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## State Actions to Mitigate Drought: Lessons Learned

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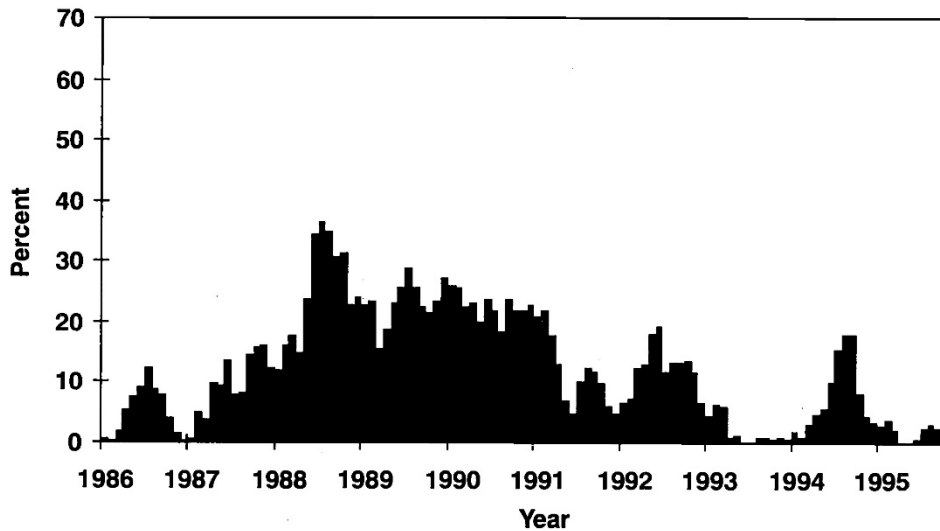
### Abstract

Drought has been a common feature in the United States during the past decade and has resulted in significant economic, social, and environmental impacts in virtually all parts of the nation. The purpose of this paper is two fold. First, the status of state drought planning is discussed to illustrate the significant increase in the number of states that have prepared response plans—from three states in 1982 to 27 in 1997. In addition, six states are now in various stages of plan development. Second, mitigative actions implemented by states in response to the series of severe drought years since 1986 are summarized. This information was obtained through a survey of states. The study concludes that states have made significant progress in addressing drought-related issues and concerns through the planning process. However, existing plans are still largely reactive in nature, treating drought in an emergency response mode. Mitigative actions adopted by states provide a unique archive that may be transferable to other states. Incorporating these actions into a more anticipatory, risk management approach to drought management will help states move away from the traditional crisis management approach.

**Keywords:** drought planning, water resources planning, water policy, water management, state government

**Introduction**

Drought is a normal, recurrent feature of the climate of virtually all portions of the United States. Because of the country's size and the wide range of climatic regimes, it is rare for drought not to exist somewhere in the country each year. The most recent series of drought years that has plagued the country since 1986 has extended almost uninterrupted to the present. During this time, drought has affected all or a portion of nearly all states; in some instances, states were affected for six or seven consecutive years. The percent area of the contiguous United States, according to the Palmer Drought Severity Index (Palmer, 1965), that has been in severe and extreme drought (i.e.,  $\leq -3.0$ ) from 1986 to 1995 is shown in figure 1. During 1988, the most severe drought year, nearly 40 percent of the nation was in severe to extreme drought. In 1996, the drought in the Southwest and southern Great Plains states affected approximately 20 percent of the nation.



**Figure 1.** Percent area of the United States experiencing severe to extreme drought, January 1986–October 1995. Source: National Climatic Data Center

The occurrence of severe drought, especially when extended over several seasons or a series of consecutive years, often results in serious economic, environmental, and social consequences. During 1995–1996, for example, drought plagued large portions of the Southwest and southern Great Plains states during the winter, spring, and summer months. For some parts of this drought-stricken region, 1996 was actually the second or third consecutive water-short year. Impacts on agriculture, energy, water supply, and other sectors were significant throughout the region. In Texas, costs and losses were the most dramatic; impacts through mid-summer were estimated to be approximately \$6.5 billion (Boyd, 1996).

