



Center for Western Weather  
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY  
AT UC SAN DIEGO

# FORECAST INFORMED RESERVOIR OPERATIONS:

*USING BETTER DATA TO OPTIMIZE EXISTING WATER  
INFRASTRUCTURE FOR FLOOD CONTROL AND WATER SUPPLY*

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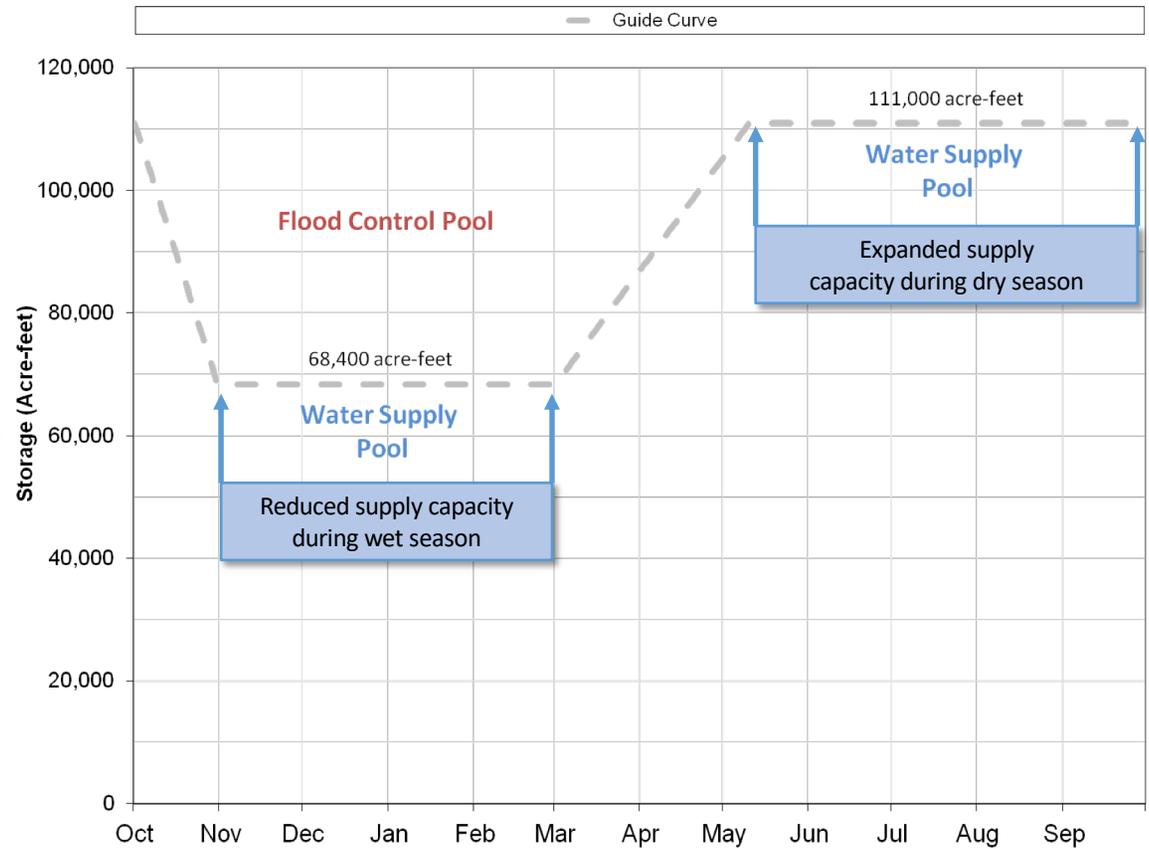
Joint TWDB-UTA-NIDIS Workshop on Forecast-informed Reservoir Operation (FIRO)  
and Water Resources Management in the States of TX and OK

