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Planning for Drought: Moving from Crisis to Risk Management

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Abstract
Severe drought is a recurring problem for the United States, as illustrated by widespread economic, social, and environmental impacts. Recent drought episodes and the widespread drought conditions in 1996, 1998, and 1999 emphasized this vulnerability and the need for a more proactive, risk management approach to drought management that would place greater emphasis on preparedness planning and mitigation actions. Drought planning has become a principal tool of states and other levels of government to improve their response to droughts. For example, since 1982, the number of states with drought plans has increased from 3 to 29. Many local governments have also adopted drought or water shortage plans. Unfortunately, most state drought plans were established during the 1980s and early 1990s and emphasize emergency response or crisis management rather than risk management. This paper presents a substantive revision of a 10-step drought planning process that has been applied widely in the United States and elsewhere. The revised planning process places more weight on risk assessment and the development and implementation of mitigation actions and programs. The goal of this paper is to encourage states to adopt this planning process in the revision of existing drought plans or, for states without plans, in the development of new plans.

Keywords: water resources planning, drought planning, water policy, water management

Introduction

Widespread and severe drought conditions in 1996 in the southwest and south central states; the recurrence of drought in 1998 in this same region and its expansion into the southeast; and the return of drought in 1999 to the southwest, southeast, and south central states, and its expansion into the mid-Atlantic and northeast states have raised serious concerns about our nation's continuing vulnerability to extended periods of drought-induced water shortages. The United States' (U.S.) vulnerability to drought is quite different from that of many developing countries, where the primary concerns are centered largely on issues of food security and meeting the nutritional needs of the population, environmental degradation, and a retardation of the development process.

In the U.S., the economic, environmental, and social impacts of drought are substantial. Drought in 1996 resulted in serious losses in crop and livestock production and increased the incidence and severity of forest fires and wildfires. Decreases in surface and ground water supplies affected public water supplies, agriculture, and water-based tourism and recreational activities. Energy demand also increased markedly in response to searing heat. Drought-related losses have been estimated at nearly $5 billion in Texas alone (Boyd, 1996); and substantial losses also occurred in Kansas, Oklahoma, New Mexico, Arizona, Utah, Nevada, and Colorado. The rapid emergence of drought in 1998 following a strong El Niño event resulted in drought-induced wildfires in Florida and acute agricultural losses in Texas, Oklahoma, Louisiana, South Carolina, Georgia, and other southern states. Losses in Texas and Oklahoma were estimated at $5 billion (Chenault and Parsons, 1998) and $2 billion (Thurman, 1998), respectively. Drought conditions that returned in 1999 in the southwest, south central, and southeast states had a cumulative effect on economic and social systems and the environment because these sectors or systems had not yet recovered from recent drought events. Drought in the mid-Atlantic and northeast states has also had devastating effects in some areas. The economic impacts of the 1999 drought will not be fully known for some time, but they are likely to be several billion dollars. Social and environmental costs were also significant.

The drought of 1996 spawned a series of political actions that resulted in the development of the Western Drought Coordination Council under the auspices of the Western Governors' Association and the passage of the National Drought Policy Act by the U.S. Congress, signed into law by President Clinton on July 16, 1998 (Public Law 105-199). The goal of both initiatives is to move the U.S. toward a more proactive approach to drought management through greater emphasis on mitigation and preparedness. Mitigation is defined as short- and long-term actions, programs, or policies implemented during and in advance of drought that reduce the degree of risk to human life, property, and productive capacity. Preparedness refers to pre-event activities designed to increase the level of readiness or improve operational and institutional capabilities for responding to a drought event (Wilhite, 2000).

The concept of a national drought policy and plan has been under discussion for some time in the U.S. (Wilhite, 1997a), but it took another series of severe droughts to remind states and others of the ineffectiveness of the crisis management approach in assessing and

responding to severe drought events and of our nation's continuing vulnerability. It is interesting to note that the move toward a national drought policy has been motivated by states (FEMA, 1996; Western Governors' Association, 1996) and received the full endorsement of the National Governors' Association.

In 1991, Wilhite published a 10-step planning process for states to follow in the development of a drought plan. This process was intended to be generic so that it could be adapted to the needs of any level of government in any drought-prone region. For nearly ten years, this process has been used by states, tribal governments, water utilities, foreign governments, and others to guide them through the drought planning process. The 10-step process has also been published in other forms for various audiences (Wilhite, 1992a; Wilhite, 1996). This original planning process, although recognizing the need for developing mitigation tools to reduce the impacts of drought, did not place as much attention on mitigation as is now warranted, given the growing emphasis on risk management in addressing the impacts associated with natural hazards. When first published, this planning process focused more attention on improving governmental response to drought emergencies through the development of greater institutional capacity, improving monitoring capability, defining a more explicit decision-making authority for implementing response measures, and improving information flow and coordination between and within various levels of government.

As vulnerability to drought has increased globally, greater attention has been directed to reducing risks associated with its occurrence through the introduction of a variety of mitigation actions (Wilhite, 1997b; Wilhite, 2000) and the development of plans to improve operational capabilities (i.e., climate and water supply monitoring, building institutional capacity). These efforts are directed at reducing drought impacts. This change in emphasis is long overdue. In the U.S., the Federal Emergency Management Agency (FEMA, 1995) estimates annual losses because of drought at $6–8 billion per year. Mitigating the effects of drought requires the use of all components of the cycle of disaster management, rather than only the crisis management portion of this cycle (fig. 1). Because of past emphasis on crisis management, society has generally moved from one disaster to another with little, if any, reduction in risk. Risk management emphasizes preparedness, mitigation, and prediction and early warning activities initiated before drought with the goal of reducing the impacts associated with subsequent events. The 10-step process presented in this paper is directed at these components of the disaster management cycle.

