

# California Water: Current Issues and Dilemmas

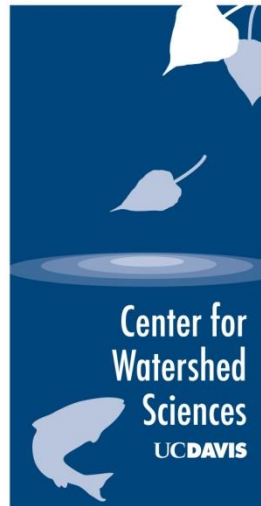
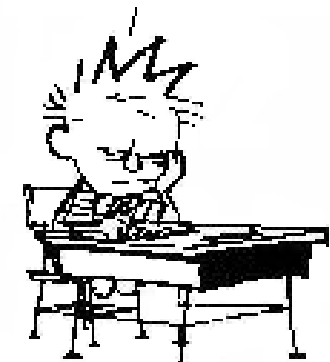
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NOBODY LIKES US  
"BIG PICTURE"  
PEOPLE



# Outline

1. California's water system

2. Eternal change

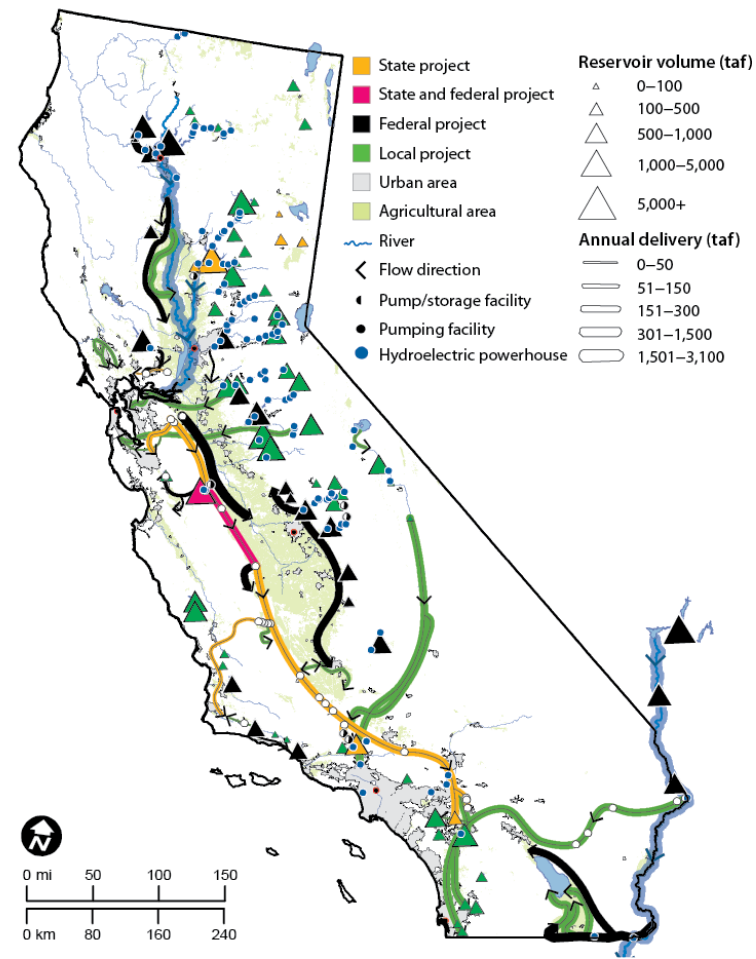
3. Major current issues

- Ecosystem management
- The Delta
- Groundwater
- Rural safe drinking water

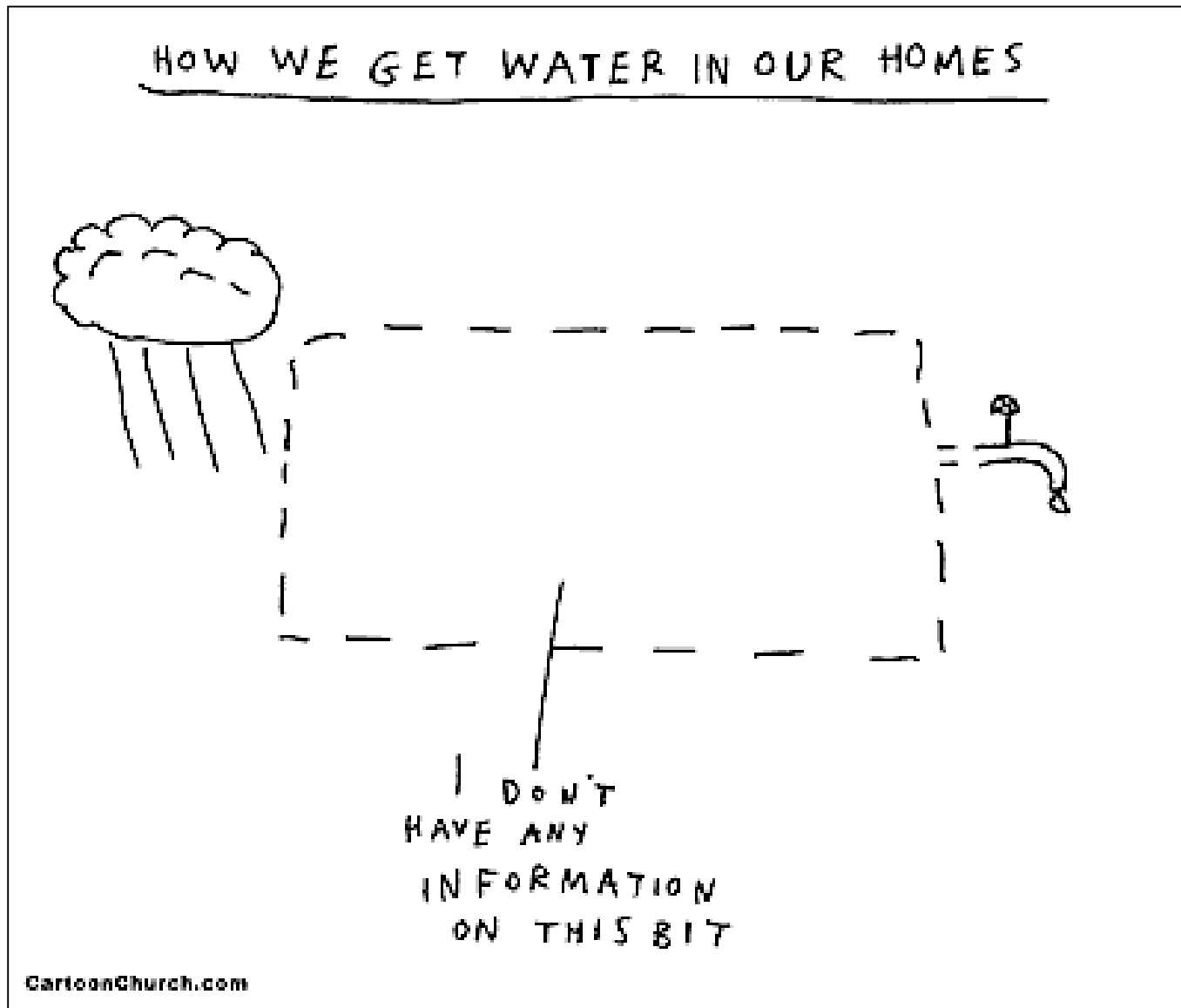
4. Future of California and water

5. Portfolio management

6. Conclusions

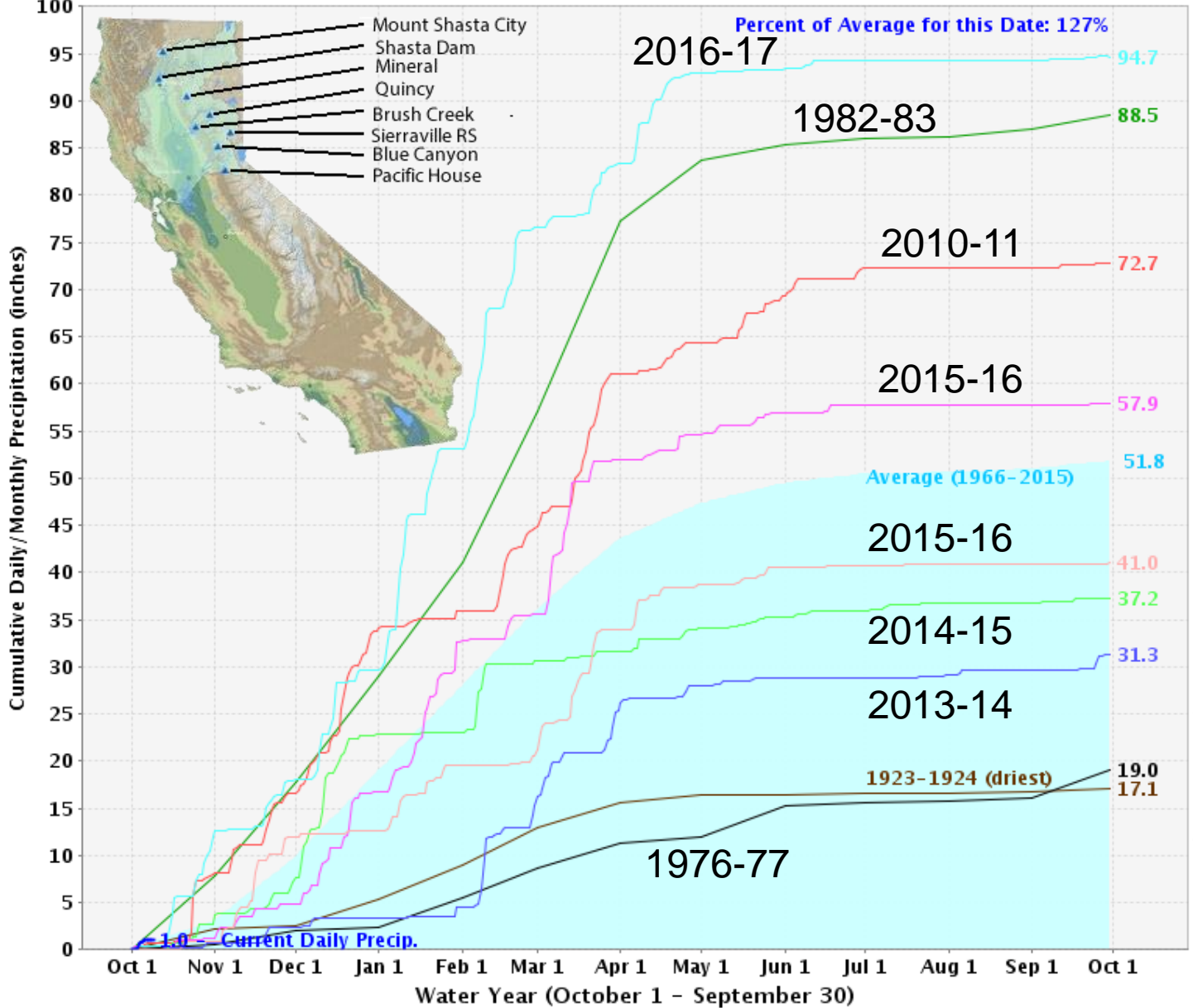


# Ubiquity of partial ignorance



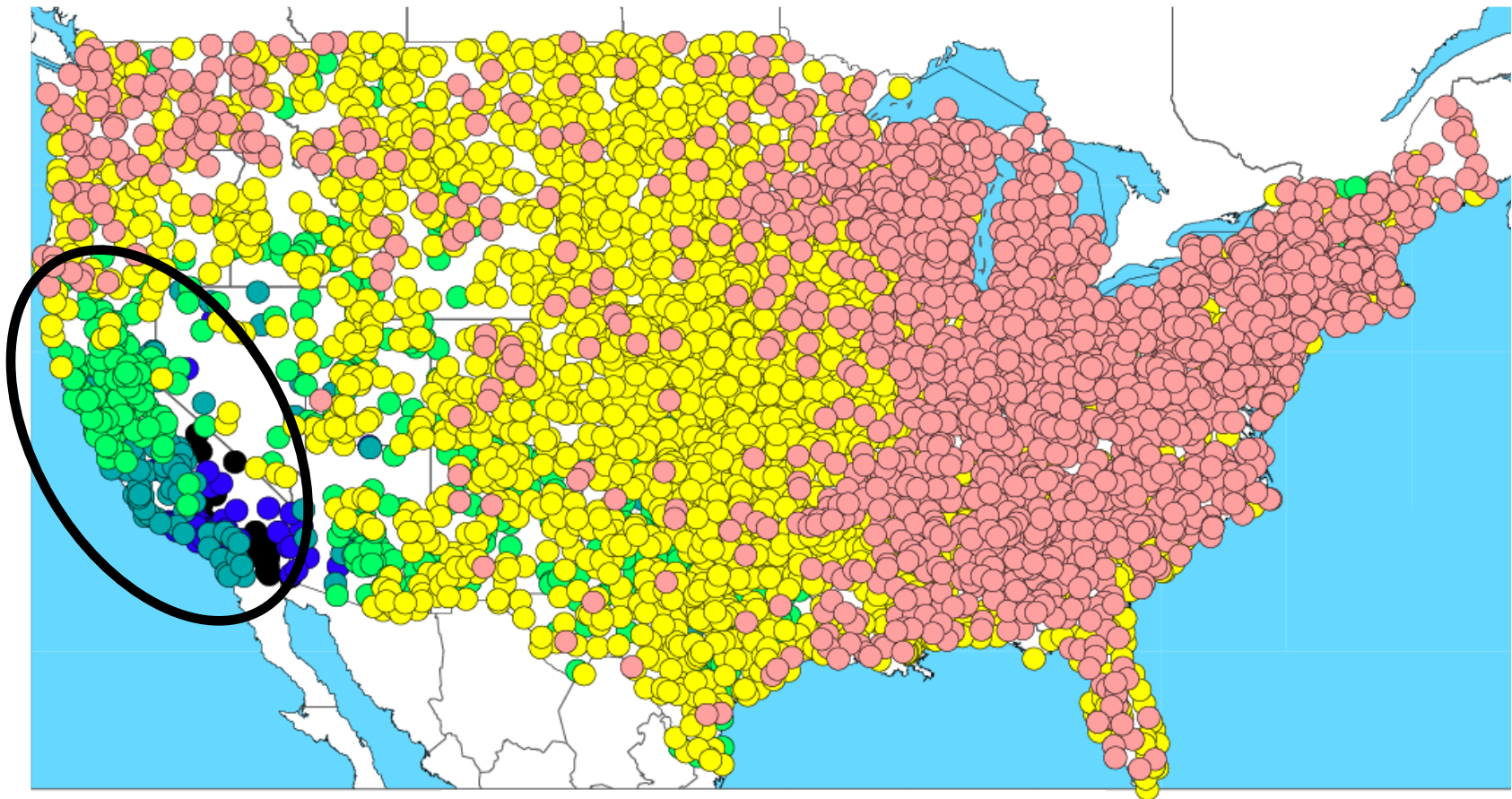
# Sacramento Valley Precipitation

Northern Sierra Precipitation: 8-Station Index, October 9, 2018



2014:  
8<sup>th</sup> driest in  
106 years,  
4<sup>th</sup> driest in  
runoff