Univ. of Texas, Arlington, TX

 UC San Diego

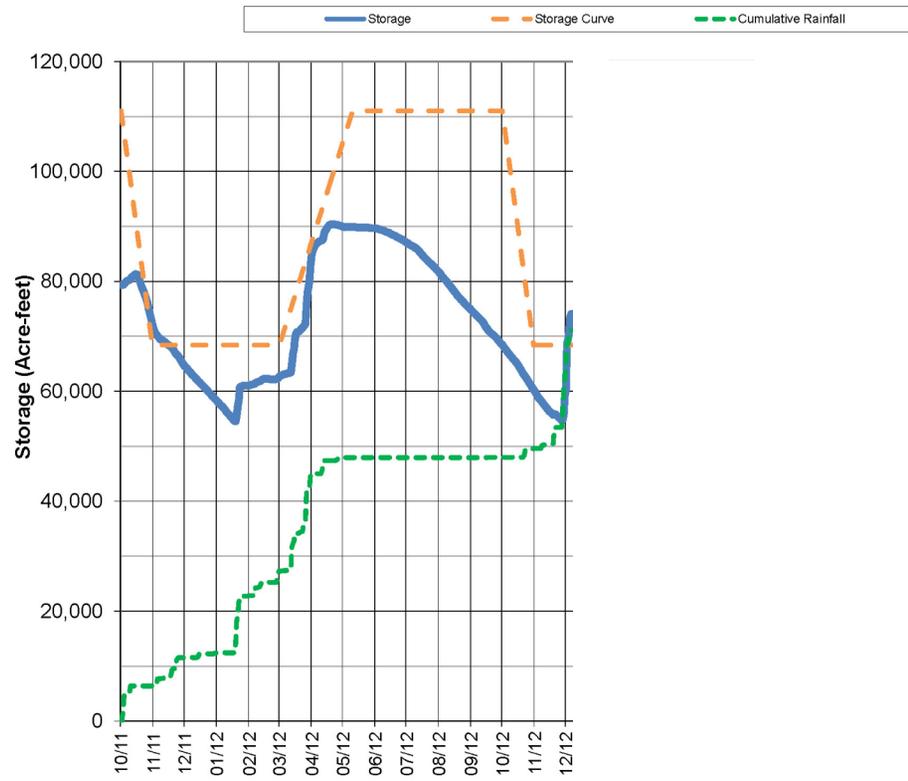
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# Lake Mendocino Guide Curve



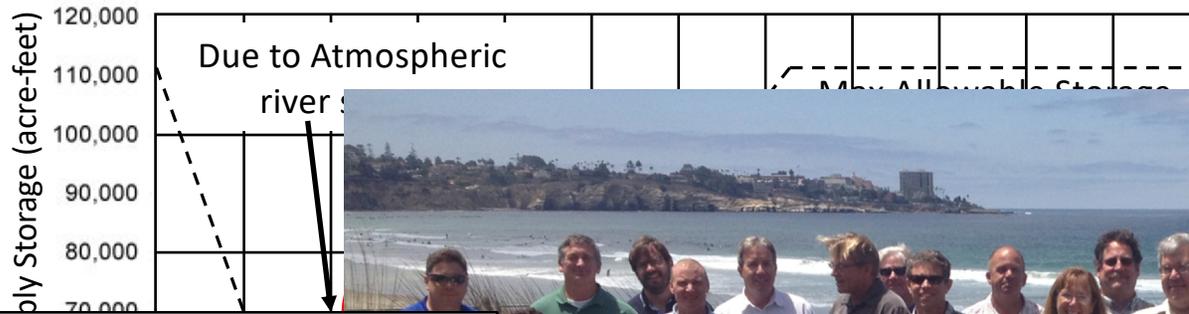
Slide provided by Chris Delaney  
 Federal Interagency Sedimentation and Hydrologic Modeling Conference, 28 June 2019, Reno, NV

### Lake Mendocino Water Years 2012 - 2014



# Lake Mendocino Forecast-Informed Reservoir Operations Concept

Hypothetical estimate of extra water retained unless an atmospheric river storm is predicted to hit the watershed; requires reliable AR prediction at 5-day lead time



