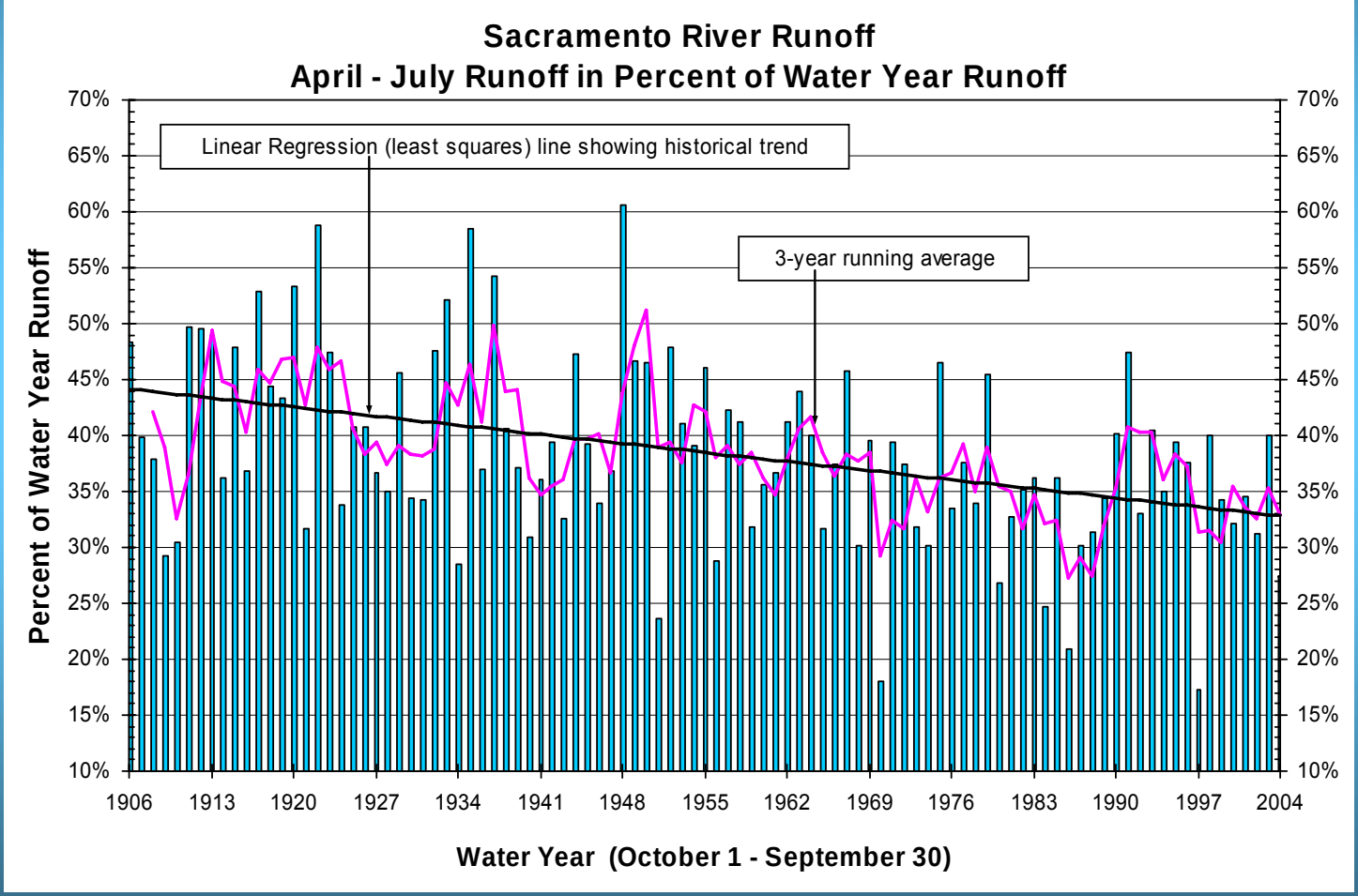
Climate Change & the *California Water Plan Update 2009*

John T. Andrew
Department of Water Resources
California Water Plan Update 2009
Advisory Committee
June 5, 2007

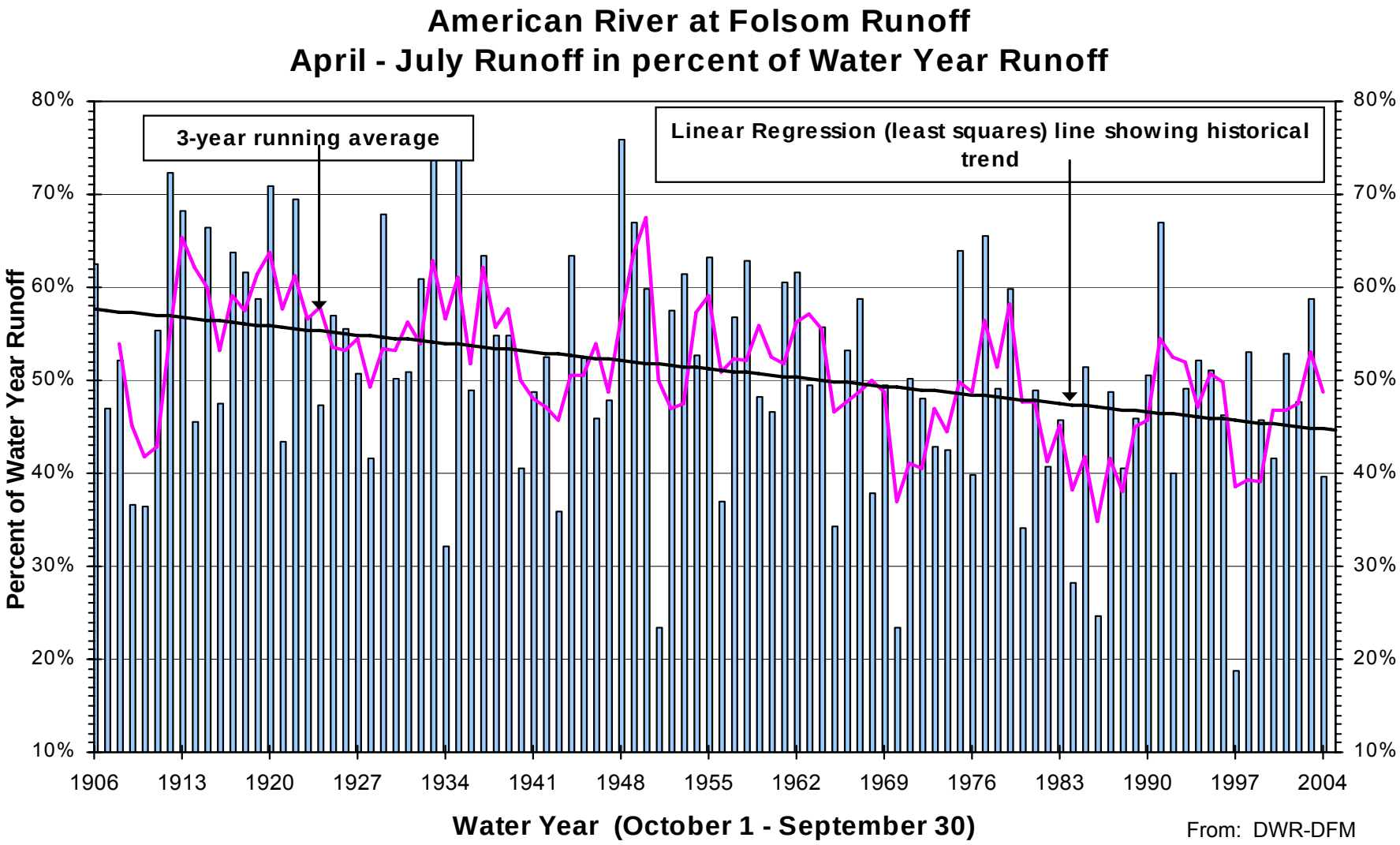
Climate Change Impacts on California's Water Resources

- Reduced snowpack, impacting water supply and hydropower
- Earlier snowmelt results in increased flood control demand on reservoir space
- Higher water temperatures impacts ecosystem
- Sea level rise impacts the Delta, threatens levees and increases salinity
- Increased demand in all sectors

