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Energy/Water Sustainability

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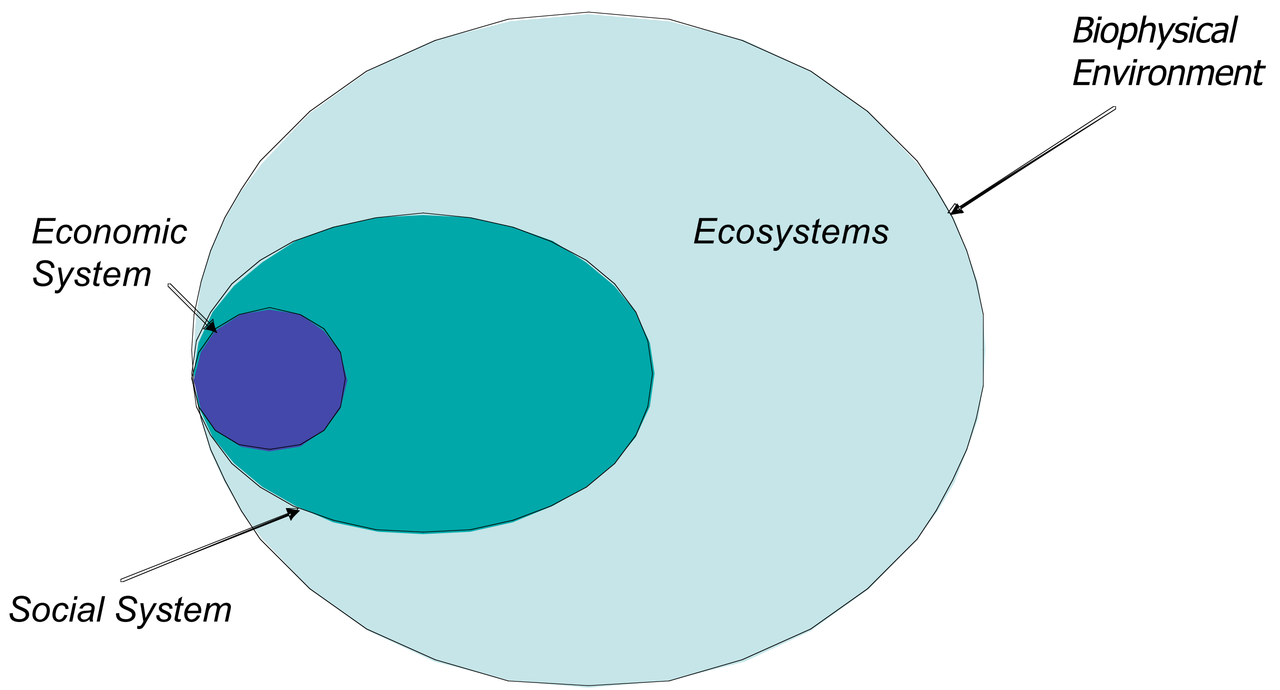
System Perspective