## FIRO Steering Committee

Sonoma Water

Scripps CW3E

U.S. Army Corps of Engineers

CA Dept. of Water Resources

NOAA, USGS, US BurRec

Meteorologists, climatologists, hydrologists

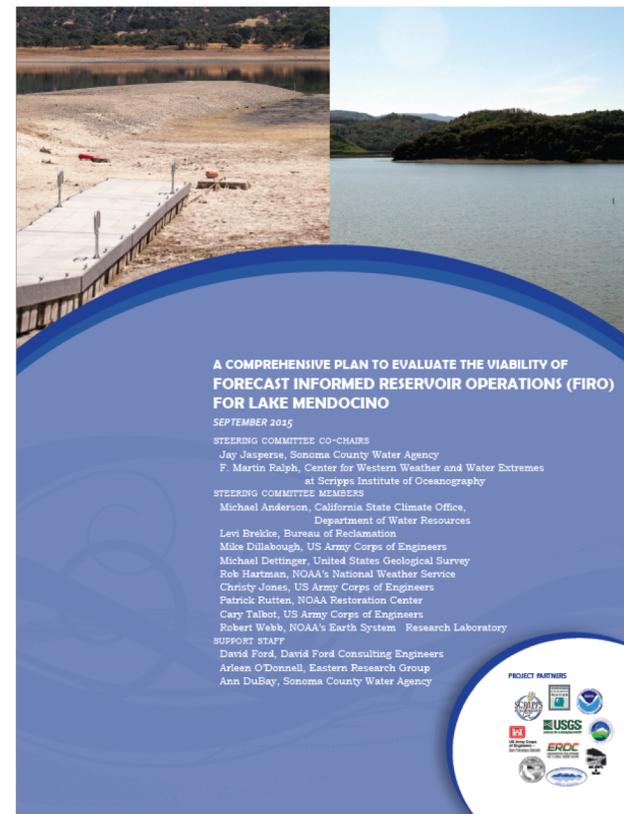
Civil Engineers, biologists, economists



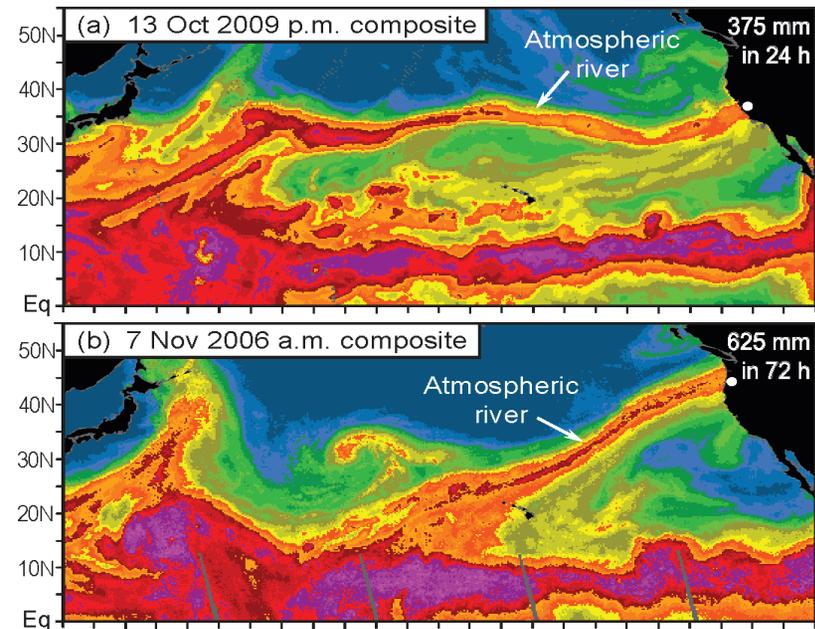
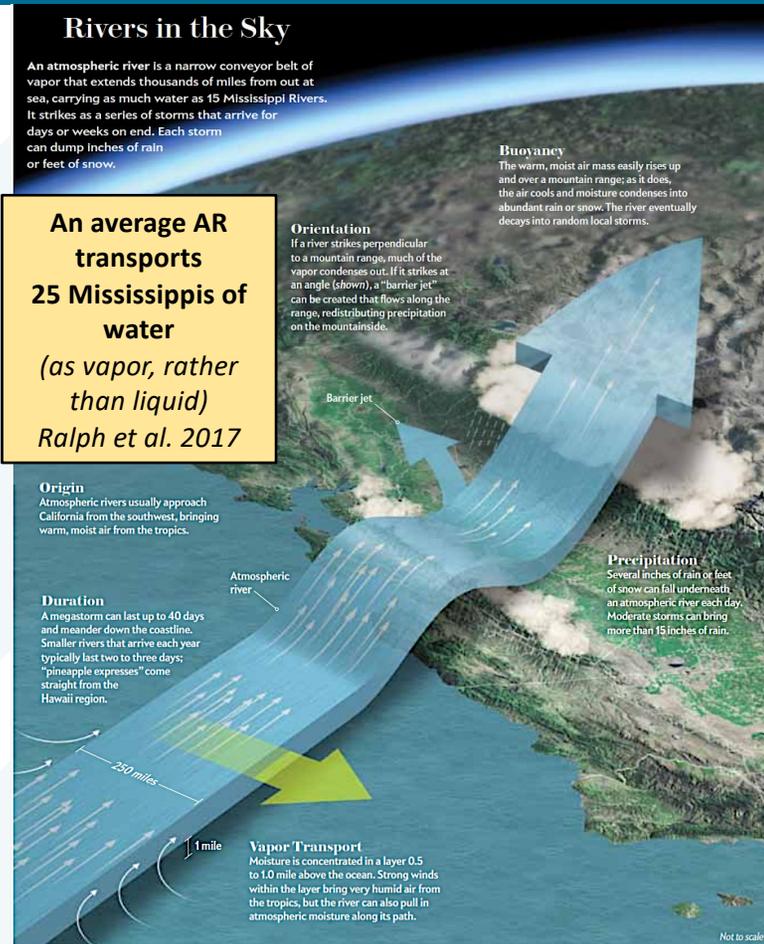
# Lake Mendocino FIRO Work Plan 2015

