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Chapter 13

Drought Mitigation in the United States: Progress by State Government

Donald A. Wilhite and Steven L. Rhodes

Introduction

Drought has been a recurrent feature of the American landscape in recent years, resulting in significant impacts in many economic sectors, including agriculture, transportation, energy, recreation, and health; it has also had adverse environmental consequences. For example, the economic impacts of the 1976–77 and 1988 droughts have been estimated at nearly \$35 billion and \$40 billion, respectively (NOAA, 1982; Riebsame et al., 1990). Other drought years, such as 1980, 1983, 1986, and 1989–91, resulted in significant losses as well. The present and future impacts of the current (1992) drought in the western states and in portions of the east are likely to be substantial and long-lasting. Almost without exception, the occurrence of widespread severe drought in the United States has illustrated the low level of drought preparedness that has existed in federal and state governments. Assessment and response programs that were implemented during the 1970s have been characterized as largely ineffective, poorly coordinated within and between levels of government, and untimely (GAO, 1979; Wilhite et al., 1986). Although state government has made considerable progress in drought preparedness, the verdict is still out on whether the federal government's response to the 1988–89 drought had improved significantly over previous response efforts. Riebsame et al. (1990) suggests only a moderate improvement in efficiency. The lessons of past response efforts in the United States strongly suggest that a "risk management" or proactive approach to drought management would be a more effective mitigation tool than the "crisis management" or reactive approach heretofore practiced.

The primary purpose of this chapter is to discuss the growth in state drought contingency plans (DCPs) in the United States and to document their effectiveness as a mitigation and response tool during recent periods of water shortage. The chapter also presents a rationale for drought planning and the principal components or elements of existing state plans. Recognizing that drought is the primary but not the only stimulus for drought plan development in most political settings, we also speculate on other factors that have fostered the increased interest of state governments in drought planning. The chapter concludes by proposing some directions for state and federal drought planning efforts in the United States. The underlying assumption is that the growth of state drought contingency planning efforts in the United States has implications for the international scientific and policy community. As interest in drought preparedness increases worldwide, the lessons learned in the United States and other countries with an extensive history in drought response may assist policy makers in understanding the social, economic, environmental, and political forces that influence the planning process.

Rationale for Drought Preparedness

The reasons behind the development of a DCP by state government in the United States have been addressed elsewhere (Wilhite, 1991a; see also Chapter 6). Simply stated, sharply focused contingency plans, prepared in advance, can assist government and others in the early identification of drought and its likely impacts; improve the efficiency of resource (fiscal, human, and natural) allocation; lessen personal hardship; and, ultimately, reduce drought-related impacts, the need for government-sponsored assistance programs, and long-term vulnerability to climate-induced periods of water shortage. In the absence of a plan, communication within and between agencies and levels of government is often poorly developed, which in turn leads to untimely or inappropriate decisions (Wilhite et al., 1986). Drought contingency plans improve the coordination and efficiency of assessment and response actions of the wide range of state agencies with responsibilities for water and also improve the linkages and working relationships with the myriad of federal agencies that are represented in each state. In the long term, contingency plans can reduce societal vulnerability to periods of water shortage and the need for drought assistance from the federal government.

Drought planning has been defined as actions taken by individual citizens, industry, government, and others in advance of drought for the purpose of mitigating some of the impacts and conflicts associated with its occurrence (Wilhite et al., 1986; Wilhite, 1991a). To be successful, drought planning must be integrated between the national and state levels of government, involving existing regional (multistate) organizations as well as the private sector where applicable. Examples of regional organizations in the United States that have been active in drought planning include the Great Lakes Commission, Western States Water Council, and Delaware River Basin Commission.

