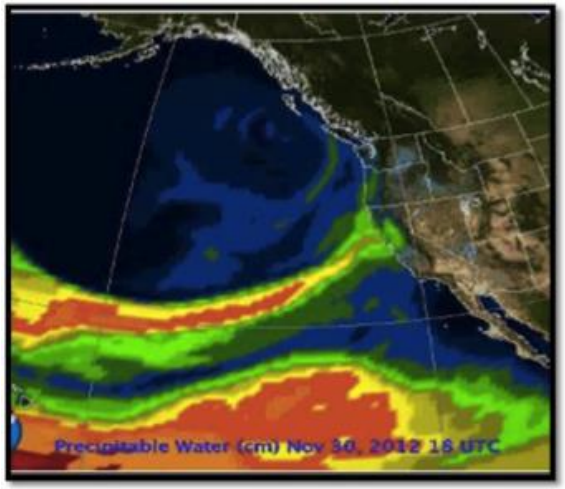
Forecast Informed Reservoir Operations & Regional Advanced Quantitative Precipitation Information Project



Western States Water Council
September 28, 2016

Jay Jasperse, Chief Engineer
Sonoma County Water Agency

SONOMA COUNTY WATER AGENCY

Russian River Reservoirs

Dual Purpose Facilities

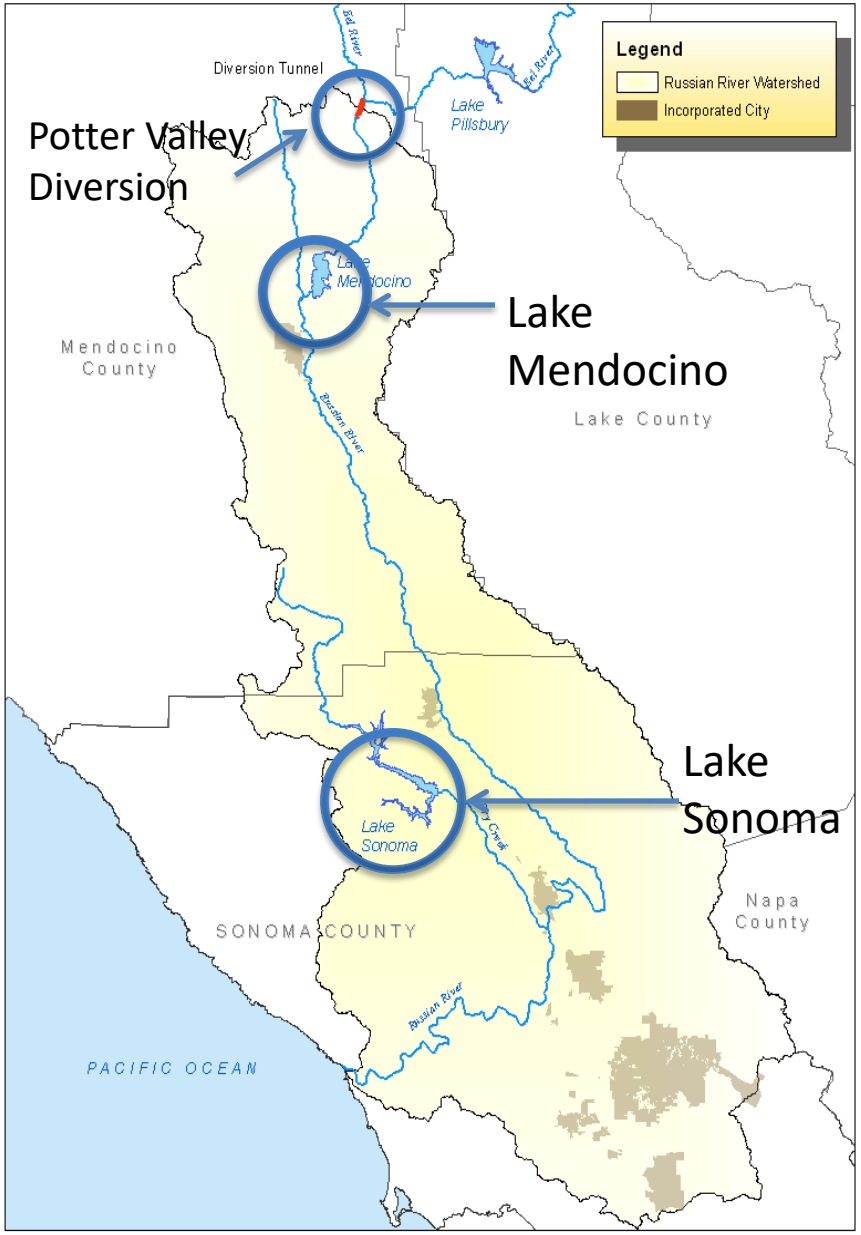
- Flood Protection (ACOE)
- Water Supply (SCWA)
- Operations Dictated by Storage Levels Relative to "Guide Curve"

Lake Sonoma (Warm Springs Dam)

Flood Control Pool:136,000 AF
Water Supply Pool: 245,000 AF

Lake Mendocino (Coyote Valley Dam)

Flood Control Pool: 48,100 AF
Water Supply Pool: 68,400 AF
(Nov. 1 – March 1)



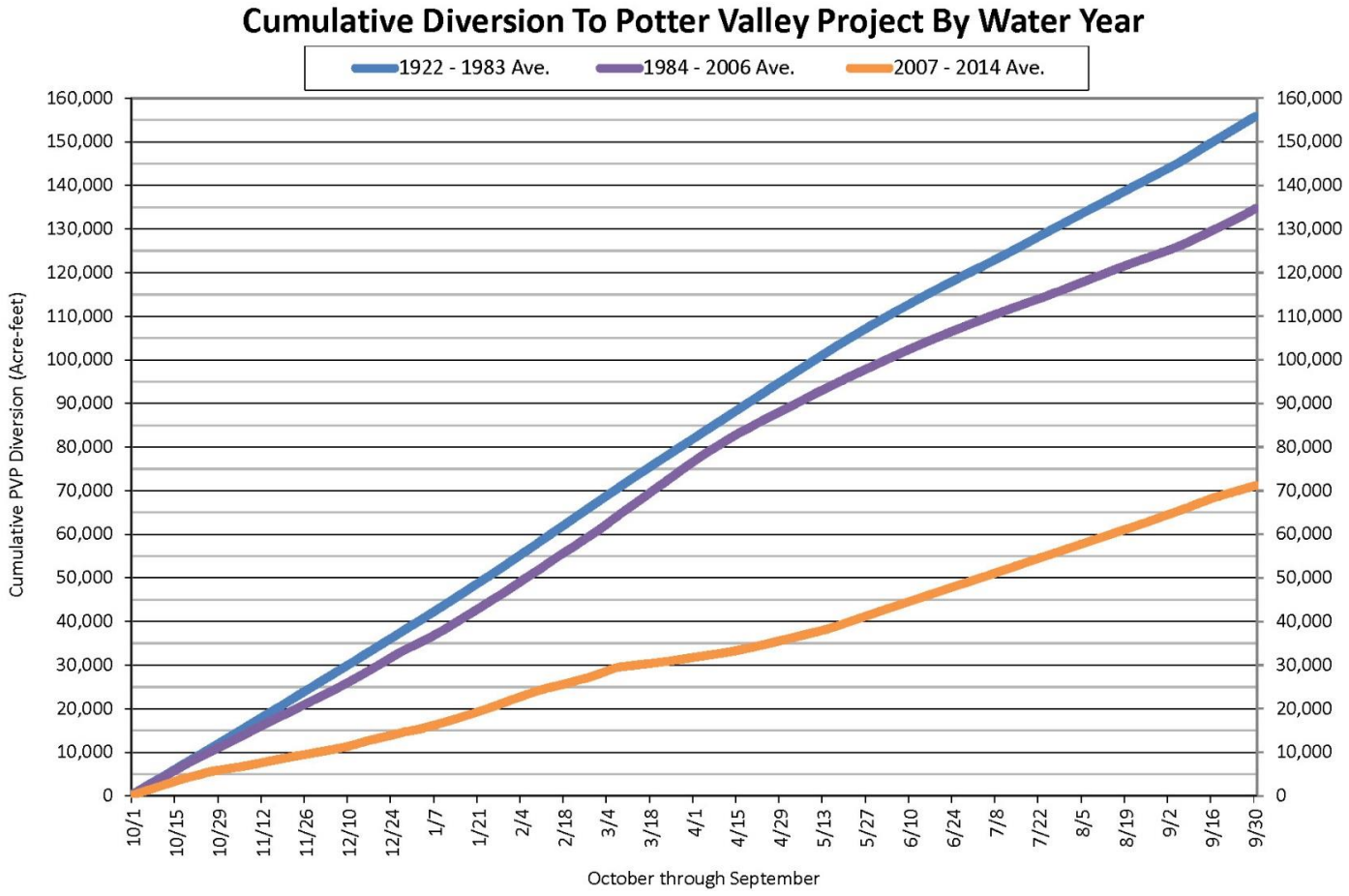
The Issue: Lake Mendocino's Water Supply Is Not Reliable

Some Reasons For Low Water Supply Reliability:

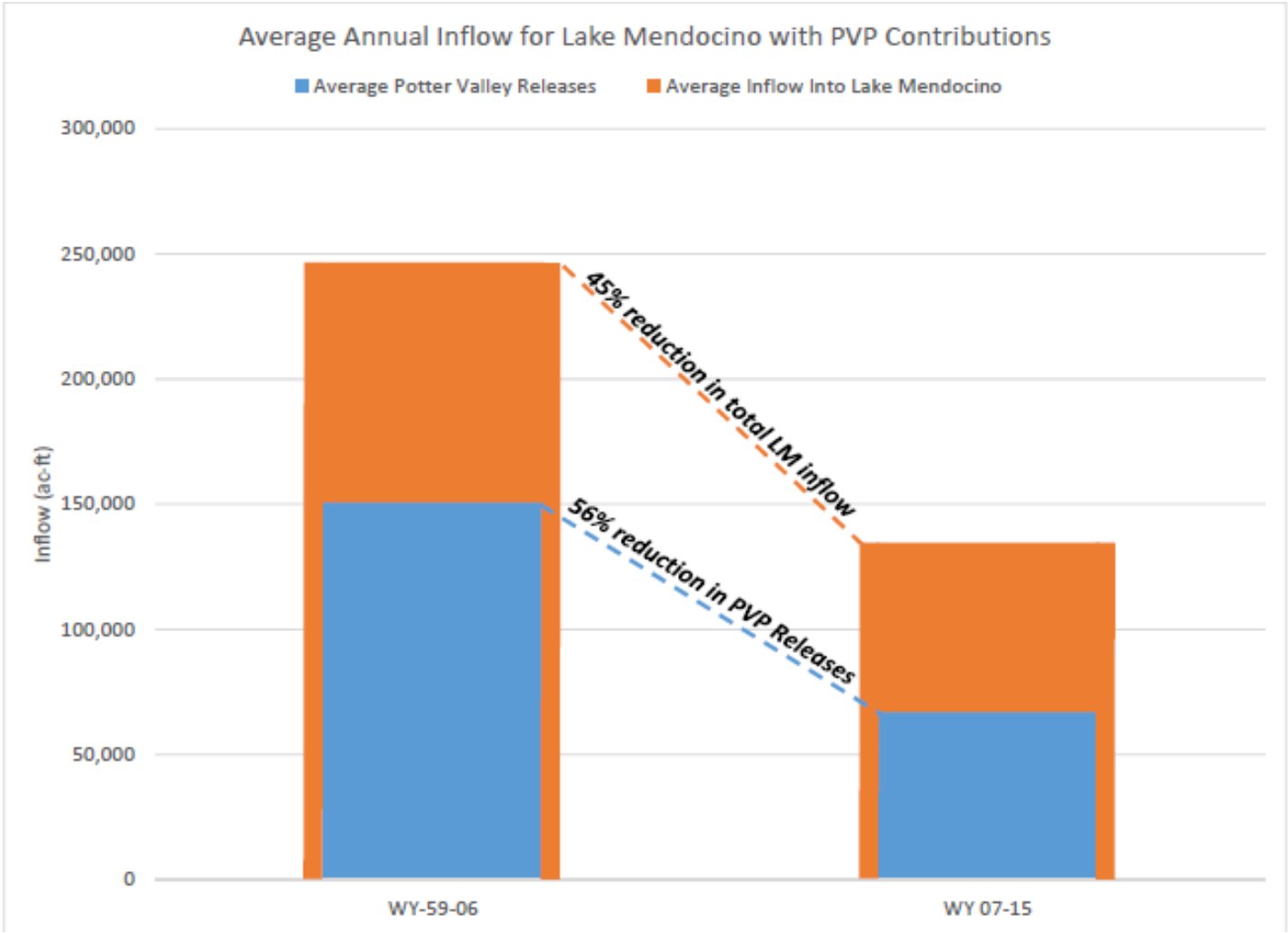
- Relatively small storage capacity
- Relatively unproductive watershed
- Reduced inflow from Potter Valley Project (Eel River)
- Highly variable precipitation patterns
  - Almost 50% rainfall from atmospheric rivers
- Future growth & climate change will likely further reduce reliability

Cumulative Potter Valley Project Diversions

A Declining Trend

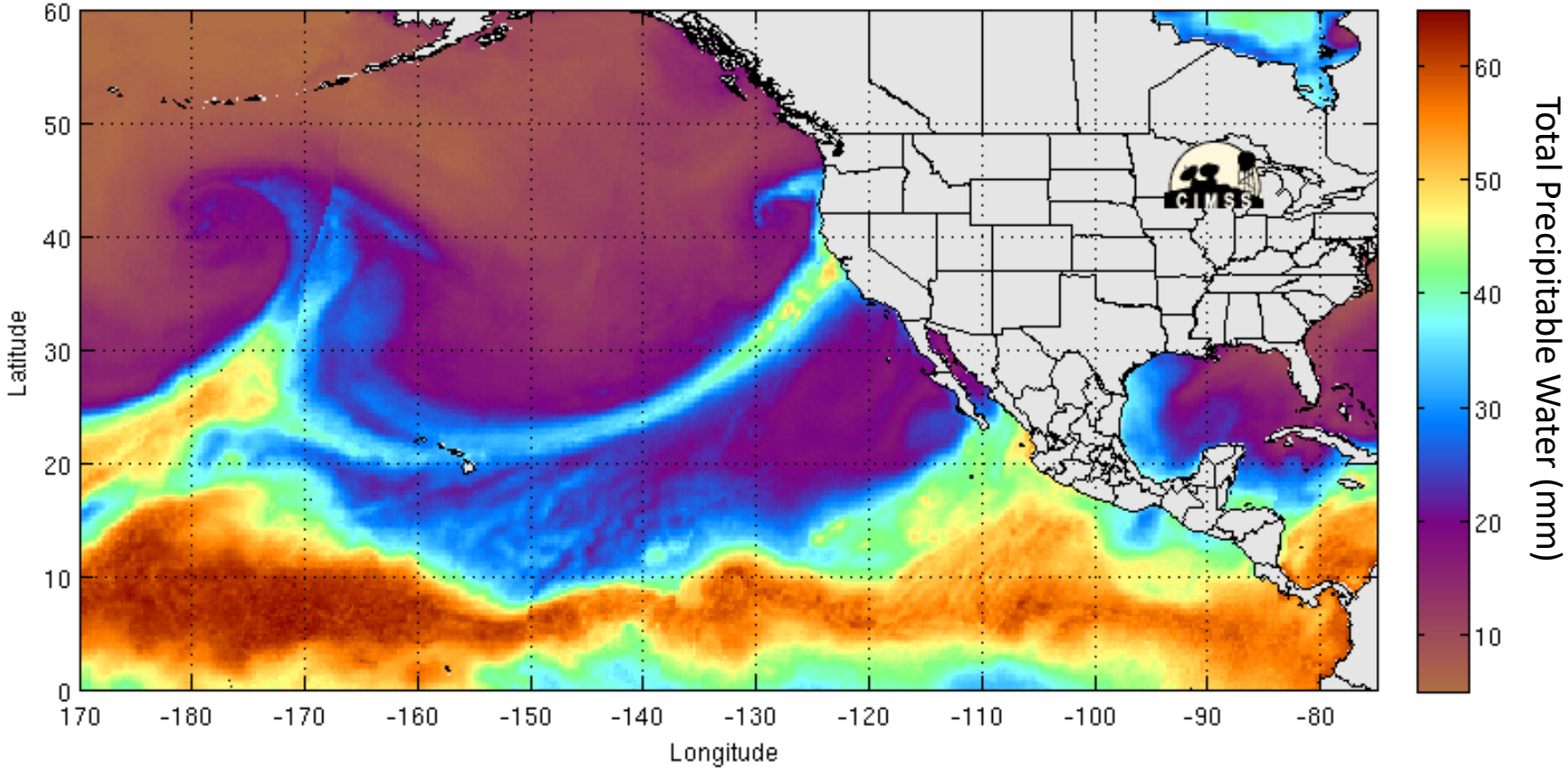


Reduced Inflows From Potter Valley Have Significant Impacts on Lake Mendocino



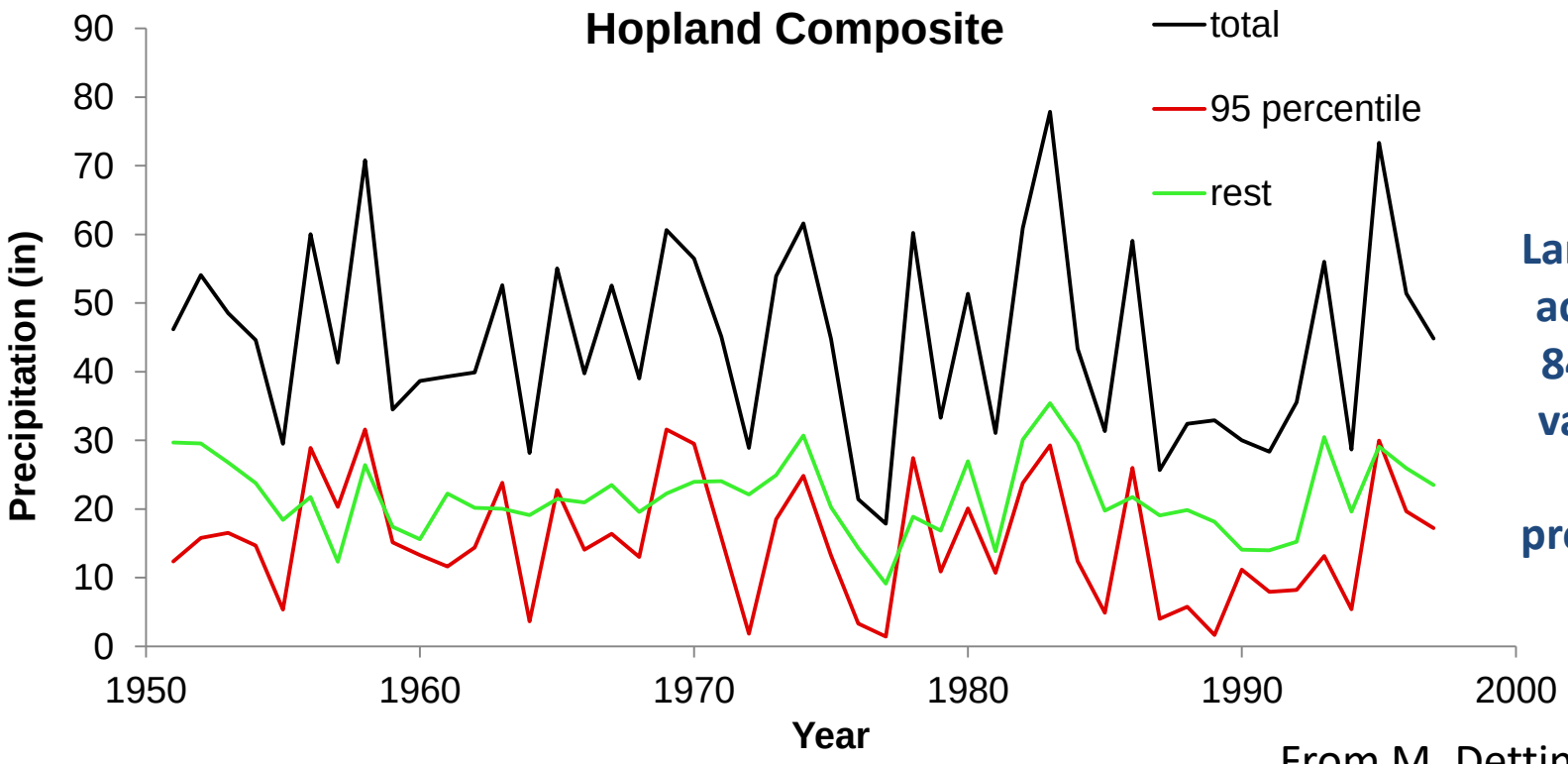
Atmospheric Rivers: Our Extreme Weather Events