# Most annual rainfall variability in US



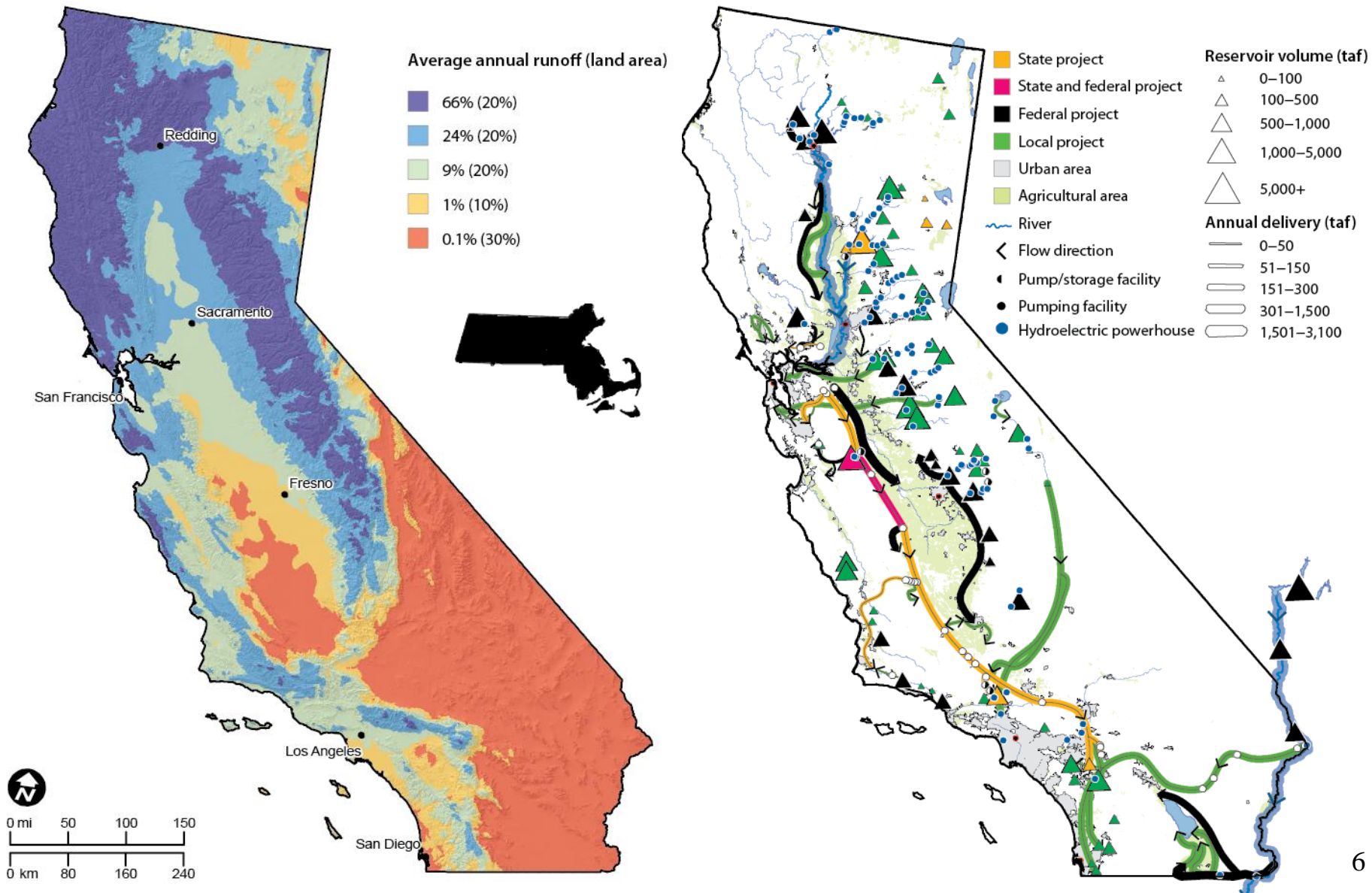
Annual coefficient of variation



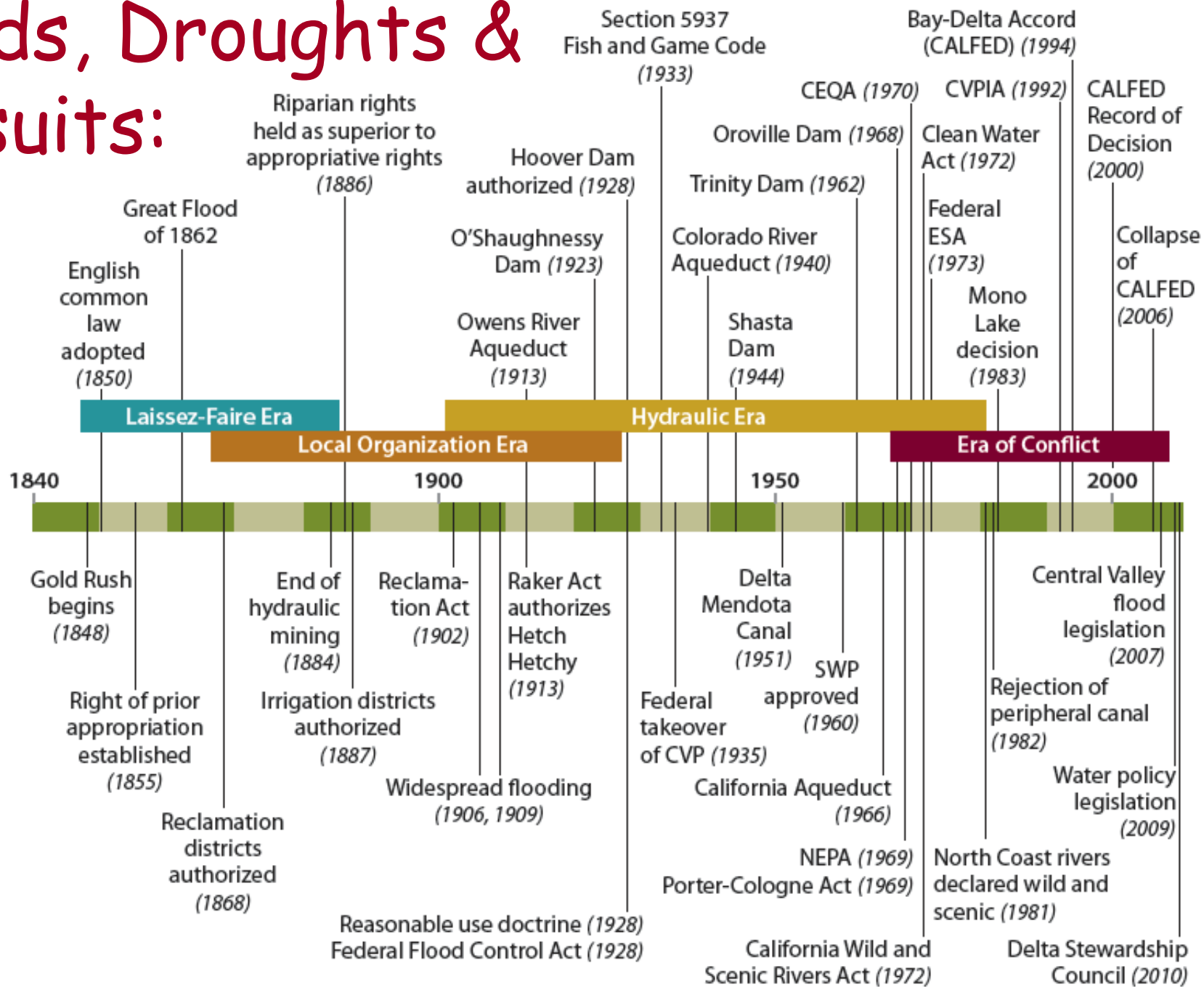
SOURCE: Michael Dettinger, 2011. "Climate Change, Atmospheric Rivers, and Floods in California—A Multimodel Analysis of Storm Frequency and Magnitude Changes." *Journal of the American Water Resources Association* 47(3):514-523.

NOTES: Dots represent the coefficient of variation of total annual precipitation at weather stations for 1951-2008, Larger values have greater year-to-year variability.

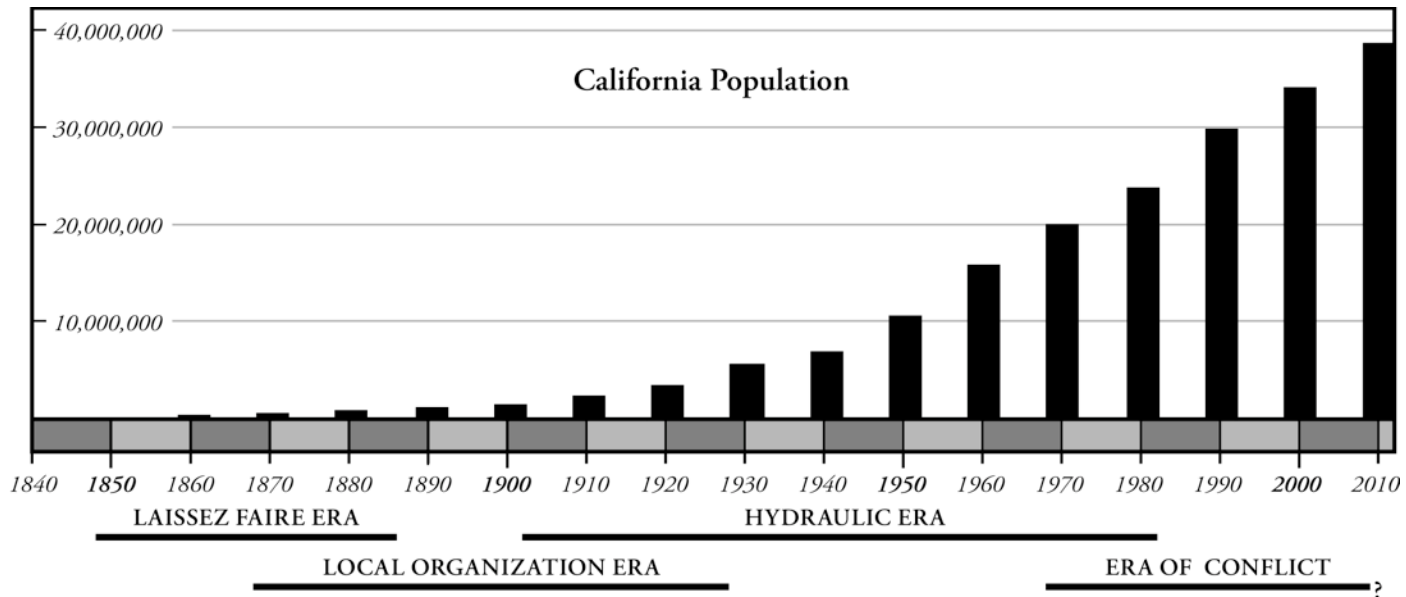
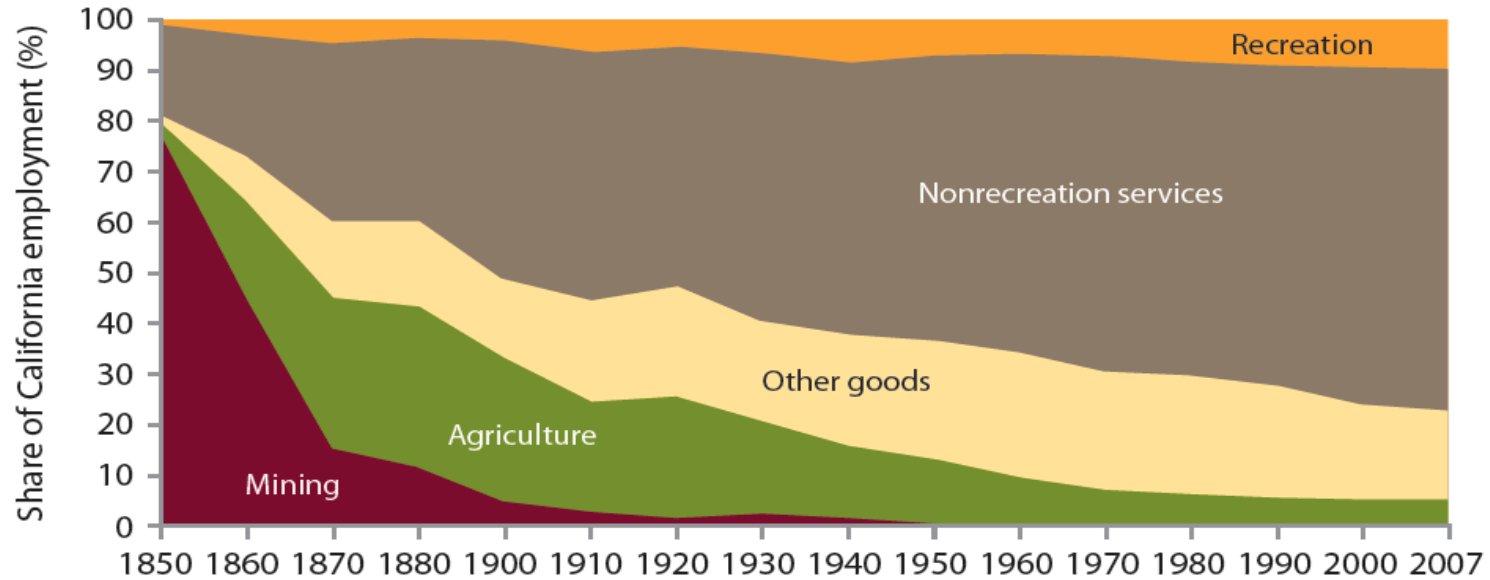
# Complexity of Water in California



# Floods, Droughts & Lawsuits:



# Changing Water Challenges



Source: Hanak et al. 2011



# Future Climate Changes

- 1) Sea level rise
- 2) Warmer temperatures
- 3) More variability
- 4) More frequent extremes

And many non-climate changes...

# Drivers of Change

- Climate
  - Sea level rise
  - Warming
  - Precipitation change
  - Extreme whiplash
- Deterioration
  - Aging infrastructure
  - Contaminants – salts, nitrates, etc.
  - Mining legacy
  - Groundwater overdraft
  - Earthquakes
  - Sacramento-San Joaquin Delta
- Economy and Demography
  - State and federal finances
  - Globalization
  - Population growth and urbanization
- Ecosystems
  - New invasive species
  - Continued degradation
- Science and technology
  - New chemicals
  - New Technologies



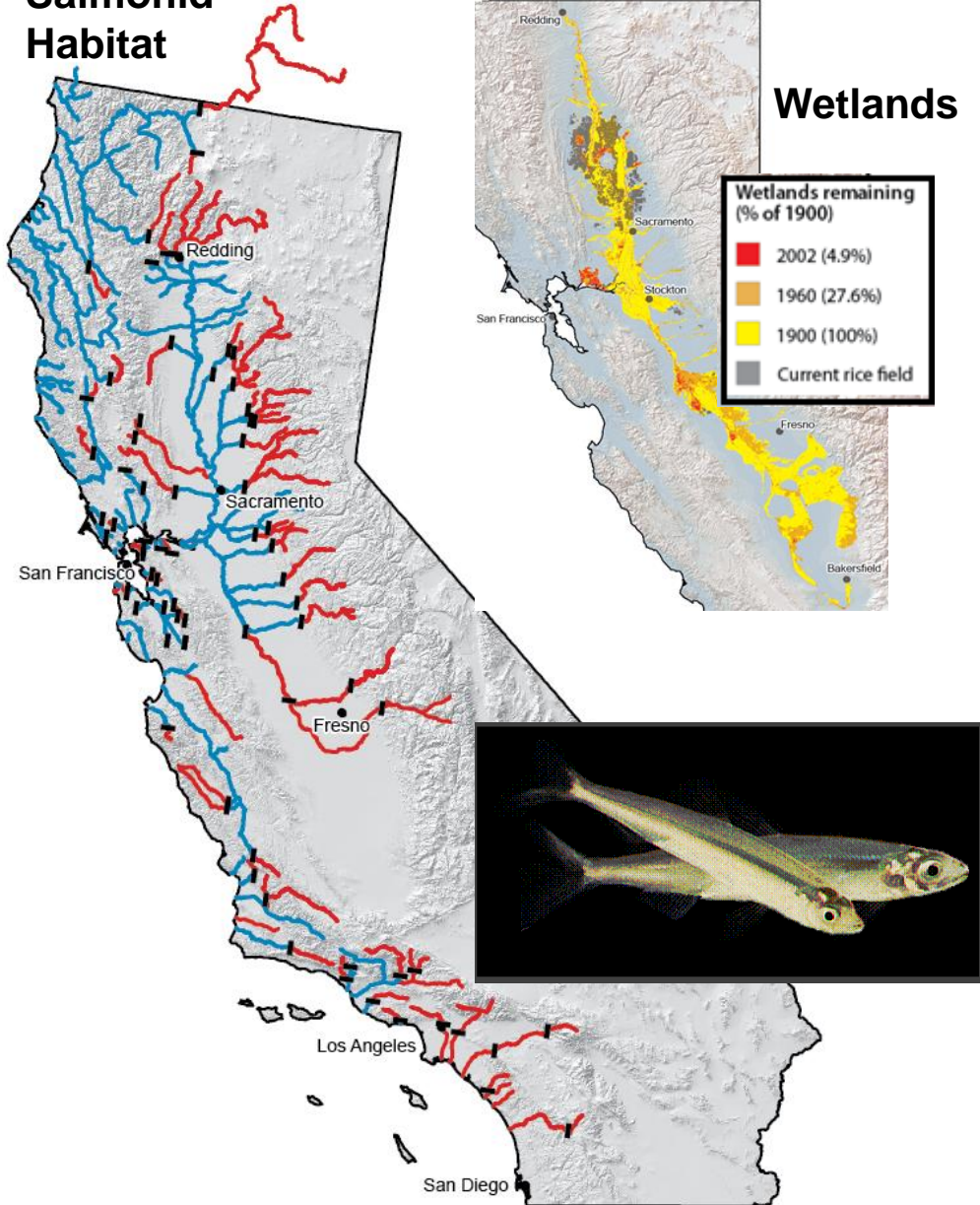
# Current Issues

- 1) Ecosystem management
- 2) The Delta
- 3) Groundwater management (SGMA)
- 4) Safe rural drinking water
- 5) Adapting to accumulating change:
  - Climate change
  - Data and technology management
  - Infrastructure
  - Globalization of economy and ecosystem
  - Shifting institutional capabilities

