Maintaining the Rio Grande-Elephant Butte Connection

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The New Mexico Interstate Stream Commission (NMISC) is excavating and maintaining a temporary channel through the delta and exposed sediment bottom of Elephant Butte Reservoir to help maintain flow through the system. Since 1999, drought has reduced inflow to Elephant Butte Reservoir and the reservoir has receded south more than 18 miles, exposing a delta of mud, water, and skeleton salt cedar trees. A large annual sediment load, low river slope, and invasive phreatophytes choke the river in the delta area and inhibit conveyance of water and sediment across the delta into the active reservoir pool. With downstream irrigators calling for full annual deliveries, the NMISC and the U.S. Bureau of Reclamation (USBR), through an annual cooperative program, are working to keep the river channel connected to the reservoir pool.

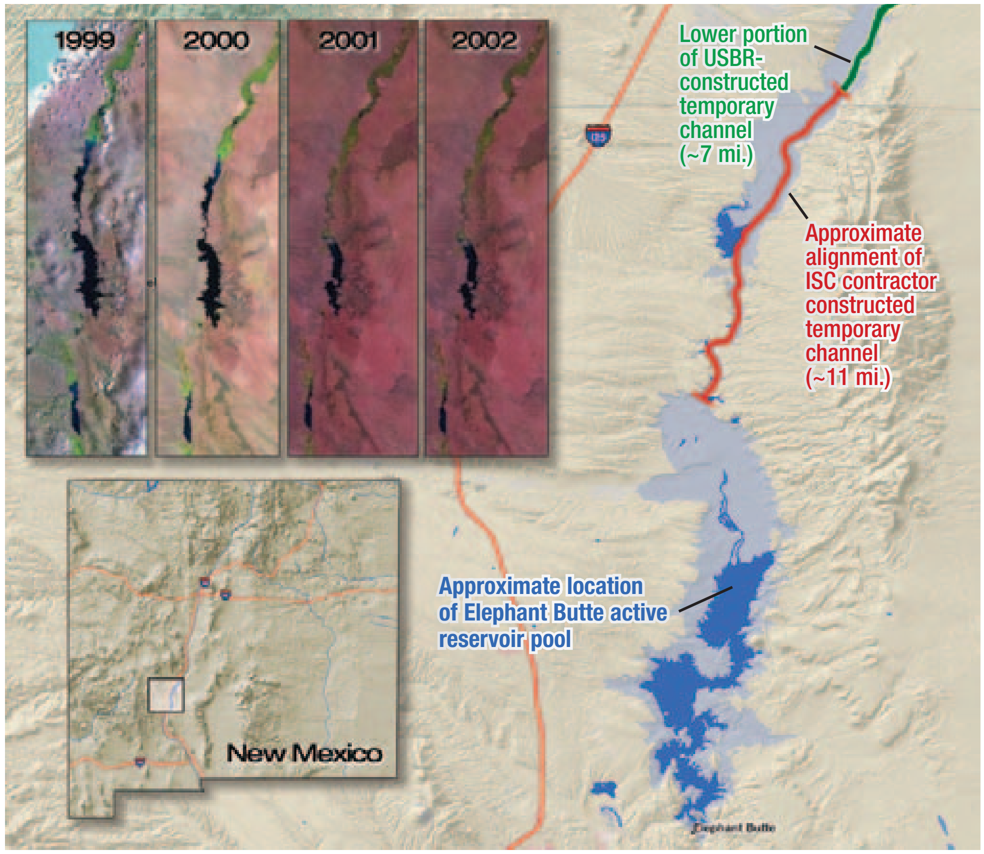
"Marsh buggies" or amphibious excavators, clear the channel through Elephant Butte Reservoir.

The temporary channel is an engineered feature constructed of soil in the reservoir bottom. Channel dimensions range from roughly 150 to 300 feet wide by three to five feet deep. The channel spoil levees are from three to more than five feet high. The project is in a remote area with limited access, roughly 45 miles south of Socorro, New Mexico. Extreme working conditions require the use of specialized heavy equipment designed to work in marshes and swamps. The photo above shows two amphibious excavators owned and operated by Wilco Marsh Buggies Inc. of Louisiana constructing the temporary channel.

