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Bridging the Gap: Ideas for Water Sustainability in the Western United States

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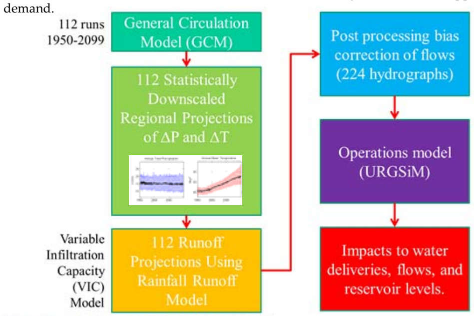
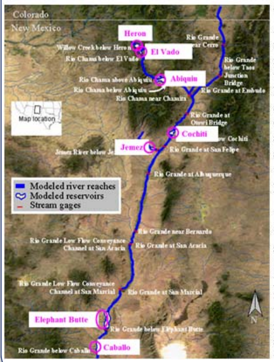
I. Background

Incremental improvements in water sustainability in the western U.S. may not be able to close the growing gap between increasing freshwater demand, climate driven variability in freshwater supply, and growing environmental consciousness. Incremental improvements include municipal conservation, improvements to irrigation technologies, desalination, water leasing, and others. These measures, as manifest today in the western U.S., are successful in themselves but limited in their ability to solve long term water scarcity issues. Examples are plainly evident and range from the steady and long term decline of important aquifers and their projected inability to provide water for future agricultural irrigation, projected declines in states' abilities to meet legal water delivery obligations between states, projected shortages of water for energy production, and others. In many cases, measures that can close the water scarcity gap have been identified, but often these solutions simply shift the gap from water to some other sector. Saline, brackish or produced water purification, for example, could help solve western water shortages in europe but will be extremely expensive, and so shift the gap from water to economics. Transfers of water out of agriculture could help close the water scarcity gap in other areas; however, loss of agriculture will shift the gap to regional food security. All these gaps, whether in water, economics, food security, or other sectors, will have a negative impact on the western states. Narrowing these future gaps requires both technical and policy solutions as well as tools to understand the tradeoffs. Here we discuss two specific examples from the western U.S., a climate risk analysis of the Upper Rio Grande basin, and assessment of water for thermoelectric development.

II. Climate Risk in the Rio Grande

The Upper Rio Grande Impact Assessment is an activity of the West Wide Climate Risk Assessment (WWCRA), a component of the U.S. Bureau of Reclamation's WaterSMART Basin Study Program. The Upper Rio Grande Impact Assessment quantitatively evaluates potential impacts associated with climate change in the Rio Grande Basin of Colorado and New Mexico, from the headwaters to Elephant Butte Reservoir, as they relate to the mission of the Bureau of Reclamation, including risks to water supplies and demand.



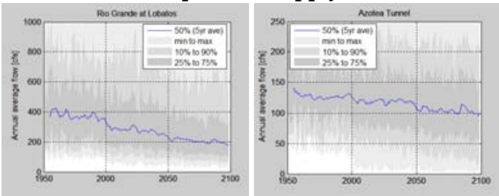


The *Upper Rio Grande Simulation Model (URGSiM)* is a monthly timestep mass balance model that tracks the movement of surface and groundwater through the Upper Rio Grande hydrologic system. URGSiM builds on available surface water, reservoir operations, groundwater, human use, and evapotranspiration models to create a systems level model of water use that is useful for scenario analysis as well as public outreach and education.

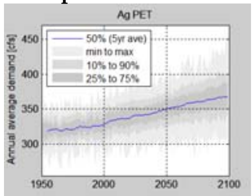
URGSiM extends from the headwaters of the Rio Grande to Caballo Reservoir in southern New Mexico, and includes the San Juan Chama transbasin diversion project. URGSiM models water movement through more than 20 surface water reaches, 7 storage reservoirs, 3 regional aquifers, ten cities and towns, and more than 60,000 acres of irrigated farmland.

II. Climate Risk in the Rio Grande (continued)

Impacts on Supply

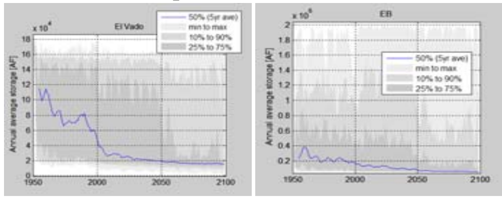


Impacts on Demand

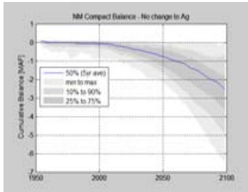


The WWCRA URGSiM modeling suggests that New Mexico's native supply of Rio Grande water as approximated by flows in the Rio Grande at Lobatos (near the Colorado New Mexico state line) and the Rio Chama near La Puente may decline by almost 50% between 2000 and 2099. San Juan-Chama supplies, imported from the Colorado River basin through the Azotea Tunnel are projected to be more reliable then native supplies, but still vulnerable to climate change impacts. Evaporative demand rising with temperature means that demand for water by crops and riparian vegetation will rise as a result of increasing temperatures in the basin.