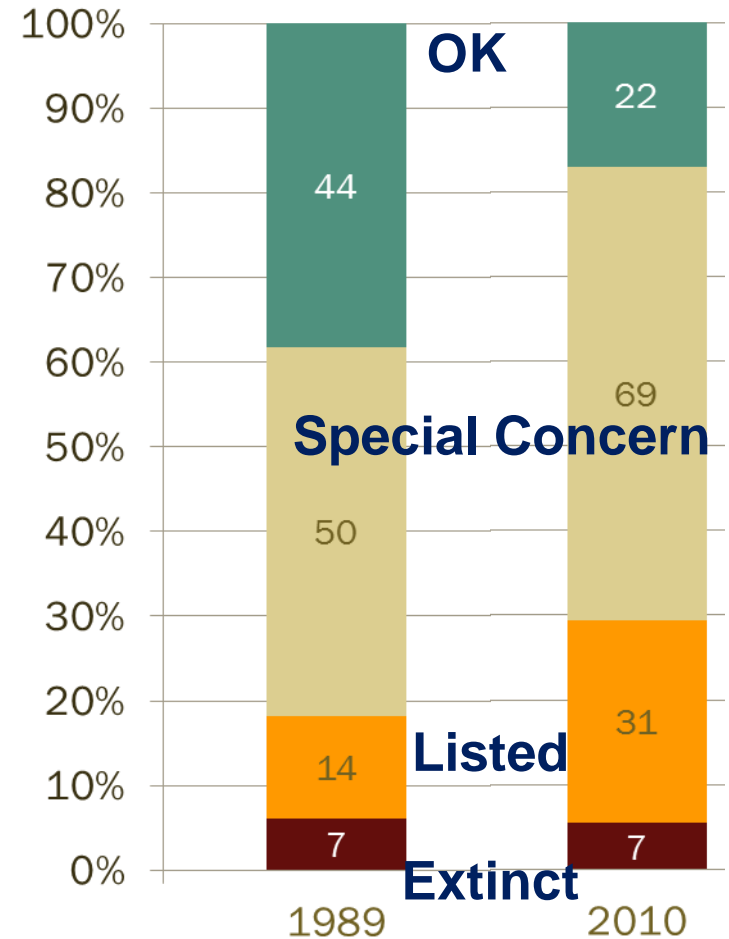


# Native Habitat and Fishes

## Salmonid Habitat

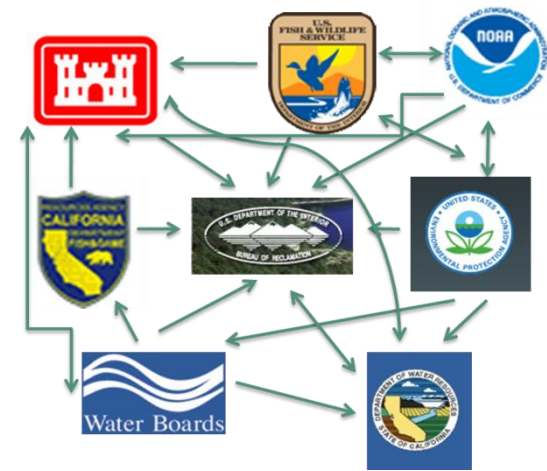


## California's freshwater fishes are losing

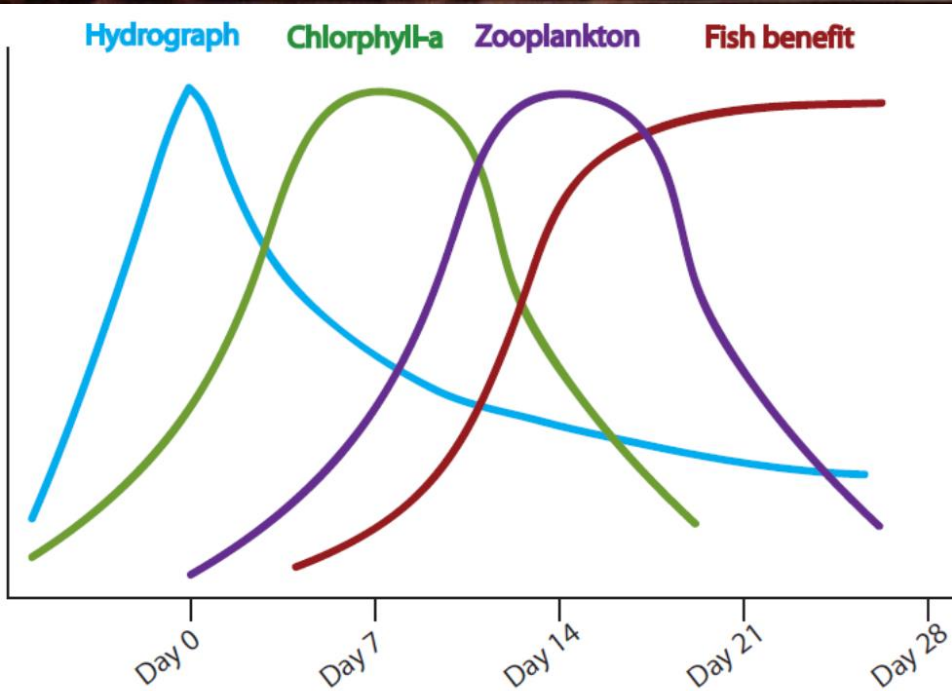
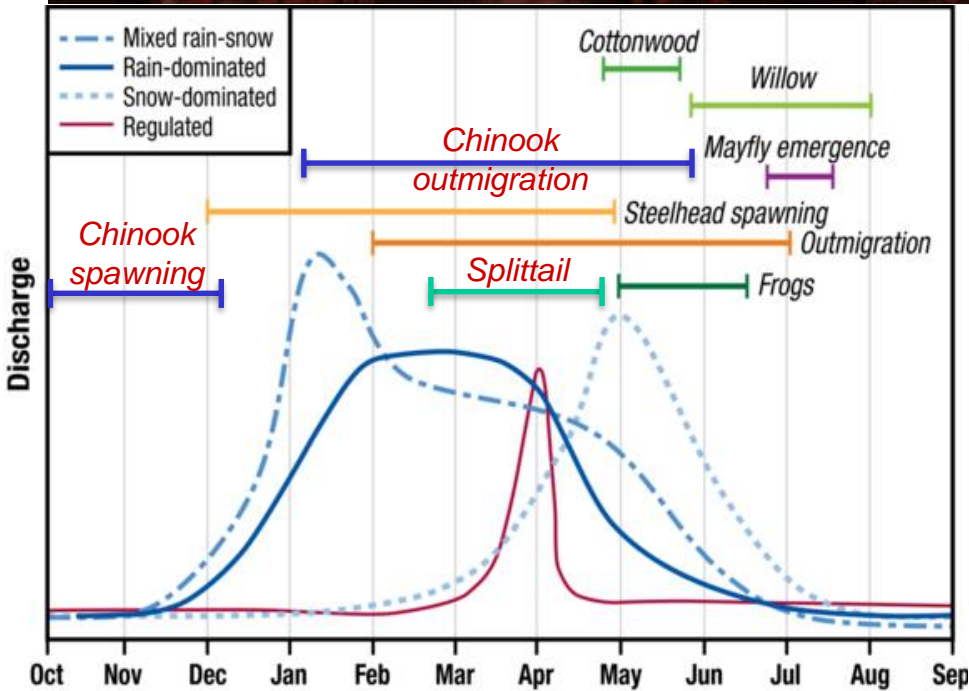


# Ecosystem management

- 1) Native ecosystem decline
- 2) Drought ratchetting of declines
- 3) Accumulating challenges:
  - Climate change, Non-native species/ecosystem globalization
- 4) Fragmented and under-resourced responses
- 5) “No” is easy, but ineffective. What can we say “Yes” to?
- 6) Waterbird management, compared to fish and forests
- 7) How to integrate management of flows, habitat, land, and invasive species
- 8) Ecosystem reconciliation – floodways and SJ Valley land following

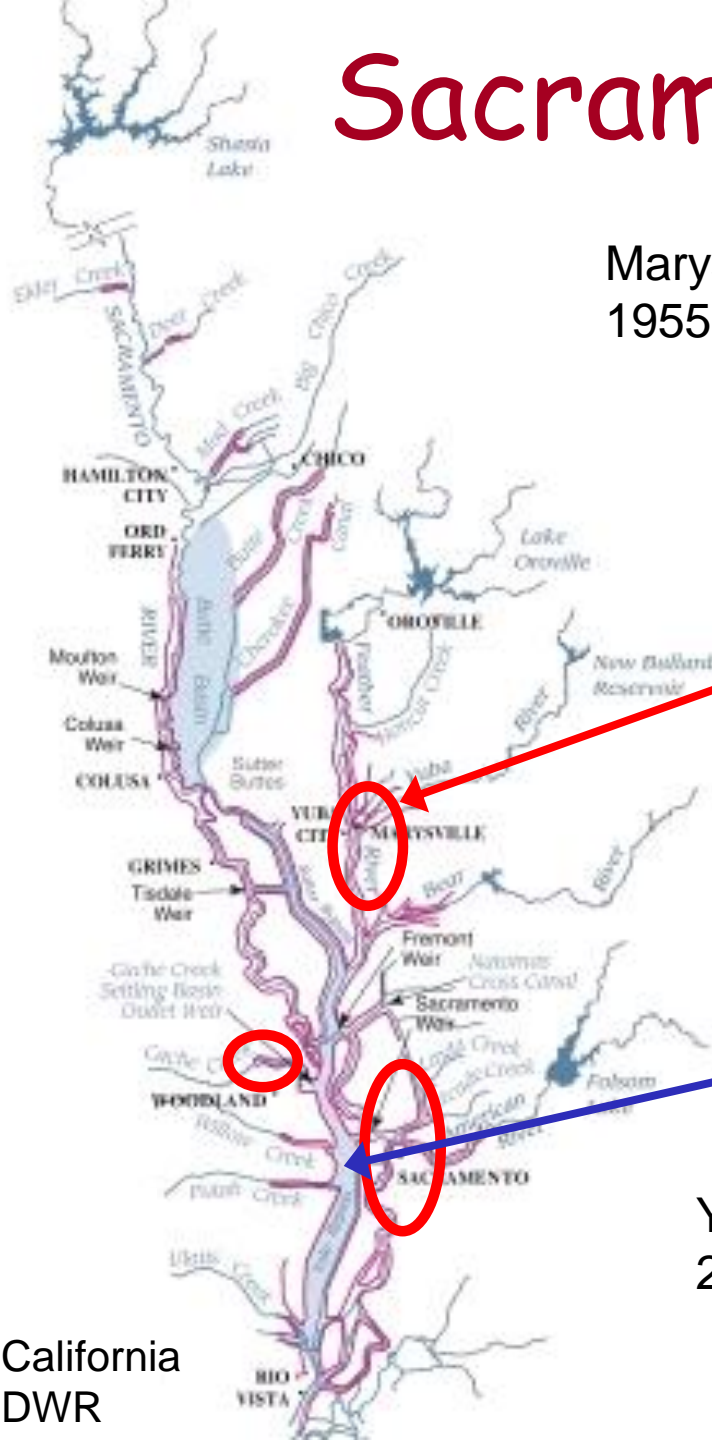


# Aquatic ecosystem restoration



# Sacramento Flood By-Pass

Marysville, 1955

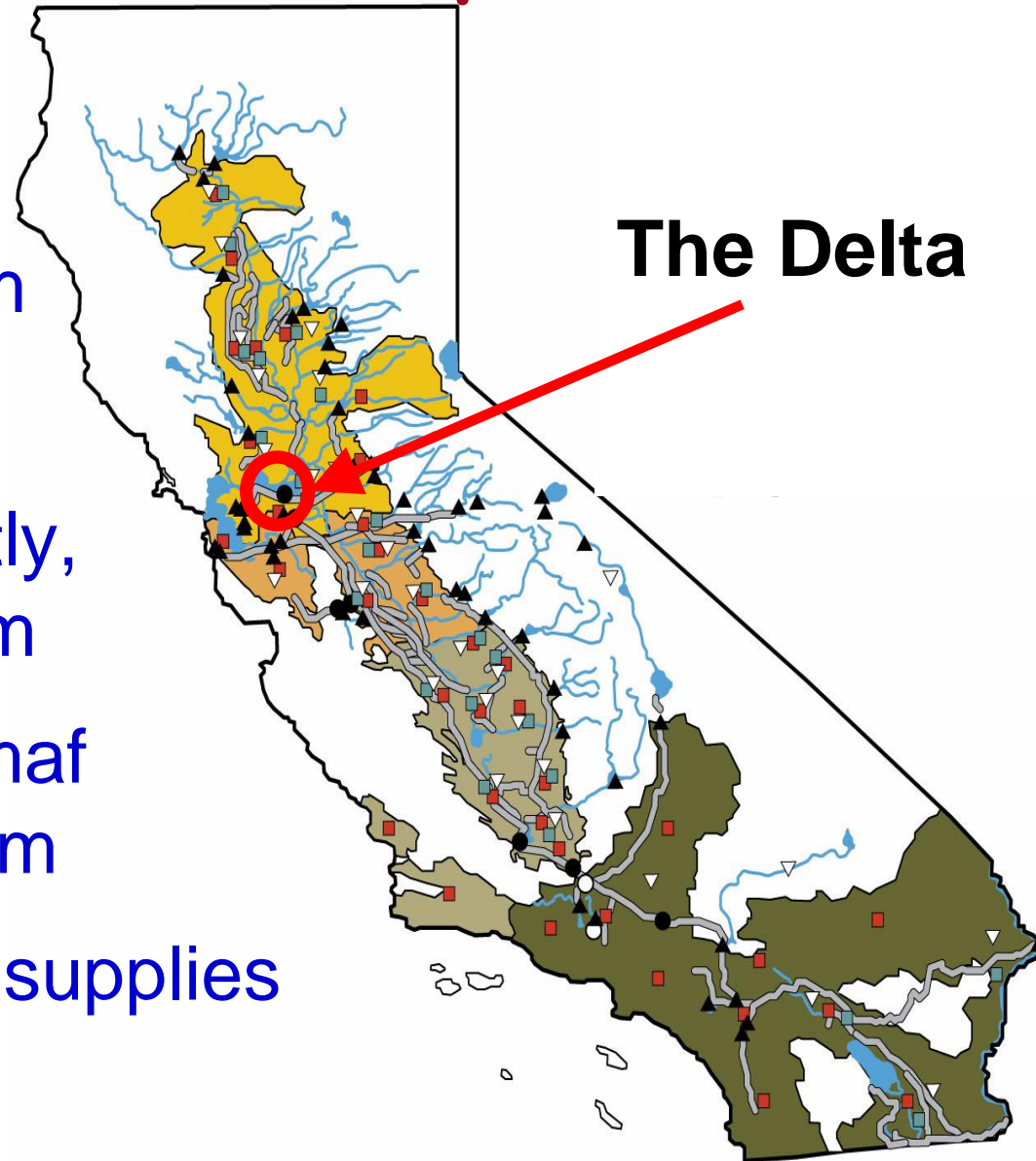


Yolo Bypass, 2011



# Sacramento-San Joaquin Delta

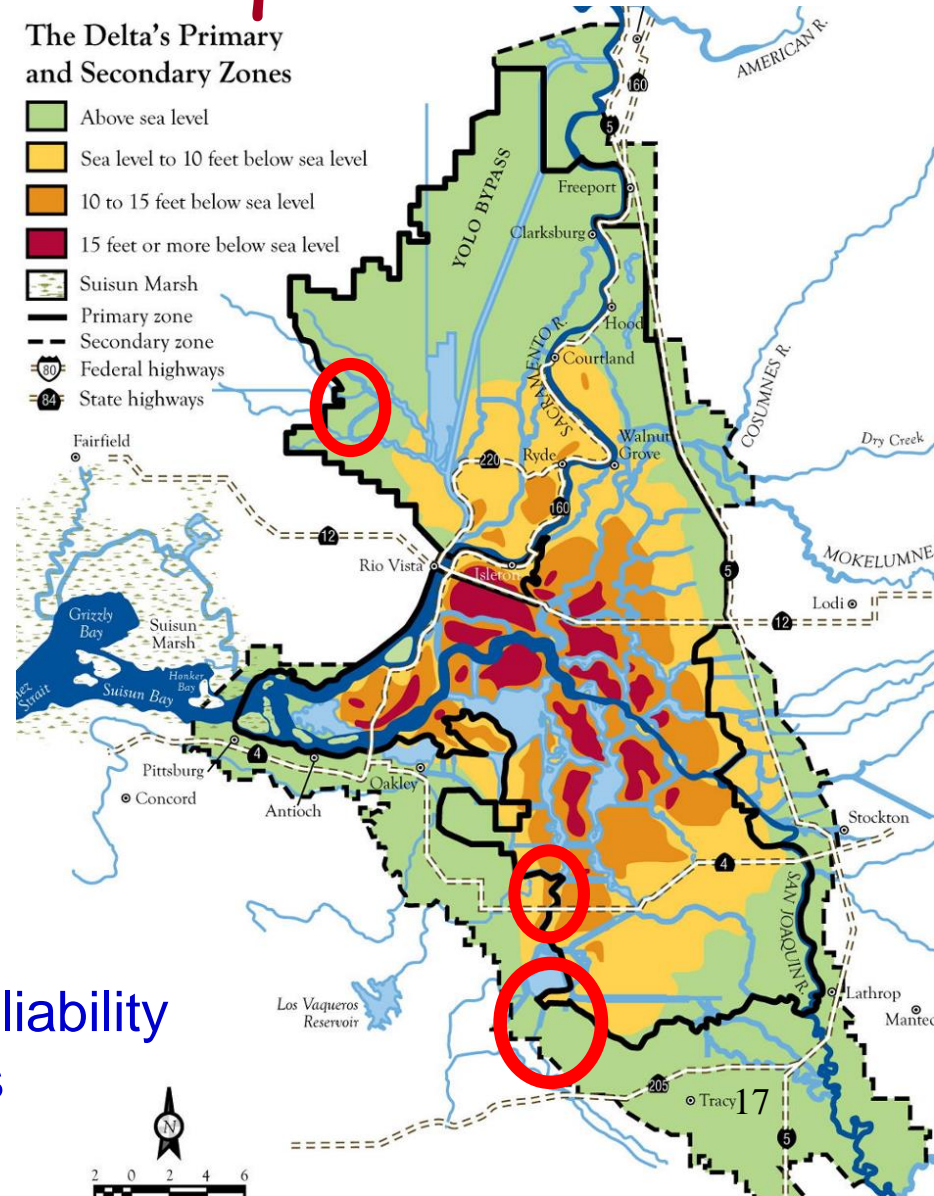
- Sacramento Valley - 4+ maf taken upstream
- Delta farmers – 1 maf
- Bay Area – 30% directly, another 40% upstream
- S. Central Valley – 4 maf directly; 4 maf upstream
- S. California – 30% of supplies