State Drought Contingency Plans: Trends and Characteristics

Progress by states in the development of DCPs in recent years has been extraordinary. During the widespread and severe drought of 1976–77, for example, no state had prepared a formal drought strategy (Wilhite, 1991a). In 1982 only three states had developed plans: South Dakota (1981), Colorado (1981), and New York (1982). Typically, states have relied on the federal government to come to their rescue with massive relief programs when water shortages reach near-disaster proportions. The federal government provided nearly \$8 billion in relief in response to the sequence of drought years in the mid-1970s; federal assistance efforts totaled more than \$5 billion in response to the 1988–89 droughts (Wilhite et al., 1986; Riebsame et al., 1990). This assistance was provided to drought victims through an assortment of federal programs administered by numerous federal agencies. In 1977, forty separate programs were administered through sixteen agencies (GAO, 1979).

During the past decade, an additional twenty-four states have developed and implemented formal drought contingency plans (see fig. 1). Twenty-seven states now have plans. In addition, three states are developing or have expressed an intent to develop plans in the near term. These planning efforts have often been conducted in conjunction with a state’s overall water management planning initiative. Clearly, states can now be labeled policy innovators in planning for drought (Wilhite, 1990).

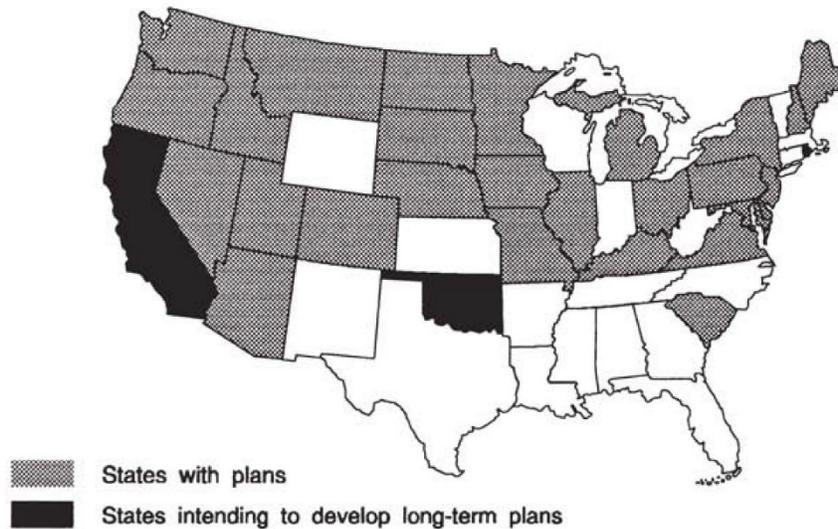


Figure 1. Status of drought planning in the United States, 1992 (Wilhite, 1992).

Because of the many resources that are now available to assist governments in the drought planning process, it is likely that the number of states with plans will continue to increase (but at a slower pace) and that existing plans will be revised periodically to incorporate new mitigation technologies as they become available. Model plans (Western States Water Council, 1987; Wilhite, 1990 and 1991 a) and 27 state plans now provide a critical

reference for states desiring to develop a plan or revise an existing plan. In addition, several regional organizations have considerable experience in drought planning and can assist states in plan development (e.g., Delaware River Basin Commission, Great Lakes Commission, Western States Water Council). At the same time, some federal agencies have attempted to improve their drought management capability but seem reluctant to pursue the development of a coordinated national policy and plan.

An examination of existing state drought plans reveals that they have certain key elements in common (Wilhite, 1991b). Administratively, a task force is responsible for the operation of the system and is directly accountable to the governor. The task force keeps the governor advised of water availability and potential problem areas; it also recommends policy options for consideration. Operationally, drought plans have three features in common. First, a water availability committee is established to continuously monitor water conditions and prepare outlooks a month or season in advance. Since most of the information necessary to comprehensively monitor water conditions (i.e., precipitation and temperature, streamflow, groundwater levels, snowpack, soil moisture, meteorological forecasts) is available from state or federal agencies, the primary role of the committee is to coordinate the collection and analysis of this information and the delivery of products to decision makers on a timely basis. The committee assimilates this information and issues timely reports and recommendations. Second, a formal mechanism usually exists to assess the potential impacts of water shortages on the most important economic sectors. In some states this task is accomplished by a single committee, or, more commonly, separate working groups are established to address each sector. Third, a committee or the task force referred to previously usually exists to consider current and potential impacts and recommend response options to the governor. The generic infrastructure for a drought plan is discussed in Chapter 6.

