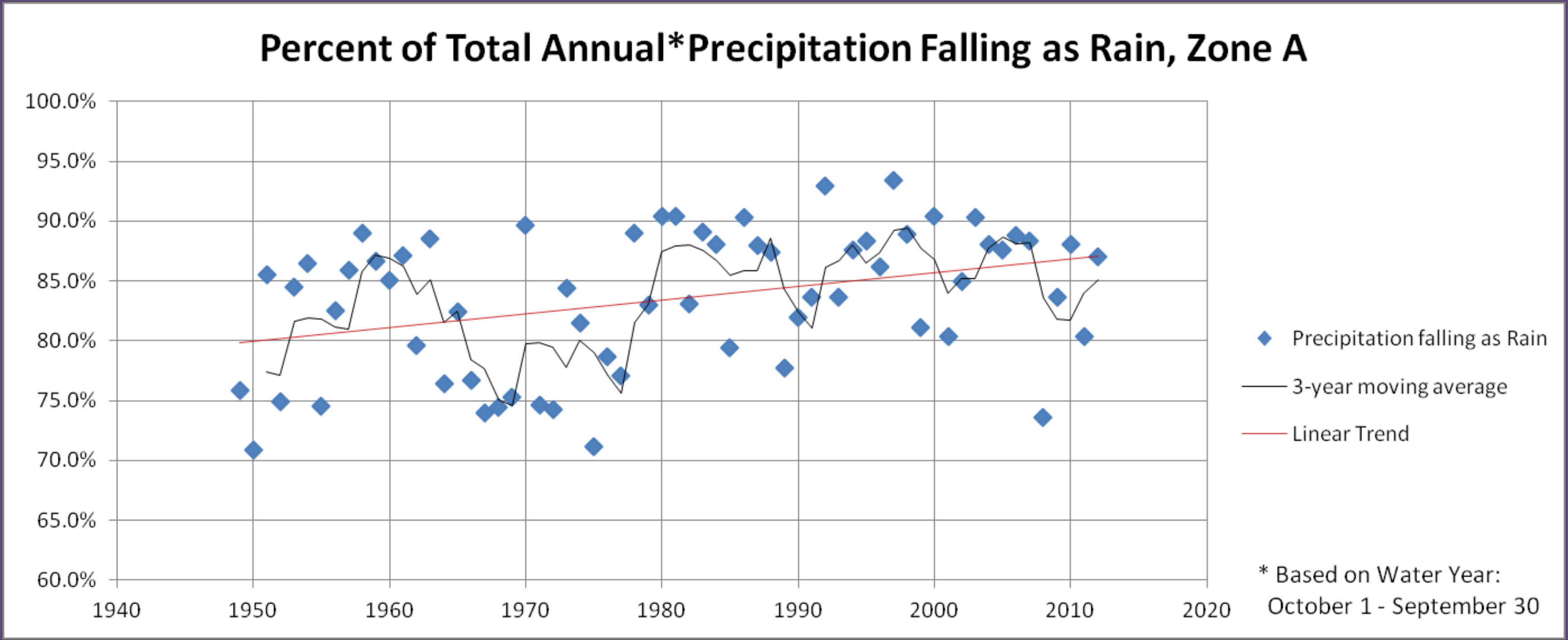
Coarse Grid - WRCC % Snow



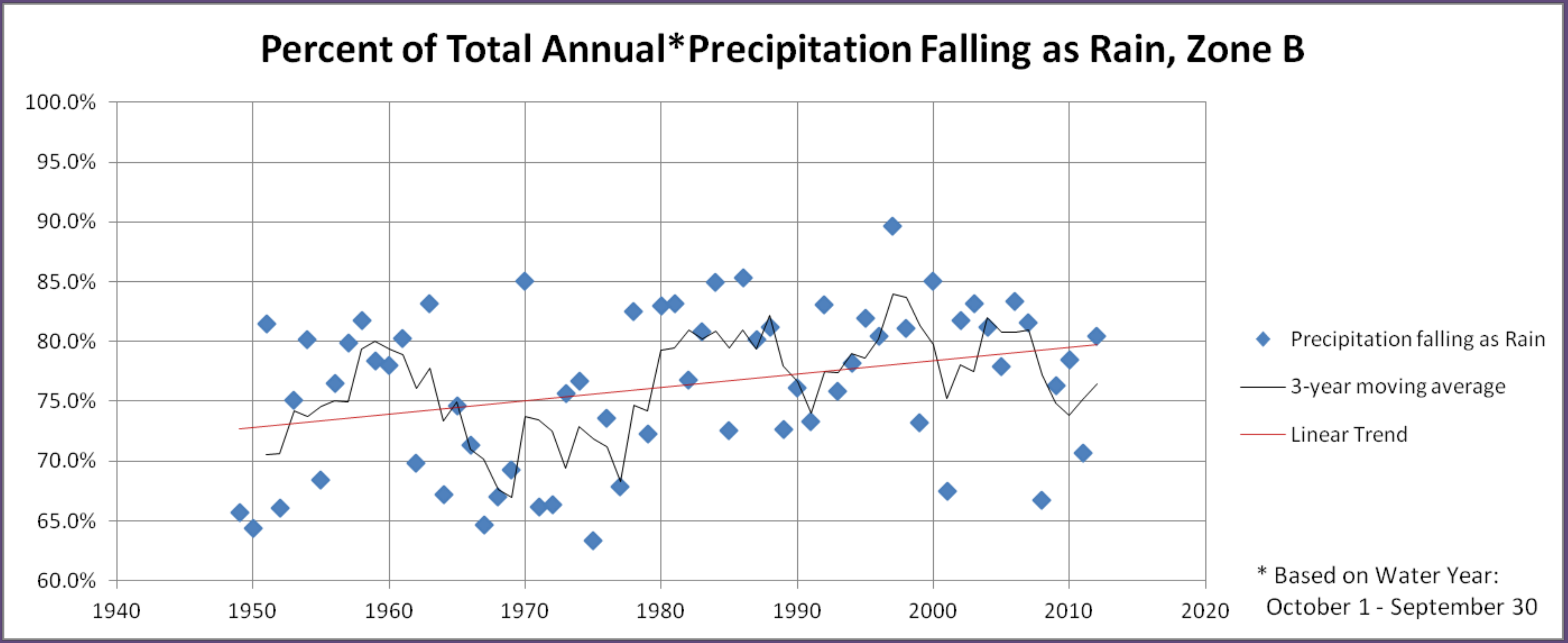
Fine Grid - PRISM Precip and DEM



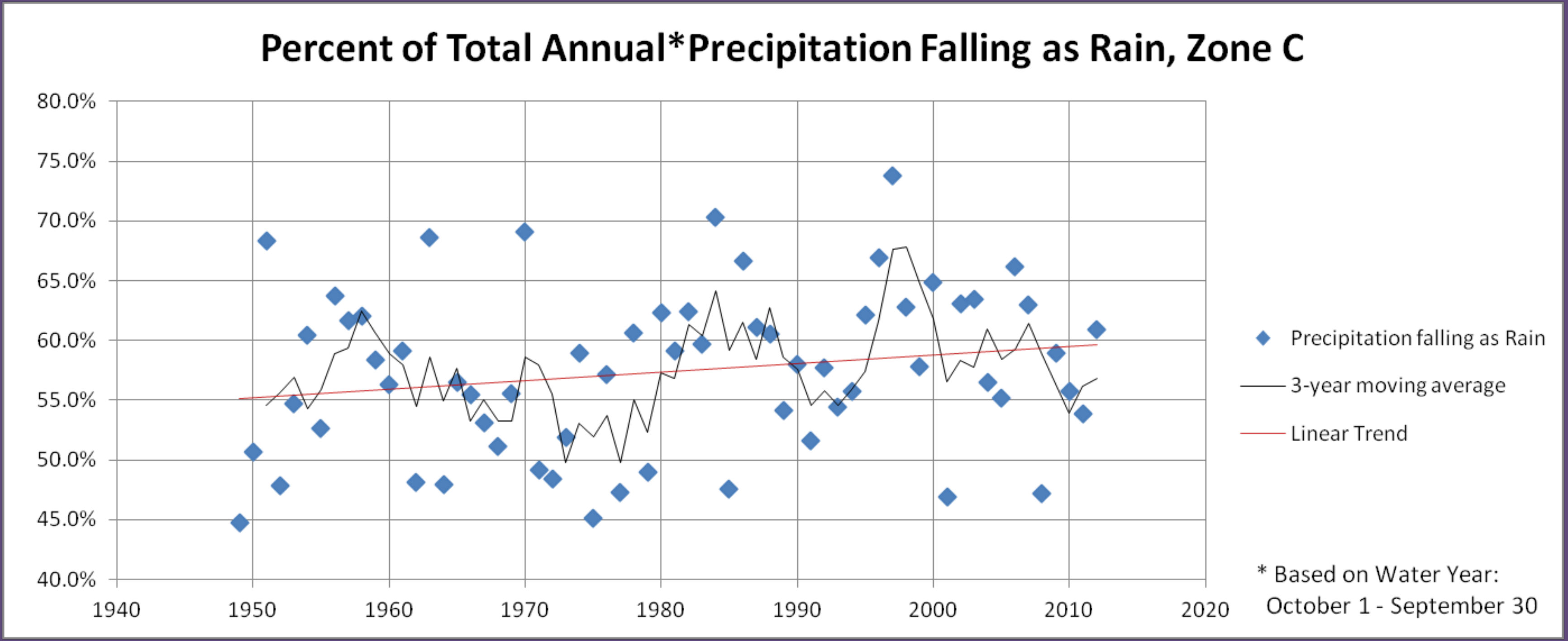
Results – Zone A



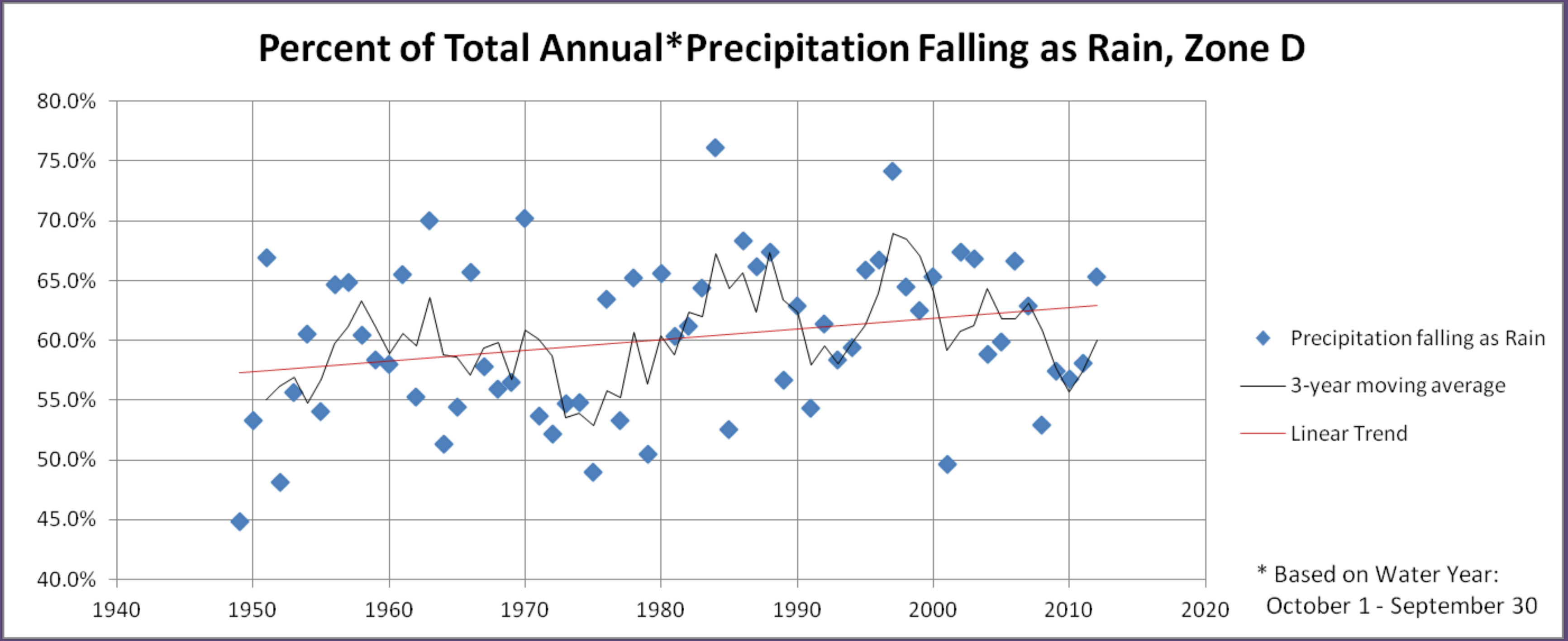
Results – Zone B



Results – Zone C



Results – Zone D



Analysis

Mann-Kendall Trend Analysis of **Annual Precipitation** by Analysis Zone
H0: No change in Annual Precipitation over time

Zone	Kendall's tau	2-sided p value	Interpretation
Zone A	-0.044	0.614	**Fail to reject H_0**
Zone B	-0.037	0.672	**Fail to reject H_0**
Zone C	0.005	0.958	**Fail to reject H_0**
Zone D	0.024	0.785	**Fail to reject H_0**
Total Analysis Area	-0.020	0.821	**Fail to reject H_0**

Analysis

Mann-Kendall trend test of **annual snow** by analysis zone

H_0: No change in annual snow over time

Zone	Kendall's tau	2-sided p value	Interpretation
Zone A	-0.232	0.007	**Reject H_0**
Zone B	-0.186	0.031	**Reject H_0**
Zone C	-0.039	0.656	**Fail to reject H_0**
Zone D	-0.037	0.672	**Fail to reject H_0**
Total Analysis Area	-0.104	0.226	**Fail to reject H_0**

Analysis

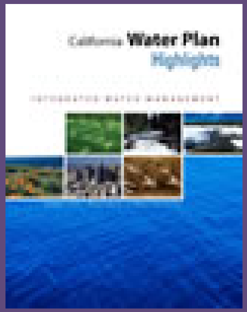
Mann-Kendall trend test of **rain as % of total precipitation,** by analysis zone
H0: No change in percent rain over time

