Exceptional service in the national interest

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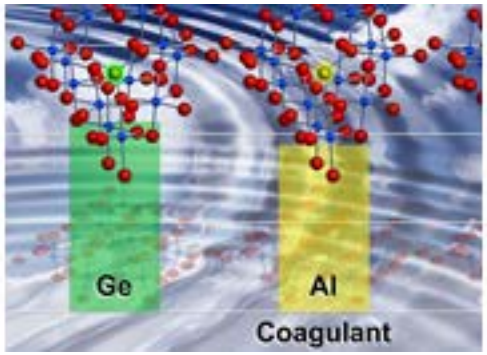

URGSiM Status Update 1.28.2014

Jesse Roach PhD Sandia National Laboratories

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

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SAND#2014-1453 P

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Upper Rio Grande Simulation Model 2013

- Upper Rio Grande Impacts Assessment
- Related analysis of SJC project reliability
- San Marcial to Elephant Butte mass balance analysis
- PCIR versus ACIR
- Mass balance interface

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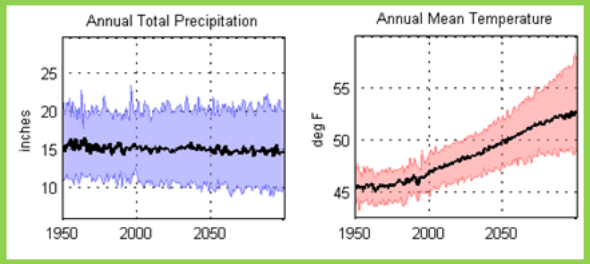
- **Upper Rio Grande (Climate Change) Impacts Assessment (URGIA)**
  - **Report on transient simulations published**
  - **The "period analysis" piece where URGWOM and URGSiM were meant to overlap is being used for the Santa Fe Basin study, and will likely be used for the Albuquerque Basin study.**
  - **The URGWOM runs that were done utilized input data that had problems with it, and so are not useable.**

Transient Simulation Methodology

112 runs
1950-2099

General Circulation Model (GCM)

112 Statistically Downscaled Regional Projections of ΔP and ΔT



Variable Infiltration Capacity (VIC) Model

112 Runoff Projections Using Rainfall Runoff Model

Post processing bias correction of flows (224 hydrographs)

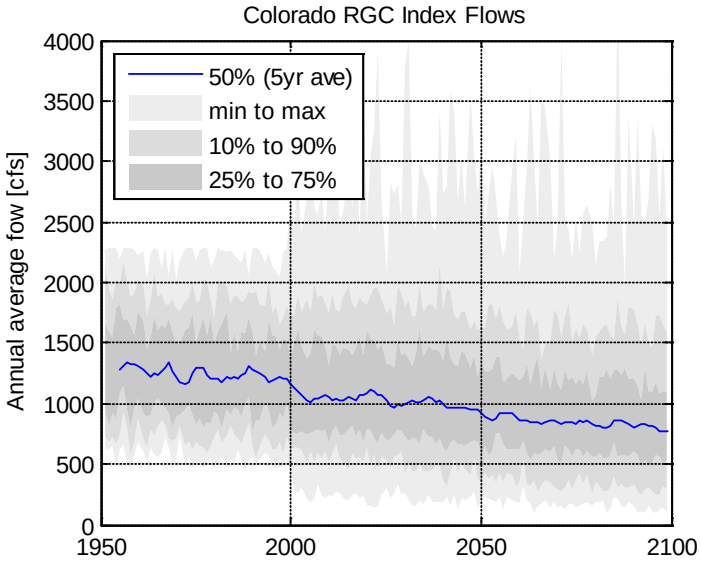
Operations model (URGSiM)

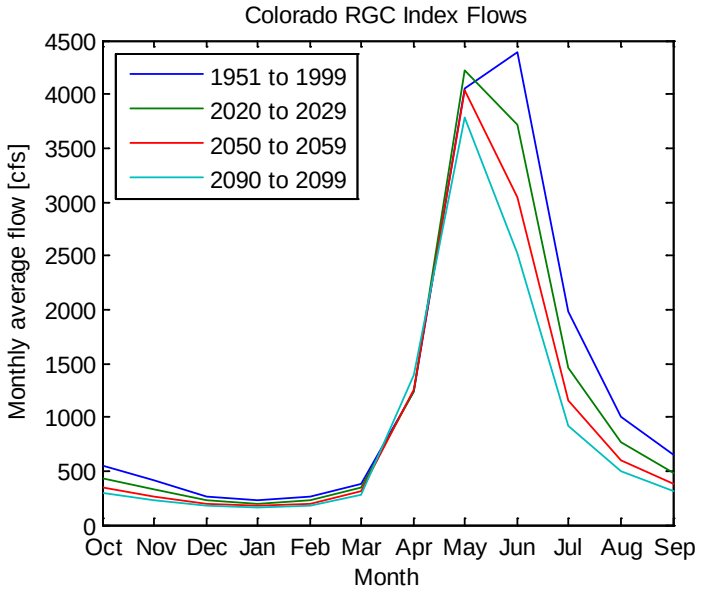
Impacts to water deliveries, flows, and reservoir levels.

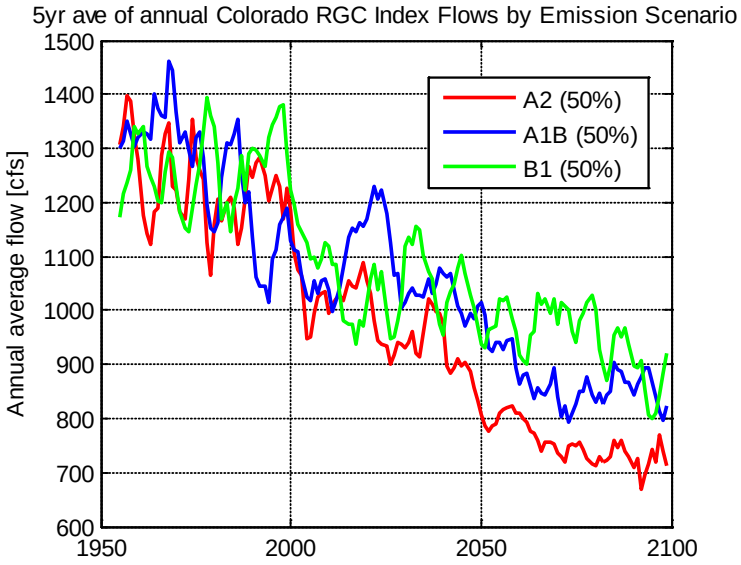
URGSiM

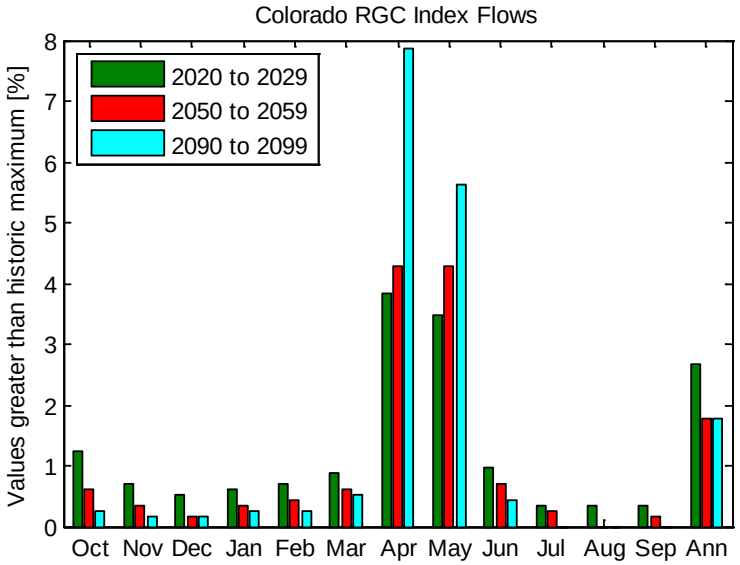
- Monthly timestep operations model of the Upper Rio Grande hydrologic system developed at Sandia National Laboratories with support from Reclamation and USACE
- Gaged flow inputs at 21 locations
- Includes regional groundwater models dynamically connected to river system.
- Includes agricultural and municipal/industrial demand, consumption, and return flows.
- Models storage and operations at 9 reservoirs