Essential Relationships of Sustainability



Source: Sustainable Water Resources Roundtable

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Big Picture

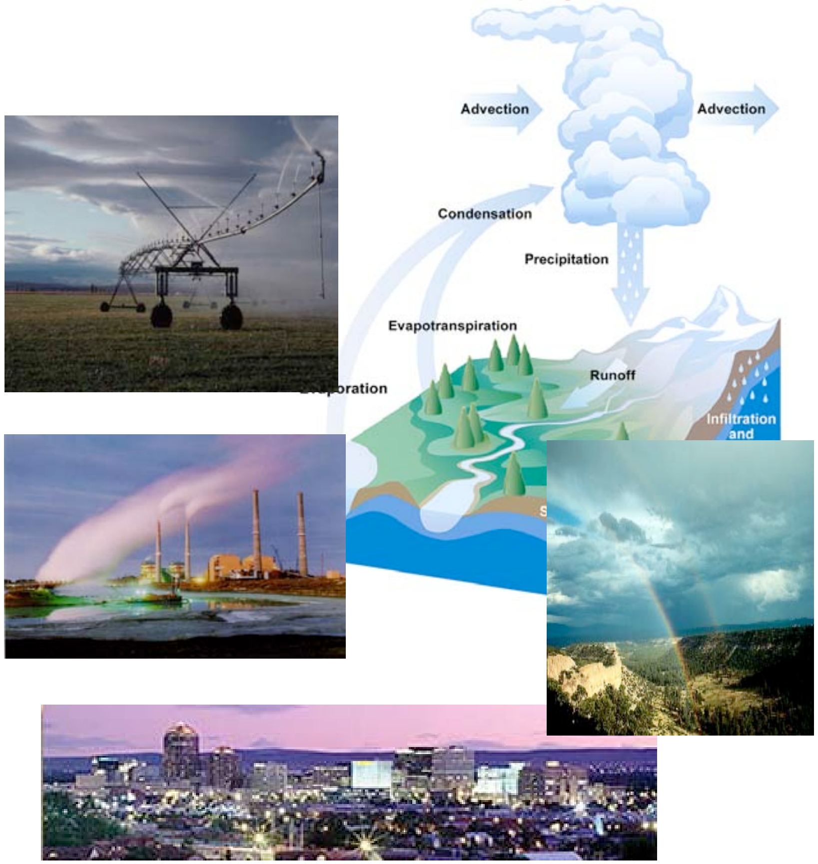
- Water is a shared community resource
- Community social and economic vitality depend on water and electricity availability
- Demand for both are increasing and are inter-related
- Water resource management requires broad stakeholder consensus
- Energy/water sustainability is a real and high priority issue for United States

Water Is a Critical Resource

- Fast growing demand for clean, fresh water
- Increased demand for environmental protection and enhancement
- Unknown impacts of climate variability/change
- All regions of US vulnerable to water shortages

Consequences of Growing Electric Power and Water Demands

SUPPLY



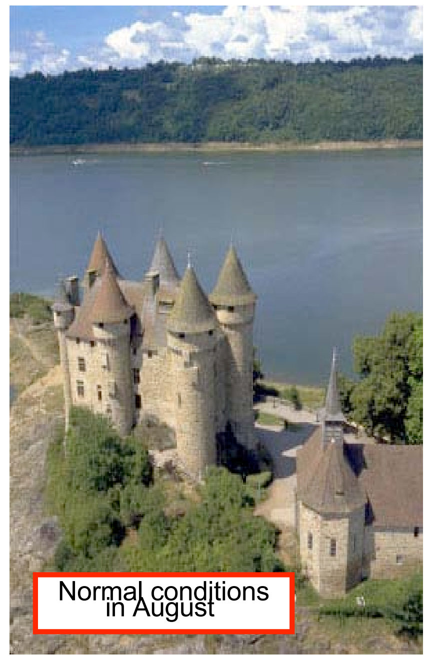
DEMAND

- Pressure on electric power sector to use less water
- More intensive management of water resources
- Greater integration between water and energy planning
- Emphasis on watershed/regional planning
- Demand for new science and technology to support planning and management needs

2003 Heat Wave Impact on French Generation System

- Loss of 7 to 15% of nuclear generation capacity for 5 weeks
- Loss of 20% of hydro generation capacity
- Purchase of large amount of electricity on wholesale power market
- Large-scale load shedding and shut off transmission to Italy
- Sharp increase in spot-market prices: 1000 to 1500 $/MWh for most critical days