Zone	Kendall's tau	2-sided p value	Interpretation
Zone A	0.227	0.008	**Reject H_0**
Zone B	0.214	0.013	**Reject H_0**
Zone C	0.132	0.125	**Fail to reject H_0**
Zone D	0.158	0.066	**Fail to reject H_0**
Total Analysis Area	0.196	0.022	**Reject H_0**

California Water Plan, Update 2013
<u>Climate Change Content</u>

- Volume 1: CA Water Today
  Impacts to Water Supply and Diagram

Andrew Schwarz



Snowpack Changes:

Climate Research Division

Evolution of Average Annual Snow Water Equivalent as a Percentage of Average 1995-2005 Values

(effect of temperature changes only: historical P, baseline T from WY 1965-1987)

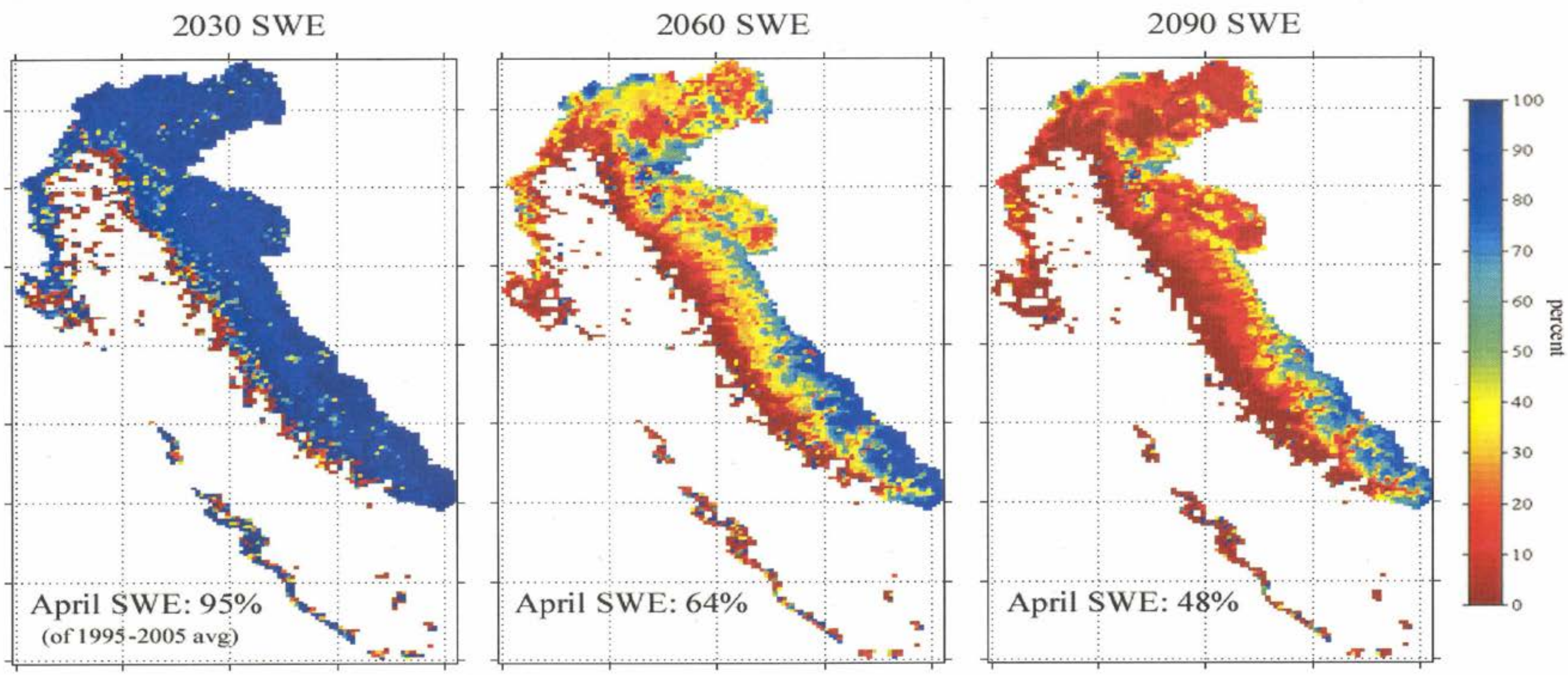
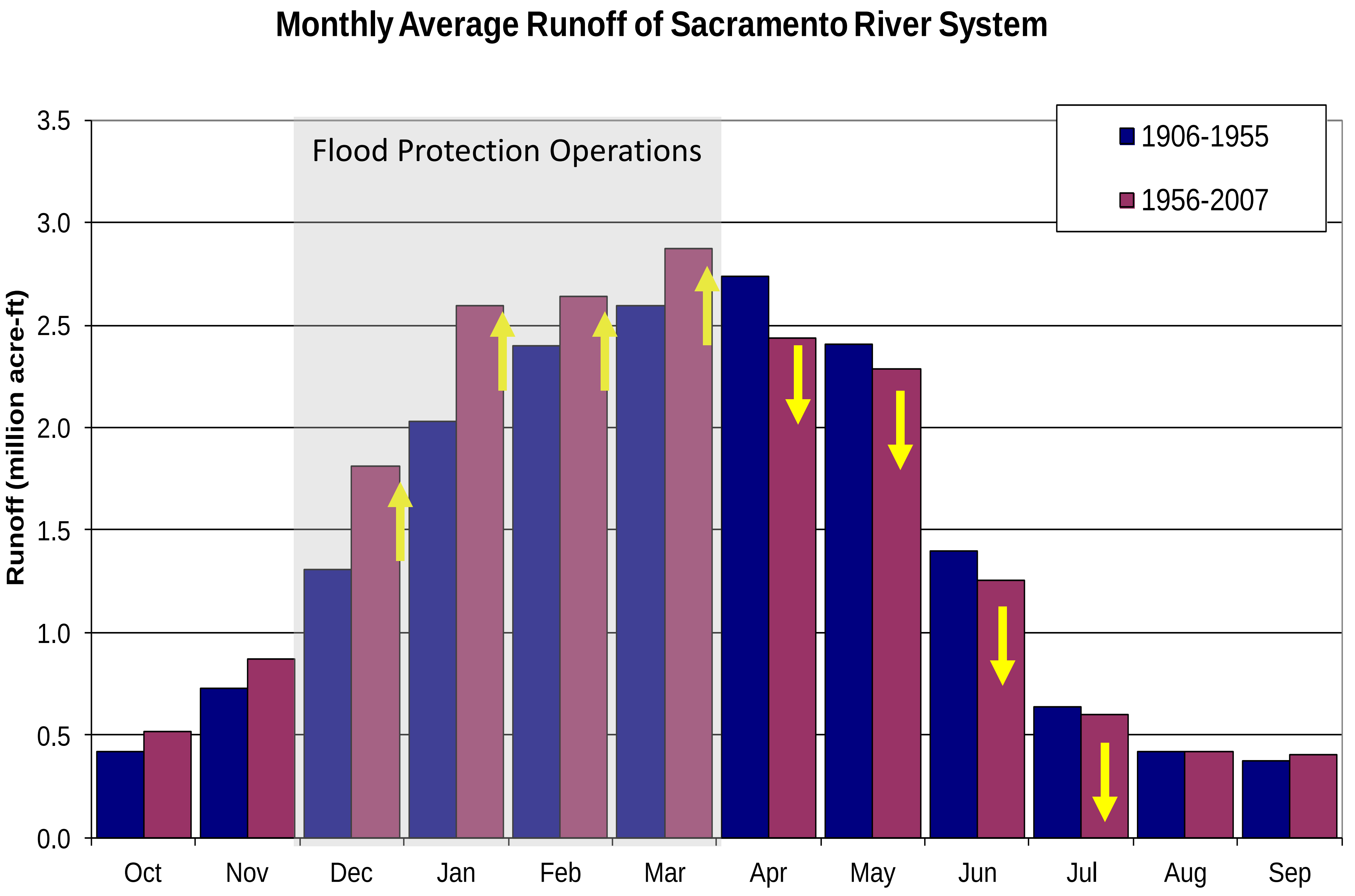


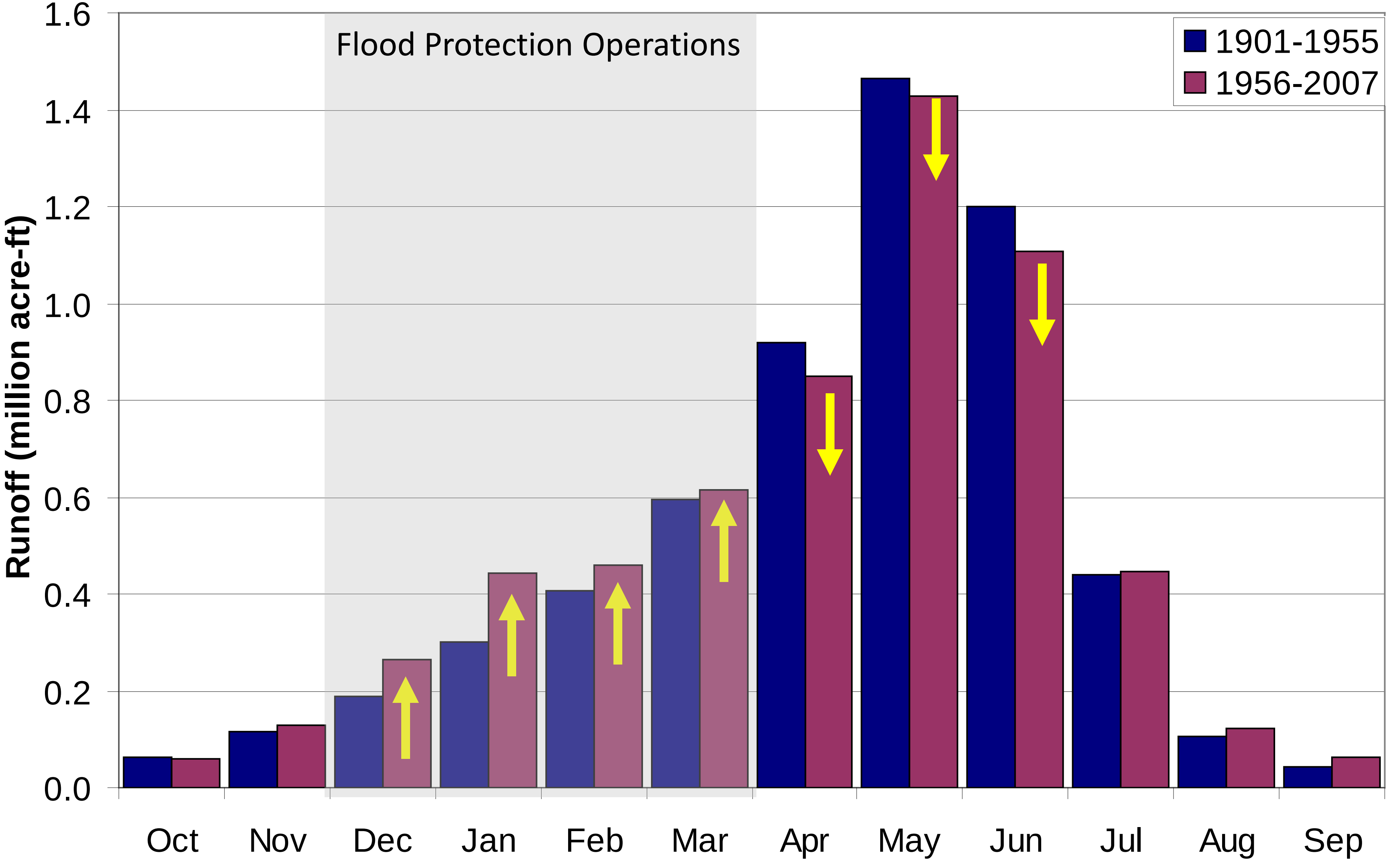
figure by N. Knowles

(20-year centered avg monthly T anoms rel to 1995-2005 monthly avgs from PCM B06.44 run, used to force BDWM with WY65-87 conditions. 6/18/01)



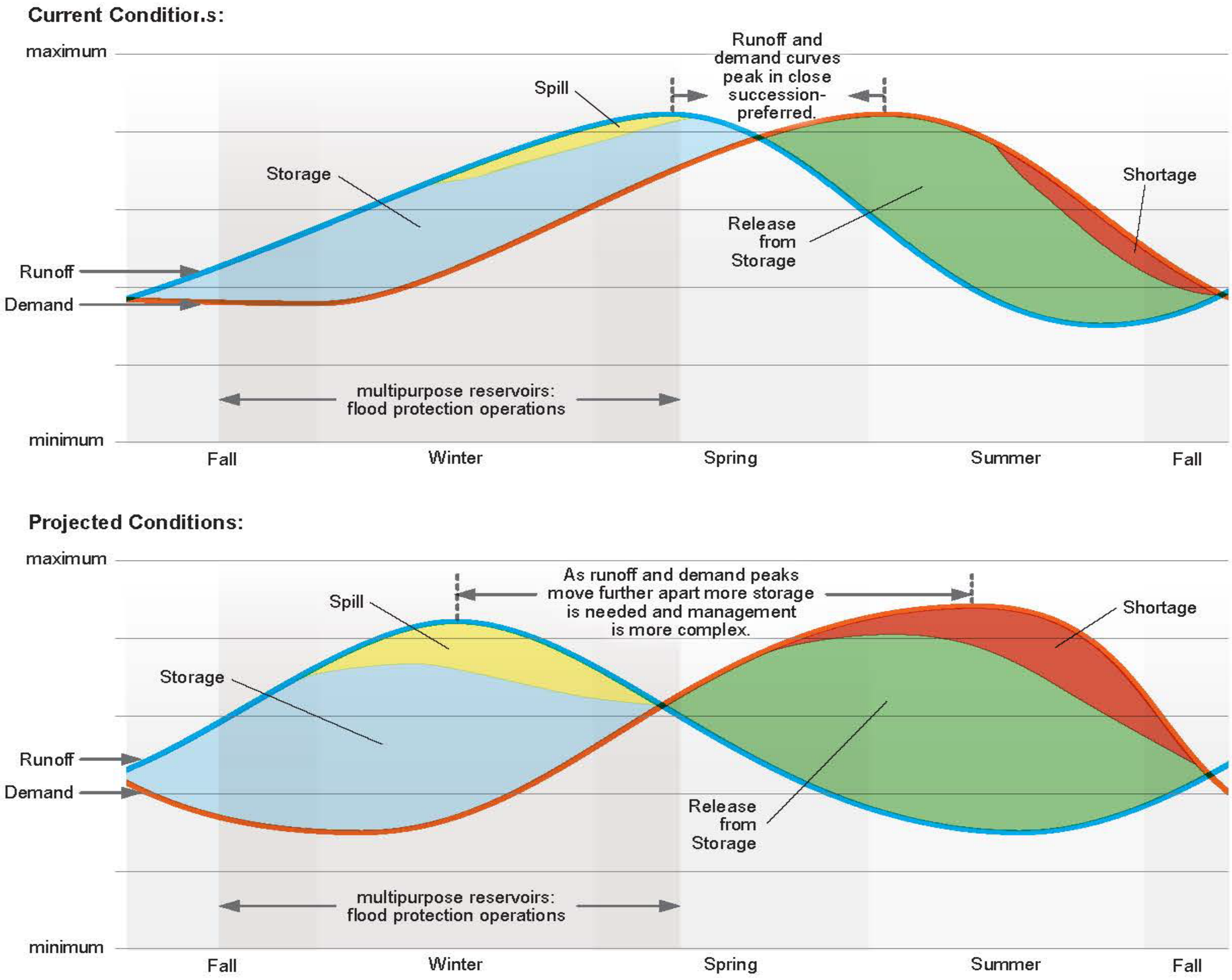
NOT a Water Plan FIGURE

Monthly Average Runoff in San Joaquin River System



NOT a Water Plan FIGURE

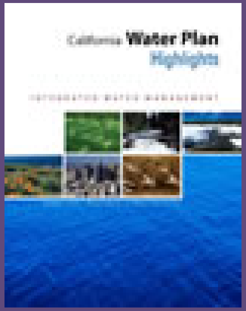
Fig. 3-21, How Earlier Runoff Affects Water Availability



