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Chapter 18 Drought: Pervasive Impacts of a Creeping Phenomenon

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Chapter 18

Drought: Pervasive Impacts of a Creeping Phenomenon

Donald A. Wilhite and Olga Vanyarkho

Introduction

Throughout human existence, drought has been a threat to the survival of societies. It has often been a trigger for massive human migrations, famines, and wars, altering the course of history itself. Today, as we prepare to enter the twenty-first century, drought continues to affect our global community in countless ways. In fact, we are still discovering the complex interrelationships between drought and society and grappling with response and mitigation strategies that will lessen impacts and therefore reduce vulnerability for future generations.

A 1984 report by the Swedish Red Cross (Hagman 1984) characterized drought as affecting more people than any other natural hazard; it was also perceived to be the least understood of all natural hazards. This apparent dichotomy is interesting because one might expect governments and international organizations to direct financial and human resources to the most urgent societal needs or problems (i.e., those with the greatest impact). Historically, this has not been the case with respect to drought. Among the principal natural hazards affecting society (i.e., earthquakes, floods, droughts, and typhoons or hurricanes), drought receives less scientific and political attention. This is due largely to its slow-onset nature; cumulative, nonstructural impacts; low death toll directly attributable to drought; and extensive areal coverage. The large spatial coverage diffuses relief and recovery efforts.

In recent years, however, there seems to have developed a growing awareness of drought and the need to direct more attention to understanding how its impacts can be reduced. Much of this interest has been kindled by the increased worldwide presence of

drought and famine in recent decades; growing environmental awareness; and concern about desertification, deforestation, and the potential implications of climate change for the frequency and severity of drought.

The purpose of this chapter is to provide an overview of the complexity of impacts associated with drought. This information will be presented in a general context since many of the chapters included in this volume, especially those included in this section, address the complexity of drought impacts and alternative management strategies in the context of specific political, economic, and social settings. A brief case study of the 1996 drought in the United States is included to illustrate the diversity and complexity of impacts of a recent drought event. Policy responses that have emerged from this event will also be discussed since they may lead to sweeping changes in drought management in the United States in the near future.

Drought Impacts Overview

To more clearly understand the impacts of drought, the phenomenon should not be viewed as merely a natural event. It is the result of an interplay between a natural event (precipitation deficiencies because of natural climatic variability) and the demand placed on water and other natural resources by human-use systems. For example, societies can exacerbate the impacts of drought by placing demands on water and other natural resources that exceed the supply of those resources. This book is replete with examples of this situation in various countries. Societies often plan for normal or above-normal water supplies, ignoring the natural variability of climate systems.

The risk that a society faces from a natural hazard is determined not only by the degree of exposure or frequency of the natural hazard but also by the vulnerability of society. According to Randolph Kent (1987), a disaster occurs when a disaster agent (e.g., drought, earthquake) exposes the vulnerability of a group or groups in such a way that their lives are directly threatened or sufficient harm has been done to economic and social structures, inevitably undermining their ability to survive.

Recent droughts in developing and developed countries and the concomitant impacts and personal hardships that resulted have underscored the vulnerability of all societies to this "natural" hazard. Recent statistics compiled by the International Decade for Natural Disaster Reduction (IDNDR 1995) indicated that drought accounted for 22 percent of the damage from disasters, 33 percent of the number of persons affected by disasters, and 3 percent of the number of deaths attributed to natural disasters. It is also important to remember that figures on damages resulting from drought include only assistance provided by the international community via international organizations, donor governments, and nongovernmental organizations. It does not include relief and recovery funds provided by governments to drought-affected areas within their own borders. For example, the United States expended nearly US$8 billion in responding to the severely affected drought areas in the western and midwestern drought areas between 1974 and 1977 (Wilhite et al. 1986). Another US$6 billion was provided by the federal government in 1988-9 (Riebsame et al. 1991). The Australian government provided assistance to drought-affected areas totaling

A$940 million between 1970 and 1984 (Wilhite 1986), and the South African government's expenditures for drought relief in 1984–85 were nearly R450 million (Wilhite 1987).