Bort-les-Orgues Reservoir



Normal conditions in August

August 27, 2003

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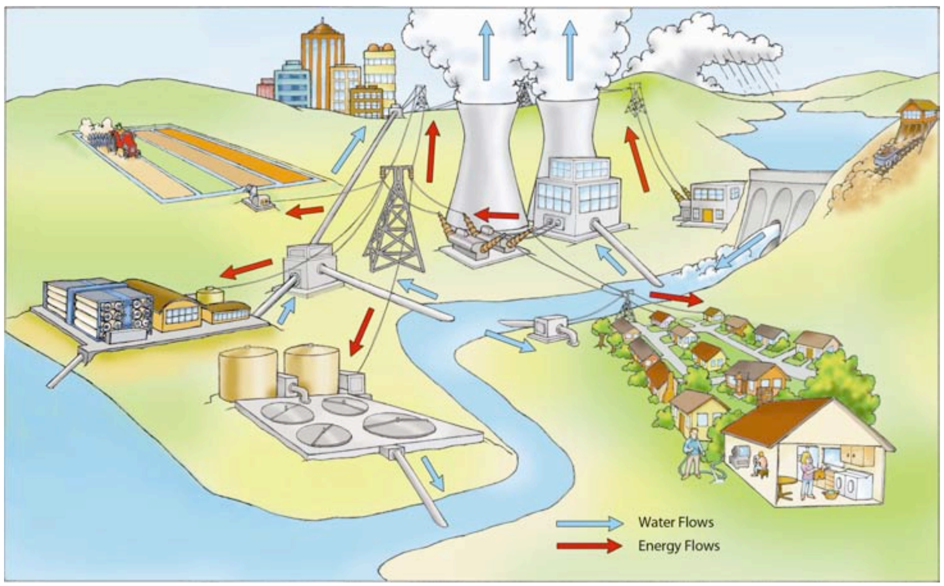
Approaches to Reaching Sustainability



- Top down
  - Watershed-based
  - Considers all stakeholder demands
  - Matches aggregate water demands to supply
  - Future projections
- Bottom up
  - Facility-based
  - Objectives
    - Increased water use efficiency
    - Conservation

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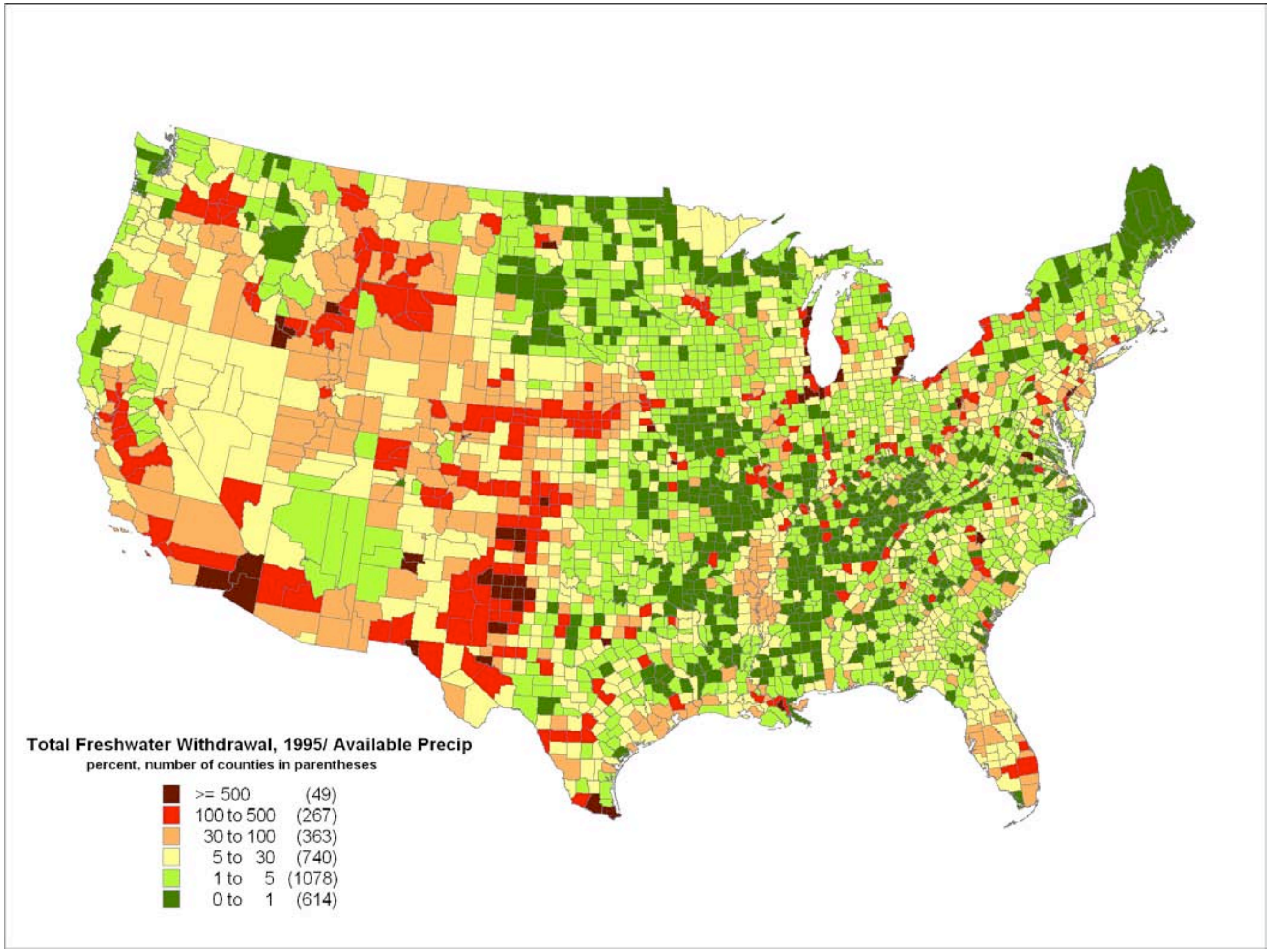
Total Freshwater Withdrawal/Available Precipitation



