INSTITUTIONAL ADJUSTMENTS FOR COPING WITH PROLONGED AND SEVERE DROUGHT IN THE RIO GRANDE BASIN

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EXECUTIVE SUMMARY

The Rio Grande originates in the southern Colorado Rocky Mountains, flows through New Mexico, and forms the border between the U.S. and Mexico on its way to the Gulf of Mexico. Serving over one-million acres of irrigated land and the municipal and industrial needs of cities like Albuquerque and El Paso, the Rio Grande represents a significant resource in the arid southwest.

In 1938, Congress approved the Rio Grande Compact which divided the annual water flow among the three states of Colorado, New Mexico, and Texas. The U.S.-Mexico Treaty of 1906 divides the river flows between the U.S. and Mexico. The Compact acknowledges the Treaty in Articles IV and VI by stating that the Compact shall not diminish the allocation of water to Mexico and shall not degrade its quality.

Since that time, significant growth in the Rio Grande Basin's demand for water due to increasing populations, growing economies, and emerging policies toward fish and wildlife habitat emphasizing endangered species, has stressed the region's already scarce water supply. Although the inevitable severe drought would cause significant economic damage to the regional economy, present institutional arrangements have not had to confront such an event since the 1950s. The objective of this research is to test the hypothesis that new institutions for interstate coordination of surface water withdrawal and reservoir operations could reduce economic losses resulting from water shortfalls in periods of severe and sustained drought.

A three-state research team of economists, hydrologists and a lawyer was formed to perform the analysis to test this hypothesis. A fully-integrated hydrologic-economic model was developed which extends the basin optimization procedures developed by Vaux and Howitt for California and by Booker and Young for the Colorado River Basin. The geographic scope included the Rio Grande Basin, from

Colorado through New Mexico to Fort Quitman, Texas, downstream of El Paso. The objective was to identify hydrological and economic impacts of possible changes in institutional structure for coping with drought.

This study was an effort to examine options facing river basin managers when confronted with the extenuating circumstance of a major drought. It did not attempt a precise description of the current system as it is managed. The research team realizes that many considered institutional changes for managing water considered in this report would be difficult to do, costly, and in some cases fought bitterly. Nevertheless, like other analyses of proposed changes in water policy, there are several reasons for conducting these policy experiments. Estimating impacts of a proposed water policy change can be a cheap substitute for carrying it out, especially if carrying it out has potentially high but unknown political or economic costs or benefits. If a proposed policy change produces a low economic benefit and high cost for many water users, information on the size and distribution of those benefits and costs is important. This information is a valuable resource for formulating or executing this action should it be considered is a real possibility. If, however, there is a high benefit and low cost to most water users, this is also important information to get out, for it may influence the shape of future policies pursued.

The general approach used in this study reflected the random supplies and uncertain demands for water. They also reflect river and reservoir management rules resulting from economic growth and competing demands for water to meet future needs such as endangered species habitats. Water supplies, which included all major tributaries, interbasin transfers, and hydrologically connected groundwater, were represented in a yearly time-step over a forty-four year planning horizon.

Agricultural water uses, the major source of water demands, were split into major crops for four major demand areas. Municipal and Industrial (M&I) and recreational demands were also identified. Separate economic values were identified for each water use at each major location. Information on the

economic value of each water use at each location provides important facts to decision makers who wish to know impacts of complex proposals whose implementation affects several uses at many locations.

A mathematical model was developed that kept track of economic benefits subject to hydrologic and institutional constraints, and was solved with GAMS optimization software (Appendix CD ROM). Each institutional innovation considered was tested against the baseline Law of the River, the current set of rules for storing, allocating, and using water in the basin. Each proposal was tested for its impact on reducing total economic damages under a future, long-run drought scenario defined by inflows produced by the drought of the 1950s. Results are presented as economic and hydrologic impacts of measures for coping with drought by state, economic sector, and institutional alternative.