In response to recent droughts, states have implemented numerous measures to mitigate some of the most serious drought impacts. Collectively, these responses help provide

a catalog of options now available to states to lessen the burden of drought. These options, in many cases, may be transferable to other states or countries, with appropriate modifications.

This paper has two objectives. First, the paper will update the reader on the status of state-level drought planning efforts in the United States. There has been a rapid increase in state-level planning efforts in recent years in response to numerous factors, including the pattern of severe drought (Wilhite and Rhodes, 1994) and the existence of models for states to follow in developing a plan (Western States Water Council, 1987; Wilhite, 1991a). Second, the paper will highlight the types of mitigative actions taken by drought-stricken states in response to droughts that occurred during the late 1980s and early 1990s. The paper will conclude with some recommendations for future directions regarding state-level drought planning efforts.

### **State-Level Drought Planning: Current Status**

The number of states with drought plans has grown from three in 1982 to 27 in 1997 (fig. 2). In 1991, 23 had drought plans (Wilhite, 1991b). In addition to the states that now have plans, six states (Alabama, Arizona, Oklahoma, Louisiana, Texas, and New Mexico) are at various stages of plan development. Texas undertook a comprehensive feasibility study in 1994 to consider an appropriate drought management plan (Water Demand/Drought Management Technical Advisory Committee, 1994). This study recognized the need for a statewide plan and recommended the development of a drought planning and response framework as part of the state water plan. Largely as a result of the 1996 drought, Texas is now moving forward with a major drought planning effort. In response to the 1996 drought, Oklahoma initiated long-term drought planning activities, and New Mexico and Arizona have received funding to develop a statewide drought contingency plan. Alabama and Louisiana began drought planning efforts before the 1996 drought. Two additional states allocate drought planning authority to regional (Florida) or local (California) authorities. Constraints to plan development were discussed by Wilhite and Easterling (1987), Wilhite (1992), and Wilhite (1996). Although the increase in the number of state drought plans is an extremely positive sign, these plans are still largely reactive, treating drought in an emergency response mode.

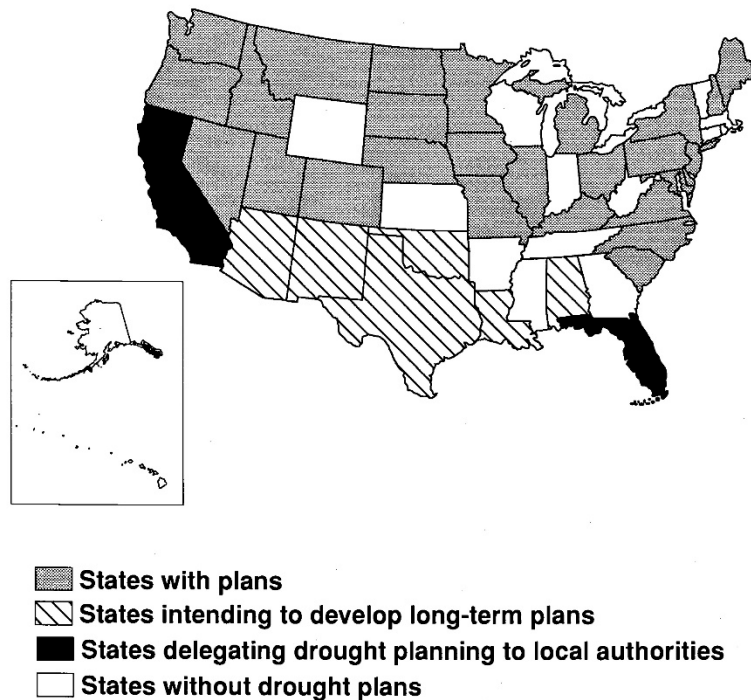


Figure 2. Status of state drought plans, August 1996

This pattern of state-level drought planning is quite complex and cannot be explained adequately on the basis of drought climatology alone. A state's decision to develop (or not to develop) a drought plan is based on specific climatological, political, economic, environmental, and demographic factors. Wilhite and Rhodes (1994) constructed a typology of state behavior in an attempt to explain the current pattern of drought plans that existed in the early 1990s and found that social, political, and institutional influences may be more important than recent drought experiences. They speculated that the increase in state drought planning activities may also have been the result of improved capabilities of state governments in conjunction with the Reagan administration's "New Federalism" initiative and concurrent federal regulatory mandates to state and local governments, states' concerns about federal intrusion into state-level water resource planning and water rights, and some states' early experiences in working with the newly formed FEMA. Issues such as these may have contributed to an increased awareness of the value of drought planning within some state governments.