The number of natural hazard events occurring in most geographic regions over the past three decades has been relatively static for most types of hazards. However, there has been a dramatic increase in the number of reported natural disasters (see chapter 1). If the number of natural hazard events has not increased dramatically for most hazards, then it is the number of people exposed to these events and their vulnerability that is changing. Vulnerability is defined as people's capacity to anticipate, cope with, and recover from a natural hazard (Blaikie et al. 1994). With the world's population increasing by more than 90 million people annually (Brown et al. 1993), the number of people vulnerable to natural hazards is increasing at an alarming rate. Each year, more people living along coastlines, in flood plains, on hillsides, and in climatically marginal zones are at risk. Environmental degradation is also increasing the risk and impacts of natural hazards at some locations.

In the case of drought and other atmospheric-based natural hazards, projected changes in climate caused by increasing concentrations of CO_2 and other atmospheric trace gases (see chapter 48) must also be considered when attempting to explain the trend in disasters. In fact, many people already believe the increased number of extreme climatic events recorded over the past decade is an indicator of a changed climate. For example, the recent increase in flood events worldwide has increased speculation that we are already experiencing the impacts of global warming. Increased precipitation amounts and more intense precipitation events are consistent with projections of a changed climate. People also attribute recent drought years to a change in climate, at times without first examining drought occurrence in the context of the historical climatology of the affected area. Attributing a drought event or series of consecutive drought years to climate change also neglects more fundamental questions of vulnerability and how to reduce it (i.e., it is considered only a natural phenomenon). When attempting to explain the causes of an extreme climatic event, such as drought, scientists must clearly distinguish between the causes of the natural event and its social consequences.

The Impacts of Drought

Drought produces a complex web of impacts that not only ripple through many sectors of the economy but may be experienced well outside the affected region, extending even to the global scale. This complexity is largely caused by the dependence of so many sectors on water for producing goods and providing services.

Impacts from drought are commonly classified as direct or indirect. Reduced crop, range land, and forest productivity; increased fire hazard; reduced water levels; increased livestock and wildlife mortality rates; and damage to wildlife and fish habitat are a few examples of direct impacts. The consequences of these impacts illustrate indirect impacts. For example, a reduction in crop, range land, and forest productivity may result in reduced income for farmers and agribusiness, increased prices for food and timber, unemployment, reduced government tax revenues because of decreased expenditures, increased crime,

foreclosures on bank loans to farmers and businesses, migration, and disaster relief programs. Direct or primary impacts are usually of a biophysical nature. Conceptually, the more removed the impact from the cause, the more complex the link to the cause.

Because of the number of affected groups and sectors associated with drought, the geographic size of the area affected, and the difficulties in quantifying environmental damages and personal hardships, the precise determination of the financial costs of drought is a formidable challenge. The economic costs and losses associated with drought are highly variable from year to year. These costs and losses are also quite variable from one drought year to another in the same place, depending on timing, intensity, and spatial extent of the droughts.

The impacts of drought are commonly classified as economic, environmental, and social (Wilhite 1992). Table 18.1 presents a comprehensive list of the impacts associated with drought. This list represents the experiences of many drought-prone areas of the world, as derived from the literature and from participants of workshops in the United States and regional training seminars in Africa, Latin America, and Asia. These meetings were conducted by the International Drought Information Center at the University of Nebraska–Lincoln between 1989 and 1993. Although drought produces impacts that are regionally distinct, there are many similarities in the types of impacts experienced from one region to another. Many economic impacts occur in broad agricultural and agriculturally related sectors, including forestry and fisheries, because of the reliance of these sectors on surface and subsurface water supplies. In addition to obvious losses in yields in both crop and livestock production, drought is associated with increases in insect infestations, plant disease, and wind erosion. Droughts also bring increased problems with insects and diseases to forests and reduce growth. The incidence of forest and range fires increases substantially during extended droughts, which in turn places both human and wildlife populations at higher levels of risk.

