

# WHOLE-BASIN, MULTI-SYSTEM MODELING ON THE RIO GRANDE

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## ABSTRACT

Public mediated resource planning is quickly becoming the norm rather than the exception. Unfortunately, supporting tools are lacking that interactively engage the public in the decision-making process and integrate over the myriad values that influence water policy. Several projects are in progress at SNL aimed at creating a set of integrated and interactive decision support tools to aid regional water planning exercises. The approach adopted employs system dynamics, a powerful mathematical framework for integrating the physical and social processes important to watershed management, while providing an interactive environment for engaging the public. As part of this effort SNL is teaming with the University of New Mexico, New Mexico Tech, and the University of Arizona to integrate the disparate systems of hydrology, ecology, climate, demographics, economics, policy and law into a decision model to better understand and quantify the complex dynamics between water supply and demand. The decision tool is being formulated in a modular manner; that is, each physical/social process are modeled as an independent module that can be linked with any combination of other process modules to capture the dynamics of a specific watershed. This modularity allows the creation of sophisticated, highly integrated models that water professionals can use as well as simplified models aimed at public outreach. This modeling approach is being tested on a reach of the Lower Rio Grande (Elephant Butte Reservoir to the Texas State Line) aimed at exploring the pros and cons of water banking/water leasing.

Often resource planning exercises focus on a particular region delineated by unphysical political boundaries. Such planning exercises would benefit from a broader understanding of physical/social processes occurring both upstream and downstream of the decision region. Toward these ends a model for the entire Rio Grande from the headwaters to the Gulf of Mexico is being developed. Several projects are being leveraged to create the integrated basin model, which include collaboration with team members from the Upper Rio Grande Operations Program EIS working group and Mexico's Instituto Mexicano de Tecnología del Agua.

### *Problem*

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- Planning and management of water resources is often constrained to non-physical boundaries.
- Such exercises would benefit from holistic basin views.

## Objective

- Develop an integrated water planning model for the Rio Grande from its headwaters to the Gulf of Mexico
- Result of unique opportunity to leverage multiple modeling projects



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## URG Water Operations Review

- Cooperative project with:
  - Corps of Engineers
  - Bureau of Reclamation, and
  - New Mexico Interstate Stream Commission
- Modeling supports the public outreach component of the Upper Rio Grande Water Operations Review



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## URG Water Operations Review

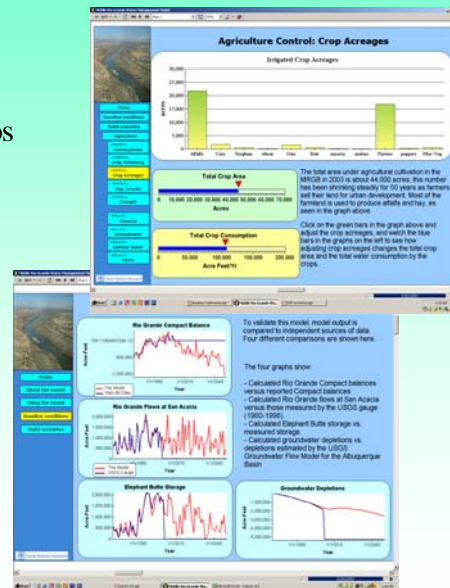
- Based on URGWOM model
- Monthly time step
- Closed Basin in Colorado to Ft. Quitman, Texas,
- 17 discrete reaches for the Rio Grande, Rio Chama, and Rio Jemez
- Model mainstem flows along with tributary flows, river losses, and key demands (open water evaporation, riparian, agricultural, and municipal)



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## URG Water Operations Review

- User options:
  - Climatic conditions: wet/normal/dry
  - 5 different water operations scenarios
- Graphical output:
  - Water delivery
  - Water storage,
  - Water quality,
  - Aquatic habitat,
  - Riparian health,
  - Flood inundation,
  - Sediment management, and
  - Land use.



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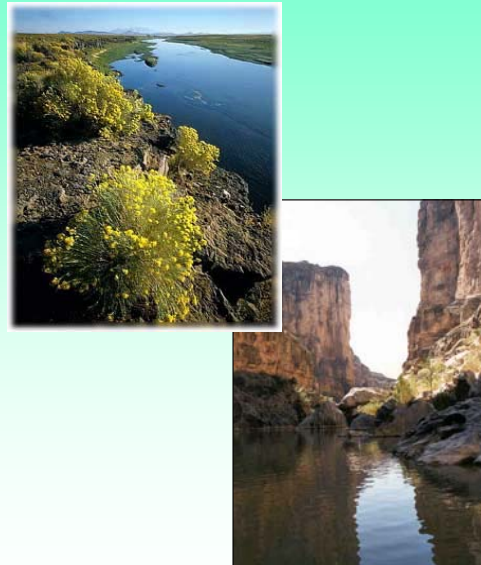
## *URG Water Operations Review*

- Community workshop venue
- 10 meetings scheduled throughout the Rio Grande, Rio Chama, and Rio Jemez basins.
- Meeting objectives include:
  - Soliciting public feedback on alternative water management strategies, and
  - Identify the public's preferred alternative.