California Water Plan, Update 2013
Climate Change Content

- Volume 1: CA Water Today
  Water-Energy Nexus and Diagram

Qinqin Liu



Water-Energy Connection

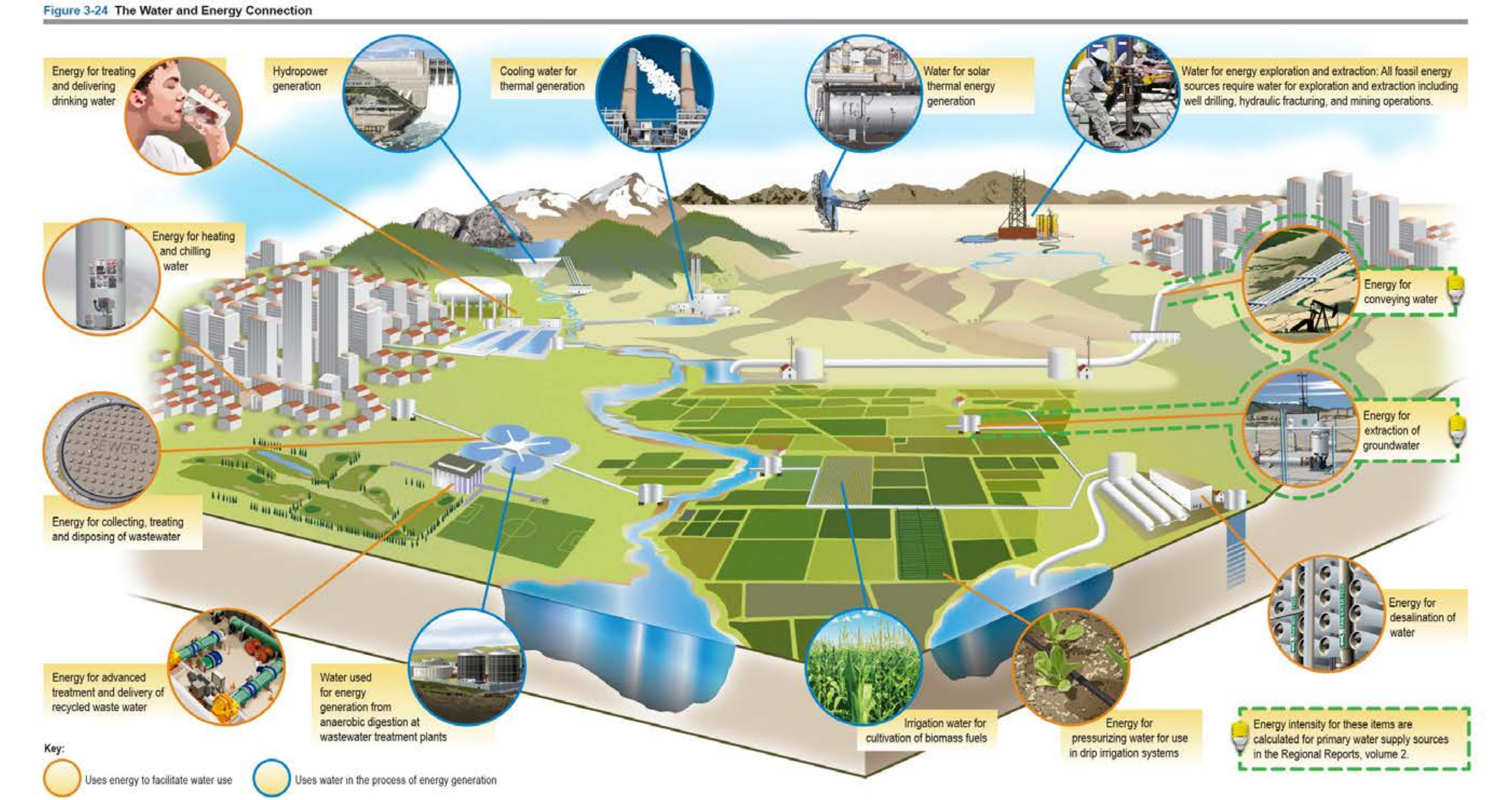
Objectives

Develop Water-Energy Information Framework

- Water management program portfolios to evaluate different regional water supply options
- Water use efficiency, water system energy efficiency
- Water and energy saving
- GHG reduction and climate change

Facilitate Interagency coordination and public outreach

Fig. 3-24
Water and Energy Connection



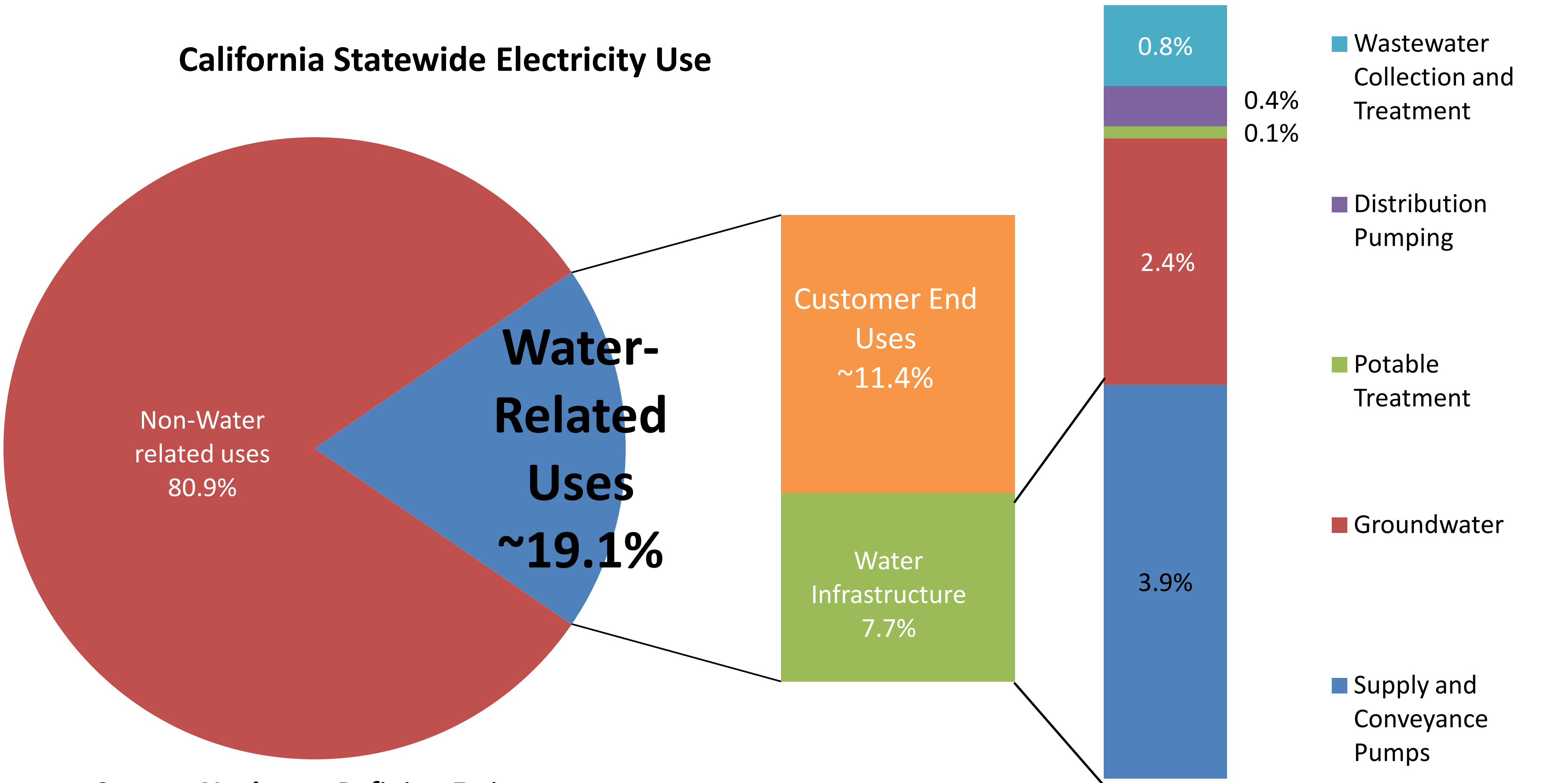
Blue circles: Water in Energy

Orange Circles: Energy in Water

Water-Energy Related Policy and coordination

- **AB32 scoping plan**
  - Mandated a GHG reduction to 1990 level by 2020;
  - Water management actions (Water Use Efficiency, Water recycling Water System Energy Efficiency, Reuse Urban Runoff, Renewable Energy)
- **SB7x7**
  - Reduce statewide per capita urban water use by 20% by the year 2020;
  - Agricultural entities required to apply efficient water management practices to reduce water demands.
- **Interagency coordination-WETCAT**
  - The Water-Energy Team (WETCAT) of the Governor's Climate Action Team

Electricity Energy Use in Water



Source: **Navigant**. *Refining Estimates of Water Related Energy Use In California.* 2006

Source: CPUC **Study 1 and Study 2**

NOT a Water Plan FIGURE

Energy in Water

Energy Intensity EI

A measure of efficiency in water uses and water systems

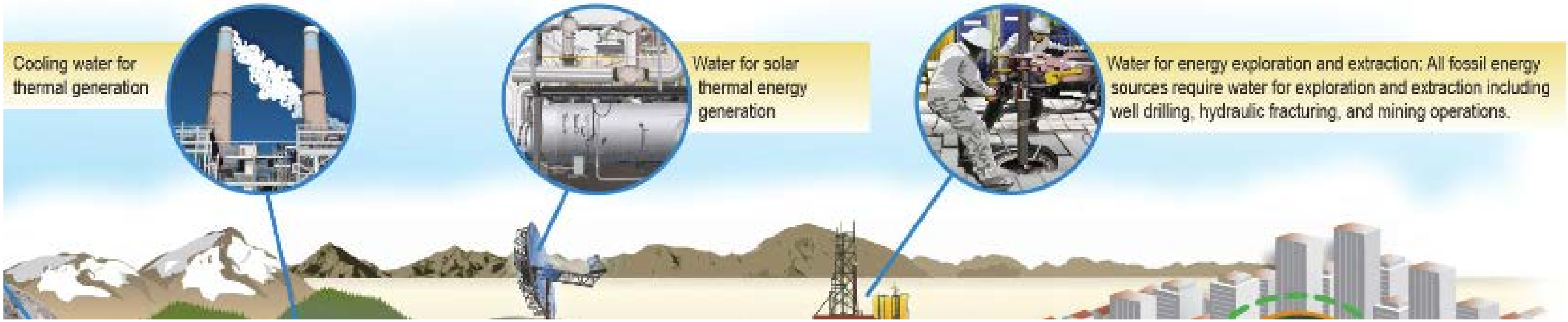
Energy used for water transport, distribution or treatment or end uses on a per unit basis (kilowatt hours per acre-foot of water [kWh/AF]).

Energy Embedded in Water

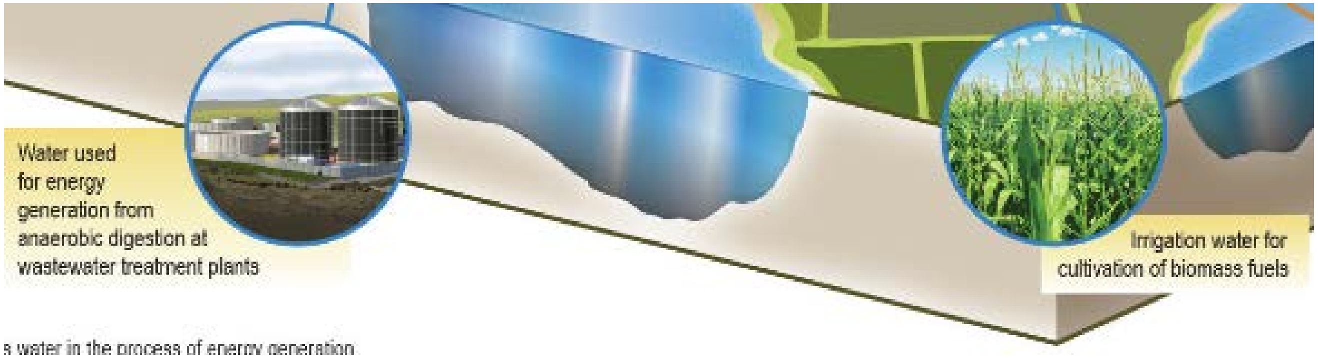
The amount of energy used in water cycles including: conveyance, treatment, and distribution, and wastewater collection, treatment and end use activities

Useful in quantifying energy savings as a result of water savings:

Embedded energy saved =water saved x EI



Water in Energy



Water in Energy

Background and definition

- Water footprint is used to assess amount of water used for energy production and consumption processes
- Examples: amount of water used in cooling thermoelectric power plants, agricultural and bio- fuel production, and extracting oil and natural gas.