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Thermoelectric Power Plant Strategies to increase Water Use Efficiency and Reduce Freshwater Use

- Dry/hybrid cooling
- Recycle water within plant
  - Increase closed cooling cycles
  - Treat blowdown and reuse
  - Capture vapor produced in wet cooling tower
- Use degraded/reclaimed waters
- Increase thermal conversion efficiency

Pilot Spray Enhancement Testing
Crockett Cogeneration Station

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Solving the problem
Requires Science and Technology

Demonstration,
Test Beds, Outreach

Policy, Economic and
Market Analysis

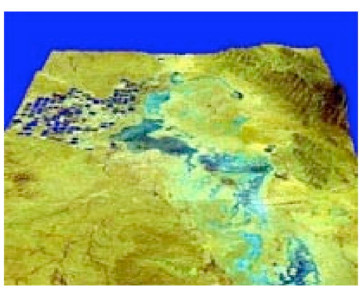
Prediction &
Decision Support

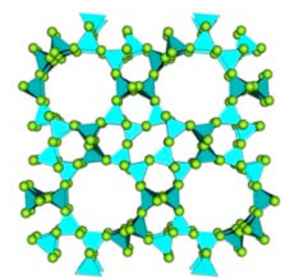
Monitoring &
Measurement
Science
&Technology

