Using Tree Rings to Inform Water Resource Management

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THE UNIVERSITY OF ARIZONA

LTRR Laboratory of Tree-Ring Research University of Arizona

Acknowledgements: Photo contributions from Dave Meko, Erica Bigio, Brewster Malevich. Field and lab assistance from Brewster Malevich, Chris Zemp, Jordan Krcmaric, Maya Antoun, Sarah Frederick, Mark Losleben, Tony Caprio, other others
Project funding from CADWR

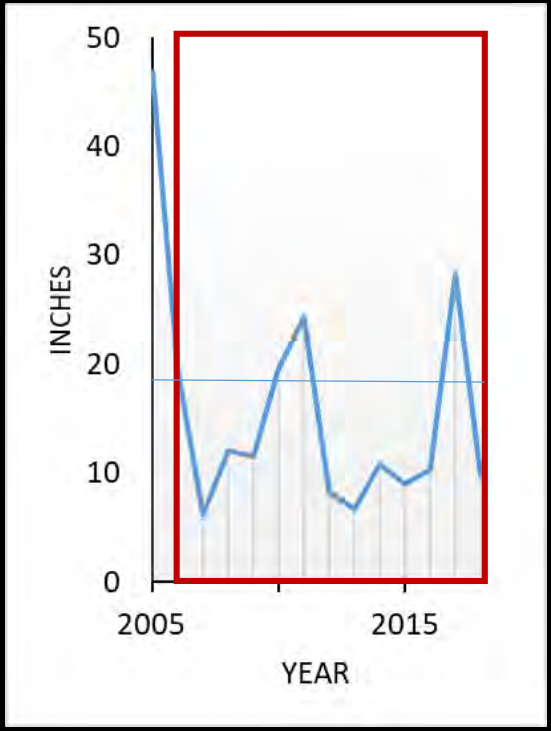
Questions addressed in this presentation:

1. Why consider the past when planning for the future?
2. Why is the long-term perspective important for water resource management?
3. What information can be provided by records of past hydrology that might be useful?
4. How are tree-ring reconstructions of past hydrology being used in water resource management?
5. What resources are available for water managers?

1. Why consider the past when planning for the future?

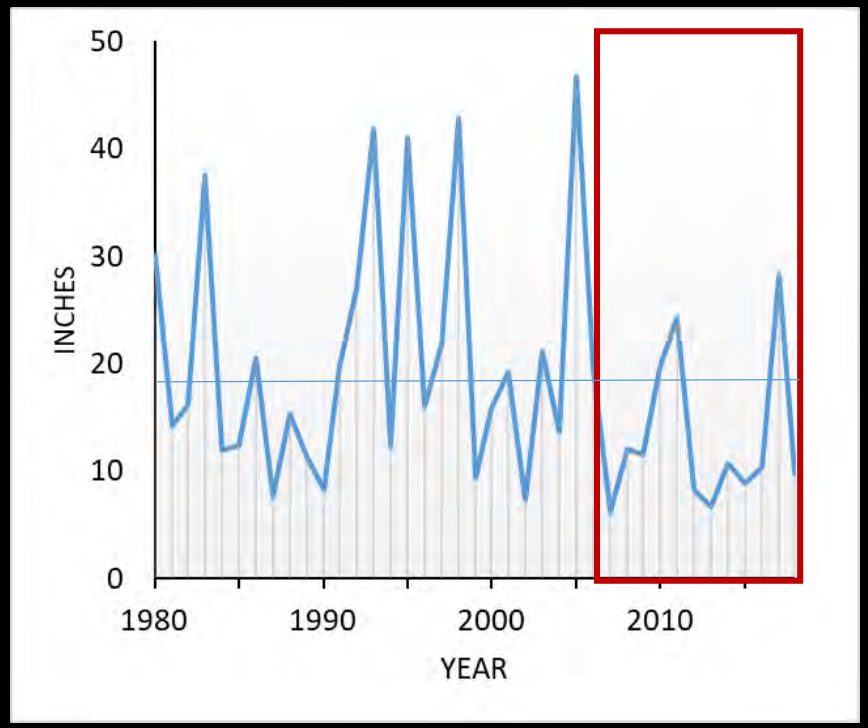
perspective

Ojai, CA
total precipitation
Oct-March 2005-2018



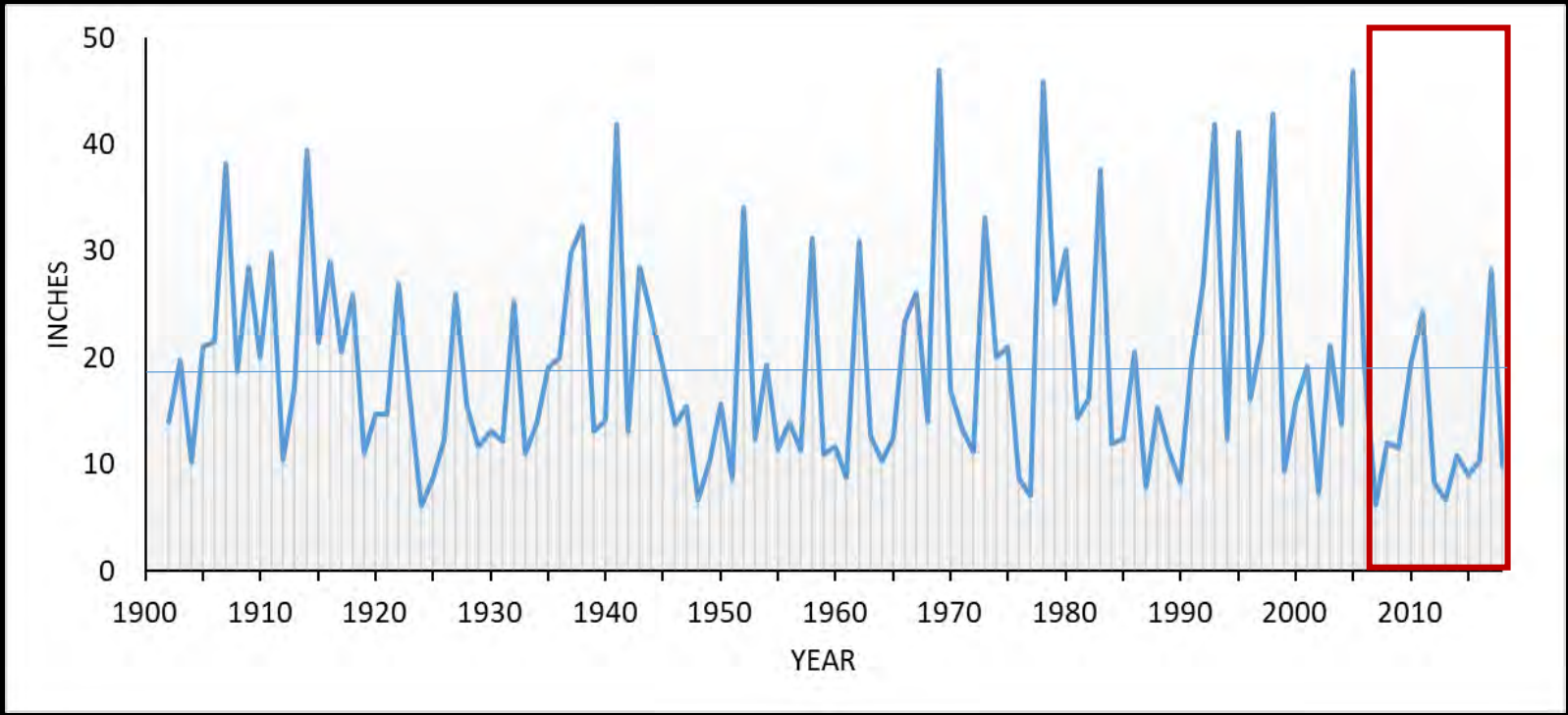
perspective

Ojai, CA
total precipitation
Oct-March 1980-2018

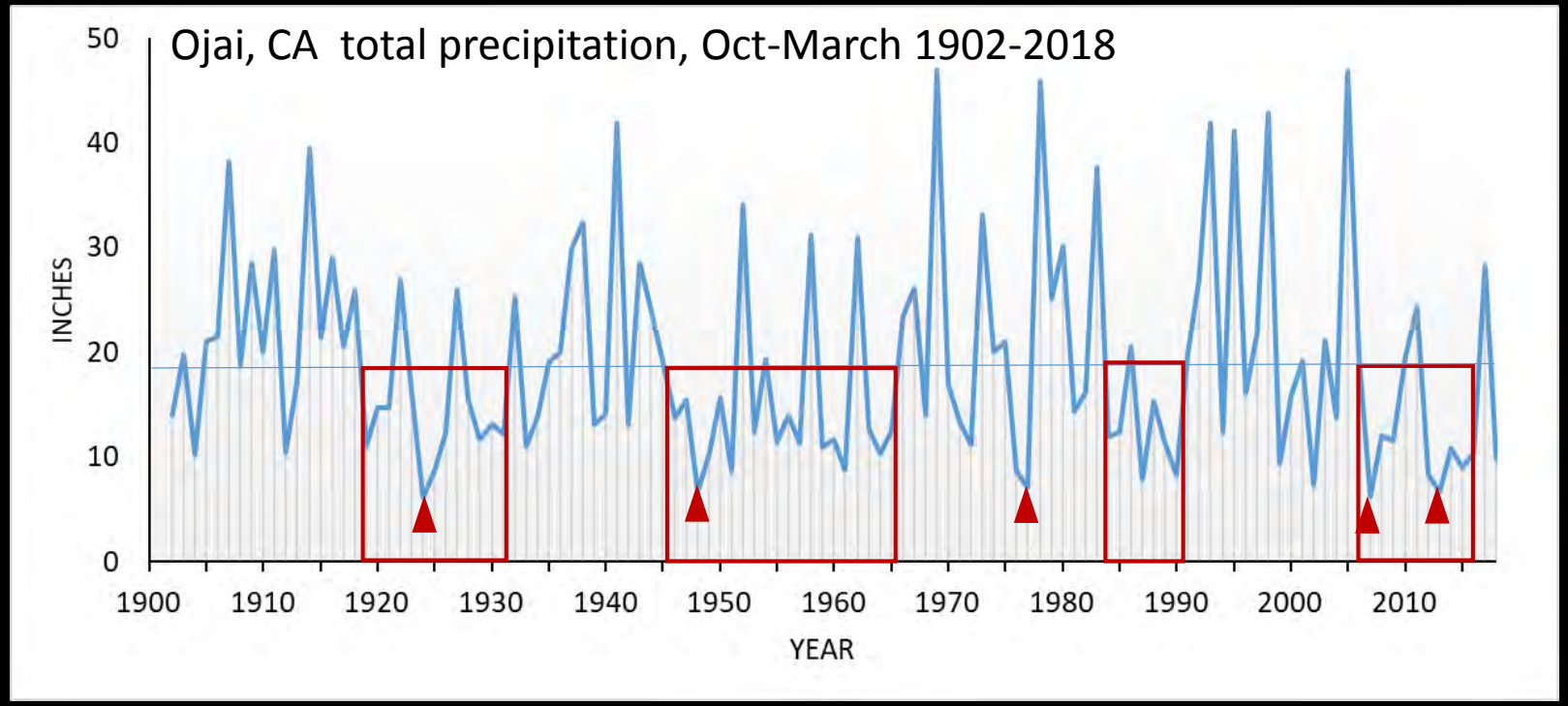


perspective

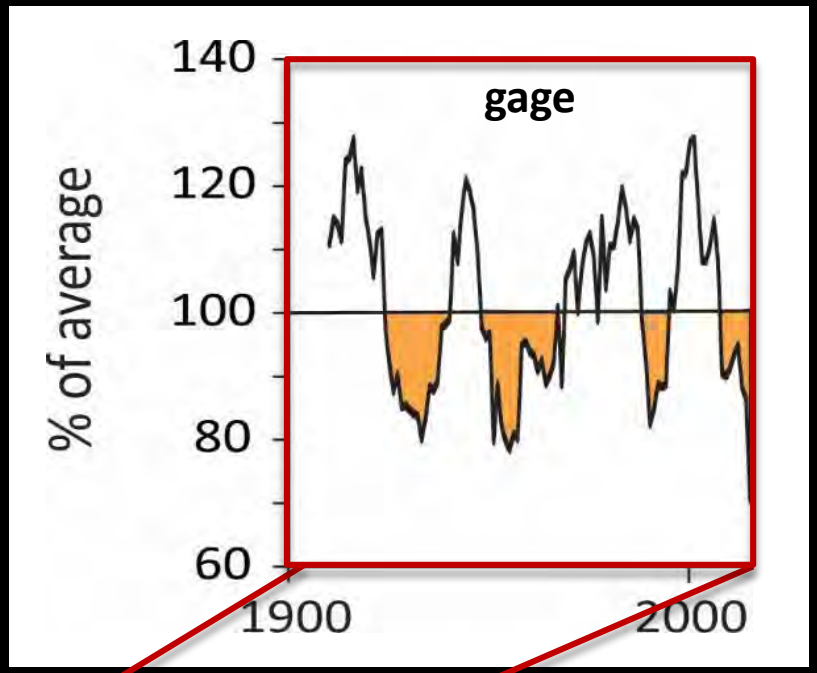
Ojai, CA
total precipitation
Oct-March 1902-2018

