


Collaborative Stakeholder-Driven Water-Energy-Food Resource Modeling and Planning

Sandia National Laboratories



***Resource planning is more complicated
and more critical than it has ever been***

- Increasing population
- Increasing resource consumption
- Decreasing resource availability
- Increasing stakeholder involvement
- Increasing appreciation of the complexity
 - multi sector/discipline
 - many variables, interdependencies, feedbacks, time lags



One solution: Collaborative Stakeholder-Driven Modeling, Roadmapping and Planning

- Engage multi-sector, multi-disciplinary experts
- Collect knowledge, data, information
- Build computer simulation models for
 - evaluating tradeoffs
 - developing consensus
 - educating stakeholders, policy makers, community, public
 - planning future strategies
- Ongoing efforts: modeling improves management, experience improves the model

INTERACTIVE, USER FRIENDLY MODELS

Allows for real time construction and evaluation of competing development strategies

Middle Rio Grande Water Management Model

Run 2 | 70%

Residential/Non-Residential Control: Residential

Existing Population to Convert to Low Flow Appliances
Slider: 0 to 100 (% of Existing Homes)

Low Flow Appliances in New Homes
Buttons: No, Yes

Existing Homes Changing Yards to Xeriscape
Slider: 0 to 100 (% of Existing Homes)

Xeriscaping of New Homes
Buttons: No, Yes

Reduce Irrigated Acreage of Yards in New Homes
Slider: 0 to 100 (% Size Reduction)

Reduction in Consumption by Xeriscape
Slider: 0 to 100 (% Reduction in Consumption)

Water Pricing Controls
Additional Controls

Remember the model limitations

RESULTS: General, Ground Water, Surface Water, Costs

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Irrigated Crop Characteristics by Nation for Scenario

Scenario Irrigated Area Selection	Slider: 2,339,411 ha / 1,764,450 ha	Slider Model
Area Change	Slider: 0 %/yr	
Intensity	Slider: 135 %	
Efficiency	Slider: 52 %	

Check for Fixed Supply

Category	Relative Percent of Crops	Final Percent
Grain	Slider: 0 to 100	79 %
Industrial Crops	Slider: 0 to 100	2.13 %
Legumes	Slider: 0 to 100	2.59 %
Oil	Slider: 0 to 100	1.48 %
Vegetable Crops	Slider: 0 to 100	11.69 %
Fodder	Slider: 0 to 100	2.71 %

According to discussion in 2nd workshop:

* Pre 1993 returns back to river of origin. Main Outfall Drain (MOD) constructed in 1993.

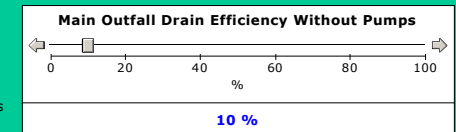
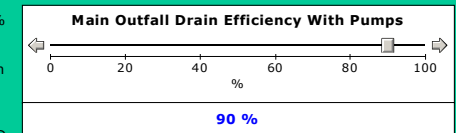
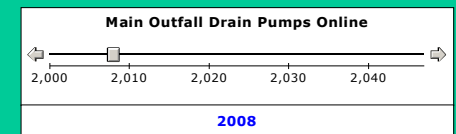
* 1993 - 2003 returns from between rivers below Baghdad and Fallujah go back to the Euphrates via MOD.

* 2003 - 2008 to Central Marsh via MOD (90% to marsh, 10% to gulf via Shatt al Basrah).

* After 2008 to gulf via MOD and pump station to Shatt al Basrah (90% to gulf, 10% to Central Marsh).

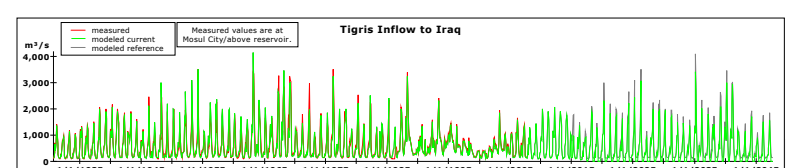
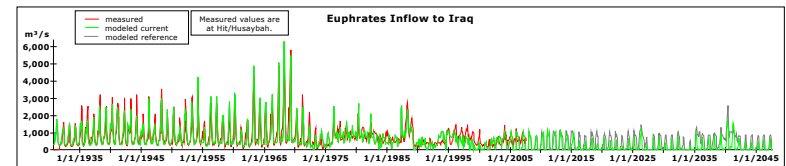
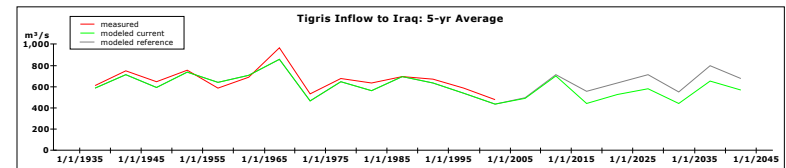
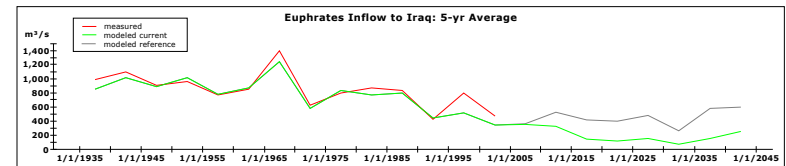
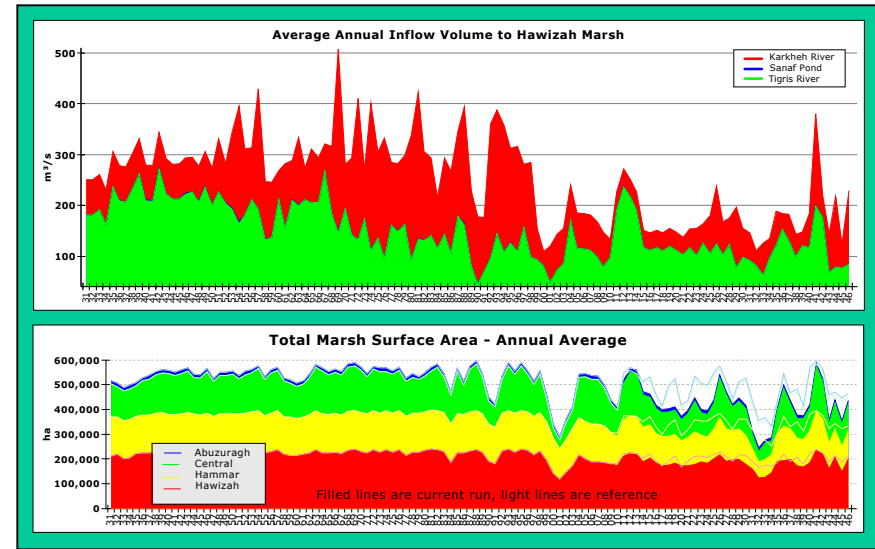
These sliders allow user to adjust the year MOD pumps begin working, and the efficiency of the MOD in terms of how much water is delivered directly to gulf with and without pump station.