Advanced
Cooling Technology

Conservation, Efficiency
& Renewables

Degraded Water
Treatment and Use
Technology





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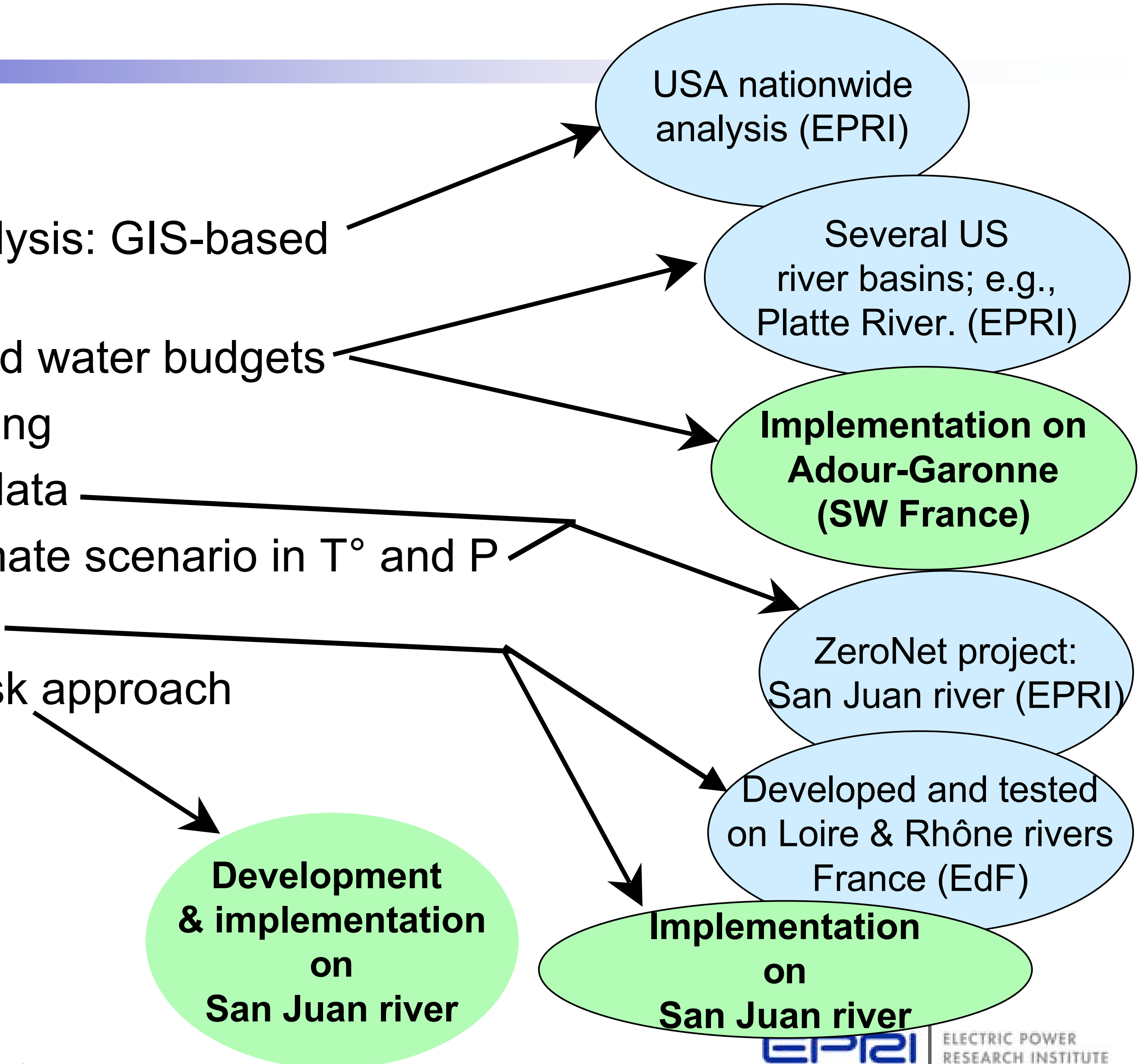
Tiered Approach: Water Resource Assessment and Management

1 : Scoping level analysis: GIS-based indicators

2 : Detailed watershed water budgets

3 : Watershed modeling

- 3.1 Real weather data
- 3.2 Postulated climate scenario in T° and P
- 3.3 GCM forcing
- 3.4 Probabilistic risk approach