# Problems of California's Sacramento-San Joaquin Delta

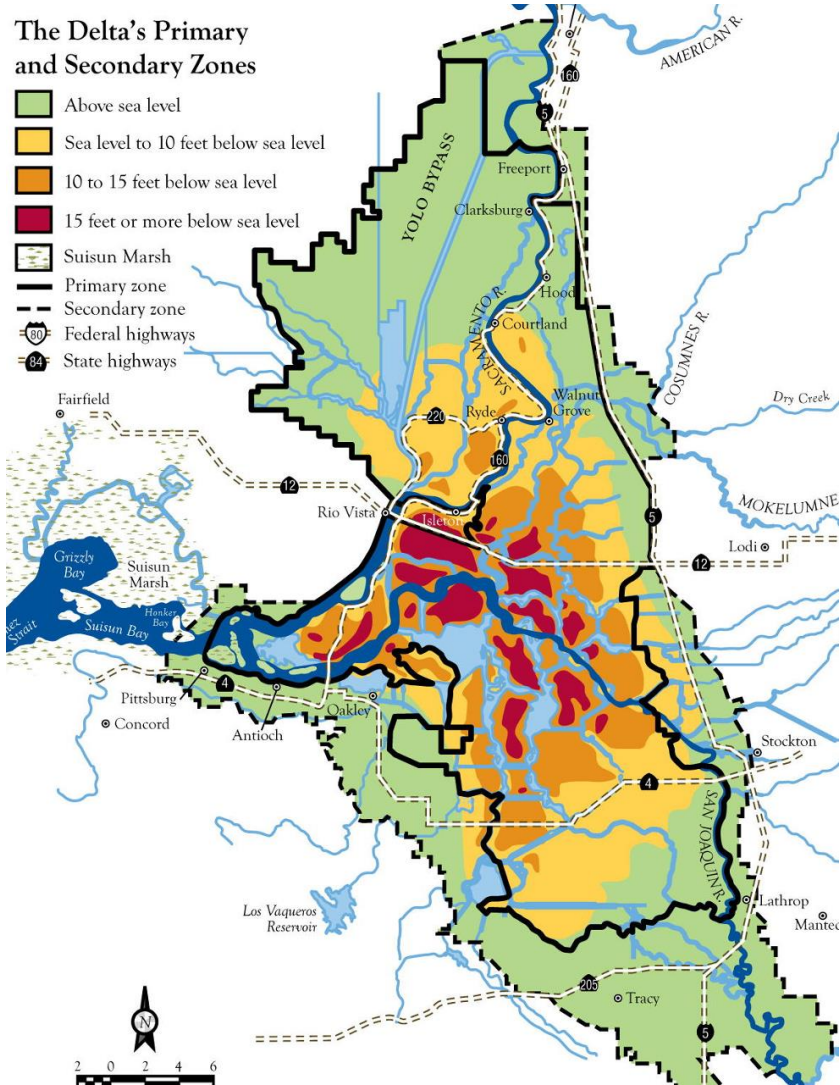
- Physical instability
  - Land subsidence
  - Sea level rise
  - Floods
  - Earthquakes
- Ecosystem instability
  - Habitat alteration
  - Non-native species
- Economic instability
  - High costs to repair islands
  - Worsening water quality and reliability for agricultural and urban users



# Delta Levees and Islands

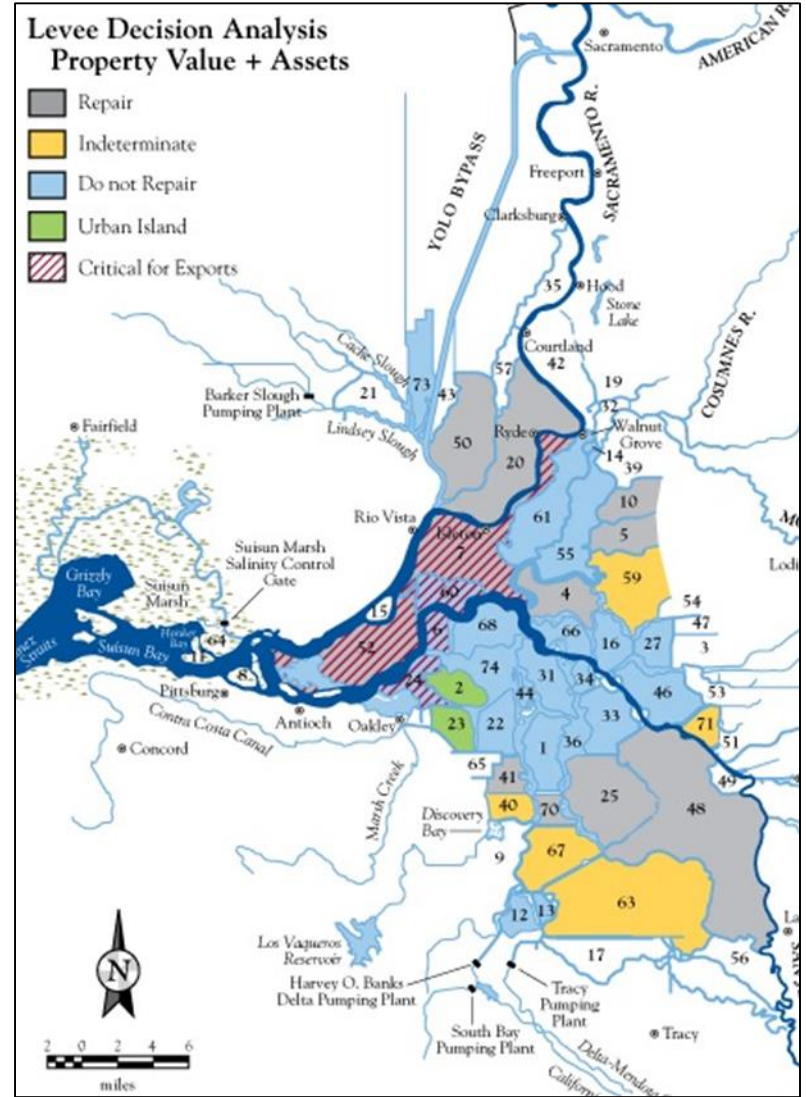
## The Delta's Primary and Secondary Zones

- Above sea level
- Sea level to 10 feet below sea level
- 10 to 15 feet below sea level
- 15 feet or more below sea level
- Suisun Marsh
- Primary zone
- Secondary zone
- Federal highways
- State highways

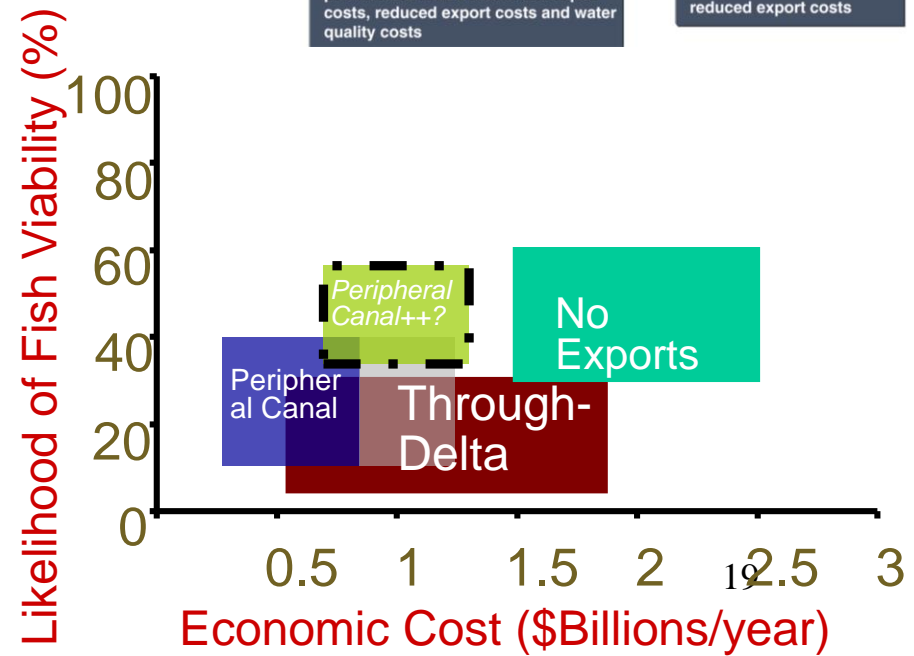
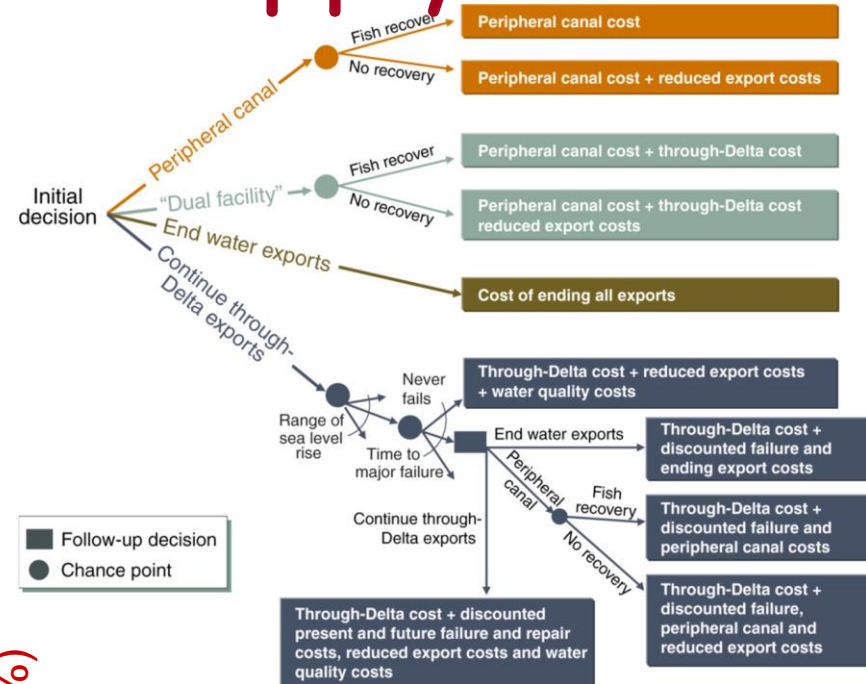
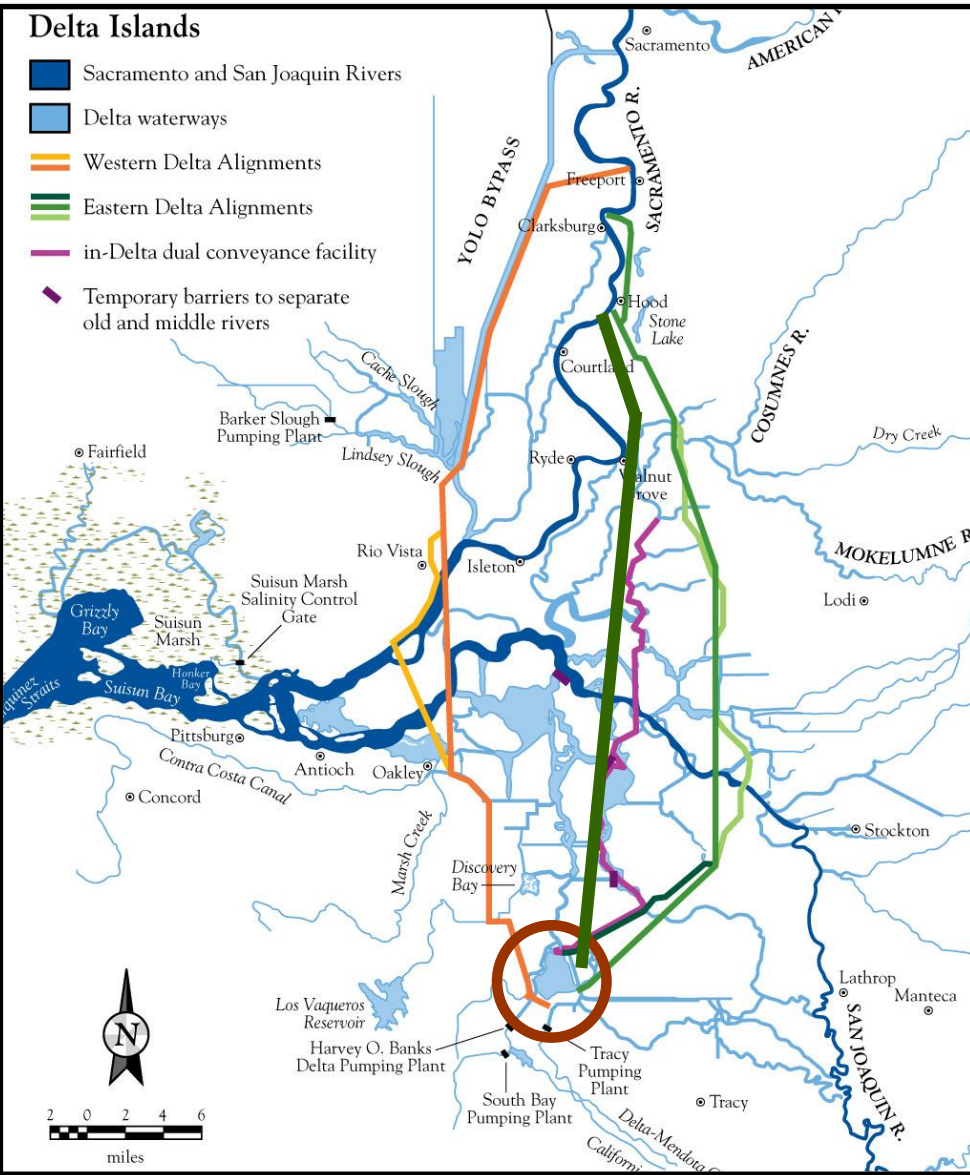