Composite Dec 11, 2014



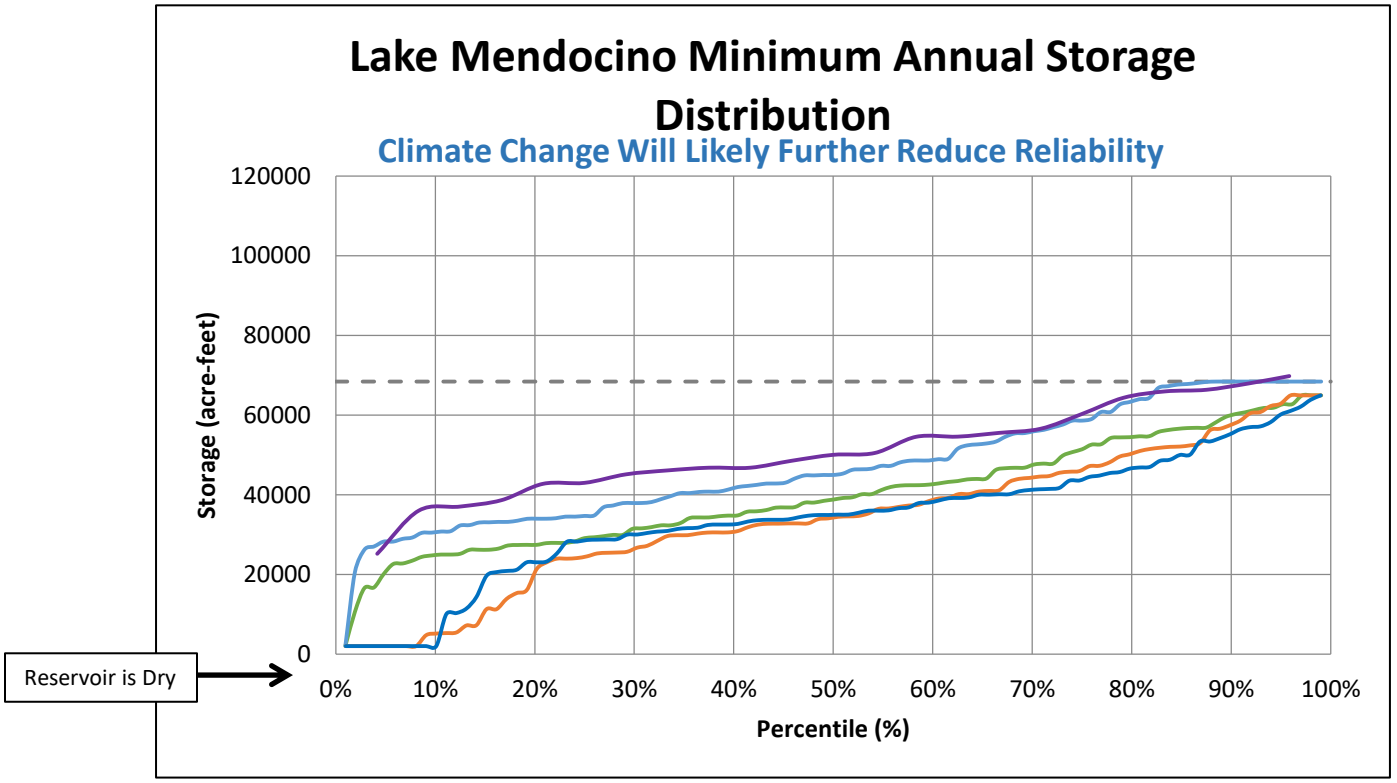
Source: CIMSS

Atmospheric Rivers Drive Droughts & Floods



Large storms account for 84% of the variance of total precipitation

From M. Dettinger



Scenario #1: Modeled Data (1910 - 2013) with Current Operations of PVP, 2015 Projected Demands, and Modeled Historical Climate

Scenario #4: Modeled Data (1910 - 2013) with Current Operations of PVP, 2045 Projected High Demands, and Modeled Historical Climate

Scenario #6: Modeled Data (2001 - 2099) with Current Operations of PVP, 2045 Projected High Demands, and Modeled Dry Climate

Scenario #8: Modeled Data (2001 - 2099) with Current Operations of PVP, 2045 Projected High Demands, and Modeled Wet Climate

Observed Historical Data (1984-2006)

Lake Mendocino FIRO Demonstration Project – A Collaborative Effort

Broad coalition of federal, state, & regional agencies comprised of scientists & water managers

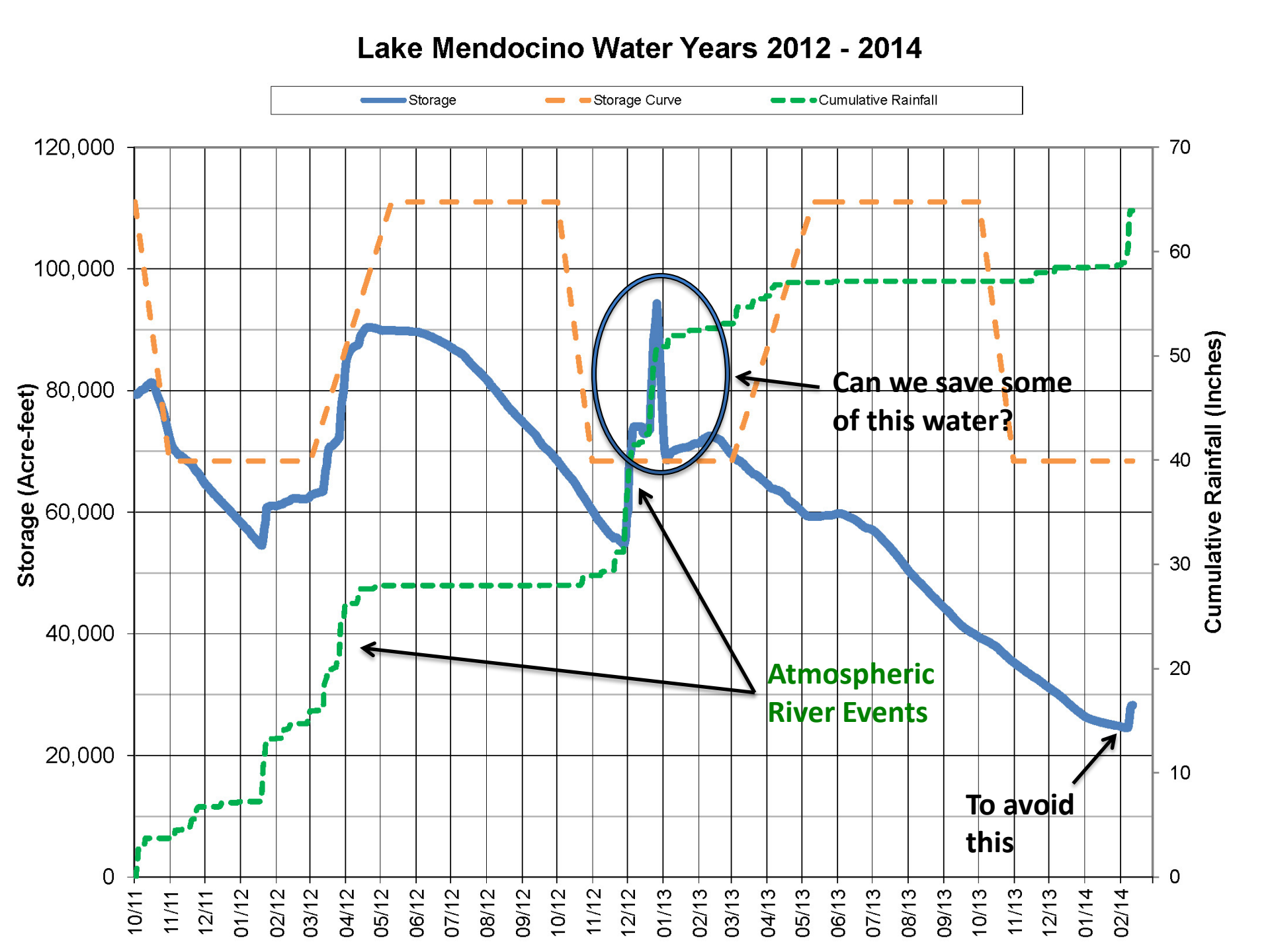
<u>Steering Committee:</u>

Federal: NOAA (OAR, NWS, NMFS), USGS, Army Corps of Engineers, & Bureau of Reclamation

State: California Department of Water Resources & Scripps Center for Western Weather & Water Extremes

Regional: Sonoma County Water Agency

Partnerships: NOAA Habitat Blueprint
Integrated Water Resource Sciences & Services


Lake Mendocino Water Years 2012 - 2014
Storage
Storage Curve
Cumulative Rainfall
Storage (Acre-feet)
Cumulative Rainfall (Inches)
120,000
100,000
80,000
60,000
40,000
20,000
0
70
60
50
40
30
20
10
0
10/11
11/11
12/11
01/12
02/12
03/12
04/12
05/12
06/12
07/12
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12/13
01/14
02/14
Can we save some of this water?
Atmospheric River Events
To avoid this

Possible Operational Improvements: Forecast Informed Operations

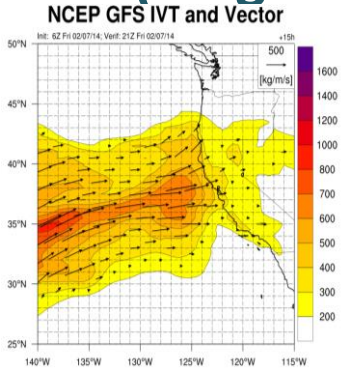
Incorporate current forecast skill into operations for periods when no storm events are predicted (near-term)