Table 18.1. Classification of drought-related impacts (costs and losses)

Problem sectors	Impacts
Economic	loss from crop production
	annual and perennial crop losses; damage to crop quality
	reduced productivity of cropland (wind erosion, etc.)
	insect infestation
	plant disease
	wildlife damage to crops
	loss from dairy and livestock production
	reduced productivity of range land
	forced reduction of foundation stock
	closure/limitation of public lands to grazing
	high cost/unavailability of water for livestock
	high cost/unavailability of feed for livestock
	high livestock mortality rates
	increased predation
	range fires

	loss from timber production
	forest fires
	tree disease
	insect infestation
	impaired productivity of forest land
	loss from fishery production
	damage to fish habitat
	loss of young fish due to decreased flows
	loss of national economic growth, retardation of economic development
	income loss for farmers and others directly affected
	loss of farmers through bankruptcy
	loss to recreational and tourism industry
	loss to manufacturers and sellers of recreational equipment
	increased energy demand and reduced supply because of drought-related power curtailments
	costs to energy industry and consumers associated with substituting more expensive fuels (oil) for hydroelectric power
	loss to industries directly dependent on agricultural production (e.g., machinery and fertilizer manufacturers, food processors, etc.)
	decline in food production/disrupted food supply
	increase in food prices
	increased importation of food (higher costs)
	disruption of water supplies
	unemployment from drought-related production declines
	strain on financial institutions (foreclosures, greater credit risks, capital shortfalls, etc.)
	revenue losses to federal, state, and local governments (from reduced tax base)
	deters capital investment, expansion
	dislocation of businesses
	revenues to water supply firms
	revenue shortfalls
	windfall profits
	loss from impaired navigability of streams, rivers, and canals
	cost of water transport or transfer
	cost of new or supplemental water resource development
Environmental	damage to animal species
	reduction and degradation of fish and wildlife habitat
	lack of feed and drinking water
	disease
	increased vulnerability to predation (e.g., from species concentration near water)
	loss of biodiversity
	wind and water erosion of soils
	reservoir and lake drawdown
	damage to plant species
	water quality effects (e.g., salt concentration, increased water temperatures, pH, dissolved oxygen)
	air quality effects (dust, pollutants)
	visual and landscape quality (dust, vegetative cover, etc.)
	increased fire hazard

	estuarine impacts; changes in salinity levels, reduced flushing
Social	increased ground water depletion (mining), land subsidence
	loss of wetlands
	loss of cultural sites
	insect infestation
	food shortages (decreased nutritional level, malnutrition, famine)
	loss of human life (e.g., food shortages, heat)
	public safety from forest and range fires
	conflicts between water users, public policy conflicts
	increased anxiety
	loss of aesthetic values
	health-related low flow problems (e.g., diminished sewage flows, increased pollutant concentrations, etc.)
	recognition of institutional constraints on water use
	inequity in the distribution of drought impacts/relief
	decreased quality of life in rural areas
	increased poverty
	reduced quality of life, changes in lifestyle
	social unrest, civil strife
	population migration (rural to urban areas)
	reevaluation of social values
	increased data/information needs, coordination of dissemination activities
	loss of confidence in government officials
	recreational impacts

Source: Wilhite and Wood 1994

Income loss is another indicator used in assessing the impacts of drought because so many sectors are affected. Reduced income for farmers has a ripple effect because their ability to purchase goods and services is limited. Thus, many retailers experience significant reductions in sales. This leads to unemployment; increased credit risk for financial institutions; capital shortfalls; and loss of tax revenue for local, state, and federal government. The recreation and tourism industries are also affected because many consumers have less discretionary income available. Prices for food, energy, and other products increase as supplies are reduced. In some cases, local supply shortfalls for certain goods will result in the importation of these goods from outside the stricken region. Reduced water supply impairs the navigability of rivers and results in increased transportation costs because products must be transported by rail or truck. Hydropower production is also significantly reduced. For example, hydropower generation was 25–40 percent below average for large sections of the United States in 1988 (table 18.2), resulting in serious revenue losses for the industry (Wilhite 1993).