Transient results: Reduced Supply at Colorado Index Gages



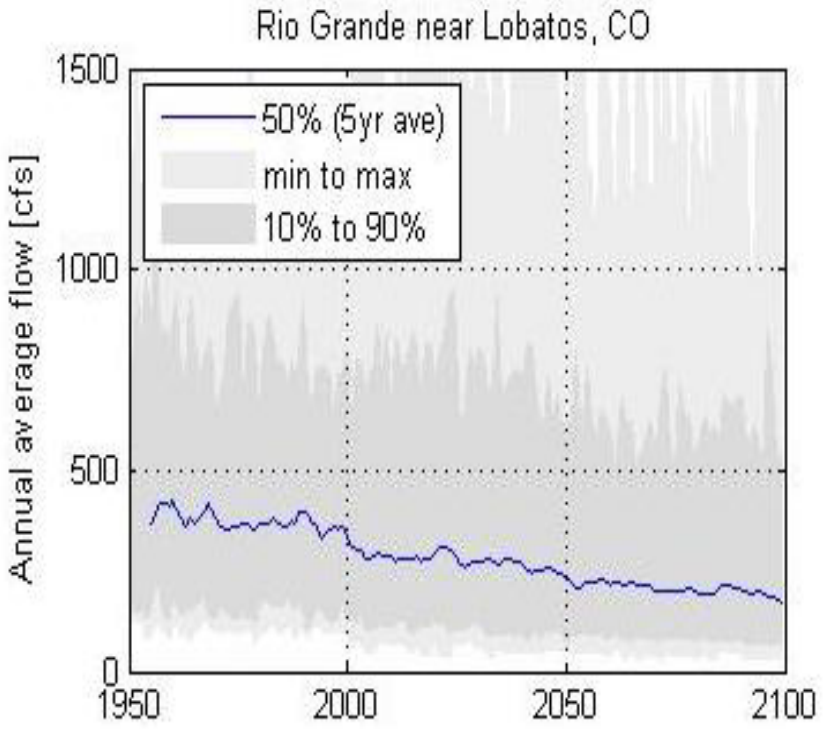


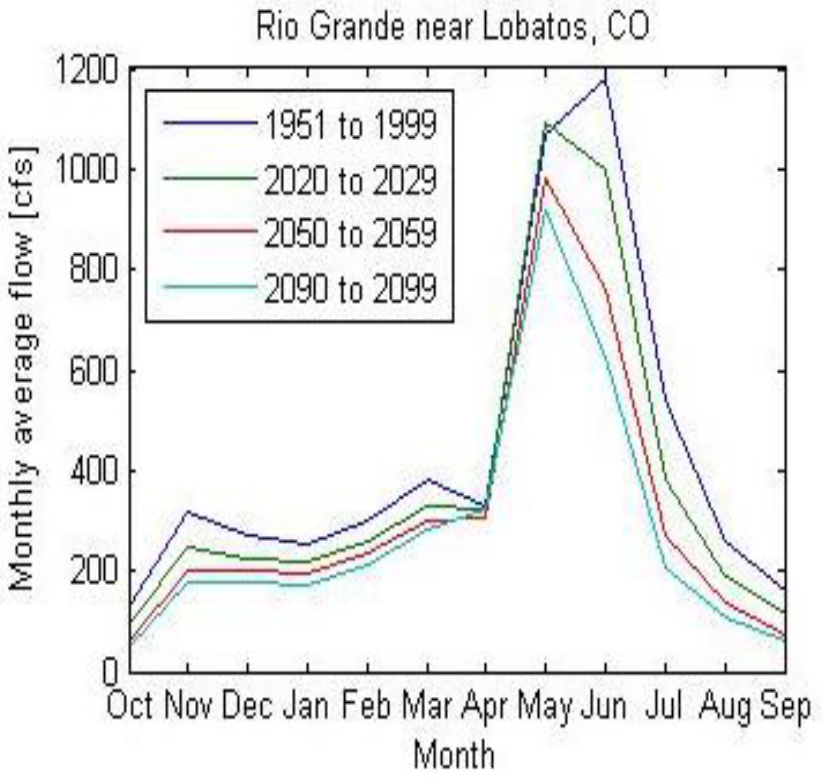




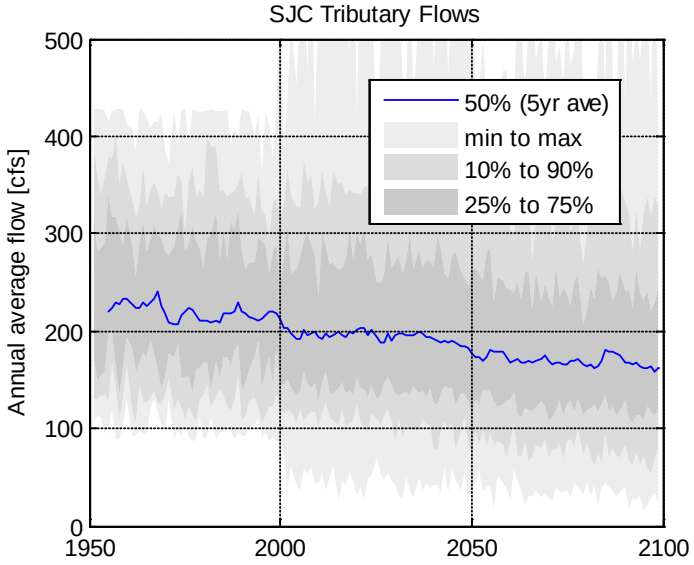
Which is magnified at Lobatos

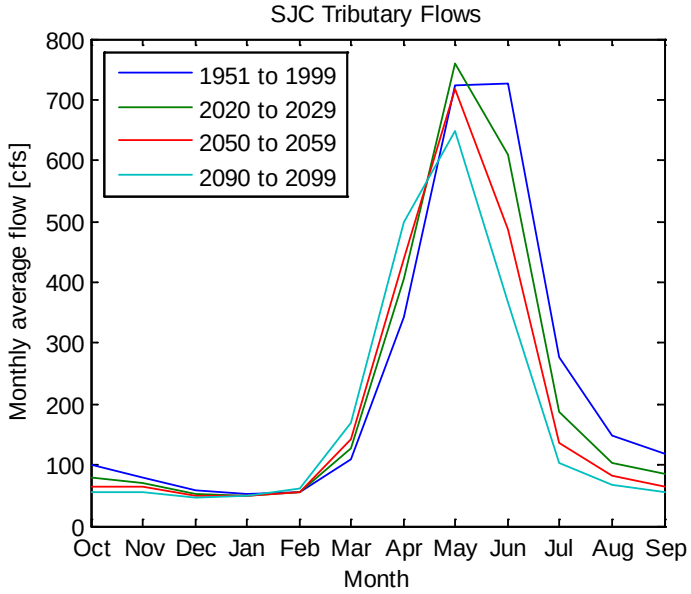
- Colorado State-Line Deliveries to New Mexico: ~ 50% median decrease, most of which occurs in June through August