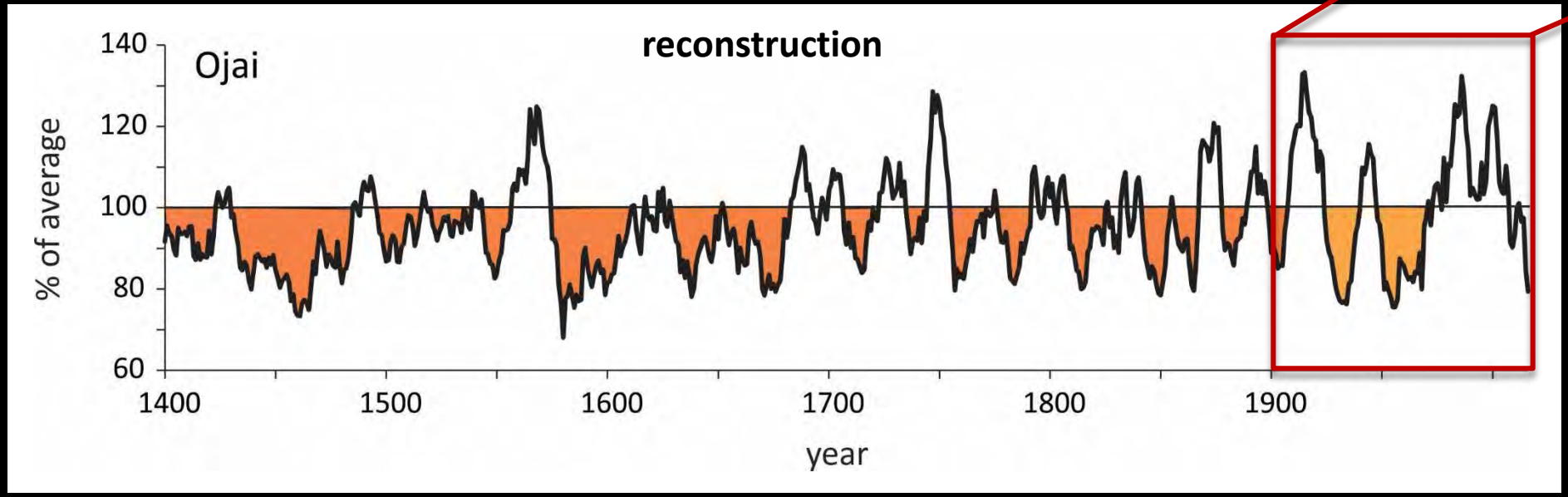


Most gage record extend 100 years or so, at best. These records document extreme dry years and persistent drought.



How representative is the gage record over a longer time frame?

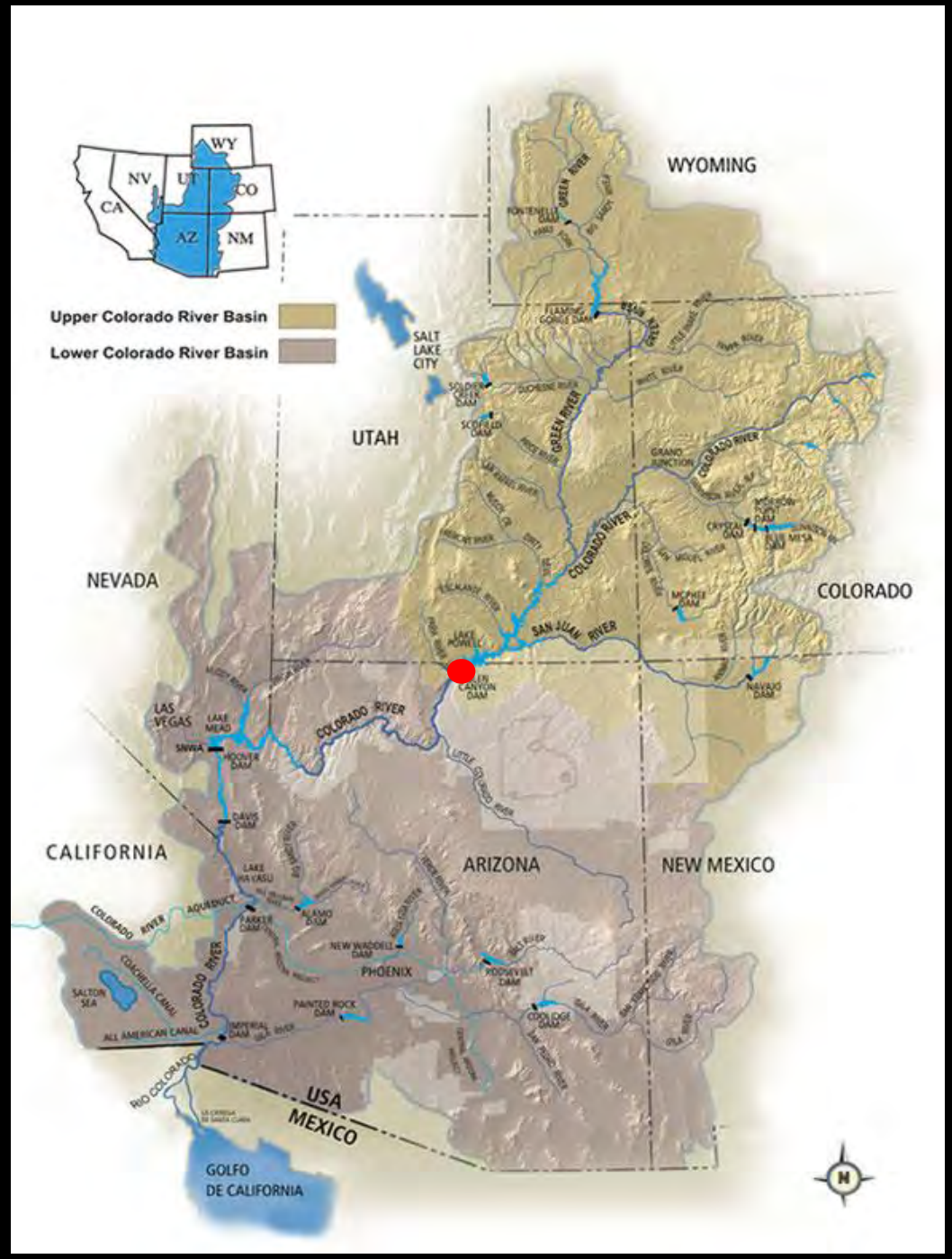


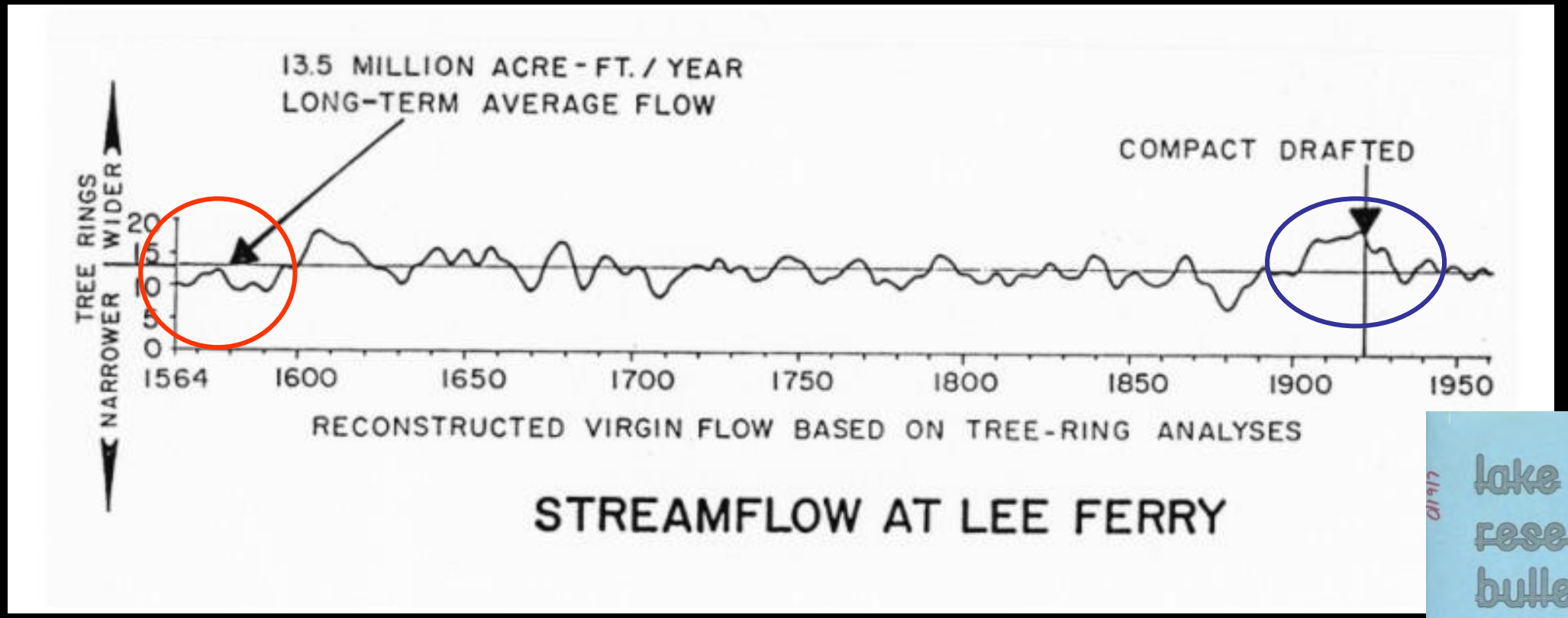


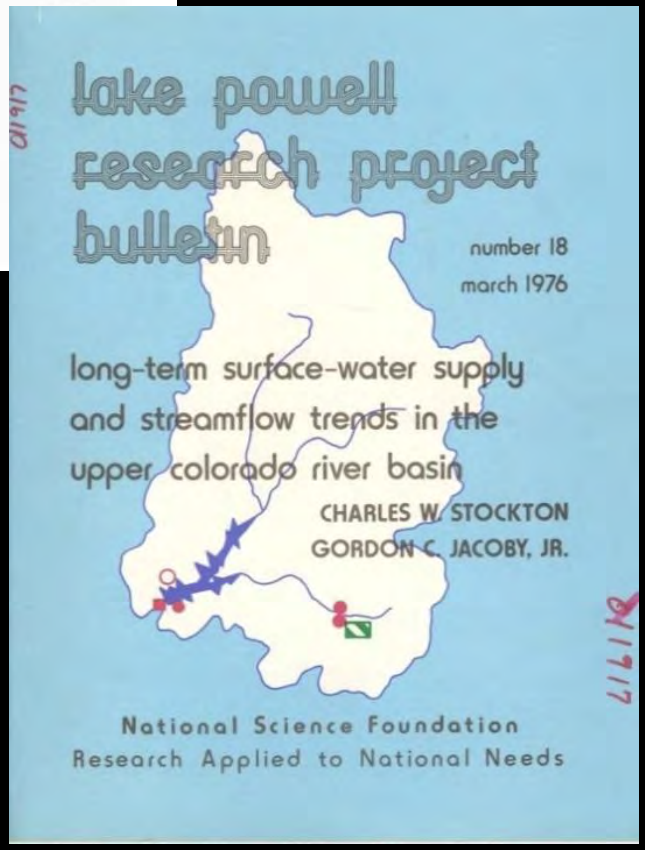
2. Why is this long-term perspective important for water resource management?