Table 18.2. Hydropower production by selected US power producers in 1988 compared to a ten-year average

Region and producer	Total hydro operating capacity (in MW)	Ten-year average 1983–92 (1,000 Mwh)	Total hydro generation for 1988 (1,000 Mwh)	1988 hydro generation % of ten-year average
Northeast: New York Power Authority	4,068	24,747	22,471	91
South: Corps of Engineers	4,162	11,031	7,560	69
Tennessee Valley Authority	3,346	16,871	9,620	57
Great Lakes: Corps of Engineers	479	1,767	1,041	59
Plains: Corps of Engineers	2,873	9,659	9,949	103
Southwest: Bureau of Reclamation	4,472	15,744	11,304	72
Pacific Gas & Electric	3,904	10,706	7,884	74
Northwest: Corps of Engineers	13,093	55,794	48,507	87
Total/Averages	36,397	146,807	118,335	81

Source: Hydro Review's Hydropower Generation Report database

Environmental losses are the result of damages to plant and animal species, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation. However, many species will eventually recover from this temporary aberration. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity of the landscape. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects.

Social impacts mainly involve public safety, health, conflicts between water users, reduced quality of life, and inequities in the distribution of impacts and disaster relief. Many of the impacts specified as economic and environmental have social components as well. Population outmigration is a significant problem in many countries as people affected by drought choose to migrate to urban areas within the stressed areas or to regions outside the drought area. Food is generally more available in urban areas. However, when drought conditions have abated, these persons seldom return home, placing ever-increasing pressure on the urban environment and infrastructure of the region to which they have emigrated. In the drought-prone northeast region of Brazil, there was a net loss of nearly 5.5 million people between 1950 and 1980 (Magalhães 1988). Although all of this movement was not directly attributable to drought, it was a primary factor in the decision to relocate for many persons. This continues to be a significant problem in Brazil and many other drought-prone nations. This shift in population may lead to greater poverty and social unrest.

As with all natural hazards, the economic impacts of drought are highly variable within and between economic sectors and geographic regions, producing a complex assortment

of winners and losers with the occurrence of each disaster. For example, decreases in agricultural production result in enormous negative financial impacts on farmers in drought-affected areas, at times leading to foreclosure. This decreased production also leads to higher grain, vegetable, and fruit prices. These price increases have a negative impact on all consumers as food prices increase. However, farmers outside the drought-affected area with normal or above-normal production or those with significant grain in storage reap the benefits of these higher prices. Similar examples of winners and losers could be given for other economic sectors as well. For example, some of the winners associated with the 1988 drought included agricultural producers in nondrought areas; water-producing technologies such as well drilling; weather modification companies; electric utilities; coal companies; Great Lakes ports (lake shipping increased because of decreased river shipping); construction industries; and commercial aviation (Riebsame et al. 1991).

The 1996 Drought in the United States: Case Study

In 1995, a severe drought developed in portions of western Texas and New Mexico in the American Southwest. This drought carried over into 1996 in these states and expanded into Arizona, central and eastern Texas, and parts of California, Nevada, Utah, Colorado, Oklahoma, and Kansas. The drought area intensified during the late winter and spring months, reaching a peak severity in the May–July period for various portions of the region.

The impacts of drought began in February as the incidence of range fires increased dramatically in Texas, Oklahoma, and Kansas, destroying homes and injuring people. In February, range fires had already caused significant damage in parts of Texas, Oklahoma, and Kansas (O'Hanlon 1996). By March, depletion of groundwater supplies was becoming a problem in parts of Texas, and residents of the Barton Springs/Edwards Aquifer Conservation District were asked to cut water usage by 20 percent (US Water News Online 1996). By April, the US Department of Agriculture (USDA) reported winter wheat conditions in nineteen states in poor to very poor condition, with the greatest problems in Kansas, Oklahoma, Missouri, and Illinois (Edwards 1996). In May, prices for gasoline, diesel, and liquified petroleum were reported by USDA to be 15 percent above 1995 levels. Reports from ski resorts in New Mexico indicated reduced revenues of more than 20 percent (Reuters 1996). Fires increased in central Arizona, California, and New Mexico (Associated Press 1996). Winter wheat production in Texas was reduced to 27 percent of 1995 production (Houston Chronicle 1996). Agricultural losses for cotton, wheat, feed grains, cattle, and corn were estimated in June at US$2.4 billion in Texas, with an additional US$4.1 billion in losses for agriculturally related industries such as harvesting, trucking, and food processing (United Press International 1996). Reduced irrigation water was responsible for much of the reduction in vegetable production in Texas, with concomitant losses in jobs and income (Antosh 1996). Later estimates of drought losses in Texas were revised downward to about US$5 billion, reflecting lower commodity prices than originally estimated (Fohn 1996). Wheat production in Kansas was estimated at 183 million bushels, only 64 percent of the 1995 crop (Reuters 1996). Colorado's winter wheat crop was down more than 30 percent (Algeo 1996); Oklahoma cotton production was down 24 percent (Stafford 1996).