## Levee Decision Analysis Property Value + Assets

- Repair
- Indeterminate
- Do not Repair
- Urban Island
- Critical for Exports

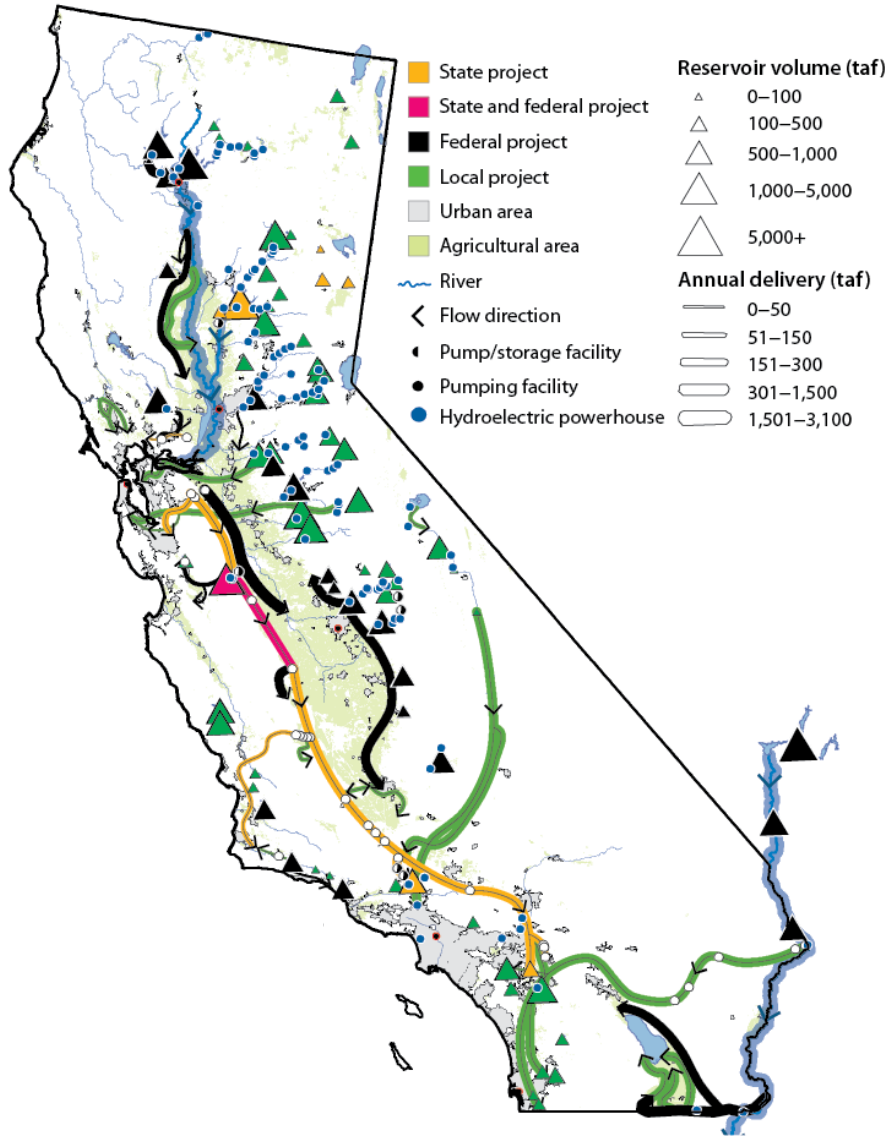


# Delta Water Supply

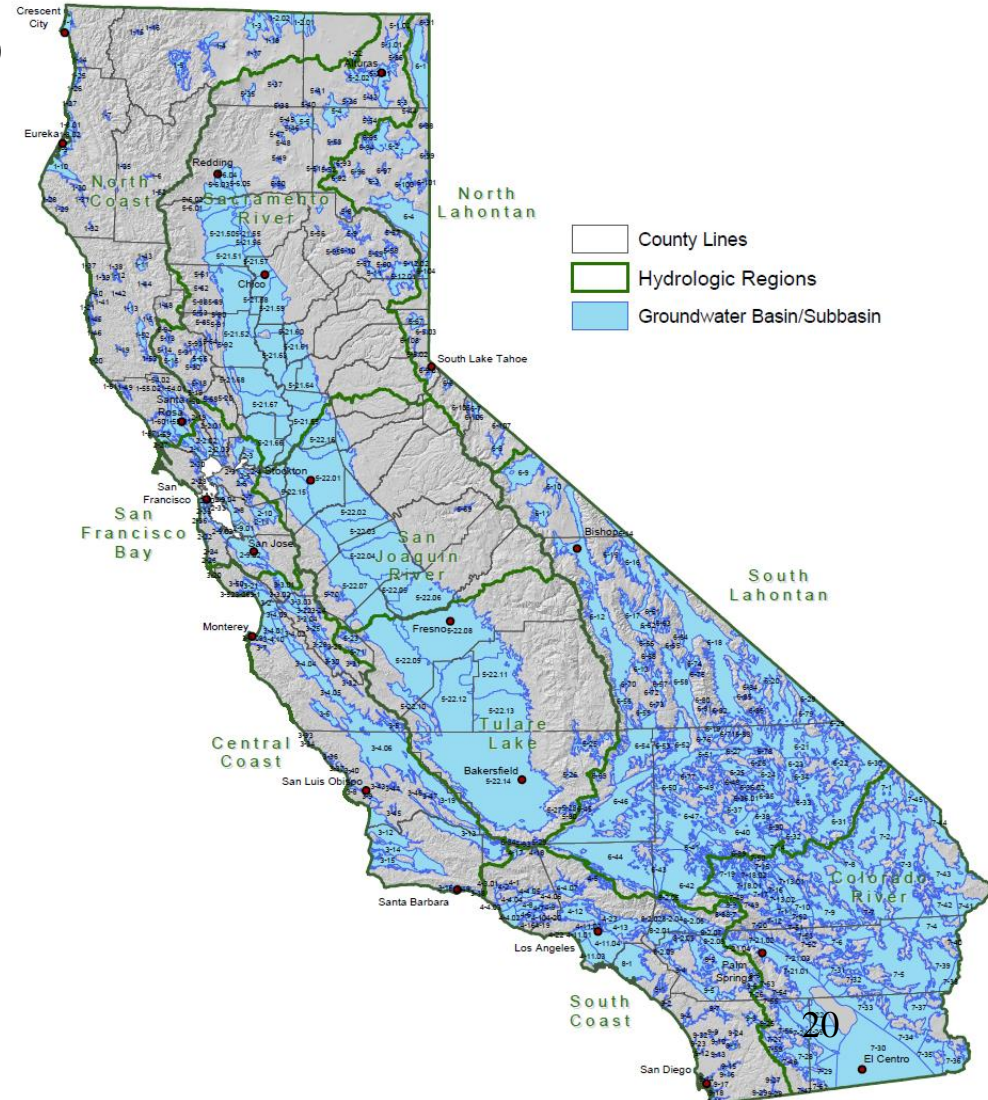


# California Water and Infrastructure

## Top down view



## Aquifer up view



# Groundwater management

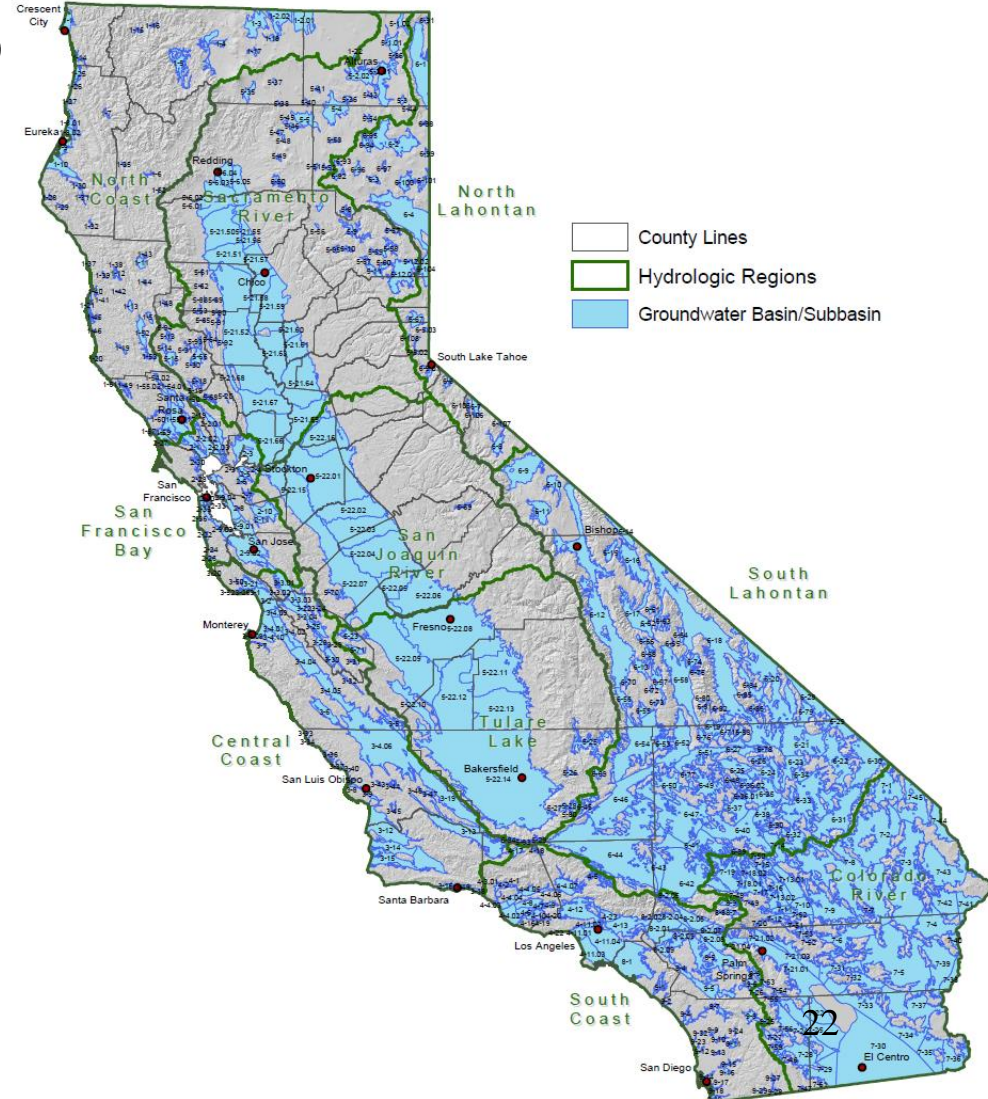
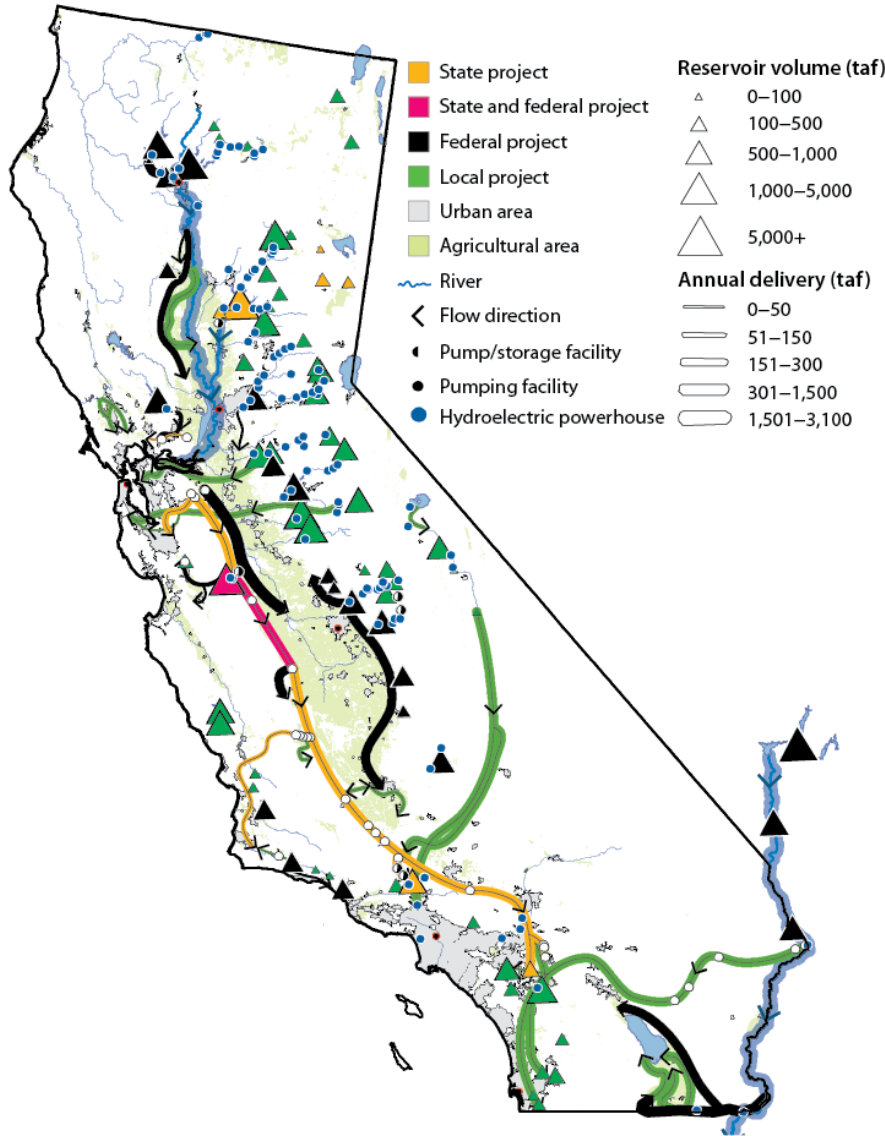
- 1) SGMA
- 2) SGMA
- 3) SGMA
- 4) Contaminants – nitrate, salt
- 5) Long-term threat from salt in some areas
- 6) Potential of SGMA implementation to help with other problems
- 7) Using SGMA data, models, analyses, plans, and agreements to organize and resolve other important water problems