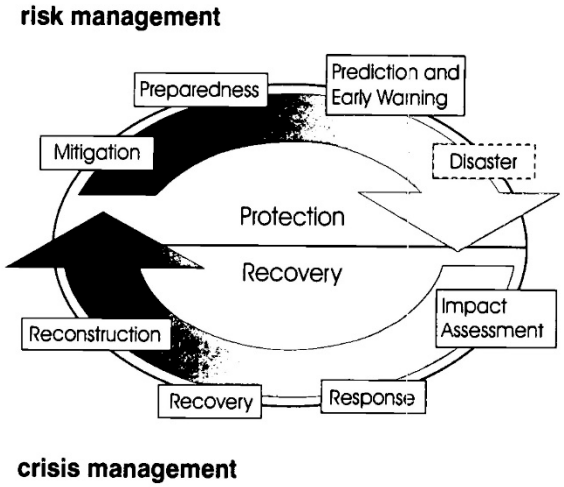

Figure 1. The Cycle of Disaster Management.

Since 1982, there has been a rapid development of drought plans by state governments in the U.S. In 1982, only three states (Colorado, New York, and South Dakota) had completed drought plans. In 2000, 29 states have drought plans in place and Texas, Hawaii, and Arizona are moving forward with plan development (fig. 2). Georgia has also expressed an intent to develop a drought plan. Most state drought plans place primary emphasis on response (i.e., post-impact programs and actions), largely because there was little understanding of how drought-related impacts could be reduced through mitigative actions when these plans were first developed in the 1980s. Also, states mainly relied on the federal government to provide disaster assistance during periods of severe drought. Today, most states give some attention to mitigation, although this emphasis is quite variable from state to state. Mitigation is at the foundation of the drought plan recently developed by New Mexico. Utah and Nebraska have revised existing plans to place more emphasis on mitigation and Texas is emphasizing mitigation in the plan currently under development. In the early years of state-level drought planning, Colorado's drought plan served as a model for others to emulate, and many states borrowed heavily from its organizational structure and operating procedures. The four states mentioned above that are placing more emphasis on mitigation are now serving as models.

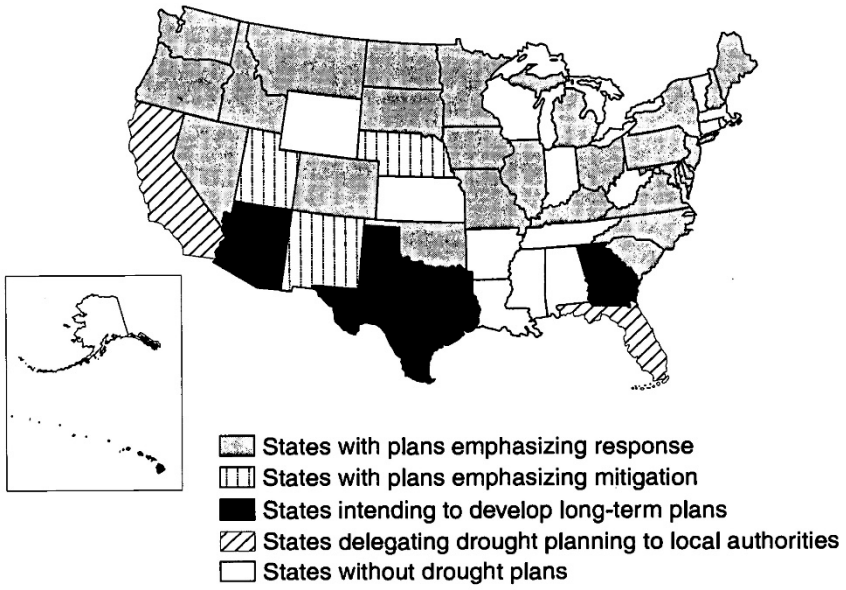

Figure 2. Status of Drought Planning, August 1999.

The purpose of this paper is to present a substantial revision of the 10-step drought planning methodology. The goal of this planning process is to derive a plan that states and other governments can implement that is dynamic and reflects changing government policies, technologies, natural resources management practices, and so forth. The goal is not to produce a static document or plan. Like earlier versions of the 10-step planning process, this revised and expanded process is intended to be flexible so local, state, national, or tribal governments can adapt it to their needs.

Planning for Drought: The Process

Drought is a natural hazard that differs from other hazards in that it has a slow onset, evolves over months or even years, affects a large spatial region, and causes little structural damage. Its onset and end are often difficult to determine, as is its severity (Wilhite, 1992b). Like other hazards, the impacts of drought span economic, environmental, and social sectors and can be reduced through mitigation and preparedness. Because droughts are a normal part of climate variability for virtually all regions, it is important to develop plans to deal with these extended periods of water shortage in a timely, systematic manner as they evolve. Whether in the U.S. or elsewhere, this planning process needs to occur at various levels of government and be integrated between levels of government.