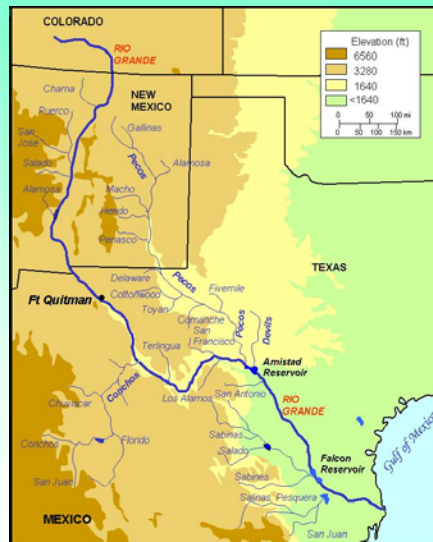
## *US/Mexico Border*

- Cooperative project with:
  - Instituto Mexicano de Tecnologia del Agua,
  - University of Arizona,
  - International Boundary and Water Commission



## US/Mexico Border

- Monthly time step
- Ft. Quitman to Gulf
- Eight discrete reaches including Rio Conchos, Rio Salado and Rio San Juan
- Model main stem flows along with tributary flows, river losses, and key demands (open water evaporation, riparian, agricultural, and municipal)



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## US/Mexico Border

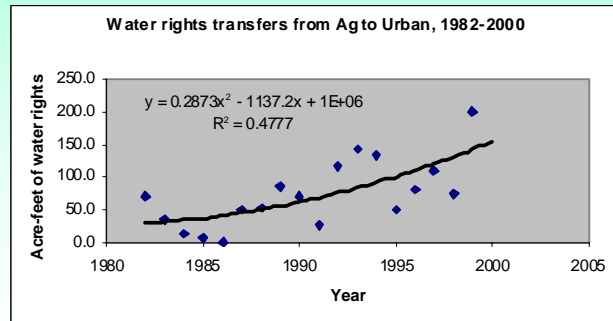
- Primary purpose of effort is to develop a truly international model of the Rio Grande.
- Model will allow exploration of “what if” scenarios
  - How will improved irrigation efficiency change instream flows?
  - How should growing urban demand be met?
  - How will drought impact the delivery of compact/treaty waters?



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## Water Transfers

- Focus is on developing approaches for modeling mixed market and non-market driven decisions.
- Will model water transfers from agriculture to municipal use.
- Implement within the MRG model.
- Use historical data to calibrate and verify the model.



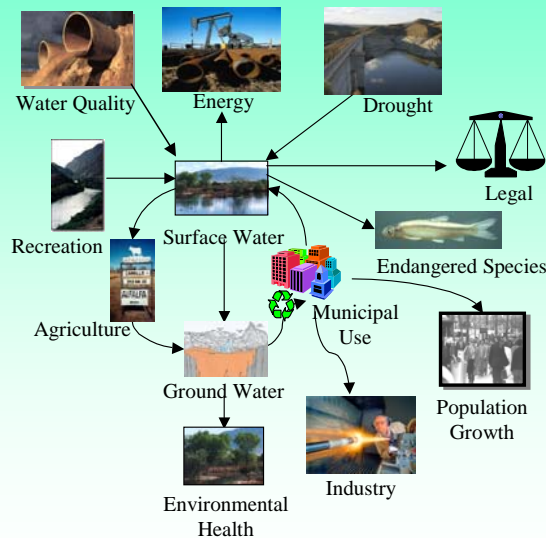
## System Dynamics Toolbox

- Collaborative Project with:

- Univ. New Mexico
- New Mexico Tech
- Univ. of Arizona

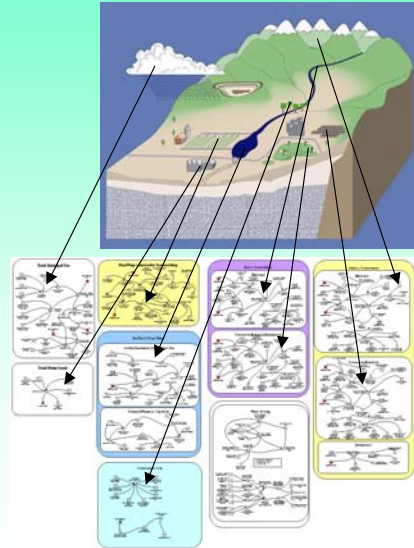
- Multidisciplinary integration:

- Economics,
- Surface/groundwater,
- Climate,
- Water quality,
- Ecology,
- Policy, and
- Legal.



## System Dynamics Toolbox

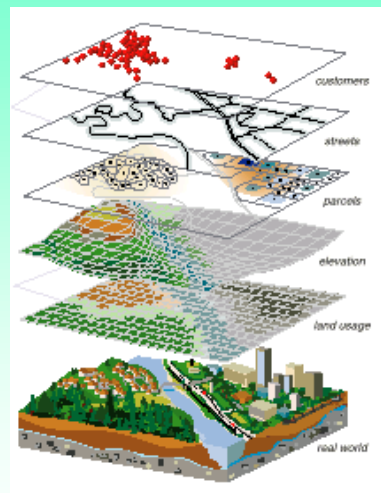
- Computerized toolbox of generic physical and social process modules.
- Modules are assembled into networks to create models of unique watersheds.
- Resulting models are flexible in spatial/temporal scales, and degree of sophistication.
- Coupled with series of interfaces designed for specific user groups.



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## System Dynamics Toolbox

- Distributed modeling provides:
  - Preprocessor to SD (data aggregation),
  - Means of handling spatially heterogeneous processes,
  - Link to real-time insitu and remotely sensed data, and
  - Visualization of spatial trends/data.



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## System Dynamics Toolbox

- Toolbox development will be approached through modeling a series of issues.
- First issue will focus on water banking/leasing:
  - Broad consequences,
  - Appropriate markets,
  - 3<sup>rd</sup> party effects.



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## Summary

- Creating a planning model for the Rio Grande that is:
  - Whole basin,
  - International,
  - Multidisciplinary, and
  - User friendly.



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