- Current studies and information gaps

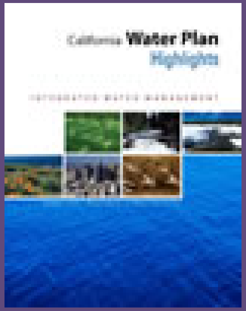


Challenges and Future Needs

- Coordination of climate change adaptation and mitigation
- Statewide and regional data
- Tools and standards
- Funding
- Policy alignment and management
- coordination in water and energy sectors

California Water Plan, Update 2013
Climate Change Content

- Volume 2: Regional Reports
  Mitigation/ Energy Intensity
  Jennifer Morales



Mitigation in the Regional Reports

Climate change mitigation has been added to every Regional Report

(excluding Mountain Counties and the Delta)

- Water-energy connection

- Introduces the Energy Intensity Diagram

- Covers the purpose, exclusions and caveats of the Energy Intensity Diagram

- Embedded energy

- Hydroelectric power in energy intensity calculations

Energy Intensity Diagram

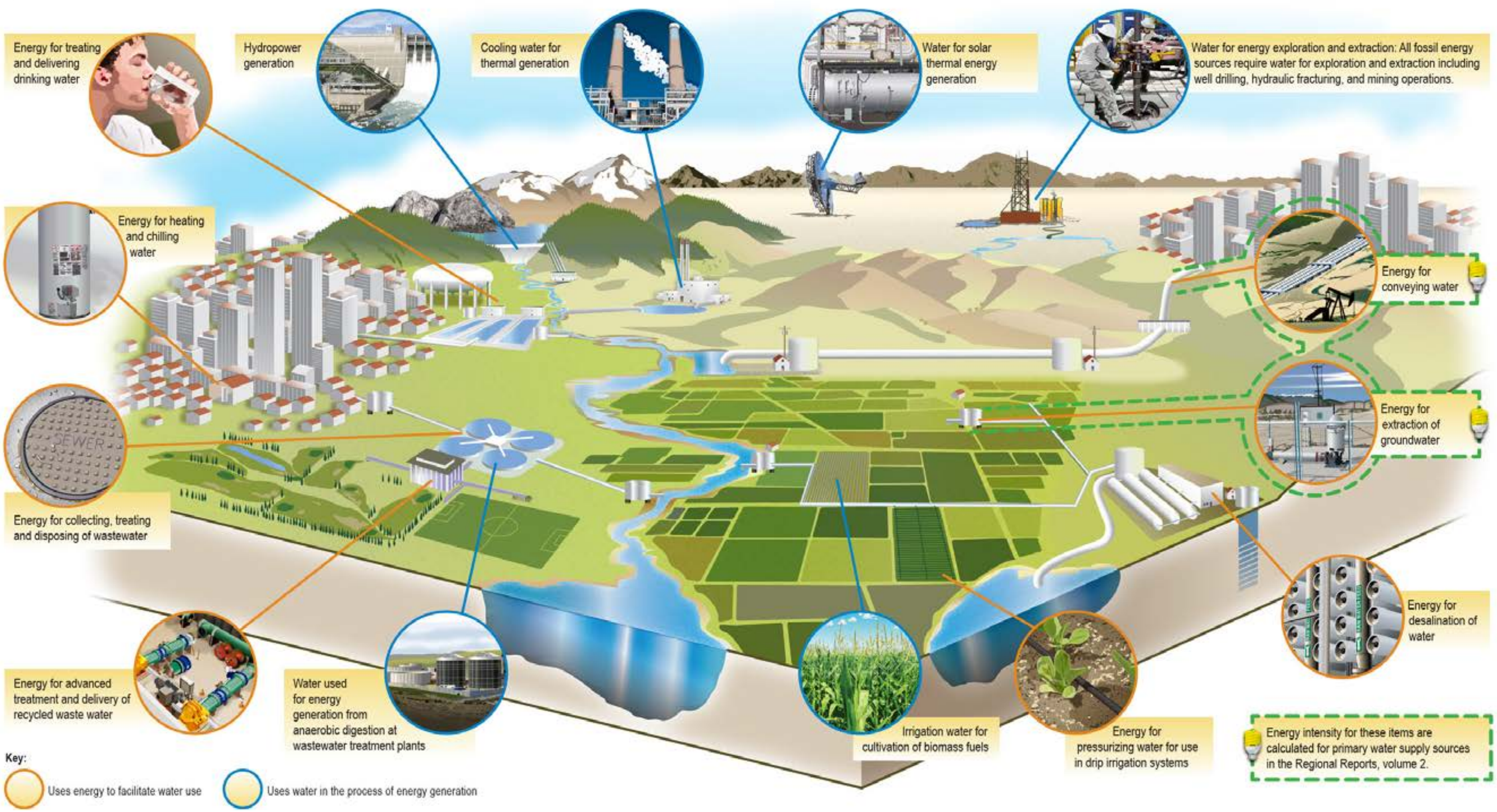
The Goal:
To provide a tool which allows water managers to compare the general energy intensity of the various water sources in their region to aid in decision making.

For this purpose 'energy intensity' in defined as the total amount of energy required for the **extraction** and **conveyance** of one acre-foot of water

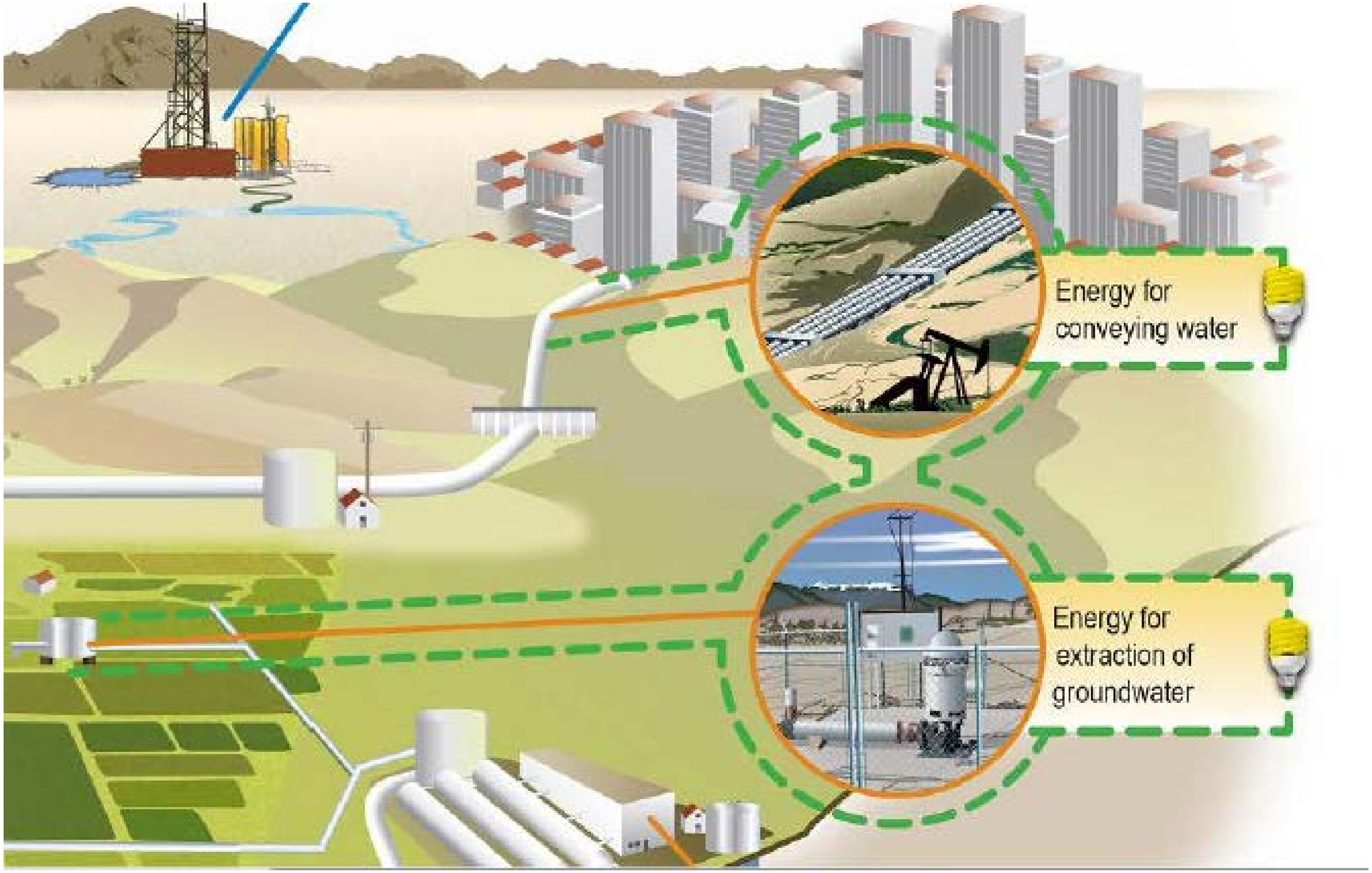
The energy needed for treatment, distribution or end-use was not included.

The Water and Energy Connection

Figure 3-24 **The Water and Energy Connection**

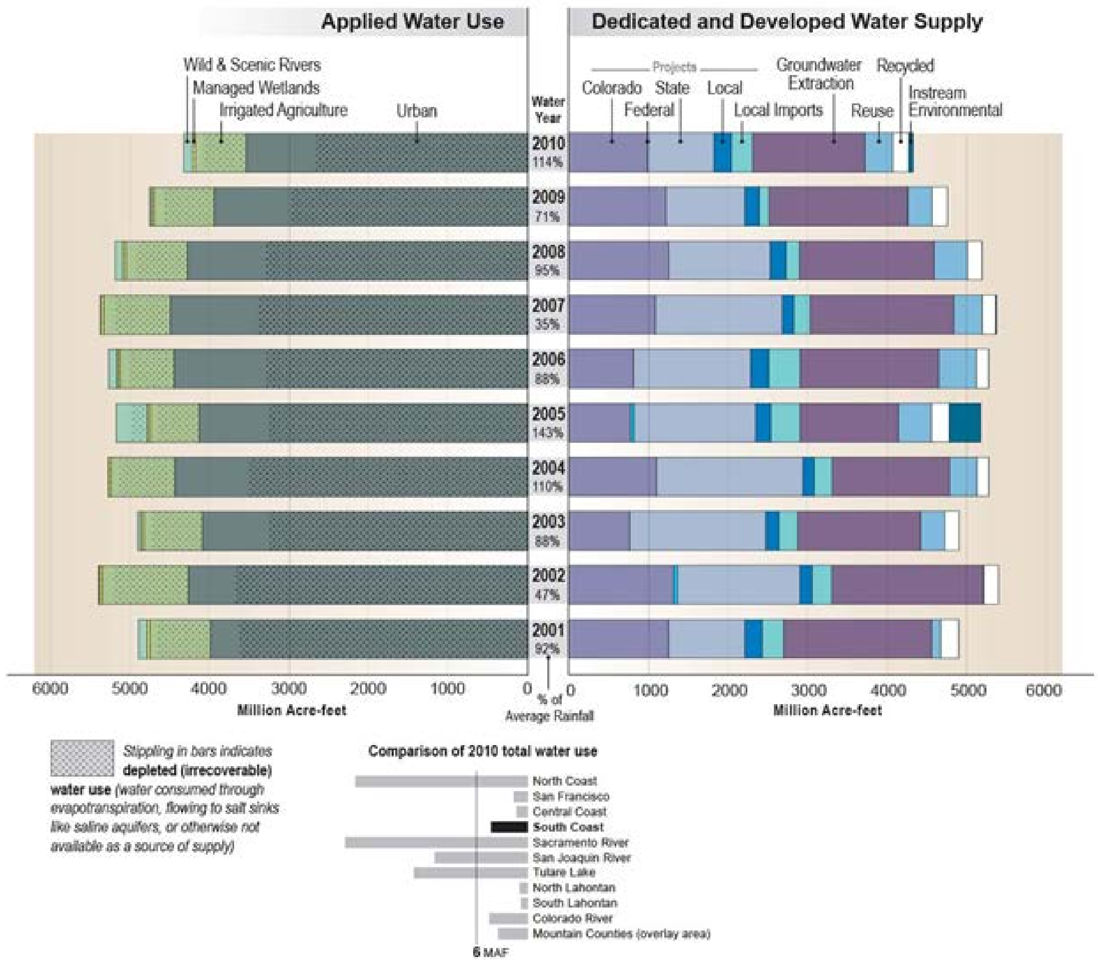


Energy Intensity for Water Types



We determined the water sources with…

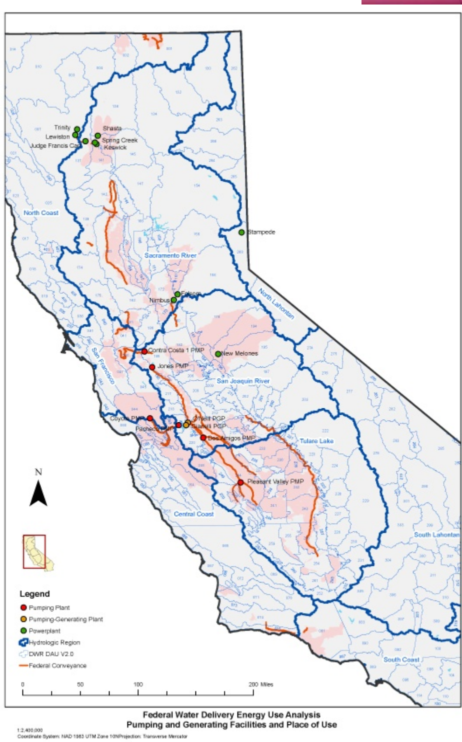
Figure SC-15 South Coast Hydrologic Region Water Balance by Water Year, 2001-2010

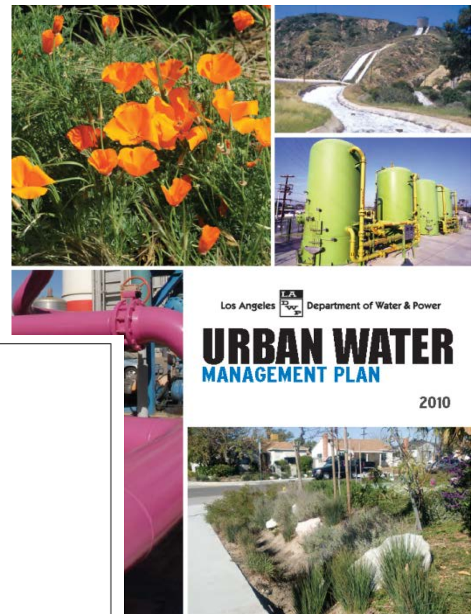


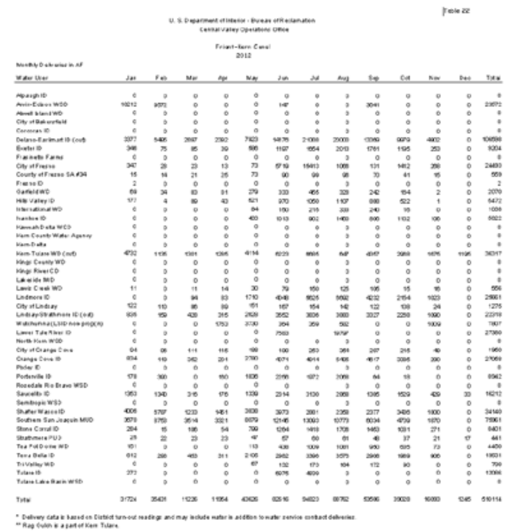
We determined the energy intensity with….