Water restrictions continued to increase in many cities across the region. Houston residents were forced to cut back on nonessential uses (Houston Chronicle 1996) and Santa Fe was forced to reduce water usage by 25 percent. Water levels in the Edwards Aquifer, the primary source of water for 1.5 million people in San Antonio and five counties in south Texas, was rapidly reaching the lowest level ever recorded (Smith 1996). Fires continued to be a major problem throughout the drought. In particular, New Mexico, Arizona, Nevada, Colorado, and Utah experienced major forest and wildfires. In Colorado, nearly 68,000 fires burned more than 2 million acres (810,000 ha) (Hillard 1996). Reports of wind and insect damage to crops were being received from Colorado and New Mexico (Reuters 1996a and 1996b). Livestock began to take a toll on range lands in the region as overgrazing began to worsen existing erosion problems in Arizona. A shortage of hay throughout the region reached disastrous proportions in June (Smith 1996), forcing ranchers to sell cattle at the lowest prices in ten years. Environmental damages began to emerge as endangered species were affected, landscapes were eroded, and fires damaged countless areas in the region (Holmes 1996). Nitrate levels in hay rose dramatically in Oklahoma, reaching toxic or near-toxic levels for livestock (Schafer 1996).

Food prices responded to the lower production levels for milk, meat, produce, and other foodstuffs (Lee 1996, Carrillo 1996). For example, the price of fruit increased more than 22 percent in June (Carrillo 1996). Fires continued to occur throughout the region and expanded into the Pacific Northwest and the northern Rocky Mountain states (Laceky 1996, Associated Press 1996).

There are no official estimates of the total losses and damages from the 1996 drought. Given the US$5 billion in impacts that occurred in Texas, total regional impacts could be safely estimated in the US$10–15 billion range, although it is difficult to quantify many social and environmental impacts. What was remarkable to many was the significant level of regional vulnerability, the diversity of impacts, and the lack of preparedness to respond to many of these impacts. Many of the states in this region have now initiated longer-term planning efforts directed at improving mitigation and preparedness efforts. Some of the possible policy approaches to dealing with droughts are discussed below.

Reducing the Impacts of Drought: Implications for Policy

The increase in the number of natural disasters was documented in chapter 1. With growing population pressures, more people are exposed to the risks associated with natural hazards each year, leading to a steady increase in the number of natural disasters reported. A concerted effort by governments and the international community is required to reduce this trend. It was for this reason that the decade of the 1990s was designated by the United Nations as the International Decade for Natural Disaster Reduction (IDNDR).

Strategies for responding to and preparing for drought are numerous and range from household or community level to national level. These strategies (discussed in other parts of this volume) take many forms. At the local level, people and communities possess detailed knowledge of the likely occurrence of drought and its effects and have developed (over decades or centuries) a broad range of survival strategies to help them reduce its effects and recover once the rains have returned. These strategies range from a change in

cropping or planting patterns to a reduction of assets, such as reducing herd size or selling jewelry or other valuables.