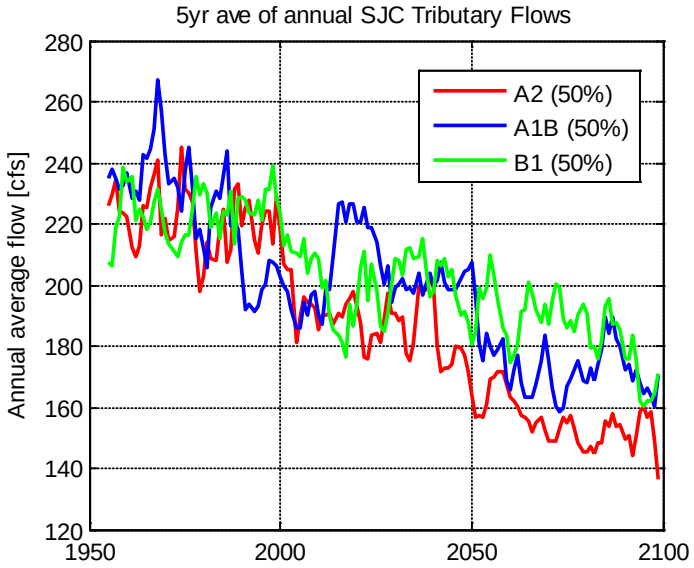


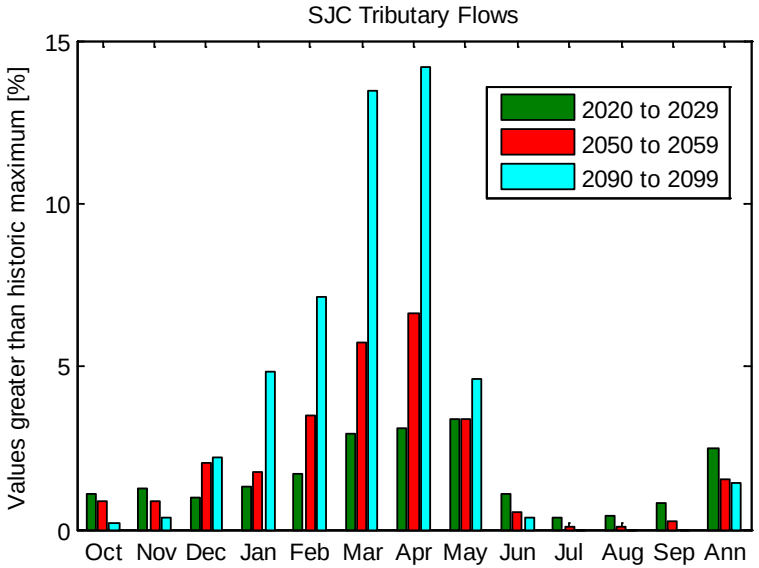


and SJC on SJ side of the divide









But reduction not as severe on Chama side of divide

- Imported water (San Juan – Chama Project). ~15% reduction

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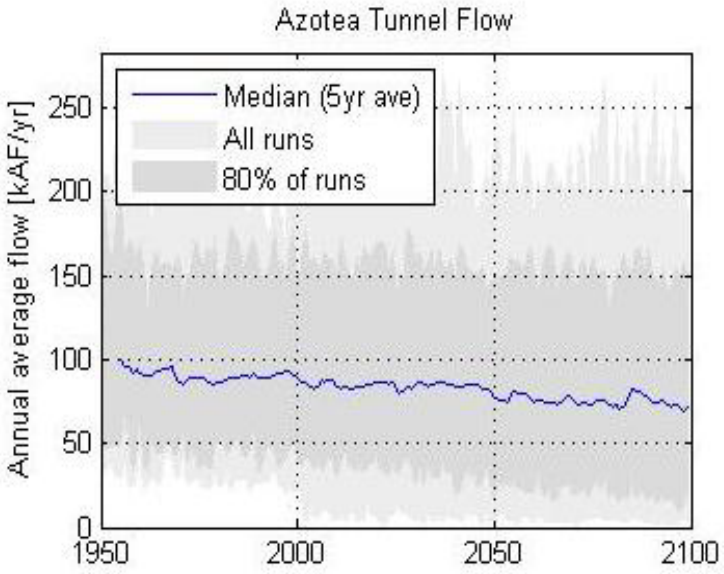
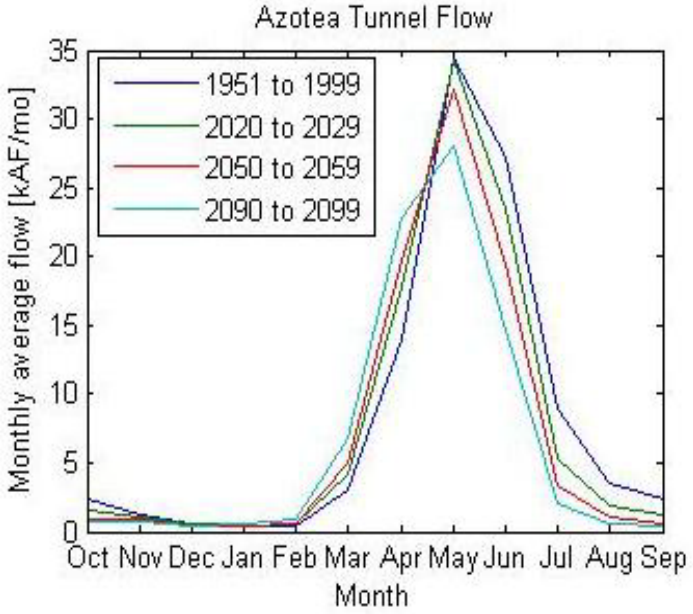
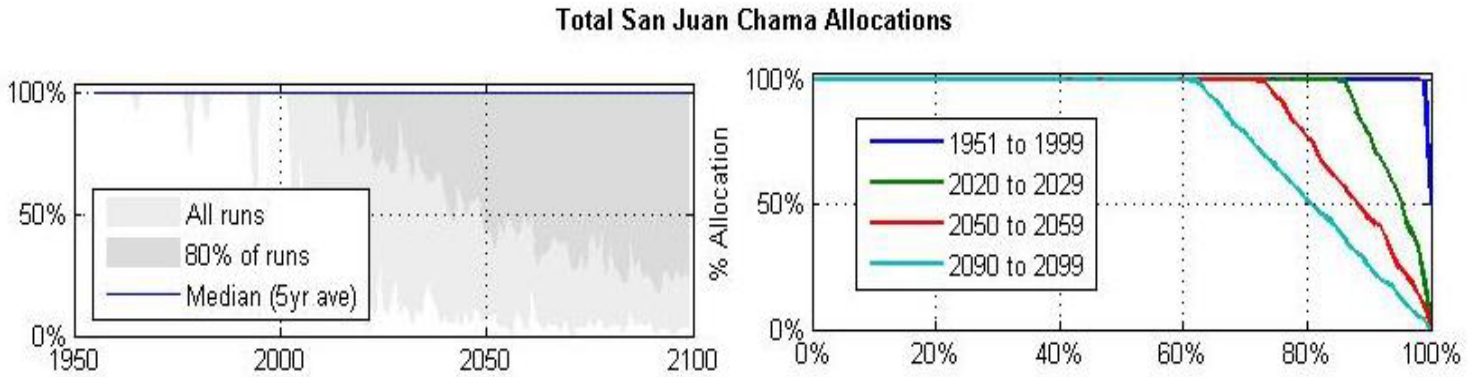
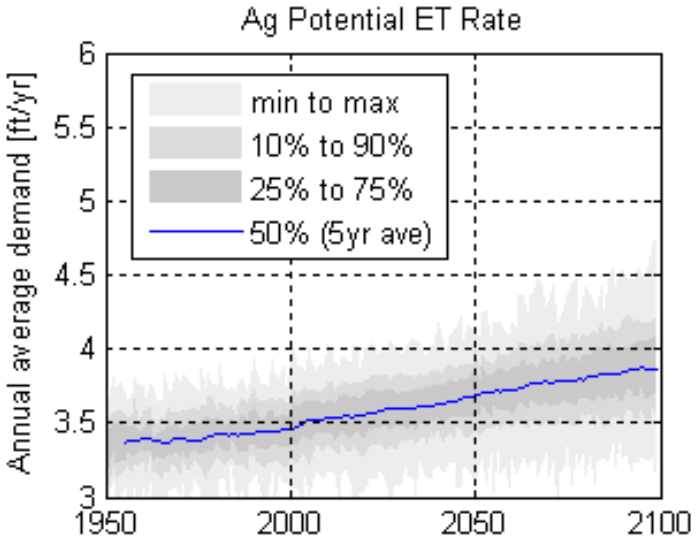
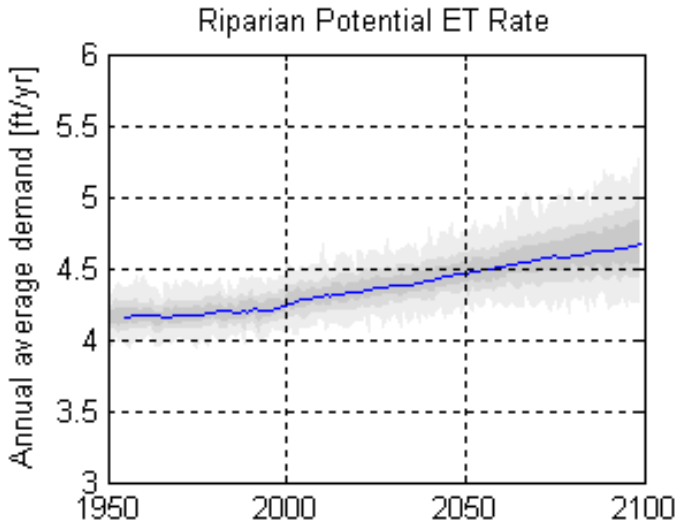