An example from the Colorado River

Colorado River Commission, 1922, from Water Resources Archive, CSU





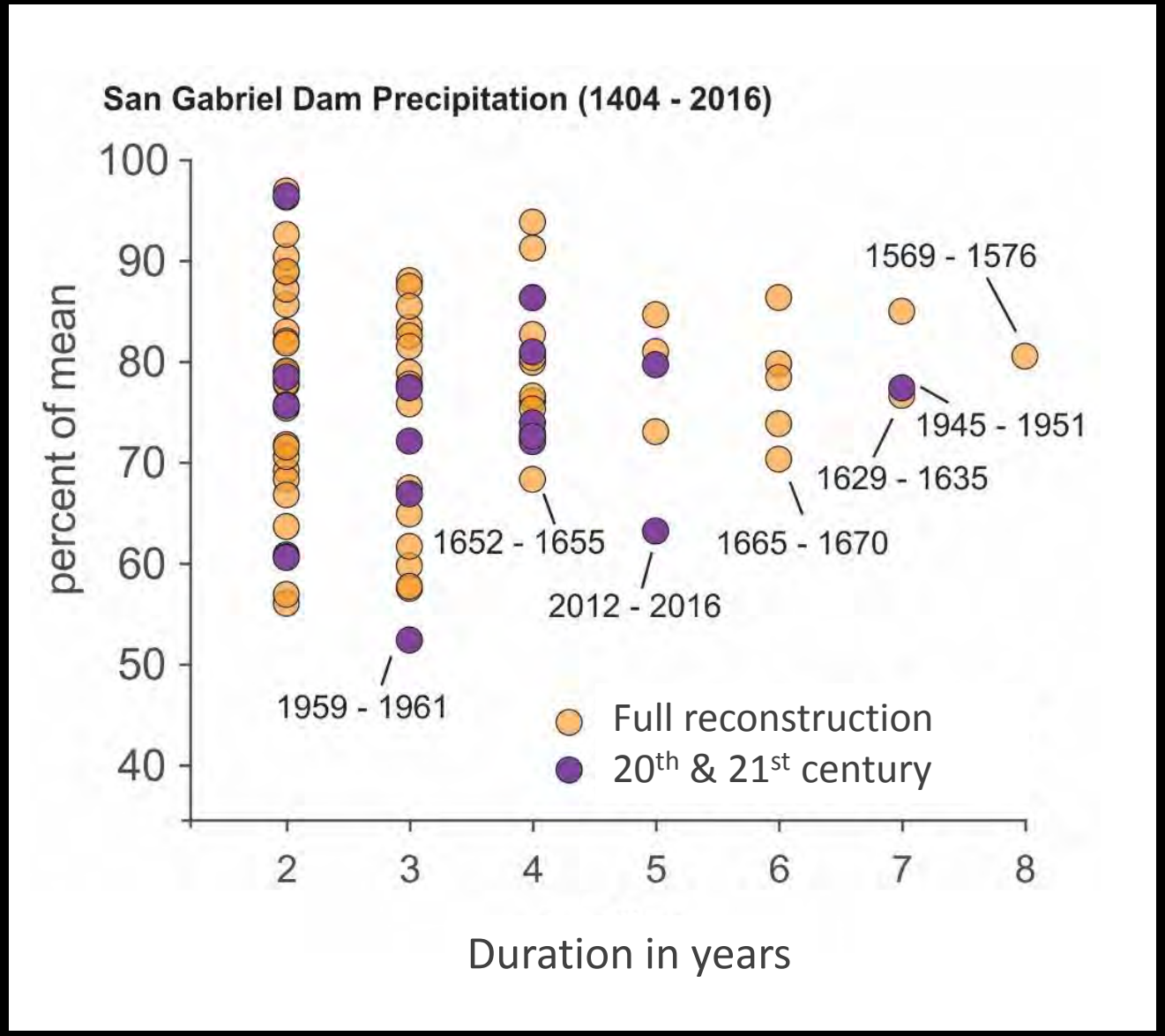


"The general picture of a collision between water demand and supply in the UCRB in the not-too-distant future is all too apparent."

Stockton and Jacoby 1976

3. What information can be provided by records of past hydrology that might be useful for water resource management?

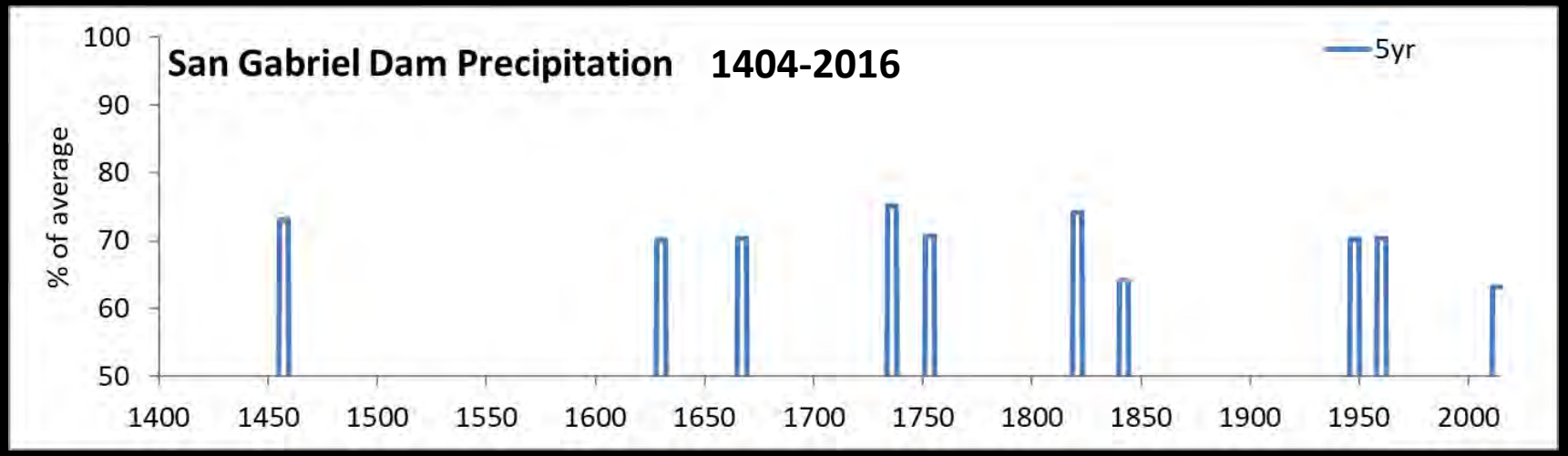
Droughts: how long and how frequent



Driest periods

- 5-year periods

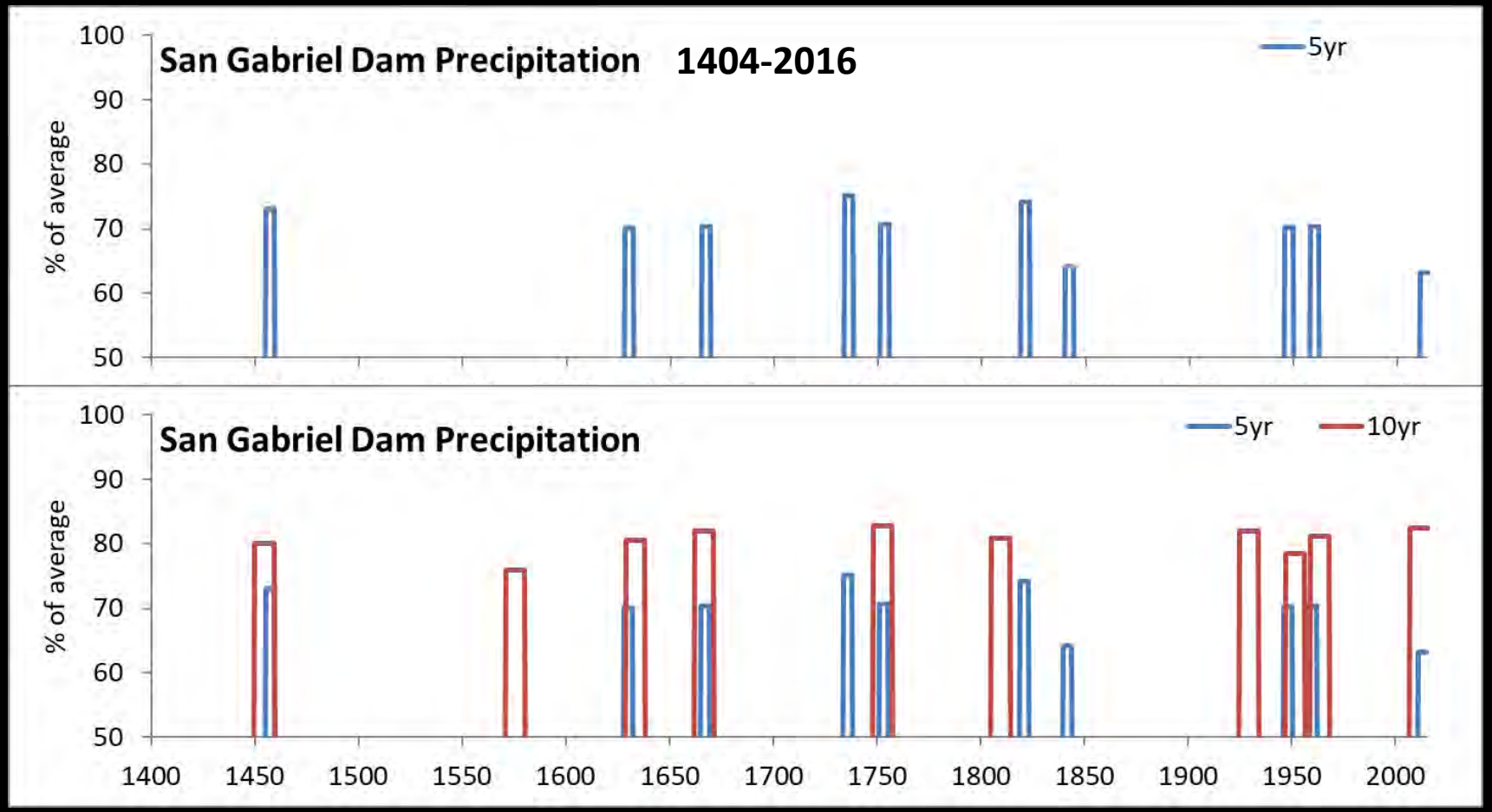
  (non-overlapping)



Driest periods

- 5-year periods
- 10-year periods

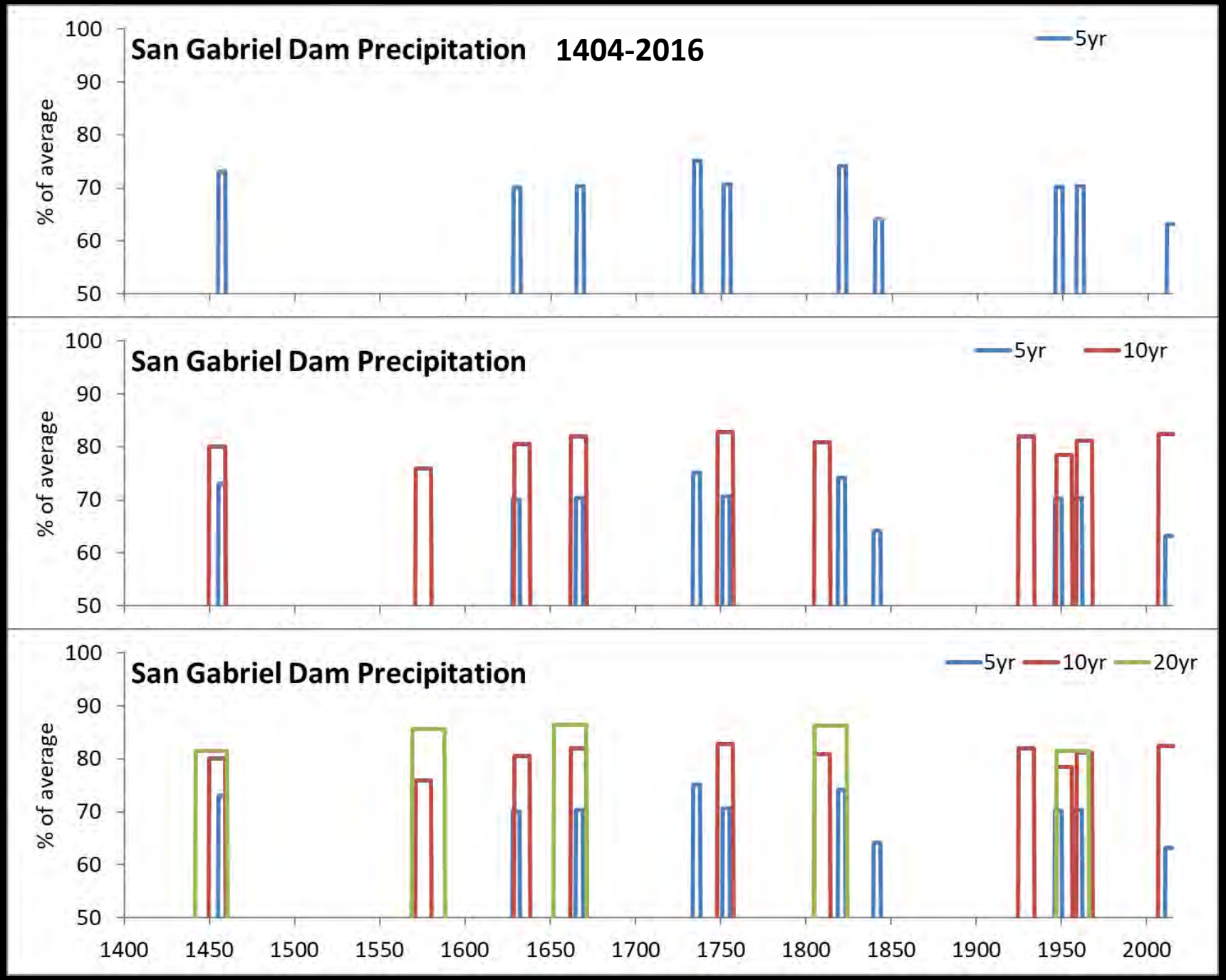
  (non-overlapping)