The 10-step planning process developed by Wilhite (1991) was based largely on interactions with many states in the U.S. and sought to incorporate their experiences and lessons learned. It evolved from a 10-step process conceptualized by Wilhite and Easterling (1987) in response to discussions emanating from an international drought symposium and workshop held at the University of Nebraska in 1986. This planning process has gone

through several iterations in recent years in order to tailor it to specific countries or subsets of countries. It has also been the basis for discussions at a series of regional training workshops and seminars on drought management and preparedness held throughout the world over the past decade (Wilhite, 1996). Recent drought planning workshops in the U.S., Mexico, and Brazil, which were conducted by the National Drought Mitigation Center (NDMC), have also relied on the 10-step process as an organizational tool for the development of drought plans.

In brief, Steps 1–4 of the planning process focus on making sure the right people are brought together, have a clear understanding of the process, know what the drought plan must accomplish, and are supplied with adequate data to make fair and equitable decisions when formulating and writing the actual drought plan (fig. 3). Step 5 describes the process of developing an organizational structure for completion of the tasks necessary to prepare the plan. Steps 6 and 7 detail the need for ongoing research and coordination between scientists and policy makers. Steps 8 and 9 stress the importance of promoting and testing the plan before drought occurs. Finally, Step 10 emphasizes revising the plan to keep it current and making an evaluation of the plan's effectiveness in the post-drought period. Although the steps are sequential, many of these tasks are addressed simultaneously under the leadership of a drought task force and its complement of committees and working groups. Each of the steps described below should be considered part of an integrated planning process rather than as a series of discrete tasks. These steps, and the tasks included in each, provide a "checklist" that should be considered and may be completed as part of the planning process.

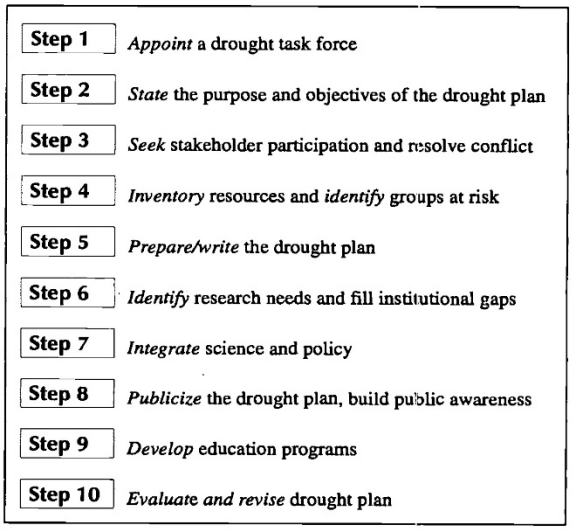

Figure 3. Ten-Step Planning Process.

Step 1: Appoint a Drought Task Force

The drought planning process is initiated through appointment of a drought task force by the governor. The task force has two purposes. First, the task force supervises and coordinates development of the plan. Second, after the plan is developed and during times of drought when the plan is activated, the task force coordinates actions, implements mitigation and response programs, and makes policy recommendations to the governor. The task force is encouraged to oversee development of a website that would contain information about the planning process while the plan is under development and a copy of the plan and current climate/water supply information once the plan is completed. A more detailed discussion of this proposed web site is included in Step 5.

The task force should reflect the multidisciplinary nature of drought and its impacts, and it should include representatives of both state and federal government agencies and universities (e.g., representatives from extension, climatologists, policy specialists, planners). A representative from the governor's office should be a member of the task force. Environmental and public interest groups and others from the private sector, including industries, can be included on the task force or can serve on an advisory council (see Step 3), as appropriate. These groups would be involved to a considerable extent in the activities of the working groups associated with the Risk Assessment Committee discussed in Step 5. The actual makeup of this task force would be highly variable between states, reflecting the principal economic sectors affected, the state's political infrastructure, and other factors.

Depending on the nature of recent experiences with drought, the task force may find itself in the public spotlight from the outset, or it may work in relative obscurity. No matter what the initial level of public attention is, the task force needs to incorporate people who know how to conduct effective two-way communication with the public. The task force should include a public information official who is familiar with local media's needs and preferences, and a public participation practitioner who can help establish a process that includes and accommodates both well-funded and disadvantaged stakeholder or interest groups.

Step 2: State the Purpose and Objectives of the Drought Plan

As its first official action, the drought task force should state the general purpose for the drought plan. State officials should consider many questions as they define the purpose of the plan, such as the:

- purpose and role of state government in drought mitigation and response efforts;
- scope of the plan;
- most drought-prone areas of the state;
- historical impacts of drought;
- historical response to drought;
- most vulnerable economic and social sectors;
- role of the plan in resolving conflict between water users and other vulnerable groups during periods of shortage;

- current trends (e.g., land and water use, population growth) that may increase/decrease vulnerability and conflicts in the future;
- resources (human and economic) that the state is willing to commit to the planning process;
- legal and social implications of the plan; and
- principal environmental concerns caused by drought.

A generic statement of purpose for a plan is to reduce the impacts of drought by identifying principal activities, groups, or regions most at risk and developing mitigation actions and programs that alter these vulnerabilities. The plan is directed at providing government with an effective and systematic means of assessing drought conditions, developing mitigation actions and programs to reduce risk in advance of drought, and developing response options that minimize economic stress, environmental losses, and social hardships during drought.