Embedded Energy in Water Studies
Study 1: Statewide and Regional Water-Energy Relationship

Prepared by
GEI Consultants/Navigant Consulting, Inc.

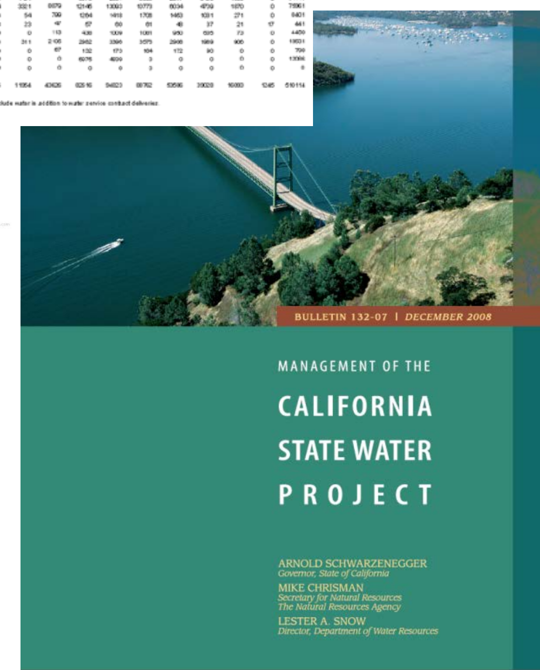





U. S. Department of Interior - Bureau of Reclamation
Central Valley Operations Office

Friant-Kern Canal
2012

Monthly Deliveries in AF



Energy Intensity Diagram – Figure X in each Regional Report

Figure x: South Coast energy intensity per acre foot of water

Type of Water	Energy Intensity (yellow bulb = 1-500 kWh/AF)	% of regional water supply
Colorado (Project)	5 bulbs - no hydro	21%
Federal (Project)	1 bulb <250 kWh/AF	0%
State (Project)	7 bulbs	27%
Local (Project)	1 bulb <250 kWh/AF	4%
Local Imports	0*	5%
Groundwater	2 bulbs	33%

* LAA is a net energy provider

South Coast Example shown

California Water Plan, Update 2013
Climate Change Content

- Volume 2: Regional Reports
  Adaptation
  Pete Coombe

Climate Change Adaptation

- *Regional Report Organization*

- **Intro- Common Themes in California**
- **Regional Specific Climate Information**
    - Observations
    - Projections and Impacts
- **Adaptation**
    - Vulnerabilities
    - RMS- Resource Management Strategies
    - IRWM

Common Themes

- *Intro- Common Themes in California*
- State and federal governments have been preparing for the effects of climate change for over 2 decades

Bulletin 160–93 The California Water Plan Update

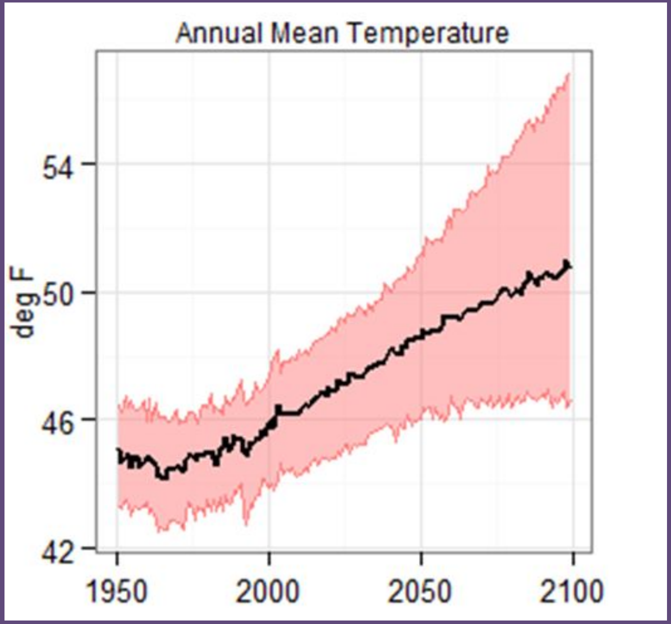
Possible Effects of Global Climate Change

Much concern has been expressed about possible future climate change caused by burning fossil fuel and other modern human activities that increase carbon dioxide and other trace greenhouse gases in the atmosphere. World weather records indicate an overall warming trend during the last century, with a surge of warming prior to 1940 (which cannot be attributed to greenhouse gases) and a more recent rise during the 1980s. The extent to which this latest rise is real or an artifact of instrument location (heat island effect of growing cities) or a temporary anomaly is debated among climatologists. For now, most of the projections of future climate change are derived from computer climate simulation studies. Not yet well–represented in the simulation models are cloud effects, which can have a large influence on the study results.

Common Themes

- *Intro- Common Themes in California*
- State and federal governments have been preparing for the effects of climate change for over 2 decades

- Climate model simulations project increasing temperatures (all models)



Common Themes

- *Intro- Common Themes in California*
- State and federal governments have been preparing for the effects of climate change for over 2 decades
- Climate model simulations project increasing temperatures (all models)
- Precipitation Patterns
  - Changes to surface runoff timing, volume, and type
  - Increase in intensity of Atmospheric Rivers

Regional Observations

- *Regional Specific Climate Information*
- *Observed changes over the past century:*
  - Air temperature trends
  - Precipitation trends
  - Shifts in spring snowpack
  - Streamflow trends
  - Sea Level Trends
    (Coastal Regions)

Regional Observations

- *Regional Specific Climate Information*

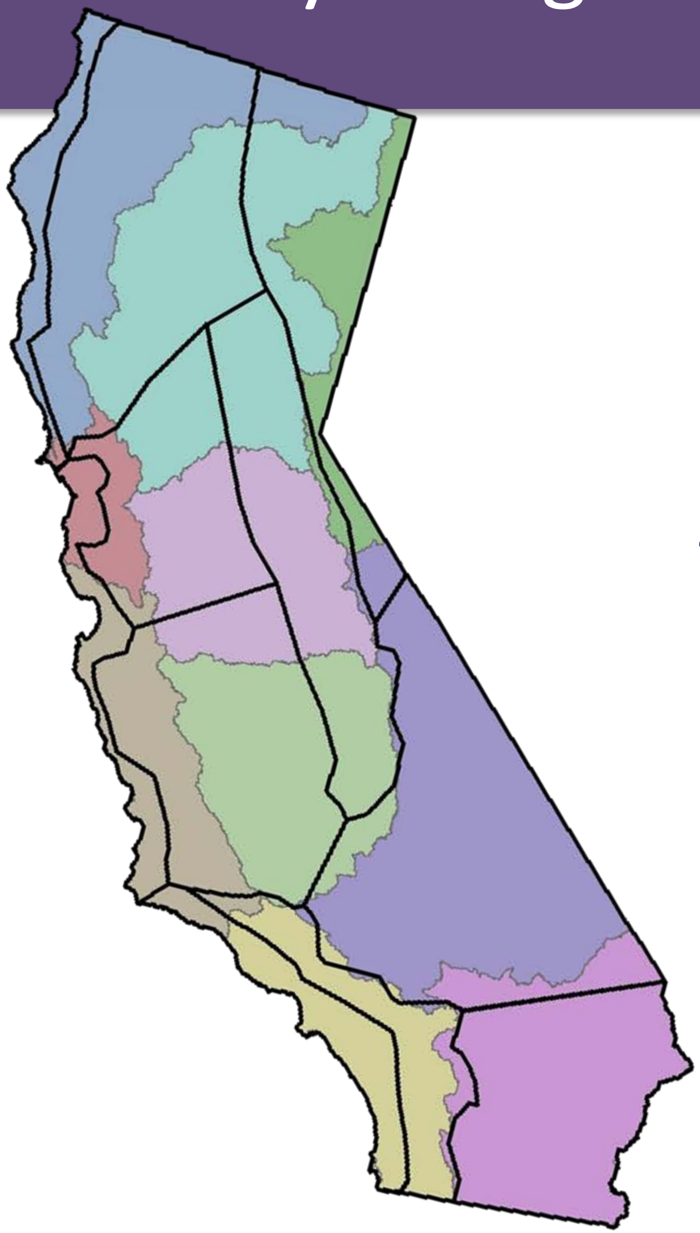
- *Observed changes over the past century:*

Air temperature trends- Evaluated using (WRCC)

Western Regional Climate Center Data

http://www.calclim.dri.edu/

Hydrologic Region VS. Climate Region



- **CWP Hydrologic Regions**
  1. North Coast
  2. Sacramento River
  3. North Lahontan
  4. San Francisco Bay
  5. Mountain Counties
  6. San Joaquin River
  7. Central Coast
  8. South Coast
  9. Tulare Lake
  10. South Lahontan
  11. Colorado River

- **WRCC Climate Regions**
  1. North Coast
  2. North Central
  3. Northeast
  4. Sacramento-Delta
  5. Sierra
  6. San Joaquin Valley
  7. Central Coast
  8. South Coast
  9. Southern Interior
  10. Mohave Desert
  11. Sonoran Desert

Regional Observations

- *Example: Observed changes over the past century*

- Air temperature trends

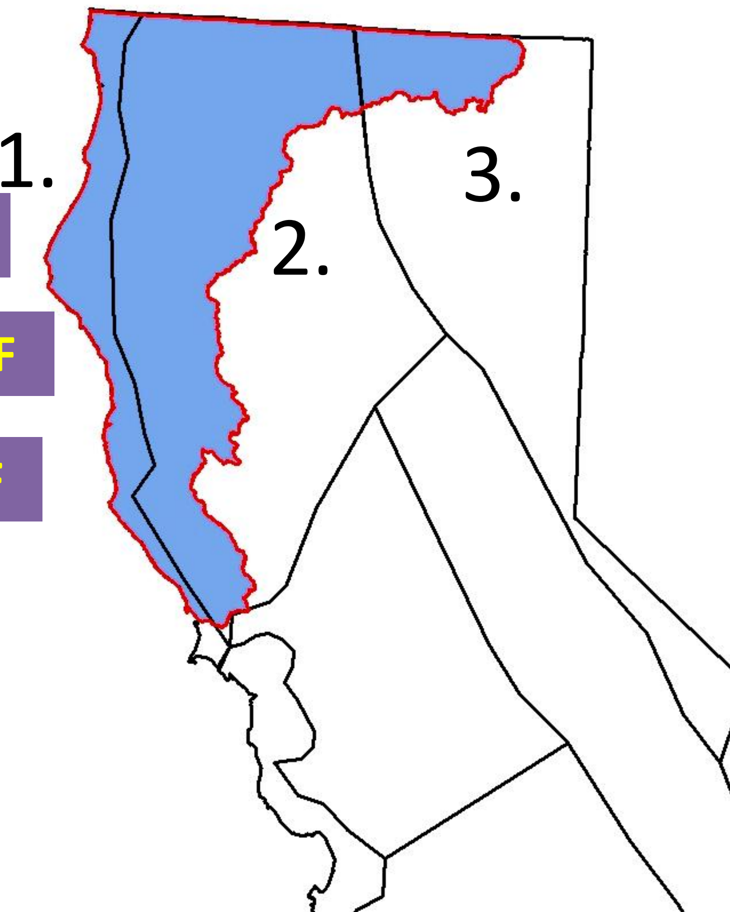
1. Northern Coastal climate region
2. North Central climate region
3. North East climate region

0.4 to 1.3 F

0.5 to 2.8 F

0.8 to 2.0 F

North Coast Hydrologic Region

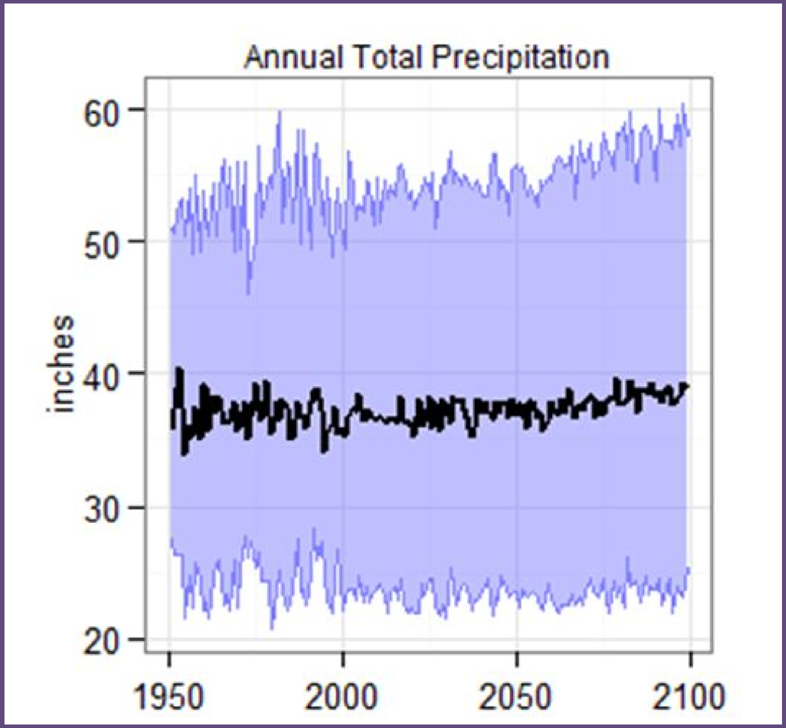


NOT a Water Plan Figure

Regional Projections and Impacts

- *Regional Specific Climate Information*

- *Projected future scenarios*
  - Air temperature
  - Precipitation trends
  - Spring snowpack simulations
  - Sea level projections (Coastal Regions)