MoWR engineers provided a spreadsheet that somewhat contradicted this in terms of which diversions go to MOD, and discrepancy remains unresolved.



GRAPHICAL OUTPUT

Allows real time comparison of alternatives, education of stakeholders and policy makers, and development of rigorous, quantitative development plans



General Results [Settings](#)

Back to:

- Residential / non-residential
- Bosque
- Agriculture
- Reservoirs
- Desalination
- Pop. Growth
- Drought
- Transfers

Global Settings

Random Seed: 1.0

Annual Cost, 2000 dollars

Present Value: \$629,772,603.20

Annual Reduction in Consumption

Annual average reduction: 72,960.90 AF

Cumulative R.G. Compact Balance

Cumulative RGC balance: -12,404.88 AF

Cumulative Groundwater Depletion

Total GW depletion: -1,726,501.67 AF

Avg. cost/AF water saved: \$267.85 per AF

[More info](#) [Tabular annual output](#)

Graphs show cumulative results for all changes made to the model. These cumulative results are plotted against the baseline condition that assumes no changes to current water use practices. See other results pages for more results.



Collaborative Stakeholder Involvement

- Collaborative stakeholder involvement is key
 - Brings together experts from across disciplines and sectors
 - Over months or years they work together to better understand interdependencies among systems
 - Their collaborative experience is captured in a quantitative model
 - Model is clearinghouse for best data and knowledge
- Model *AND* the collaborative process are both important products of the work
 - Both form the structure for ongoing planning, evaluation of consequences, improvement of models, and so on . . .



Overall advantages of the approach

- Reduces guess work associated with large-scale infrastructure planning projects
- Can include climatic variability, demographic patterns, economics
- Provides rigorous and quantitative evaluation of outcomes
- Provides a user-friendly, interactive tool perfect for educating policy makers and the public
- SNL projects include capacity development
 - Modeling and planning skills stay after SNL leaves

SNL decision support systems:

Active projects (as of November 2010)

Past projects beginning in 1992

Domestic

- Upper Rio Grande Simulation Model
- Energy, Power & Water Simulation Model
- SunCity Model
- Water, Energy and Carbon Sequestration Model
- Gila Basin-Az Water Settlement Model
- Electrical Grid Storage Valuation Model
- Alternative Liquid Fuels Simulation Model
- Electricity Generation Cost Simulation Model
- Virtual Water Market Model
- Geothermal Energy Tradeoff and Scenario Analysis Model
- Transition to Renewable Energy – County of Maui
- Cut-off Grade Determination for Potash Mining in New Mexico
- Validation and Verification of VISION Civilian Nuclear Fuel Cycle Model

- U.S. Energy and GH Gas Model
- Sandia-GM Biofuel Deployment Model
- Renewable Energy Systems & Learning Model
- String of Pearls Model
- Middle Rio Grande Cooperative Water Model
- Nambe Pueblo Water Budget Model
- Hydrogen Futures Simulations Model
- Barton Springs Urban Growth and Groundwater Sustainability Model
- US-Mexico Border Permeability Model
- Upper Rio Hondo Water Availability Model
- Biofuels Feasibility Modeling & Analysis Project
- Algae Biofuels Techno-Economic Modeling and Analysis Project
- Climate Change Risk Assessment Model
- Willamette Basin Temperature TMDL Model
- Insurgency as a Business Enterprise

International

- Strategy for Water and Land Resources in Iraq Model
- US-Canada Algae Biofuel Co-Location Model
- Libyan Water-Energy-Food Model
- Strategic Water Allocation Demonstration Model for the Canterbury Region of New Zealand
- Spent Fuel Management – Taipower Taiwan

- China Energy and GH Gas Model
- India Energy and GH Gas Model
- Electricity Generation Cost Simulation Model
- Iraq Water-Energy-Food Model
- The US/Mexico Water Management Model
- The Rainy River Model