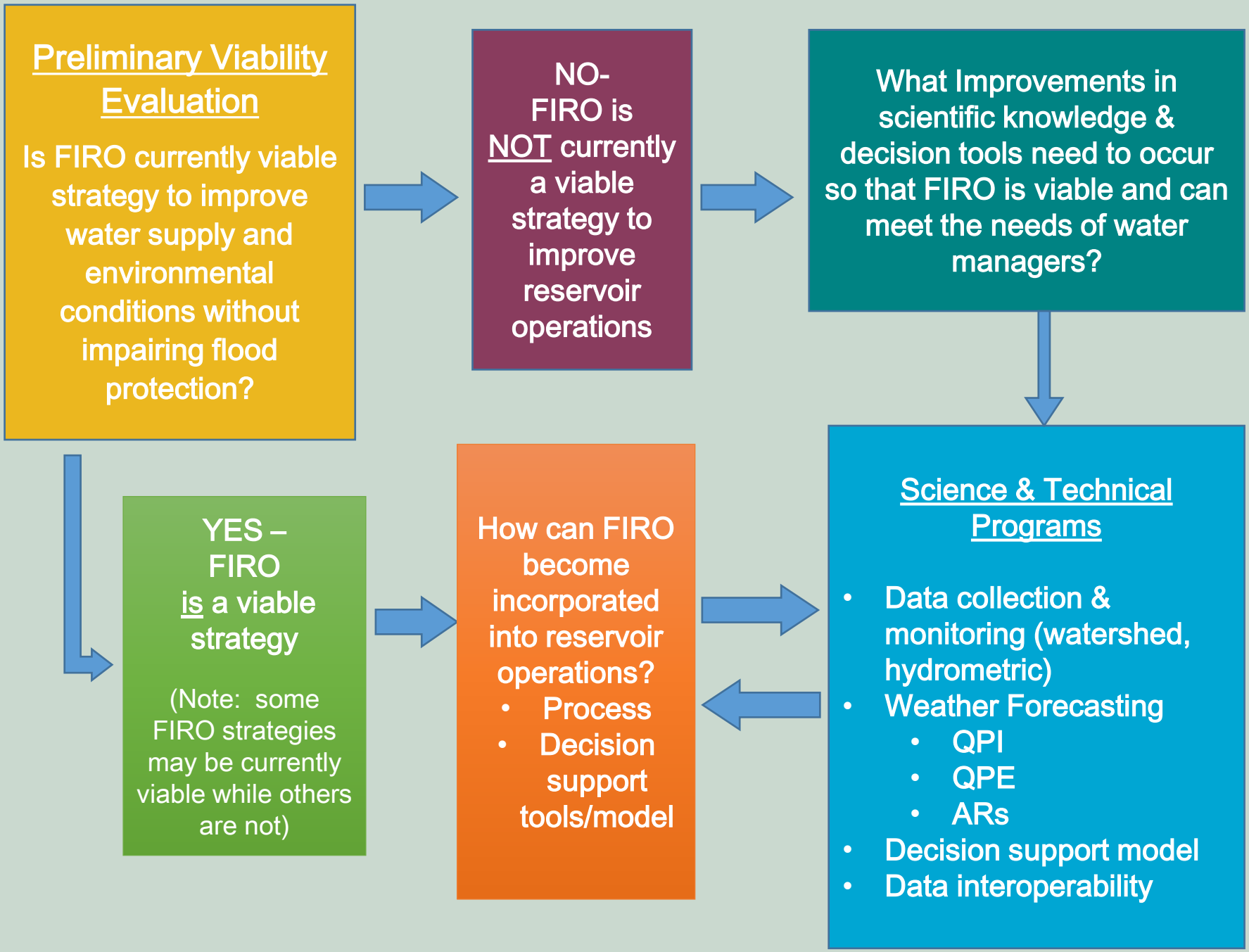
Reservoir operations consider watershed conditions (near-term)

- SCWA/NOAA/USGS install soil moisture & rain gages above reservoirs
- Develop correlations between rainfall-soil moisture-reservoir inflow

Forecast skill for atmospheric river events (long-term)

- Predict landfall & intensity of storms
- CalWater-2 and other research




Preliminary Viability Evaluation
Is FIRO currently viable strategy to improve water supply and environmental conditions without impairing flood protection?
NO- FIRO is NOT currently a viable strategy to improve reservoir operations
What Improvements in scientific knowledge & decision tools need to occur so that FIRO is viable and can meet the needs of water managers?
YES – FIRO is a viable strategy
(Note: some FIRO strategies may be currently viable while others are not)
How can FIRO become incorporated into reservoir operations?
• Process
• Decision support tools/model
Science & Technical Programs
• Data collection & monitoring (watershed, hydrometric)
• Weather Forecasting
• QPI
• QPE
• ARs
• Decision support model
• Data interoperability

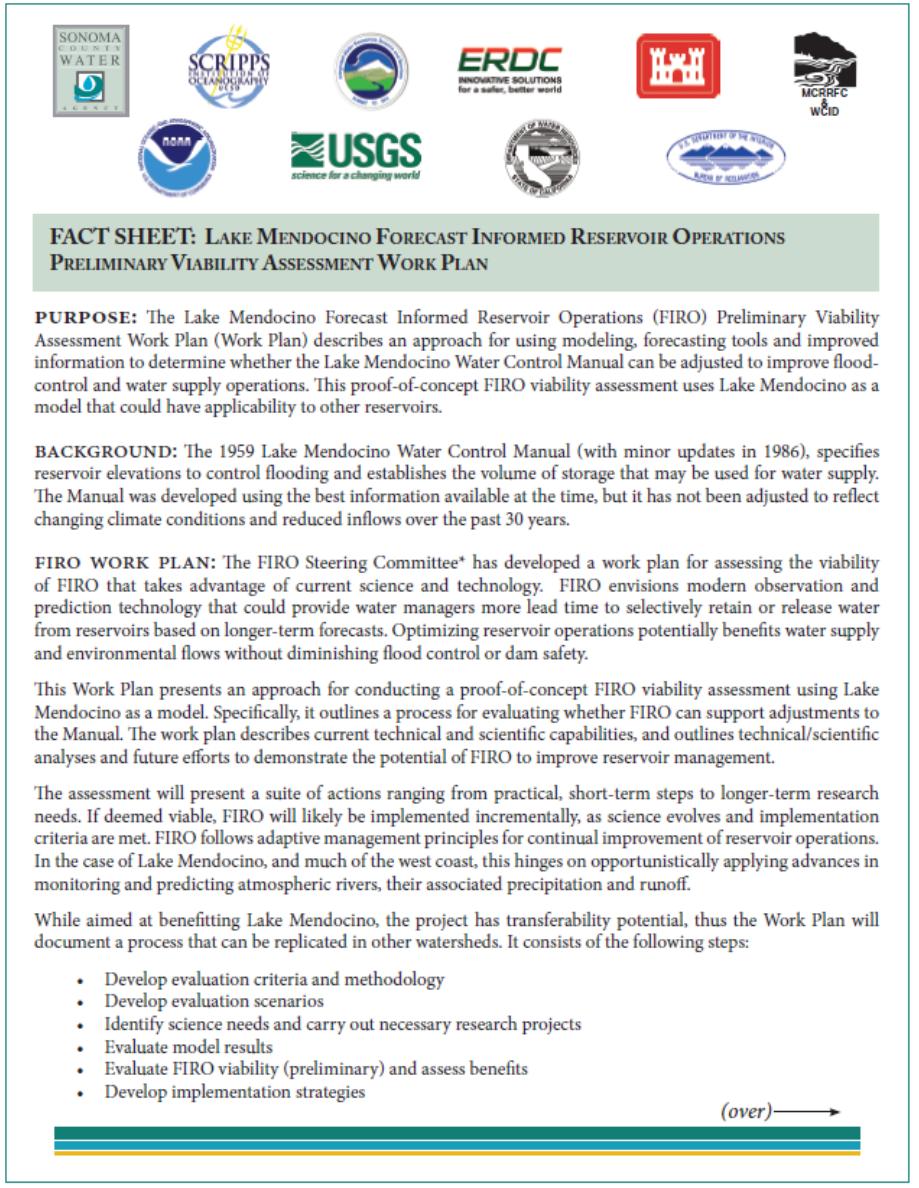
Demonstration Project Status

Steering Committee
- Monthly calls
- Quarterly meetings

Annual Workshops
- Three workshops to date

Completed Work Plan Summer 2015

Three Workgroups
- **Preliminary Viability Assessment (Winter 2017)**
- Procedural Matters & Implementation
- Science & Research



FACT SHEET: LAKE MENDOCINO FORECAST INFORMED RESERVOIR OPERATIONS PRELIMINARY VIABILITY ASSESSMENT WORK PLAN

PURPOSE: The Lake Mendocino Forecast Informed Reservoir Operations (FIRO) Preliminary Viability Assessment Work Plan (Work Plan) describes an approach for using modeling, forecasting tools and improved information to determine whether the Lake Mendocino Water Control Manual can be adjusted to improve flood-control and water supply operations. This proof-of-concept FIRO viability assessment uses Lake Mendocino as a model that could have applicability to other reservoirs.

BACKGROUND: The 1959 Lake Mendocino Water Control Manual (with minor updates in 1986), specifies reservoir elevations to control flooding and establishes the volume of storage that may be used for water supply. The Manual was developed using the best information available at the time, but it has not been adjusted to reflect changing climate conditions and reduced inflows over the past 30 years.

FIRO WORK PLAN: The FIRO Steering Committee* has developed a work plan for assessing the viability of FIRO that takes advantage of current science and technology. FIRO envisions modern observation and prediction technology that could provide water managers more lead time to selectively retain or release water from reservoirs based on longer-term forecasts. Optimizing reservoir operations potentially benefits water supply and environmental flows without diminishing flood control or dam safety.

This Work Plan presents an approach for conducting a proof-of-concept FIRO viability assessment using Lake Mendocino as a model. Specifically, it outlines a process for evaluating whether FIRO can support adjustments to the Manual. The work plan describes current technical and scientific capabilities, and outlines technical/scientific analyses and future efforts to demonstrate the potential of FIRO to improve reservoir management.

The assessment will present a suite of actions ranging from practical, short-term steps to longer-term research needs. If deemed viable, FIRO will likely be implemented incrementally, as science evolves and implementation criteria are met. FIRO follows adaptive management principles for continual improvement of reservoir operations. In the case of Lake Mendocino, and much of the west coast, this hinges on opportunistically applying advances in monitoring and predicting atmospheric rivers, their associated precipitation and runoff.

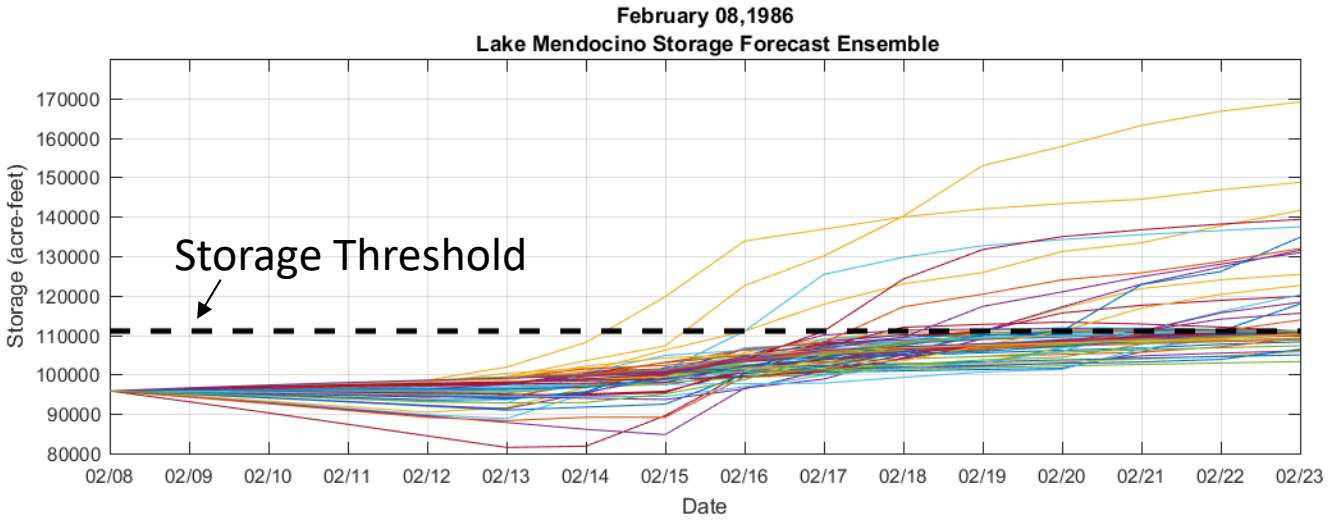
While aimed at benefitting Lake Mendocino, the project has transferability potential, thus the Work Plan will document a process that can be replicated in other watersheds. It consists of the following steps:

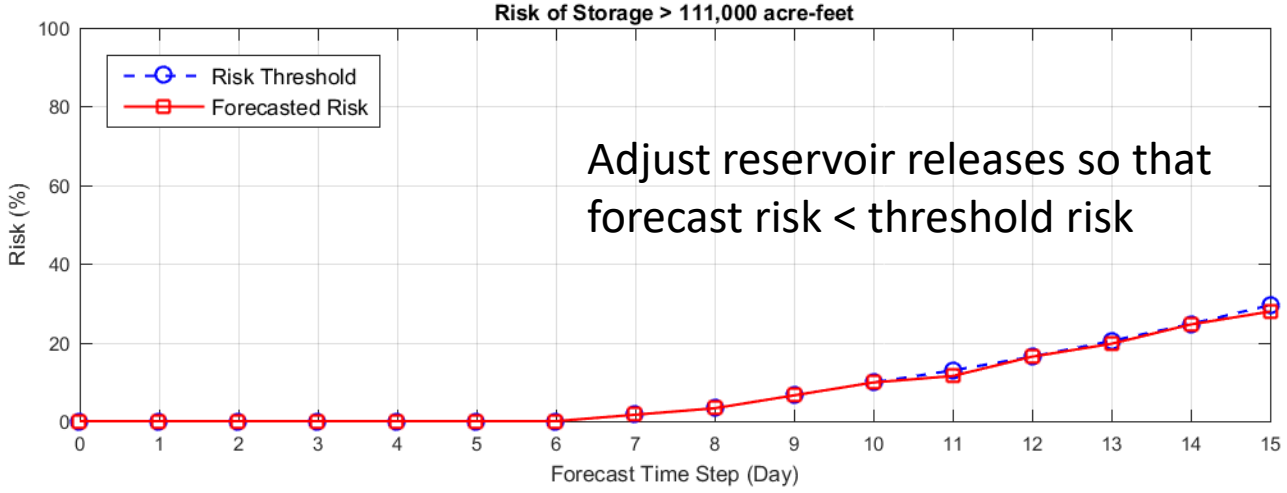
- Develop evaluation criteria and methodology
- Develop evaluation scenarios
- Identify science needs and carry out necessary research projects
- Evaluate model results
- Evaluate FIRO viability (preliminary) and assess benefits
- Develop implementation strategies

(over)

Risk Evaluation

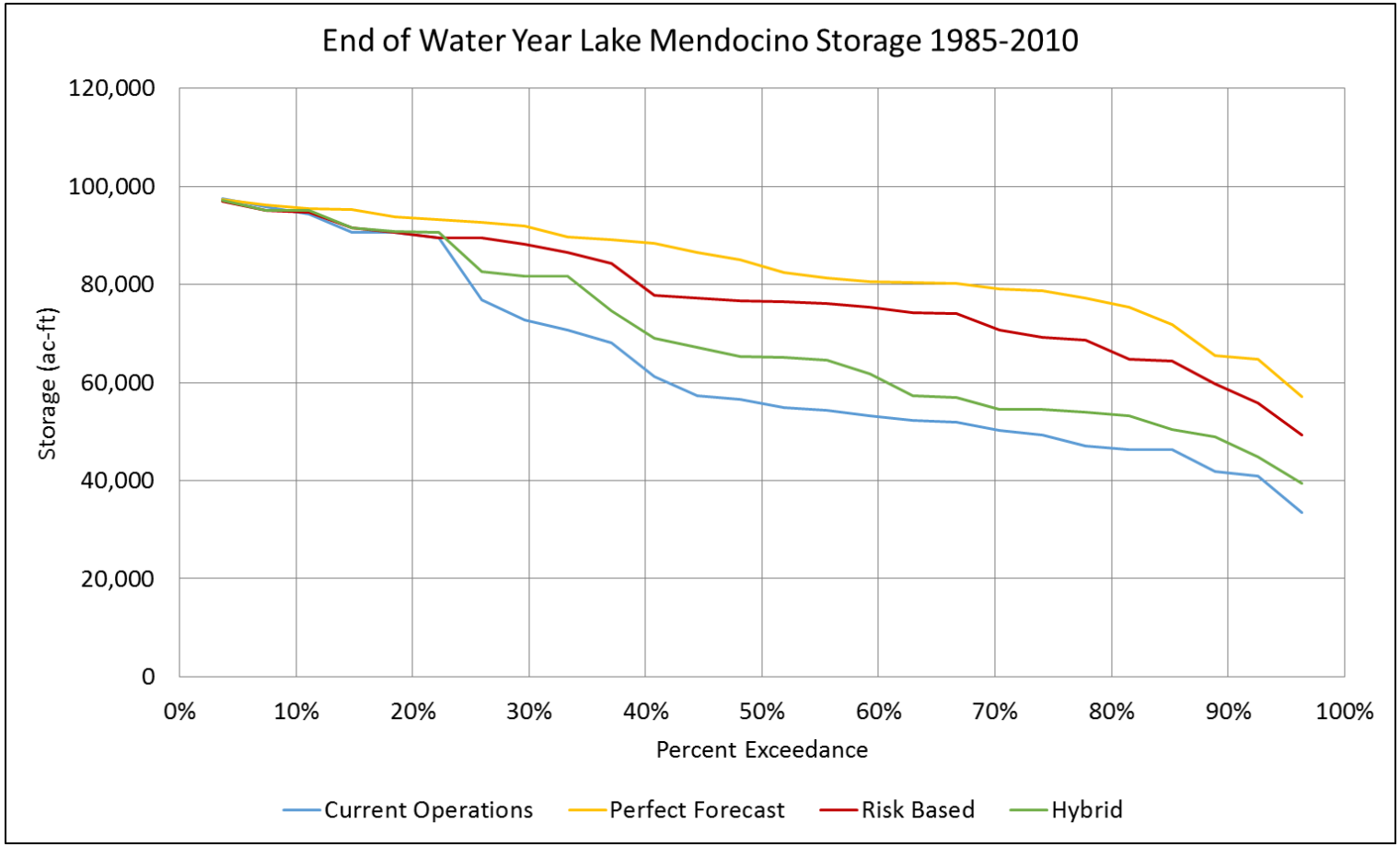
Storage Forecast Ensemble (1985-2010) – Current Forecast Skill