NOT a Water Plan Figure

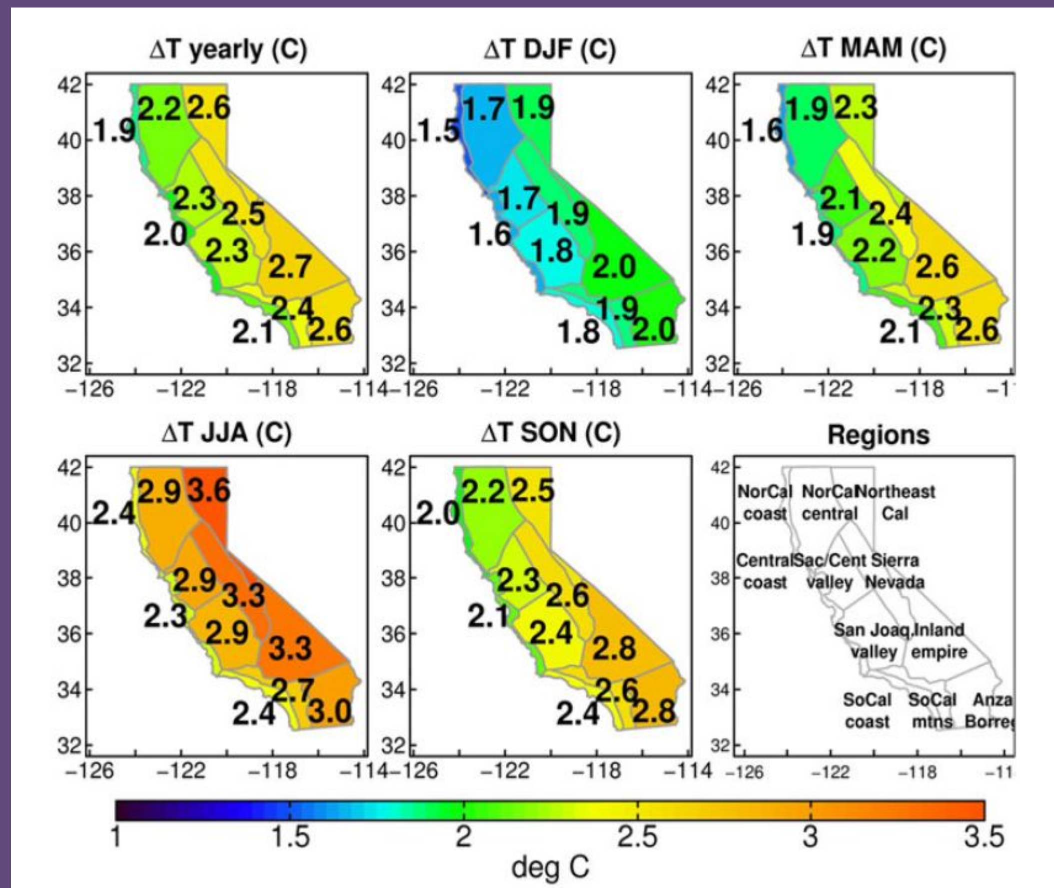
Regional Projections and Impacts

- *Projected future scenarios*
- **Air temperature change 1985–1994 to 2060–2069**

Example:
North Coast Region

Change in Temp
JJA
2.4 to 3.6 deg (C)
4.3 to 6.5 deg (F)

Scripps Institution of Oceanography, Pierce et al, 2012



NOT a Water Plan Figure

Adaptation

- *Key Ideas for Developing Adaptation Strategies*
- Strategies that benefit the region at the present and into the future
- Vulnerabilities are best assessed on a regional basis
- Adaptation to climate change should be both proactive and adaptive
- Loss of "stationarity“
- Climate change adds another layer of uncertainty to water planning

Adaptation

- *Example: Highlights from the North Coast Regional Report*

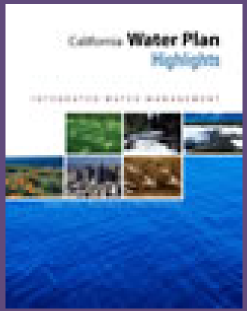
- Vulnerabilities-
  - Diminished snowpack, few significant aquifers, increased potential for water shortages

- Recommended (RMS) Strategies-
  - Agricultural/Urban
    Water Use Efficiency
  - Forest/Watershed Management

California Water Plan, Update 2013
Climate Change Content

Andrew Schwarz

- Volume 3: Resource Management Strategies



Climate Change and the RMS's

- Specific ***Climate Change Impacts*** related to the RMS
- ***Adaptation* -** How does the RMS act to make water resources more resilient or adaptable to climate change
- ***Mitigation*** – Does the RMS act to reduce GHG emissions or does it actually cost carbon/energy to achieve

Example: Urban Water Use Efficiency

Impacts:

- Higher temperatures
- changing hydrology/storage patterns
- higher variability--need highly reliable water

Adaptation (+):

- **Reduce overall need for water -> prepares water users for reductions in supply.**

Mitigation (+) :

- **Lower water consumption -> Lower Energy -> Lower GHG Emissions**

Example: Ag Water Use Efficiency

Impacts:

- Higher temperatures –could lead to longer growing seasons, crop shifting
- changing hydrology/storage patterns
- higher variability—crop shifting, volatile commodity prices

Adaptation (+):

- Reduce overall need for water -> improved ability to meet water needs allow for maximum flexibility in use

Mitigation (-):

- Lower water consumption -> Higher Energy -> Higher GHG Emissions

Example: Conjunctive Water Management

Impacts:

- Higher temperatures –increased water demand
- changing hydrology/extreme events
- higher variability—more floods and droughts

  greater reliance on groundwater

Adaptation (+):

- Improved drought supplies, improved management of flood waters, groundwater recharge, improve storage capacity, system reoperation

Mitigation (+/-):

- Increased energy for injection wells and extraction wells, reduced reliance on imported or higher energy supplies, improved groundwater levels (reduced pumping depth)

Desalination and Recycled Water

Energy Intensity Information

- Desal and Recycling are different…
- Lots of variables…
- Energy factors for various types of processes are provided

Next Steps and Comments

- **CA Water Today: Statewide Strategies**
  - Adaptation
  - Water-Energy Nexus
- **Regional Reports**
  - Regionally appropriate Adaptation strategies
  - Energy Intensity of Raw Water Extraction and Conveyance
- **Resource Management Strategies**
  - Assess for Climate Change Adaptation
  - Impact on Greenhouse Gas Emissions (Mitigation)
- **Reference Material**

  Technical and policy background information

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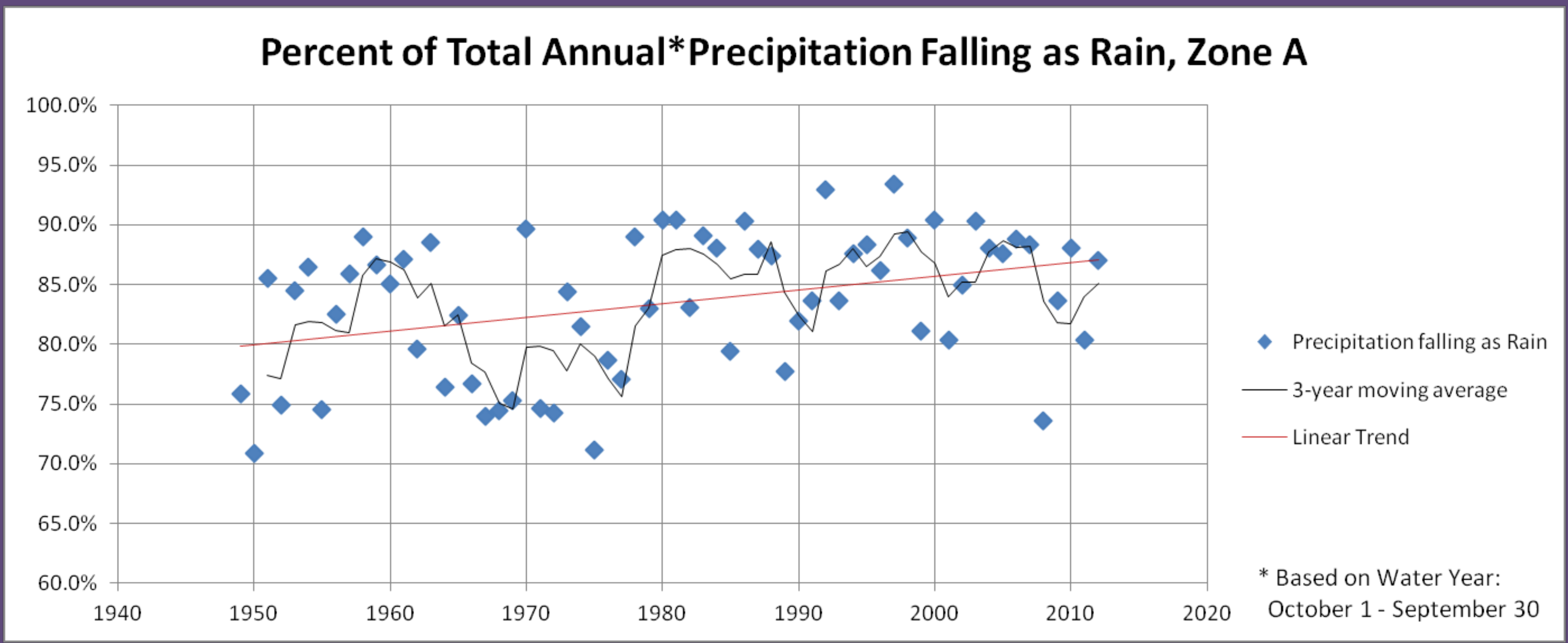
Thank You