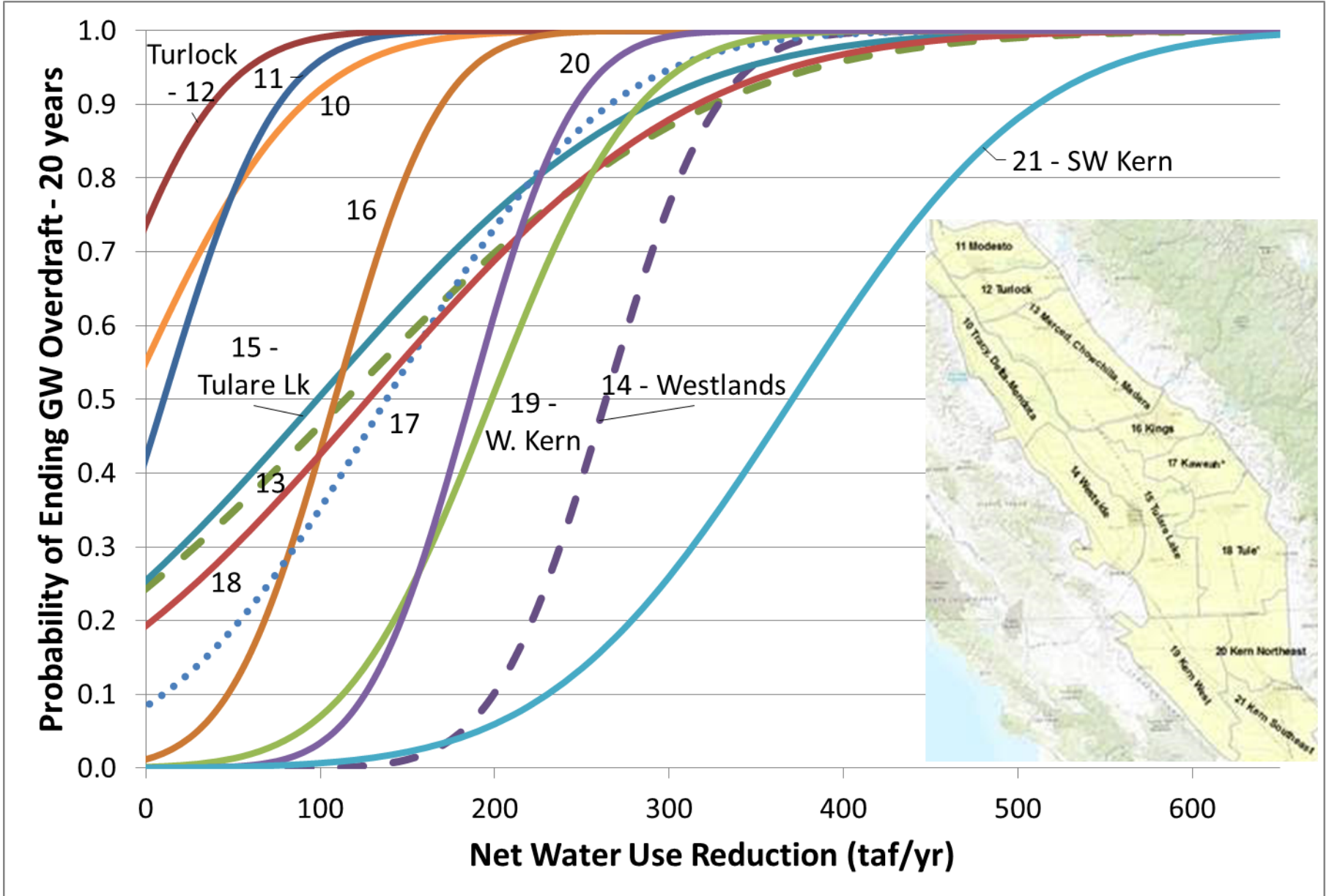
# Aquifers and Infrastructure

Top down view

Bottom up view

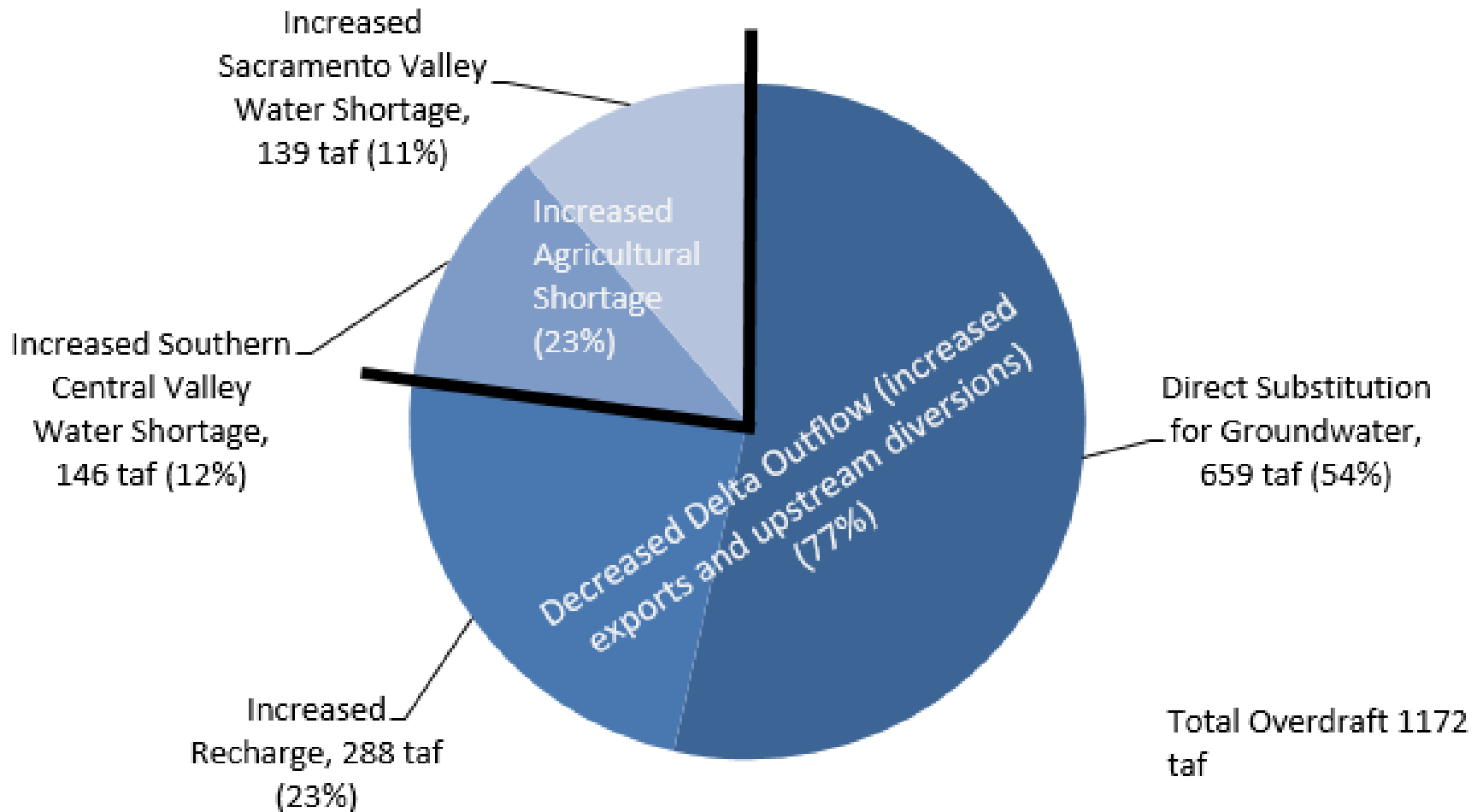


# Groundwater sustainability



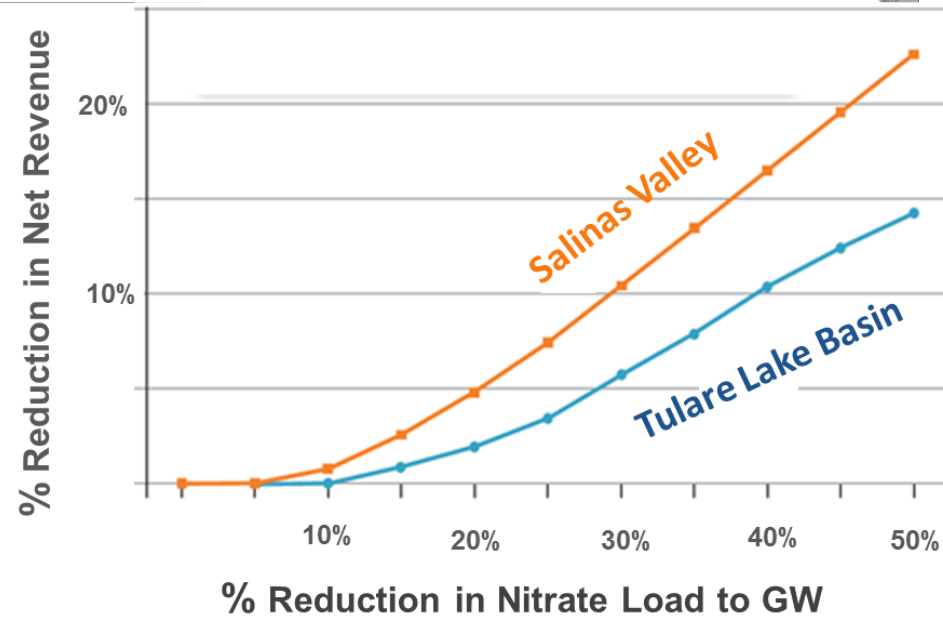
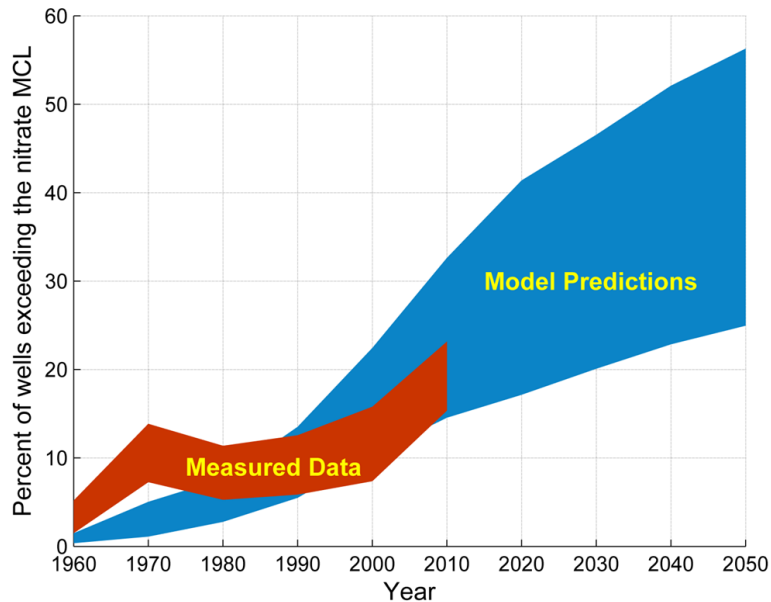
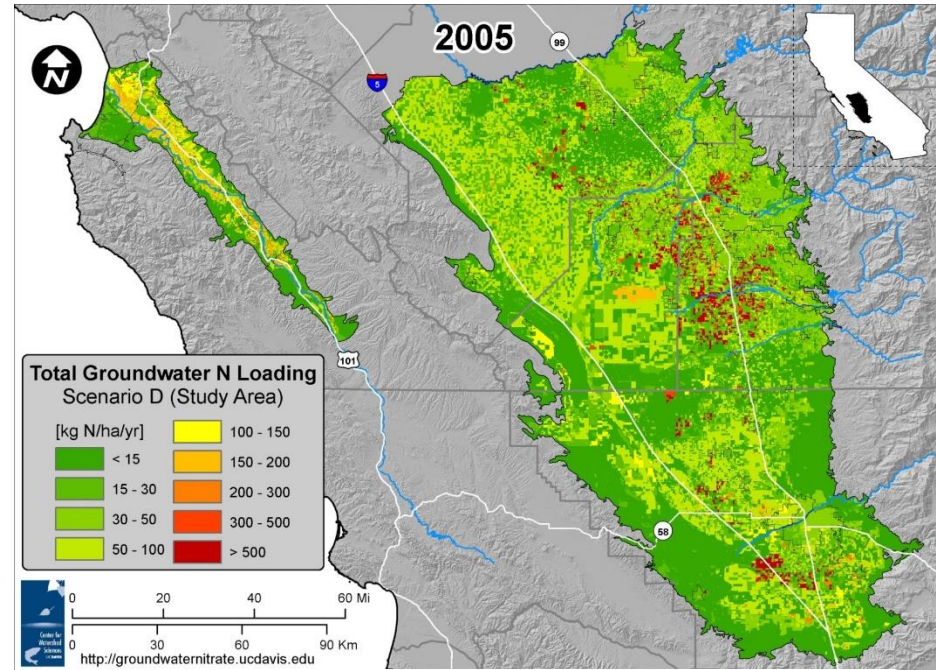
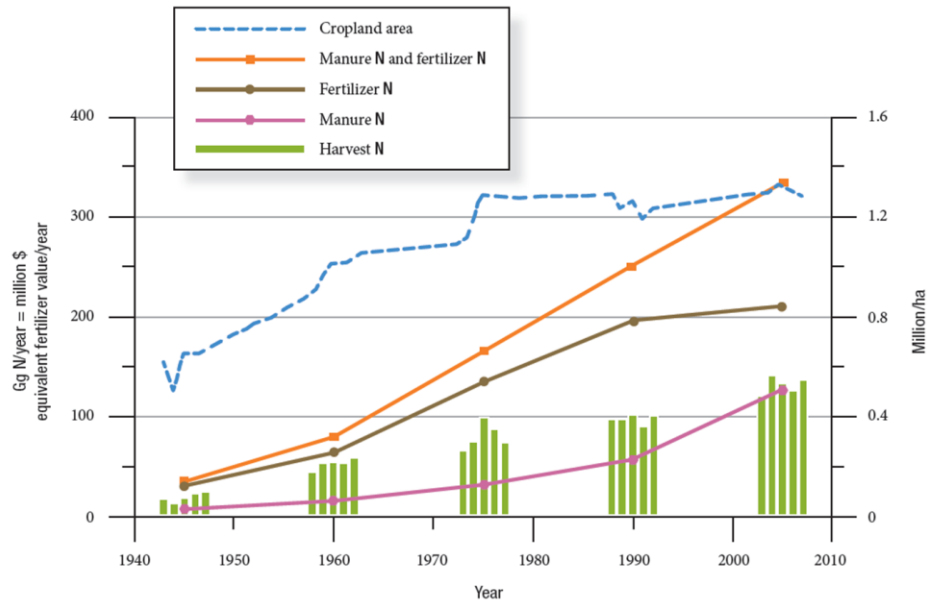
# SGMA connects to the Delta

- Ending overdraft increases pressure on Delta operations. CALVIN results (Nelson et al., 2016)



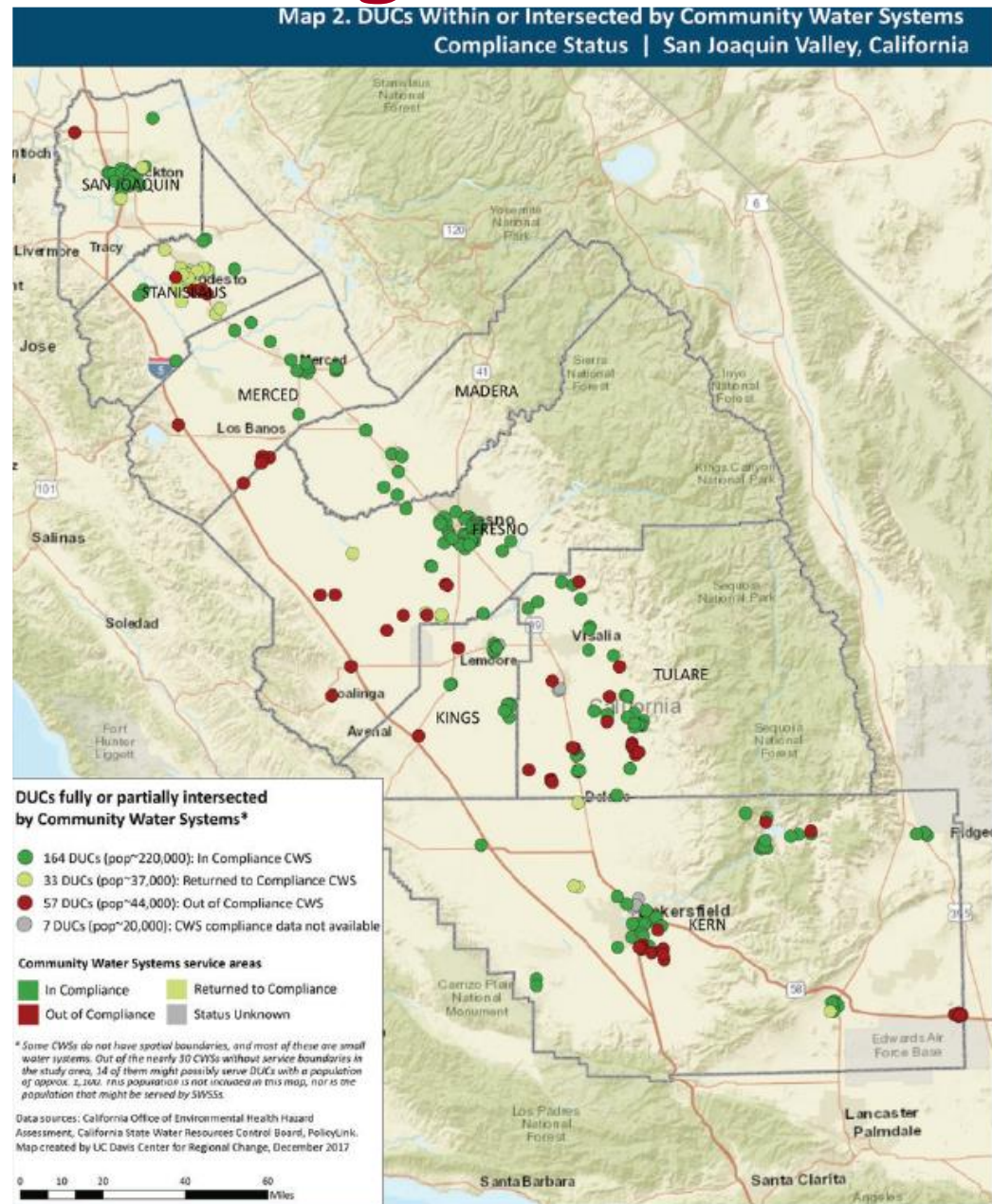


# Nitrate Groundwater Contamination



# Safe rural drinking water

- 1) ~1-2% of state's population affected
- 2) Unsafe rural water systems
- 3) Unsafe domestic wells
- 4) Often small poorer communities



