

2004

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Wilhite, Donald A., "Drought" (2004). *Drought Mitigation Center Faculty Publications*. 78.
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Published in *Encyclopedia of the Great Plains*, edited by David J. Wishart, pp. 852–853 (Lincoln: University of Nebraska Press, 2004).

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Drought is a normal feature of the climate for virtually all portions of the United States and some portions of Canada, but it is one of the defining characteristics of the North American Great Plains. Early maps referred to this region as the Great American Desert, a belief attributed to the explorations of Zebulon Pike across the Southern Plains in 1806 and of Stephen Long across the Central Plains in 1819–20. The drought of the 1890s and, in particular, the Dust Bowl years of the 1930s define the region's climatic past. More recently, droughts have occurred at regular intervals, affecting, at one time or another, all portions of the region.

Drought is the consequence of a natural reduction in the amount of precipitation received over an extended period of time, usually a season or more in length. Drought is never the result of a single cause but, rather, the result of many causes that are synergistic in nature. Prolonged droughts in the Great Plains occur when large-scale anomalies in atmospheric circulation patterns become established and persist for periods of months, seasons, or longer. Impacts are complex, vary on spatial and temporal scales, and depend on the societal context of the drought. The impacts of drought in the Great Plains consequently differ from those experienced in other portions of the United States and Canada.

Historical climate records for the Great Plains only reach back to about 1900, and at only a few locations. Tree-ring data have been used to reconstruct the earlier drought history of the region, and these data illustrate a pattern of periodic and extended droughts, sometimes continuing for several decades. For example, H. E. Weakly identified a drought period of thirty-six years from 1631 to 1667 from an analysis of tree rings in western Nebraska.

A number of conclusions can be drawn from the occurrence of severe to extreme drought in the Great Plains over the last 100 years. First, the percentage of the area in drought is highly variable from year to year. The peak drought year was 1934, when 95 percent of the region experienced severe to extreme drought. Second, it is rare for severe

drought not to occur somewhere in the region every year. Third, clusters of drought years, although rare, appear in the 1890s, 1930s, mid-1950s, late 1970s, late 1980s to early 1990s, and, to date, the first three years of the twenty-first century.

Drought produces a complex web of impacts that not only reverberate throughout the region's economy but may also affect other regions, extending even to the global scale (if, for example, harvests fail and crop exports are reduced). These impacts are commonly classified as economic, environmental, and social. Many economic impacts occur in broad agricultural and agriculturally related sectors because these sectors are dependent on surface and subsurface water supplies. In addition to crop and livestock production losses, drought is associated with increases in insect infestations, plant disease, and wind erosion. The incidence of wildfires increases substantially during extended droughts, which in turn places human and wildlife populations at greater risk. Income loss is another indicator used to assess drought because so many sectors are affected. Reduced income for farmers has a ripple-down effect as their purchasing power is reduced, leaving small-town businesses without customers.

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 after the drought. Other environmental effects linger for some time or may even become permanent. For example, short-term effects might entail a reduction of fish or wildlife species or impacts on air quality. Permanent or long-term effects could be reduced soil productivity from soil erosion or an extinction of fish or wildlife species.

Social impacts mainly involve public safety, health, conflicts between water users, reduced quality of life, and inequity in the distribution of impacts and disaster relief. Many of the impacts that are considered economic and environmental have social components as well. The economic hardships of the 1930s drought, for example, caused significant population out-migration from and massive flows of aid into the Great Plains.

Although drought is a natural hazard, vulnerability to its impacts can be reduced. Improving management of drought effects requires identifying both the natural and social repercussions. The Great Plains has historically had a very high incidence of drought, and there is no reason to believe that this incidence will diminish in the future. Vulnerability, on the other hand, is determined by factors such as population numbers, demographic characteristics, technology, government policy, and social behavior. These factors change over time, and vulnerability may increase or decrease in response to these changes. There was relatively little dust blowing in the 1890s drought, for example, for much of the grass cover had not yet been removed by farming.

Much has been done to lessen societal vulnerability to drought in the Great Plains. Irrigation, conservation tillage practices, soil evaporation reduction measures, snow management, and irrigation scheduling have all proved effective in stabilizing agricultural production in a region exposed to the vagaries of weather.

The impacts of recent droughts, however, illustrate the continuing vulnerability. In 1988, drought affected nearly 40 percent of the nation and resulted in nearly \$16 billion in agricultural losses. In the Great Plains, this drought reduced spring wheat yields by 54

percent. In 1996, drought in the Southwest and the Southern Great Plains resulted in substantial agricultural losses, increased incidence of forest and range fires, municipal water supply problems, and losses in recreation and tourism. In Texas alone, drought losses were estimated to be \$6.5 billion. In 1998, drought in Texas and Oklahoma was estimated to have resulted in \$5.8 billion and \$2 billion in losses, respectively.

Drought planning is one mechanism that states and provinces have employed to reduce the economic losses and personal hardships. The goal of such plans is to improve the effectiveness of response and preparedness efforts through improved monitoring and early warning; impact and vulnerability assessment; and mitigation programs. These plans are also directed at improving coordination and building partnerships within state government agencies and between state and provincial, local, and federal governments. Most Great Plains states currently have drought plans in place. Plans recently developed by New Mexico and Nebraska are the most progressive because they incorporate mitigation actions as a key component of the planning process. Formal drought plans do not exist in the Prairie Provinces.

Drought is a complex, recurrent, and insidious natural hazard that inflicts considerable pain and hardship on Plains residents. The economic, social, and environmental repercussions of drought result from complex interactions between physical and social systems, and they are difficult to quantify. Scientists and policymakers must understand the characteristics of drought and appreciate the magnitude and complexity of impacts in order for viable assessment, response, and mitigation strategies to be established.

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Wilhite, Donald A., ed. *Drought Assessment, Management, and Planning: Theory and Case Studies*. Boston: Kluwer Academic Publishers, 1993.