The task force should then identify the specific objectives that support the purpose of the plan. Drought plan objectives will, of course, vary between states and should reflect the unique physical, environmental, socioeconomic, and political characteristics of each state. At the state level, plan objectives will place less emphasis on financial assistance measures (traditionally a role of the federal government in the U.S.) than would the objectives of a national plan. Technical assistance is a common element of state agency missions. Support for educational and research programs is typically a shared responsibility of state and federal government. Objectives that states should consider include the following:

- Collect and analyze drought-related information in a timely and systematic manner. Establish criteria for declaring drought emergencies and triggering various mitigation and response activities.
- Provide an organizational structure and delivery system that assures information flow between and within levels of government.
- Define the duties and responsibilities of all agencies with respect to drought.
- Maintain a current inventory of state and federal programs used in assessing and responding to drought emergencies.
- Identify drought-prone areas of the state and vulnerable economic sectors, individuals, or environments.
- Identify mitigation actions that can be taken to address vulnerabilities and reduce drought impacts.
- Provide a mechanism to ensure timely and accurate assessment of drought's impacts on agriculture, industry, municipalities, wildlife, tourism and recreation, health, and other areas.
- Keep the public informed of current conditions and response actions by providing accurate, timely information to media in print and electronic form (e.g., via TV, radio, and the World Wide Web).

- Establish and pursue a strategy to remove obstacles to the equitable allocation of water during shortages and establish requirements or provide incentives to encourage water conservation.
- Establish a set of procedures to continually evaluate and exercise the plan and periodically revise the plan so it will stay responsive to the needs of the state.

Step 3: Seek Stakeholder Participation and Resolve Conflict

Social, economic, and environmental values often clash as competition for scarce water resources intensifies. Therefore, it is essential for task force members to identify all citizen groups that have a stake in drought planning (stakeholders) and their interests. These groups must be involved early and continuously in order for there to be fair representation and effective drought management and planning. Discussing concerns early in the process gives participants a chance to develop an understanding of one another's various viewpoints, and to generate collaborative solutions. Although the level of involvement of these groups will vary notably from state to state, the power of public interest groups in policy making is considerable. In fact, these groups are likely to impede progress in the development of plans if they are not included in the process. The task force should also protect the interests of stakeholders who may lack the financial resources to serve as their own advocates. One way to facilitate public participation is to establish a citizen's advisory council as a permanent feature of the drought plan to help the task force keep information flowing and resolve conflicts between stakeholders.

States should also consider whether district or regional advisory councils need to be established. These councils could bring neighbors together to discuss their water use issues and problems and seek collaborative solutions. At the state level, a representative of each district council should be included in the membership of the state's citizens' advisory council to represent the interests and values of their constituencies. The state's citizens' advisory council can then make recommendations and express concerns to the task force as well as respond to requests for situation reports and updates.

Step 4: Inventory Resources and Identify Groups at Risk

An inventory of natural, biological, and human resources, including the identification of constraints that may impede the planning process, may need to be initiated by the task force. In most states in the U.S., much information already exists about natural and biological resources through various state and federal agencies. It is important to determine the vulnerability of these resources to periods of water shortage that result from drought. The most obvious natural resource of importance is water; where is it located, how accessible is it, of what quality is it? Biological resources refer to the quantity and quality of grasslands/rangelands, forests, wildlife, and so forth. Human resources include the labor needed to develop water resources, lay pipeline, haul water and livestock feed, process citizen complaints, provide technical assistance, and direct citizens to available services.

It is also imperative to identify constraints to the planning process and to the activation of the plan in response to a developing drought. These constraints may be physical, financial, legal, or political. The costs associated with the development of a plan must be

weighed against the losses that will likely result if no plan is in place. The purpose of a drought plan is to reduce risk and, therefore, economic, social, and environmental impacts. Generally speaking, the costs associated with the development of a state-level plan have been $50,000–$100,000, plus in-kind costs to state and federal agencies. This price tag seems inconsequential in comparison to the impacts associated with drought. Legal constraints can include water rights, existing public trust laws, requirements for public water suppliers, liability issues, and so forth.

In drought planning, making the transition from crisis to risk management is difficult because, historically, little has been done to understand and address the risks associated with drought. To solve this problem, areas of high risk should be identified, as should actions that can be taken before a drought occurs to reduce those risks. Risk is defined by both the exposure of a location to the drought hazard and the vulnerability of that location to periods of drought-induced water shortages (Blaikie et al., 1994). Drought is a natural event. It is important to define the exposure (i.e., frequency of drought of various intensities and durations) of various parts of the state to the drought hazard. Some areas are likely to be more at risk than others. Vulnerability, on the other hand, is defined by social factors such as land use patterns, government policies, social behavior, water use, population, economic development, diversity of economic base, cultural composition, and so forth. The drought task force should address these issues early in the planning process so they can provide more direction to the committees and working groups that will be developed under Step 5 of the planning process.

Step 5: Establish and Write Drought Plan

This step describes the process of establishing relevant committees to develop and write the drought plan. The drought plan should have three primary components: monitoring, risk and impact assessment, and mitigation and response. It is recommended that a committee be established to focus on the first two of these needs; the mitigation and response function can in most instances be carried out by the drought task force. The suggested organizational structure for the plan is illustrated in figure 4.