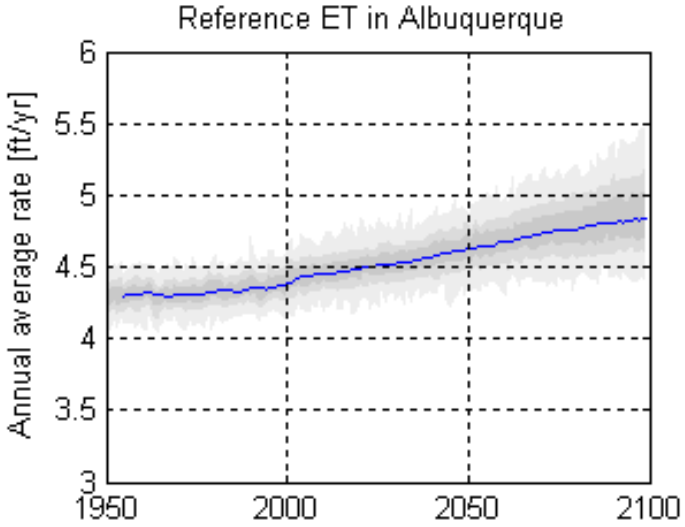


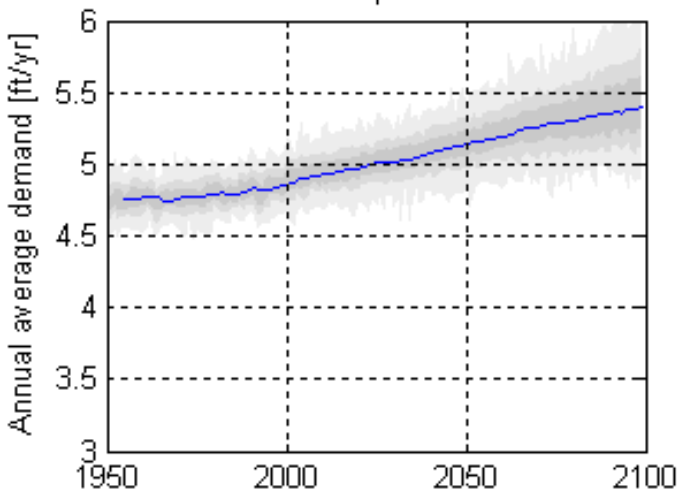


Results: Increased temperature leads to increased demand









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Results: Total consumptive use does not rise

(due to reduced availability and especially reduced reservoir area)