Driest periods

- 5-year periods
- 10-year periods
- 20-year periods

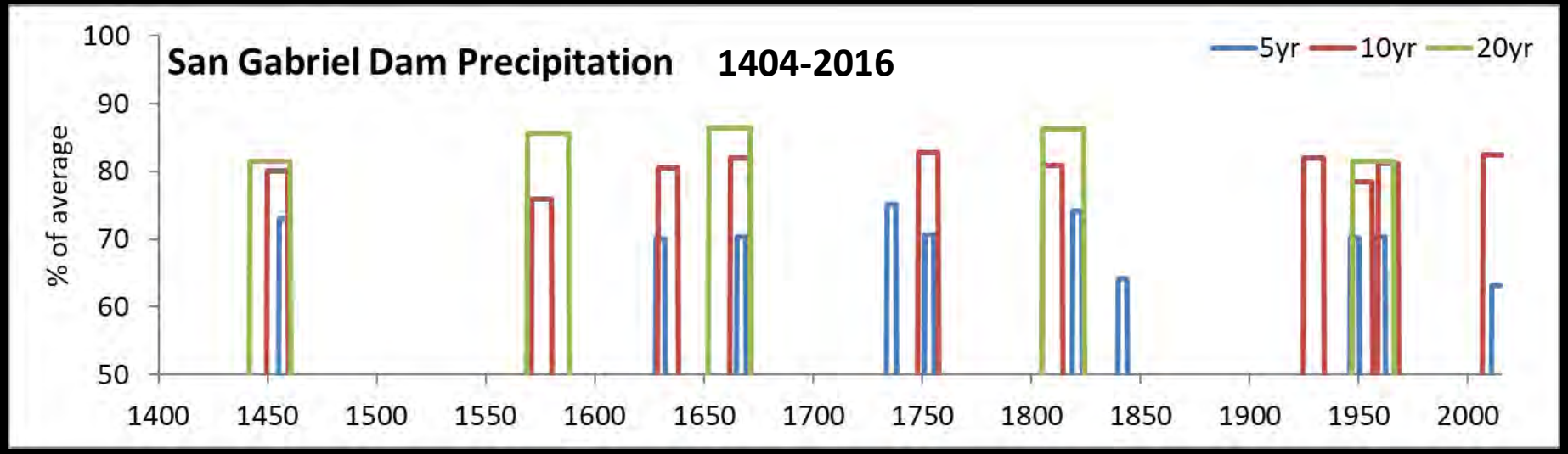
(non-overlapping)

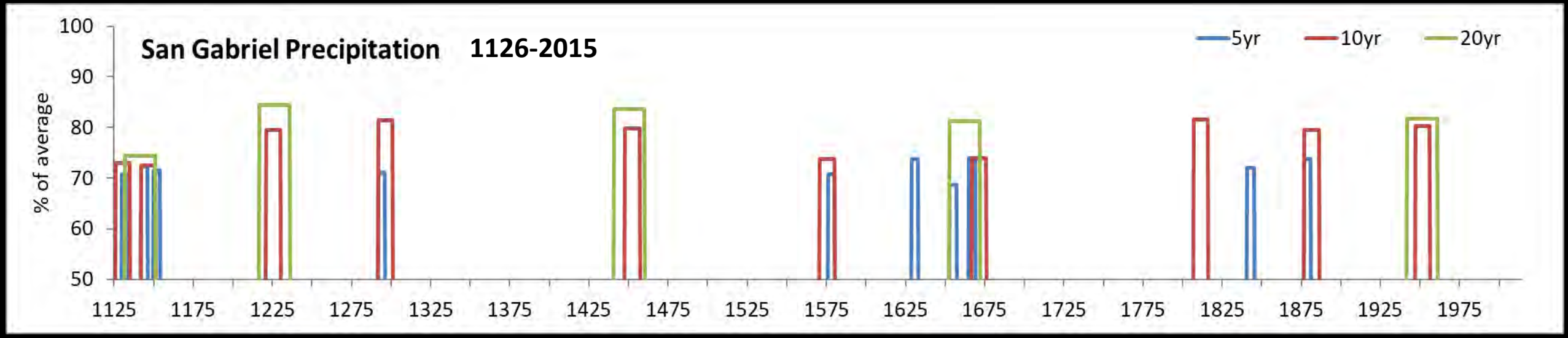


Driest periods

- 5-year periods
- 10-year periods
- 20-year periods

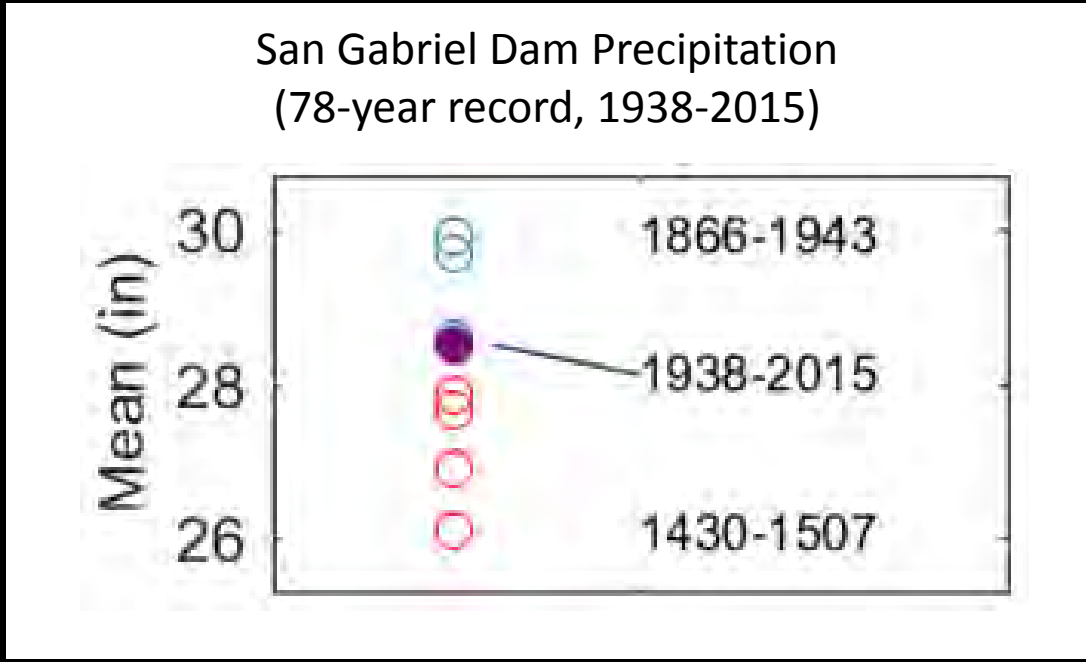
(non-overlapping)





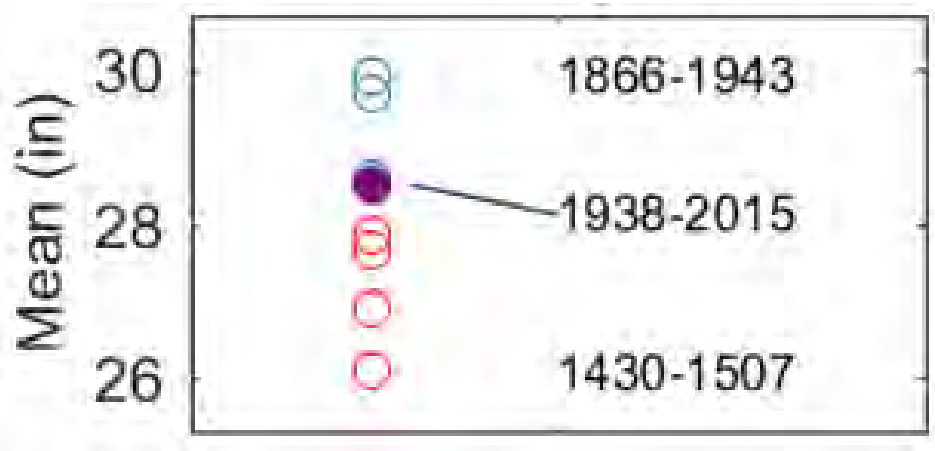
Is the average precipitation or streamflow over the 20^{th}-21^{st} centuries representative of past centuries?

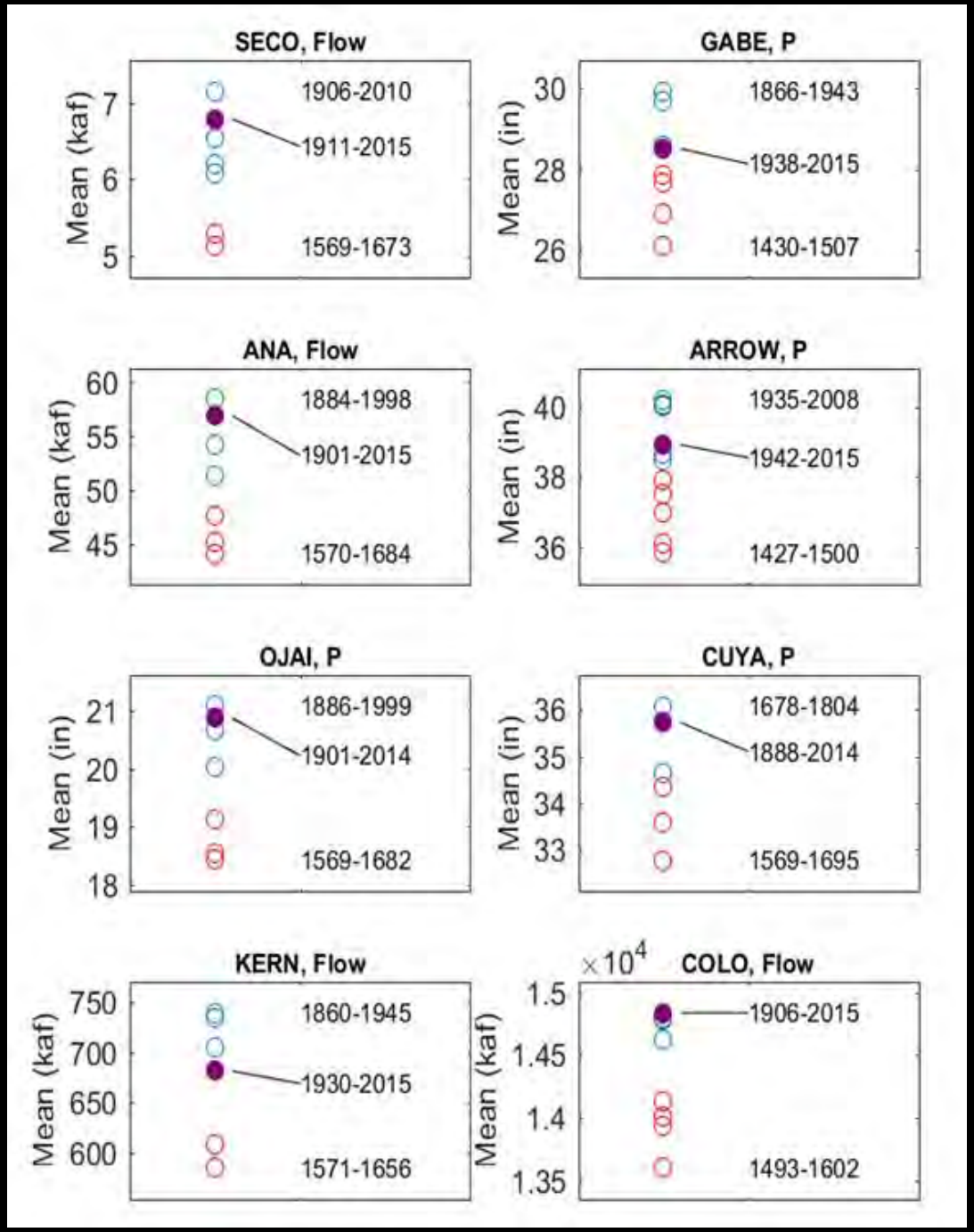
Gage period average compared to the wettest and driest non-overlapping time periods of the same length, 1404-2016