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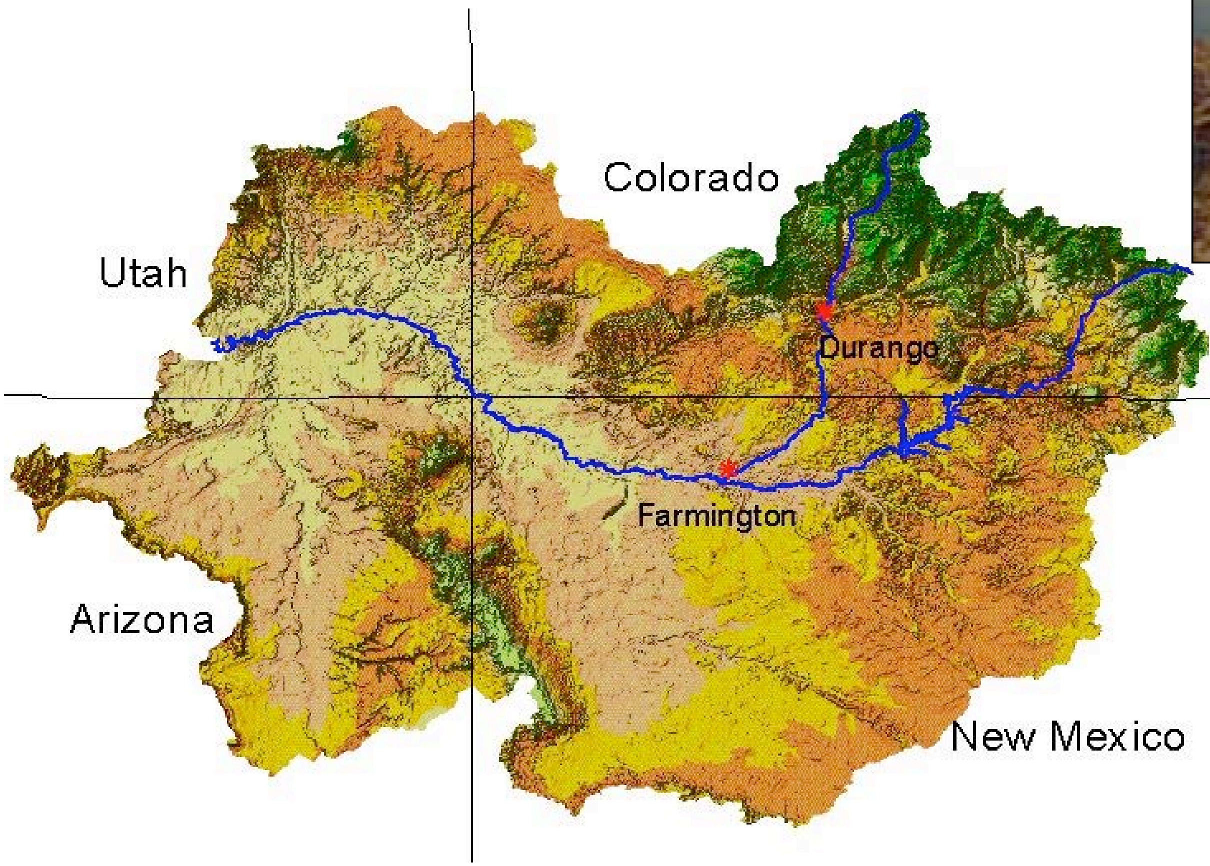
Water Availability Assessment - San Juan Basin Using WARMF Watershed Model