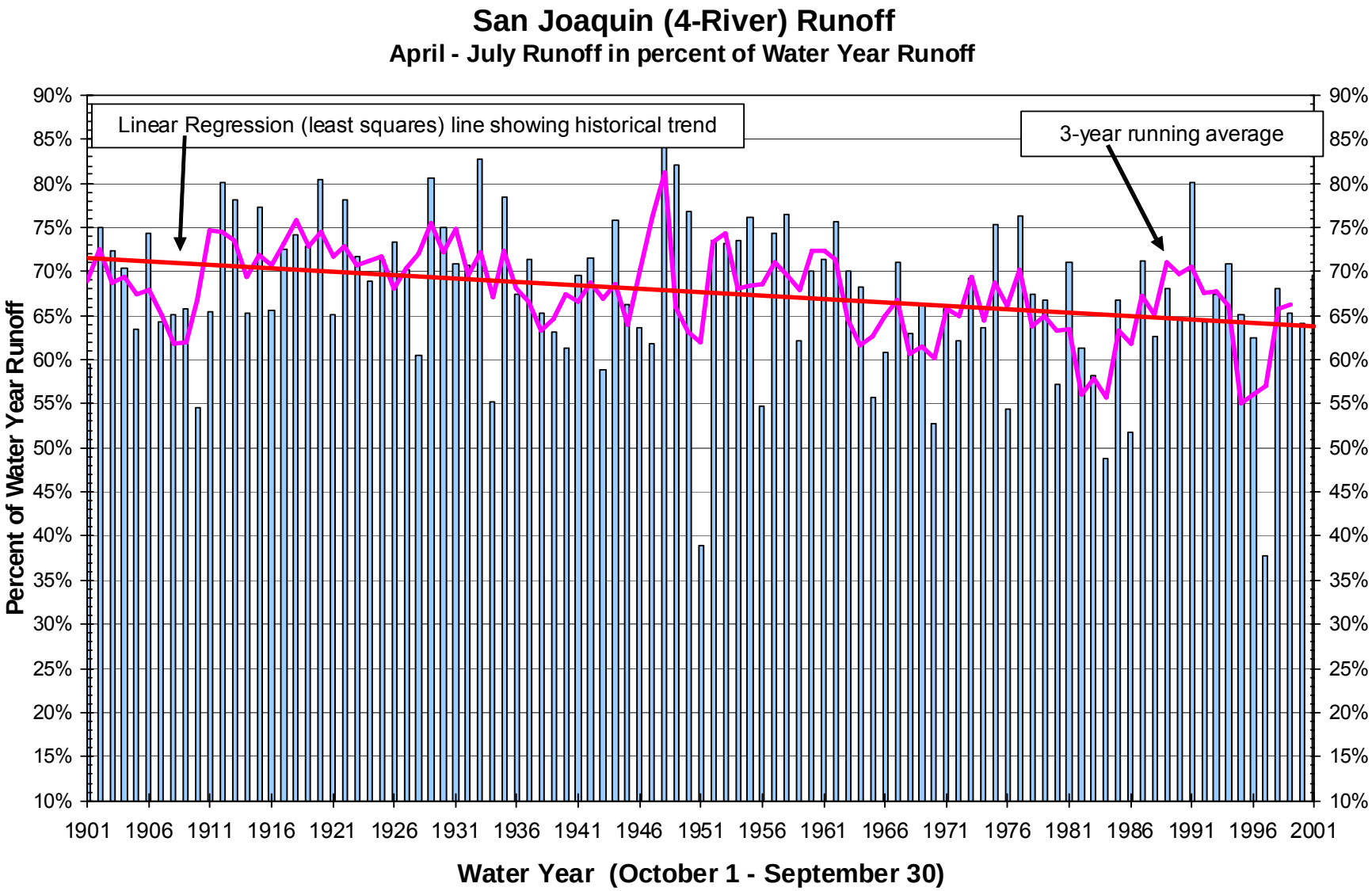
Changes in Runoff Timing



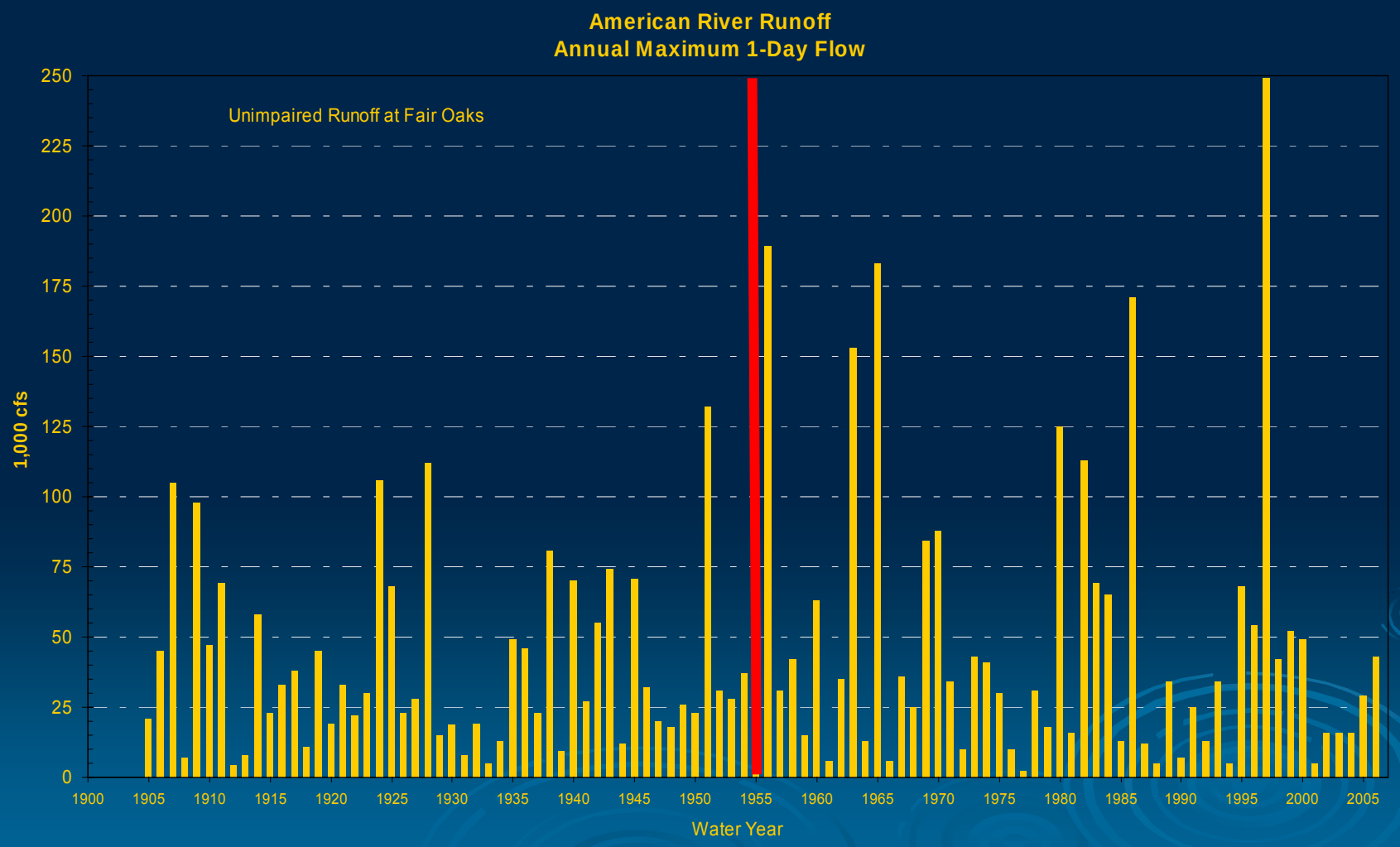
Changes in Runoff Timing



Changes in Runoff Timing

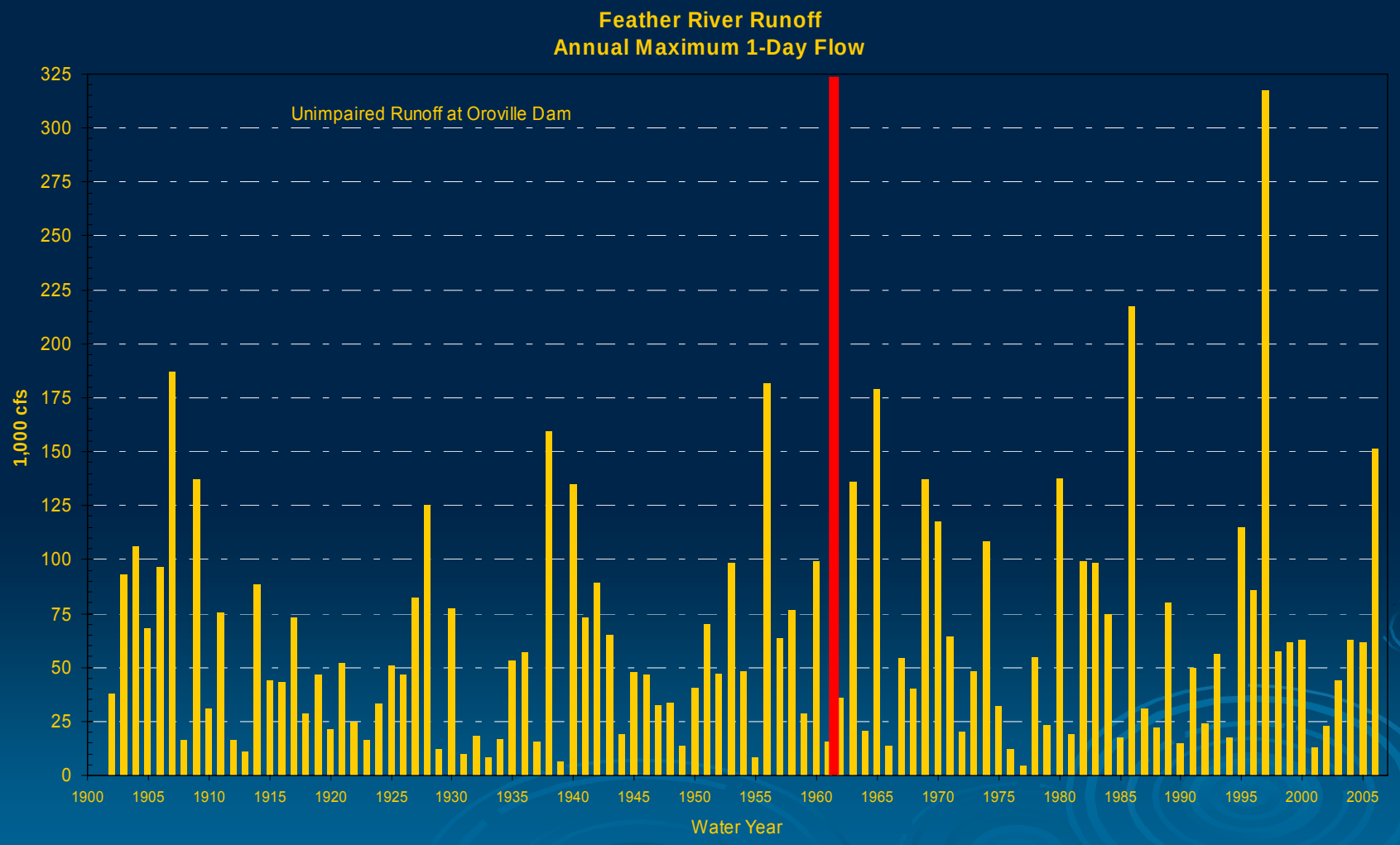


Changes in Peak Flows
American River



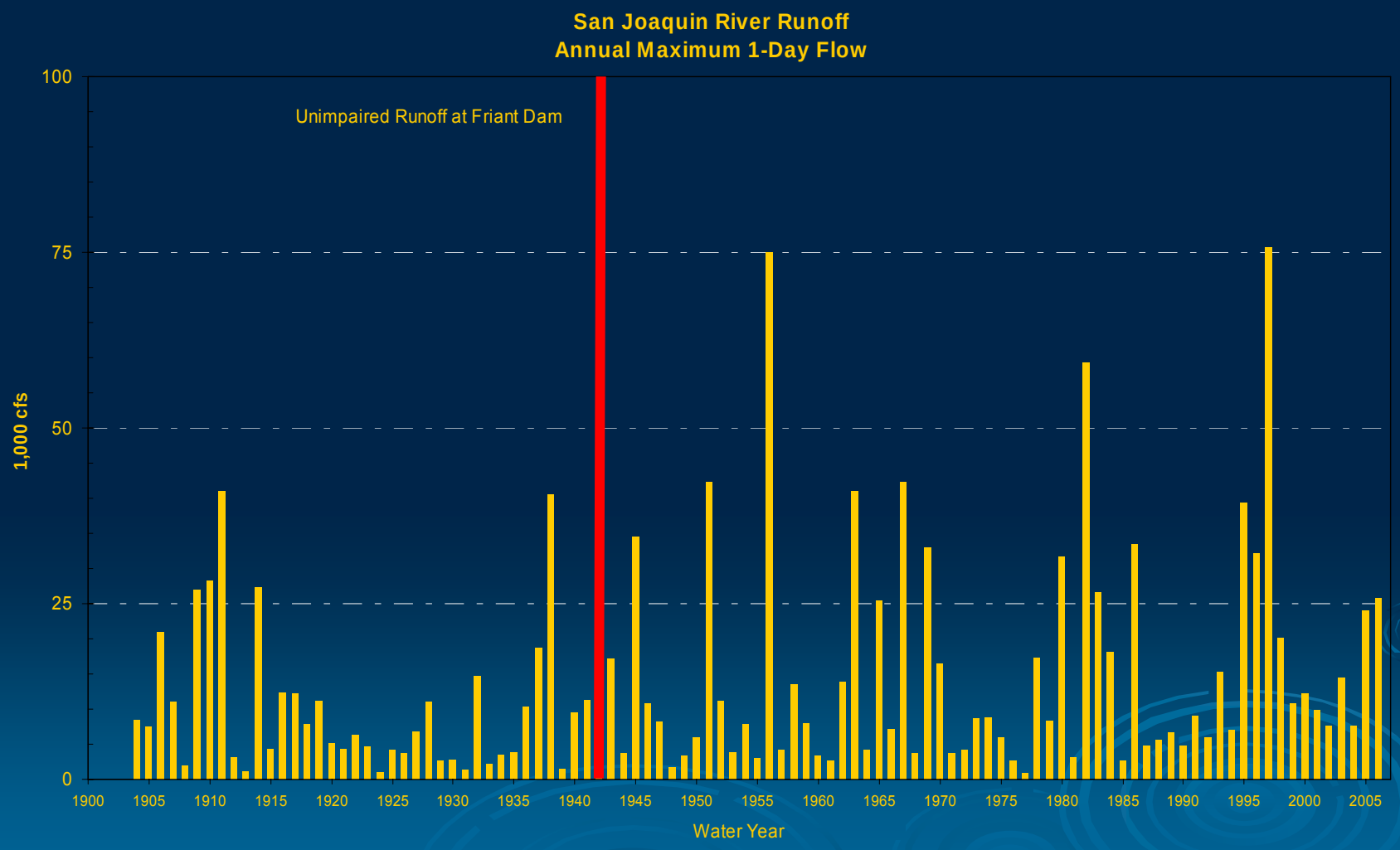
Red Line = Construction of Folsom Dam