Gage period average compared to the wettest and driest non-overlapping time periods of the same length, 1404-2016

San Gabriel Dam Precipitation
(78-year record, 1938-2015)



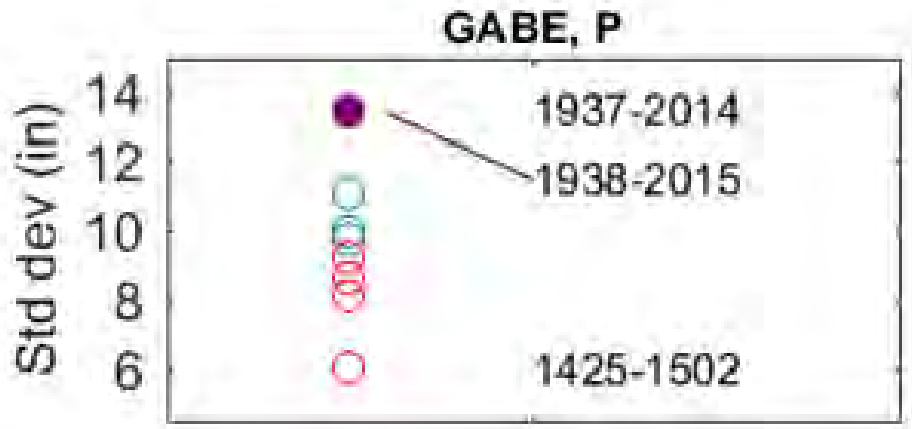


Is the average precipitation or flow over the 20th-21st centuries representative of past centuries?

What about the variability?

Gage period variability compared to the most and least variable non-overlapping time periods of the same length, 1404-2016

San Gabriel Dam Precipitation
(78-year record, 1938-2015)



Gage period variability compared to the most and least variable non-overlapping time periods of the same length, 1404-2016

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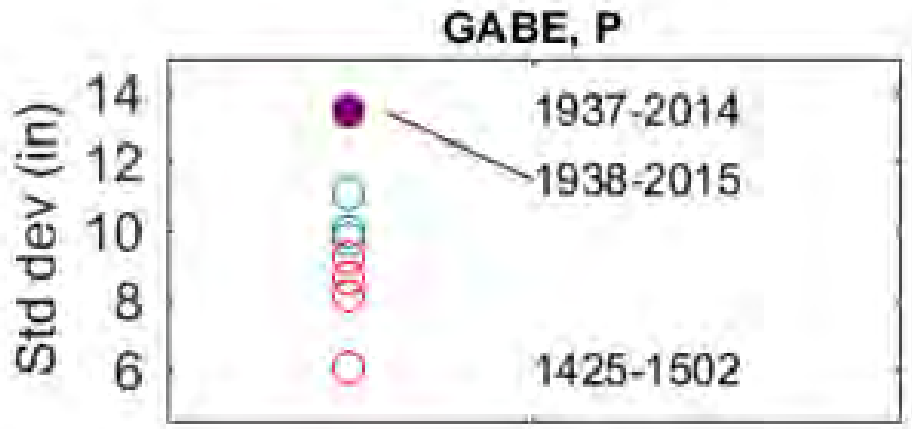
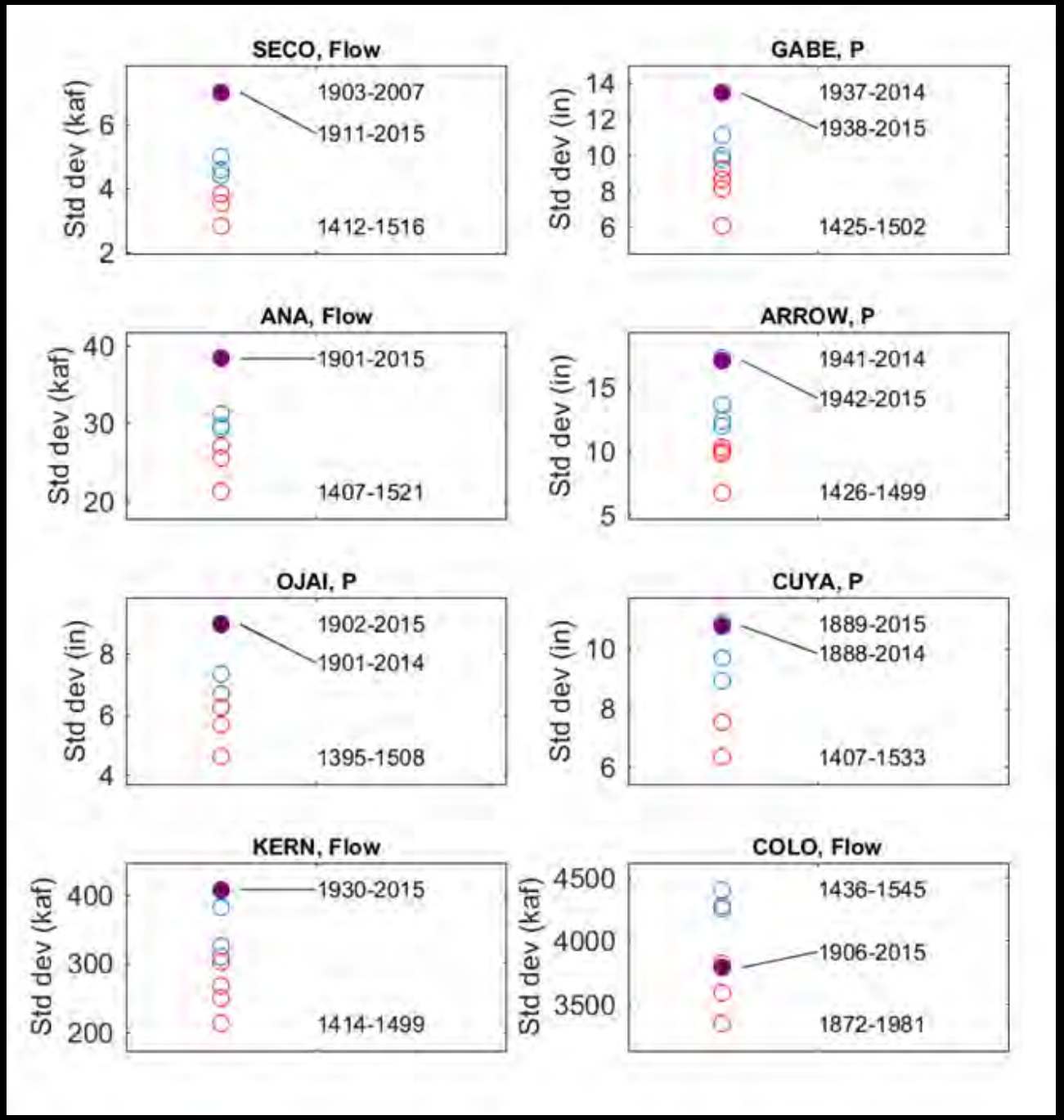
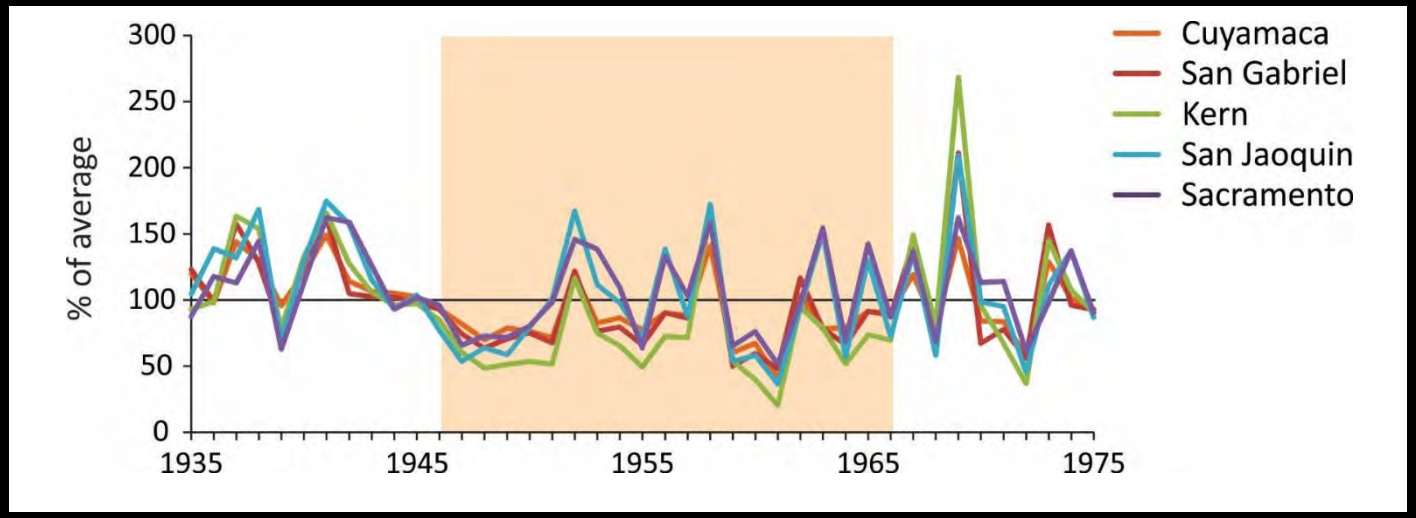




How do the worst statewide periods of drought in the 20th century compare to those over past centuries?

