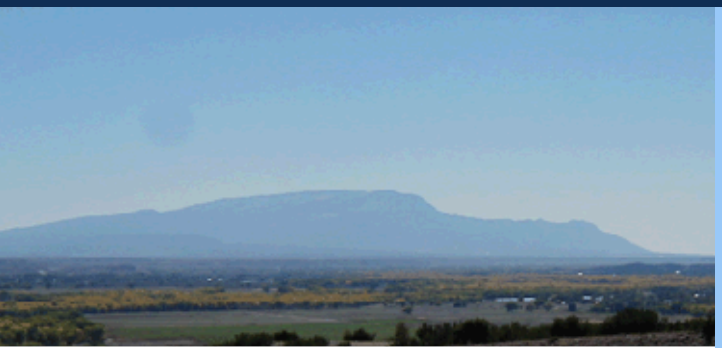
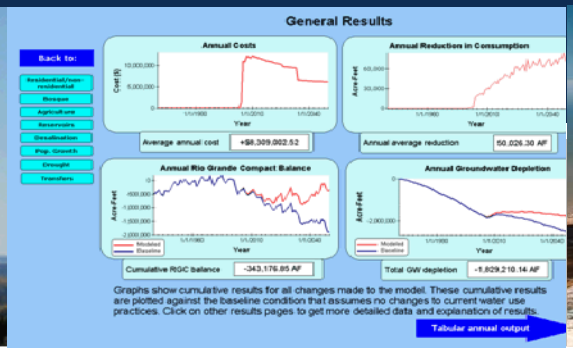
SAND2013-9393C

Exceptional service in the national interest

Sandia National Laboratories





Resource Management and Climate Adaptation Through Collaborative Modeling

Vincent Tidwell
Sandia National Laboratories
November 28, 2013

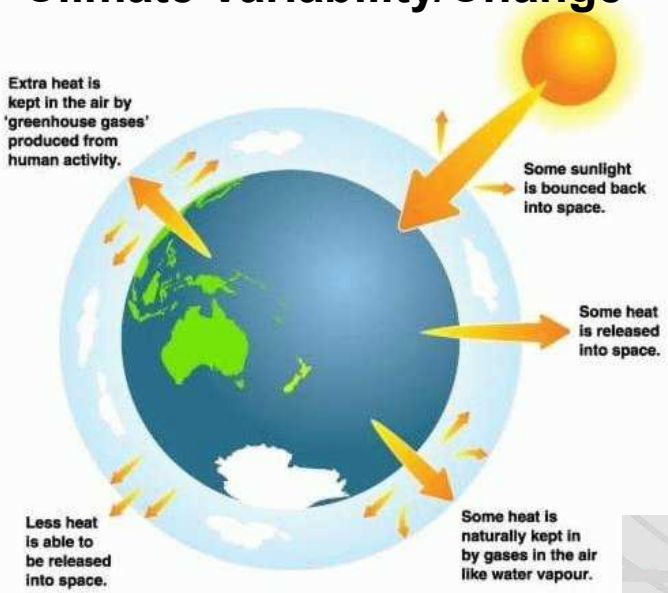
U.S. DEPARTMENT OF ENERGY | NNSA Nuclear National Security Administration