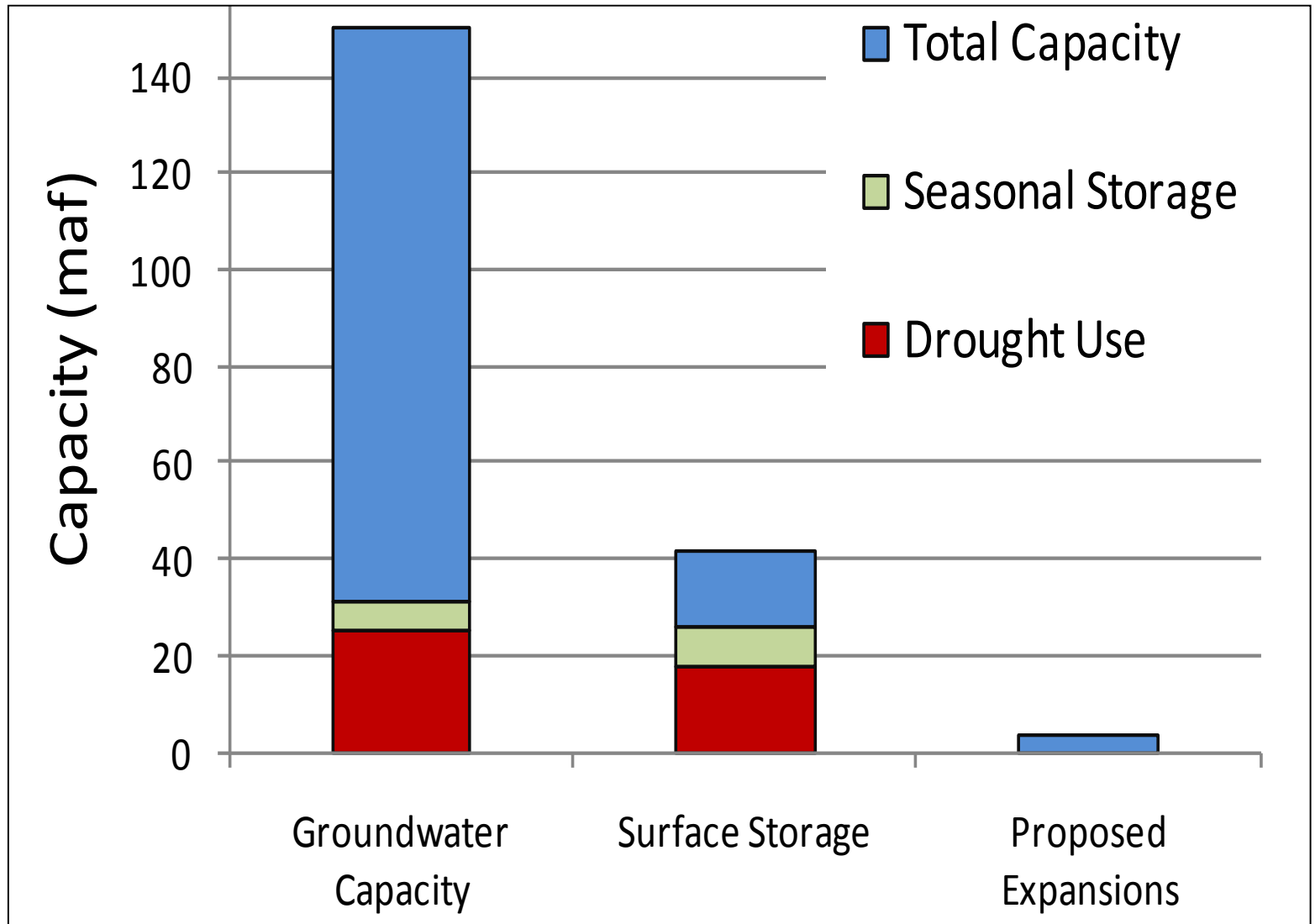
# Safe rural drinking water

- 1) Small scale rural problems, poverty
- 2) Drinking water safety
  - Nitrate, arsenic, salt, other contamination
- 3) Drought stranding
- 4) Organizing small systems
- 5) Funding small rural systems
  - Regionalization/inter-ties
  - County government support
  - Compensation for nitrate contamination?
  - State funding?
  - State water fee?

# Solutions?

- 1) Taking advantage of the system
- 2) No silver bullets
- 3) Portfolio approaches
  - Complementary supply and demand actions
  - Infrastructure and operations changes
  - Multi-agency, multi-sector complementary benefits
  - Data, modeling, and technology management
  - Shifting institutional capabilities
- 4) Organizing and funding problems so they can be solved

# Water Storage Capacity and Uses in California



# Water supply system portfolio actions

## Water supply

### Water Source availability

Capture of fog, precipitation, streams, groundwater, wastewater

Protection of source water quality

### Conveyance capacities

Canals, pipelines, aquifers, tankers (sea or land), bottles, etc.

### Storage capacities

Surface reservoirs, aquifers and recharge, tanks, snowpack, etc.

### Treatment

Existing water and wastewater treatment

New water and wastewater treatment

Wastewater reuse

Ocean Desalination

Contaminated aquifers

### Operations

Reoperation of storage and conveyance

Conjunctive use

## Water demands and allocation

Agricultural use efficiencies and reductions

Ecosystem demand management

Urban water use efficiencies and reductions

Recreation water use efficiencies

## Incentives to work well together

Pricing

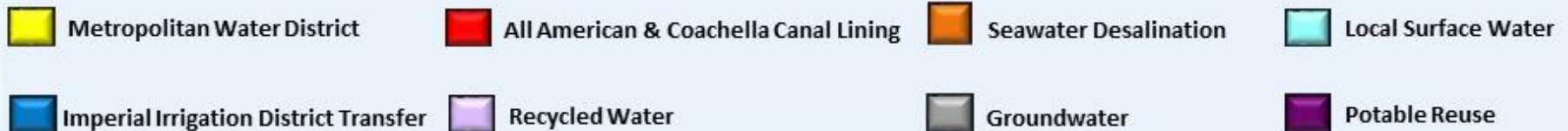
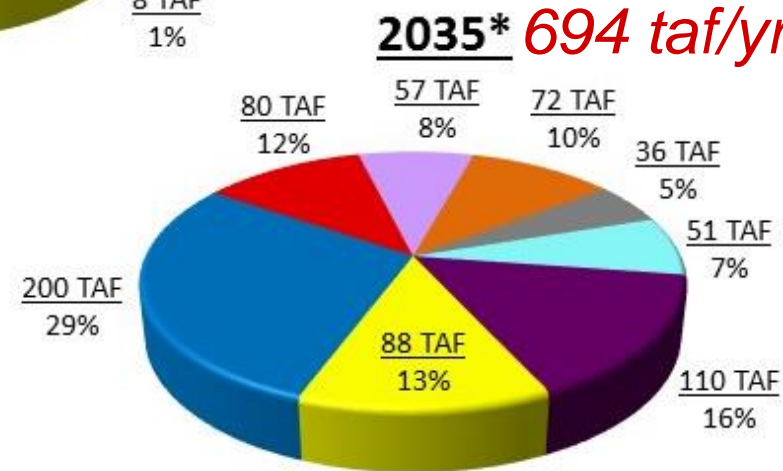
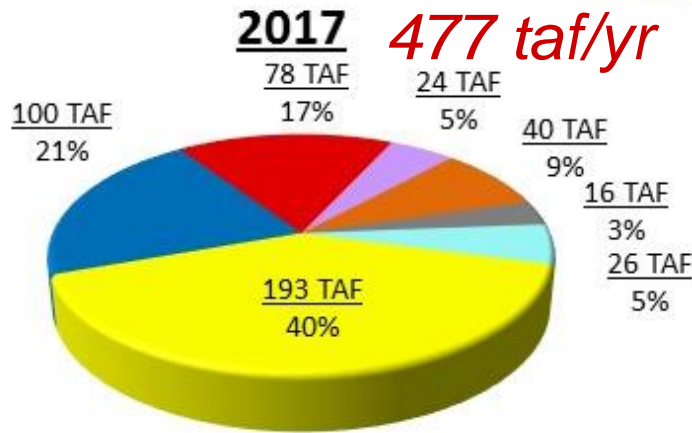
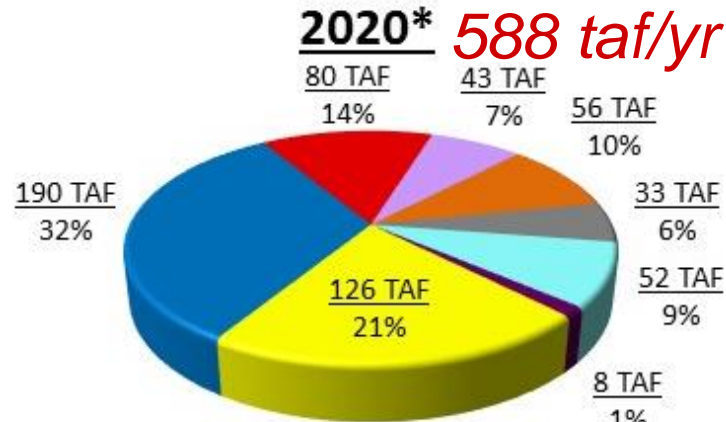
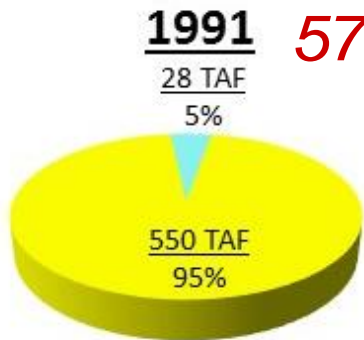
Subsidies, taxes

Markets

Education

“Norming”, shaming

# San Diego water supply portfolio



\* Includes verifiable and additional planned local supply projects from 2015 UWMP

(TAF=Thousand Acre-Feet)

# Flood management- portfolio of actions

## Preparatory actions

### Protection

Levees  
 Flood walls and doors  
 Closed conduits  
 Channel improvements and flood corridors  
 Reservoirs  
 Bypasses  
 Sacrificial flooding  
 Flood easements (bypasses, designated flood areas)  
 Local detention basins, drainage, and pumps  
 Regular inspections, assessments, and maintenance

### Vulnerability reduction (reduced damage and casualty potential)

Relocation of vulnerable human activities  
 Floodplain zoning and building codes  
 Floodproofing—raising structures, sacrificial first floor, flood doors  
 Flood warning and evacuation systems  
 Flood insurance and reinsurance  
 Flood risk disclosure  
 Public and policymaker education  
 Flood preparation and training exercises  
 Floodplain mapping, gaging, data collection  
 Community engagement and multi-hazard planning

## Response actions

Levee and flood wall monitoring  
 Flood fighting—sandbagging, sheet pile installation, wave wash protection, splash cap installation, ring levee construction, relief cut, pumping, and breach closure  
 Flood door closure and gate operation  
 Reservoir operation—including coordinated operations, rule curve operations and encroachment, flash board installation, surcharging

Warnings, evacuation calls, and emergency mobilization  
 High water staking

## Recovery actions

Reconstruction and repair of flood infrastructure

Flood damage assessment—flood infrastructure surveys, system performance, damage, response costs  
 Flood insurance and reinsurance  
 Reconstruction and repair  
 Relocation/reconstruction to reduce future vulnerability



# Water Quality Management Portfolio

<b>Multiple-barriers Infrastructure</b>	<b>Institutional Accountability</b>
1. Banned chemicals, activities	Local water utility, elected boards
2. Water source protection	Public health agencies
Rivers, reservoirs	State regulators
Aquifers	Federal regulators
3. Treatment	Professional societies
5. Distribution system	Universities
6. Public health system	NGOs

# Building an Integrated Ecosystem Portfolio?

## Salmon Life-cycle support

- Ocean harvesting
- Return spawners
- Eggs
- Rearing juveniles
- Return to sea

Population only as strong as its weakest stage

Assets and organization to give support, flexibility, and accountability.

## Institutional support

- Local groups
- Local government
- State government
- Federal government
- NGOs
- Professional societies
- Organized science & education
- Funding for each level
- Common framework

# Elements of an Effective Problem Management Portfolio?

1. Substantial consensus on problem, objectives, organization, and responsibilities
2. Substantial, reliable resources (\$)
3. Mutually reinforcing institutions – local, state, federal, professional, educational
4. Accountability for each institution (\$, votes)
5. Data, analysis, and document availability
6. Outside research, analysis, and education

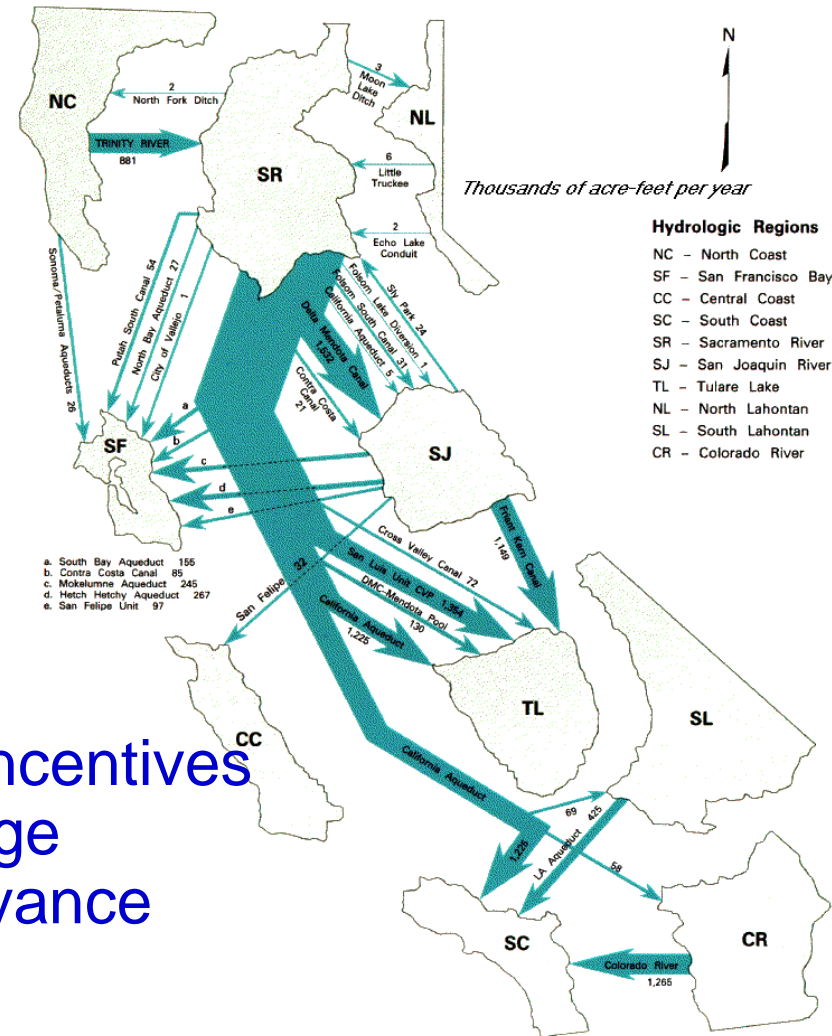
# Local and Statewide Portfolio

## Local Activities:

- Conservation and use efficiency
- Wastewater reuse
- Desalination (brackish & ocean)
- Groundwater use and recharge
- Surface reservoir operations
- Water markets and exchanges

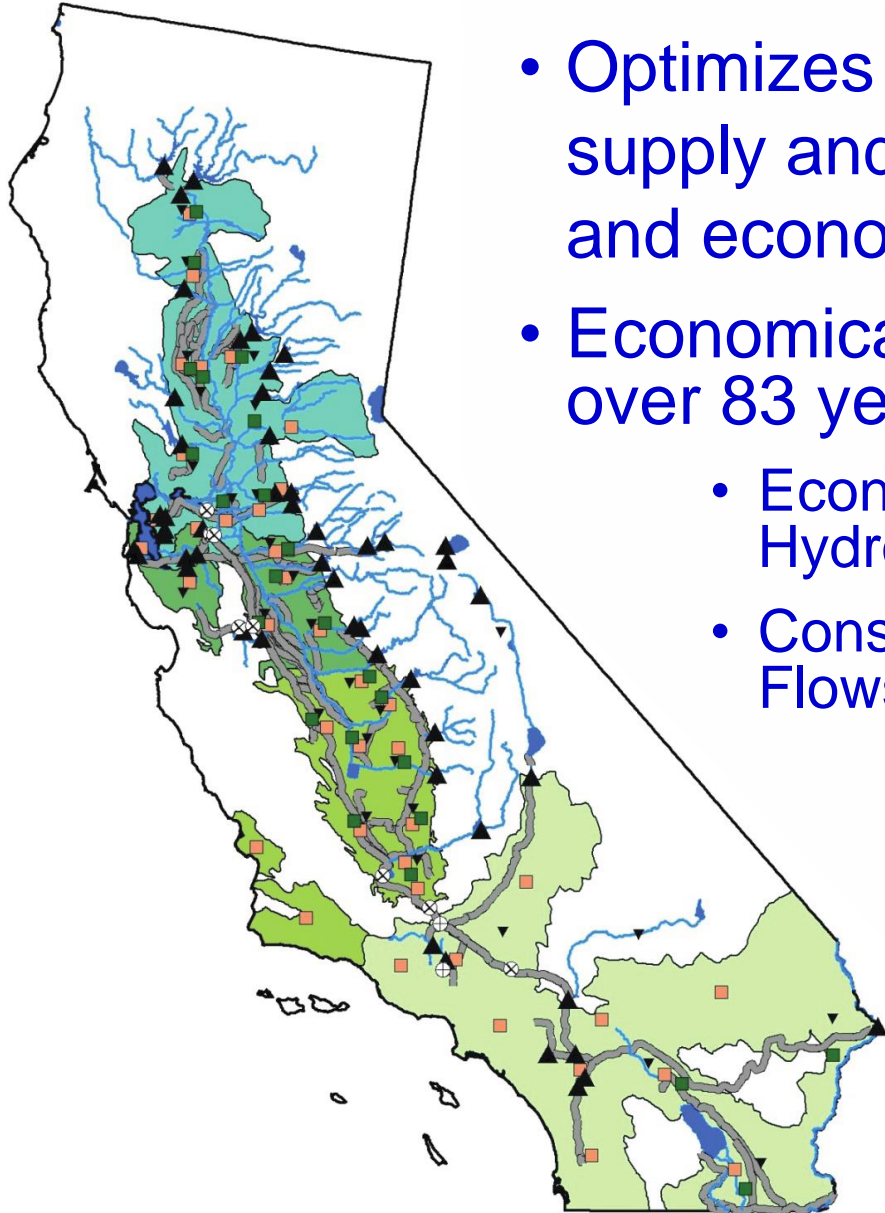
## Statewide Activities:

- Inter-regional water conveyance
- Surface reservoir operations
- Plumbing codes & conservation incentives
- Groundwater banking and recharge
- Water market support and conveyance
- Wastewater reuse subsidies



Integrating mix of actions – portfolio planning

# CALVIN Water Supply Model

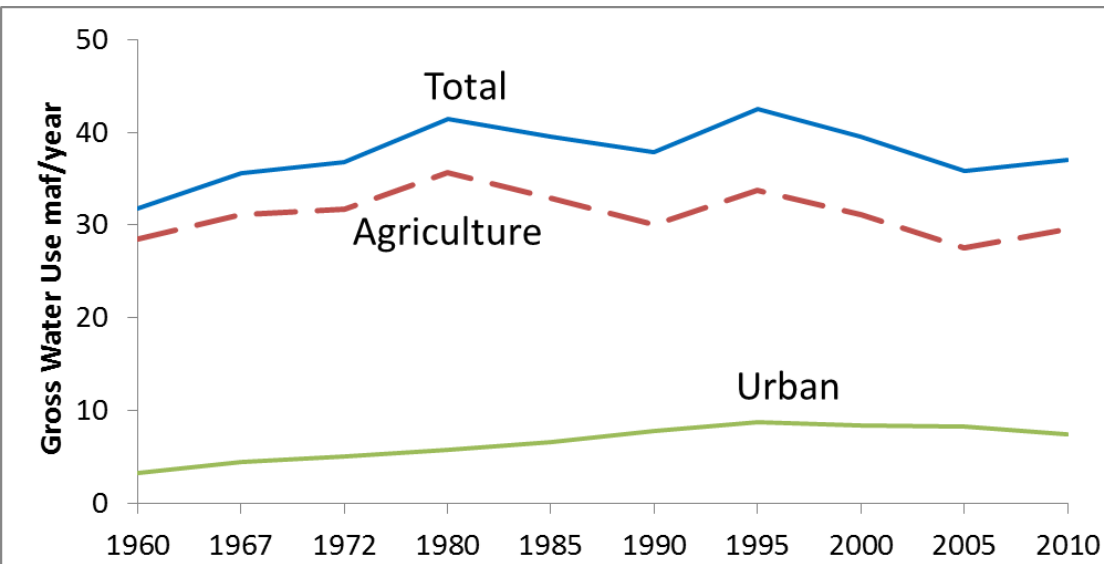


- Optimizes portfolio of many (not all) supply and demand management options and economic values
- Economically optimizes portfolio by month over 83 years of hydrology
  - Economic values for Agricultural, Urban, & Hydropower Uses, and operating costs
  - Constraints for Environmental Uses and Flows

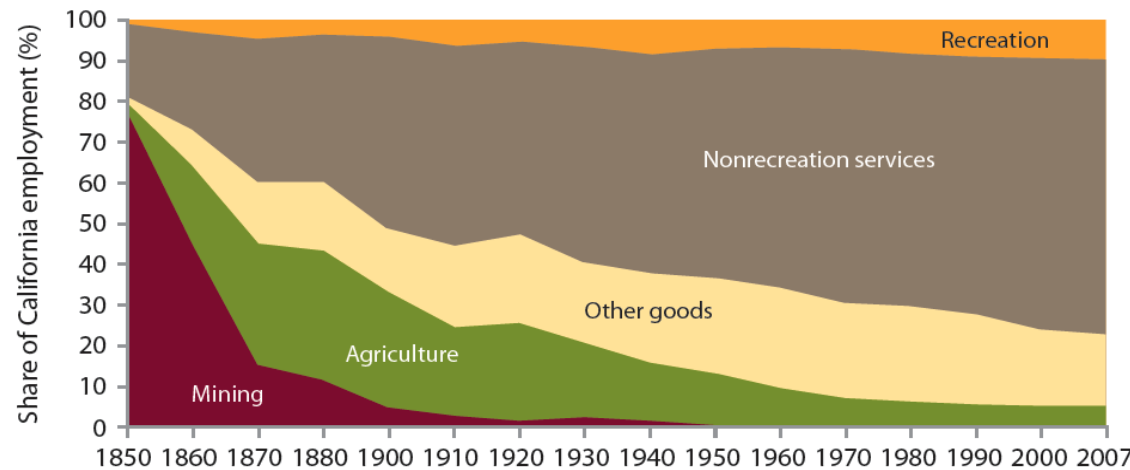
Forces quantitative understanding of integrated water and economic system

Value of water & infrastructure

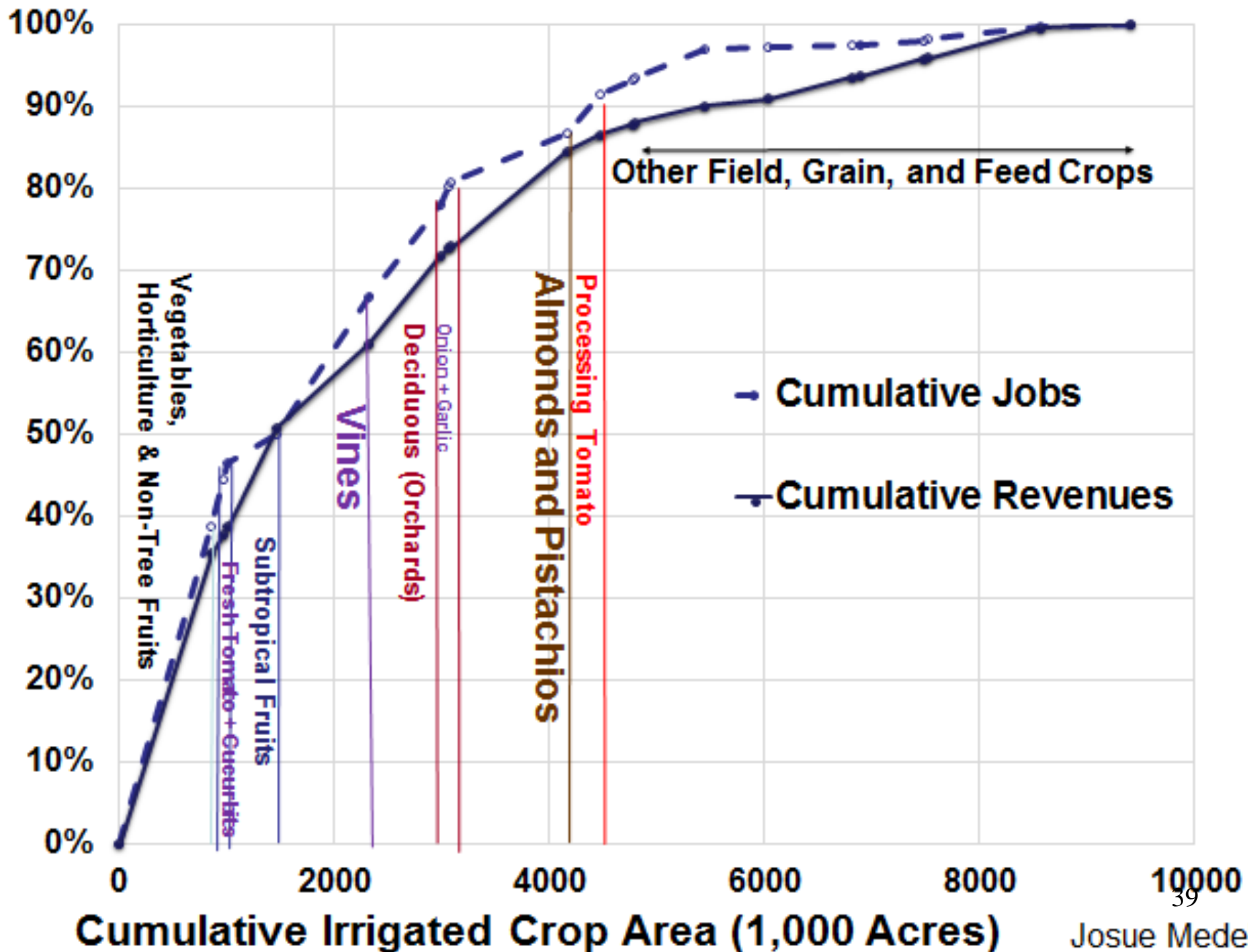
# Reasons for Hope



- 1) Human water use peaked?
- 2) Economy depends less on water abundance
- 3) Water markets can shift use and civilize change
- 4) We agree we have a problem

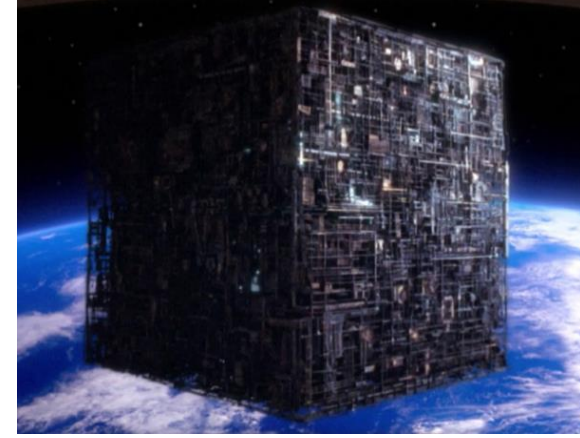


# Cumulative Jobs and Revenues



# Resistance is Futile

- 1) Flooding in parts of the Delta
- 2) Reduced Delta diversions
- 3) Less irrigated land in the southern Central Valley
- 4) Less urban water use, more reuse & storm capture
- 5) Some native species unsustainable in the wild
- 6) Funding solutions mostly local and regional
- 7) State's leverage is mostly regulatory, not funding
- 8) Nitrate groundwater contamination is inevitable
- 9) Groundwater will be managed more tightly
- 10) The Salton Sink will be largely restored

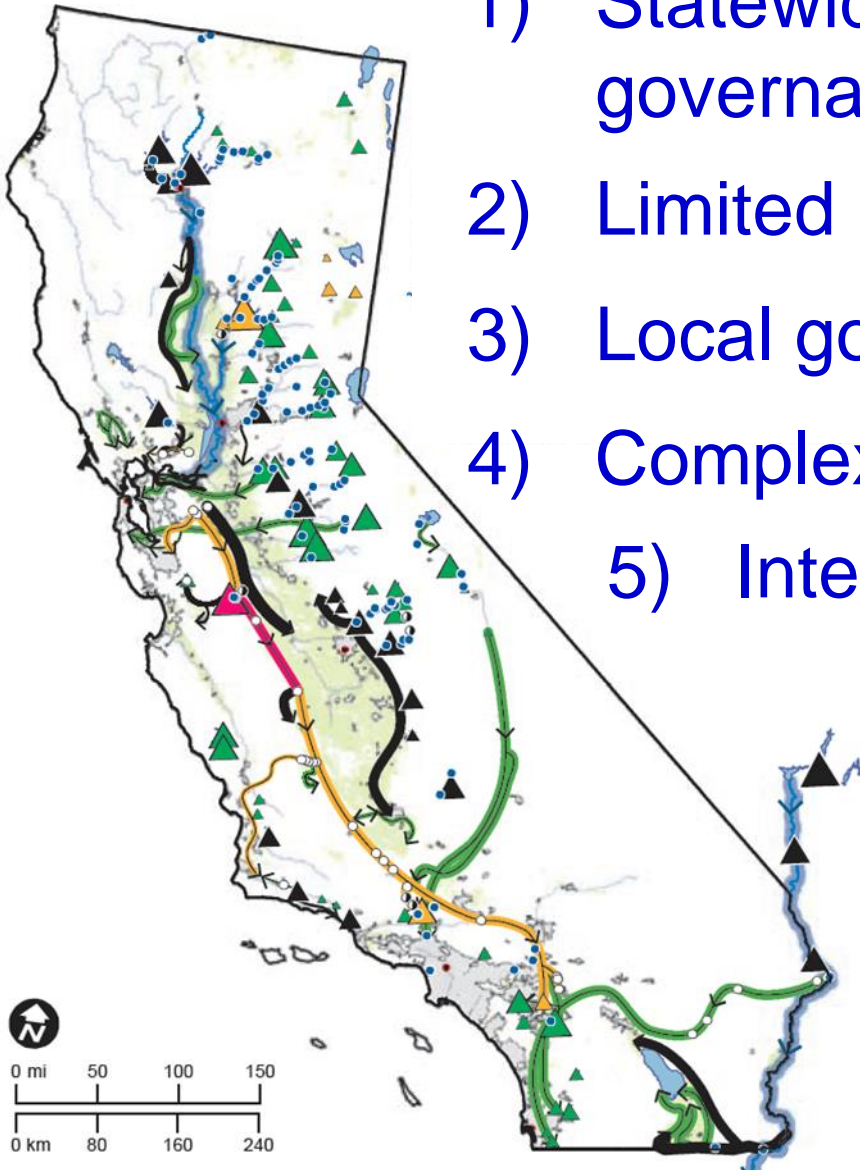


We cannot drought-proof, but we can manage better.

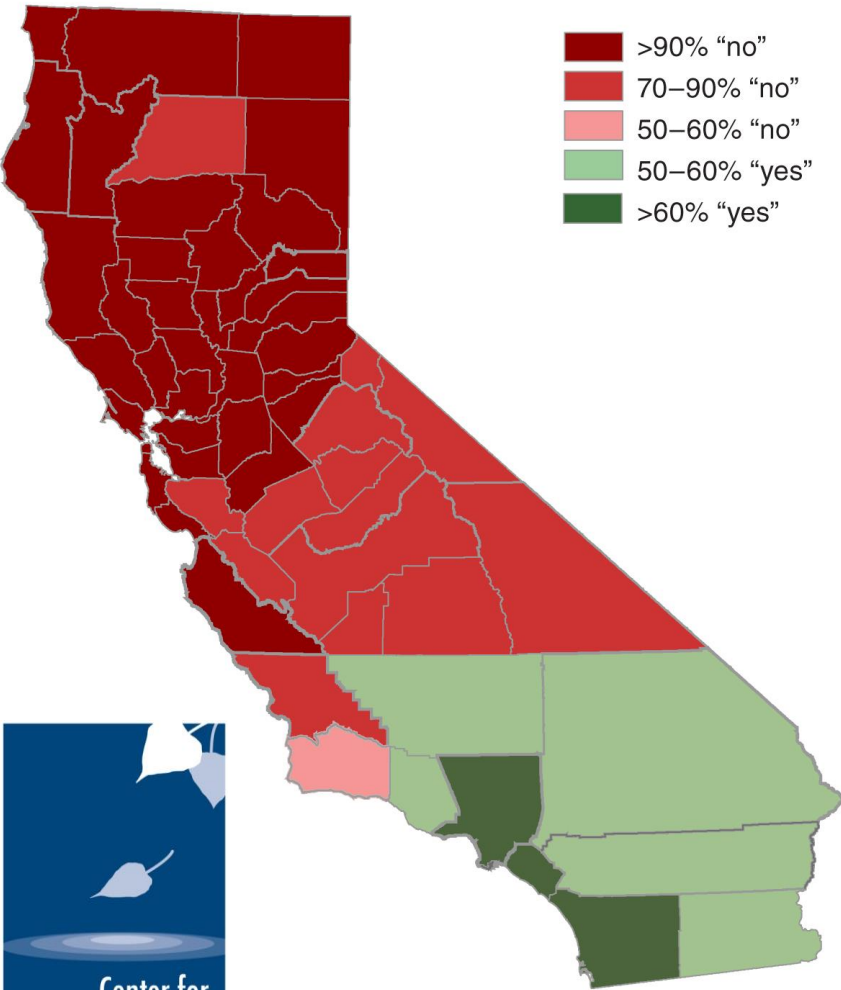


# Conclusions

- 1) Statewide water system, with local governance and fragmented regulation
- 2) Limited State and Federal abilities
- 3) Local government is most important
- 4) Complexity enriches possibilities
- 5) Integrated portfolios are the future
- 6) Nature and economics eventually prevail over indecision and existing law
- 7) Universities can help



# Suggested Readings



Hanak et al. (2011) *Managing California's Water*, PPIC.org

Hanak et al. (2010) *Myths of California Water*, PPIC.org

Hundley (1992), *The Great Thirst*, UC Press.

Kelley (1989), *Battling the Inland Sea*, UC Press.

Lund et al. (2010) *Comparing Futures for the Sacramento San Joaquin Delta*, UC Press

Lund et al. (2018) "Lessons from California's 2012-2016 Drought"

Pisani (1983), *From Family Farms to Agribusiness*, UC Press

MavensNotebook.com

CaliforniaWaterBlog.com