Changes in Peak Flows
Feather River



Red Line = Construction of Oroville Dam

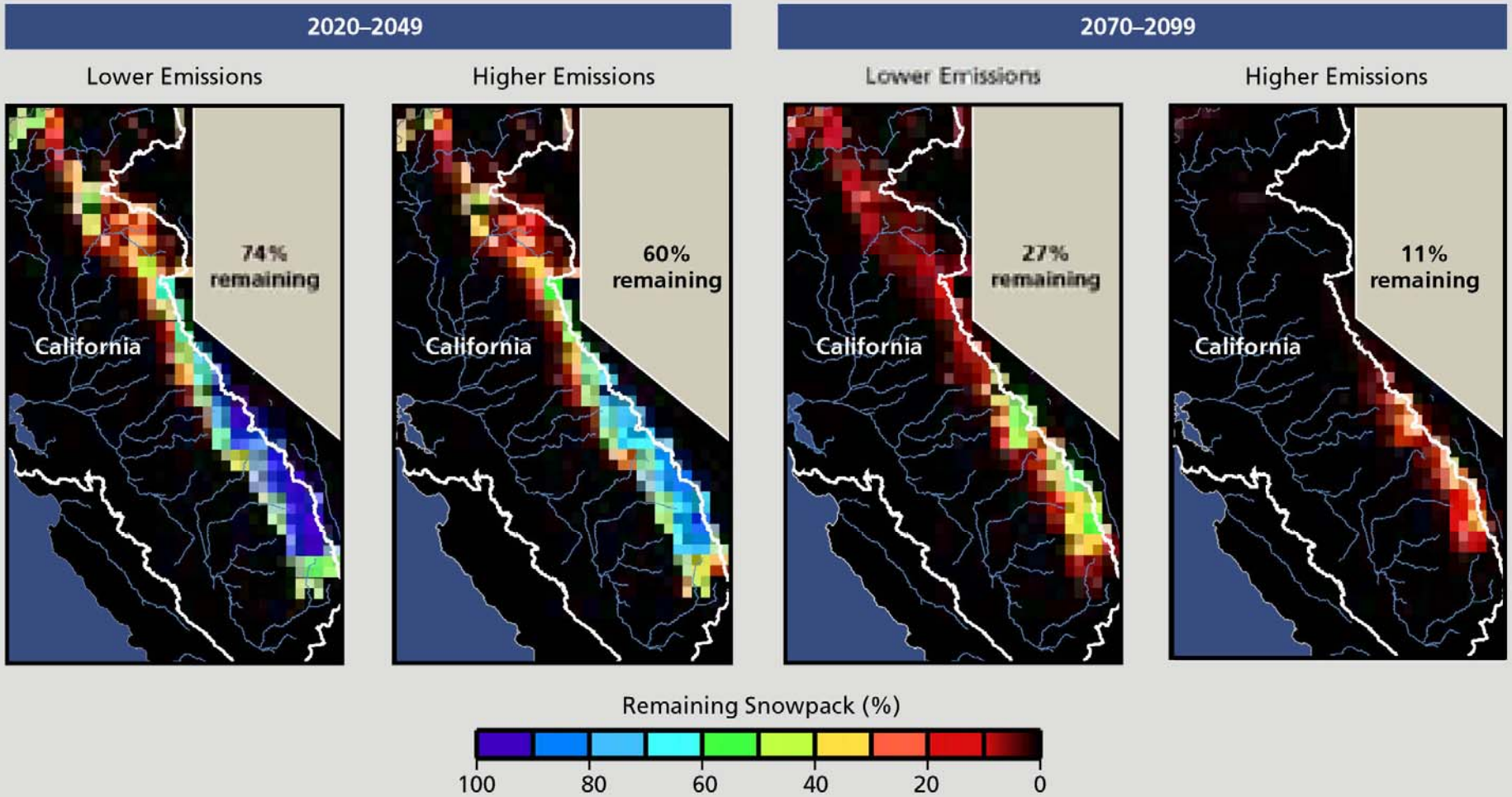
Changes in Peak Flows
San Joaquin River



Red Line = Construction of Friant Dam

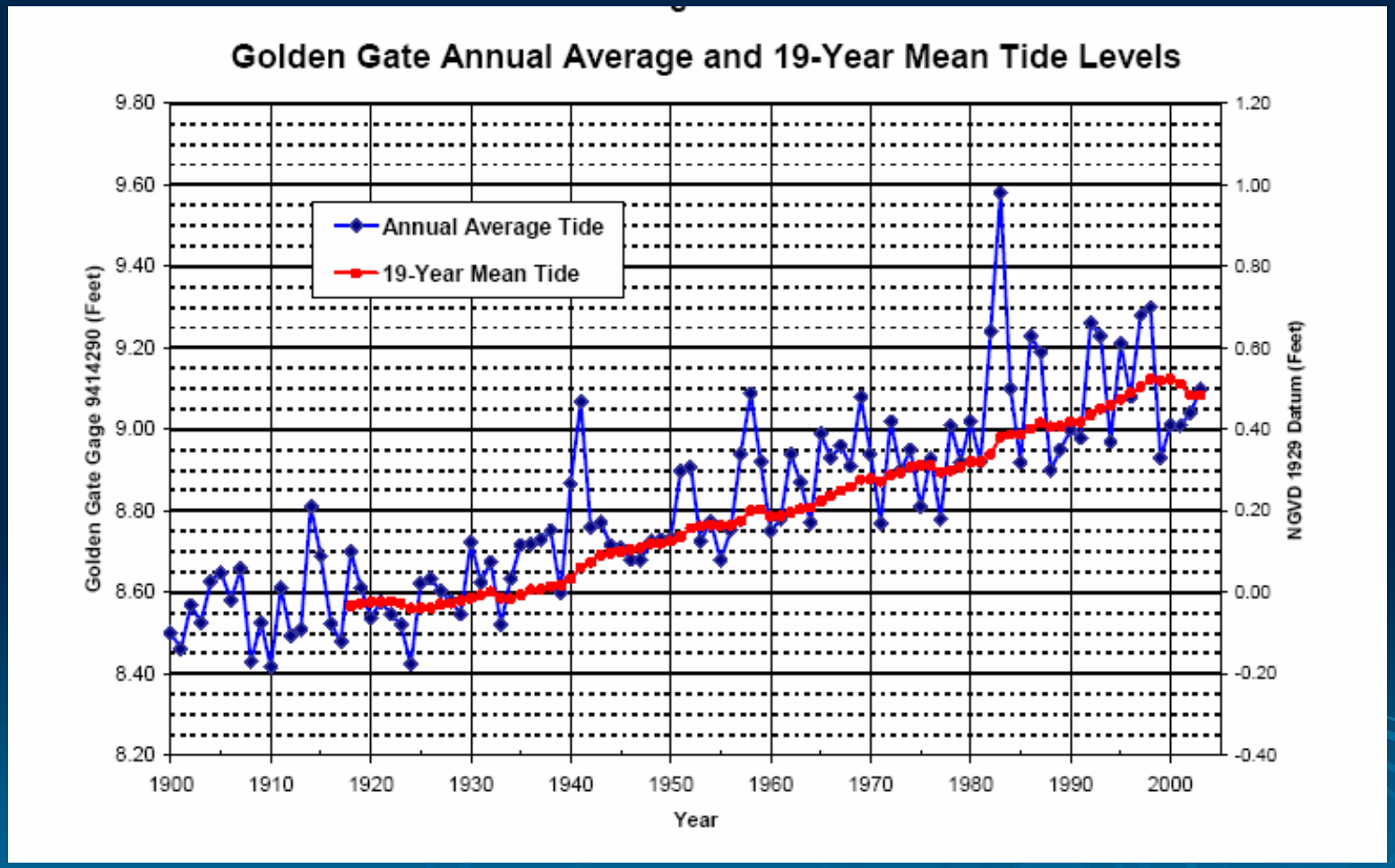
Diminishing Sierra Snowpack

% Remaining, Relative to 1961-1990



(Hanemann *et al*., 2004)