The USBR is presently maintaining Phase 1 of the project, a seven-mile segment of the temporary channel at the upper end. NMISC's contractor is currently maintaining Phase 2, a section about 11 miles long located downstream from Phase 1. Phase 3, scheduled for construction in early 2005, will extend the channel further downstream to the active reservoir pool (see map next page). In the Phase 3 reach, a poorly defined, meandering natural channel will be maintained, excavated, and straightened as necessary to improve conveyance of water and sediments into the reservoir. The overall length of Phase 3 will depend on hydrologic conditions, but is expected to be three to seven miles.

The temporary channel is critical to the water supply and for meeting Rio Grande Compact obligations to Texas. An excavated and maintained pilot channel reduces water losses due to evaporation

Left: Elephant Butte panorama (photo by James Hogan). Below: Location of temporary channels. Inset: Shrinking Elephant Butte (center) and Caballo (bottom) reservoir levels, 1999-2002. Photos taken in October each year.



and riparian evapotranspiration. Preliminary calculations of total water salvage with the channel in place versus no channel indicate that depletions are reduced on the order of 600 to 1,000 acre-feet annually per mile of channel. If the current drought persists, such water savings will become increasingly important.

This project is important to the citizens of New Mexico and is being undertaken by the NMISC for several reasons:

- New Mexico's Rio Grande Compact deliveries to Texas are measured at Elephant Butte Reservoir.
- Lack of usable Rio Grande Project water affects New Mexico's ability to store water in upstream reservoirs constructed after 1929 (Article VII of the Rio Grande Compact).
- The interruption between the river and the reservoir in the 1950s contributed to New Mexico's significant accrued debit pursuant to the Compact. The Rio Grande became disconnected from the reservoir by a distance of approximately 30 miles during that time, resulting in large water losses and unmet Compact obligations. Since then, channel work has been ongoing to maintain a connection to the reservoir during periods of low project storage.
- Water savings generated by the pilot channel benefits the Elephant Butte Irrigation District, which is entitled to 57 percent of the Rio Grande Project supply released from the reservoir.
- The pilot channel project also benefits recreational water users at Elephant Butte by facilitating delivery of water to the reservoir.

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Evaluating Increased Groundwater Use in the Yaqui Valley, Mexico

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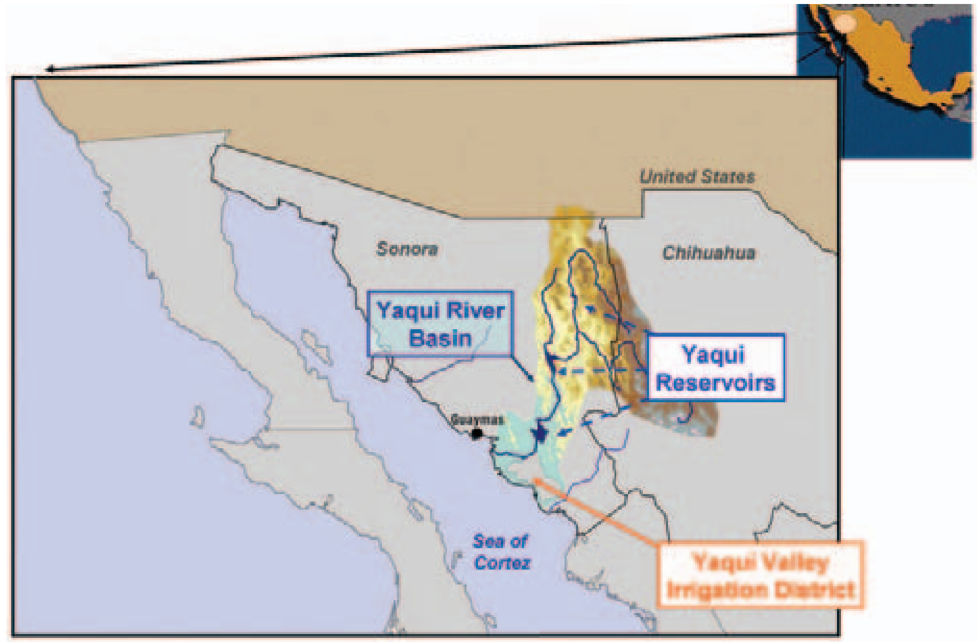


