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Climate Change and the Future of the American  
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### SLIDES: Summary—The California Perspective and California Perspective: Climate Change and Water Resources

Jeanine Jones

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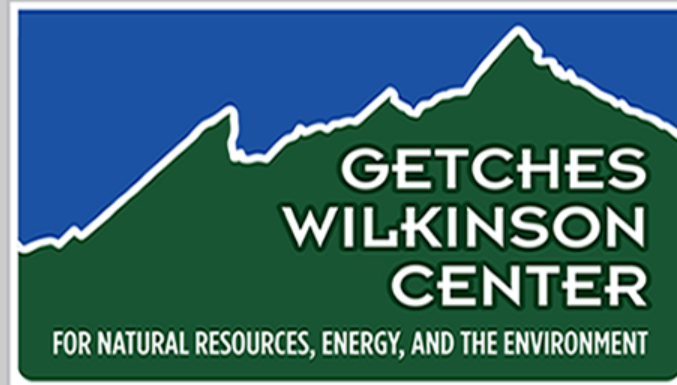
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Jeanine Jones, *Summary—The California Perspective and California Perspective: Climate Change and Water Resources, in CLIMATE CHANGE AND THE FUTURE OF THE AMERICAN WEST: EXPLORING THE LEGAL AND POLICY DIMENSIONS* (Natural Res. Law Ctr., Univ. of Colo. Sch. of Law 2006).

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Session 2 – Coping with Climate Change in the American West  
Climate Change & Water Resources

**SUMMARY -- THE CALIFORNIA PERSPECTIVE**

Jeanine Jones, Interstate Resources Manager  
California Department of Water Resources

Background

About two-thirds of California's water supplies occur in the wetter northern portion of the state, while about two-thirds of the urban and agricultural needs occur in the drier southern portion. Federal, state, and local agencies have developed an extensive system of water infrastructure to collect available supplies and to convey them to where they are needed. Intrastate runoff from the Sierra Nevada is key to fueling this system, with Sierra snowpack acting as a seasonal reservoir that collects winter precipitation and subsequently feeds spring runoff. Water storage capacity in the Sierran snowpack is equivalent to about half the storage capacity in California's major reservoirs. Operations of Sierran reservoirs are carefully balanced to provide downstream flood control during the winter and spring, and to maximize water storage once the peak of the flood season has passed. Runoff from the Sierra flows through the Central Valley and into the Sacramento-San Joaquin River Delta (Delta) on its way to the Pacific Ocean. The Delta, a low-lying area partitioned into numerous islands by a network of fragile levees, acts as the hub for much of California's water infrastructure.

Governor's Executive Order

At a June 2005 United Nations World Environment Day conference, Governor Arnold Schwarzenegger signed an Executive Order establishing greenhouse gas emission reduction targets for California and directing state agencies to prepare a report on global warming impacts to California. The report, to be updated biannually, is to address impacts including "impacts to water supply, public health, agriculture, the coastline, and forestry" and is to include mitigation and adaptation plans to combat the impacts.

Water Resources Impacts

The multi-agency Climate Action Team assembled in response to the Governor's Executive Order has completed its initial report on impacts to the Governor and to the Legislature. The report considered future scenarios based on a range of results from several global climate models. All models predicted a significant increase in temperature over the 21<sup>st</sup> century, with a low range of 1.7°C to 3.0°C and a high range of 4.4°C to 5.8°C. The modeling results did not yield a clear trend for precipitation projections over this time period. Recent Intergovernmental Panel on Climate Change modeling suggests that relatively little change in total precipitation might be expected, with a tendency toward slightly greater winter precipitation and lower spring precipitation.

Water resources impacts can occur from changes in amount and timing of supply (hydrologic impacts), from changes in water demands, and from sea level rise. With respect to hydrologic impacts, rising temperatures would diminish snow accumulation in the Sierra. By 2035-2064,

Sierra snowpack could decrease 10 to 40 percent, depending on warming and precipitation patterns. By the end of the century, snowpack could decrease by as much as 90 percent if temperatures rise to the higher warming range. The resultant impact to water supplies would depend on the extent to which reservoirs could be operated to capture the earlier snowmelt without impairing their flood control capability. The global scale of present climate models is a limiting factor with regard to quantitative assessment of water supply impacts. Until climate models can be downscaled to a regional or watershed level, the information they can provide is not sufficiently detailed to allow assessment of the trade-off in reservoir operations between water supply and flood control.

The Colorado River is an important source of imported supply for Southern California. As with the Sierra Nevada, climate models suggest rising temperatures with less certainty as to precipitation outcomes among different models. Because the Colorado River system has a much greater storage-to-annual flow ratio than do most Sierran rivers, along with a greater amount of high-elevation snowpack, hydrologic impacts are likely to be less than would be the case with the Sierra.