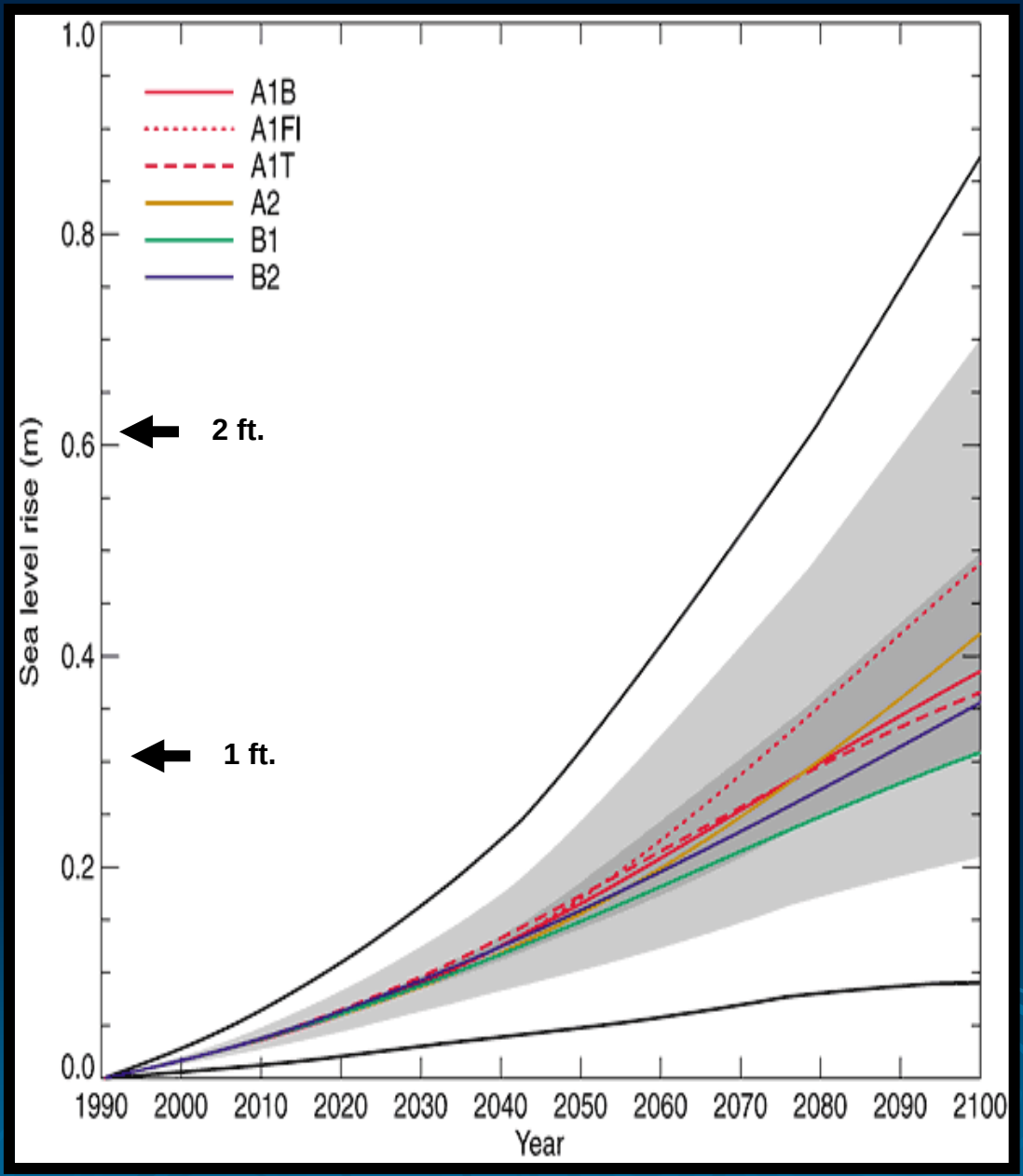
Sea Level Rise



Source: Roos 2003

Sea Level Rise

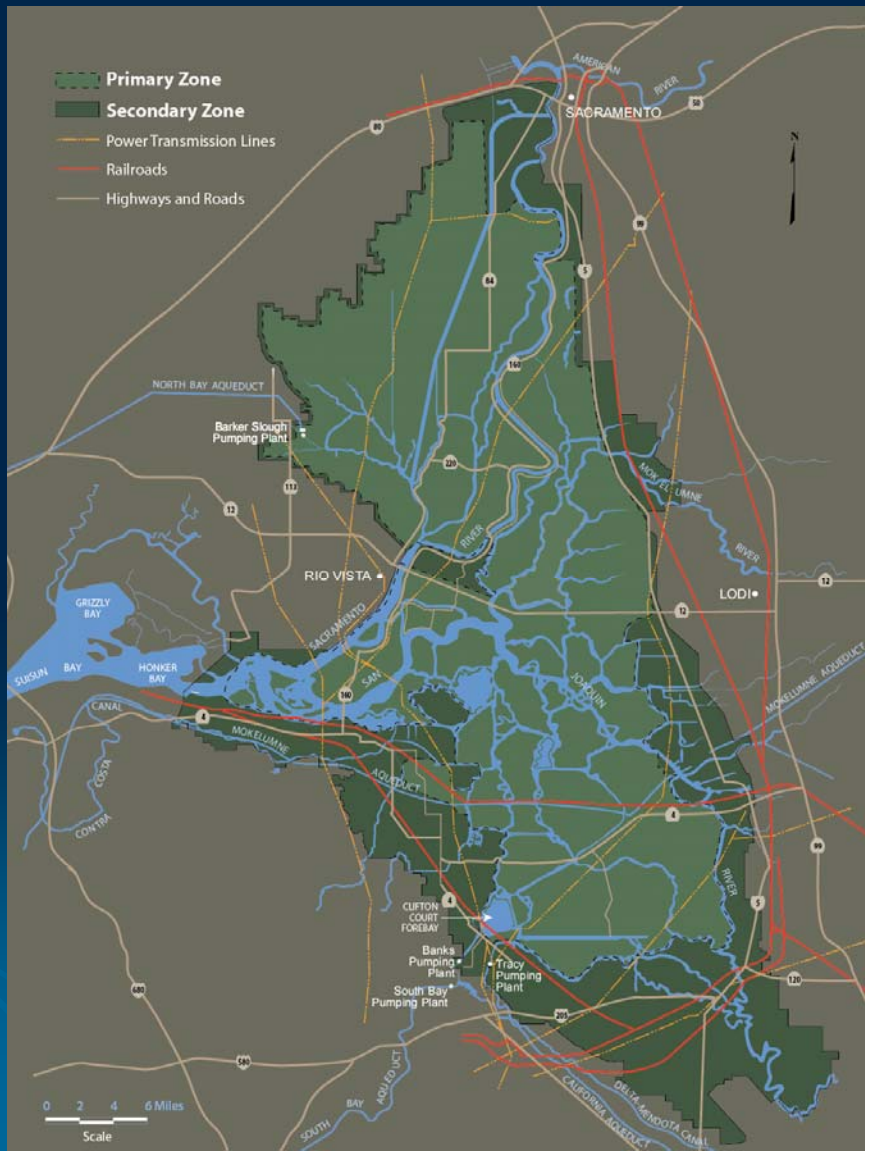
Projections



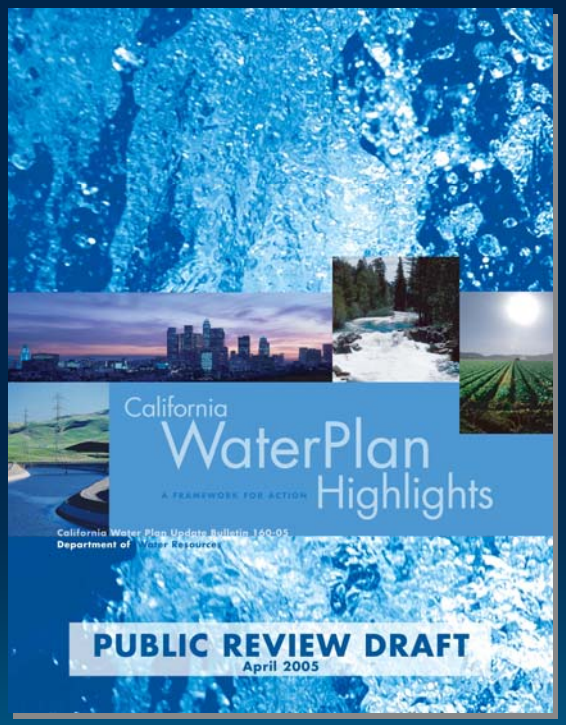
Source: IPCC, 2001

Implications of Sea Level Rise in the Delta

- Salinity intrusion degrades water quality, requires additional releases
- Habitat changes, losses
- Levee failure
- Inundation
- Interruption of water supplies



Framework for Action
Sustainable & Reliable Water in 2030



California Water Plan Update 2005
Recommendation 10

State government must help predict and prepare for the effects of global climate change on our water resources and water management systems.

State government should work with and assist researchers to monitor, predict and prepare for the effects of global climate change on California's water systems and the environment.

DWR should develop alternative flow data to help State, federal, and regional planners test the potential effects of global climate change on different resource management strategies; and to help water facility operators test alternative reoperation strategies, including the State Water Project.

Executive Order S-3-05 Statewide GHG Targets

By 2010, Reduce to 2000 Emission Levels*

By 2020, Reduce to 1990 Emission Levels**

By 2050, Reduce to 80% Below 1990 Levels

* Equals ~60 Million Tons Emission Reductions, 11% Below BAU

** Equals ~170 Million Tons Emission Reductions, 30% Below BAU

Climate Action Team

- CalEPA Secretary Chairs the Team
- BT&H, CDFA, Resources, PUC, ARB, CIWMB, and CEC are Represented
- The CAT Report:
  - Key Recommendations
  - Emission Reduction Strategies
  - Market-Based Program
  - Scenario Analysis
  - Environmental Justice Considerations
  - Final Report to Governor and Legislature in March 2006 (updated Biennially)

DWR Technical Memorandum Report

July, 2006

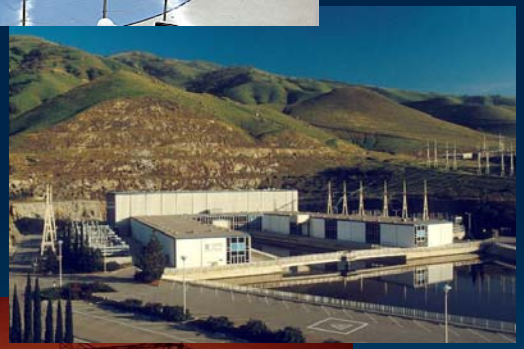
Francis Chung
Jamie Anderson
Mike Anderson
Levi Brekke (USBR)
Dan Easton
Messele Ejeta
Michael Floyd
Guido Franco (CEC)
Alan Olson
Morteza Orang
Michael Perrone
Roy Peterson
Maury Roos
Richard Snyder (UCD)
David Todd
Russell Yaworsky (USBR)
Hongbing Yin

www.baydeltaoffice.water.ca.gov/climatechange.cfm

Assembly Bill 32

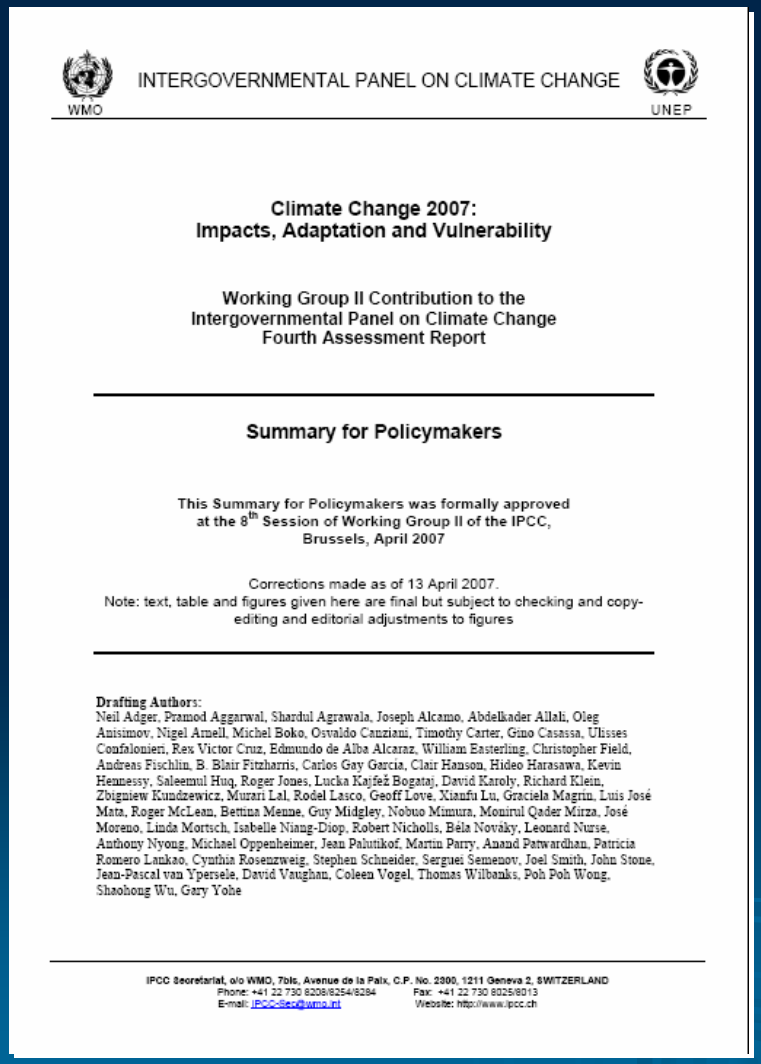
- Global Warming Solutions Act of 2006
- Reduce GHG emissions to 1990 levels by 2020 (30% reduction)
- Applies to Kyoto pollutants
  - CO_2, CH_4, N_2O, HFC, PFC, SF_6
- Detailed action schedule

Water, Energy and Climate Change



Future water management activities must consider strategies to reduce greenhouse gas emissions

New IPCC Findings



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

WMO UNEP

Climate Change 2007:
Impacts, Adaptation and Vulnerability

Working Group II Contribution to the
Intergovernmental Panel on Climate Change
Fourth Assessment Report

Summary for Policymakers

This Summary for Policymakers was formally approved
at the 8th Session of Working Group II of the IPCC,
Brussels, April 2007

Corrections made as of 13 April 2007.
Note: text, table and figures given here are final but subject to checking and copy-editing and editorial adjustments to figures

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- Confirms impacts we are already witnessing
- Emphasizes the importance of adaptation
- Impacts dependent upon both climate change and adaptive capacity
- Recommends a portfolio approach

California Water Plan Update 2009
Climate Change Technical Advisory Group

(as of April 26, 2007)

Barney Austin,
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Dan Cayan, USGS/Scripps
Michael Dettinger, USGS/Scripps
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Spreck Rosecrans,
Environmental Defense
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Richard Snyder, UC Davis
KT Shum, EBMUD
Michael Tansey, USBR
Stu Townsley, USACE
Bob Wilkinson, UCSB

Climate Change TAG Deliverables

- Coordinate with Governor's Climate Action Team and next CAT report update
- Coordinate with DWR climate change matrix team
- Incorporate climate change into scenarios
- Recommend climate change adaptation strategies for California water management

California Water Management and Climate Change

- Climate change presents significant challenges for the management of California's water resources.
- Climate change is occurring incrementally and will likely continue to do so based on historical records over the past 100 years and most projections.
- California's water management systems already provide a great deal of operational flexibility.
- We should have time to plan for future climate change and then adapt to it.