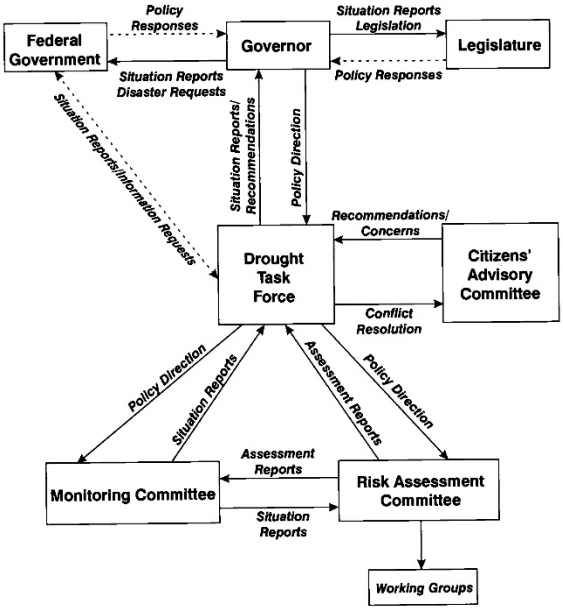

Figure 4. Suggested Organizational Structure for Drought Plan.

These committees will have their own tasks and goals, but well-established communication and information flow between committees and the task force is a necessity to ensure effective planning.

Monitoring Committee

A reliable assessment of water availability and its outlook for the near- and long-term is valuable information in both dry and wet periods. During drought, the value of this information increases markedly. The Monitoring Committee should include representatives from agencies with responsibilities for monitoring climate and water supply. It is recommended that data and information on each of the applicable indicators (e.g., precipitation, temperature, evapotranspiration, long-range weather forecasts, soil moisture, streamflow, ground water levels, reservoir and lake levels, and snowpack) be considered in the committee's evaluation of the water situation and outlook for the state. The agencies responsible for collecting, analyzing, and disseminating data and information will vary according to the state organizational structure and by geographic region.

The Monitoring Committee should meet regularly, especially in advance of the peak demand season. Following each meeting, reports should be prepared and disseminated to the state's drought task force, relevant state and federal agencies, and the media. The chairperson of the Monitoring Committee should be a permanent member of the drought task force. In many states, this person may be the state climatologist. If conditions warrant, the task force should brief the governor about the contents of the report, including any recom-

mendations for specific actions. It is essential for the public to receive a balanced interpretation of changing conditions. The Monitoring Committee should work closely with public information specialists to keep the public well-informed.

The primary objectives of the Monitoring Committee are to:

1. Adopt a workable definition of drought that could be used to phase in and phase out levels of state and federal actions in response to drought. It may be necessary to adopt more than one definition of drought in identifying impacts in various economic, social, and environmental sectors. Several indices are available (Hayes, 1998), including the Standardized Precipitation Index (McKee et al., 1993; 1995), which is gaining widespread acceptance (Guttman, 1998; Hayes et al., 1999; also see http://enso.unl.edu/ndmc/watch/watch.htm#section1a). The commonly used Palmer Drought Severity Index (Palmer, 1965) is being replaced or supplemented as a monitoring tool in many states. The trend is for states to rely on multiple drought indices to trigger responses, which are calibrated to various intensities of drought. The current thought is that no single index of drought is adequate to measure the complex interrelationships between the various components of the hydrological cycle and impacts.

It is helpful to establish a sequence of descriptive terms for water supply alert levels, such as "advisory," "alert," "emergency," and "rationing" (as opposed to more generic terms such as "phase 1" and "phase 2," or sensational terms such as "disaster"). It would be helpful to review the terminology used by other entities (i.e., local utilities, states, river basin commissions) and choose terms that are consistent so as not to confuse the public with different terms in areas where there may be authorities with overlapping regional responsibilities. These alert levels should be defined in discussions with both the Risk Assessment Committee and the task force.

In considering emergency measures such as rationing, it is important to remember that the impacts of drought may vary significantly from one area to the next, depending on the sources and uses of water and the degree of planning previously implemented. For example, some cities may have recently expanded their water supply capacity while other adjacent communities may have an inadequate water supply capacity during periods of drought. Imposing general emergency measures on people or communities without regard for their existing vulnerability may result in considerable political repercussions.

A related consideration is that some municipal water systems may be out of date or in poor operating condition, so that even moderate drought strains a community's ability to supply customers with water. Identifying inadequate (i.e., vulnerable) water supply systems and upgrading those systems should be part of a long-term drought mitigation program.

2. Establish drought management areas (i.e., subdivide the state or region into more conveniently sized districts by political boundaries, shared hydrological characteristics, climatological characteristics, or other means such as drought probability or risk). These subdivisions may be useful in drought management since they may allow drought stages and mitigation and response options to be regionalized. Climatic divisions are the most commonly used subdivisions at the state level, but they may not be the most appropriate, given topographic features, land use patterns, or water use characteristics.

3. Develop a drought monitoring system. Most states already have a good data collection system for monitoring climate and water supplies and identifying potential shortfalls. Responsibility for collecting, analyzing, and disseminating the data is divided between many state and federal agencies and other entities. The Monitoring Committee's challenge is to coordinate and integrate the analysis so decision makers and the public receive early warning of emerging drought conditions. On a national basis, much of this information has been compiled under the Drought Watch section of the NDMC's website (http://enso.unl.edu/ndmc/). Two new products, the Drought Monitor (http://enso.unl.edu/monitor/monitor.html) and Current Droughts Affecting the U.S. (http://enso.unl.edu/ndmc/impacts/us/usimpact.htm), should be noted. This section is also linked to specific state websites that illustrate how others are organizing information on drought conditions.