FIRO Improves Water Storage

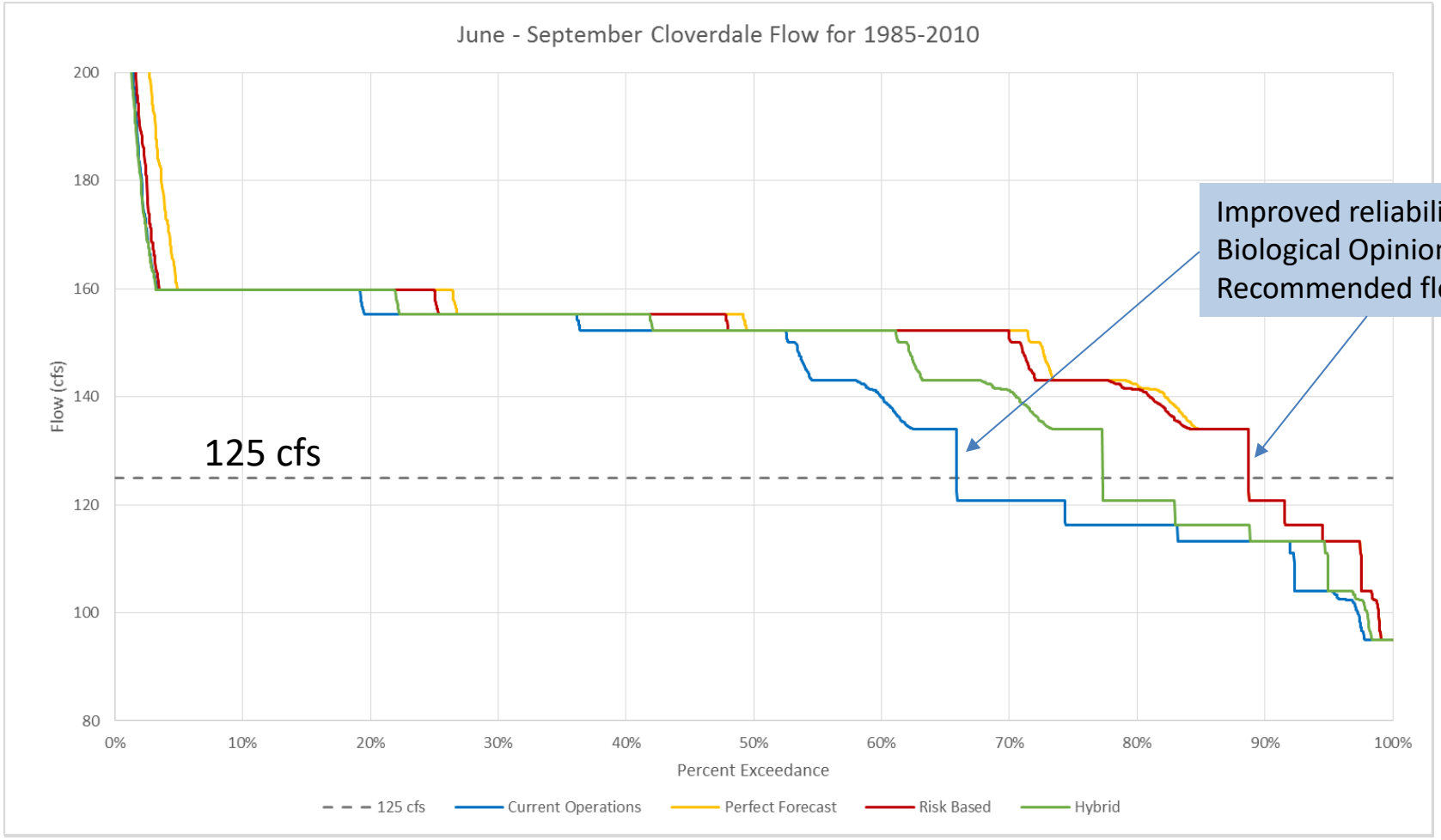
Preliminary Modeling Results



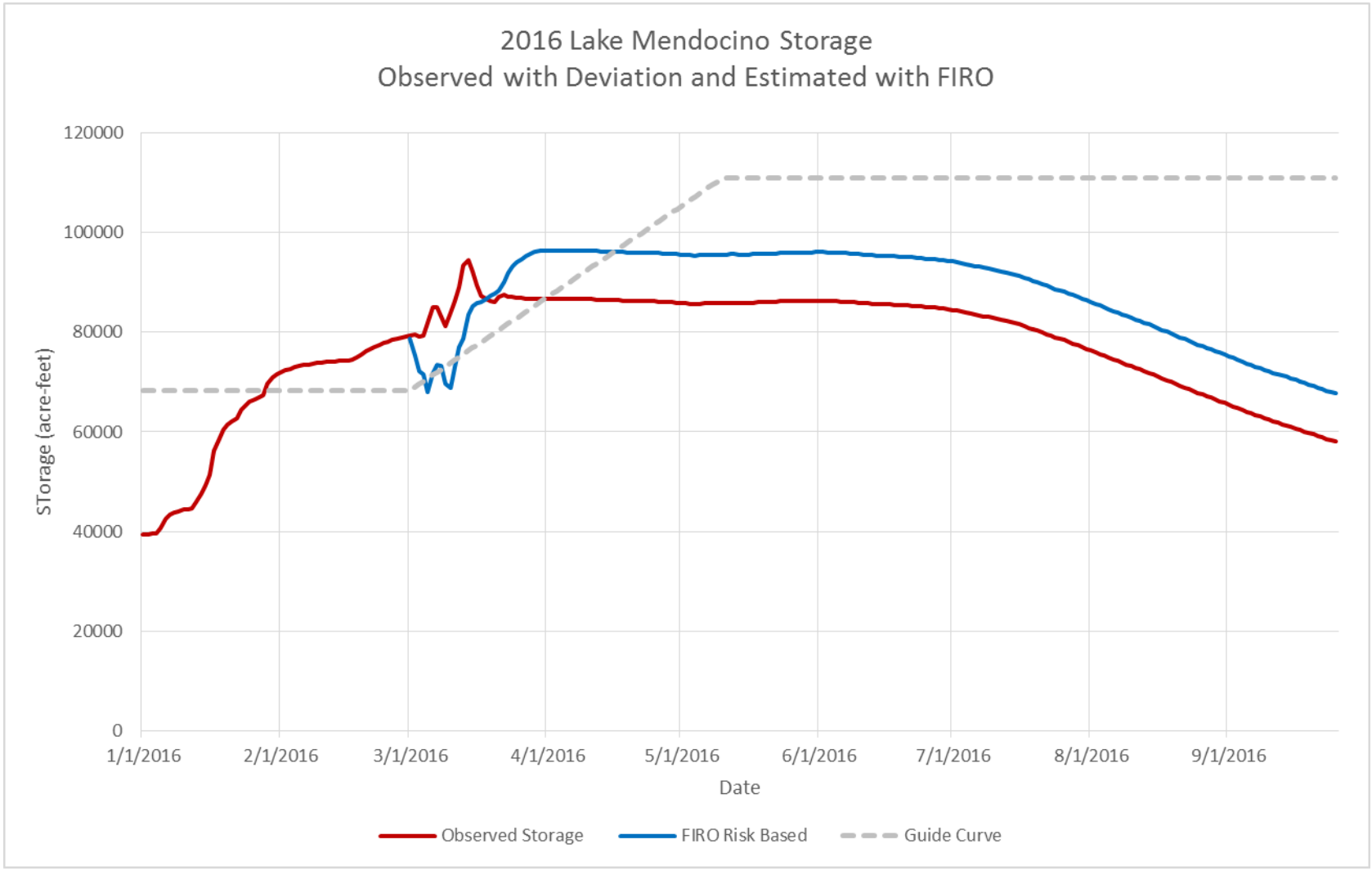
FIRO Improves In-Stream Flows

June to September Cloverdale Flows

Preliminary Modeling Results

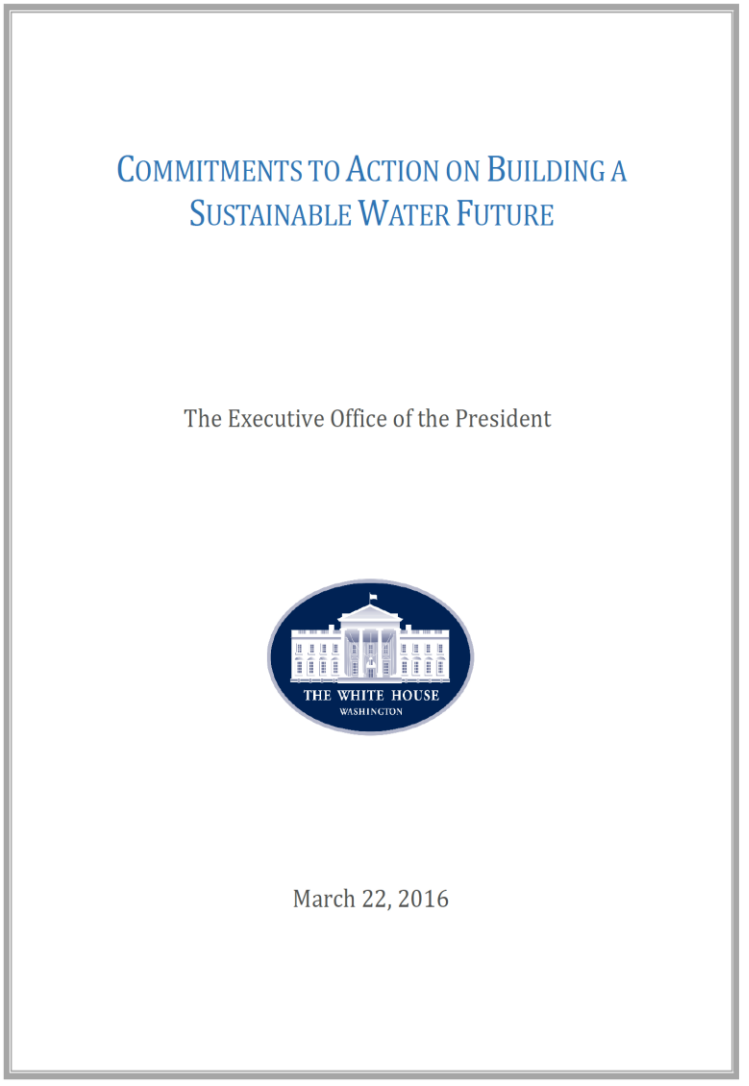


2016 Lake Mendocino Storage Simulated Risk Based Operations Test



Lake Mendocino Forecast Informed Reservoir Operations Highlighted in 2016 White House Report

- **Piloting promising solutions.** Testing and demonstration of new approaches to water sustainability is an essential precursor to large-scale implementation. Today, the Administration is announcing pilots of several such approaches:
    - Improving weather forecasts for water-management operations. This year, **NOAA**, **USGS**, and the **U.S. Army Corps of Engineers (Army Corps)**, along with the **Sonoma County Water Agency** and other local and state partners, will launch the Lake Mendocino Forecast Informed Reservoir Operations pilot project in California's Russian River. This pilot will demonstrate ways in which improved weather forecasts can aid the decisions made by Army Corps and other water-resource managers as they balance flood and drought risks, maximize reservoir-storage potential, and minimize conflict among competing water users.



COMMITMENTS TO ACTION ON BUILDING A SUSTAINABLE WATER FUTURE

The Executive Office of the President

THE WHITE HOUSE
WASHINGTON

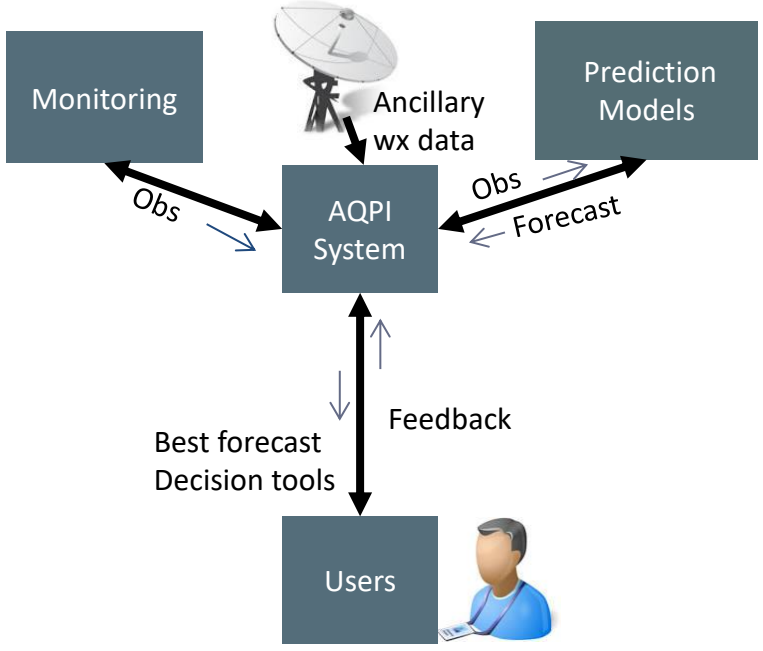
March 22, 2016

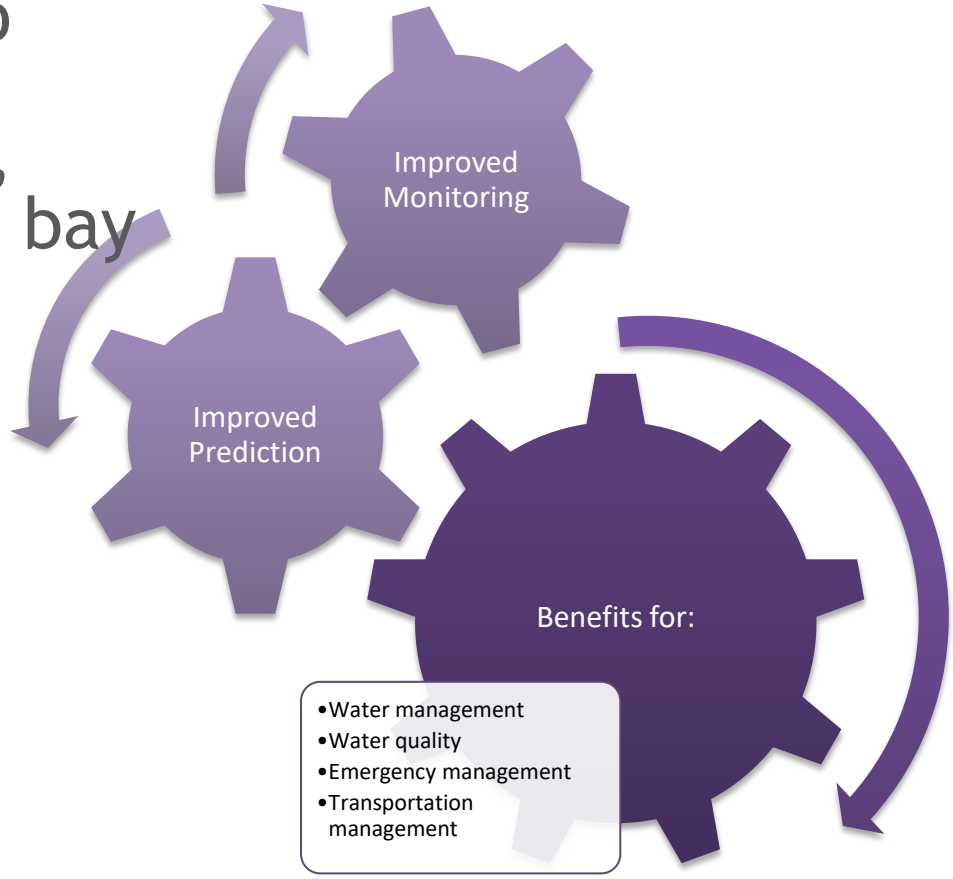
Bay Area Advanced Quantitive Precipitation Information (AQPI) Project

- Prop 84 grant awarded by DWR
  - $19M over 4 years
  - SCWA is local grant administrator
  - Supplements CA DWR statewide monitoring investment
  - Involves NOAA,CSU, USGS, & Scripps
- Other partners: Santa Clara Valley Water District & SF Public Utilities Commission
- Complements Forecast Informed Reservoir Operations (FIRO) pilot study
  - Focus on Lake Mendocino

What is an AQPI System?