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Plaquemines Parish, Louisiana, November 9, 2005

DWR Climate Change Policy

- DWR/SWP
  - Filed intent to register with Climate Action Registry
  - Will not renew Reid Gardner contract
- Statewide water planning
  - Focus on adaptation
  - Diversified portfolio approach (IRWM)
  - Major theme of B160-09
  - Flood protection
  - GHG emissions reduction and water management

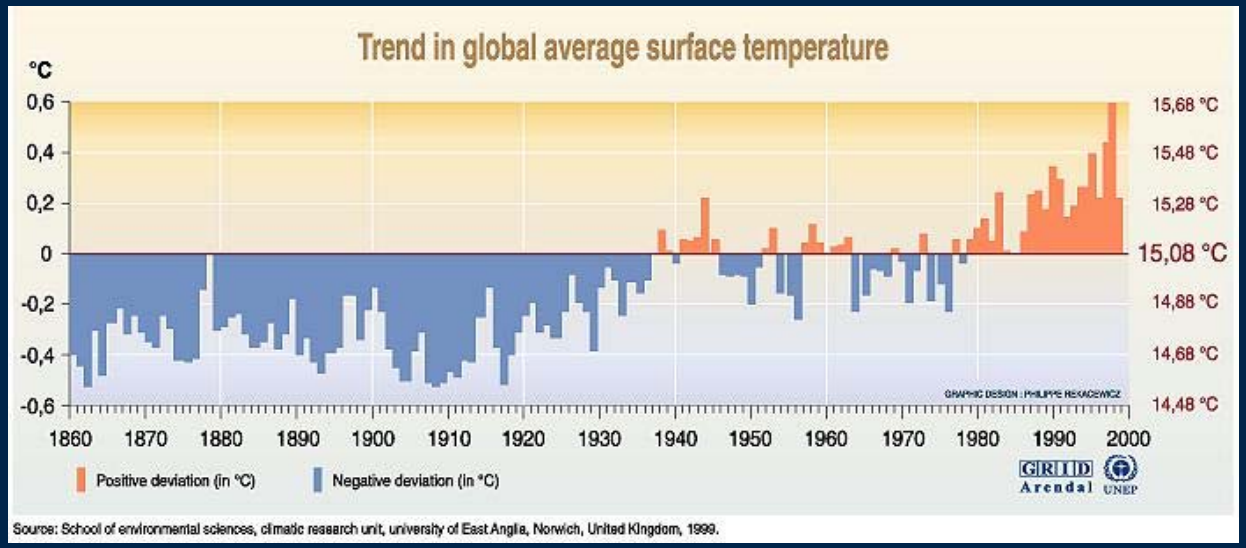


Figure 2-4 Trend in Global Average Temperature from 1860 to 2000

Explanation: The figure depicts global average combined land-surface air and sea surface temperatures from 1861 to 1998 relative to the average temperature between 1961 and 1990. The left vertical scale is in degrees Celsius.

Source: United Nation's Environment Programme Global Resource Information Database - Arendal website at: http://www.grida.no/climate/vital/17.htm.

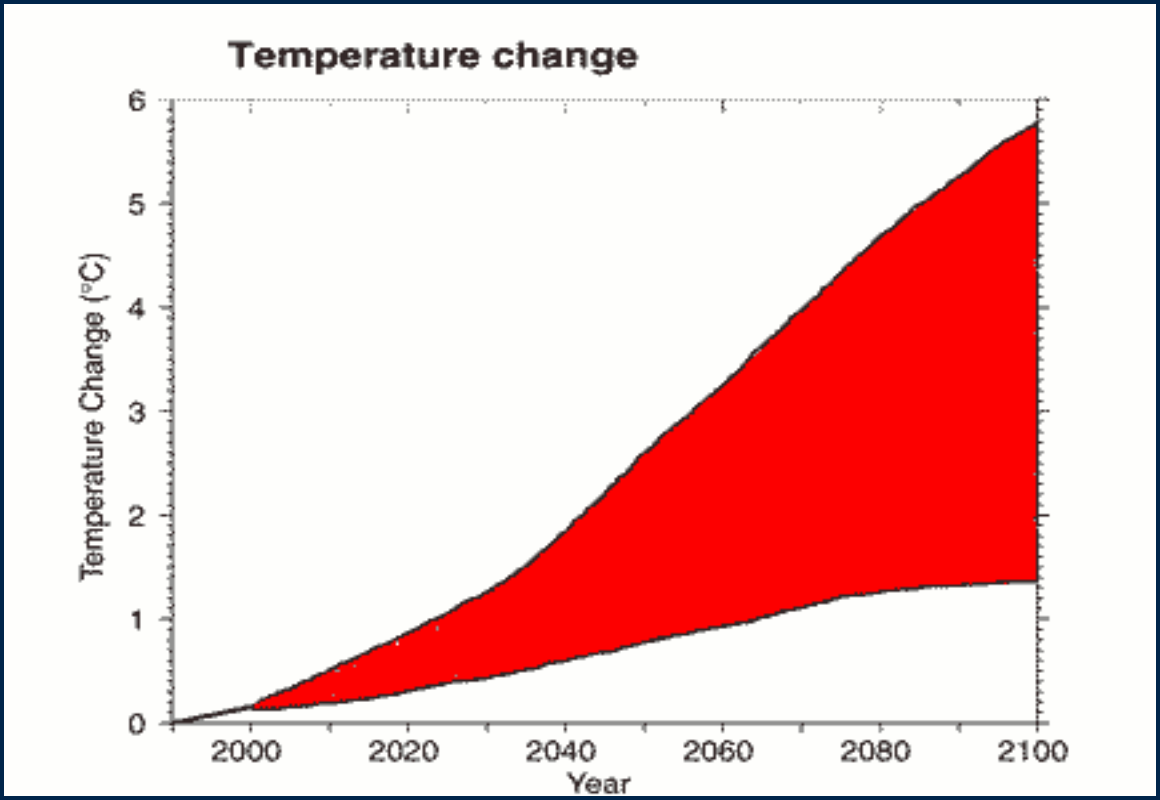


Figure 2-6 Range of Projections Reported by the Intergovernmental Panel on Climate Change for Increasing Global Average Surface Temperature Through 2100.

•Source: United States Environmental Protection Agency website at: http://yosemite.epa.gov/oar/globalwarming.nsf/content/ClimateFutureClimateGlobalTemperature.html

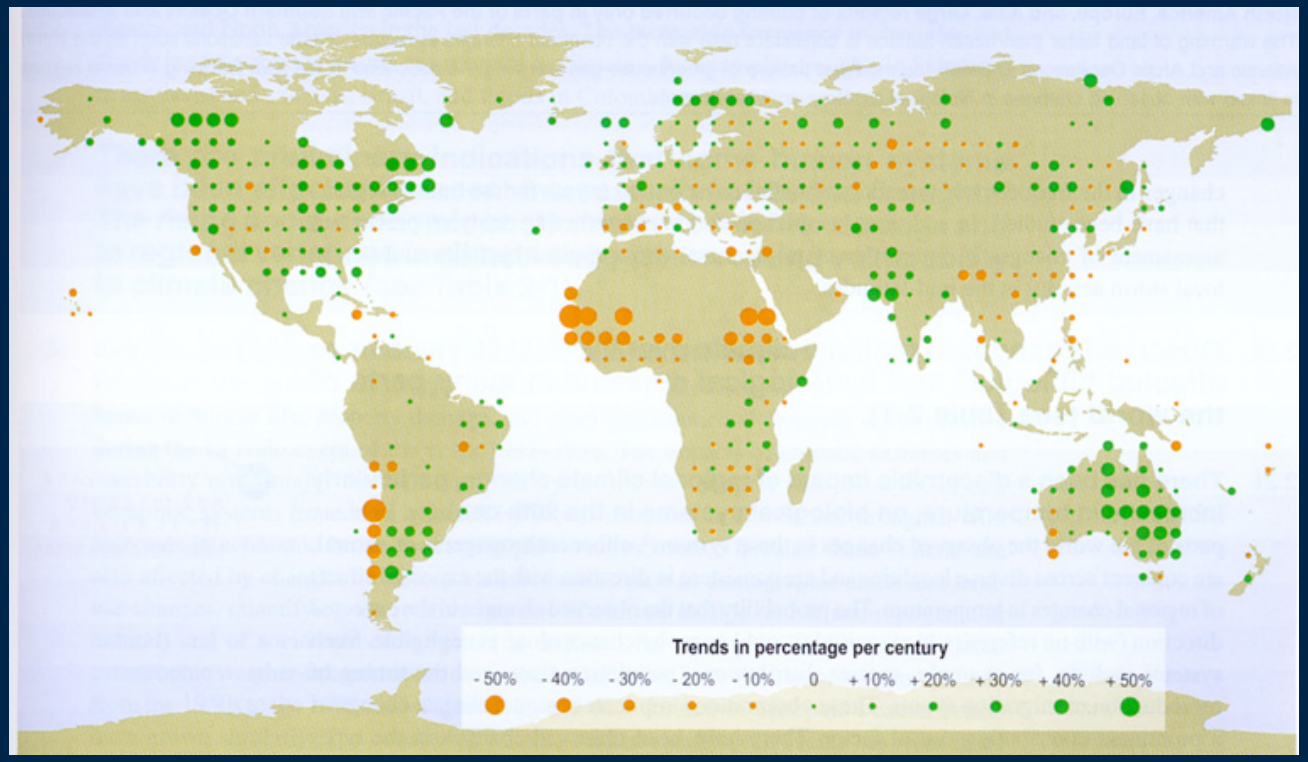
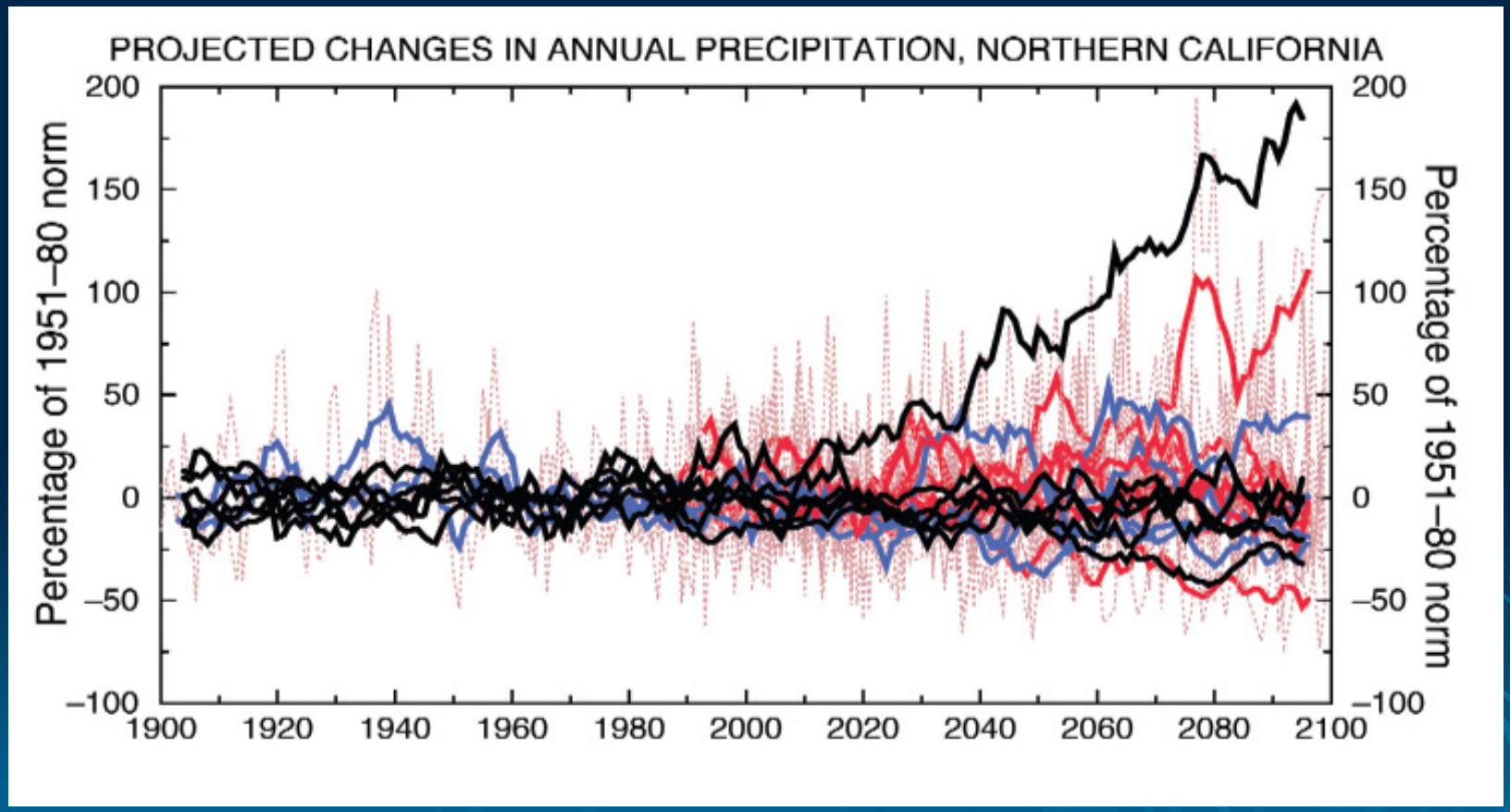