One baseline and three alternative institutional innovations were selected for evaluation. The baseline Law of the River focused primarily on the Rio Grande Compact and related rules for allocating the total quantity of water entering the Rio Grande Basin and available for use. Total economic benefits were calculated for: (1) long run normal inflows, (2) a sequence of drought inflows, defined by historical inflows for the period 1942-1985. This period was chosen to represent the severe drought of the 1950s bound by the years leading up to and following that drought. The period was extended to 1942 and 1985 because spills occurred in these two years, wiping out accrued debits and credits under the Compact. For that period, average inflows summed over six headwater stream gages used for this study were 1.40 million acre-feet per year, about 11 percent below the long-run average of 1.57 million.

Total drought damages were computed as the reduction in future economic benefits if future inflows to the basin averaged 1.40 million acre-feet per year compared to economic benefits if inflows averaged 1.57 million. Future economic activity is based on best available estimates for growth in M&I uses based on projected growth of the Albuquerque and El Paso areas.

Long-run annual average future drought damages, defined as the direct economic value of damages caused by the reduced streamflows to water users, were estimated at $5.8 million for the San

Luis Valley (Colorado), $3.37 million for New Mexico, and $8.0 million for west Texas, or about $101 per acre-foot of water supply reduction. Indirect economic impacts, resulting from interactions among drought-damaged water-users and the rest of the economy, were not measured.

The first institutional adjustment analyzed was increased carryover storage at Elephant Butte Reservoir. This carryover storage was based on reducing Rio Grande project deliveries downstream of Elephant Butte by 25,000 acre-feet per year in normal years, to be stored for use in drought years. The long- run average annual economic value of drought damages mitigated by this institutional change was zero for Colorado, minus $200,000 for New Mexico, and minus $433,000 for west Texas. This means that the current Law of the River produces less drought damage than the proposed institution of storing the added water at Elephant Butte.

The second institutional adjustment analyzed was a proposal to invest in technical measures to increase irrigation efficiency for the Middle Rio Grande Conservancy District, in which net stream depletions required for application to crops would be reduced by 18 percent. This institutional change produced virtually zero drought damage mitigation to each of the three states. Reduced water diverted from the Rio Grande brought about by greater irrigation efficiency would also considerably reduce irrigation return flows to the river. The result would be virtually zero water saved and essentially zero economic benefit. Zero drought damage mitigation benefits accrued to Colorado, $7,000 per year to New Mexico, and $15,000 to West Texas. This means that the cost of technologies needed to implement these increased irrigation efficiencies would have to be virtually zero to justify such investments economically.

The final institutional adjustment analyzed was to build 100,000 acre feet of new reservoir storage in northern New Mexico above Cochiti Lake. This action produced zero long-run average annual benefit to Colorado, $134,000 to New Mexico water users, and $685,000 to West Texas water users. The bulk of these benefits would result from reduced reservoir evaporation and reduced Rio Grande Compact over-deliveries by New Mexico to Texas.

Although the model developed for this study was comprehensive and detailed, it has several limitations in its current state. Overall, it does not precisely represent the behavior of the Rio Grande Basin system. One special area where further improvement is needed is to develop a better understanding and modeling of connections among economics, surface water movement, groundwater hydrology, and behavior of water users.

If improved models are to be used to support development, execution, and evaluation of proposed decisions, considerable resources need to be put into model development and use. The kind of integrated, basin-wide modeling described in this report is a new area of research. The integrations required between modeling the behavior of water users and underlying natural processes are quite complex, poorly understood, and will require much work and patience to bring to full fruition.

Nevertheless, this study succeeded in organizing a highly integrated interdisciplinary study dealing with water management in an important western river basin. Most western river basins are under stress, from natural factors like drought, institutional factors such as endangered species requirements, and external factors like economic growth. The use of interdisciplinary teams to build and apply models such as described in this report, helps prepare society for dealing with unexpected circumstances, such as drought, to cope with future stresses on river basins.

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