At the state or national level, governments may respond to drought in three ways: predrought mitigation programs for impact reduction; postdrought relief programs to provide emergency assistance to victims; and preparedness or contingency planning to develop institutional capacity to respond in a more timely and effective manner and reduce impacts (Parry and Carter 1987). Examples of predrought mitigation programs include the development of an early warning system, augmentation of water supplies, demand reduction (such as water conservation programs), and crop insurance. Postdrought interventions refer to those reactive programs or tactics implemented by government in response to drought. This includes a wide range of reactive emergency measures such as low-interest loans, transportation subsidies for livestock and livestock feed, provision of food, water transport, and drilling wells for irrigation and public water supplies. This reactive crisis management approach has been criticized by scientists, government officials, and many relief recipients as inefficient, ineffective, and untimely. More recently, the provision of emergency relief in times of drought has also been criticized as being a disincentive to the sustainable use of natural resources because it does not promote self-reliance. In fact, this approach may increase vulnerability to drought. Preparedness planning refers to the development of policies and plans that can be useful in preparing for drought. These are usually developed at national and provincial levels with linkages to the local level.

Policy Responses to the 1996 Drought in the United States: A Model for Other Regions?

As described previously, the impacts of the 1996 drought in the United States resulted in diverse and dramatic regional impacts that rippled to both the national and international level. However, the legacy of the 1996 drought is not likely to be the impacts that resulted but rather the policy initiatives that occurred in the post-drought period. These initiatives appear to be changing the way droughts are viewed and managed in the United States. The real question at this point is whether these changes will result in permanent and substantive modifications in the way governmental entities deal with drought.

In June 1996, the Federal Emergency Management Agency (FEMA) was asked to chair a multistate drought task force to address the drought situation in the Southwest and southern Great Plains states. The purpose of the task force was to coordinate federal response to drought-related problems in the stricken region by identifying needs, applicable programs, and program barriers. The task force was also directed to suggest ways to improve drought management through both short- and long-term national actions. To accomplish these objectives, a workshop was held in June that included representatives from many federal agencies, the drought-affected states, universities, and the Native American tribal groups. The final report of this workshop (FEMA 1996) divided short- and long-term recommendations and issues into three categories: policy, legislative, and executive branch. These recommendations are the product of intensive discussions and represent the opinions of participating parties.

Several long-term issues and recommendations noted in the FEMA report are relevant to the discussion of policy responses to drought impacts. First, participants recommended

the development of a national drought policy based on the philosophy of cooperation with state and local stakeholders. They emphasized that this policy should be developed now even though "regional interests and states' rights advocates may occasionally throw up roadblocks." Participants emphasized the need for a contingency plan to help apply lessons from the past to future drought events. This policy should include a national climate/drought monitoring system to provide early warning of the onset and severity of drought to federal, state, and local officials. This policy would also include an institutionalized organizational structure to address the issue of drought on a national scale. Second, it was suggested that a regional forum be created to assess regional needs and resources, identify critical areas and interests, provide reliable and timely information, and coordinate state actions. It was suggested that multistate and impact-specific working groups be established under this forum to identify critical needs. Third, FEMA was asked to include drought as one of the natural hazards addressed in the National Mitigation Strategy (FEMA 1995), given the substantial costs associated with its occurrence and the numerous opportunities available to mitigate its effects. This report estimated annual losses because of drought at US$6–8 billion. Fourth, states strongly requested that a single federal agency be appointed to coordinate drought preparedness and response. The states recommended that FEMA be given this responsibility; FEMA suggested that USDA be the agency in charge, given its program responsibilities in agriculture, often the first sector affected. This report was submitted to the president in August 1996.

The second initiative was the development of a drought task force under the leadership of the Western Governors' Association (WGA). This task force was formed in June 1996 as a result of a resolution offered by Governor Gary Johnson of New Mexico. The resolution states, "The western governors believe that a comprehensive, integrated response to drought emergencies is critical . . . [and that] it is important to work together and cooperatively with other affected entities to plan for and implement measures that will provide relief from the current drought and prepare for future drought emergencies" (WGA 1996).

The WGA Drought Task Force produced a report (WGA 1996) in November that made several important recommendations that were intended to reduce vulnerability to future droughts. First, the task force recommended that a national drought policy or framework be developed that integrates actions and responsibilities among all levels of government and emphasizes preparedness, response, and mitigation measures that should be adopted. Second, each state should be encouraged to develop a drought contingency plan that includes early warning, triggers, and short- and long-term planning and mitigation measures. Third, a regional drought coordinating council should be created to develop sustainable policy, monitor drought conditions, assess state-level responses, identify impacts and issues for resolution, and work in partnership with the federal government to address drought-related needs. Fourth, a federal interagency coordinating group should be established with a designated lead agency for drought coordination with states and regional agencies.