Figure 2-7 Worldwide Precipitation Trend for 1900 to 2000
Source: (IPCC, 2001b) http://www.grida.no/climate/ipcc_tar/vol4/english/fig2-6a.htm

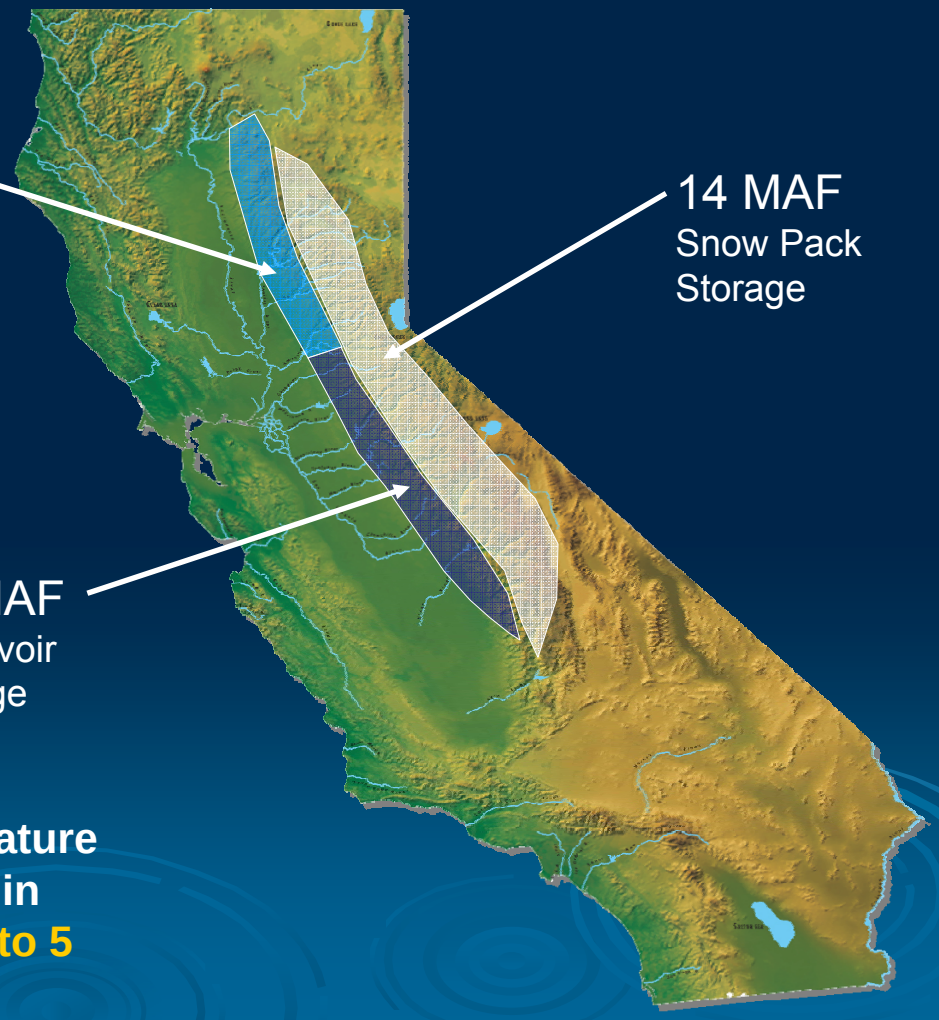
Changes in the Amount of Precipitation

Projections



From: Dettinger, 2005

Expected Storage Capacity Impacts from Changes in Runoff

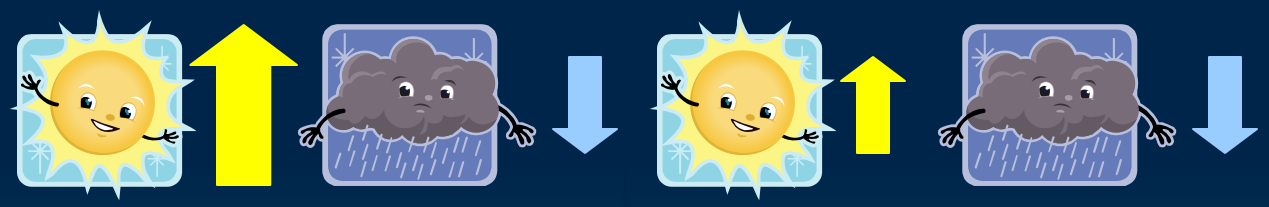
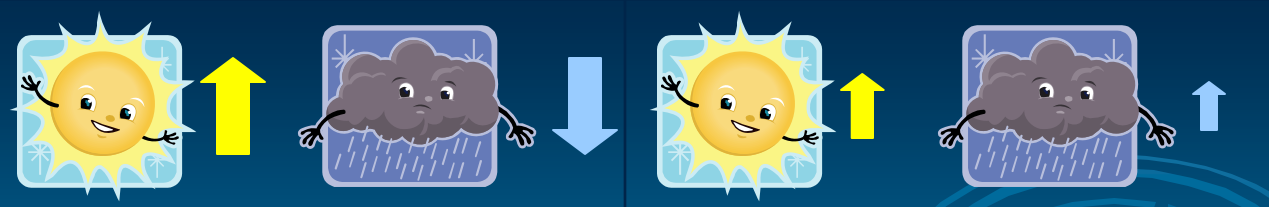


A moderate 3°C *increase* in temperature is projected to result in an increase in snow elevation of 1500 feet and a 4 to 5 MAF *decrease* in Sierra snow pack

Impacts Assessment

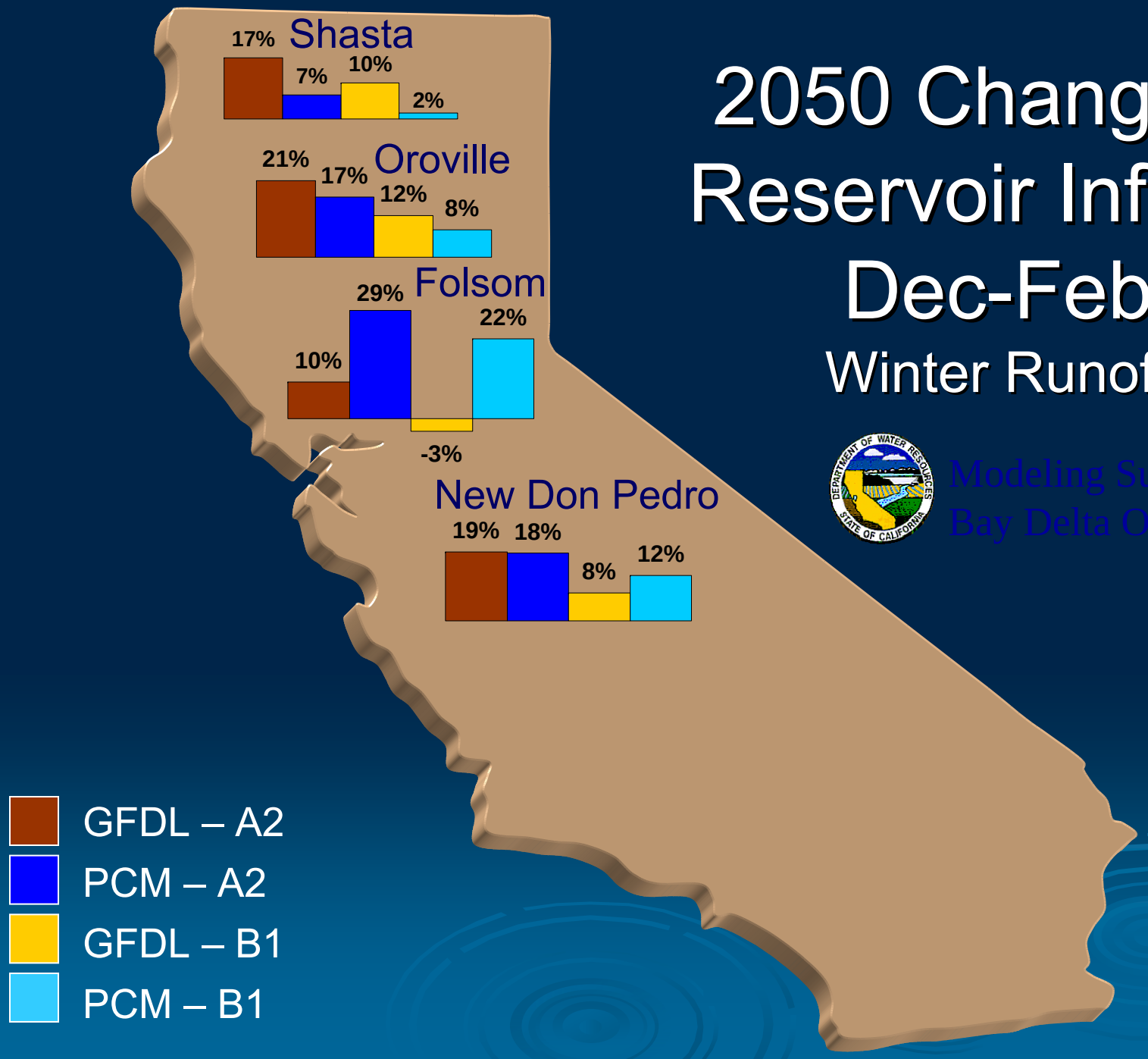
Precipitation & Air Temp. Projections (2050)

