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Drought Preparedness in the United States: Recent Progress

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Abstract

Since 1986, the United States has experienced numerous droughts causing billions of dollars in losses in many economic, social, and environmental sectors. To lessen the risks associated with drought, governments at all levels have taken greater interest in drought planning, with the greatest progress coming at the state level. However, state plans, and recent actions taken by states in response to drought, have been largely reactive, emphasizing short-term actions over long-term planning. The National Drought Mitigation Center's program is directed toward helping governments and others lessen societal vulnerability to drought. The NDMC provides a national drought information clearinghouse; assists state, federal, and regional entities in drought planning; advises on policy issues; and interacts with scientists on an international level. The establishment of the National Drought Policy Commission by the U.S. Congress in 1997 indicates a new commitment to a national drought policy that emphasizes risk management, but the accomplishment of this commission is uncertain at this time.

1. Introduction

Drought continues to be a common visitor to the American landscape despite a trend of increasing precipitation for most portions of the country (Karl et al., 1995). The period from 1986 to the present witnessed numerous severe and extended drought periods that resulted in significant impacts in nearly all portions of the nation. Drought conditions in 1986 affected most of the Southeast, and these conditions continued into 1987 for a portion of the region. The West experienced widespread drought in 1987, with conditions worsening in 1988. Drought persisted through 1992 for a large portion of the West. Some portions of

this region, particularly California and Nevada, experienced six consecutive drought years from 1987 to 1992.

The most widespread drought year during the period from 1986 to 1992 was 1988, when nearly 40% of the nation experienced severe to extreme drought conditions. Drought extended across most of the West through the northern Great Plains and into the Midwest and parts of the Southeast. Costs and losses associated with this drought have been estimated at nearly \$40 billion (Riebsame et al., 1991), making it the costliest disaster in American history. Impacts affected many sectors, including agriculture, transportation, energy, and recreation and tourism. Environmental impacts were also significant as forest and rangeland fires were rampant throughout the West and water shortages put wildlife at risk. Federal government responded with more than \$5 billion in drought relief programs (Riebsame et al., 1991). Drought continued in 1989 but was confined mostly to the western states; it resulted in serious reductions in agricultural yields in the Great Plains.

This series of drought years ended abruptly in 1993 with one of the wettest years on record. Flooding occurred over much of the Missouri and Mississippi river basins. However, drought conditions emerged again in 1994 over large portions of the West. In 1995, a short-term drought affected the northeastern states, followed by severe drought in the Southwest and southern Great Plains states in 1996. This drought resulted in impacts of nearly \$6 billion in Texas alone (Boyd, 1996). Drought revisited this region in 1998. Drought conditions also existed in the Southeast in 1998; in particular, Louisiana, Georgia, Florida, and South Carolina experienced serious impacts on agriculture, tourism, and municipal water supply. Wildfires were especially serious in portions of Florida. Drought impacts were estimated to be \$2 billion and \$5 billion in Oklahoma and Texas, respectively (Thurman, 1998; Chenault and Parsons, 1998). Drought conditions developed in the northeastern and mid-Atlantic states during the 1998–99 winter season, resulting in drought warnings in portions of New York, Pennsylvania, and the Delaware River Basin. These conditions eased in early February. Other portions of the United States, in particular the Southwest and southern Great Plains states, are preparing for the possibility of severe drought during the spring and summer months of 1999 as a result of La Niña.

During the period since 1986, interest in drought planning increased dramatically as a strategy to reduce the risk associated with extended periods of water shortage, and political will to make substantive changes in the way governments at all levels in the United States deal with drought is being sustained. Historically, government actions have focused on response, with little attention to mitigation. This crisis management approach to drought management has been largely ineffective, poorly coordinated, and untimely (Wilhite et al., 1986), as recent drought assessments (e.g., Western Governors' Association, 1996) have noted.

The purpose of this paper is to review recent progress in drought planning and mitigation in the United States. Discussion will focus on progress made by state government in drought planning, examples of recent mitigation actions, the role of the National Drought Mitigation Center (NDMC), and the mission of the newly formed National Drought Policy Commission (NDPC). The paper will conclude by speculating on some recommended next steps. Some of the lessons learned in the United States may be of value to Europe as it tries to initiate a more coordinated approach to drought mitigation.

and response and mitigation programs. These plans are also directed at improving coordination within agencies of state government and between 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. Drought plans are the foundation for improved drought management in the United States.