## A Comprehensive Plan to Evaluate FIRO for Lake Mendocino

- Preliminary Viability Assessment
- Evaluation Framework
- Focused Science Program
- Final Viability Assessment
- Benefits Assessment
- Implementation Strategies
- Major Deviation Requests
- Technical and Scientific Support



# KEY SCIENCE RESULT: ATMOSPHERIC RIVERS: PRIMARY SOURCE OF MOISTURE FOR PRECIPITATION IN THE REGION; USEABLE PREDICTIVE SKILL



**ARs Can produce extreme precipitation and flooding.**

**However, ARs also provide up to half of annual precipitation and Sierra snow – ARs are key to water supply.**

# DROUGHT TO FLOOD: ATMOSPHERIC RIVERS MAKE THE DIFFERENCE

**Drought**



**85% of the variation of annual precipitation in northern California is due to how the top 5% wettest days vary from year to year, i.e., how many ARs hit and how strong they are**

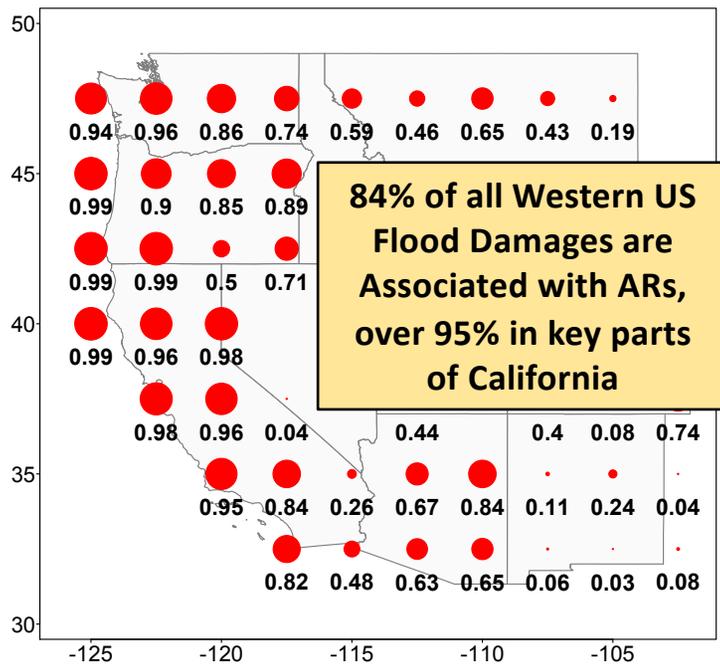
**Flood**



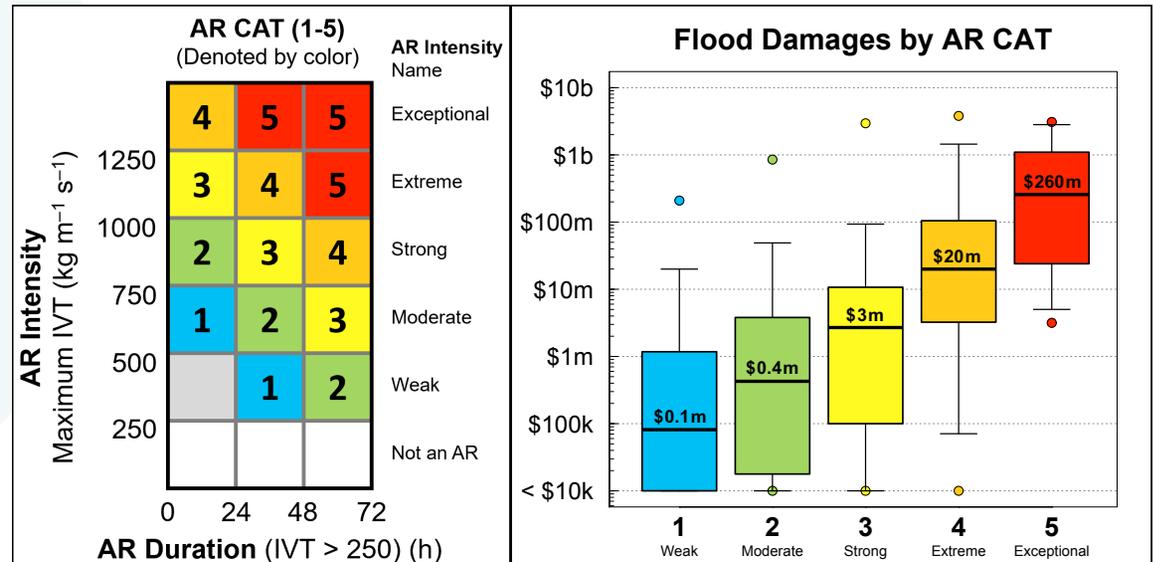
**Western US' Major Floods are due to Atmospheric Rivers that are strong, long-lasting and strike an already saturated area, and can cause Billions of dollars in damages**

# ARS DRIVE FLOOD DAMAGES IN THE WESTERN U.S.

Proportion of Insured Losses Due to ARs



Corringham et al. 2019 in press, Science Advances



Ralph et al. Bulletin of the American Meteorological Society, 2019

Corringham et al. 2019 in press, Science Advances