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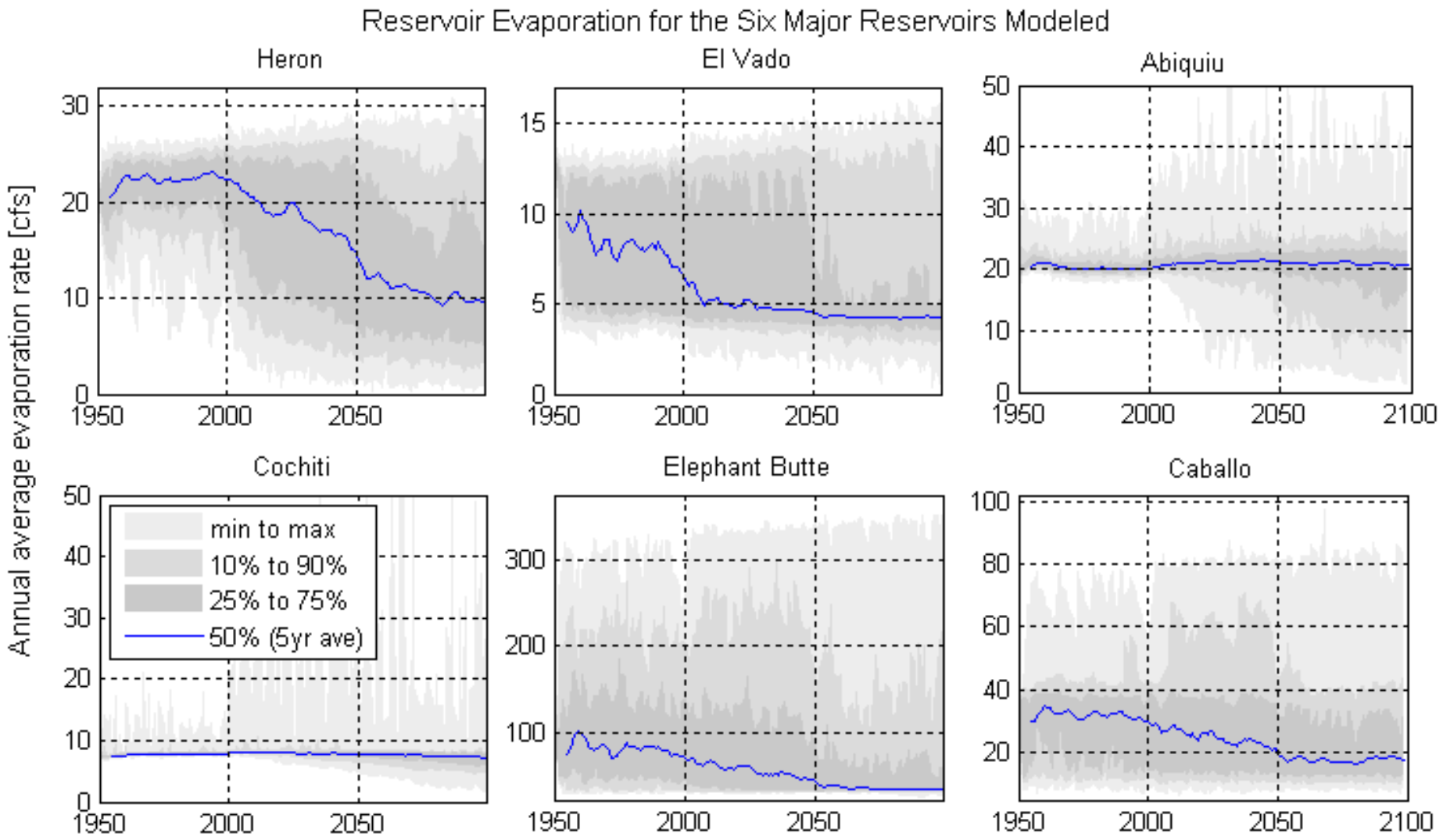
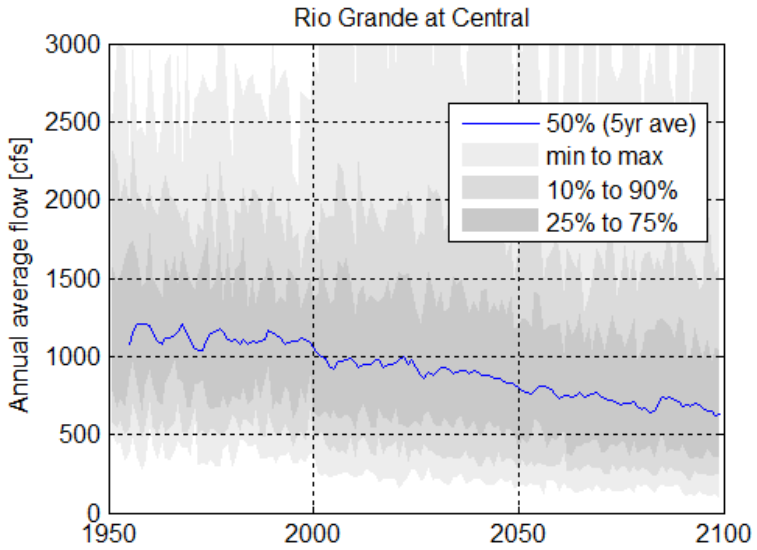
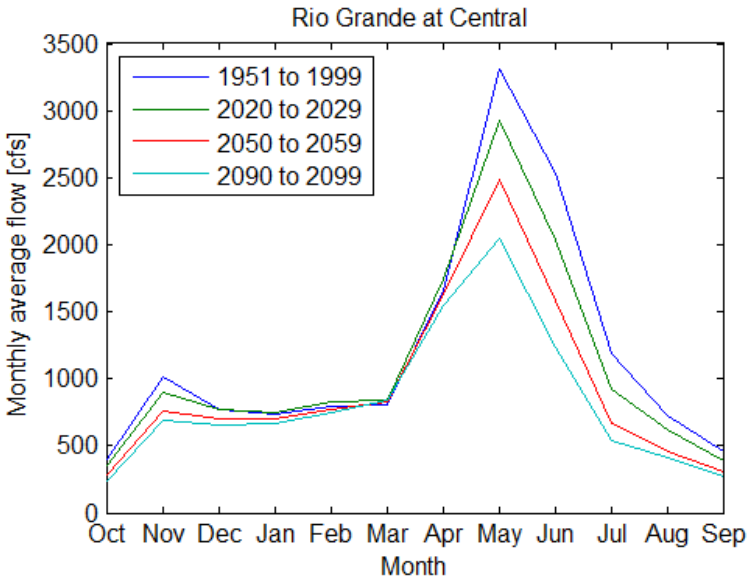
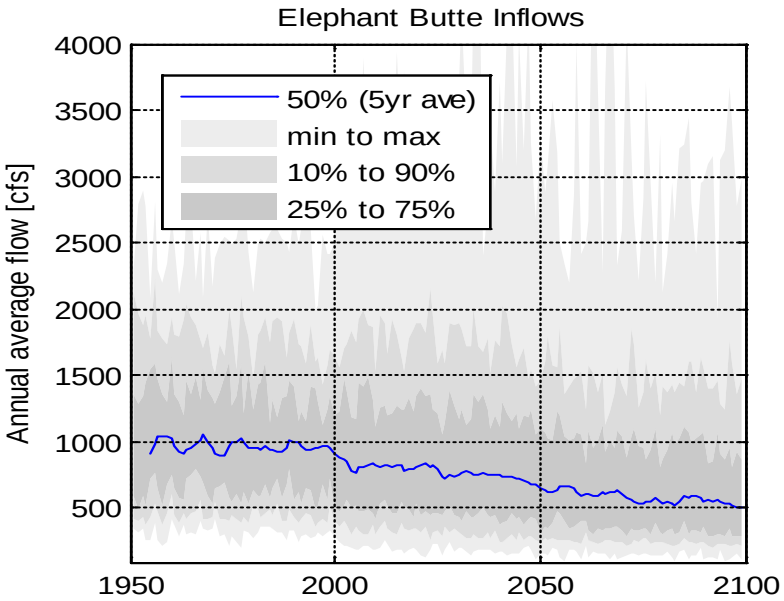
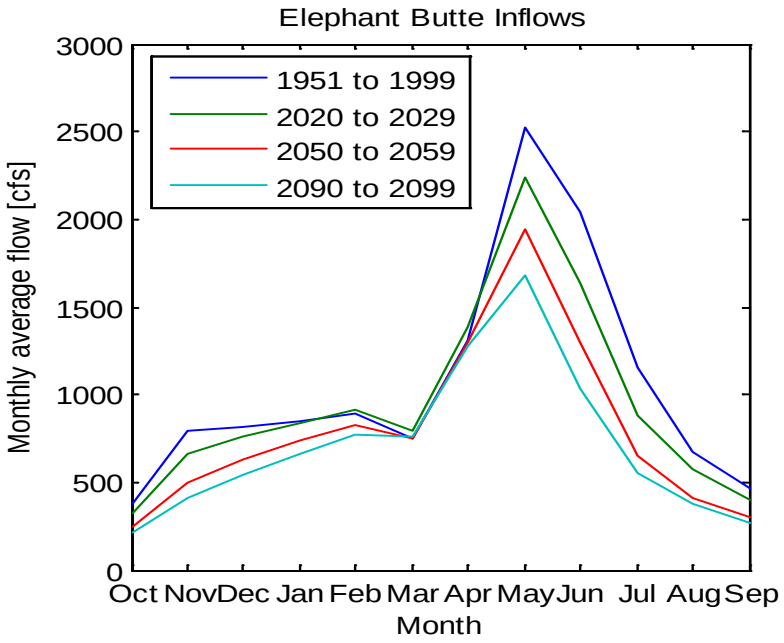