The 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 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 pattern of drought plans that existed in the early 1990s and found that social, political, and institutional influences may be as important as or more important than recent drought experiences. This conclusion has been altered somewhat in the years since this study was completed, since the occurrence of drought in the Southwest and southern Great Plains in 1996 prompted planning actions by Oklahoma, Texas, New Mexico, Utah, and Arizona.

3. Mitigating Drought Impacts: Recent State Actions

Ongoing federal, interstate, and state drought mitigation technologies, programs, and policies in the United States were assessed by Wilhite (1993; 1997a). 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. 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 underway at all levels of government. One of the goals of the study was to identify opportunities to improve the effectiveness of drought mitigation efforts by 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.

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 taken by states during recent droughts (Wilhite, 1997a)

Category	Specific Action
Assessment Programs	<ul style="list-style-type: none"> Developed criteria or triggers for drought-related actions Developed early warning system, monitoring program Conducted inventories of data availability Established new data collection networks Monitored vulnerable public water suppliers
Legislation/Public Policy	<ul style="list-style-type: none"> Prepared position papers for legislature on public policy issues Examined water rights statutes for possible modification during water shortages Passed legislation to protect instream flows Established a water banking program
Water Supply Augmentation/ Development of New Supplies	<ul style="list-style-type: none"> Issued emergency permits for water use Provided pumps and pipes for distribution Proposed and implemented program to rehabilitate reservoirs to operate at design capacity Undertook water supply vulnerability assessments Inventoried self-supplied industrial water users for possible use of their supplies for emergency public water supplies Inventoried and reviewed reservoir operation plans
Public Awareness/ Education Programs	<ul style="list-style-type: none"> Organized drought information meetings for the public and the media Implemented water conservation awareness programs Published and distributed pamphlets to individuals, businesses, and municipalities on water conservation techniques and agricultural drought management strategies Organized workshops on special drought-related topics Prepared sample ordinances on water conservation for municipalities and domestic rural supplies
Technical Assistance on Water Conservation	<ul style="list-style-type: none"> Provided advice on potential new sources of water Evaluated water quantity and quality from new sources Advised water suppliers on assessing vulnerability of existing supply system Recommended the adoption of water conservation measures to suppliers
Demand Reduction/ Water Conservation Programs	<ul style="list-style-type: none"> Established stronger economic incentives for private investment in water conservation Encouraged voluntary water conservation Improved water use and conveyance efficiencies Implemented water metering and leak detection programs
Emergency Response Programs	<ul style="list-style-type: none"> Established alert procedures for water quality problems Stockpiled supplies of pumps, pipes, water filters, and other equipment Established water hauling programs for livestock from reservoirs and other sources Compiled list of locations for livestock watering Established hay hotline Provided funds for improvement of water systems, developing new systems, and digging wells Provided funds for recovery programs for drought and other natural disasters

	Lowered well intakes on reservoirs for rural water supplies
	Extended boat ramps and docks in recreational areas
Water Use Conflict Resolution	Acted to resolve emerging water use conflicts
	Negotiated with irrigators to gain voluntary restrictions on irrigation in areas where domestic wells were likely to be affected
	Clarified state law regarding sale of water
	Clarified state law on changes in water rights
	Suspended water use permits in watersheds with low water levels
	Investigated complaints of irrigation wells interfering with domestic wells
Drought Contingency Plans	Recommended to water suppliers the development of drought plans
	Established statewide contingency plan
	Evaluated worst-case drought scenarios for possible further actions

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 weather data networks such as those that exist in Nebraska, California, and Oklahoma have significantly improved state monitoring and early warning 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, snow pack, and soil moisture. Each of these parameters represents different components of the hydrologic system and, therefore, different 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., 1991) or integrated climate monitoring system (U.S. Congress, OTA 1993; Wilhite and Wood, 1994; FEMA, 1996) have been offered, but none have been 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 taken by states 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 available from states. 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). MacDonnell et al. (1994) have reviewed water banks 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 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 to be mitigative. However, if these measures are implemented to reduce immediate impacts or the risk of future impacts as part of a long-term 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 the states took 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 drought's 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 the Southwest in 1996. The challenge is to transform this framework into a response/mitigation plan during the postdrought period. A brief window of opportunity usually exists to initiate a longer-term mitigation program immediately following a drought.

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. Table 1 is illustrative of the arsenal of mitigation programs and actions currently available to states. In the future, state drought plans need to address a broader range of mitigative actions, including provisions for expanding the level of intergovernmental coordination. One of the goals of the NDMC is to facilitate this process by identifying and disseminating potential mitigative programs to governments at all levels in the United States and elsewhere. Improved coordination will require a greater commitment by federal, state, local, and tribal governments to work together to promote an integrated approach to drought planning.