Many states (e.g., Nebraska, Oklahoma, California) have developed automated weather data networks that provide rapid access to climate data. These networks can be invaluable in monitoring emerging and ongoing drought conditions. These data can be coupled with data available from federal agencies (e.g., Natural Resources Conservation Service) to provide a comprehensive monitoring of climate and water systems. Data and data products should be disseminated on a timely basis in printed, form and electronically via the World Wide Web.

4. Inventory data quantity and quality from current observation networks. Many networks monitor key elements of the hydrologic system. Most of these networks are operated by federal or state agencies, but other networks also exist and may provide critical information for a portion of a state or region. Meteorological data are important but represent only one part of a comprehensive monitoring system. These other physical indicators (soil moisture, streamflow, reservoir and ground water levels) must be monitored to reflect impacts of drought on agriculture, households, industry, energy production, and other water users. Helpful technology includes soil moisture sensors, automated weather stations, and satellite data such as digital data obtained from the Advanced Very High Resolution Radiometer (AVHRR), transmitted from a National Oceanic and Atmospheric Administration satellite, which is useful in detecting areas where moisture deficiencies are affecting vegetation growth. Much of this data will be integrated under the Unified Climate Access Network (UCAN).

5. Determine the data needs of primary users. Developing new or modifying existing data collection systems is most effective when the people who will be using the data are consulted early and often. Soliciting input on expected new products or obtaining feedback on existing products is critical to ensuring that products meet the needs of primary users and, therefore, will be used in decision making. Training on how to use or apply products in routine decision making is also essential.

6. Develop and/or modify current data and information delivery systems. People need to be warned of drought as soon as it is detected, but often they are not. Information needs to reach people in time for them to use it in making decisions. In establishing information channels, the monitoring committee needs to consider when people need what kinds of

information. These decision points can determine whether the information provided is used or ignored.

The drought task force, possibly under the lead of the Monitoring Committee, should develop a website for displaying information about the drought plan, including current climate and water supply data and products, agency contacts and committee members, and a copy of the plan containing an organizational chart. Models that could be followed are webpages for the states of Texas, Montana, Pennsylvania, Oklahoma, New Mexico, South Carolina, and Nebraska (table 1). These can all be accessed through the "Drought Links" section of the NDMC's website (http://enso.unl.edu/ndmc/go/go.htm).

Table 1. Drought-Related Websites for Various States in the United States

State	Website Address
Montana	http://nris.mt.gov/wis/supply1.htm
Nebraska	http://carc.nrc.state.ne.us/carcunl
New Mexico	http://weather.nmsu.edu/drought
Oklahoma	http://www.state.ok.us/~owrb/features/drought.html
Pennsylvania	http://www.dep.state.pa.us/dep/subject/hotopics/drought/drought.htm
South Carolina	http://water.dnr.state.sc.us/climate/sco/drought.html
Texas	http://rio.twdb.state.tx.us/rio/hydro/drought.html

Risk Assessment Committee

Drought impacts cut across many sectors and across normal divisions of responsibility of local, state, and federal agencies. These impacts have been classified by Wilhite and Vanyarkho (2000) and are chronicled in the "Impacts" section of the NDMC's website (http://enso.unl.edu/ndmc/impacts/effects.htm). Impacts from current and recent drought events in the U.S. are also included under the "Drought Watch" section (http://enso.unl.edu/ndmc/impacts/us/usimpact.htm). Risk is the result of exposure to the drought hazard (i.e., probability of occurrence) and societal vulnerability, represented by a combination of economic, environmental, and social factors. Therefore, in order to reduce vulnerability to drought, it is essential to identify the most significant impacts and assess their underlying causes.

Information on drought's impacts and their causes is crucial for reducing risk before drought occurs and for appropriate responses during drought. The membership of the Risk Assessment Committee should represent economic sectors, social groups, and ecosystems most at risk from drought. The committee's chairperson should be a member of the drought task force.

The most effective approach to follow in determining vulnerability to and impacts of drought is to create a series of working groups under the aegis of the Risk Assessment Committee. The responsibility of the committee and working groups is to assess sectors, population groups, and ecosystems most at risk and identify appropriate and reasonable mitigation measures to address these risks. Working groups would be composed of technical specialists representing those areas referred to above. The chair of each working

group, as a member of the Risk Assessment Committee, would report directly to the Committee. Following this model, the responsibility of the committee is to direct the activities of each of the working groups and make recommendations to the drought task force on mitigation actions.

The number of working groups will vary considerably between states. Colorado has identified eight impact working groups: municipal water, wildfire protection, agricultural industry, commerce and tourism, wildlife, economic, energy loss, and health. Idaho's drought plan outlines the responsibilities of five subcommittees: water data, public information, agriculture, municipal supplies and water quality, and recreation and tourism. New Mexico uses four subgroups: agricultural; drinking water, health, and energy; wildlife and wildfire protection; and tourism and economic impact. Nebraska's drought plan identifies two working groups: agriculture, natural resources, wildlife, tourism, and recreation; and municipal water supply, health, and energy.