**Flood damages increase exponentially with AR CAT**



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## FIRO Projects: Covering a Range of Conditions

Reservoir/River	Total capacity	Approx. Water Supply/Flood Mitigation	Urban/Rural location or use?	Snow a factor?	Ecosystem dimensions	Operations coordinated with other dam?
Lake Mendocino (Russian River)	116,500	60% supply 40% flood	Rural	No	Salmon Biological Opinion	Yes, Lake Sonoma
Prado Dam (Santa Ana River)	174,000	10% buffer 90% flood	Dense Urban	Small	Songbird	No
New Bullards Bar (Yuba River)	966,000	80% supply 20% flood	Agricultural on Mainstem of state system	Major	Fish, Bay Delta	Yes, with Oroville using FCO
Lake Oroville (Feather River)	3,538,000	80% supply 20% flood	Agricultural on Mainstem of state system	Major	Fish, Bay Delta	Yes, with New Bullards bar using FCO



# Formula for FIRO Projects

1. Partner with local sponsoring agency
  - Lake Mendocino – Sonoma Water
  - Prado Dam – Orange County Water District
  - Yuba-Feather System – Yuba Water Agency and CA State Water Project
2. Form a Steering Committee with a support team
3. Initiate research investigations
4. Develop Workplan for the Viability Assessment
5. Conduct the Viability Assessment
6. Pursue an update to the Water Control Manual

# FIRO Success

Recognizes,  
develops, and  
supports  
relationships