Iconic Droughts of California

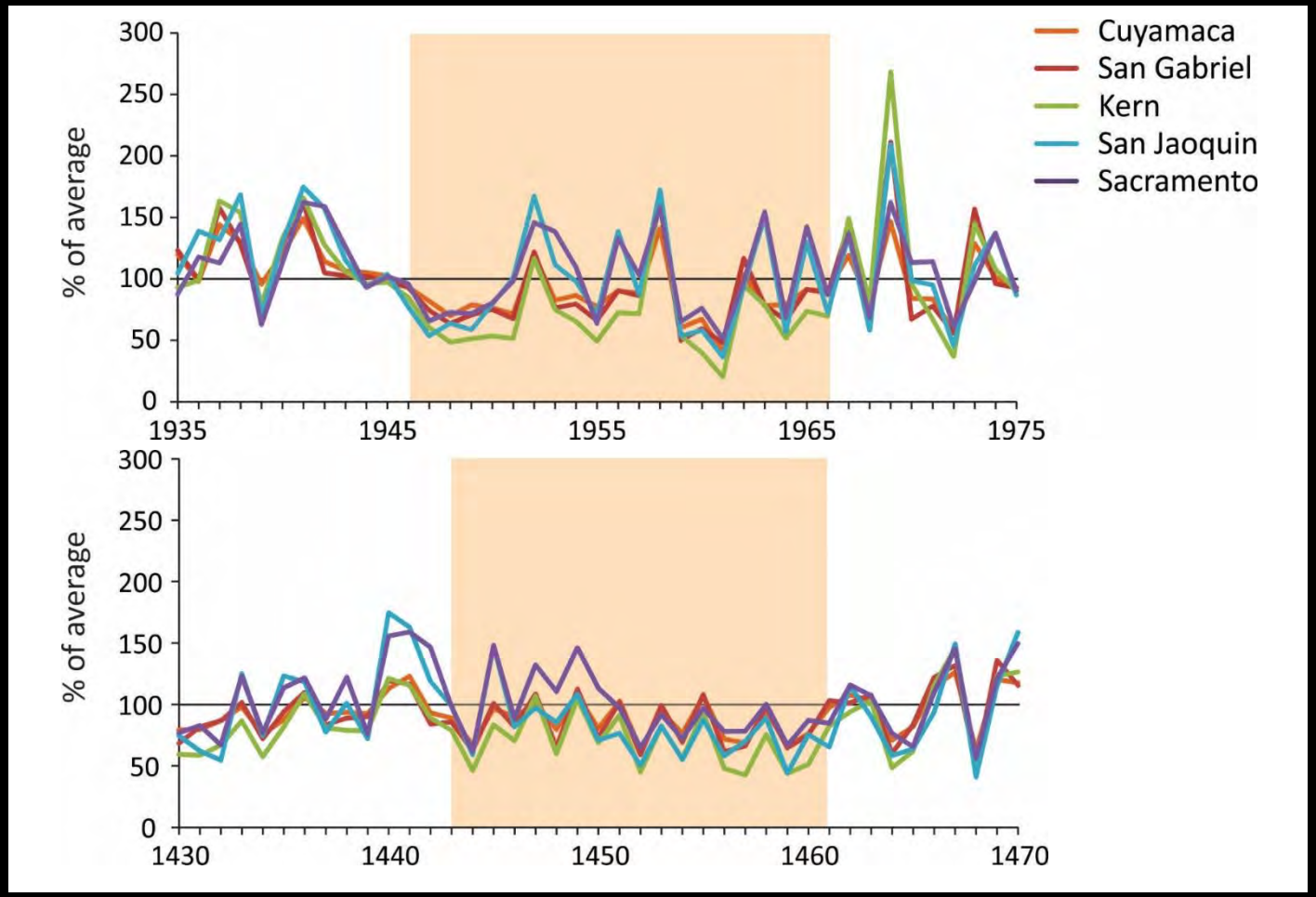
1946-1966



Iconic Droughts of California

1946-1966

1443-1461

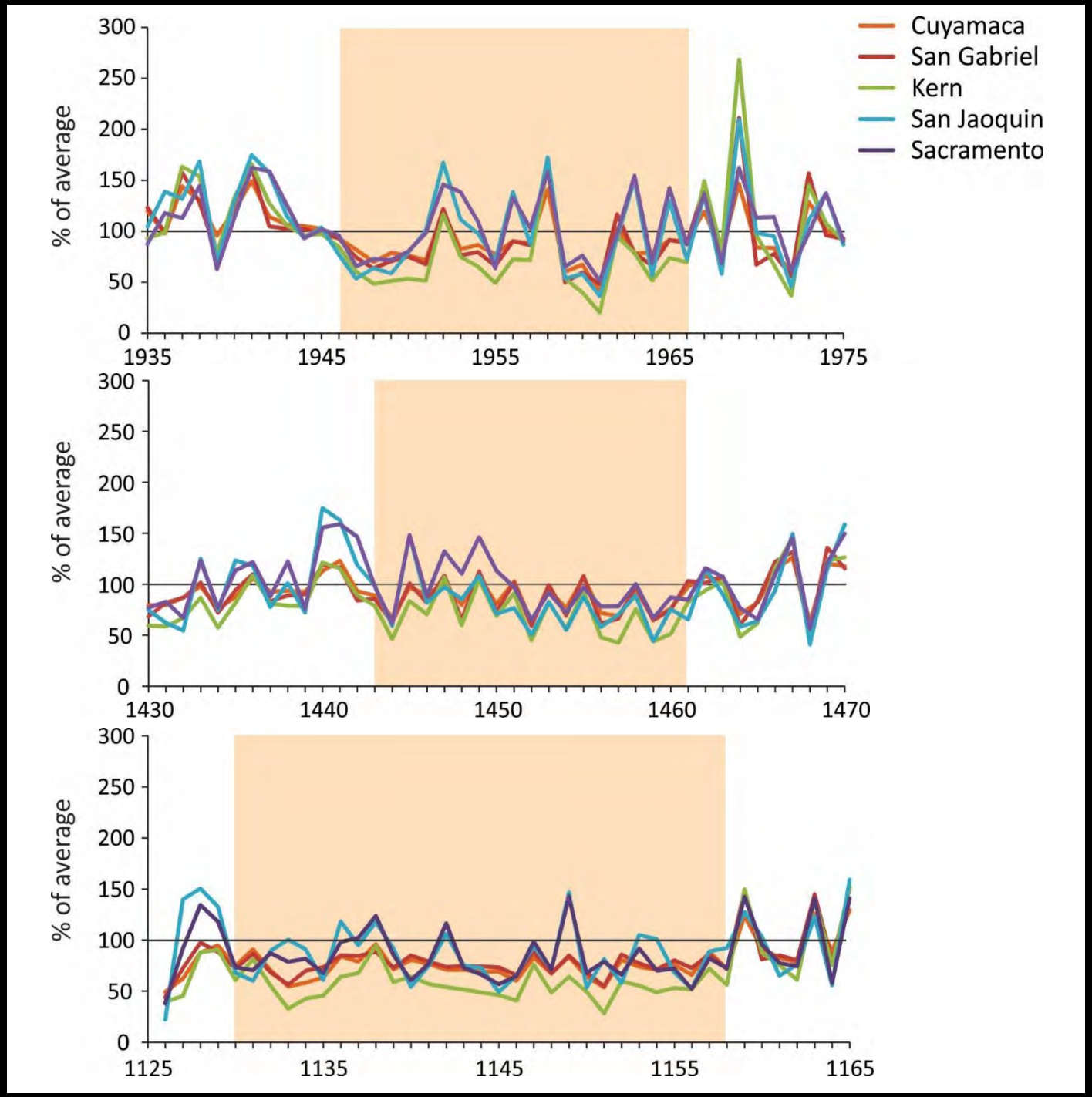


Iconic Droughts of California

1946-1966

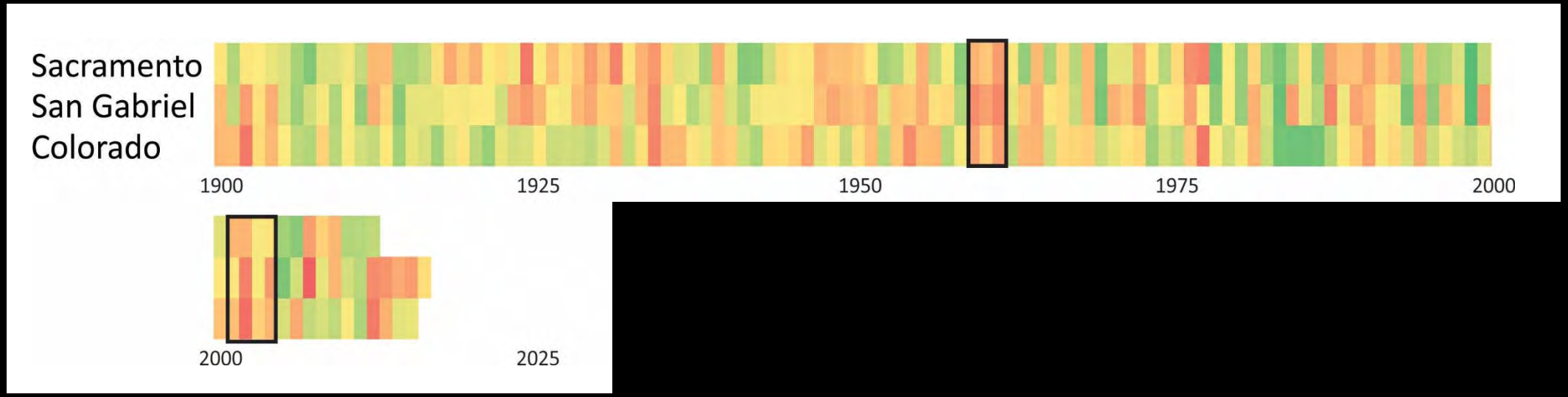
1443-1461

1130-1158

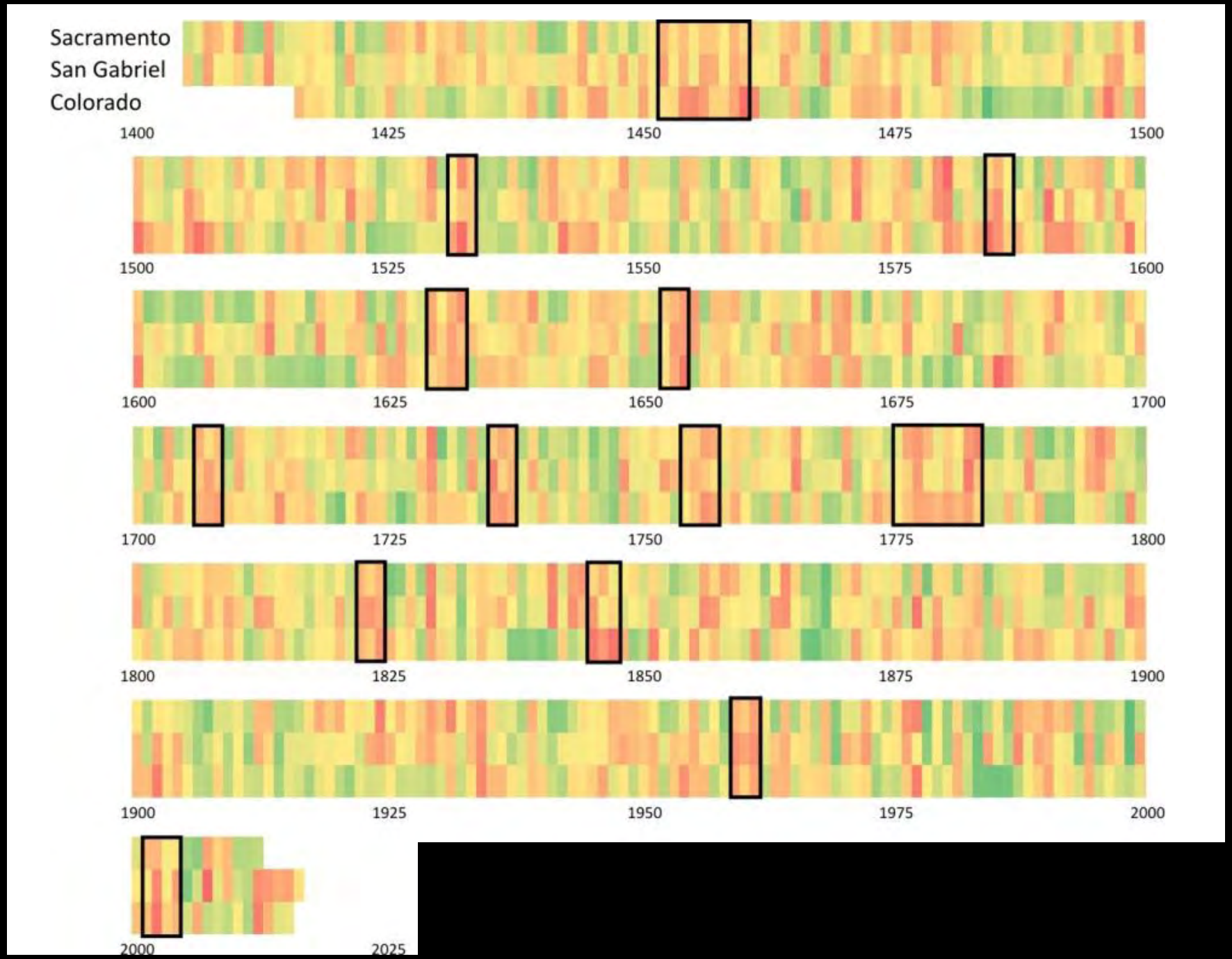


What about West-wide droughts?