Factors Influencing Drought Plan Development

Numerous factors may influence a state's decision to develop a drought contingency plan. It is important to note at the outset that the primary motivating factors for plan development vary considerably from state to state. The decision to develop (or not to develop) a plan is a highly individual one that, in reality, reflects several factors, some of which may be unique to that state. Certainly, the droughts of the mid- to late 1980s and early 1990s and their associated impacts seem to have played a large part in generating momentum at the state level. Coupled with this factor has been a growing awareness of and concern about the inefficiency of past response efforts and a genuine desire on the part of state government to improve their assessment and response capability. As figure 1 demonstrates, however, the pattern of drought plans currently in existence cannot be explained on the basis of climatological factors alone since many states with plans lie in the more humid eastern portion of the country, a region that historically has had a lower probability of severe drought occurrence. When droughts occur in this region, they tend to be of shorter duration (Karl, 1983).

A typology of state behavior was constructed to help explain the current pattern of drought contingency plan development and its relationship to the occurrence of drought

during the past ten years. Lester (1986) developed this methodological approach to decipher the relationships between state commitment to environmental quality and state dependency on federal aid. Lester's typology was modified for this study to attempt to explain state commitment to drought plan preparation on the basis of the frequency of severe to extreme drought during the period from 1982 to 1991. The classification of severe to extreme drought was based on the Palmer Drought Severity Index (PDSI), a meteorological drought index used extensively by federal and state government in the United States to monitor long-term climate trends, including the pattern and severity of drought (Palmer, 1965). The PDSI has been used routinely by the federal government as one of the principal criteria for disaster designation (i.e., eligibility to receive federal drought relief; Wilhite et al., 1986). Alaska and Hawaii were not included in this study because PDSI values were unavailable for comparison.

The 1982–91 period was chosen to explain the relationship between state commitment to drought plan preparation and drought frequency because of the rapid growth in the number of plans developed during these years. To arrive at an average statewide drought frequency value for the period in question, the frequency of severe to extreme drought was first determined for each climatological division (i.e., relatively homogeneous climatic regions). Most states contain between six and nine climatic divisions. The divisional averages were then averaged to derive an unweighted state average. States were then divided into two drought frequency groups, $\geq 10\%$ (High) and $< 10\%$ (Low). The 10% threshold was chosen because a one-in-ten probability of severe to extreme drought is often considered significant by decision makers (e.g., High Plains Associates, 1982).

State commitment to drought plan preparation was divided on the basis of whether or not a plan had been developed (Yes or No). Thus, states with a high frequency of severe to extreme drought during the 1982–91 period and a drought plan would be placed in Sector A. Conversely, states with a relatively low frequency of severe to extreme drought and no drought plan would be placed in Sector D. The outcome of this typological analysis is presented in figure 2.

A significant number of states (15) were classified in Sector A (high drought frequency and a drought plan or intent to develop one). Most of these states are in the west, where drought is a common feature of the climate. Only South Dakota had developed a plan before 1983. This plan was developed primarily in response to the mid-1970s droughts. In the more humid east, only Delaware falls into this sector, experiencing severe to extreme drought in 10% of the months during the 1982–91 period. The only other eastern state included in Sector A is Florida, with a 12.4% frequency. Florida is unique in that the authority for water management/drought planning is transferred to water management districts.

Fifteen states fall into Sector D (low drought frequency and no drought plan). The majority of these states are located in the more humid east. Three states in this sector that might be expected to have a plan (based on their climatic regimes) but do not are Kansas, New Mexico, and Texas. These states are all located in the drought-prone west. However, in each of these cases, the statewide average percent frequency of severe to extreme drought was below the 10% threshold during the 1982–91 period. Drought frequency greater than 10% was associated with portions of Kansas and Texas but averaged out to less than 10% for the state as a whole.