A methodology for assessing and reducing the risks associated with drought has recently been completed as a result of collaboration between the NDMC and the Western Drought Coordination Council's (WDCC) Mitigation and Response Working Group (Knutson et al., 1998) and is available on the NDMC's website at http://enso.unl.edu/ndmc/handbook/risk.pdf. The guide focuses on identifying and prioritizing drought impacts, determining their underlying causes, and choosing actions to address the underlying causes. This methodology can be employed by each of the working groups. This effort requires an interdisciplinary analysis of impacts and management options and is divided into six tasks:

1. *Assemble the Team.* Select stakeholders, government planners, and others with a working knowledge of drought's effects on primary sectors, regions, and people.
2. *Evaluate the Effects of Past Droughts.* Identify how drought has affected the region, group, or ecosystem. Consult climatological records to determine the "drought of record," the worst in recorded history, and project what would happen if a similar drought occurred this year or in the near future, considering changes in land use, population growth, and development that have taken place since that drought.
3. *Rank Impacts.* Determine which of the drought's effects are most urgently in need of attention. Various considerations in prioritizing these effects include cost, areal extent, trends over time, public opinion, social equity, and the ability of the affected area to recover.
4. *Identify Underlying Causes.* Determine those factors that are causing the highest levels of risk for various sectors, regions, and populations. For example, an unreliable source of water for municipalities in a particular region may explain the impacts that have resulted from recent droughts in that area. To reduce the potential for drought impacts in the future, it is necessary to understand the underlying environmental, economic, and social causes of these impacts. To do this, drought impacts must be identified and the reason for their occurrence determined.
5. *Identify Ways to Reduce Risk.* Identify actions that can be taken before drought that will reduce risk. In the example above, taking steps to identify new or alternative

sources of water (e.g., ground water) could increase resiliency to subsequent episodes of drought.

6. *Write a "To Do" List.* Choose actions that are likely to be the most feasible, cost-effective, and socially equitable. Implement steps to address these actions through existing government programs or the legislative process.

The choice of specific actions to deal with the underlying causes of the drought impacts will depend on the economic resources available arid related social values. Typical concerns are associated with cost and technical feasibility, effectiveness, equity, and cultural perspectives. This process has the potential to lead to the identification of effective and appropriate drought risk reduction activities that will reduce long-term drought impacts, rather than ad hoc responses or untested mitigation actions that may not effectively reduce the impact of future droughts.

Mitigation and Response Committee

Mitigation and response actions could be under the responsibility of the drought task force or could be assigned to a separate committee. It is recommended that the task force, working in cooperation with the Monitoring and Risk Assessment Committees, have the knowledge and experience to understand drought mitigation techniques, risk analysis (economic, environmental, and social aspects), and drought-related decision-making processes at all levels of government. The task force, as originally defined, is composed of senior policy makers from various state and federal agencies. Therefore, they are in an excellent position to recommend and/or implement mitigation actions, request assistance through various federal programs, or make policy recommendations to the legislature and governor.

Mitigation and response actions should be determined for each of the principal impact sectors identified by the Risk Assessment Committee. Wilhite (1993, 1997b) recently completed an assessment of drought mitigation technologies implemented by states in response to drought conditions during the late 1980s and early 1990s. However, the transferability of these technologies to specific situations in other states needs to be evaluated further because they may not be directly transferable in some cases. These drought mitigation technologies are available on the NDMC's website (http://enso.unl.edu/ndmc/mitigate/policy/mitig.htm#analysis).

Before the onset of drought, the task force should inventory all forms of assistance available from local, state, and federal government during severe drought. The task force should evaluate these programs for their ability to address short-term emergency situations and long-term mitigation programs for their ability to reduce risk to drought. Assistance should be defined in a very broad way to include all forms of technical, mitigation, and relief programs available. The WDCC, in association with the NDMC, has published the *Catalog of Federal Assistance Programs* (WDCC, 1999) (http://enso.unl.edu/wdcc/products/infoproducts.html). The purpose of this catalog is to help individuals and governments determine what federal assistance programs are available to reduce the effects of drought.

Writing the Plan

With input from each of the committees and working groups, the drought task force, with the assistance of professional writing specialists, will undertake the assignment of drafting the drought plan. After completion of a working draft, it is recommended that public meetings or hearings be held at several locations to explain the purpose, scope, and operational characteristics of the plan. Discussion must also be presented on the specific mitigation actions and response measures recommended in the plan. A public information specialist for the drought task force can facilitate planning for the hearings and also prepare news stories announcing the meetings and providing an overview of the plan.

As mentioned previously, the plan should not be considered a static document. The plan is dynamic. A copy of the plan should be available through the drought task force website and in hard copy for distribution.

Step 6: Identify Research Needs and Fill Institutional Gaps

As research needs and gaps in institutional responsibility become apparent during drought planning, the drought task force should compile a list of those deficiencies and make recommendations on how to remedy them to the governor, to relevant state agencies, and to the legislature. Step 6 should be carried out concurrently with Steps 4 and 5. For example, the Monitoring Committee may recommend establishing or enhancing an existing ground water monitoring program. Another recommendation may be to initiate research on the development of a climate or water supply index to help monitor water supplies and trigger specific actions by state government.

Step 7: Integrate Science and Policy

An essential aspect of the planning process is integrating the science and policy of drought management. The policy maker's understanding of the scientific issues and technical constraints involved in addressing problems associated with drought is often limited. Likewise, scientists generally have a poor understanding of existing policy constraints for responding to the impacts of drought. In many cases, communication and understanding between the science and policy communities must be enhanced if the planning process is to be successful.