Map of the Yaqui River Basin, northwestern Mexico. The basin encompasses 72,000 km² in two Mexican states (Sonora and Chihuahua).

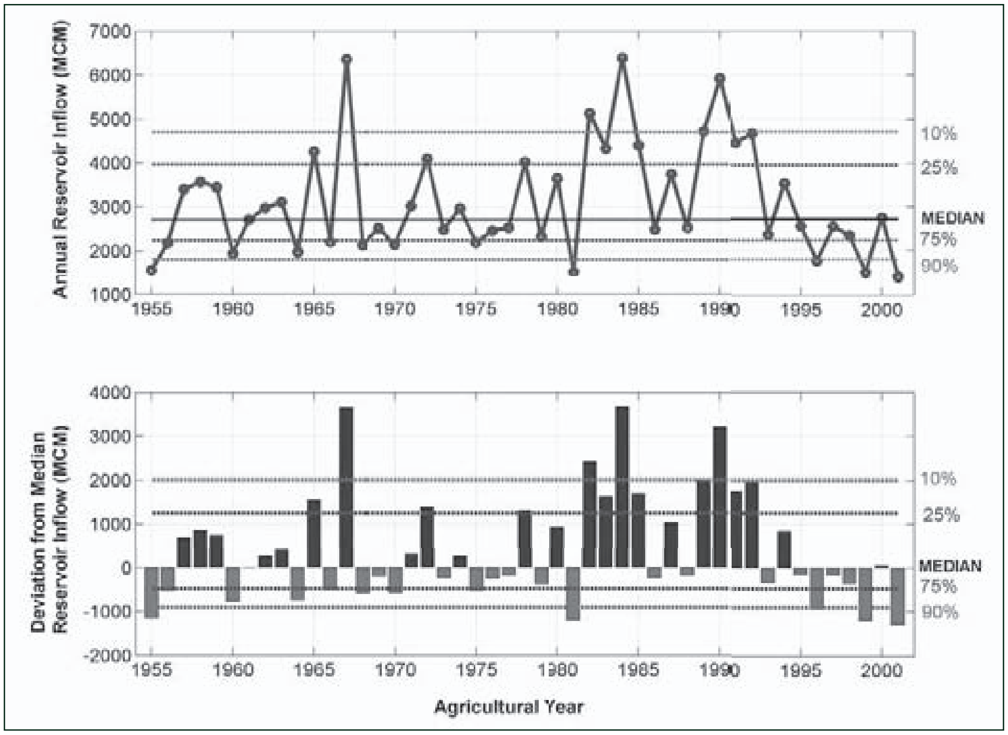
Irrigated agriculture currently accounts for 77 percent of global water withdrawals, with that figure rising to 90 percent in developing countries. Although irrigated agriculture currently represents less than 20 percent of total farmland, it contributes 40 percent to the world's total food production (World Bank, 2004). Providing enough water for agriculture requires more efficient use of existing surface water and groundwater. In addition, innovative and reliable management solutions to improve the efficiency and dependability of water systems will be crucial for maintaining the food supply from irrigated agriculture (Rosegrant et al., 2002).