State Commitment to Drought Preparation						
	High (Drought Plan)		Low (No Drought Plan)			
	A		C			
High (≥10%) Frequency of severe to ex- treme drought (PDSI ≤ -3.0) during 1983-89	California	Utah	Wyoming			
	Idaho	Washington				
	Montana	Delaware				
	Nebraska	South Dakota				
	North Dakota	Iowa				
	Oregon	Arizona				
	Florida	Minnesota				
	Nevada					
	B				D	
	Low (<10%)	Kentucky			Pennsylvania	Connecticut
Maine		South Carolina	Georgia	Wisconsin		
New Hampshire		New York	Indiana	Tennessee		
Ohio		Virginia	Louisiana	West Virginia		
Colorado		Illinois	Massachusetts	Alabama		
New Jersey		Maryland	Mississippi	Arkansas		
Missouri		Michigan	Kansas	New Mexico		
Oklahoma		Rhode Island	Vermont	Texas		

Figure 2. A typology of state behavior: Frequency of severe to extreme drought during 1983-89 and commitment to drought plan preparation.

The states classified in sectors B and C are much less easily explained on the basis of climatology. In Sector B (states with a low drought frequency and a drought plan or intent to develop one), sixteen states are represented, all but two of which are located in the east. Colorado developed a plan in 1981 in response to two significant droughts that occurred in 1977 and 1980. Governor Richard Lamm was in office during both of these events and witnessed the inefficiency of assessment and response efforts (Wilhite, 1990). In 1981, he requested the Department of Disaster Emergency Services to develop a drought plan to enhance state preparedness and future response. Thus, the existence of the Colorado plan is directly attributable to drought, but in the period before 1982. Oklahoma has expressed an intent to develop a drought plan, although the frequency of severe drought occurrence during 1982-91 is very low (1 %). This frequency is unusually low; severe drought occurred 12.3% of the time during 1951-91. New York developed a plan in 1982 in response to numerous factors, including the potential effects of drought on a water supply system stretched by the demands of an enormous urban population. Other factors that may help to explain the development of plans in the remaining thirteen states are discussed in the next section of this paper.

Only one state appears in Sector C (high drought frequency and no drought plan)—Wyoming. Statewide drought frequency during the 1982-91 period was quite high in Wyoming (33.9%). Climatology alone would certainly suggest that this state would have developed a plan to address assessment and response issues directly related to periods of

water shortage. The absence of a drought contingency plan in Wyoming may be attributed to one or more factors, including its small population base, low population density, reliance on the prior appropriation doctrine for allocating water during water-short periods, and political environment.

Although climate has been a primary stimulus to drought plan development in the past ten years, other factors, such as increasing population pressure, conflicts between water users, and antiquated water supply systems, at times in conjunction with climate, have motivated states to develop plans. Another primary motivating factor has been the policy environment of the 1980s. Some of the major policy-related factors that deserve consideration are reviewed briefly below.

Drought Planning and the 1980s Policy Environment

How did the policy environment of the 1980s contribute to the large number of states (thirty in Sectors A and B, including those with low frequency of severe to extreme drought during 1982–91) developing drought contingency plans over the past decade? It is difficult to identify specific decisions, experiences, or other factors that prompted so many states to undertake the preparation of a formal drought plan. State governments for the most part do not maintain permanent drought response offices with stable staffing, and state employees routinely move to new responsibilities within government or to the private sector. Thus, institutional memory is often quite short (i.e., lessons from recent droughts are soon forgotten).

A general assessment of the public policy environment during the 1980s suggests several policy themes that may have contributed to a growing awareness and understanding of the complexities of drought management. These themes may have directly or indirectly affected the behavior of state government officials in pursuing the development of a drought plan. These themes raise philosophical and practical questions about the nature of federal-state relations and particular water resource planning and management innovations that were adopted by several states during the 1980s.