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

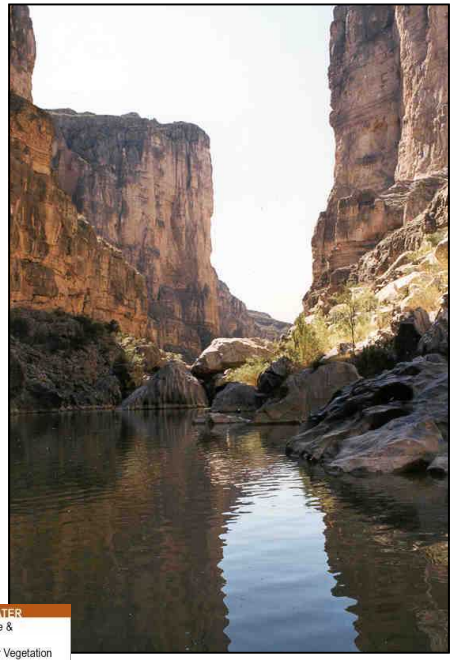
Resource Planning Challenge

Sandia National Laboratories

Climate Variability/Change

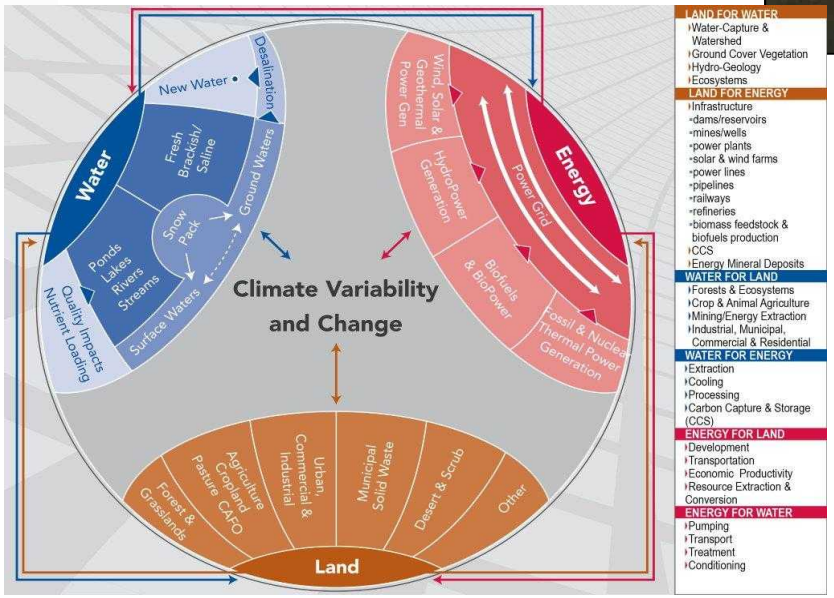


Growing Demand



Environmental Health

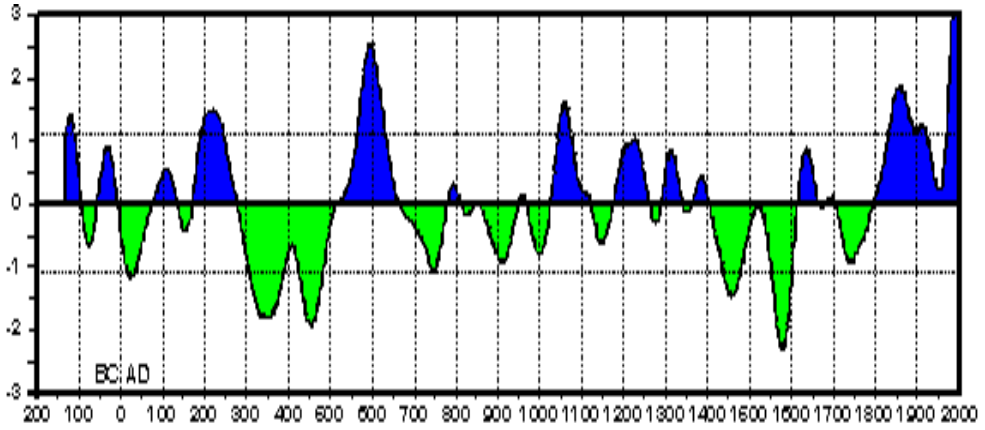
Competing Human Values

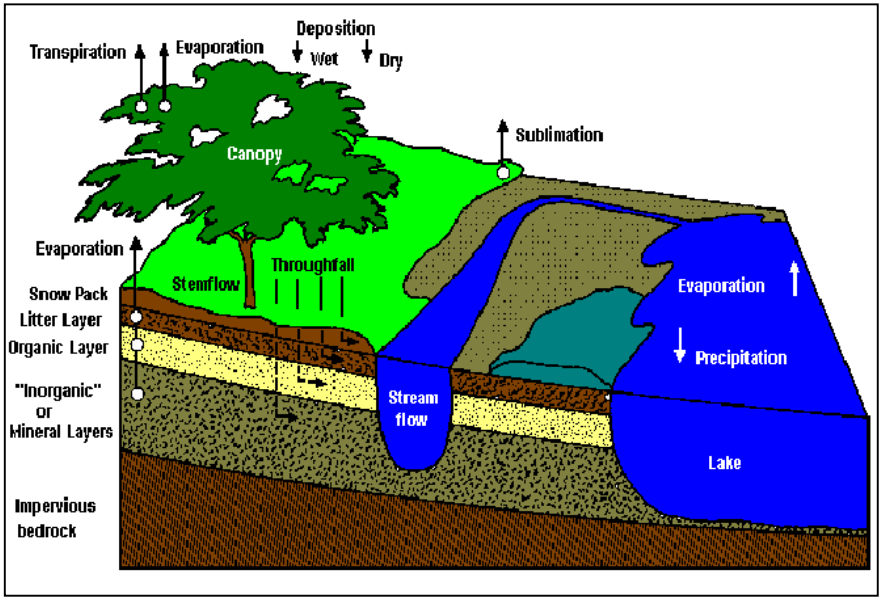


Energy/Water/ Land/….. Nexus

The Need

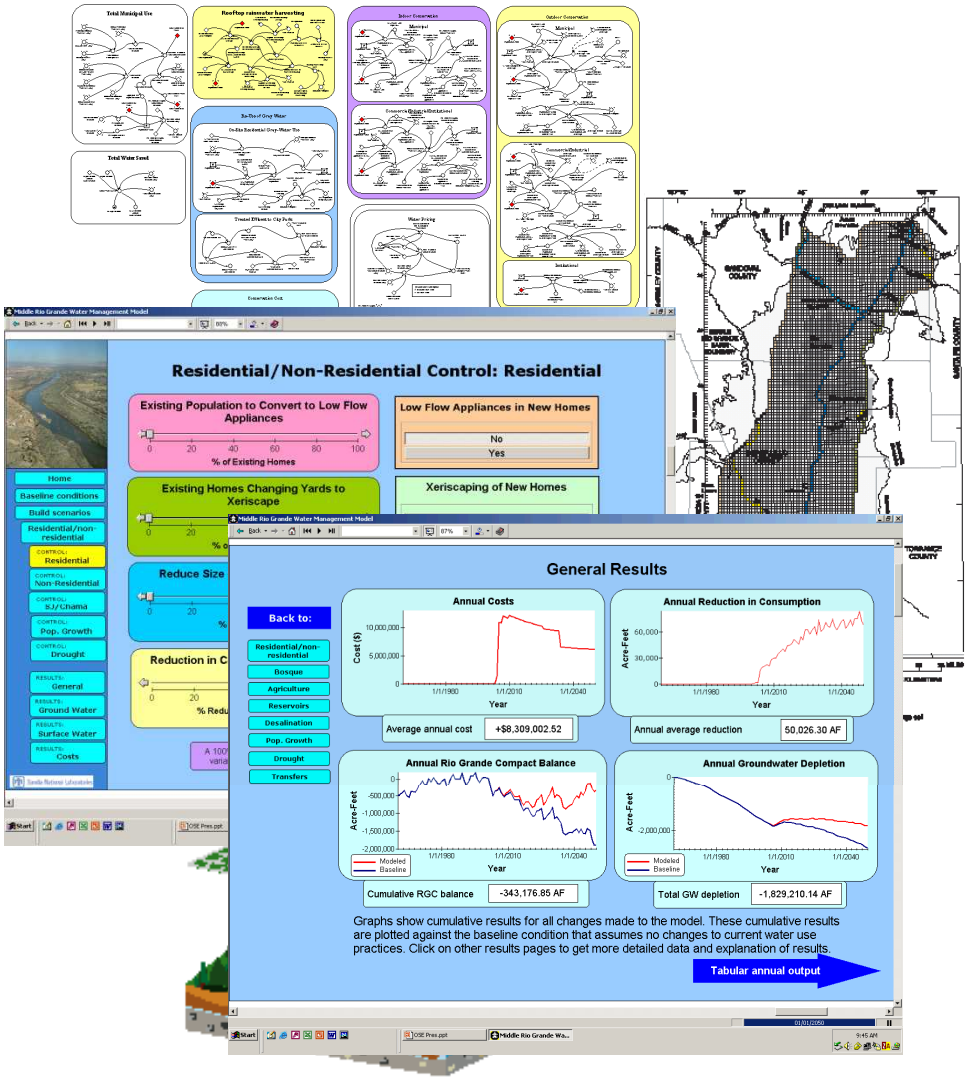
- ***Learn to speak the same language***:
  - Each person brings unique information and experience to the process.
  - No single person has the answer.
  - Need to develop a shared basis for decision making.





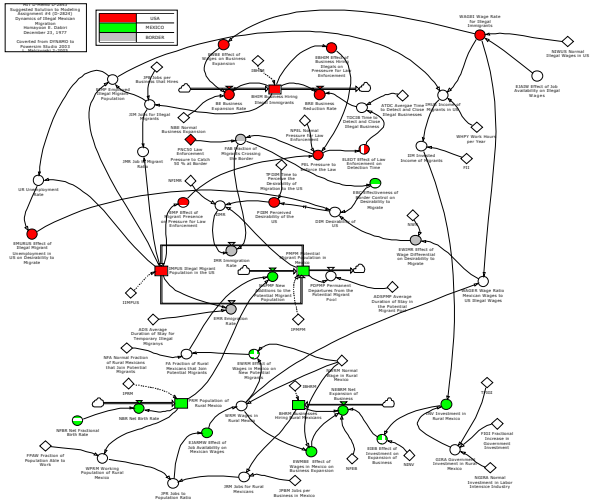
Integrative/Interdisciplinary Modeling

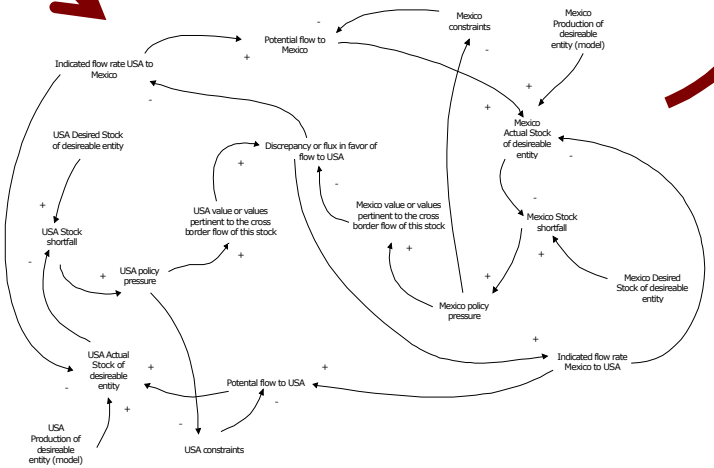
- System management,
  - High resolution,
  - Detailed physics,
  - Focused scope, and
  - Time intensive.
- System planning,
  - Low resolution
  - Scale appropriate physics,
  - Broad scope, and
  - Interactive.