The basic goal of state drought plans is to improve the effectiveness of state response efforts by enhancing monitoring and early warning; impact assessment; and preparedness, response, recovery, and mitigation programs. These plans are also directed at improving coordination within agencies of state government and between local, state, and federal government. The growth in the number of states with drought plans suggests an increased concern about the potential impact of extended water shortages and an attempt to address

those concerns through planning. In the United States, states are clearly the policy innovators for drought management (Wilhite, 1991b), in contrast to Australia, where the federal government has provided most of the leadership, in concert with the states, for the development of a national drought policy (White et al., 1993).

State drought plans take many forms. Some concentrate largely on impacts in one principal sector (e.g., agriculture, municipal water supply), while others attempt to address a full range of impacts within the state. One of the first states to develop a drought plan was Colorado. This plan was developed in 1981 at the request of the governor and is quite comprehensive. Since development, the plan has undergone revisions to improve the state's capacity to deal with extended periods of water shortage. The Colorado Drought Response Plan is administered by the Office of Emergency Management under the authority of the Colorado Natural Hazards Mitigation Council (Truby and Boulas, 1994).

### **Lessons from Recent Droughts: State-Level Mitigation Tools**

Wilhite (1993a) recently assessed ongoing and developing federal, interstate, and state drought mitigation technologies, programs, and policies in the United States. This study was based on the assumption that the roles of federal and state governments in drought mitigation needed to be reexamined, given the severity of drought experienced in the United States between 1986 and 1992; the economic, social, and environmental costs associated with these droughts; and the mitigation actions and policy efforts under way at all levels of government. The impacts of the 1987–1989 drought have been reviewed by Riebsame et al. (1990). One of the goals of the study was to identify opportunities to improve the effectiveness of drought mitigation efforts by the Soil Conservation Service (now called the Natural Resources Conservation Service) of the U.S. Department of Agriculture and other federal agencies. A premise of this study was that the nation's ability to cope with and manage water shortages resulting from drought would only be improved if an integrated approach within and between levels of government, involving regional organizations and the private sector where appropriate, were adopted.

This section of the paper reports on emerging drought assessment, response, and mitigation technologies employed by state government to lessen the effects of severe droughts in recent years. Numerous innovative institutional technologies were introduced during this period to manage water more effectively and efficiently in response to drought and increased demand. These data were collected through a survey of states and key federal agencies with responsibility for the management of water and other natural resources. The survey was directed at specific drought mitigation actions taken or programs adopted during the period from 1986 to 1992.

Mitigation is defined in several ways in the natural hazards literature. Hy and Waugh (1990) referred to mitigation as activities that reduce the degree of long-term risk to human life and property. These actions normally include insurance strategies, the adoption of building codes, land-use management, risk mapping, tax incentives and disincentives, and diversification. Drought is not often directly responsible for loss of life and its impacts are largely nonstructural. Therefore, this definition is not appropriate in this case. For the purpose of assessing mitigative actions specific to drought, this definition was modified as

follows: short- and long-term actions, programs, or policies implemented in advance of drought that reduce the degree of risk to people, property, and productive capacity.

In the study referred to above (Wilhite, 1993a), the survey instrument purposely did not define the term mitigation. States were given flexibility to define mitigation by including actions or activities that they felt were appropriate. However, the definition given above was used to help understand and cluster the actions and activities reported by states. Mitigation activities identified by states and/or local municipalities during recent droughts were diverse, reflecting regional differences in impacts, legal and institutional constraints, and institutional arrangements associated with drought plans. The diversity in responses was also related to the wide range of state agencies with principal authority for drought planning and mitigation (e.g., agriculture, natural resources, water resources, emergency or disaster management).