Concurrent drought across the Sacramento River basin, southern California, and the upper Colorado River basin, 20th and 21st centuries



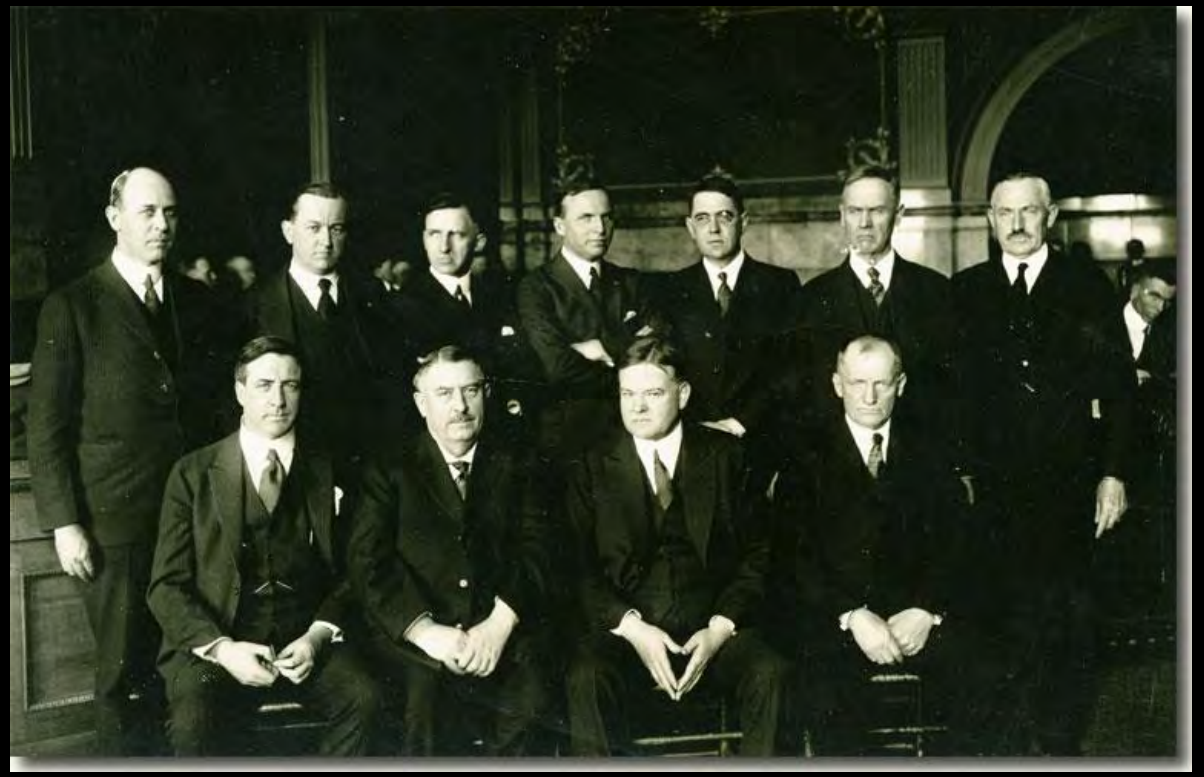
Concurrent drought across 3 regions, 1400s - present



4. How are tree-ring reconstructions of past hydrology being used in water resource management?

In the western US, tree-ring reconstructions have become a useful tool for planning and management

- The long view
- Worst-case scenarios
- Testing system reliability
- Plausible futures
- Communication of risk



Colorado River Commission, 1922, from Water Resources Archive, CSU

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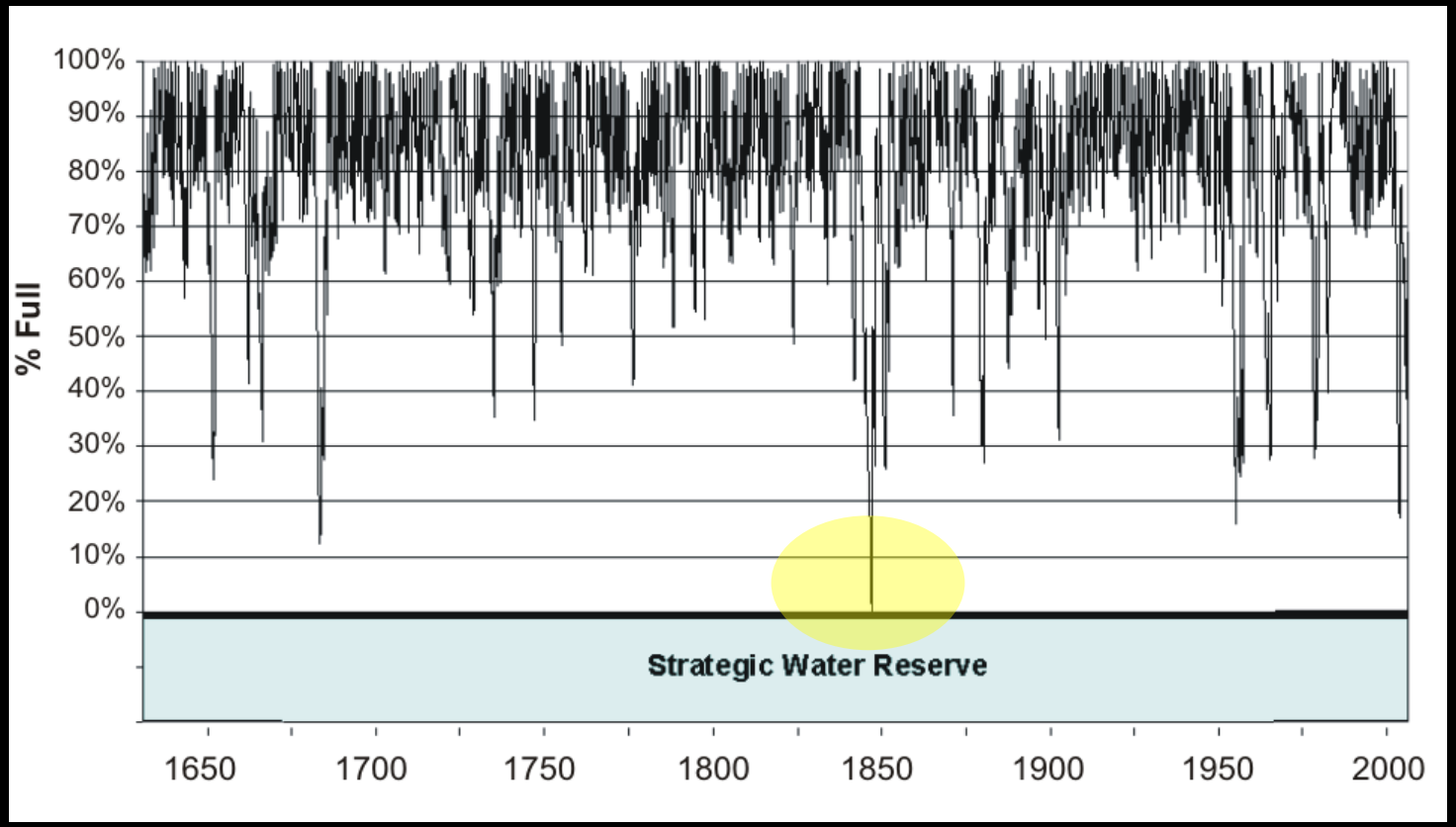

Courtesy of Denver Water

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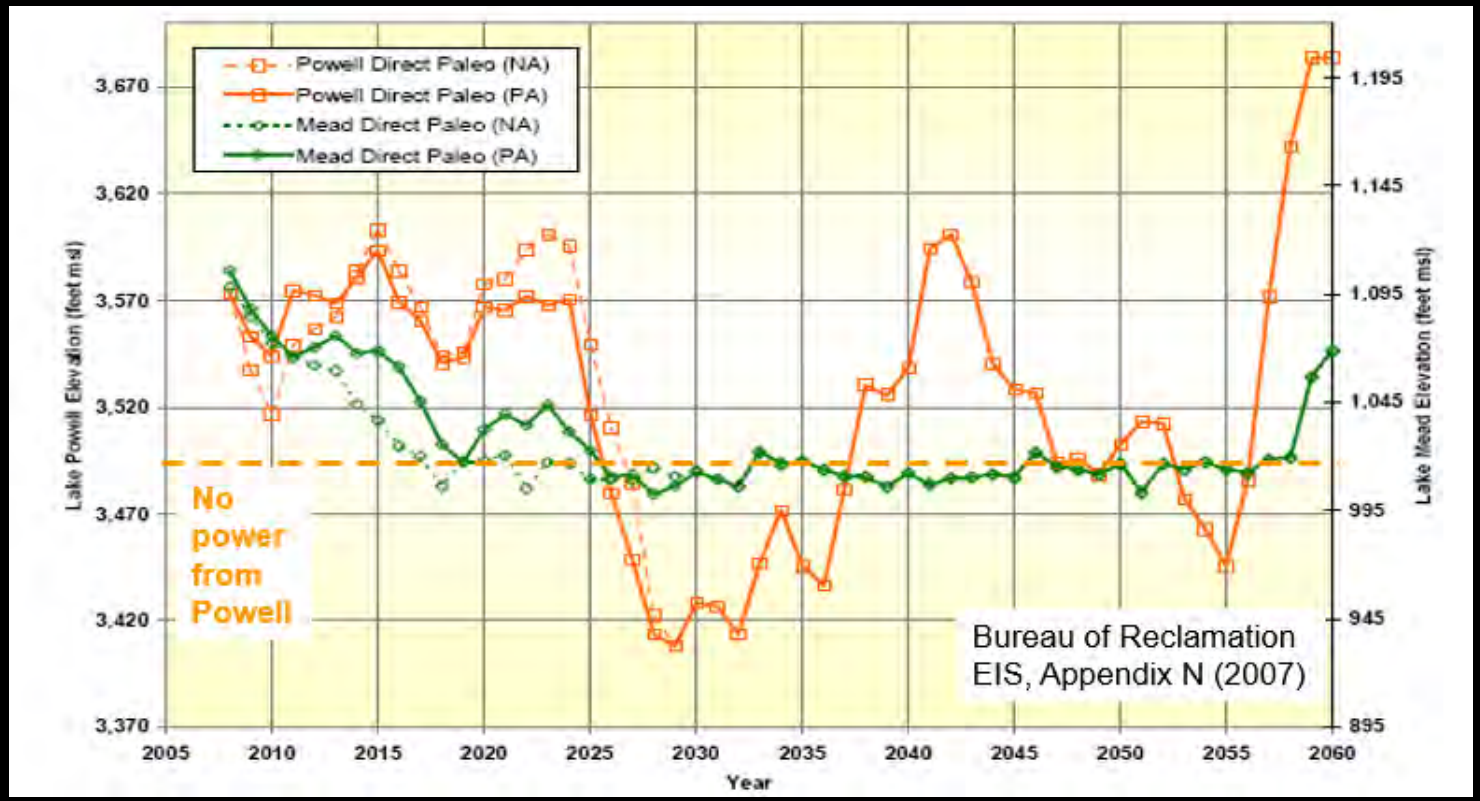

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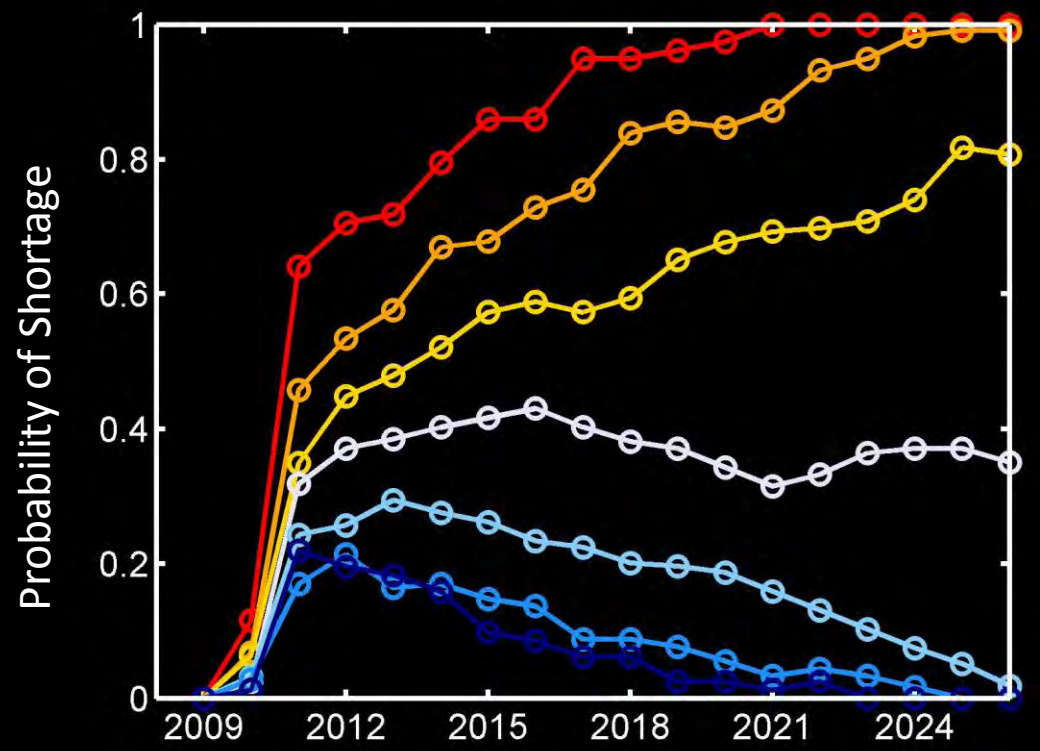
Probability of Lower Colorado R. Basin Shortage