4. National Drought Mitigation Center

The NDMC was established in 1995 with funding from the U.S. Congress through the U.S. Department of Agriculture. The NDMC is located at the University of Nebraska–Lincoln in the School of Natural Resource Sciences. The NDMC's program is aimed at lessening societal vulnerability to drought by promoting and conducting research on drought mitigation and preparedness technologies, improving coordination of drought-related activities and actions within and between levels of government, and assisting in the development, dissemination, and implementation of appropriate mitigation and preparedness technologies in the public and private sectors. Emphasis is directed toward research and outreach projects and mitigation/management strategies and programs that stress risk management measures rather than reactive, crisis management actions.

The objectives of the NDMC are:

- 1) To conduct research to maintain and enhance a national information clearinghouse.
- 2) To conduct and foster collaborative research.
- 3) To assist state and federal agencies and regional organizations in developing integrated assessments of drought severity and impacts, including current climate/drought and water supply assessments.
- 4) To foster coordination and cooperation within and between levels of government and with the private sector on drought-related activities.
- 5) To serve in an advisory capacity to policy makers and others.
- 6) To interact and conduct collaborative research with international scientists and facilitate the timely exchange of information with foreign governments, international and nongovernmental organizations, and regional organizations.

Since 1995, a major portion of the NDMC's activities have been focused in the following areas:

- **Information Clearinghouse.** The NDMC's website serves as an electronic textbook of information on drought and is linked to more than 200 websites with additional information on a wide range of topics. More than 900 websites are hotlinked to the NDMC's website. The content of the website is expanded continuously and frequently updated. Content needs are determined through continuous interaction with users through various channels. User sessions and user hits have increased dramatically in the past two years, averaging more than 15,000 user sessions, and 60,000 user hits per month. Approximately 15% of user sessions are from international sources.
- **Research projects.** The NDMC has developed a range of research activities aimed at developing new tools and methodologies that governments and others can use to reduce vulnerability to drought. The projects in progress include: (1) an analysis of state-level drought plans; (2) modification of the 10-step planning methodology; (3) an evaluation of the effectiveness of the Standardized Precipitation Index (SPI) in detecting and tracking drought conditions and other moisture anomalies; (4) the development of the Standardized Vegetation Index to track vegetation anomalies; and (5) the development of a risk assessment methodology to identify areas of vulnerability and potential mitigation actions to reduce risk.
- **Integrated Climate Monitoring/Drought Watch.** The NDMC has been networking with state and federal agencies and universities to develop an integrated climate/drought monitoring system. The emergence of the Internet and the availability of data and information products on the WWW provided the NDMC with the opportunity to create an electronically based drought watch system by linking the informational products developed by the NDMC with products available from other agencies and organizations. The NDMC has also been collaborating on an integrated drought watch system for the western United States under the framework of the Western Drought Coordinating Council (WDCC).
- **Advisor on Policy Issues.** The NDMC regularly serves in an advisory capacity to governments at all levels in the United States and internationally. The NDMC has served on various national and regional task forces and currently is the technical headquarters of the WDCC, formed in 1997 under the auspices of the Western Governors' Association. The NDMC will also serve in an advisory capacity to the National Drought Policy Commission (NDPC).
- **Training Workshops.** The NDMC organizes and conducts training workshops on drought contingency planning. Since 1997, the Center has conducted 4 regional workshops in the U.S. and co-conducted one workshop with Mexico for the U.S./Mexico border states region. The NDMC also conducted workshops in northeast Brazil in 1998 to assist them with regional and state planning efforts. During 1999, the NDMC will conduct workshops in Hawaii and southern Africa and assist with workshops in the western United States.

- **International Drought Mitigation Program.** The NOMC continuously interacts with many scientists in foreign governments and with United Nations agencies on technical issues associated with drought monitoring and planning. In addition, the NDMC is currently participating in projects in Hungary, Mexico, Brazil, and sub-Saharan Africa.

5. National Drought Policy Commission

As a result of the 1996 drought and its effects in the Southwest and southern Great Plains, policy initiatives were developed to improve federal and state drought management efforts. One of the most significant of these policy initiatives was the National Drought Policy Act, introduced in the U.S. Senate in January 1997. Both the Federal Emergency Management Agency (FEMA) and the Western Governors' Association drought task forces recommended the development of a comprehensive, integrated national drought policy to reduce the risks associated with future drought events and improve response to drought emergencies when they occur. The National Drought Policy Act was passed by the U.S. Congress in July 1998 and signed into law.