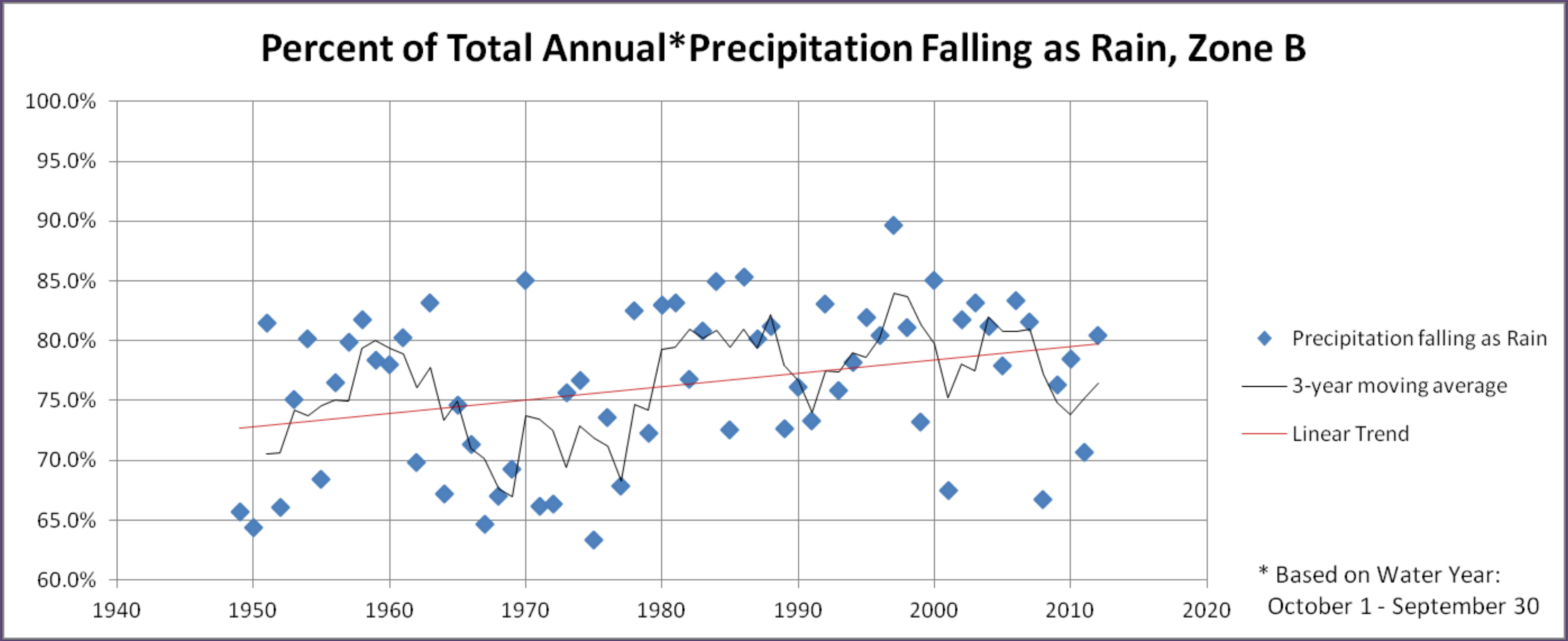
Extra Slides

Extra Aaron Slides

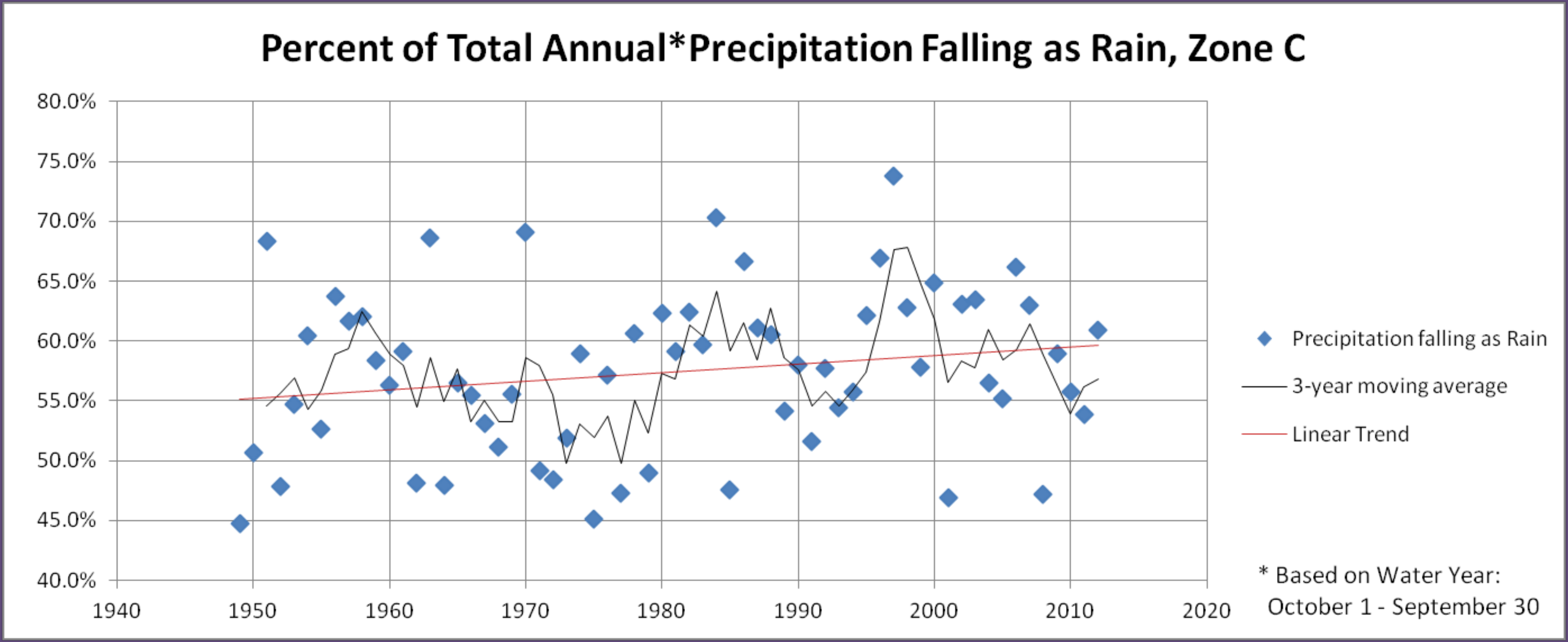
Results – Zone A



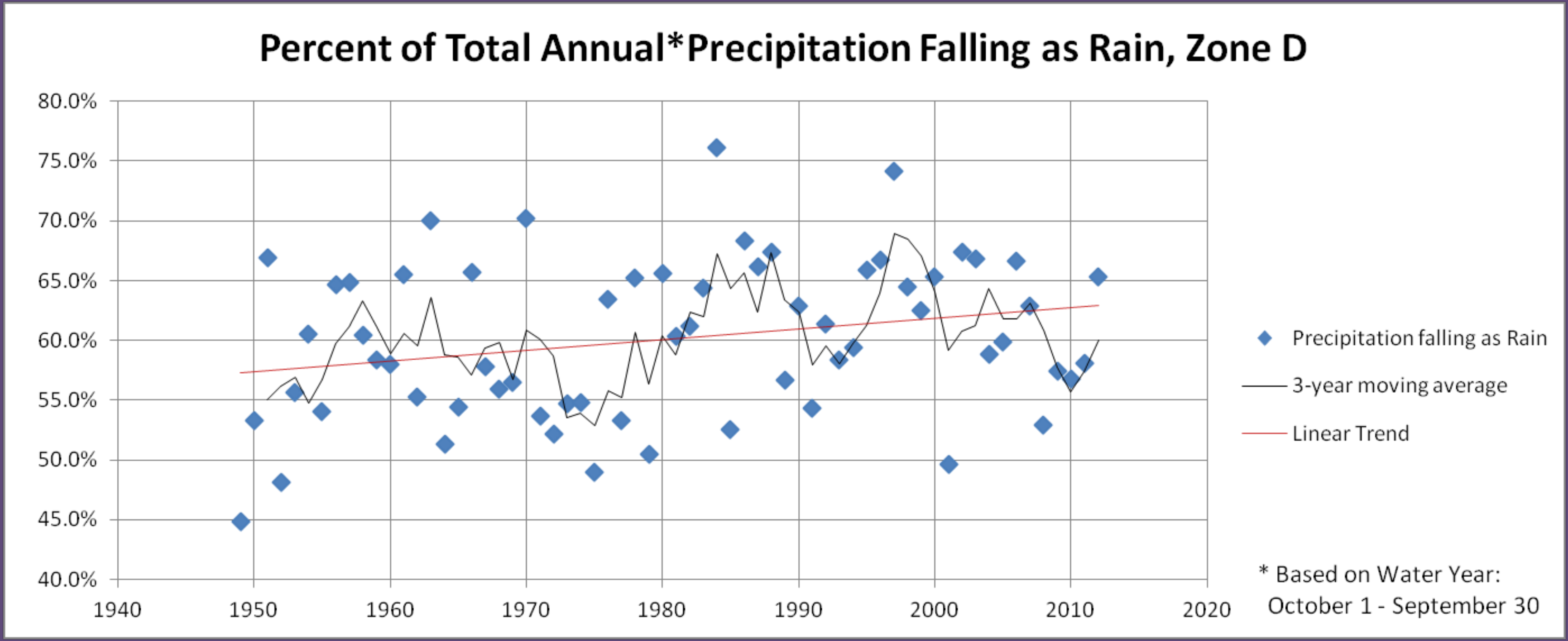
Results – Zone B



Results – Zone C



Results – Zone D



Analysis

Mann-Kendall Trend Analysis of **Annual Precipitation** by Analysis Zone
H0: No change in Annual Precipitation over time

Zone	Kendall's tau	2-sided p value	Interpretation
Zone A	-0.044	0.614	**Fail to reject H_0**
Zone B	-0.037	0.672	**Fail to reject H_0**
Zone C	0.005	0.958	**Fail to reject H_0**
Zone D	0.024	0.785	**Fail to reject H_0**
Total Analysis Area	-0.020	0.821	**Fail to reject H_0**

Analysis

Mann-Kendall trend test of **annual snow** by analysis zone
H_0: No change in annual snow over time

Zone	Kendall's tau	2-sided p value	Interpretation
Zone A	-0.232	0.007	**Reject H_0**
Zone B	-0.186	0.031	**Reject H_0**
Zone C	-0.039	0.656	**Fail to reject H_0**
Zone D	-0.037	0.672	**Fail to reject H_0**
Total Analysis Area	-0.104	0.226	**Fail to reject H_0**

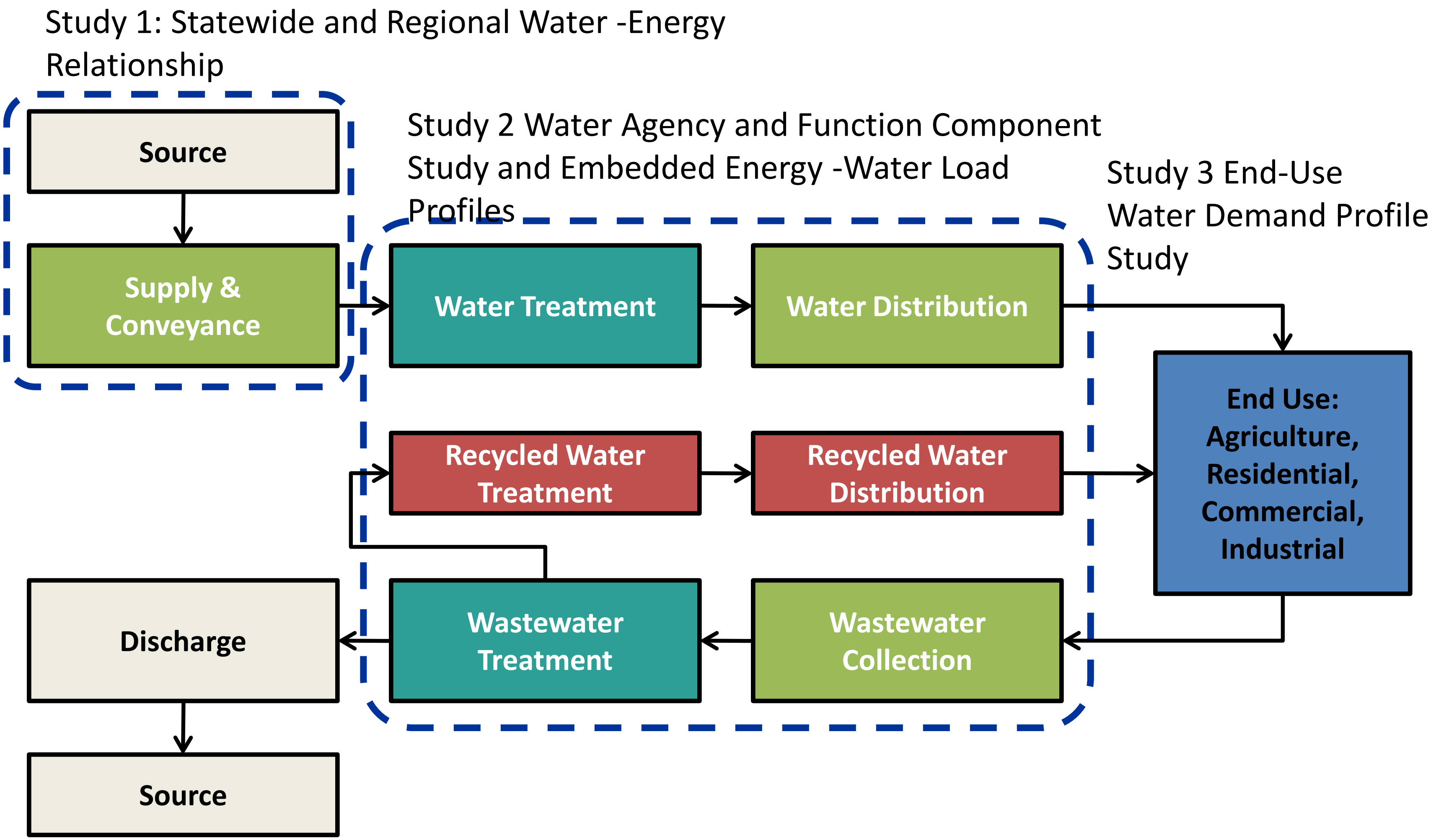
Analysis

Mann-Kendall trend test of **rain as % of total precipitation,** by analysis zone
H0: No change in percent rain over time

Zone	Kendall's tau	2-sided p value	Interpretation
Zone A	0.227	0.008	**Reject H_0**
Zone B	0.214	0.013	**Reject H_0**
Zone C	0.132	0.125	**Fail to reject H_0**
Zone D	0.158	0.066	**Fail to reject H_0**
Total Analysis Area	0.196	0.022	**Reject H_0**