But reduced supply & increased ag demand squeezes the system:









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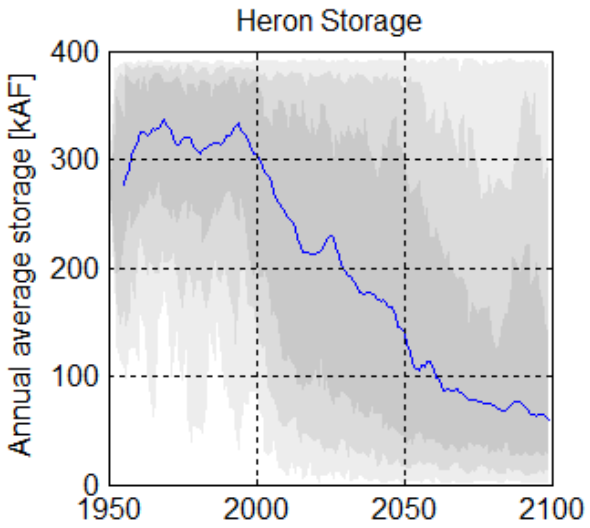
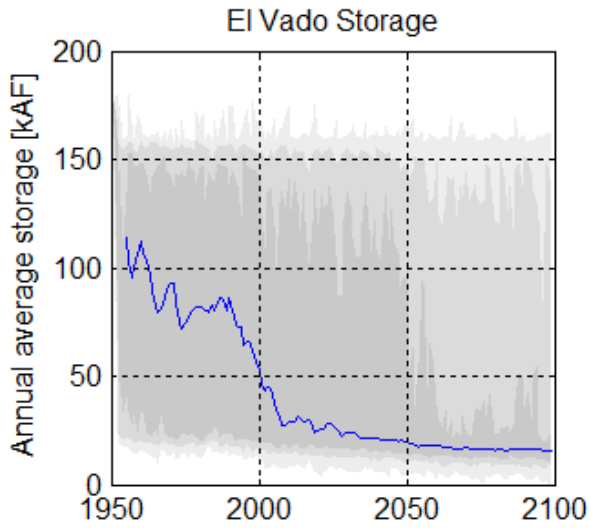
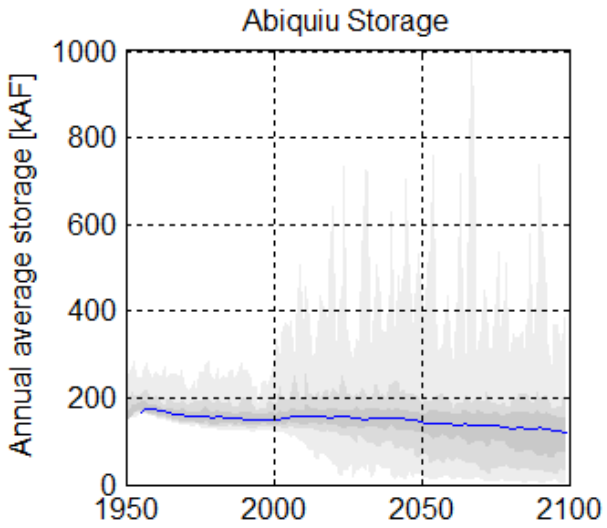
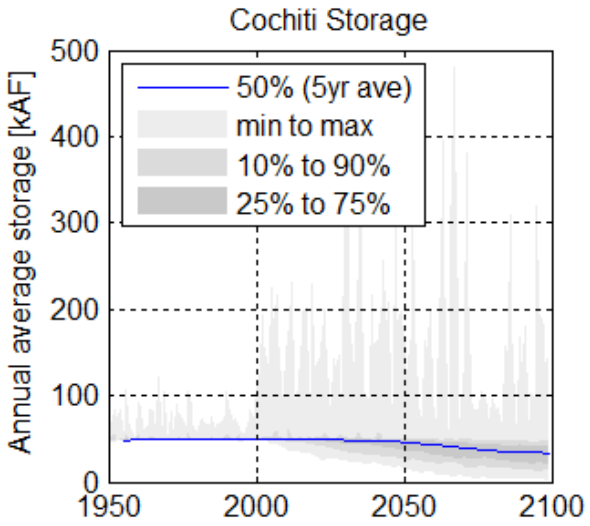
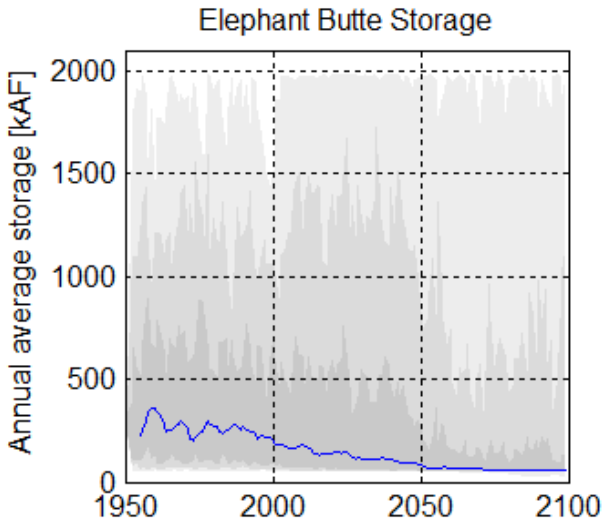
Reservoirs:

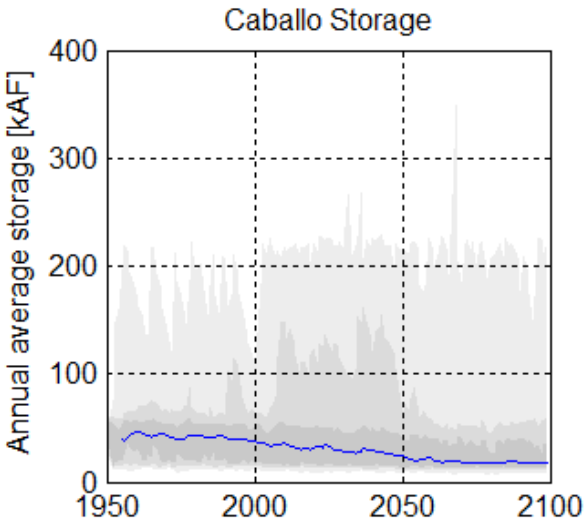

Heron Storage
Annual average storage [kAF]
400
300
200
100
0
1950
2000
2050
2100


El Vado Storage
Annual average storage [kAF]
200
150
100
50
0
1950
2000
2050
2100