Climate change impacts on water demand are in the early stages of assessment by the academic community. Conventional water supply planning is based on population and land use forecasts which typically have realistic time horizons of no more than 20-30 years, making rigorously quantitative discussions of climate change related-water resource impacts by the century's end problematical. Analytical tools typically used by local agency planners are not equipped to reflect climate adaptation factors, including demographic effects associated with higher levels of warming – such as potential changes in population growth rates in Southwestern cities that rely on Colorado River water (Phoenix, Las Vegas).

California faces unique water resources impacts from sea level rise, due to the Delta's role in the state's water infrastructure. Most of the Delta's 1100 miles of levees were built by private interests over a century ago to protect agricultural lands; many were built on unstable peat soils. Risk of levee failure is high today under winter storm conditions – without including the possibility of a seismic event or a one foot rise in sea level. Catastrophic failure of multiple Delta levees – whether precipitated by a winter storm or by an earthquake – would permit salt water from the Bay to flood the Delta's below-sea level islands, rendering water in Delta channels unusable for water supply. It should also be recognized that sea level rise would likely affect the estuarine ecosystem, necessitating adaptation by water projects to respond to changing regulatory requirements to protect species of concern.

### Uncertainties

It has taken a large investment in basic physical science research to achieve the present state of knowledge with respect to climate variability and change. In comparison, only limited work has been performed on assessing and managing climate change impacts, including impacts outside the field of the physical sciences (e.g., socioeconomics, ecosystems). Assessment of the adaptation potential within existing infrastructure and institutions is a key part of understanding water resources impacts.

# California Perspective Climate Change & Water Resources

Jeanine Jones



Department of Water Resources

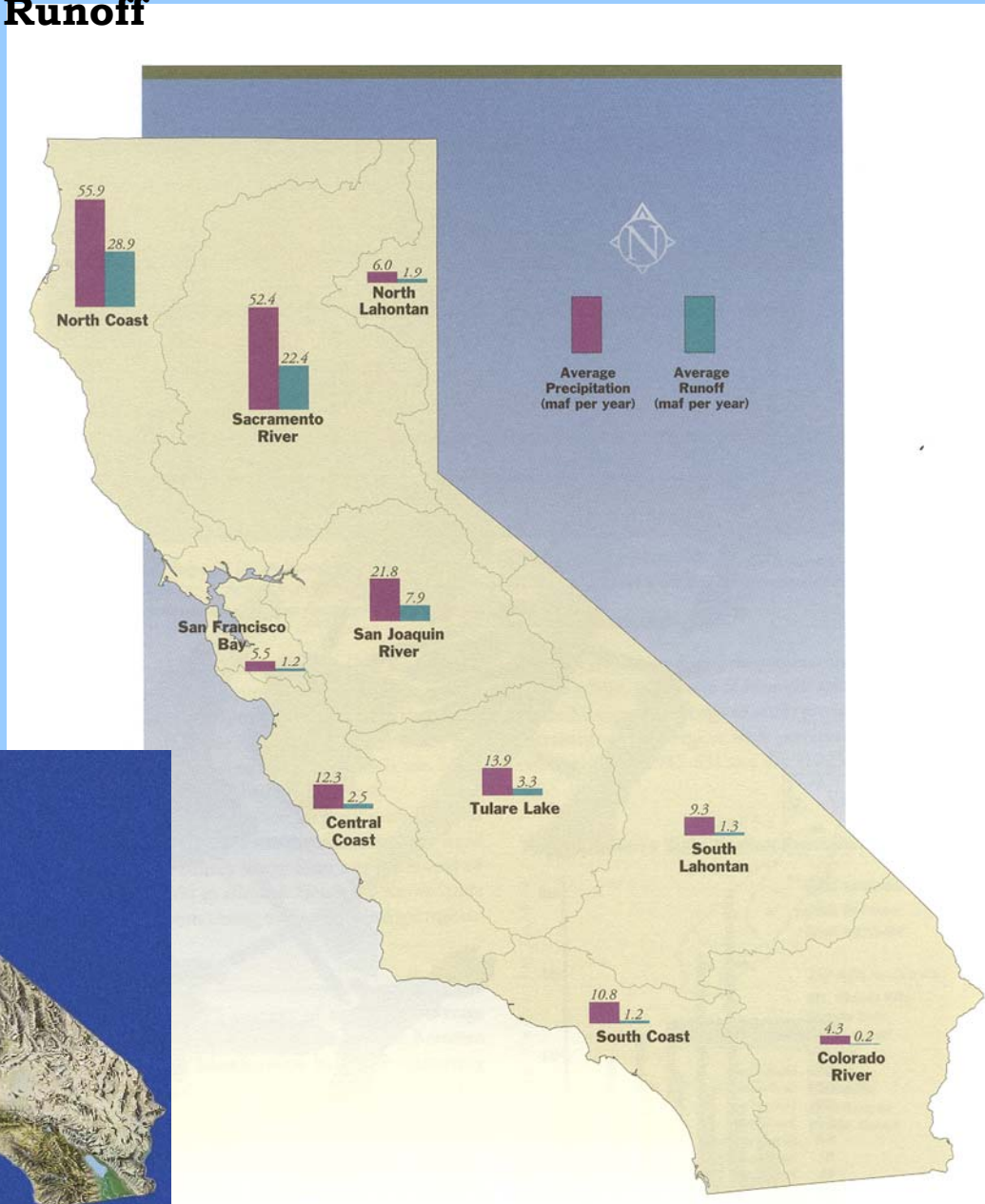
June 2006

# Overview

- California water background
- Governor's Executive Order
- Water resources impacts
- Uncertainties