The issue of federal-state relations and their possible influence on state drought planning involves three distinct elements: (1) 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; (2) states' concerns about federal intrusion into state-level water resource planning and water rights; and (3) some states' early experiences in working with the new Federal Emergency Management Agency in the early 1980s. In the case of several states, a fourth incentive to plan for droughts may have developed as a consequence of policy innovations regarding water supply planning and management. Two specific examples are: (1) the large number of states adopting groundwater management policies during the 1980s, and (2) recent water supply management problems that have been exacerbated by the riparian doctrine of water law that predominates in the states east of the Mississippi River. Although it cannot be proved that all or any of these influences affected drought planning in any particular state, it is intriguing that these perturbations to federal-state relations and growing government concerns about

future water supplies occurred during the period of accelerated state adoption of drought plans.

It is hypothesized that issues such as these may have contributed to an increased awareness of the value of drought planning within some state governments. Coupled with actual drought experiences or knowledge of other states' drought impacts, these policy influences may have helped create conditions conducive to increased state attention to drought planning.

State Mitigation Actions during Recent Droughts: Selected Examples

As previously stated, drought plans are developed to reduce drought-related impacts and improve efficiency in the allocation and use of resources. States were surveyed recently to determine mitigation actions implemented in response to the widespread occurrence of severe drought that has affected large portions of the United States during the period from 1986 to 1992 (Wilhite, 1992). At this writing, severe drought conditions continue throughout most of the western states and in selected areas in the central and eastern portion of the country.

Hy and Waugh (1990) have defined mitigation as "activities that reduce the degree of long-term risk to human life and property from natural and man-made hazards." Mitigative actions were purposely not defined in the survey instrument referred to above—states were given the flexibility to define mitigation by including those actions or activities that they felt were appropriate. Those mitigation activities identified by states and/or local municipalities during recent droughts were diverse, reflecting regional differences in impacts, legal and institutional constraints, and characteristics of contingency plans. The diversity in responses was also related to the wide range of state agencies with principal authority for planning and mitigative actions (e.g., agriculture, natural resources, water resources, emergency or disaster management).

Mitigation actions can be clustered into nine primary areas, as shown in table 1. These actions represent the 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, but others may have been adopted only in a single case. One of the most innovative and successful mitigation actions implemented during recent droughts was the water bank program initiated by California (California Department of Water Resources, 1992; Howitt et al., 1992). This program is discussed in more detail in Chapter 14. Actions listed in Table 1 include, for the most part, those that were adopted by state government. Mitigative actions adopted by other levels of government and the private sector are not summarized in table 1. However, they would, in most cases, be included in these nine categories.

Table 1. Drought-related mitigative actions	
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 on public policy issues Examined water rights statutes for possible modification during water shortages Passed legislation to protect instream flows
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 of 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 Established a water banking program 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 state-wide contingency plan Evaluated worst-case drought scenarios for possible further actions

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. However, these actions were quite successful. Other activities, such as legislative actions, drought plan development, and the development of water conservation and other public awareness programs, are considered as actions with a longer-term impact. As states gain more experience assessing and responding to drought, future actions will undoubtedly become more timely and effective and less reactive. Although the mitigative actions taken by states in response to recent drought conditions are numerous when considered in total, individual state actions were in most cases quite narrow. In the future, state drought contingency plans must become broader in scope, addressing a broader range of potential mitigative actions, including provisions for expanding the level of intergovernmental coordination. To be successful, drought planning must be integrated between local, state, and federal levels of government and with regional organizations, as appropriate. In time this will help states avoid or reduce the impacts, conflicts, and personal hardship.