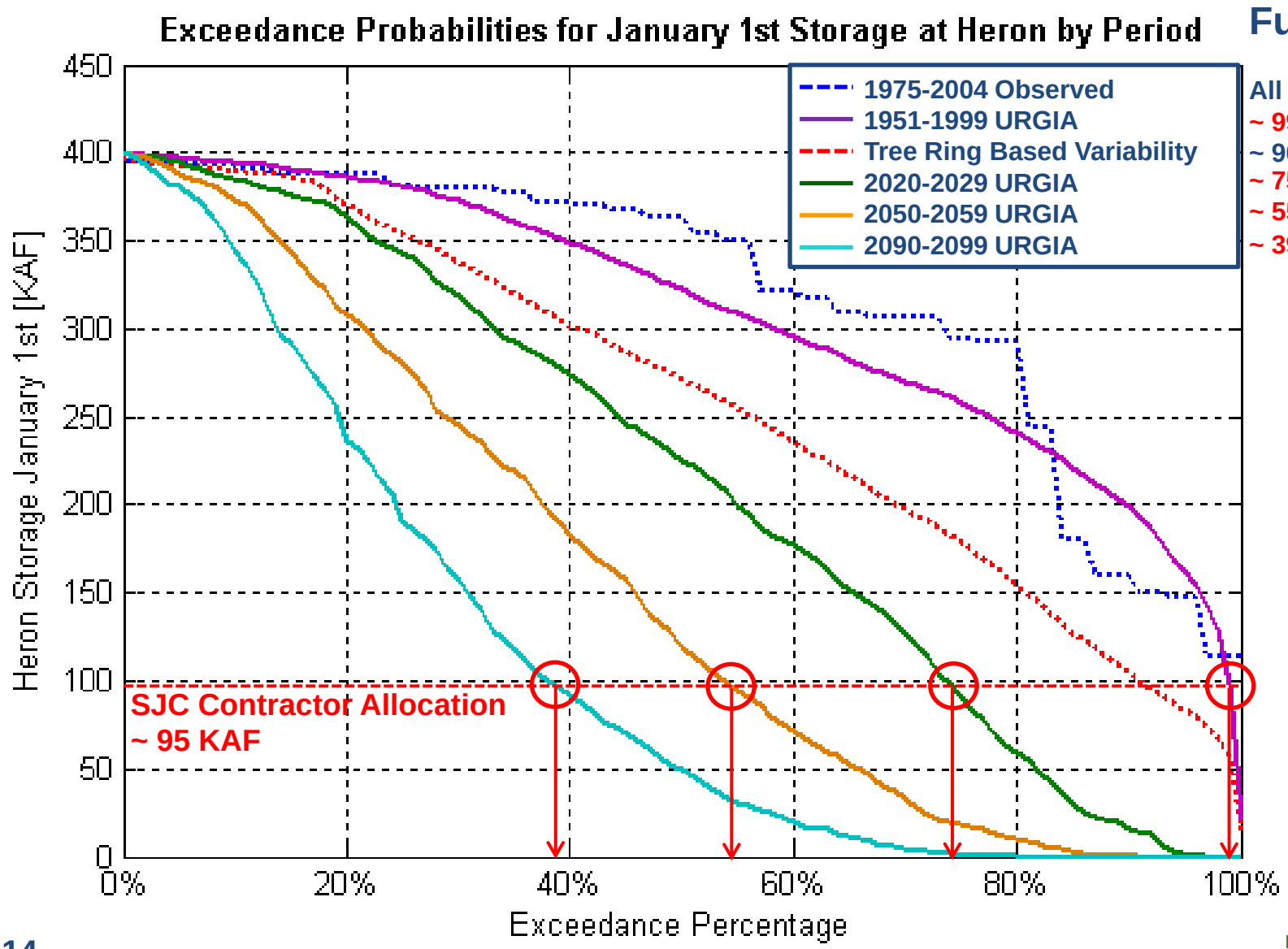

Abiquiu Storage
Annual average storage [kAF]
1000
800
600
400
200
0
1950
2000
2050
2100


Cochiti Storage
Annual average storage [kAF]
500
400
300
200
100
0
1950
2000
2050
2100
50% (5yr ave)
min to max
10% to 90%
25% to 75%


Elephant Butte Storage
Annual average storage [kAF]
2000
1500
1000
500
0
1950
2000
2050
2100


Caballo Storage
Annual average storage [kAF]
400
300
200
100
0
1950
2000
2050
2100

SJC Specific Information Presented at Contractor's meeting:



Full allocation

All years
~ 99% of years
~ 90%
~ 75%
~ 55%
~ 39%

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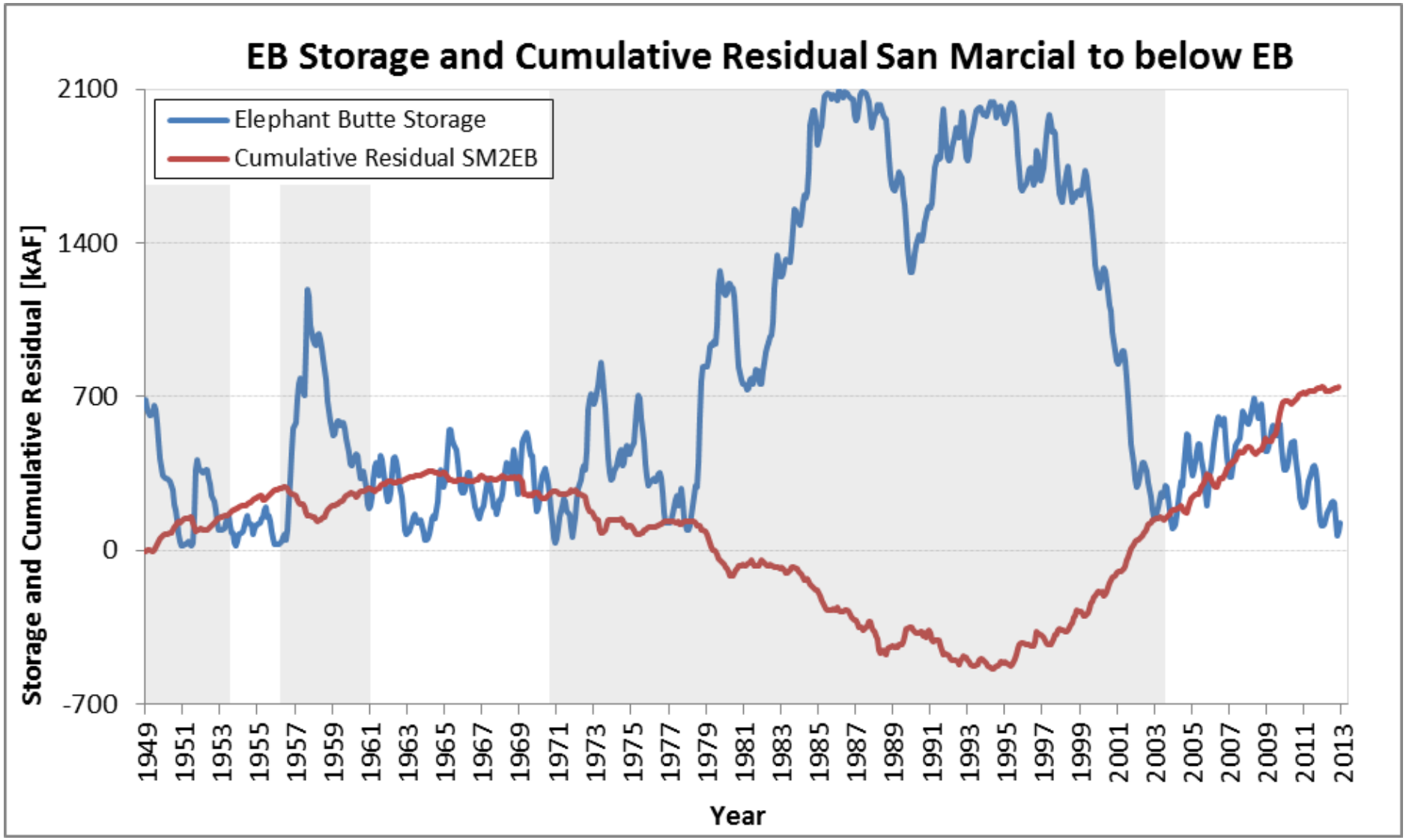
Upper Rio Grande Simulation Model 2013