Based on 1226 18-yr traces from tree-ring reconstructed flow, run through Colorado River Simulation System model

13 MAF 13.5 MAF
14 MAF 14.5 MAF
15 MAF 15.5 MAF
16 MAF

K. Morino (unpublished)

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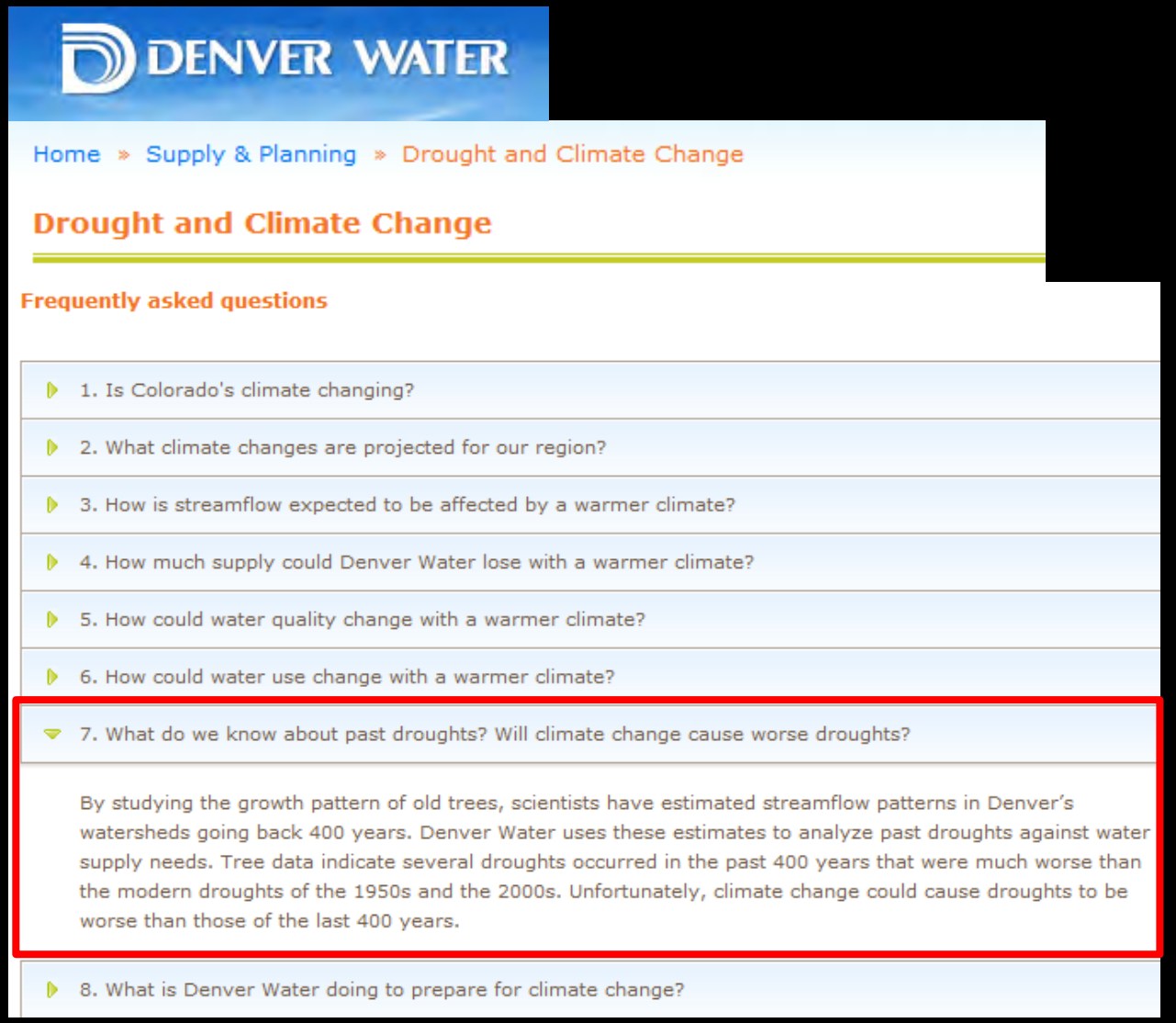

http://www.denverwater.org/SupplyPlanning/DroughtInformation/UncertainFuture/

5. Two Resources for Managers

California | TreeFlow

https://www.treeflow.info/california

Search

TreeFlow

streamflow reconstructions from tree rings

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Introduction

The watersheds which collectively make up the California hydrologic unit span a wide range of climatic, ecological, and land-use conditions, from the wet, sparsely settled northwest basins to the arid Los Angeles basin. Many of these disparate watersheds are tied together by the California State Water Project, which supplies water to over 23 million people and nearly one million acres of irrigated agriculture.

The California Department of Water Resources (DWR) was one of the first water entities to grasp the value of streamflow reconstructions in planning, supporting the development and application of tree-ring data since the 1980s. With the recent development of California blue oak tree-ring chronologies, which are excellent proxies for hydrologic variability, there is even greater potential for the development and use of reconstructions across California. See the California Tree-Ring Chronologies page for more information about existing tree-ring chronologies that could be used to reconstruct streamflow.

www.treeflow.info/california

California | TreeFlow

https://www.treeflow.info/california

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Basin Map | Reconstructions |

Introduction

The watersheds w
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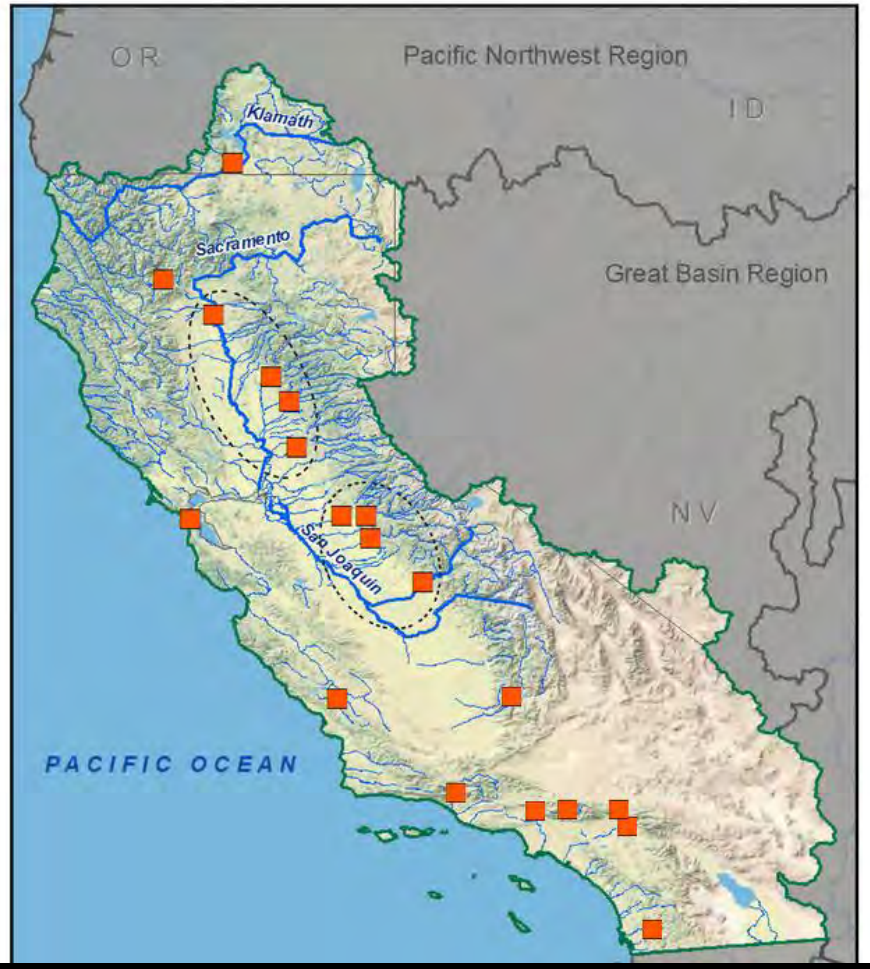
Basin Map

The map below shows the hydroclimatic reconstructions currently available for California. Place the cursor on a gage icon to view the gage name, and then click to view the page for that reconstruction, and a link to the data. A list of these reconstructions is presented below the map.

Also below the map is a list of other streamflow and precipitation reconstructions for California, not shown on the map.



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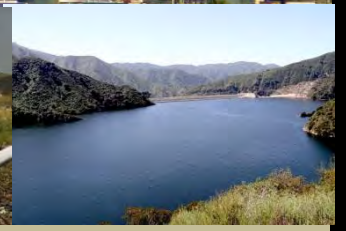
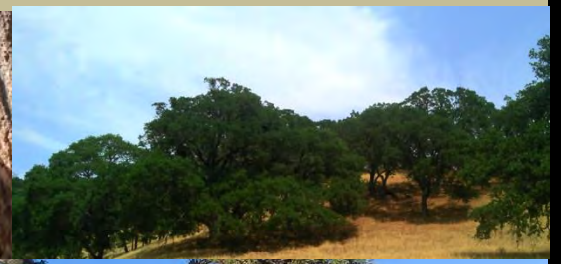
California Basin Reconstructions

Reconstruction Page	Period	Data File
Sacramento River - Four Rivers Index Update	900-2012	sacramentofourupdate.txt
Sacramento River - Four Rivers Index	901-1977	sacramentofour.txt
Feather River Inflow to Lake Oroville Update	900-2012	featherorovilleupdate.txt
Feather River Inflow to Lake Oroville	901-1977	featheroroville.txt
San Francisco Bay Salinity	1604-1997	sfbaysalinity.txt
Salinas River at Paso Robles	1409-2003	salinas.txt
Klamath R. at Keno, OR (natural flows)	1507-2003	Klamath.txt
Trinity R. at Lewiston, CA	1584-2003	Trinity.txt
Yuba River at Smartville	900-2012	Yuba.txt
American River inflow to Lake Folsom	900-2012	American.txt
Sacramento River above Bend Bridge	900-2012	Sacramento.txt
Stanislaus River inflow to New Melones	900-2012	Stanislaus.txt
Tuolumne River inflow to New Don Pedro	900-2012	Tuolumne.txt
Merced River inflow to New Exchequer	900-2012	Merced.txt
San Joaquin River inflow to Millerton	900-2012	San Joaquin.txt
San Joaquin River Four Rivers	900-2012	San Joaquin.txt
Arroyo Seco River, Pasadena	1125-2016	Arroyo Seco River.txt
Kern River below Lake Isabella	1125-2016	Kern River.txt
Lake Arrowhead Precipitation	1125-2016	Lake Arrowhead.txt
San Gabriel Dam Precipitation	1126-2016	San Gabriel Dam.txt
Ojai Precipitation	1126-2016	Ojai.txt
Cuyamaca Precipitation	1126-2016	Cuyamaca.txt
Santa Ana River nr. Mentone	1125-2016	Santa Ana River.txt
CO River at Lees Ferry	1116-2014	CO River at Lees Ferry.txt



Using Tree-Ring Records for Understanding Droughts in a Long-Term Context: A Guidebook

Connie Woodhouse, David Meko, Erica Bigio



[Guidebook url]

To Summarize:

1. Hydroclimatic reconstructions from tree rings provide a context for assessing the representativeness of the much shorter instrumental records.

2. This assessment can be useful for understanding the range of conditions that have occurred under natural variability alone, and thus have the potential to occur in the future (but with additional impacts from warming).

3. A variety of types of information can be obtained, including drought characteristics (severity, frequency, regional co-ocurrence).

4. Tree-ring reconstructions have been used by water resource managers in ways that range from basic awareness of the range of variability possible, to drought scenario planning, and public communication of drought risk.

5. Resources are available for water managers that include the TreeFlow web site and guidebook for drought planning.