2 GHG emissions scenarios x 2 GCM models

Scenario/ Model	A2	B1
GFDL		
PCM		

2050 Change in Reservoir Inflows Dec-Feb

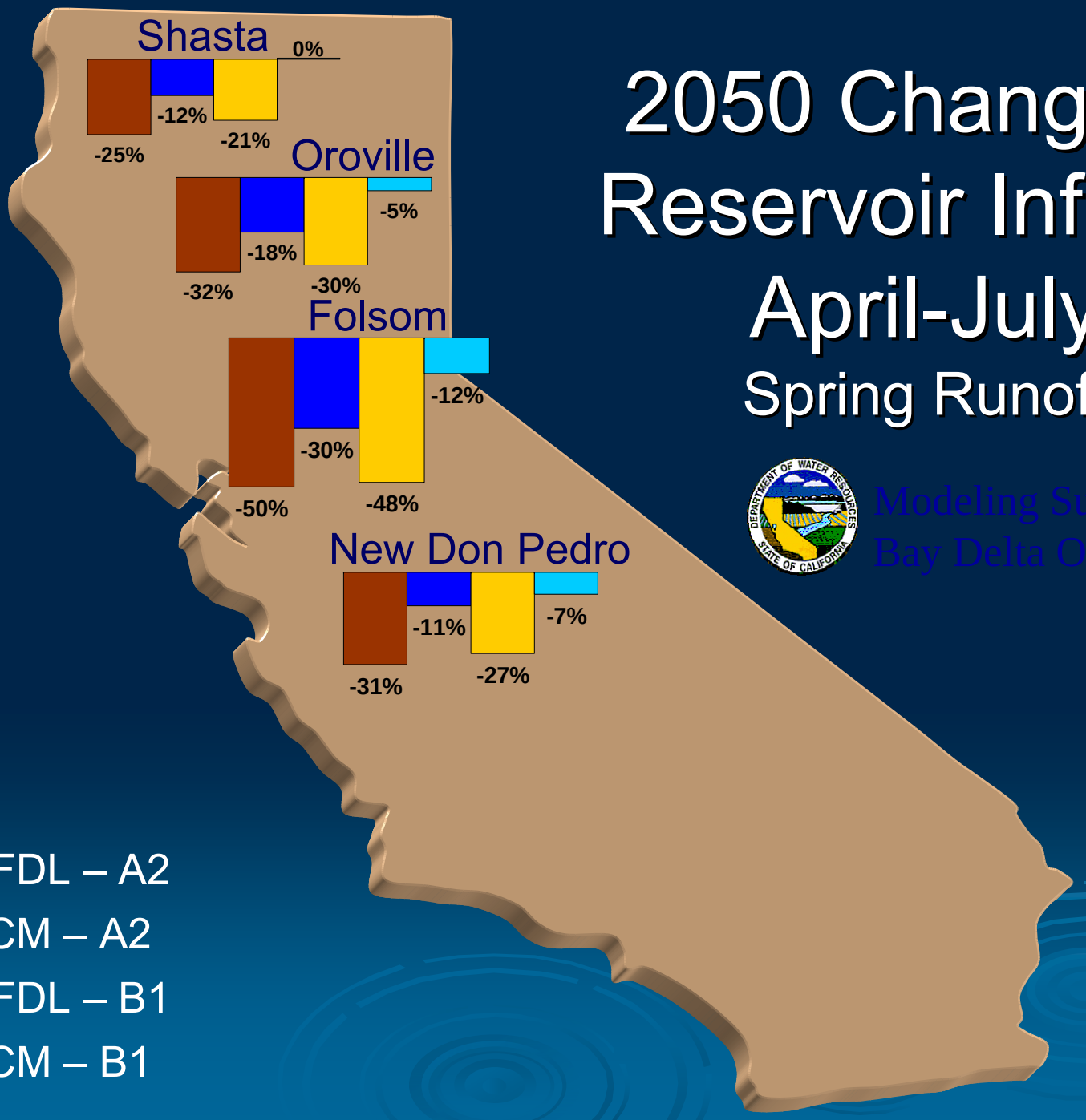
Winter Runoff



Modeling Support Branch
Bay Delta Office

2050 Change in Reservoir Inflows April-July

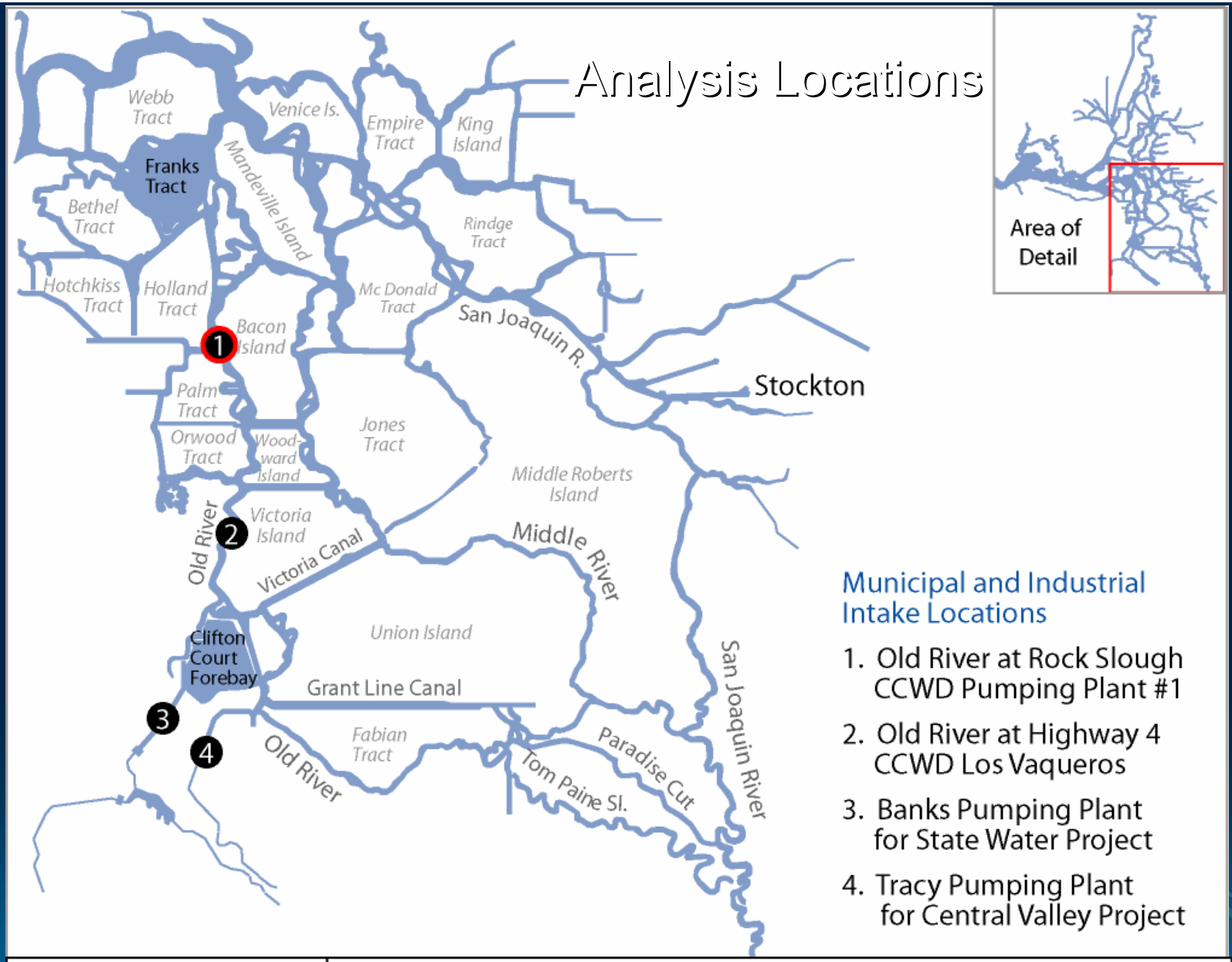
Spring Runoff



Modeling Support Branch
Bay Delta Office

Salinity Changes in the Sacramento-San Joaquin Delta

Analysis Locations



Municipal and Industrial Intake Locations

1. Old River at Rock Slough CCWD Pumping Plant #1
2. Old River at Highway 4 CCWD Los Vaqueros
3. Banks Pumping Plant for State Water Project
4. Tracy Pumping Plant for Central Valley Project

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Municipal and Industrial Compliance Locations	Daily average Cl < 250 mg/l											

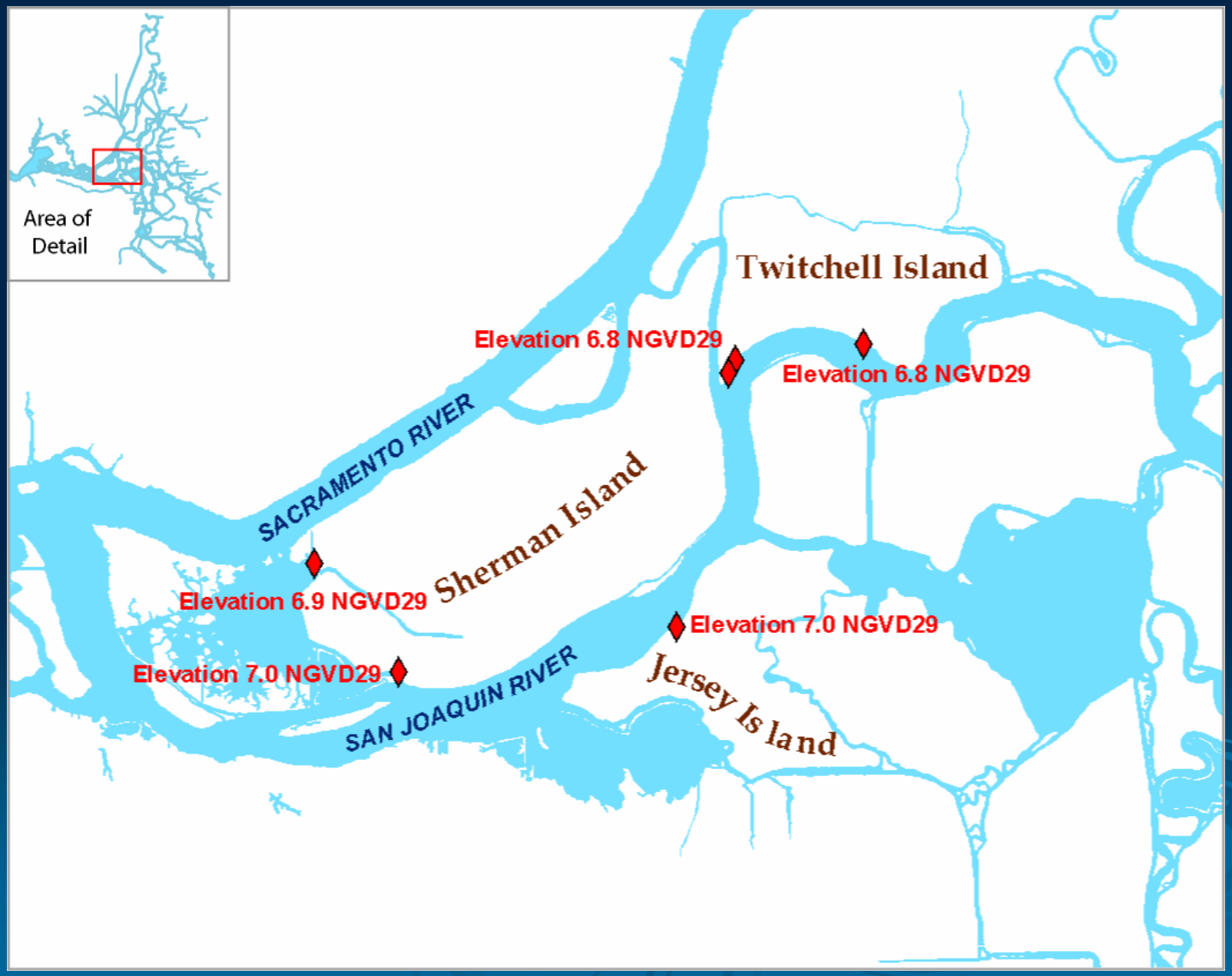
% time below 250 mg/l Chloride Threshold

Scenario/Location	BASE	1ft Sea Level Rise
CCWD- Old River at Rock Sl.	97.2%	87.5%
CCWD- Los Vaqueros*	99.9%	99.4%
SWP-Clifton Court	100%	100%
CVP-Tracy	100%	100%

Salt intrusion from a 1ft sea level rise and no changes in operations increases threshold exceedance at Old R at Rock Slough by ~10%