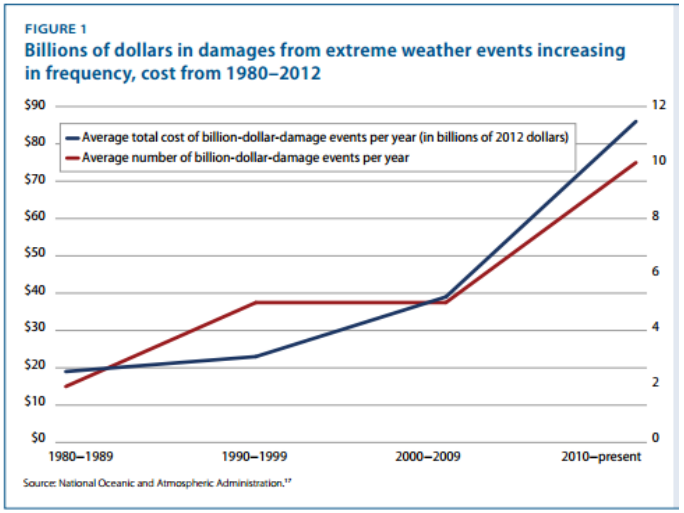
- An integrated set of observations and models to improve monitoring and prediction of precipitation, surface runoff, and coastal bay flooding

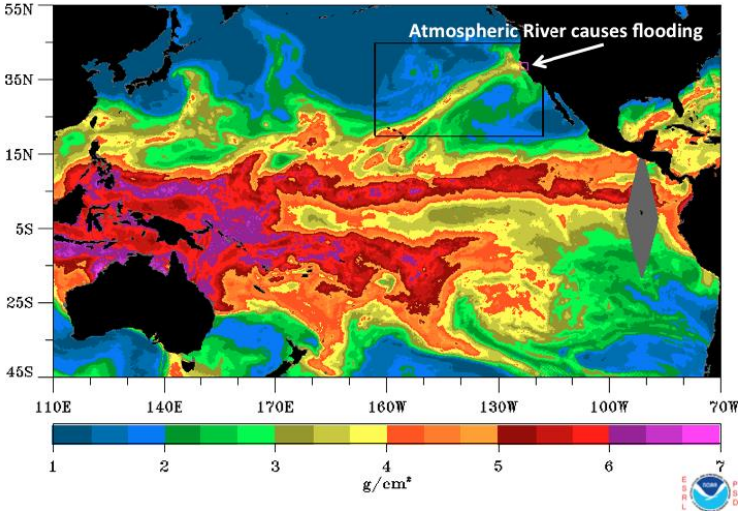




Project Need

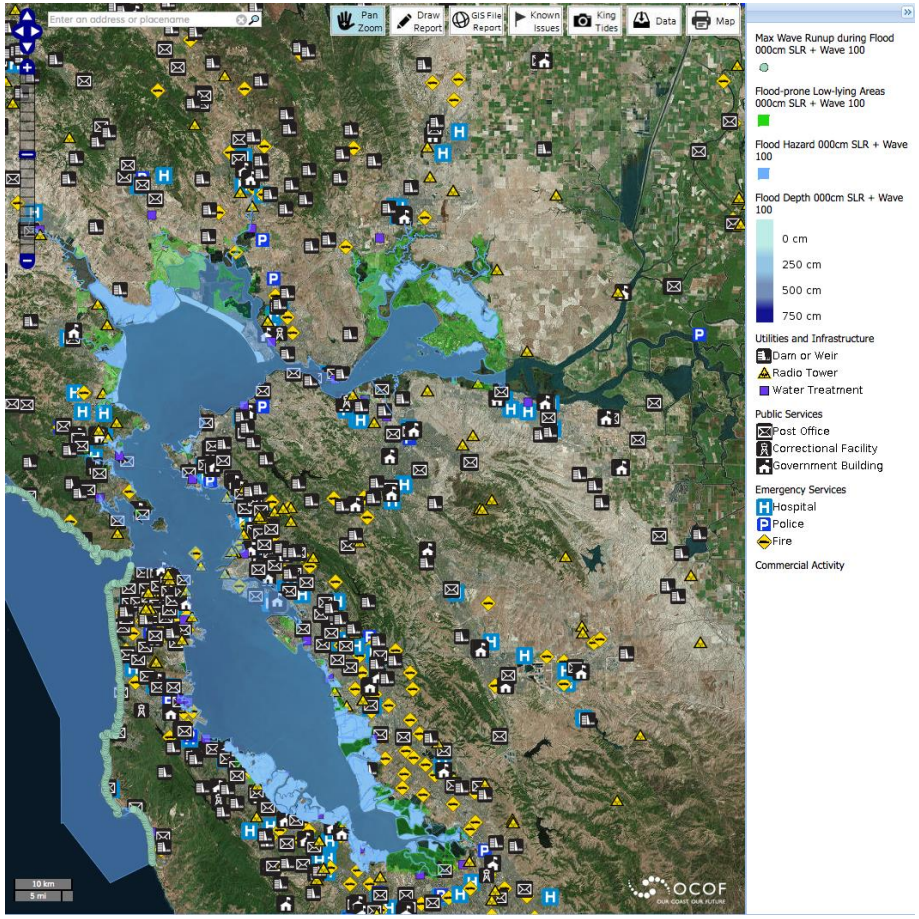
- **Rainfall monitoring & forecasting is inadequate for water management**
  - Potential higher runoff in winter combined with sea level rise will lead to more coastal and inland flooding
- **AQPI can be an effective climate adaptation strategy**
  - Provide more accurate rainfall monitoring and forecasts with longer lead times
- **More timely & site-specific forecasts will provide many benefits**
  - Reduced waste water overflows from urban areas, leading to improved water quality
  - Improved reservoir operations during wet & dry conditions
  - Improved situational awareness & preparation for emergency responders
  - Improved local and regional transportations systems – land, sea & air