Fostering a Environment of Collaboration

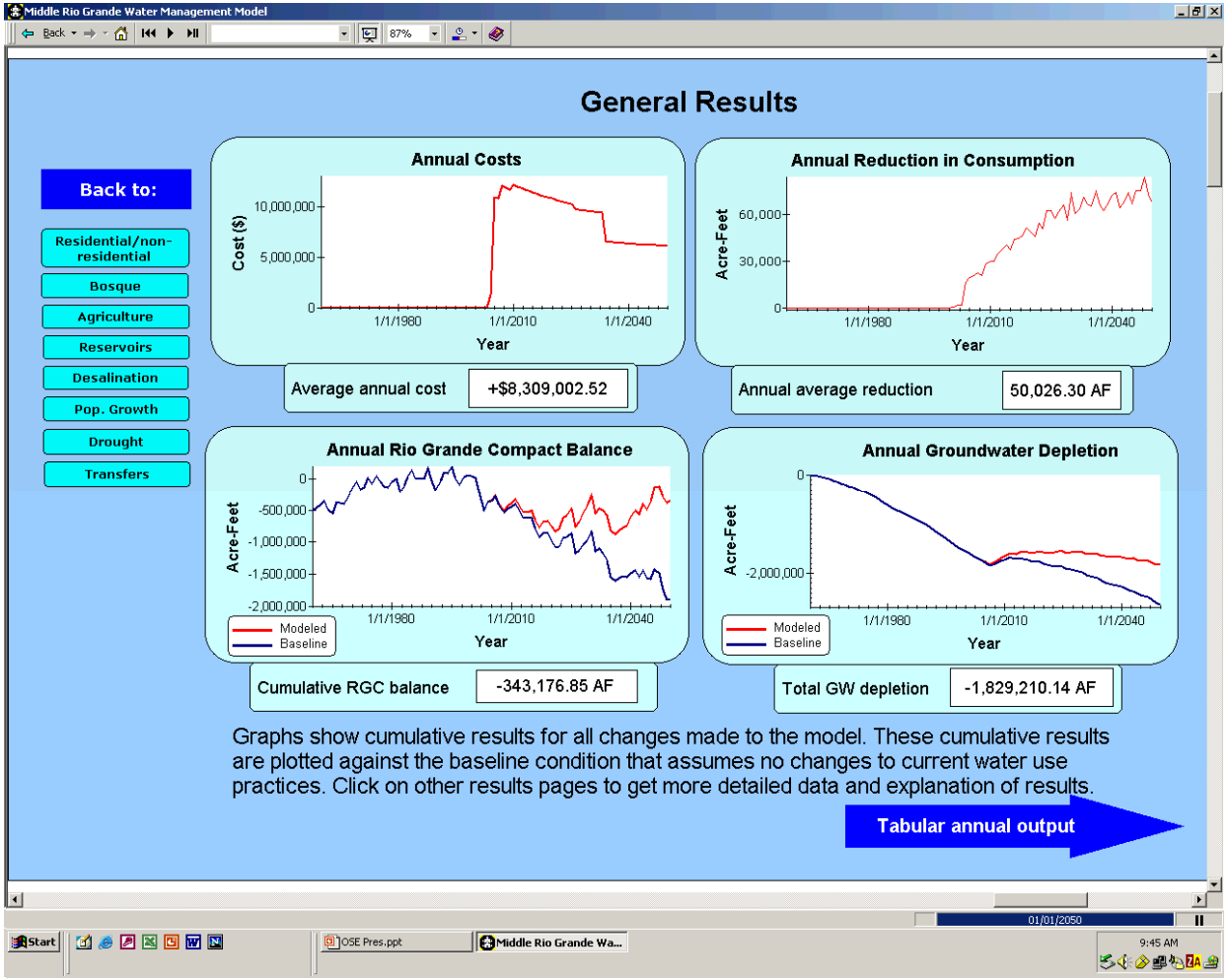
- Process of engaging decision-makers and stakeholders in:
  - Model development, and
  - Decision analysis.
- Purpose of broad input includes:
  - Expand knowledge base,
  - Structure group thinking/discussion,
  - Stimulate group learning, and
  - Ultimately lead to improved advocacy.





Visual/Interactive Environment for Analysis

- Broadly accessible
  - PC based
  - User friendly interfaces
  - Computations in seconds to minutes
- Provides interactive environment for scenario testing

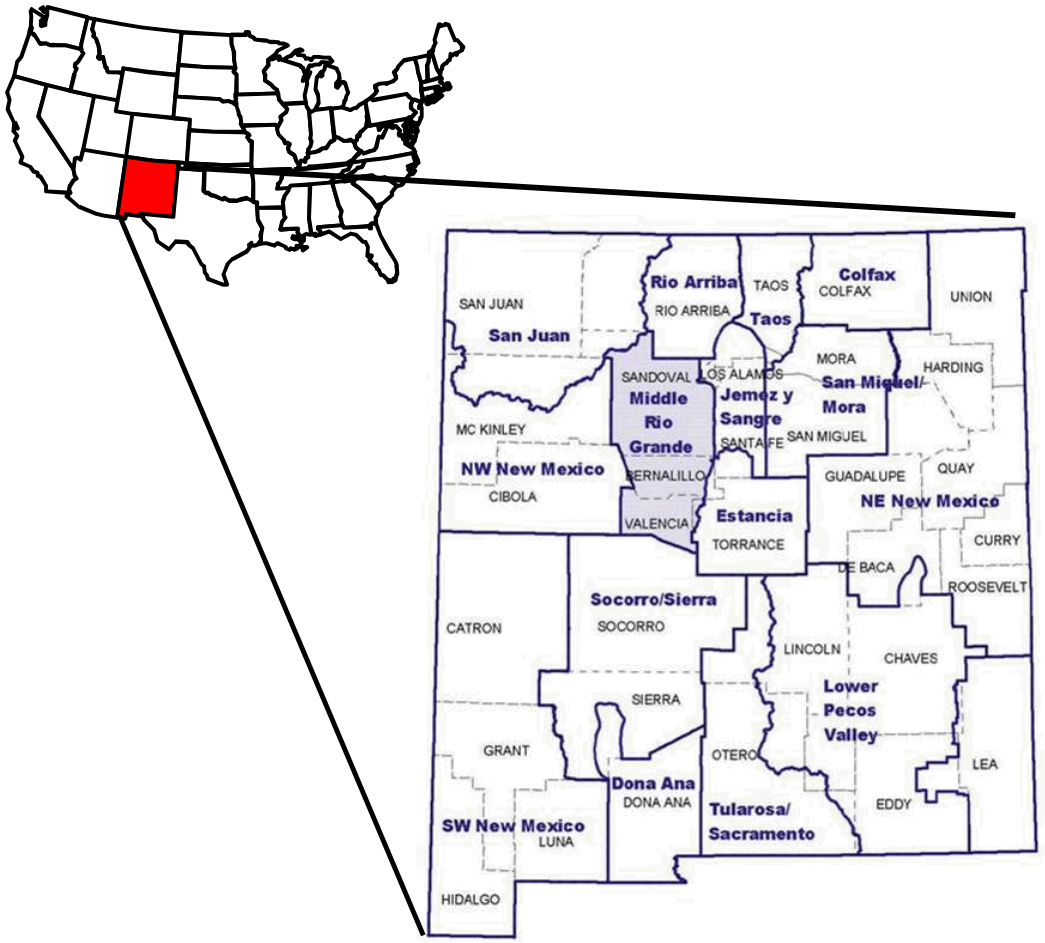


Motivation

People must be more afraid of the future than changes to the status quo

Example: MRG State Water Planning

- Three county planning region
  - Bernalillo
  - Sandoval
  - Valencia
- Total population of ~750,000 including Albuquerque, Rio Rancho, Belen, Bernalillo and Los Lunas



Planning Objectives

Sandia National Laboratories

1. **What is the region's available water supply?**
2. **What is the region's future water demand?**
3. **How will the region balance supply with demand?**
   - What actions can be taken?
   - Which are acceptable to the community?
   - How can they be implemented?

Planning horizon of 50 years!