Navajo Reservoir

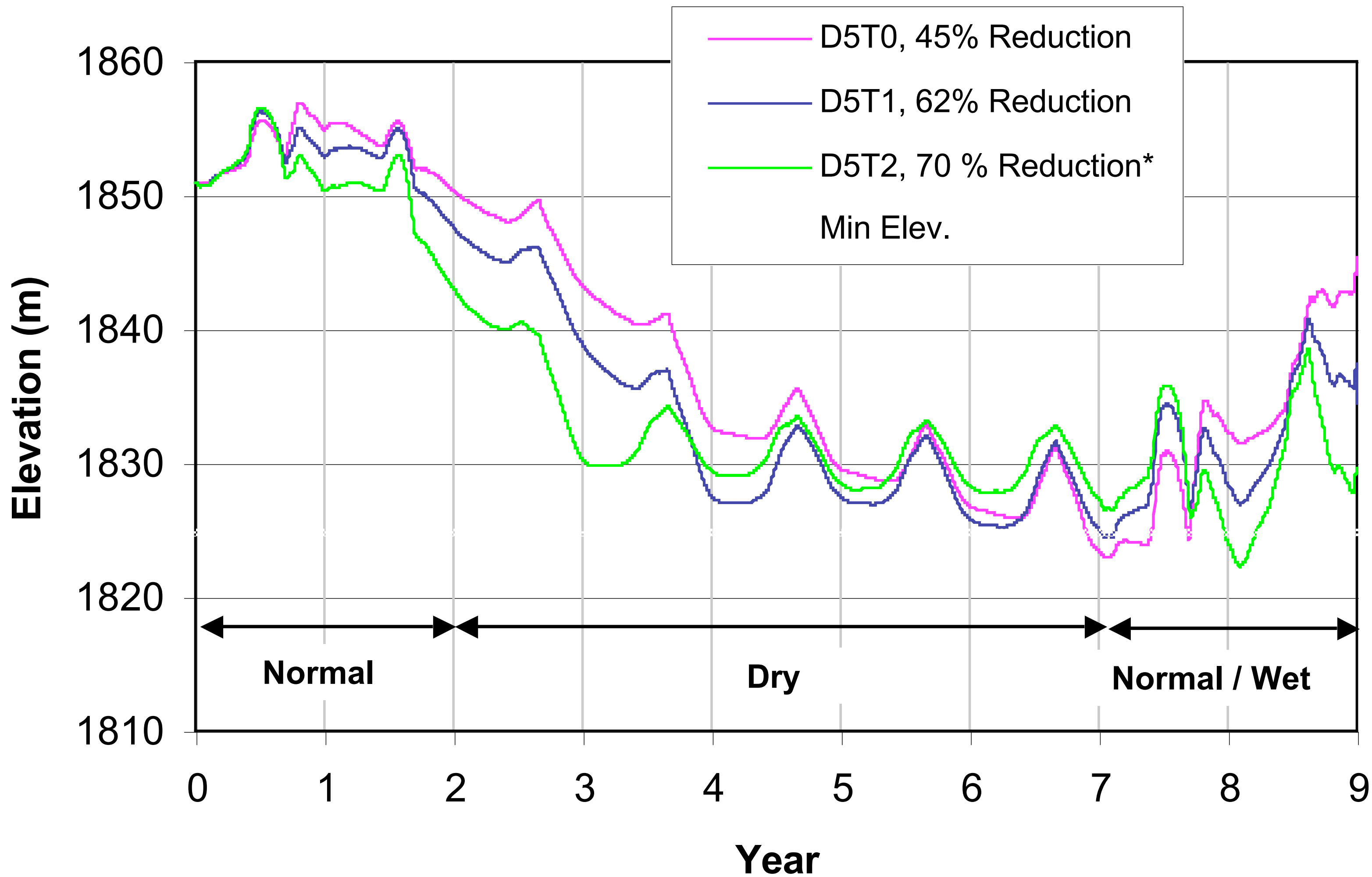
Drought/Temperature Change Scenarios

Examine impact of drought and temperature increase on water supply

Scenarios	Temp Increase (°C)	Drought Length (yr)
D3T0	+0	3
D3T1	+1	3
D3T2	+2	3
D5T0	+0	5
D5T1	+1	5
D5T2	+2	5

- 6 Scenarios
- 50 iterations per scenario (for convergence)
- Sampling random pattern of drought years

Navajo Reservoir Elevation - 5 Year Drought



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Reservoir Adjustment Summary

Volume Held Back in Reservoir				
Scenarios	**% Reduction**	**Volume Held (AF)**	**Volume Held (AF/yr)**	**# of Years**
D3T0	18	86,786	86,786	1
D3T1	65	314,010	314,010	1
D3T2	70	689,548	344,774	2
D5T0	45	656,699	218,900	3
D5T1	62	896,268	298,756	3
D5T2	70	1,358,127	339,532	4

- To meet minimum elevation criteria, reservoir release had to be reduced for all scenarios
- Both temperature and drought have significant impacts
- Holding back water in reservoir creates more critical conditions downstream