Conclusions and Recommendations

This chapter has reviewed climatological and nonclimatological factors that may have contributed to the adoption of state drought response plans in the United States since 1982. Although drought experiences and concerns about possible impacts of drought probably have had a more direct effect on state drought response planning, the policy environment of the past decade illustrates additional factors that may have contributed to increased awareness within state governments of the potential value of being prepared to respond to drought.

Of course, for those states that have not adopted formal drought response plans, specific influences have also affected their decision-making processes. Yet the sheer number of states moving forward with formal drought plans in the past decade prompts questions about the reasons for this wave of apparent drought awareness. Our assessment suggests a picture of drought policy formulation that is much more complex and multidimensional than can be accounted for by climatological explanations alone.

Given progress made at the state level in the past decade as a consequence of drought experiences and perhaps the other influences discussed in this chapter, what drought planning initiatives should be of highest priority for state (and federal) government in the future? First, we believe that there must be greater integration of existing drought management and planning activities with existing water management and natural hazard management and planning activities at both levels of government. This problem stems largely from the unique character of drought, a slow-onset disaster, in contrast to quick-onset natural disasters such as earthquakes, hurricanes, and floods. Typically, drought planning has focused on the mitigation of impacts, a shorter-term objective, rather than on longer-term water management and planning issues. At the federal level, the activities of the numerous agencies with drought-related missions in assessment, management, mitigation, and planning have never been integrated to provide a more coherent approach to drought management. A national policy and plan emphasizing a more proactive risk management approach, as called for by many agencies and organizations, must be developed.

Second, it is recommended that the mitigation, response, and planning efforts of state and federal government be better coordinated. Drought is a distinctly regional phenomenon with national and international implications. Therefore, linkages should exist between those agencies in each state with primary authority for ongoing drought planning activities. Networking between states will facilitate the dissemination of new mitigation technologies. This network will result in greater interaction between state and federal agencies on drought-related issues.

Regional organizations can play a vital role in linking the assessment and response activities of states within their region and can also help to establish dialogue with federal agencies. It is important to note here the need to coordinate drought-related planning activities at the regional level since some federal agencies have distinct regional planning authorities (e.g., Corps of Engineers, Bureau of Reclamation) that may involve drought plan development. It is imperative for district (regional) drought contingency plans developed by the Corps of Engineers, for example, to be compatible with state goals and policies.

Finally, regardless of the reasons for adopting formal drought response plans, states must expand the scope of their existing plans. It is essential for these plans to move beyond their initial impetus for plan development (i.e., reaction to crisis) and begin to address longer-term water-related issues as an integral part of the plan. This will require greater integration with other planning activities and improved coordination within and cooperation between levels of government.

Ironically, the policy themes of the past decade that we suggest may have influenced drought planning in some states in the United States are now being influenced by state drought planning efforts. This is evident in our suggestions for the need to (1) integrate drought planning with broader water management and planning efforts, (2) improve federal-state coordination in responding to drought, and (3) build on existing drought plans to address longer-term water issues in the context of federal-state relations. Because of the past decade's experience with state drought planning, issues involving the practice of federalism, water planning and jurisdiction authority, and appropriate responses to drought are becoming increasingly interrelated.

Internationally, interest in drought policy and planning has increased significantly within governments and international organizations in the past ten years and substantial progress is being made. The factors stimulating this interest are envisioned to be as complex as those discussed in this paper. Our discussion of factors affecting plan development in the United States should provide policy makers in these other settings with additional insights and understanding of this complicated but worthwhile process.

About the Authors

Donald A. Wilhite is professor of agricultural climatology in the Department of Agricultural Meteorology and director of the International Drought Information Center at the University of Nebraska–Lincoln. He specializes in studies of the impact of climate on society and societal response to climatic events, particularly drought. Dr. Wilhite is coeditor of *Planning for Drought: Toward a Reduction of Societal Vulnerability*, published by Westview Press in 1987. He has recently written a guidebook on drought preparedness for developing countries under sponsorship of the United Nations Environment Program. Dr. Wilhite is chair of the Committee on Applied Climatology of the American Meteorological Society.

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