Model Development Process

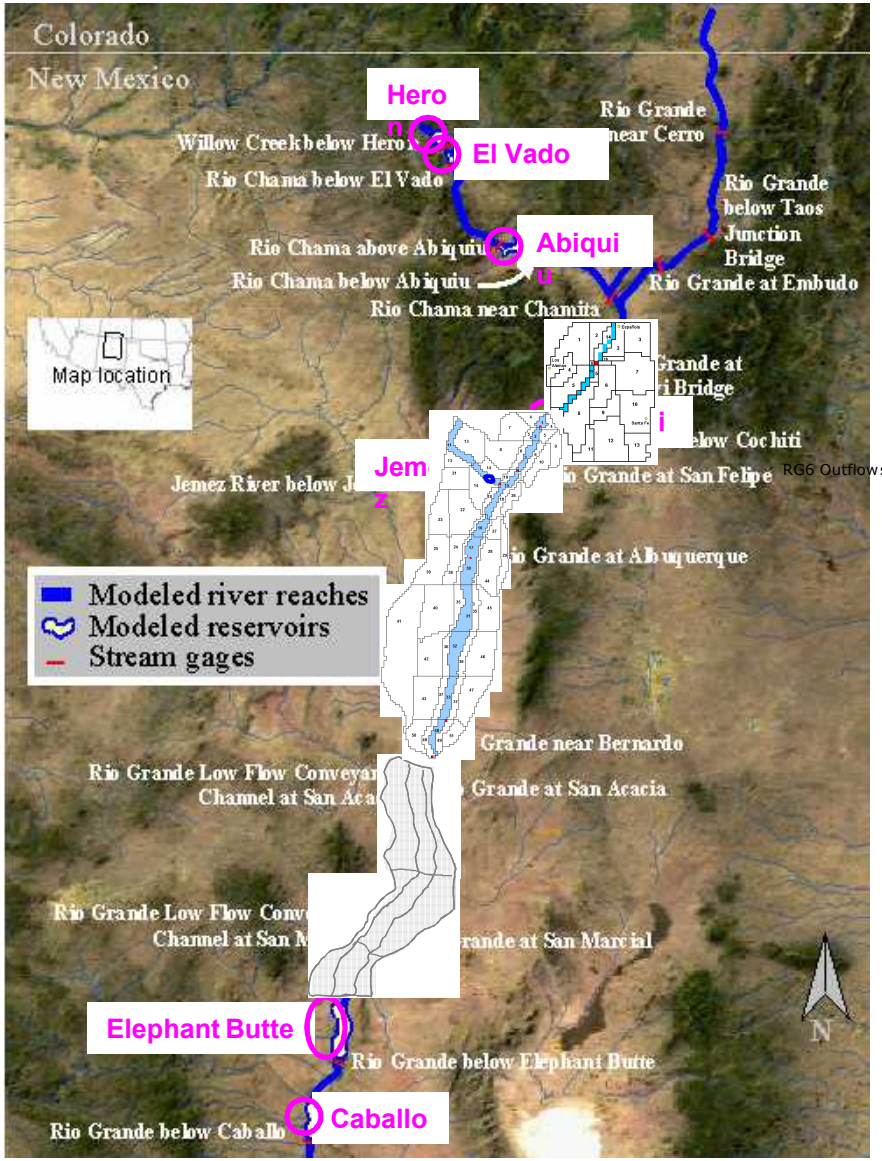
- Assembled a “Cooperative Modeling Team” including members from:
  - Each Water Assembly constituency group,
  - Middle Region Council of Governments (MRCOG), and
  - Utton Transboundary Resources Center, UNM
- Team meets every other week to:
  - Conceptualize model components,
  - Identify external sources of expertise and data, and
  - Review the model
- Community engagement
  - Expose community to model
    - Public forums,
    - Educational venues, and
    - Community events
  - Interactions with the professional community

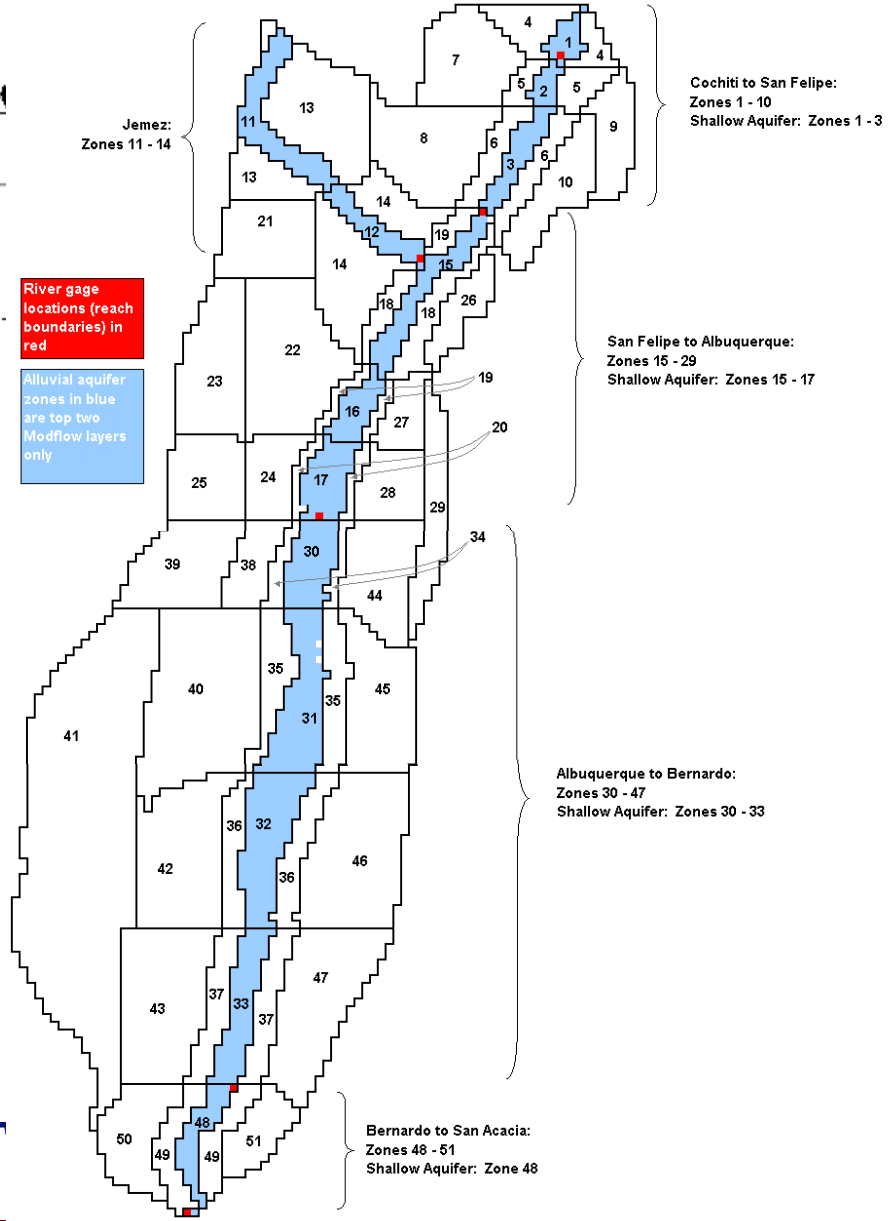
MRG Operations Planning

- Develop a decision support tool that is consistent with and complimentary to the Upper Rio Grande Water Operations Model (URWOM).
  - The primary purpose of the tool is to provide a platform for rapid scenario screening, and
  - Educate and engage the public and decision makers in water operations decision-making and planning.

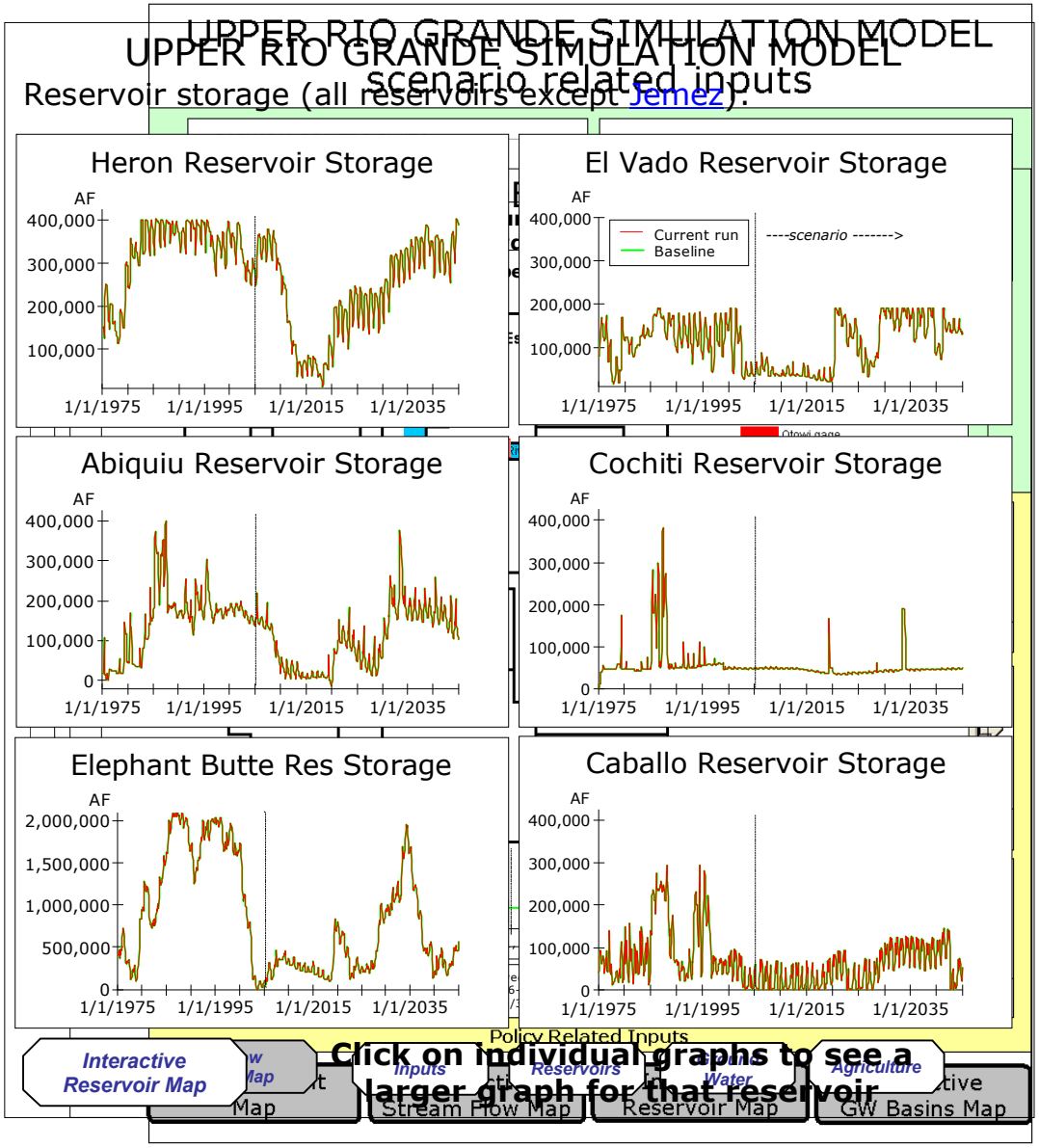
Operations Model for the Upper Rio Grande