Impacts on Reservoirs

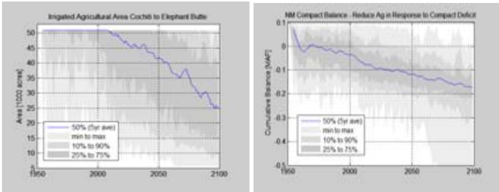


Impacts on Compact



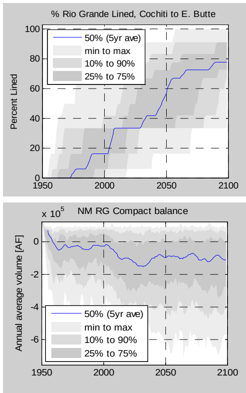
Average reservoir storage at all major storage reservoirs in the system drops significantly. Elephant Butte is almost always below 400,000 AF. El Vado, the major storage reservoir for irrigation between Cochiti and Elephant Butte reservoirs is essentially empty most years after 2050. The most significant impact however is to downstream deliveries required by the Rio Grande Compact.

Mitigation Option: Reduce Agriculture



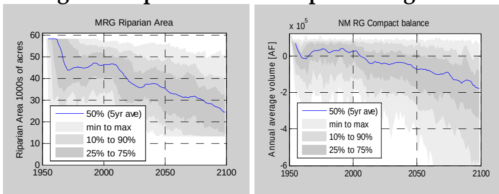
Reducing irrigated agriculture can be used to maintain New Mexico's Compact debit to a legally acceptable level. However, this strategy, used alone will require significant reductions in irrigated acreage. The median loss of irrigated acreage among the 112 projections is about 25,000 acres, or about half of the current irrigated acreage in the Middle Rio Grande.

Mitigation Option: Line River



Reducing seepage from the river can also be used to mitigate the Compact debit to legally acceptable levels. However, this strategy alone, would require that 70% to 80% of the river between Cochiti and Elephant Butte be lined by 2100. This costly lining will reduce seepage and shallow groundwater levels, leading to reduction of riparian area as trees die off.

Mitigation Option: Reduce Riparian Vegetation

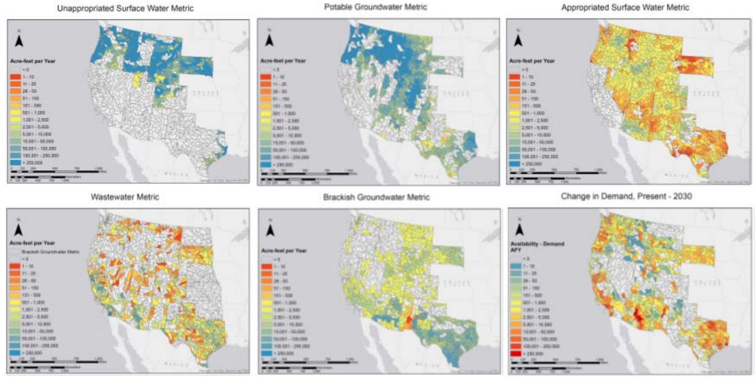


Reducing riparian vegetation area to reduce riparian consumption can also be used to reduce Compact debit. However, this strategy results in reduction of the Middle Rio Grande Bosque from ~60,000 acres to less than 30,000 acres, a change that would certainly have significant ecologic and aesthetic impacts.

III. Water for Energy in the Western U.S.

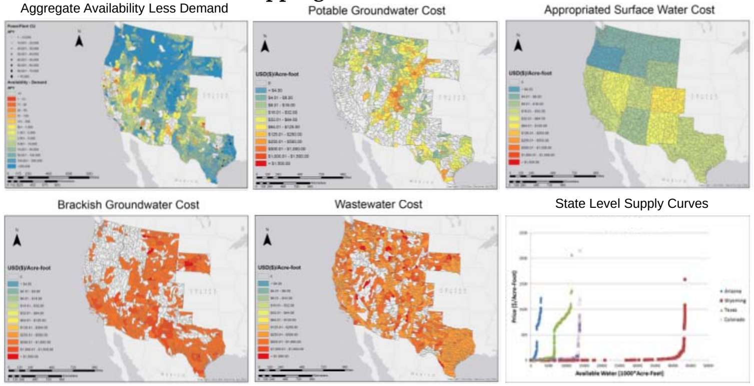
Sandia National Laboratories, supported by 4 other national labs (Argonne, Idaho, Pacific Northwest, and the National Renewal Energy Laboratory), the Electric Power Research Institute and the University of Texas is working with the Western Electricity Coordinating Council and the Electric Reliability Council of Texas in evaluating where water might limit future expansion of the power grid in the western U.S. Working with the Western States Water Council and Western Governor's Association the availability and cost of five different sources of water have been mapped for over 1200 watersheds in the West. Alternative sources of water include surface water, groundwater, abandoned water rights, municipal waste water and brackish groundwater. Water availability and costs are then aggregated into regional supply curves that are subsequently used in transmission expansion planning to balance cost, reliability, and environmental impact.

Mapping Water Availability



To explore the nexus between thermoelectric power development and water resources, the availability of five different sources of water has been mapped at the HUC8 level (~1200 watersheds) across the western U.S. Also mapped is the projected development in the non-thermoelectric sector. Metrics and data were developed in cooperation with the Western States Water Council.

Mapping the Cost of Water



Aggregating the five sources of water together and subtracting projected future non-thermoelectric demands yields the water available for thermoelectric development (top left). Results suggest there is water available in most basins for some development. However, in the majority of these basins the cost to utilize that water will be significantly more expensive than historically. The state level supply curves (bottom right) provide a rough indication of how differently the balance of water supply and associated cost vary regionally.

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NNSA National Nuclear Security Administration

U.S. DEPARTMENT OF ENERGY

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