The Yaqui Valley, a semi-arid, irrigated coastal plain in Sonora, Mexico, approximately 500 miles south of the Arizona border (see map), provides much of the wheat grown in Mexico. During the past seven years, however, a severe drought has reduced Yaqui River discharge, with significant economic consequences for the agriculture that is dependent upon it. Although National Water Commission planners are separately working on improved, long-term operating rules for reservoir management, local farmers in the irrigation district are beginning to turn to groundwater and have secured international funding to effectively double the well capacity through new drilling (*La Tribuna*, 2003).

In principle, increasing the use of Yaqui Valley groundwater as a buffer to surface water variability seems like a good idea. In contrast to neighboring agricultural regions to the north and south (and much of the arid southwestern United States), the Yaqui Valley historically has underutilized groundwater resources because of the normally plentiful surface water supply of the river. Prior to the recent drought, Yaqui River water used for agriculture averaged 2,619 million cubic meters (MCM) (2.1 million acre-feet) per year compared with only 225 MCM (182 acre-feet) per year of groundwater, about 8 percent of the total.

To evaluate the potential benefits of increased groundwater use in the Yaqui Valley, an integrated hydrologic-economic-agronomic modeling framework was developed by researchers at Stanford University. The management model framework represented crop and water decision-making by farm subunits of the irrigation district as well as water distribution and well pumping decision-making by the irrigation district. Eight crops were available to each module, with the three major crops (wheat, maize, and safflower) also modeled for yield response to water and salinity. A spatially explicit groundwater flow model and a canal network simulator are linked to the management models. The economics of crop prices and production costs, including energy costs for pumping, significantly influence agricultural decision-making in this area and are also integrated into the modeling framework. Since surface water is essentially free for the irrigation district, the price of district-provided water depends on both the fraction of groundwater used by the district and the pumping costs that must be passed along to farmers.

The model was run using the two-level management-modeling framework to predict groundwater use behavior over the drought period from 1995 to 2003. Initial results showed that farmers would indeed use more well capacity to supplement declining reservoir allocations. However, even though total modeled extractions are "sustainable" in a resource sense, the model also showed that during years of extremely low surface-water availability, the cumulative groundwater drawdown resulted in exceptionally high pumping costs (and therefore water prices) during the "critical year." Only high-value crops (citrus and vegetables) could be profitably grown during such a situation. Using this insight, policy makers and lenders can consider the secondary economic assistance that may be needed to support crop diversification in the valley before drilling more wells. From these preliminary results, the model will be extended to answer related "what-if" scenarios of proposed infrastructure change, such as canal lining, as well as climatic variations.



Historical reservoir inflows (net runoff) for the Yaqui River Basin, 1955-2002. The most recent drought started in 1996.

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References

La Tribuna, "Autorizan 70 Mdd al Distrito de Riego," May 12, 2003.

Rosegrant, M.W., X. Cai, and S.A. Cline, 2002. World Water and Food to 2025: Dealing with Scarcity. Washington, D.C., International Food Policy Research Institute.

World Bank, 2004. Water Resources Sector Strategy: Strategic Directions for World Bank Engagement. Washington, D.C., World Bank.

Southwest Hydrology HydroFacts

Increase in the cost of all goods and services in U.S., 1980-2003: 97%
Increase in the cost of water and sewer services in U.S., 1980-2003: 175%

Budget for NOAA's 2004 climate change research program: $70 million
Budget for 2004 climate change movie, "The Day After Tomorrow": $125 million

Maximum number of typhoons ever to hit Japan in one season prior to 2004: 7
Number of typhoons that hit Japan during 2004: 10

Fraction of water news articles, Aug. '01 to Oct. '04, from Africa containing the word "sustainable": 1 in 22
Fraction of water news articles, Aug. '01 to Oct. '04, from U.S. containing the word "sustainable": 1 in 200

Average annual population growth rate for U.S., 1970-2002: 1.1%
Average annual population growth rate for Albuquerque, Tucson, Phoenix and Las Vegas metropolitan areas: 1.9%, 2.9%, 3.9%, and 5.5%, respectively.

Gallons of water used to refine one gallon of crude oil: 44
Gallons of water used to manufacture one car, including tires: 39,090