- Upper Rio Grande Impacts Assessment
- Related analysis of SJC project reliability
- **San Marcial to Elephant Butte mass balance analysis**
- **PCIR versus ACIR**
- **Mass balance interface**

San Marcial to Elephant Butte Mass Balance



San Marcial to Elephant Butte Mass Balance

Potential Mechanisms Explored to Explain Residuals:

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- **Local Inflow**
- **ACAP Adjustments and ACAP Error**
- **Bank Storage**
- **Gage Error**
- **Reservoir Precipitation**
- **Reservoir Evaporation**

San Marcial to Elephant Butte Mass Balance

Potential Mechanisms Explored to Explain Residuals:

Sandia National Laboratories

- **Local Inflow**

  Can't see gaged tributary inflow events at reservoir.
- **ACAP Adjustments and ACAP Error**

  Important 1951, 1956, 1961, 1970, 1974, 1981, 1989, 2001, 2009
- **Bank Storage**

  Potentially important. Hard to separate from reservoir evap error.
- **Gage Error**

  Potentially important but difficult to account for.
- **Reservoir Precipitation**

  Not significant.
- **Reservoir Evaporation**

  Summer pan evap based rates likely too high. (But need another way to lose water if we reduce summer evaporation.)

Potential CIR vs Actual Crop ET in URGSiM

- **For historic period 1975-2009 URGSiM Actual Crop ET averages ~94% of potential Consumptive Irrigation Requirement (CIR)**

	Average Annual Potential CIR and Actual CIR Simulated by URGSiM 1975-2009					
	Cti2SFp	SFp2Alb	Alb2Bdo	Bdo2SA	SA2SM	MRG
PCIR [kAF/yr]	7.7	29.4	122.5	0.9	37.5	198.0
ACIR [kAF/yr]	7.7	29.4	116.2	0.9	32.7	186.9
ACIR as % PCIR	100%	100%	95%	100%	87%	**94%**

URGSiM Calibration

- **Reducing calculated PCIR by 20% would have implications on calibration:**

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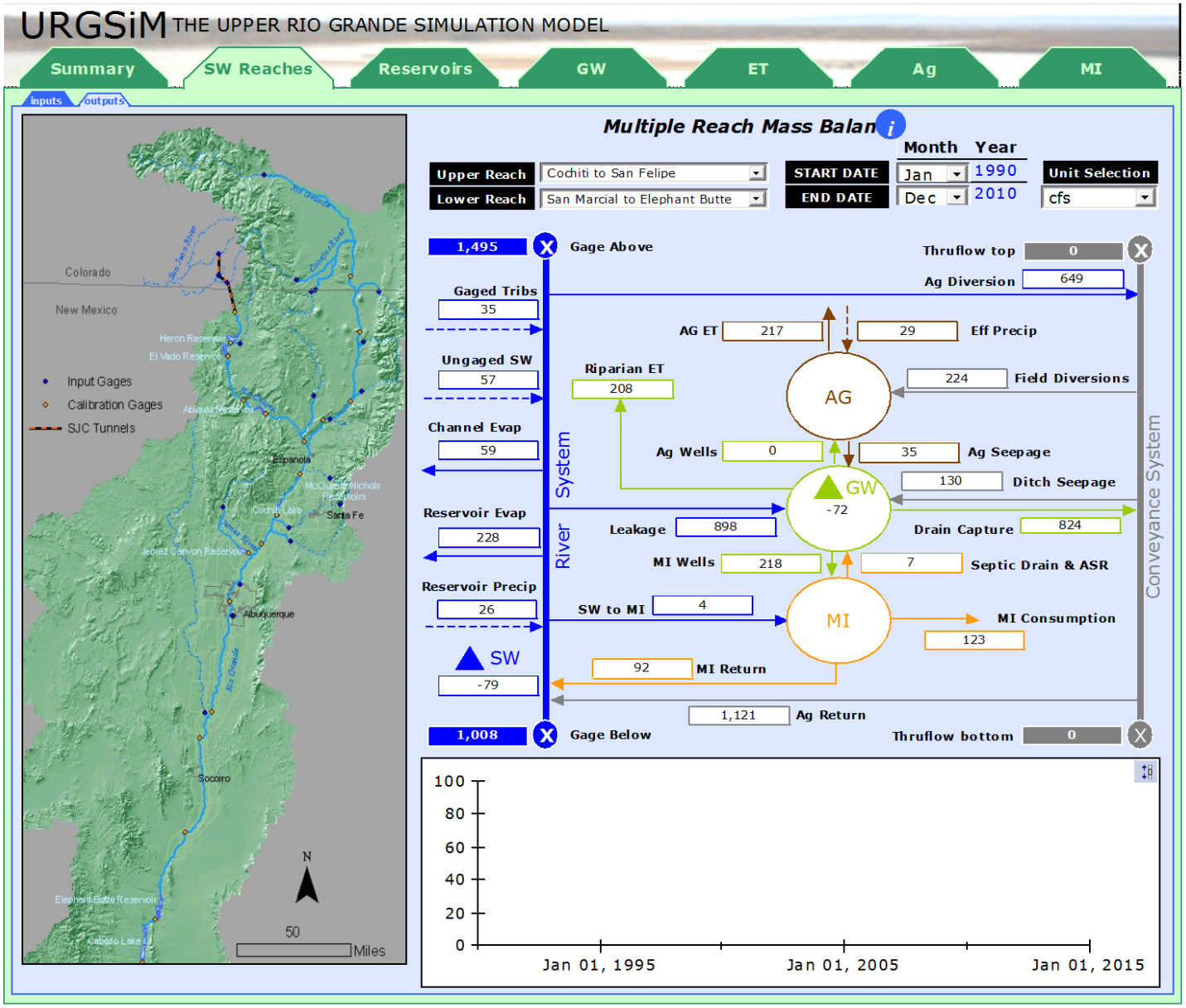
Reach or Reservoir	Calibration Term	Gage Used	Factor Used	Average Magnitude 1975-1999 [cfs]
Chama: Below Abiquiu Res. to Chamita	Ungaged SW inflow	Ojo Caliente near La Madera	3.5% summer only	3
Embudo to Otowi	Ungaged SW inflow	Rio Nambe below Reservoir	47cfs base + 120% summer gage	63
Otowi to below Cochiti Reservoir	Reservoir leakage	NA	none	-31
Below Cochiti Reservoir to San Felipe	Ungaged SW inflow	Galisteo Creek below Galisteo Dam	156%	9
Jemez: Jemez Pueblo to below Reservoir	Ungaged SW inflow	Jemez River near Jemez	52% of flows up to 200 cfs only	36
San Felipe to Albuquerque	Ungaged SW inflow	N Floodway Channel near Alameda	92%	36
Albuquerque to Bernardo	Ungaged SW inflow	Tijeras Arroyo & S Div Channel	165%	2.5
Bernardo to San Acacia	Gaged SW reduction	Rio Puerco near Bernardo	36% reduction	-12
San Acacia to San Marcial	Carriage Water	none	11% instead of 15%	NA

URGSiM Mass Balance Based Interface