Sandia National Laboratories





Operations Model for the Upper Rio Grande

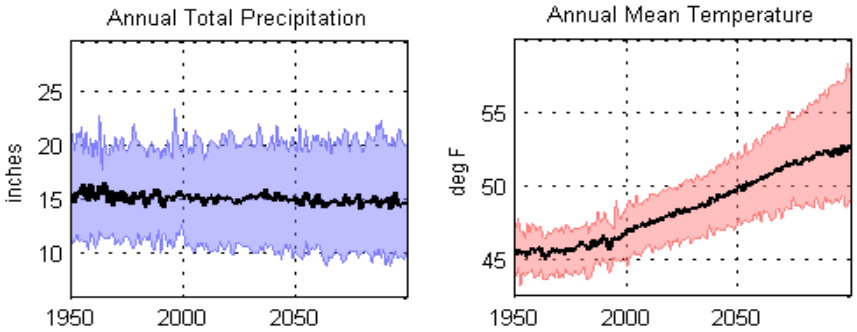


Modeling: Downscaling IPCC Model

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

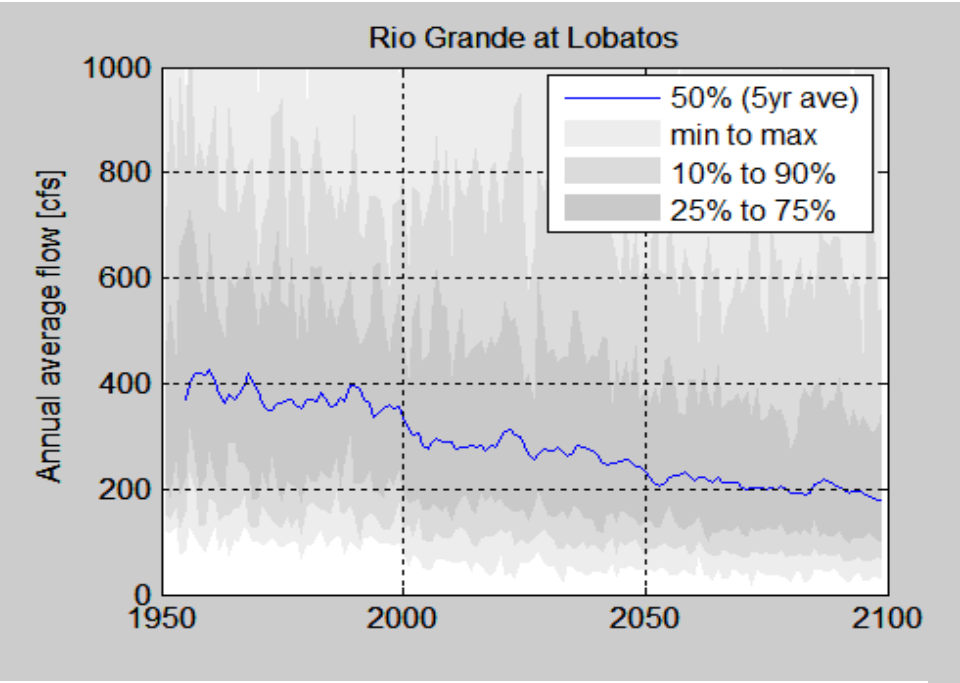
Post processing bias correction of flows (224 hydrographs)

Operations model (URGSiM)

Impacts to water deliveries, flows, and reservoir levels.

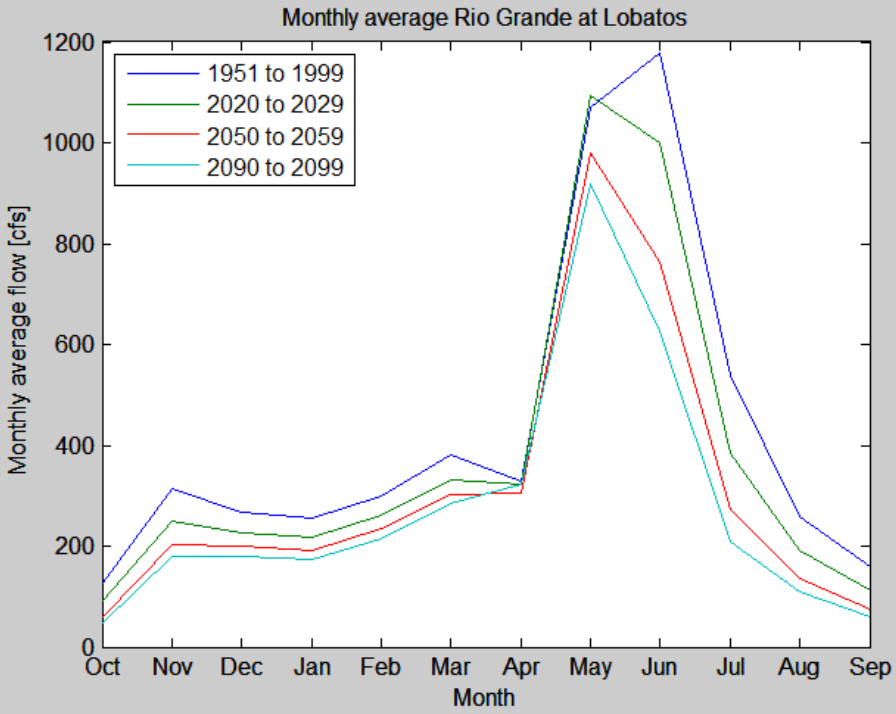
Roach et. al., 2013

Impact on Rio Grande Flows

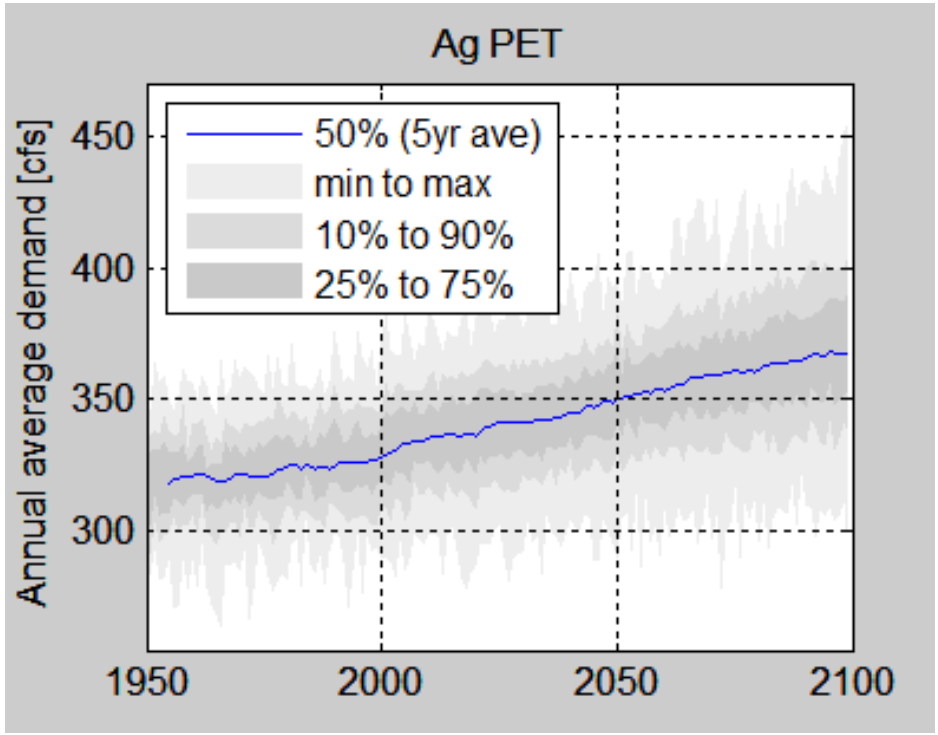


"Results are not predictions, but rather a starting point for dialogue and increased awareness of potential impacts of climate change."