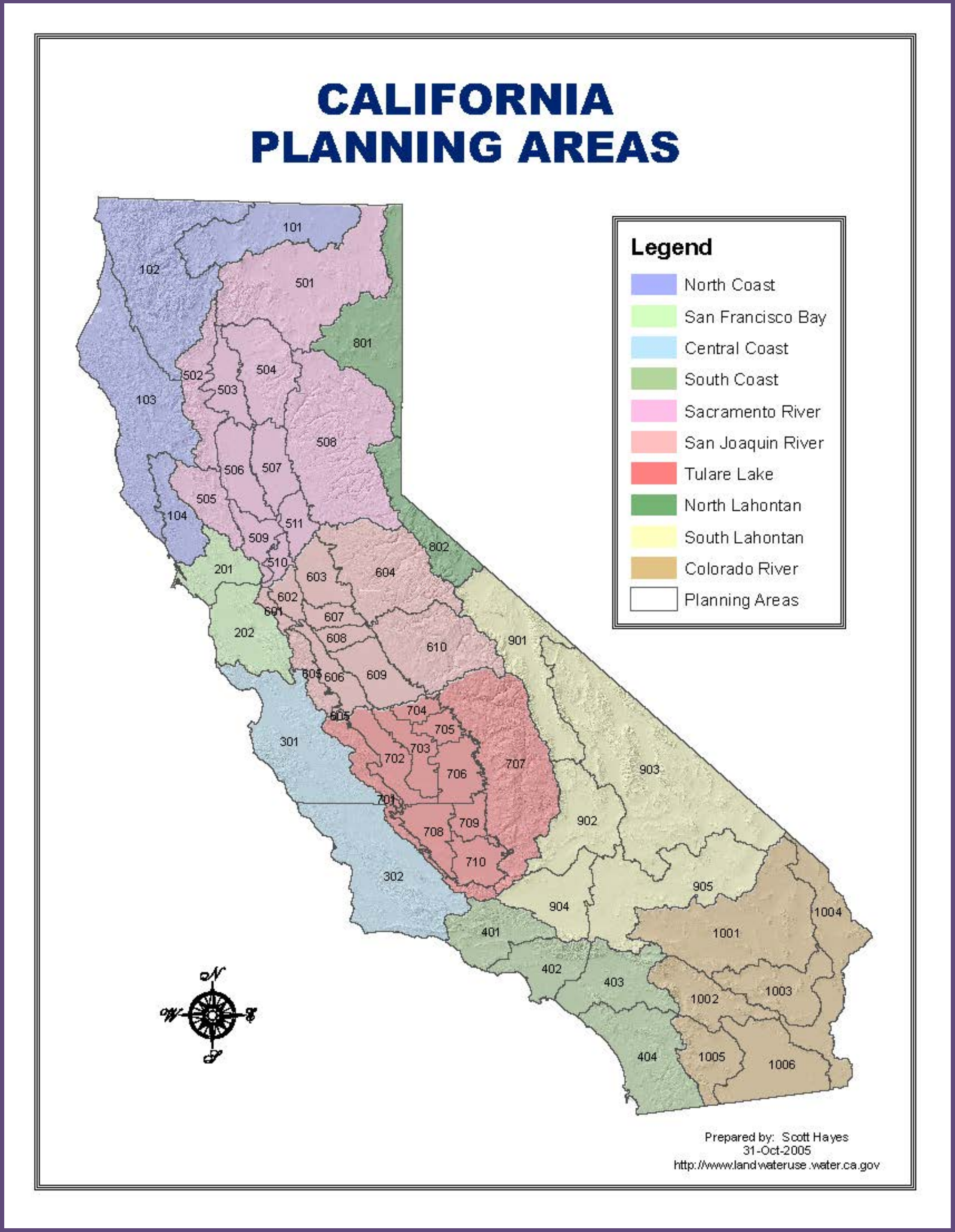
Extra Qinqin Slides

CPUC Studies in the Water System



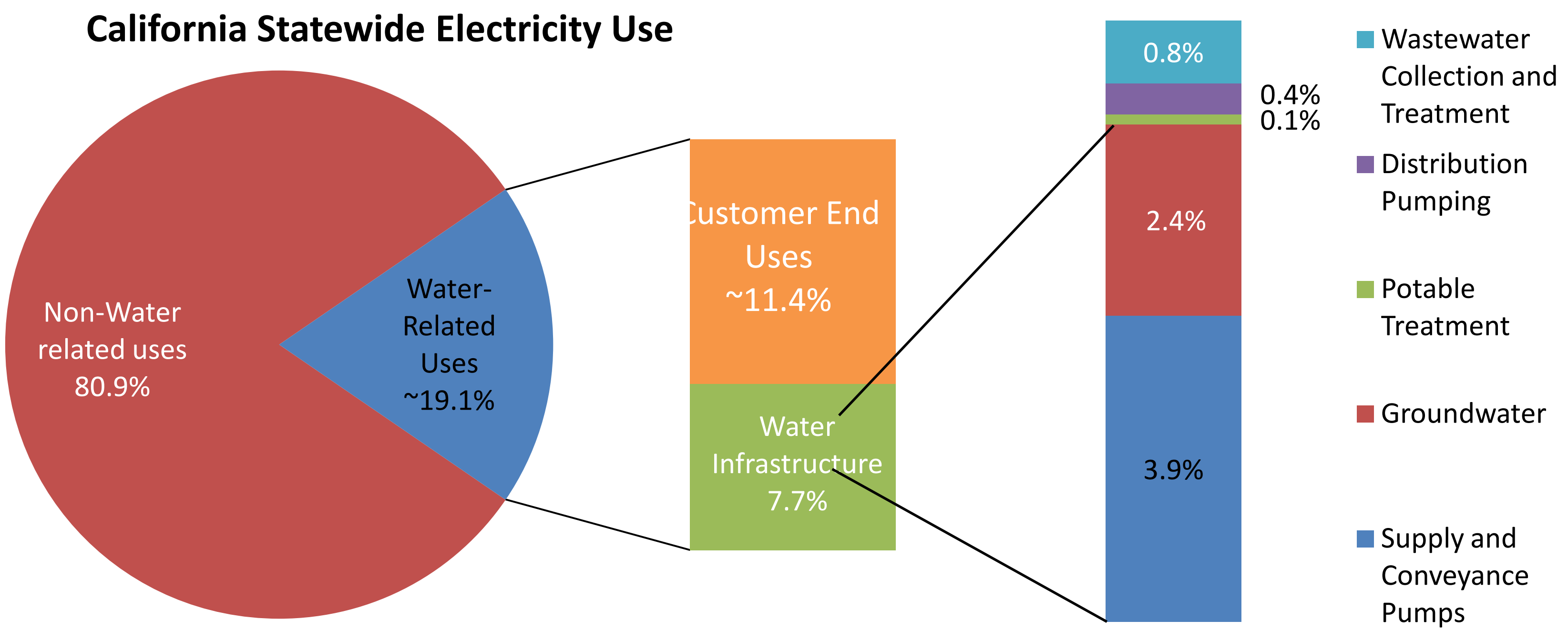
10 Hydrologic Regions

(plus Delta and Mountain Co.s)



Energy in Water

- Estimated CA State Wide Water Related Electricity Use 19.1%;
- GHG Produced 20.46 Million Tonnes of CO_2 equivalent (GHG by electric power 2006/IPCC)



Source: **Navigant**. *Refining Estimates of Water Related Energy Use In California.* 2006

Source: CPUC **Study 1 and Study 2**

Extra Jennifer Slides

Water Year 2008

2008 Water Year Ends Critically Dry

The 2008 water year officially ended Sept. 30. Following a dry 2007, the 2008 water year was designated

critically dry. Statewide runoff totaled just 57% of normal for the year. The state's major reservoirs are at

about one-third of capacity at a time when they would typically be at about two-thirds.[1]

Current Conditions[2]:

• In Northern California, Lakes Shasta, Oroville and Folsom are at or below 30% of capacity. Lakes San Luis and Pine Flat are at 12% of capacity.

• The Colorado River is only at 56% and has seen the lowest 10 year flow average on record, but it is recovering.

• The seven-month period March-September 2008 was the driest on record in the Northern Sierra. Only 3.5" or rainfall was received: merely 23% of average.

• Statewide precipitation for the six-month period March-August 2008 was 31% of average; the driest of 114 years on record.

• Southern California experienced its driest year on record last year.

With all signs pointing to a third dry year for Southern California, water agencies are gearing up for more challenges and the possibility of widespread water shortages.3

1 Association of California Water Agencies, "Dealing with Drought", October 2008.

2 CA Department of Water Resources, "Water Conditions-2008 factsheet.pdf", October 2008

3 Association of California Water Agencies, "Dealing with Drought", October 2008.

Federal Justifications

- **North Coast**- No pumping plants according to FWDEUA map. It has two power plants; Trinity and Lewiston, both operated by BOR.
- **North Lahontan**- No CVP deliveries according to CPUC. It has one power plant; Stampede, operated by BOR.
- **Sacramento River**- No CVP deliveries according to WY2008 Delivery Report. There are small pumps, but have such low EI that they will not be considered. The 15 KWh/ac-ft figure comes from Red Bluff Fish Passage Improvement Project per TCCA.
- **San Francisco**- County of Santa Clara, DAU 44 received 97,639 ac-ft of CVP water. Water comes from the southern tip of the Sacramento-San Joaquin Delta->Jones PMP->DMC-> O'Neill PGP->Pacheco PMP->Coyote PMP. 332.5 KWh/ac-ft (Gianelli removed)

Just because it quacks like a duck and walks like a duck doesn't mean its not the Delta-Mendota Canal

San Joaquin River Hydrologic Region: 217 KWh/ac-ft weighted average

- DAU 185 (Tracy)->Jones PMP->DMC.
- DAU 204 (County of Fresno)-> gravity fed through Friant-Kern Canal.
- DAU 212 (Los Banos)->Jones PMP->DMC->Mendota Pool.
- DAU 213 (Madera County)->Madera Canal.
- DAU 214 (Counties of Fresno and Madera)-> Millerton lake.
- DAU 215 (Madera County) 64,453 ac-ft; 55,524 ac-ft goes to Columbia Canal Co from DMC, and 7,951 ac-ft goes to Gravelly Ford WD from Millerton Lake.

SJR

DAU 216

- Central California ID: Jones->DMC->SJR and Mendota Pool
- Del Puerto WD: Jones->DMC
- City of Dos Palos: Jones->DMC->O'Neill->San Luis Canal
- Eagle Field WD: Jones->DMC
- Firebaugh Canal WD: Jones-> DMC-> SJR and Mendota Pool
- Grasslands WD: Jones->DMC
- Los Banos WA: Jones->DMC
- Mercy Springs WD: Jones->DMC
- North Grasslands WA: Jones->DMC
- O' Neill Forebay WA: Jones->DMC->O'Neill
- Oro Loma WD: Jones->DMC
- Pacheco CCID: Jones->DMC->O'Neill->San Luis Canal
- Pacheco WD: Jones->DMC->O'Neill->San Luis Canal
- Pacheco WD Ag: Jones->DMC
- Pacheco WD M&I: Jones->DMC
- Patterson WD: Jones->DMC
- San Luis Canal Co: Jones-> DMC-> SJR and Mendota Pool
- San Luis NWR: Jones-> DMC-> SJR and Mendota Pool
- San Luis WD Ag: Jones-> DMC
- San Luis WD M&I: Jones-> DMC
- VA Cemetery: Jones->DMC->O'Neill
- Volta WA: Jones->DMC
- West Stanislaus ID: Jones->DMC

SJR

Tulare Lake- 202 KWh/ac-ft

DAU 233- (Fresno County) Friant-Kern Canal and the CVC.

DAU235- (Fresno County) Jones-> DMC->SJR and Mendota Pool

DAU 237- (Fresno County) Jones-> DMC->SJR and Mendota Pool

DAU 240- (Fresno County) CVC and Friant-Kern Canal

DAU 242- (Kings County, Tulare County) CVC and Friant-Kern Canal

DAU 243- (Tulare County) Friant-Kern Canal

DAU 244- (Fresno County) Jones->DMC->O'Neill->Dos Amigos->San Luis Canal

DAU 245- (Kings County, Fresno County) Jones->DMC->O'Neill->Dos Amigos->Pleasant Valley->San Luis Canal

DAU 254- (Kern County) Friant-Kern Canal

DAU 255- (Kern County) Jones->DMC->O'Neill->Dos Amigos->Pleasant Valley->San Luis Canal

DAU 256- (Kern County) Friant-Kern Canal

DAU 257- (Kern County) Friant- Kern Canal

DAU 258- (Kern County) Friant- Kern Canal

- **Central Coast Hydrologic Region**

- DAU 62 County of San Benito: Jones PMP->DMC->O'Neill PGP->Pacheco PMP. 314 KWh/ac-ft

- **South Coast**

- No CVP deliveries according to CPUC.

- **South Lahontan**

- No CVP deliveries according to CPUC.

Figure x: Tulare Lake energy intensity per acre foot of water

Type of Water	Energy Intensity (yellow bulb = 1-500 kWh/AF)	% of regional water supply
Colorado (Project)	*This type of water not available*	0%
Federal (Project)	 <250 kWh/AF	15%
State (Project)		8%
Local (Project)	 <250 kWh/AF	16%
Local Imports	*This type of water not available*	0%
Groundwater		50%

Figure x: Sacramento River energy intensity per acre foot of water

Type of Water	**Energy Intensity** (yellow bulb = 1-500 kWh/AF)	% of regional water supply
Colorado (Project)	*This type of water not available*	0%
Federal (Project)	<250 kWh/AF	28%
State (Project)	<250 kWh/AF	0%
Local (Project)	<250 kWh/AF	30%
Local Imports	*This type of water not available*	0%
Groundwater	<250 kWh/AF	19%

Figure x: South Lahontan energy intensity per acre foot of water

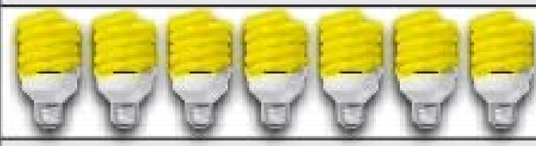
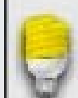
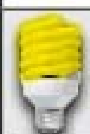
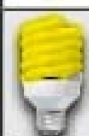
Type of Water	**Energy Intensity** (yellow bulb = 1-500 kWh/AF)	% of regional water supply
Colorado (Project)	*This type of water not available*	0%
Federal (Project)	*This type of water not available*	0%
State (Project)		14%
Local (Project)	 <250 kWh/AF	7%
Local Imports	*This type of water not available*	0%
Groundwater		64%

Figure x: San Joaquin energy intensity per acre foot of water

Type of Water	Energy Intensity (yellow bulb = 1-500 kWh/AF)	% of regional water supply
Colorado (Project)	*This type of water not available*	0%
Federal (Project)	<250 kWh/AF	16%
State (Project)		0%
Local (Project)	<250 kWh/AF	29%
Local Imports	*This type of water not available*	0%
Groundwater	<250 kWh/AF	31%

Figure x: San Francisco energy intensity per acre foot of water

Type of Water	**Energy Intensity** (yellow bulb = 1-500 kWh/AF)	% of regional water supply
Colorado (Project)	*This type of water not available*	0%
Federal (Project)		12%
State (Project)		12%
Local (Project)	 <250 kWh/AF	15%
Local Imports	 *<250 kWh/AF	38%
Groundwater		19%

* Hetch Hetchy is a net energy provider

Figure x: North Lahontan energy intensity per acre foot of water

Type of Water	Energy Intensity (yellow bulb = 1-500 kWh/AF)	% of regional water supply
Colorado (Project)	*This type of water not available*	0%
Federal (Project)	*This type of water not available*	0%
State (Project)	*This type of water not available*	0%
Local (Project)	<250 kWh/AF	44%
Local Imports	*This type of water not available*	0%
Groundwater	<250 kWh/AF	22%

Figure x: North Coast energy intensity per acre foot of water

Type of Water	**Energy Intensity** (yellow bulb = 1-500 kWh/AF)	% of regional water supply
Colorado (Project)	*This type of water not available*	0%
Federal (Project)	<250 kWh/AF	21%
State (Project)	*This type of water not available*	0%
Local (Project)	<250 kWh/AF	27%
Local Imports	*This type of water not available*	1%
Groundwater	<250 kWh/AF	28%

Figure x: Colorado River energy intensity per acre foot of water

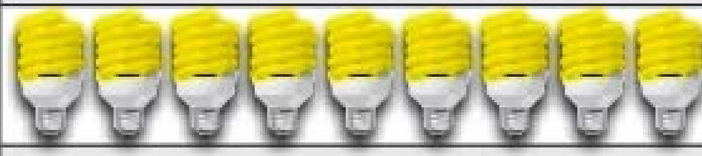
Type of Water	**Energy Intensity** (yellow bulb = 1-500 kWh/AF)	% of regional water supply
Colorado (Project)	 <250 kWh/AF	79%
Federal (Project)	*This type of water not available*	0%
State (Project)		1%
Local (Project)	 <250 kWh/AF	0%
Local Imports	*This type of water not available*	0%
Groundwater		9%

Figure x: Central Coast energy intensity per acre foot of water

Type of Water	**Energy Intensity** (yellow bulb = 1-500 kWh/AF)	% of regional water supply
Colorado (Project)	*This type of water not available*	0%
Federal (Project)		7%
State (Project)		3%
Local (Project)	 <250 kWh/AF	3%
Local Imports	*This type of water not available*	0%
Groundwater		79%