State mitigation actions used to address issues during recent droughts are clustered into nine primary areas in table 1. These actions represent a full range of possible mitigative actions, from monitoring and assessment programs to the development of drought contingency plans. Some of the actions included were adopted by many states, while others may have been adopted only in a single case.

**Table 1.** Drought-Related Mitigative Actions of State Government in Response to Recent Episodes of Drought (Wilhite, 1993b)

Category	Specific Action
Assessment Programs	<ul style="list-style-type: none"> <li>▪ Developed criteria or triggers for drought-related actions</li> <li>▪ Developed early warning system, monitoring program</li> <li>▪ Conducted inventories of data availability</li> <li>▪ Established new data collection networks</li> <li>▪ Monitored vulnerable public water suppliers</li> </ul>
Legislation/Public Policy	<ul style="list-style-type: none"> <li>▪ Prepared position papers for legislature on public policy issues</li> <li>▪ Examined statutes governing water rights for possible modification during water shortages</li> <li>▪ Passed legislation to protect instream flows</li> <li>▪ Passed legislation providing guaranteed low-interest loans to farmers</li> <li>▪ Imposed limits on urban development</li> </ul>
Water Supply Augmentation/ Development of New Supplies	<ul style="list-style-type: none"> <li>▪ Issued emergency permits for water use</li> <li>▪ Provided pumps and pipes for distribution</li> <li>▪ Proposed and implemented program to rehabilitate reservoirs to operate at design capacity</li> <li>▪ Undertook water supply vulnerability assessments</li> <li>▪ Inventoried self-supplied industrial water users for possible use of their supplies for emergency public water supplies</li> <li>▪ Inventoried and reviewed reservoir operation plans</li> </ul>

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| Public Awareness/Education Programs  | <ul style="list-style-type: none"><li>▪ Organized drought information meetings for the public and the media</li><li>▪ Implemented water conservation awareness programs</li><li>▪ Published and distributed pamphlets to individuals, businesses, and municipalities on water conservation techniques and agricultural drought management strategies</li><li>▪ Organized workshops on special drought-related topics</li><li>▪ Prepared sample ordinances on water conservation for municipalities and domestic rural supplies</li><li>▪ Established drought information center as a focal point for activities, information, and assistance</li></ul>  |
| Technical Assistance on Water/<br>Water Conservation and Other Water-Related<br>Activities | <ul style="list-style-type: none"><li>▪ Provided advice on potential new sources of water</li><li>▪ Evaluated water quantity and quality from new sources</li><li>▪ Advised water suppliers on assessing vulnerability of existing supply system</li><li>▪ Recommended that suppliers adopt water conservation measures</li></ul>   |
| Demand Reduction/<br>Water Conservation Programs   | <ul style="list-style-type: none"><li>▪ Established stronger economic incentives for private investment in water conservation</li><li>▪ Encouraged voluntary water conservation</li><li>▪ Improved water use and conveyance efficiencies</li><li>▪ Implemented water metering and leak detection programs</li></ul>   |
| Emergency Response Programs  | <ul style="list-style-type: none"><li>▪ Established alert procedures for water quality problems</li><li>▪ Stockpiled supplies of pumps, pipes, water filters, and other equipment</li><li>▪ Established water hauling programs for livestock from reservoirs and other sources</li><li>▪ Compiled list of locations for livestock watering</li><li>▪ Established hay hotline</li><li>▪ Provided funds for improving water systems, developing new systems, and digging wells</li><li>▪ Provided funds for recovery programs for drought and other natural disasters</li><li>▪ Lowered well intakes on reservoirs for rural water supplies</li><li>▪ Extended boat ramps and docks in recreational areas</li><li>▪ Issued emergency surface water irrigation permits from state waters</li><li>▪ Created low-interest loan and aid programs for agricultural sector</li><li>▪ Created a drought property tax credit program for farmers</li><li>▪ Established a tuition assistance program to enable farmers to enroll in farm management programs</li></ul> |