A number of important policy initiatives have resulted from the FEMA and WGA reports. First, the National Drought Policy Act of 1997 (Senate Bill 222) was introduced in the US Senate in January 1997. This bill, if passed, would create a commission to make recommendations to the president and Congress on the development of a national drought

policy. The bill was passed by the Senate in November 1997. A comparable bill was introduced in the House and will be debated in early 1998. This bill would be the first step in the development of a national drought policy. Second, a memorandum of understanding (MOU) was signed in early 1997 between the WGA and the Departments of Agriculture, Interior, and Commerce; FEMA; and the Small Business Administration. This MOU pledges the development of a partnership between federal, state, local, and tribal governments to reduce the impacts of drought in the western states through improved response and more attention to preparedness and mitigation. This MOU has resulted in the following actions: (1) the western Drought Coordination Council (WDCC) was formed in June 1997 to address the recommendations of the western governors (WGA 1996), and the WDCC is actively working on these recommendations as part of its annual work plan; (2) USDA was designated by the president as the lead federal agency for drought; and (3) USDA has established a federal interagency drought coordinating group to facilitate coordination between the numerous federal agencies with drought-related program responsibilities.

In addition to these activities, the National Drought Mitigation Center is conducting a series of regional training workshops on drought contingency planning. These workshops are exposing people at various levels of government in all parts of the country to the mechanics of drought contingency planning with the hope of stimulating improved levels of preparedness, the development of better mitigation tools, and networking between levels of governments. States in the 1996 drought-affected area are moving toward the development of plans, as noted by Wilhite (see chapter 39), so that they will be better prepared to deal with the next episode of severe drought.

Conclusions

Drought is a pervasive natural hazard that is a normal part of the climate of virtually all regions. It should not be viewed as merely a physical phenomenon. Rather, drought is the result of an interplay between a natural event and the demand placed on water and other natural resources by human-use systems.

The impacts of drought are diverse; they ripple through the economy and may linger for years after the termination of the period of deficient precipitation. Impacts are often referred to as direct or indirect. Because of the number of groups and economic sectors affected by drought, its geographic extent, and the difficulties in quantifying environmental damages and personal hardships, the precise calculation of the financial costs of drought is difficult. Drought years frequently occur in clusters, and thus the costs of drought are not evenly distributed between years. Drought impacts are classified as economic, environmental, and social.

Government response to drought includes a wide range of potential actions to deal with the impacts of water shortages on people and various economic sectors. The types of actions taken will vary considerably between developed and developing countries and from one region to another. Few, if any, actions of government attempt to reduce long-term vulnerability to the hazard. Rather, assistance or relief programs are reactive and address only short-term emergency needs; they are intended to reduce the impacts and hardship of the present drought.

Developing a drought policy and contingency plan is one way that governments can reduce the impacts of future droughts and improve the effectiveness and efficiency of future response efforts. Drought is a global problem that can be addressed only through a strong interdisciplinary effort from the scientific community, interaction between scientists and policy makers, and the cooperation of international organizations. This is evident for all aspects of drought, including prediction, monitoring, impact assessment, adaptation, response and recovery, and preparedness. A key in this process is the establishment of national and international networks of scientists, natural resource managers, policy makers, and others to foster collaboration on the critical issues associated with improving predictability, enhancing monitoring and early warning capacity, maintaining and improving observational networks, developing improved models for early estimations of impact, identifying existing (and promoting the development of new and innovative) coping and mitigation strategies, and disseminating methodologies for drought preparedness. These networks will significantly enhance the opportunities for technical cooperation within and between levels of government and between nations. An information clearinghouse that centralizes available material from national and international sources on all aspects of drought prediction, monitoring, impact assessment, mitigation, and preparedness would greatly facilitate the transfer of technology between nations and organizations.

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