Levee Overtopping

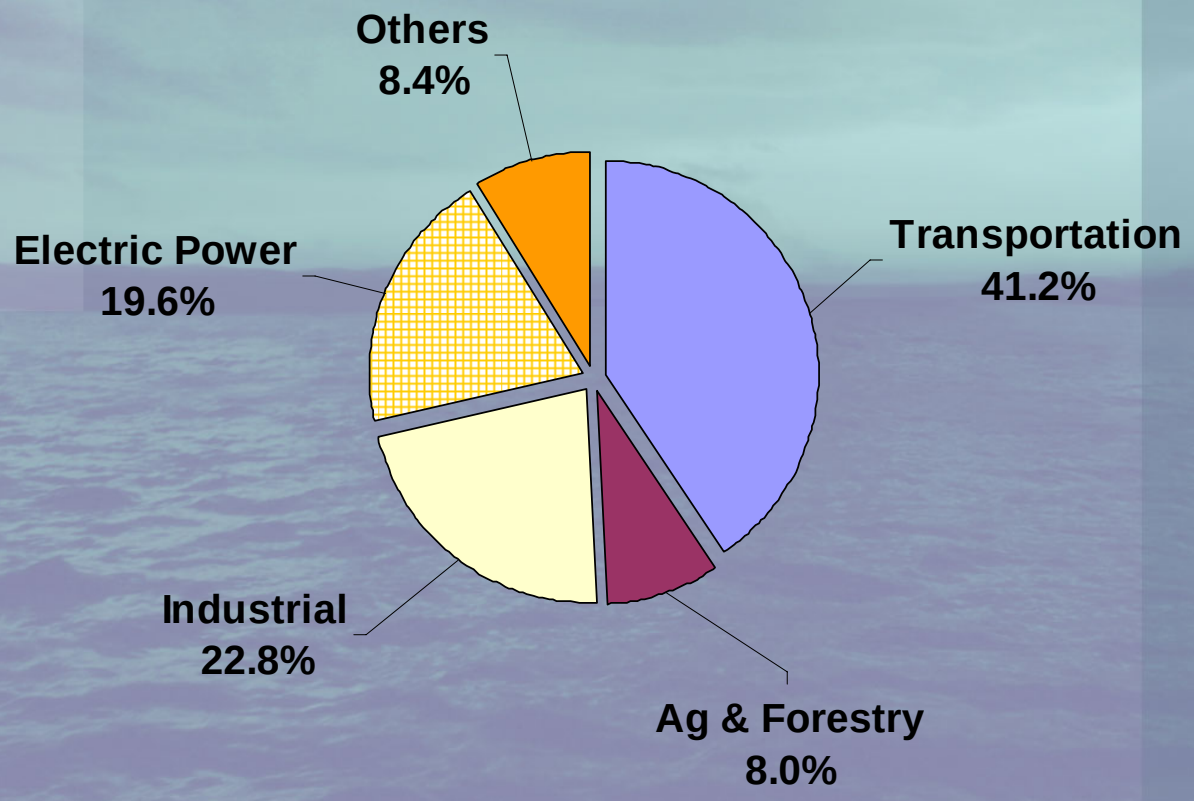
Minimum Levee Crest Elevations



Levee Overtopping Potential

Location	# of Potential Overtopping Events in 16 yrs			
	Base	4 Climate Change Scenarios	1 ft SLR	4 Climate Change Scenarios +1ft SLR
Sherman Is	0	0	2	2
Twitchell Is	0	0	2	2
Jersey Is	0	0	2	2

Climate Change Emissions -- California



Scenario Demand Changes by Region

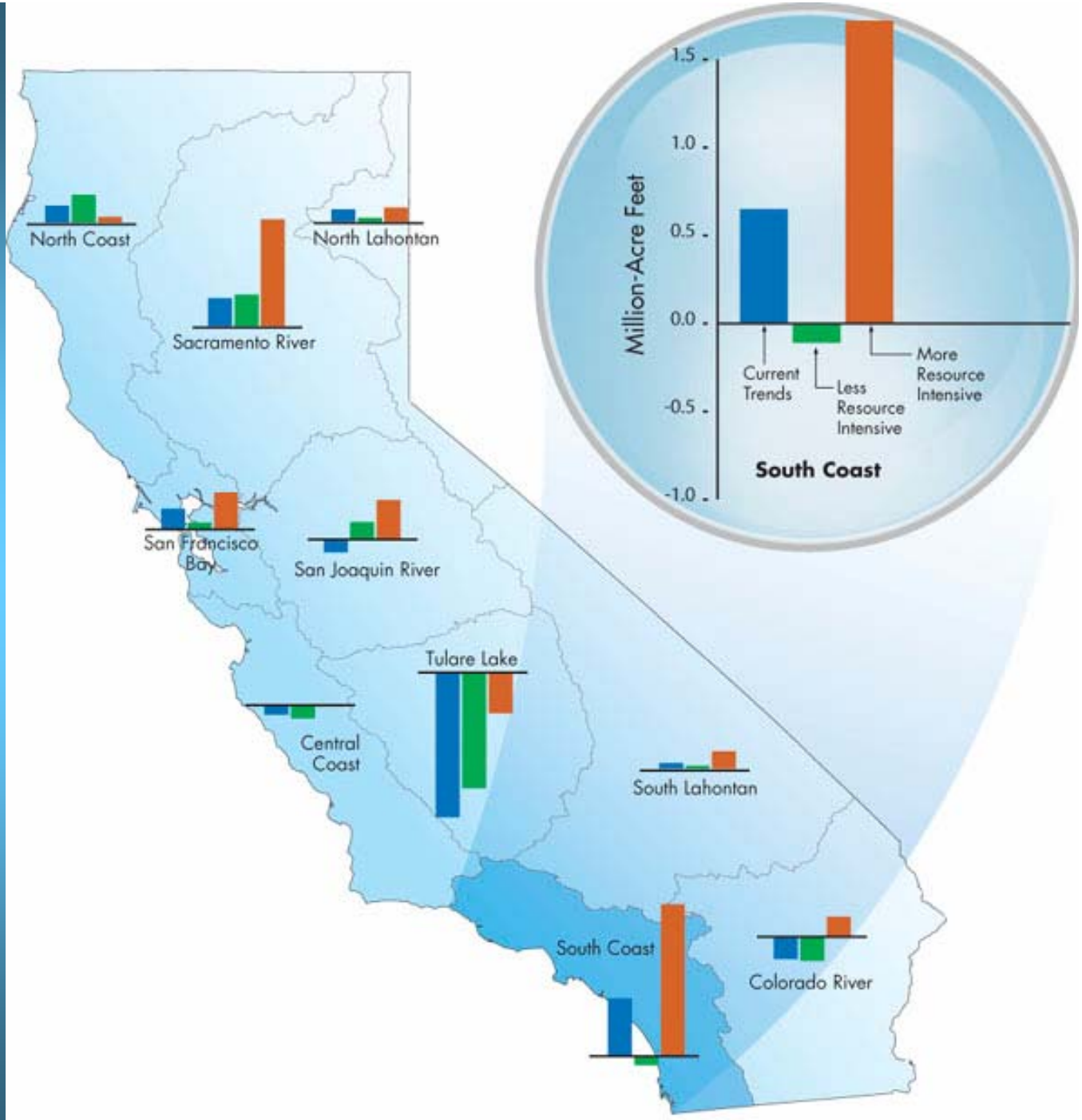
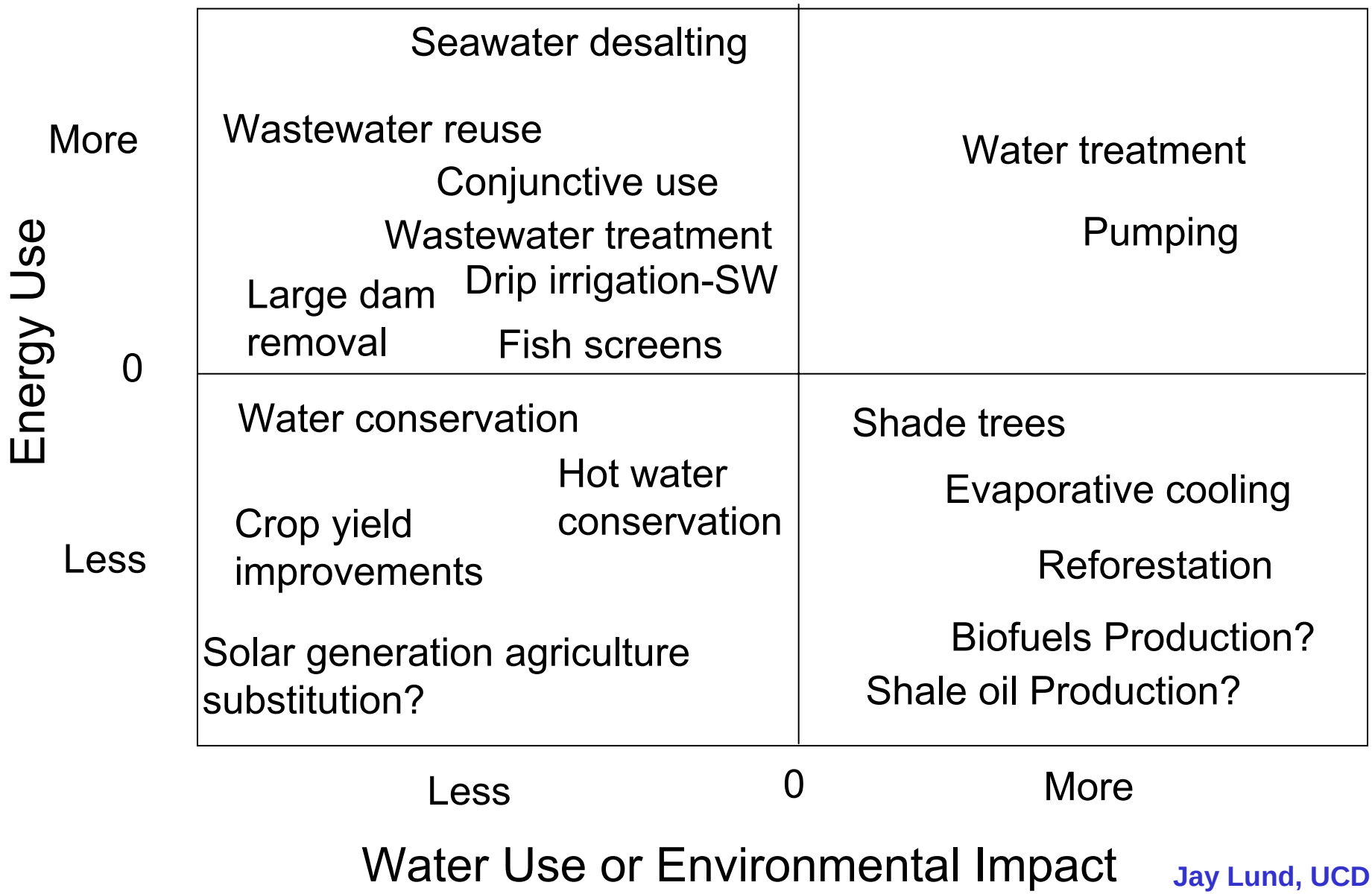


Table 2-4 Runoff Statistics and Trends for Selected River Basins in California

Basin/River System	Period of Record	Period A-J[1] Average (TAF)[3]	Period WY[2] Average (TAF)	Period A-J Linear Trend (TAF/yr)[4]	Period WY Linear Trend (TAF/yr)[4]
Central Valley River Systems					
Sacramento River System[5]	1906-2005	6,847	18,024	-17	3
San Joaquin System[6]	1901-2005	3,922	5,900	-7	-3
Sacramento Valley Basins					
Sacramento at Bend Bridge	1906-2005	2,522	8,476	-3	6
Feather	1906-2005	1,901	4,490	-6	2
Yuba	1901-2005	1,096	2,372	-3	-2
American	1901-2005	1,359	2,739	-5	-3
North San Joaquin Valley Basins					
Cosumnes	1908-2005	127	369	0	0
Mokelumne	1901-2005	487	758	-1	-1
Stanislaus	1901-2005	745	1,175	-2	-1
Tuolumne	1901-2005	1,248	1,911	-1	0
Merced	1901-2005	646	997	-1	0
San Joaquin	1901-2005	1,283	1,816	-2	-1
South San Joaquin Valley Basins					
Kings	1901-2005	1,238	1,683	-2	-1
Kaweah	1901-2005	285	432	0	0
Tule	1930-2005	63	145	0	0
Kern at Isabella	1930-2005	453	697	0	1
Kern at Bakersfield	1901-2005	473	739	0	2

Common Energy-Water Tradeoffs



Jay Lund, UCD

California Water Plan Update 2005
Parking Lot Issues

- Integrate water and energy policy recommendations
- More on climate change impacts and responses
- More on energy cost impacts and water-energy relationship

California Water Plan Update 2009
Agency Issues

Climate change or water-energy cited by:

- Business, Transportation & Housing (CalTrans)
- California Energy Commission
- California Public Utilities Commission
- California Department of Food and Agriculture
- Office of Planning and Research
- State Lands Commission