Water Use Conflict Resolution	<ul style="list-style-type: none"> <li>▪ Acted to resolve emerging water use conflicts</li> <li>▪ Negotiated with irrigators to gain voluntary restrictions on irrigation in areas where domestic wells were likely to be affected</li> <li>▪ Established a water banking program</li> <li>▪ Clarified state law regarding sale of water</li> <li>▪ Clarified state law on changes in water rights</li> <li>▪ Suspended water use permits in watersheds with low water levels</li> <li>▪ Investigated complaints of irrigation wells interfering with domestic wells</li> </ul>
Drought Contingency Plans	<ul style="list-style-type: none"> <li>▪ Established statewide contingency plans</li> <li>▪ Recommended to water suppliers the development of drought plans</li> <li>▪ Evaluated worst-case drought scenarios for possible further actions</li> <li>▪ Established natural hazard mitigation council</li> </ul>

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Assessment programs adopted by states range from the development of improved criteria or triggers for the initiation of specific actions in response to drought to the establishment of new data collection networks. Automated networks such as those that exist in Nebraska, California, and Oklahoma have significantly improved the states' monitoring capabilities. One of the three critical components of a drought plan is a comprehensive early warning system. Parameters that must be monitored to detect the early onset of drought include temperature and precipitation, stream flow, reservoir and ground water levels, snowpack, and soil moisture. Each of these parameters represent different components of the hydrologic system and, therefore, impact sectors (e.g., agriculture, energy, transportation, recreation and tourism). To assess emerging drought conditions, these data must be integrated to provide a comprehensive snapshot of water availability and outlook. Many recommendations for the development of a national drought watch (Riebsame et al., 1990) or integrated climate monitoring system (U.S. Congress, OTA, 1993; Wilhite and Wood, 1994; FEMA, 1996) have been offered but not implemented. Some states have also undertaken vulnerability assessments of public water supplies in conjunction with drought planning efforts. This is an especially critical issue in states with many small water supply systems that may be quite sensitive to extended periods of water shortage. It is important to identify vulnerable systems in advance so that adequate mitigation measures can be adopted.

Legislative actions included the passage of measures to protect instream flows and guarantee low-interest loans to farmers. Low-interest loans, a common federal response to drought, are not generally state financed. Many states have been reexamining aspects of water rights doctrine in response to growing water use and associated conflicts. Water banks have been used in some states (e.g., California) as a means of temporarily modifying water allocation procedures during water shortages. The California Drought Water Bank program is an example of an innovative and successful mitigation action (California Department of Water Resources, 1992). This program was created in 1991. It allowed the Department of Water Resources to acquire water in three ways: (1) by purchasing water from

farmers who chose not to irrigate; (2) by purchasing surplus water from local water districts; and (3) by paying farmers or water districts to use ground water instead of surface water. MacDonnell et al. (1994) present a review of water banking in the West.

Augmentation of water supplies during recent droughts included rehabilitating reservoirs to operate at design capacity and reviewing reservoir operation plans. Cities also worked with self-supplied industrial Wilhite users on programs to reallocate some water for emergency public water supplies.

One of the key responsibilities of state government during periods of drought is to keep the public aware of the severity of the situation through timely reports. These reports must provide a clear rationale for mitigative actions that are being imposed on either a voluntary or mandatory basis. During recent droughts, states organized informational meetings for the media and the public, implemented water conservation awareness programs, prepared and distributed informational materials, and organized workshops on drought-related topics. Sample ordinances on water conservation were also prepared and distributed to municipalities and rural suppliers.

Most states lack the financial resources necessary to provide drought relief to individual citizens during times of emergency. However, it is often within the mission and capacity of state agencies to provide technical assistance to municipalities and others. During recent droughts, states assisted by providing advice on potential new sources of water and evaluating the quality and quantity of those supplies. Agencies also assisted municipalities in assessing the vulnerability of water supply systems. States encouraged the adoption of voluntary water conservation measures and established stronger economic incentives for water conservation within the private sector. Water metering and leak detection programs were implemented.