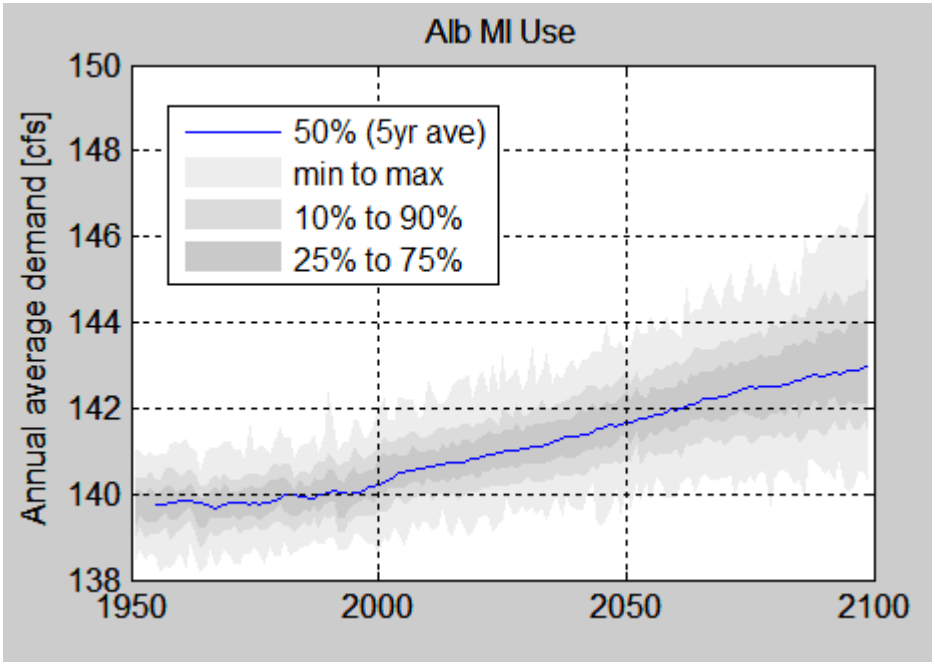
Roach et. al., 2013



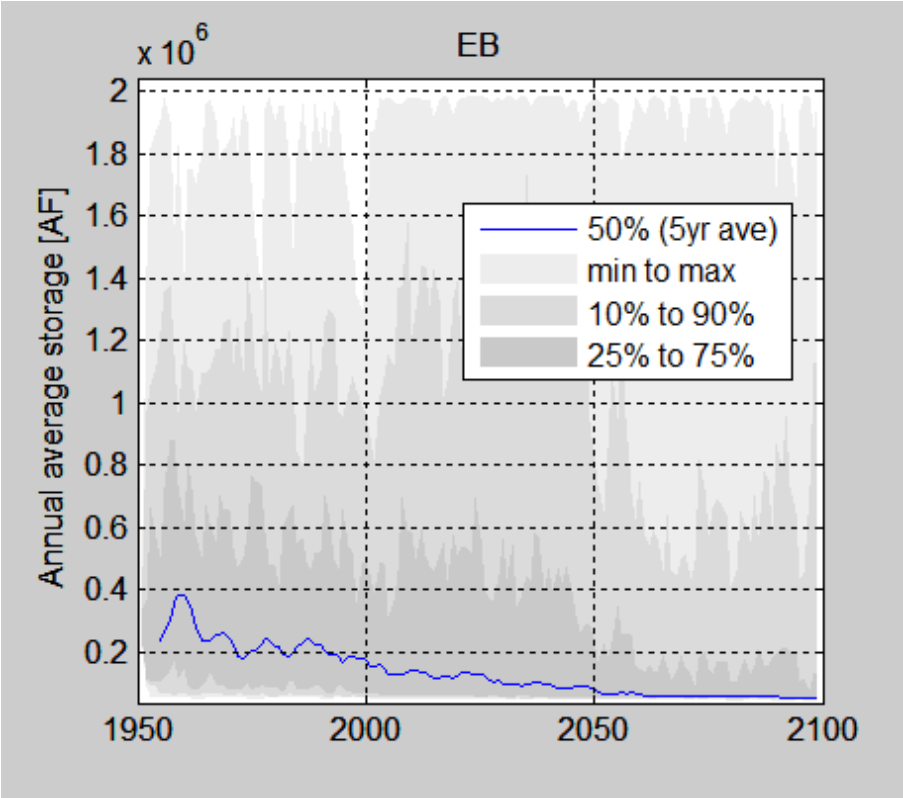
Impacts on Water Demand

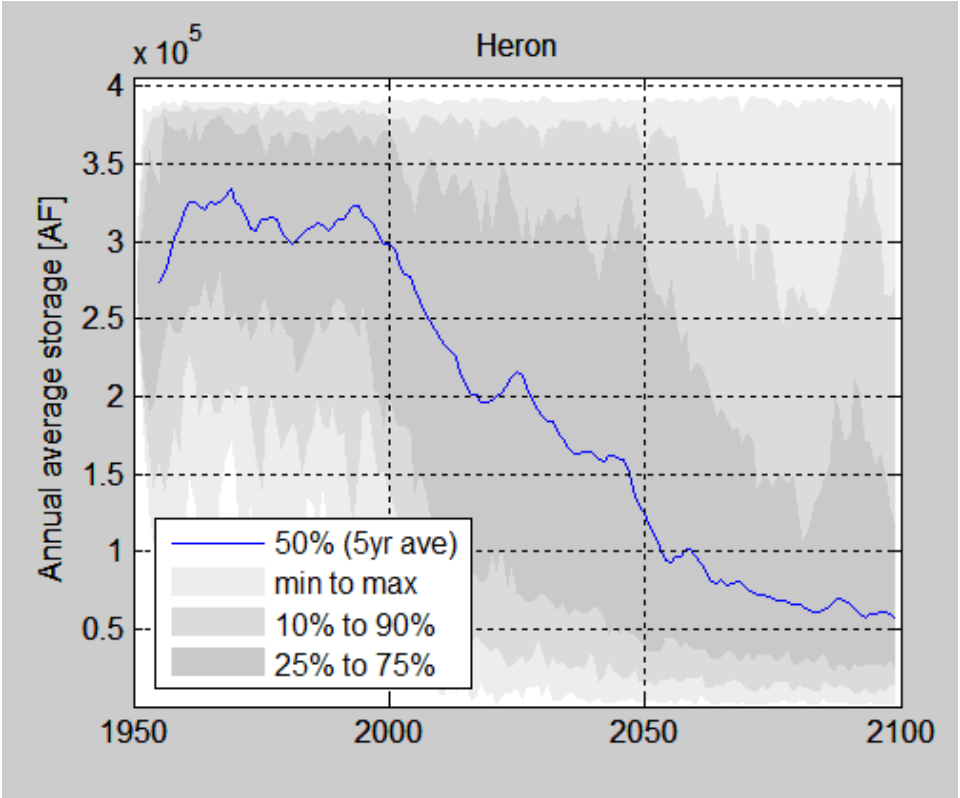


Roach et. al., 2013



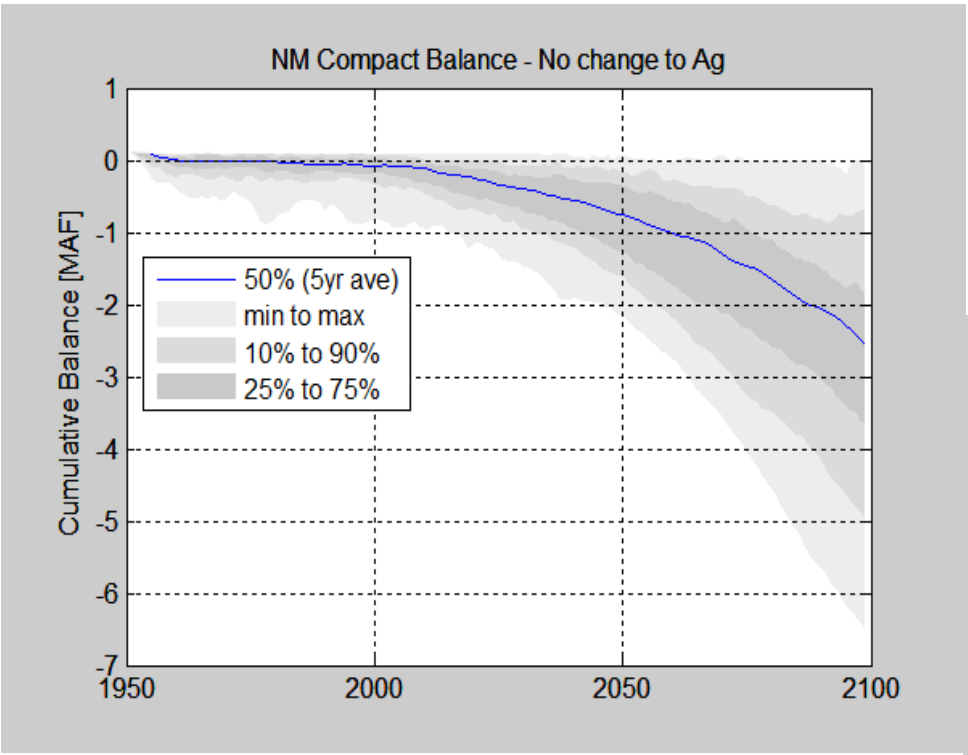
Impacts to Reservoirs



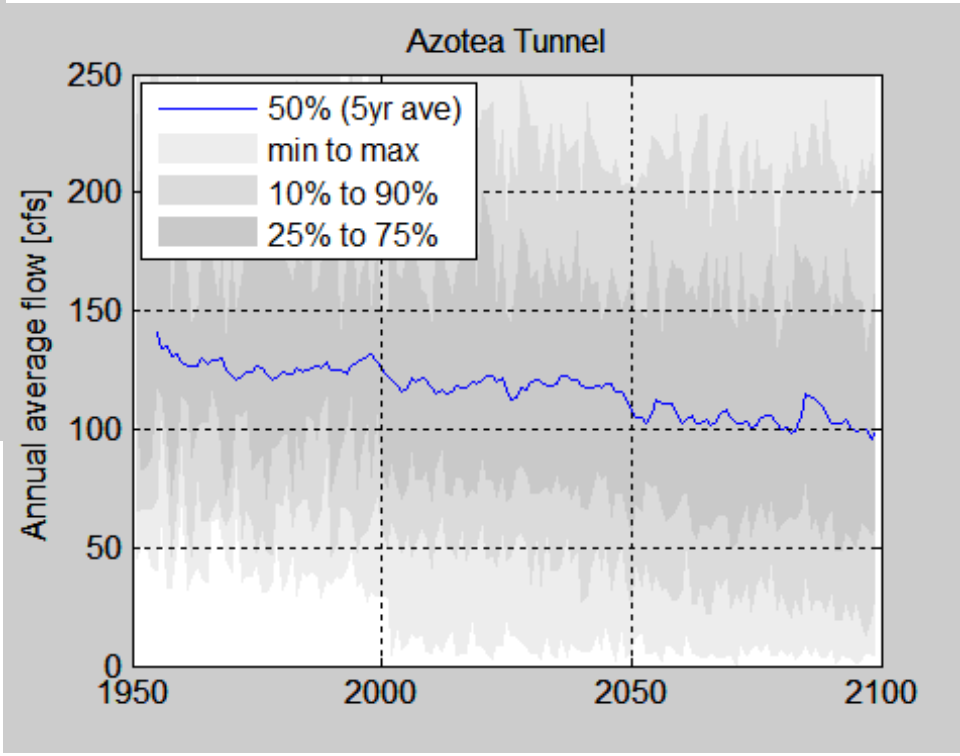


Roach et. al., 2013

Impacts on Water Deliveries



Roach et. al., 2013



Water Leasing Market Experiments

Sandia National Laboratories

You are Cash Farmer 1 on Reach 1

What do you want to do?

- Buy
- Sell

1.00 AF units

For this Price: $

Cost per AF: $ / AF

Submit

YEAR	ROUND	TIME LEFT
1076	May of Year 1	03:05

CURRENT PAYOFF