The major tenet of this bill is the establishment of an advisory commission (National Drought Policy Commission/NDPC) "to provide advice and recommendations on the creation of an integrated, coordinated Federal policy designed to prepare for, mitigate the impacts of, respond to, and recover from serious drought emergencies." The NDPC will function under the leadership of the U.S. Department of Agriculture and will be composed of 16 members, including federal agencies; representatives of states, counties, and cities; and six at-large members from groups affected by drought. The NDPC will begin meeting in spring 1999 and conclude its study within 18 months. The commission will submit a thorough study of drought policy needs to the U.S. Congress and the president at that time.

During its existence, the NDPC is required to: (1) determine the needs that exist at all levels to prepare for and respond to drought emergencies; (2) review existing federal, local, state, and tribal laws and programs relating to drought; (3) determine what differences exist between the needs of those affected by drought and the federal laws and programs designed to mitigate the impacts of and respond to drought; (4) collaborate with appropriate entities to consider appropriate regional drought initiatives and the application of such initiatives at the national level; (5) make recommendations on how federal drought laws and programs can be integrated with local, state, and tribal laws and programs into a comprehensive national policy; (6) make recommendations on improving public awareness of the need for drought mitigation and prevention; and (7) recommend whether all federal drought preparation and response programs should be consolidated under one existing federal agency.

6. Future Directions and Challenges

A review of drought management and policy needs for the western United States was recently completed by Wilhite (1997b; 1997c) at the request of the Western Water Policy Review Advisory Commission. In this report, Wilhite reviewed major studies that had evaluated federal and state government's role in drought management and had offered

recommendations to improve future management efforts. These studies were reviewed to identify common themes that might help to highlight future needs or actions that the federal government could take to improve drought management in the western United States. The common themes identified included:

- Create a national drought policy and plan
- Develop a comprehensive, integrated national climate monitoring system
- Incorporate drought in the National Mitigation Strategy
- Conduct post-drought audits of federal/state response efforts
- Establish regional drought forums
- Encourage development of state drought mitigation plans

The development of a national drought policy is progressing under the leadership of the NDPC. I am cautiously optimistic that the commission will produce recommendations that will move the nation to a greater emphasis on risk management. There is considerably less optimism that these recommendations will be acted on in a prompt manner by the U.S. Congress.

A regional integrated climate monitoring system is currently operational under the leadership of the WDCC and the NDMC. The goal should be to expand the geographical coverage of this system to include all portions of the United States. This system should also be integrated with systems established by the states and regional climate centers to deliver better and more timely information to decision makers at local, state, and national levels.

The National Mitigation Strategy (FEMA 1995) includes all major natural hazards, except drought. The FEMA-led drought task force recommended that steps be taken to incorporate drought in this strategy. No action has taken place on this recommendation. Post-drought audits of federal and state drought response and mitigation efforts are not routinely conducted to determine successes and failures. The NDPC should make specific recommendations to address this issue. Results from these studies could significantly improve national and state-level policies and plans.

The WDCC is the only existing regional forum, and it has experienced only moderate success, largely because of budgetary constraints. Regardless of the limited success, it is imperative that approaches to drought management be region specific, and regional forums could facilitate that process. Regional forums could also be useful in tailoring federal response and mitigation programs to better address regional needs.

All states should be encouraged to develop comprehensive drought mitigation plans through the provision of incentives. Methodologies are now available for states to follow in placing emphasis on mitigation actions and programs. Examples from Utah, New Mexico, and Nebraska should further facilitate this process. The lack of methodologies and models has been one of the constraints to the adoption of an approach to drought management that emphasizes mitigation.

7. Conclusions

Although considerable progress has been made in several key areas in drought management in the United States in the past 15 years, there has been little progress in the development of an integrated national approach that incorporates the needs of local, state, federal, and tribal governments. Although the impacts of drought occur mainly at the local, state, and regional level, it is imperative for the federal government to provide the leadership necessary to improve the way the United States prepares for and responds to drought. The federal role should be one of facilitating the development of a national policy and plan through a participatory process involving all levels of government, regional organizations, the private sector, and other interests. The establishment of the National Drought Policy Commission by the U.S. Congress is an indication that a more coordinated approach within and between levels of government is needed to address this issue. Whether the NDPC will be able to identify needs and assemble the resources necessary to accomplish this objective is open to speculation at this time.

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