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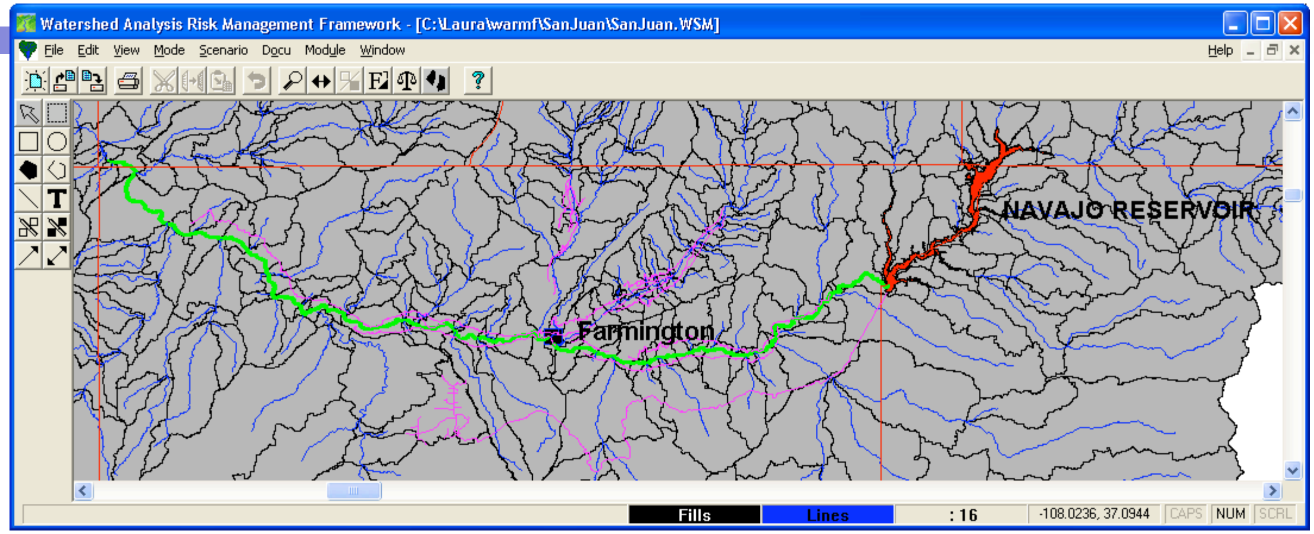
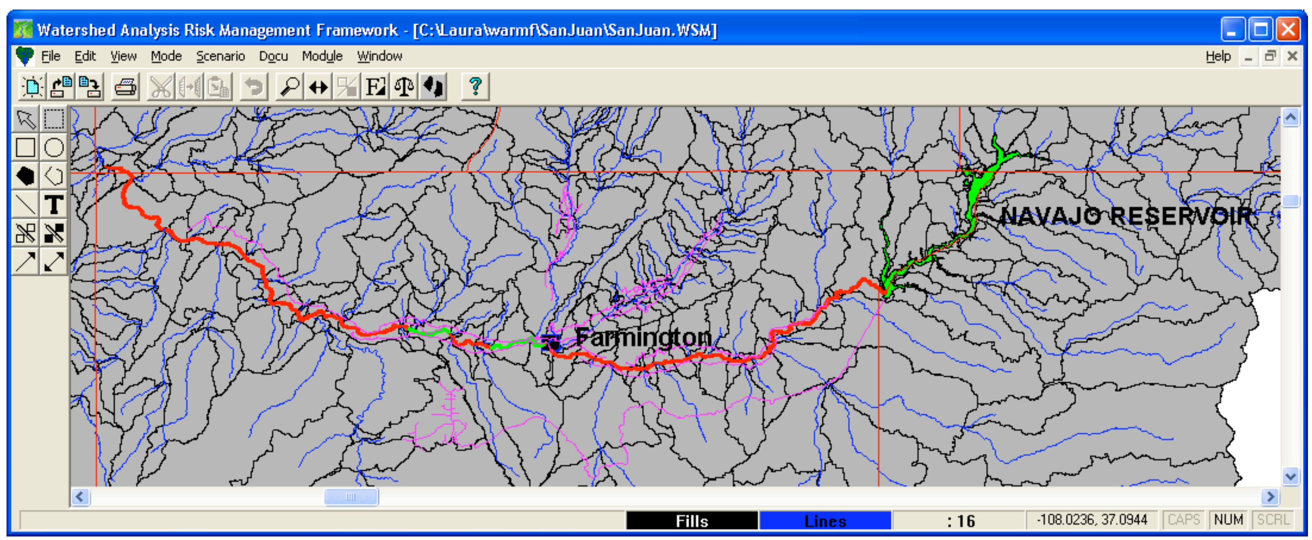
Impact of Reservoir Adjustment



No Adjustment:

- Reservoir violates minimum elevation
- SJ River meets minimum flow requirement



With Adjustment:

- Reservoir meets minimum elevation
- Most of SJ River violates minimum flow requirement

Concluding Thoughts

- Potential for increased water use efficiency and conservation
- Research can enhance potential and cost savings
- Relative benefits of individual technologies and practices are site dependent
- Value to create tool box of technologies and practices
- Increased efficiency and conservation are necessary but not sufficient conditions for sustainability
- Important to consider climate change

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