Water Balance (B)	4.35AF
Water Balance Value (V)	$0.0
Trading Cash (C)	$10.0
Year-end Earnings (C+V)	$10.0

Min. AF to get yield 0.67

Refresh me

Previous Round Earnings

BIDS AND OFFERS (click on link to sell or buy)

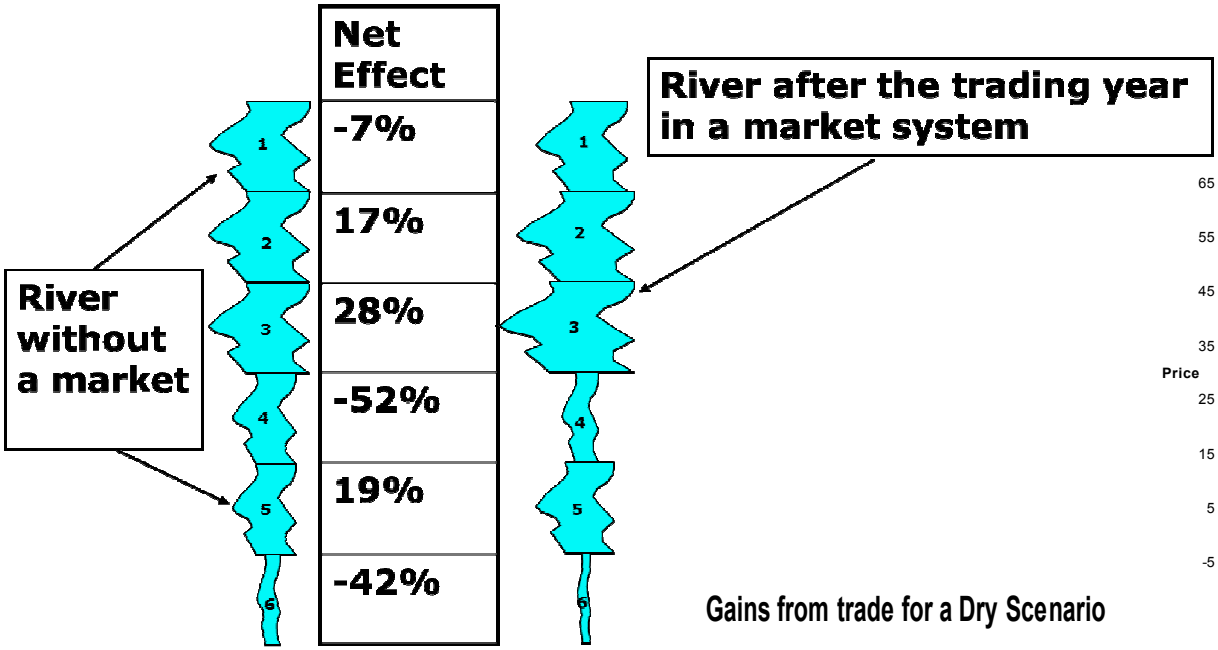
Reach	Player	Click to Sell	Click to Buy
1	**Cash Farmer 1**		
1	Cash Farmer 3		0.7 AF @ $4.00 ($5.71/AF)
1	Cash Farmer 2		
2	Pecan Farmer 1		
2	Urban		
2	Cash Farmer 5		
2	Cash Farmer 4		
3	Pecan Farmer 2		
3	Cash Farmer 7		
3	Cash Farmer 6		
4	Pecan Farmer 3		
4	Cash Farmer 8		
5	Cash Farmer 9		0.79 AF @ $8.00 ($10.11/AF)
5	Cash Farmer 10		
0	Environmental		1.20 AF @ $7.00 ($5.50/AF)