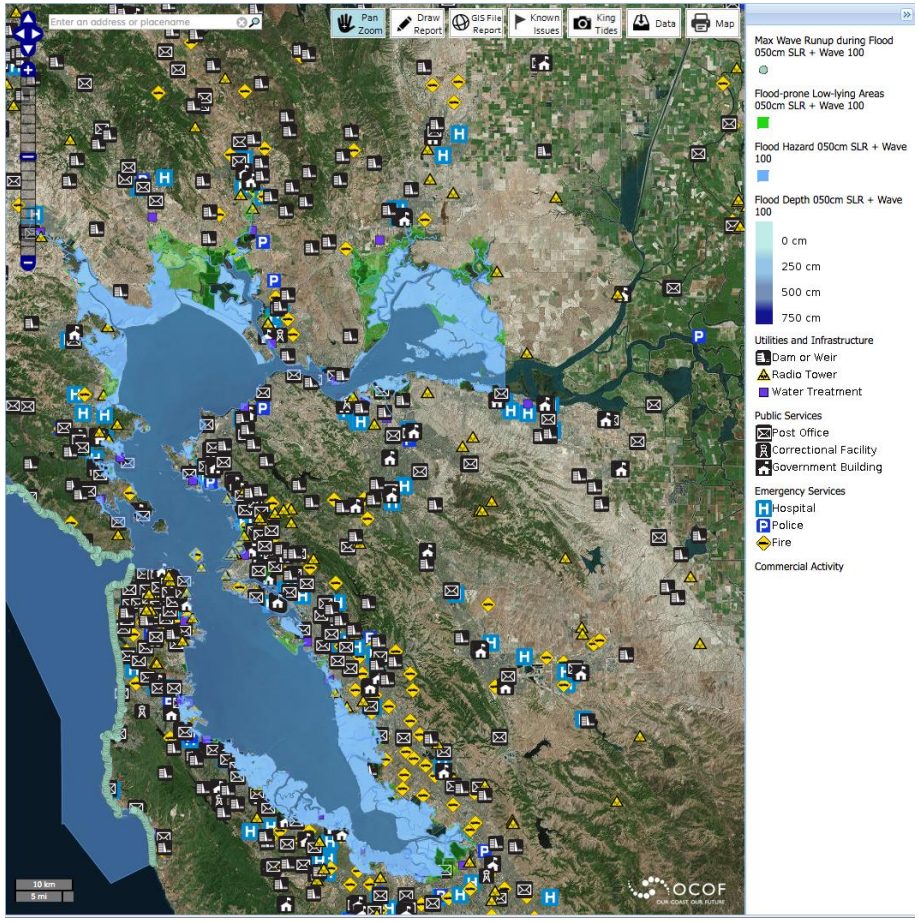


Sea Level Rise and Coastal Flooding Impacts

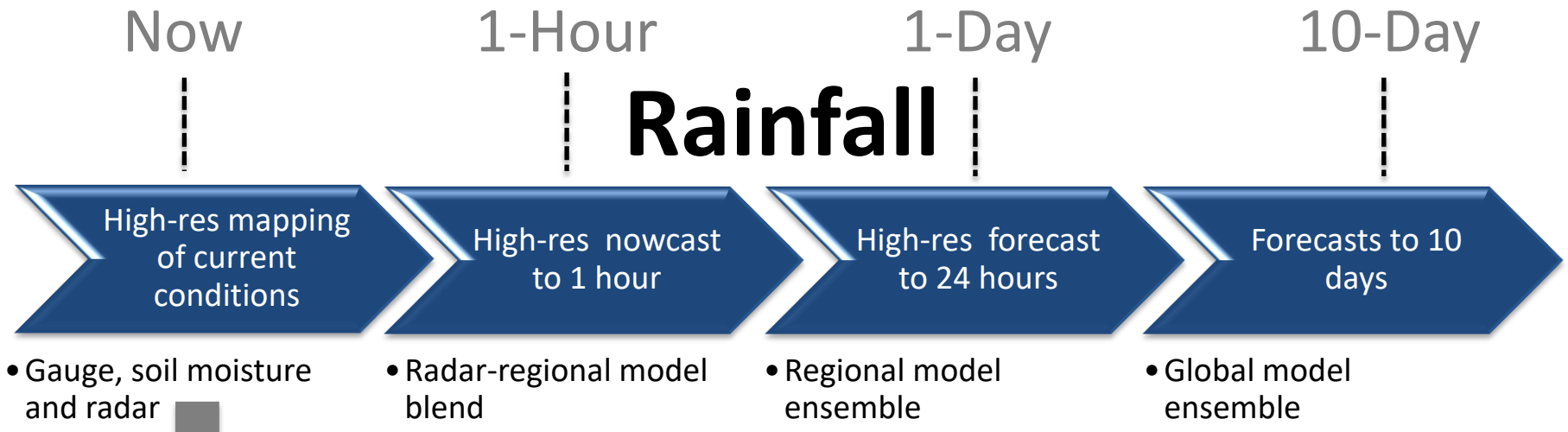
100 Yr Return Period Storm – No SLR

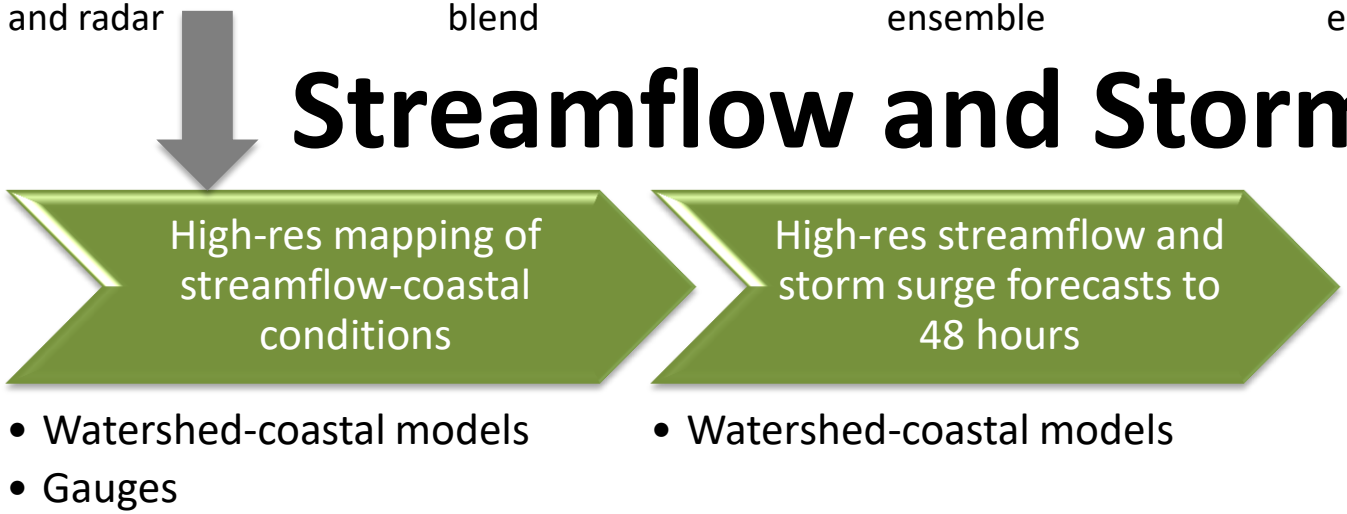


100 Yr Return Period Storm – 50 cm SLR



AQPI: better monitoring of current and future weather and water conditions



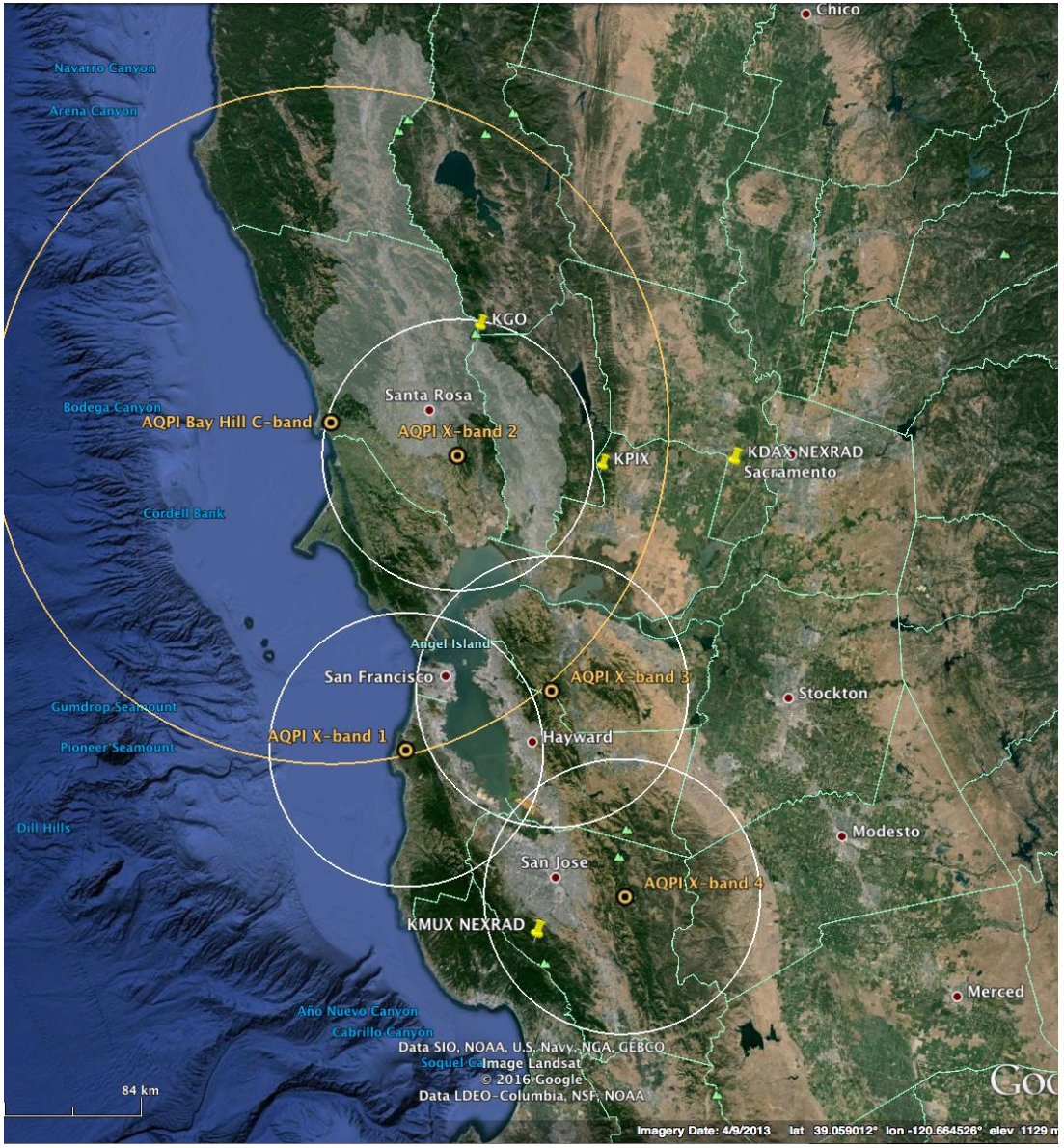


Improve Observation Network

- Radars
  - X-band

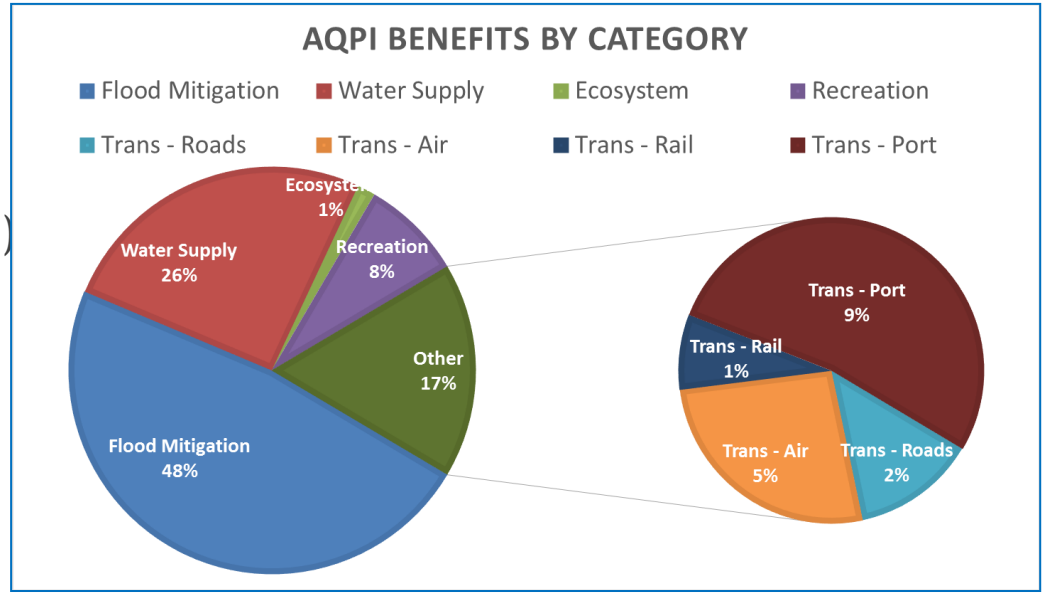
  - C-band

- Surface stations
  - Rain gauges
  - Surface meteorology
  - Soil moisture
  - Stream gauges



AQPI Benefits Summary

- **Overall**
  - Total Wx Benefits ($240M/yr; $34/person)
  - Incremental AQPI Benefits ($79M/yr; $11/person)
- **By Category**
  - Flood Mitigation (48%)
  - Water Supply (26%)
  - Ecosystem Services (9%)
  - Transportation (17% (Ports 9%)
- **Present Value**
  - PV(6%, 10yr)
  - Benefits - $460M
  - Costs - $90M
- **Benefit/Cost Estimates**
  - Best Estimate – 5:1
  - Optimistic Estimate – 13:1
  - Pessimistic Estimate - 2:1



From Johnson et al. 2015: "*Benefits Of An Advanced Quantitative Precipitation Information System: San Francisco Bay Area Case Study*"

Summary

Forecast Informed Reservoir Operations

- FIRO shows promise for improved water supply & in-stream flows while deferring/avoiding expensive capital projects
- Must ensure flood protection won't be compromised
- Incremental FIRO implementation (version 1, version 2, etc.)

Advanced Quantitative Precipitation Information Project

- Improved monitoring & precipitation/flood prediction can enhance public safety
- Broad array of other benefits: water supply, ecosystem services & transportation