# Distribution of Average Annual Precipitation and Runoff

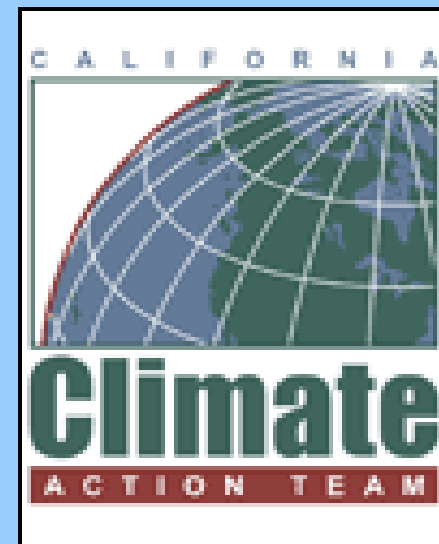






# Governor's June 2005 Climate Change Executive Order

- Establishes greenhouse gas emissions targets
- Directs state agencies to prepare report on impacts, and mitigation & adaptation plans for impacts



# Climate Action Team Report

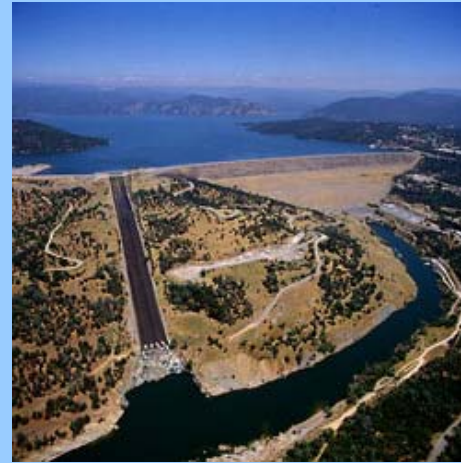
- Based on results of multiple GCM runs through 2100
- Temperature increases – low range (1.7-3.0°C), high range (4.4-5.8°C)
- Unclear outcome on precipitation trends
- Water resources impacts -- hydrologic, sea level rise, water use

# Hydrologic Impacts

- Water storage capacity in Sierra Nevada snowpack now  $\approx \frac{1}{2}$  total capacity of California's major reservoirs
- **Possible** reduction in Sierra Nevada snowpack of 10-40% by 2035-2064
- **Possible** Sierran snowpack decrease of up to 90% by 2100
- **Actual** water supply impact due to lost storage capacity depends on reservoir operations changes that can't now be modeled

# Reservoir Operations Tradeoff

- Tradeoff between operating Sierran reservoirs for water storage or flood control
- Issue less acute in Colorado River Basin, due to greater reservoir storage volumes



# Flood Control Considerations

- Central Valley Flood Control Project includes dedicated storage in numerous reservoirs & and 1,600 miles of Project levees
- Possible increase in magnitude/number of extreme storm events problematical for levee system



# Impacts of Sea Level Rise -- Sacramento-San Joaquin Delta

- Delta is hub of California water supply systems
- 1100 miles of mostly non-engineered levees protecting below-sea level islands
- Highly vulnerable to flooding & sea level rise



# Water Use Impacts

- Changes in water use for agricultural crops & urban landscaping
- Uncertain demographic impacts
- Uncertain ecosystem-related water use impacts





# Uncertainties

- Mismatch between level of detail & planning horizons used for conventional water resources planning and information available from climate change scenarios
- Presently, greater uncertainty in **quantifying** water use impacts than in hydrologic ones
- Hydrologic impacts – GCMs need to be downscaled to generate watershed-level data to assess water supply/flood control tradeoff

# Uncertainties– Water Use Impacts

- Are 100-year socioeconomic projections meaningful?
- Limitations of demographic models
- Planning horizons – e.g. U.S. Census only to 2050
- Local land use planning based on timing of General Plan updates
- Changes in agricultural water use dependent on urban land conversion, global trade patterns, not just local climate

# **Limitations of Long-Term Socioeconomic Forecasting – California in 1900 & in 2000**

- 1.5 million v. 34 million people
- Horse & buggy v. 23.4 million cars
- U.S. Life expectancy (male) at birth – 48 v. 74
- Difficult to make predictions, especially about the future (Yogi Berra)

# Closing Thoughts

- Plans are worthless, but planning is priceless (Eisenhower)
- Adaptability, flexibility key in future planning
- Trends in water resources planning -- integrated resources management, adaptive management, diversification