FORECAST INFORMED RESERVOIR OPERATIONS:

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

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Director, Center for Western Weather and Water Extremes

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
Reduced supply capacity during wet season
Expanded supply capacity during dry season

Lake Mendocino Guide Curve

Flood Control Pool
Water Supply Pool

Reduced supply capacity during wet season
Expanded supply capacity during dry season

Federal Interagency Sedimentation and Hydrologic Modeling Conference, 28 June 2019, Reno, NV
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

An average AR transports 25 Mississippis of water (as vapor, rather than liquid) Ralph et al. 2017

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

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.

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.

84% of all Western US Flood Damages are Associated with ARs, over 95% in key parts of California.

Flood damages increase exponentially with AR CAT

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**Proportion of Insured Losses Due to ARs**

![Proportion of Insured Losses Due to ARs](image)

84% of all Western US Flood Damages are Associated with ARs, over 95% in key parts of California.

**Flood Damages by AR CAT**

![Flood Damages by AR CAT](image)

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Corringham et al. 2019 in press, Science Advances

Ralph et al. Bulletin of the American Meteorological Society, 2019
<table>
<thead>
<tr>
<th>Reservoir/River</th>
<th>Total capacity</th>
<th>Approx. Water Supply/Flood Mitigation</th>
<th>Urban/Rural location or use?</th>
<th>Snow a factor?</th>
<th>Ecosystem dimensions</th>
<th>Operations coordinated with other dam?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Mendocino (Russian River)</td>
<td>116,500</td>
<td>60% supply 40% flood</td>
<td>Rural</td>
<td>No</td>
<td>Salmon Biological Opinion</td>
<td>Yes, Lake Sonoma</td>
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<tr>
<td>Prado Dam (Santa Ana River)</td>
<td>174,000</td>
<td>10% buffer 90% flood</td>
<td>Dense Urban</td>
<td>Small</td>
<td>Songbird</td>
<td>No</td>
</tr>
<tr>
<td>New Bullards Bar (Yuba River)</td>
<td>966,000</td>
<td>80% supply 20% flood</td>
<td>Agricultural on Mainstem of state system</td>
<td>Major</td>
<td>Fish, Bay Delta</td>
<td>Yes, with Oroville using FCO</td>
</tr>
<tr>
<td>Lake Oroville (Feather River)</td>
<td>3,538,000</td>
<td>80% supply 20% flood</td>
<td>Agricultural on Mainstem of state system</td>
<td>Major</td>
<td>Fish, Bay Delta</td>
<td>Yes, with New Bullards bar using FCO</td>
</tr>
</tbody>
</table>
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