Good communication is required between the two groups in order to distinguish what is feasible from what is not achievable for a broad range of science and policy issues. Integration of science and policy during the planning process will also be useful in setting research priorities and synthesizing current understanding. The drought task force should consider various alternatives to bring these groups together and maintain a strong working relationship.

Step 8: Publicize the Drought Plan, Build Public Awareness

If there has been good communication with the public throughout the process of establishing a drought plan, there may already be better-than-normal awareness of drought and drought planning by the time the plan is actually written. Themes to emphasize in writing news stories during and after the drought planning process could include:

- How the drought plan is expected to relieve impacts of drought. Stories can focus on the human dimensions of drought, such as how it affects a farm family; on its environmental consequences, such as reduced wildlife habitat; and on its economic effects, such as the costs to a particular industry or to the state's overall economy.
- What changes people might be asked to make in response to different degrees of drought, such as restricted lawn watering and car washing, or not irrigating certain crops at certain times.

In subsequent years, it may be useful to do "drought plan refresher" news releases at the beginning of the most drought-sensitive season, letting people know whether there is pressure on water supplies or reasons to believe that there will be shortfalls later in the season, and reminding them of the plan's existence, history, and any associated success stories. It may be useful to refresh people's memories ahead of time on circumstances that would lead to water use restrictions.

During drought, the task force should work with public information professionals to keep the public well informed of the current status of water supplies, whether conditions are approaching "trigger points" that will lead to requests for voluntary or mandatory use restrictions, and how victims of drought can access assistance. All pertinent information should also be available on the drought task forces' World Wide Web site so that the public can get information directly from the task force without having to rely on mass media.

Step 9: Develop Education Programs

A broad-based education program to raise awareness of short- and long-term water supply issues will help ensure that people know how to respond to drought when it occurs and that drought planning does not lose ground during non-drought years. It would be useful to tailor information to the needs of specific groups (e.g., elementary and secondary education, small business, industry, homeowners, utilities). The drought task force or participating agencies should consider developing presentations and educational materials for events such as a water awareness week, community observations of Earth Day, relevant trade shows, specialized workshops, and other gatherings that focus on natural resource stewardship or management.

Step 10: Evaluate and Revise Drought Plan

The final step in the planning process is to create a detailed set of procedures to ensure adequate plan evaluation. Periodic testing, evaluation, and updating of the drought plan is essential to keep the plan responsive to state needs. To maximize the effectiveness of the system, two modes of evaluation must be in place:

Ongoing Evaluation

An ongoing or operational evaluation keeps track of how societal changes such as new technology, new research, new laws, and changes in political leadership may affect drought risk and the operational aspects of the drought plan. Drought risk may be evalu-

ated quite frequently while the overall drought plan may be evaluated less often. An evaluation under simulated drought conditions (i.e., drought exercise) is recommended before the drought plan is implemented and periodically thereafter. The virtual drought exercise developed in association with a recent national study conducted by the U.S. Army Corps of Engineers (Werick and Whipple, 1994) is one mechanism that has been used to simulate drought conditions and related decisions. It is important to remember that drought planning is a process, not a discrete event.

Post-Drought Evaluation

A post-drought evaluation or audit documents and analyzes the assessment and response actions of government, nongovernmental organizations, and others, and provides for a mechanism to implement recommendations for improving the system. Without post-drought evaluations, it is difficult to learn from past successes and mistakes, as institutional memory fades.

Post-drought evaluations should include an analysis of the climatic and environmental aspects of the drought; its economic and social consequences; the extent to which pre-drought planning was useful in mitigating impacts, in facilitating relief or assistance to stricken areas, and in post-recovery; and any other weaknesses or problems caused by or not covered by the plan. Attention must also be directed to situations in which drought-coping mechanisms worked and where societies exhibited resilience; evaluations should not focus only on those situations in which coping mechanisms failed. Evaluations of previous responses to severe drought are also a good planning aid.

To ensure an unbiased appraisal, governments may wish to place the responsibility for evaluating drought and societal response to it in the hands of nongovernmental organizations such as universities and/or specialized research institutes.

Summary and Conclusion

For the most part, previous responses to drought in the U.S. have been reactive, representing the crisis management approach. This approach has been ineffective (i.e., assistance poorly targeted to specific impacts or population groups), poorly coordinated, and untimely; more importantly, it has done little to reduce the risks associated with drought. In fact, the economic, social, and environmental impacts of drought have increased significantly in recent decades. A similar trend exists for all natural hazards.

This paper presented a substantial revision to a planning process that was developed about ten years ago to derive a comprehensive drought plan at the state level in the U.S. Since it was originally published, this ten-step planning process has been used at all levels of government in the U.S. and elsewhere to guide the development of a drought plan. The goal of this planning process is to change significantly the way we prepare for and respond to drought by placing greater emphasis on risk management and the adoption of appropriate mitigation actions. The ten steps included in this process are considered to be generic in order to enable governments to choose those steps and components that are most applicable to their situation.

The significant increase in the number of states with drought plans emphasizes the importance that state governments are now placing on drought preparedness. It is recommended that states with existing plans revise those plans to include greater emphasis on risk management. The ten-step planning process, along with the procedures followed by New Mexico, Utah, and Nebraska will assist them in this effort. Those states without drought plans are encouraged to consider or reconsider plan development and how the ten-step process could facilitate that planning effort.

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