Emergency response programs would not be considered by some as a mitigative action. However, if these measures are implemented to reduce immediate impacts or the risk of future impacts as part of a longterm mitigation program, they represent a proactive approach to drought management. State responses included a wide range of measures such as lowering of well intakes on reservoirs for rural water supplies, establishing water hauling programs for livestock, extending boat ramps in recreational areas, and creating a tuition assistance program to enable farmers to participate in farm management classes.

Conflicts between water users increase during water-short periods. Timely intervention to resolve these conflicts will become increasingly necessary as demands on limited water supplies continue to expand in number and complexity. The best approach is to anticipate these conflicts well in advance of drought and initiate appropriate actions to avoid conflict. Many of the actions taken focused on the growing conflicts between municipal and agricultural water use.

As mentioned previously, the growing number of states with drought plans is an indication of greater concern about the impacts of drought and the acceptance by states of the role that planning can play in reducing some of its most adverse effects. The optimal time to plan for drought is during nondrought periods; however, considerable progress in establishing a basic response framework is often accomplished during the period of peak severity, as occurred in several drought-stricken states in 1996. The challenge is to transform this framework into a response/mitigation plan during the post-drought period. A

brief window of opportunity usually exists to initiate a longer term mitigation program between the panic stage of the hydro-illogical cycle at the peak of drought severity and the beginning of the apathy stage when rainfall returns to normal. The hydro-illogical cycle is often used to explain the crisis management approach to drought management and is discussed in detail at the National Drought Mitigation Center's home page (<http://enso.unl.edu/ndmc>) and by Wilhite (1993b). Several states in the Southwest and southern Great Plains are attempting to capture the interest in this past summer's crisis and direct it toward a longer term planning process (e.g., New Mexico, Texas, and Oklahoma).

Many of the mitigative programs implemented by states during recent droughts can be characterized as emergency or short-term actions taken to alleviate the crisis at hand, although these actions can be successful, especially if they are part of a preparedness or mitigation plan. Other activities, such as legislative actions, drought plan development, and the development of water conservation and other public awareness programs, are considered actions with a longer-term vision. As states gain more experience assessing and responding to drought, future actions will undoubtedly become more timely and effective and less reactive. Viewed collectively, the mitigative actions of states in response to recent drought conditions are numerous, but most individual state actions were quite narrow. In the future, state drought plans need to address a broader range of mitigative actions, including provisions for expanding the level of intergovernmental coordination. Table 1 is illustrative of the arsenal of mitigation programs and actions currently available to states. One of the goals of the NDMC is to facilitate this process. Improved coordination will require a greater commitment by federal agencies to work together and with states to promote an integrated approach to drought planning. Coordination at the federal level will likely require the establishment of an interagency task force, as recommended by the U.S. Congressional Office of Technology Assessment (1993).

### **Conclusions and Recommendations**

The trend is clear. Societal vulnerability to natural hazards such as drought is increasing and at an alarming rate. Increasing demand for water and other shared natural resources is real and illustrates the necessity of learning to cope more effectively with both short-term and extended periods of drought in the United States and elsewhere. During the past decade in the United States, widespread and severe drought has resulted in an increased awareness of the nation's continuing vulnerability to this creeping natural hazard. This experience has resulted in numerous initiatives by state government to improve the timeliness and effectiveness of response efforts.

Progress made by states in the past 15 years in the field of drought planning has been impressive, but these plans continue to stress emergency response. Although these plans generally provide for a more coordinated and effective response to the emergency, they are still largely reactive (i.e., crisis management) rather than proactive (i.e., risk management). Little thought or attention has been given to actions that could be taken or programs that could be implemented in advance of the next drought to reduce impacts. What is needed is a thorough and systematic assessment of vulnerable sectors by each of the states.

As noted in this paper, states have developed and implemented a wide range of mitigation measures, but the transition from crisis to risk management is a difficult task. Each state must assess its own unique experiences (i.e., lessons learned) and share these lessons with other states. The collective experiences of states in responding to and preparing for drought is a unique archive of information that, if applied systematically, can help mitigate the effects of future drought.

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