ALL TRANSACTIONS FOR EXPERIMENT

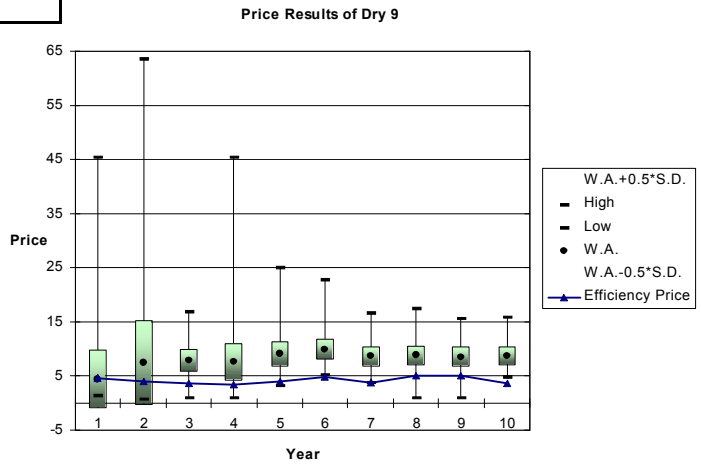
Player	Action	Player	Actual Units	Price	Price per AF
Cash Farmer 5	>>	Cash Farmer 1	1	$8	$8
Cash Farmer 6	<<	Env.	1	$5	$5
Cash Farmer 6	>>	Env.	1	$4	$4
Cash Farmer 6	<<	Cash Farmer 8	1	$2	$2
Cash Farmer 9	>>	Urban	1	$8	$8

Water Leasing Market Experiments

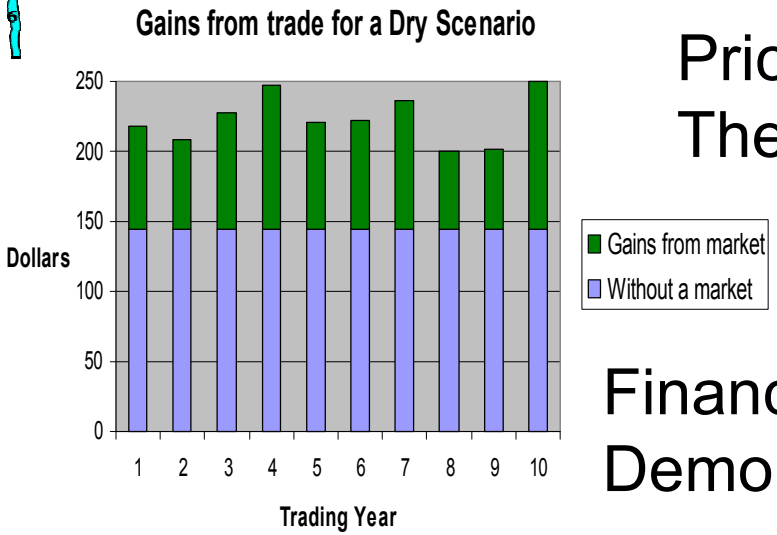
Sandia National Laboratories



Impacts on Distribution of River Flows



Prices Trend to Theory



Financial Gains Demonstrated

Collaborative Modeling

Sandia National Laboratories

- Learning to speak the same language:
  - Integrated/interdisciplinary modeling,
  - Environment of collaboration,
  - Visual/interactive platform for analysis, and
  - Motivation.

Collaborative Modeling Community

- Conducted three conferences
- Produced published proceedings and book
- Tools of the trade:
  - Best practices,
  - Metrics of success,
  - Practitioners list/project survey.

Collaborators

- Howard Passell
- Len Malczynski
- Tom Lowry
- Jesse Roach
- Beth Richards
- Marissa Reno
- Peter Kobos
- Will Peplinski
- Geoff Klise
- Ron Pate
- Barbie Moreland
- Stephanie Kuzio
- Ray Finley
- Erik Webb

Sandia National Laboratories

intel

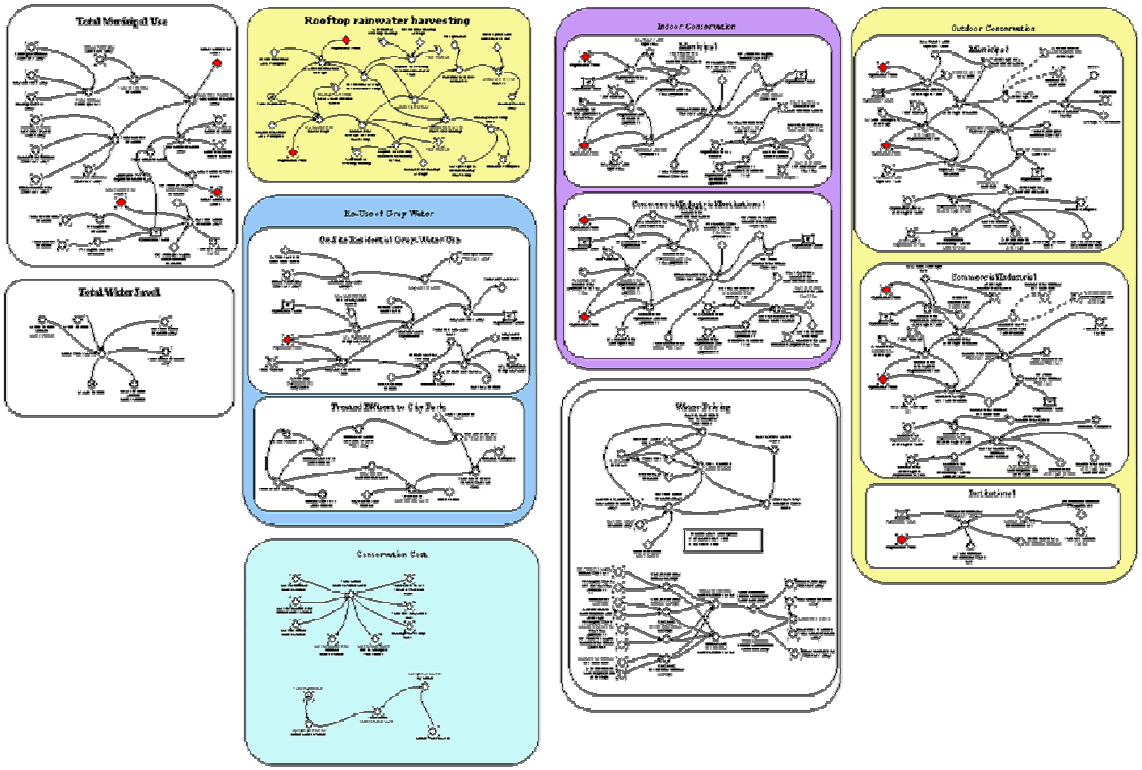
THE UNIVERSITY OF ARIZONA
TUCSON ARIZONA

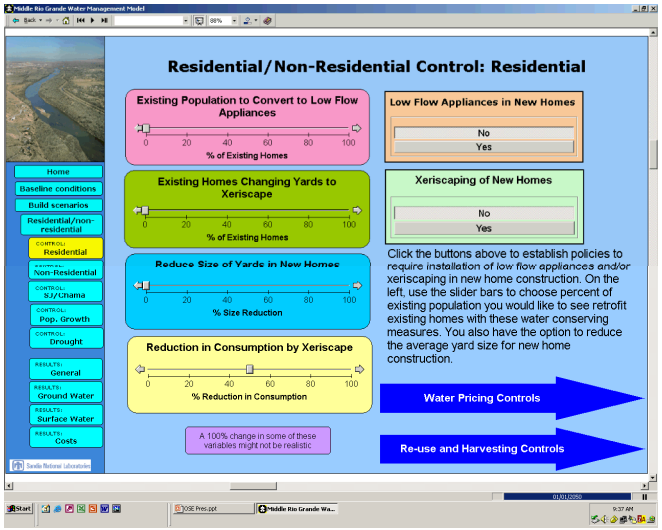
The University of New Mexico

New Mexico Tech
SCIENCE · ENGINEERING · RESEARCH · UNIVERSITY

THE UNIVERSITY OF TEXAS AT AUSTIN
JACKSON
SCHOOL OF GEOSCIENCES

NEW MEXICO STATE UNIVERSITY





Vincent Tidwell

vctidwe@sandia.gov

http://energy.sandia.gov/