CHAPTER 2 -- RELATED RESEARCH

Causes and Effects of Drought

Climate describes a normal condition. A climatic change alters that condition. In contrast, a drought is a temporary departure from the normal. However, this conceptual distinction blurs in application because one never knows at the time they occur whether a series of years is a short-term fluctuation or a change in the long-term condition.

While continued future efforts will add scientific understanding with long-term payoffs, the near-term need is to develop quantitative models for better drought evaluation. This will buy time in preparing for the drought and relax the more stringent and costly water use controls during and after serious drought periods. The result could provide sounder information for deciding which water management policies should be implemented, intensified, or discontinued.

Yevjevich (1967) described how drought losses grow out of the time and space processes of supply and demand for water. The severity of a drought depends on its duration intensity, and geographical extent. These physical factors define the supply side. On the demand side, drought is a deficit in water availability for human purposes, riparian vegetation, and endangered species. Where past research has emphasized hydrologic characteristics, this study extends to societal impacts by integrating demand with supply considerations.

A primary problem in studying the interface between water supply and demand is that the water shortages during drought years occur in different ways. Mixing these concepts often leads to management confusion on what action to take. A drought may be meteorologic (shortages in precipitation), agricultural (shortages in soil moisture), hydrologic (shortages in runoff, streamflow, and reservoir contents), or economic (losses determined by all three shortages). The four indicators are poorly correlated (Wilhite and Glantz 1987) because of complex but unknown relations in the divisions

of rainfall between infiltration and runoff and infiltrated soil moisture between soil-water storage and percolation below the plant root zone. Quantitatively, agricultural and hydrologic drought are based on two different precipitation filters. Economic drought adds a third.

Systems Operations

The structural systems supplying water in the three Basin states of Colorado, New Mexico, and Texas, are distinct but interlinked (Figure 1.1). Their operating rules, governed largely by the Rio Grande Compact, are mostly coordinated on an ad hoc basis and are generally inflexible when adapting to extreme drought events. One major potential contribution of drought contingency planning in this case comes from a finding (Getches 1989) that people and institutions are largely willing to cooperate in emergencies. Having contingency plans should help them quickly reach sound policies so they do not have to rely on ad hoc consideration of rapidly changing events.

Each structural system is operated following rules that have largely been developed and tested over time and codified into law. These have been incorporated into the models used by the various agencies for their water management purposes. The U.S. Bureau of Reclamation, the Corps of Engineers, and Texas A&M University (Rosenthal, et. al. 1995; Srinivasan and Arnold 1994; Srinivasan and Engle 1994) have developed models that could have been adapted for the Rio Grande system.

Drought Response Planning

There is a need to complement state drought programs with regional and national plans that address trans-state water and land use management issues (Easterling 1988; Morton 1988). However, this is complicated by:

- The difficulty in measuring the long-term and cumulative effects of drought (Riebsame 1987).

- The fact that the magnitude and severity of drought is never known until the event is viewed in retrospect (Gleick 1988).
- The spatial and temporal scales affiliated with drought exceed those for which policies and programs have historically been developed (Ciborowski and Abrahamson 1987).

Political and Institutional Analysis

A series of papers published in the *Water Resources Bulletin* summarized findings from a comprehensive study on coping with severe and sustained drought in the Colorado River Basin. These papers included hydrologic aspects (Meko et. al. 1995; Tarboton 1995), economic issues (Booker and Colby 1995; Booker 1995) , and institutional (Kenney 1995) and policy (Henderson and Lord 1995) responses to drought.

Institutional innovation may well be the most important present challenge in water resources planning (Ingram 1986; Allee et al. 1982). It offers potential solutions to many water resource problems, such as the use of water markets in managing water supply (Livingston 1985; Lord 1984). Several sets of criteria for evaluating water resource institutions have been proposed (Ostrom and Ostrom 1972; Dworsky and Francis 1973; Minton et al. 1980; and Blomquist and Ostrom 1985). These criteria cover the jurisdiction and authorities of an agency; the accountability, equity, and public acceptance of an agency's programs; and the technical capabilities of an institution. The evaluation criteria used for the current study were developed to identify economic damages of drought from the perspectives of each water-use sector (e.g., instream, agricultural, municipal, industrial), each drought scenario considered, and each of the three states.