California Climate Change: A Historical Perspective

Michael Anderson, Ph.D., P.E.
California Department of Water Resources
Division of Flood Management
CH1 Introduction
CH2 Background
CH3 DWR Studies
CH4 SWP-CVP Impacts
CH5 Delta Impacts
CH6 Flood Management
CH7 Evapotranspiration
CH8 Future Directions

Peer reviewed chapters
Acknowledgments

Thanks to Jim Goodridge retired state climatologist, David Rizzardo, Matt Winston, Boone Lek, BG Heiland, Tawnly Pranger, Aaron Miller, Maury Roos, John King, and Steve Nemeth of DWR-DFM and Jamie Anderson of DWR Delta Modeling.
Presentation Outline

- Introduction
- Historical Data
- Climate Change
- Impacts Assessment
Introduction

• **Climate vs. Weather** – “Climate is what you expect and weather is what you get”
  - Mark Twain

• **Global Climate Models** aim to predict climate, not weather

• **Individual weather events** may vary greatly for a given climate
Introduction

• Looking back to frame a look ahead
• Examine historical record for trends and variability
  – Temperature
  – Precipitation
  – Runoff
  – Flood Peaks
  – Sea Level Rise
• How does variability compare to trends?
Statewide average observed warming of about 0.5 °C (1 °F)
Historical Precipitation

- Statewide Average Precipitation: Lots of variability, no trend

1890-2000: 23.9 inches
1915-1935: 20.8 inches
1980-2000: 25.6 inches
Historical Runoff Timing

Sacramento River System

Water Year Runoff

Runoff Volume (tAF)

Water Year (October 1 - September 30)
Historical Runoff Timing

Sacramento River System

April-July Runoff

Water Year (October 1 - September 30)
Historical Runoff Timing

San Joaquin River System

Water Year (October 1 - September 30)
Historical Runoff Timing

San Joaquin River System

April - July Runoff

Runoff Volume (tAF)

Water Year (October 1 - September 30)
## Changes in Annual Peak Runoff

<table>
<thead>
<tr>
<th>Pre/Post 1955</th>
<th>Feather</th>
<th>Tuolumne</th>
<th>Eel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>42/52</td>
<td>12/17</td>
<td>93/123</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>33/50</td>
<td>11/19</td>
<td>48/84</td>
</tr>
<tr>
<td>Range</td>
<td>145/232</td>
<td>52/91</td>
<td>165/489</td>
</tr>
</tbody>
</table>

Values in 1000 cfs for annual peaks of 3-day average flows
1904-2004 data used for analysis
Range is maximum-minimum values for time period
Sea Level Rise

Golden Gate

Increase ~0.08 in/yr
Total increase from 1900-2003 = 8.15 in
A look ahead...

Climate change model information from Global Climate Models
Projected Changes Temperature

Some Uncertainty  From Dettinger, 2005
Projected Changes Precipitation

Lots of Uncertainty!

From Dettinger, 2005
Impacts Assessment - Hydrology

- Examine possible impacts of increases in mean atmospheric temperature of 1-5°C
- Assume snowpack retreats at 500 feet per 1°C
Snowpack Reduction Impacts

![Graph showing the relationship between average atmospheric temperature increase (°C) and percent snow free above Shasta, Oroville, and Folsom reservoirs.](image-url)
Storm Runoff Impacts

- Higher snow levels yield more direct runoff per storm
Impacts Assessments

• **Initial Assessments**
  - CVP/SWP Operations – Dan Easton (DWR)
  - Delta Issues – Jamie Anderson (DWR)

• **Ensemble Methods – The next step**
  - CVP/SWP Operations Impacts with Ensemble Analysis – Levi Brekke (USBR)
  - Weighted Estimation of Projection Distributions – Levi Brekke (USBR)
Questions?

Web Page: http://www.climate.water.ca.gov
Email: climate@water.ca.gov