Drought 2002 in Colorado: An Unprecedented Drought or a Routine Drought?

ROGER A. PIELKE, Sr.,1 NOLAN DOESKEN,1 ODILIA BLISS,1 TARA GREEN,1 CLARA CHAFFIN,1,2 JOSE D. SALAS,3 CONNIE A. WOODHOUSE,4 JEFFREY J. LUKAS,5 and KLAUS WOLTER6

Abstract — The 2002 drought in Colorado was reported by the media and by public figures, and even by a national drought-monitoring agency, as an exceptionally severe drought. In this paper we examine evidence for this claim. Our study shows that, while the impacts of water shortages were exceptional everywhere, the observed precipitation deficit was less than extreme over a good fraction of the state. A likely explanation of this discrepancy is the imbalance between water supply and water demand over time. For a given level of water supply, water shortages become intensified as water demands increase over time. The sobering conclusion is that Colorado is more vulnerable to drought today than under similar precipitation deficits in the past.

Key words: Drought, precipitation, Colorado, streamflow, snowpack, paleoclimatology.

1. Introduction

In reference to the 2002 drought, the Governor of Colorado stated in his 2003 State of the State address,

“... scientists tell us that this is perhaps the worst drought in 350 years.”
(http://www.thedenverchannel.com/print/1913350/detail.html?use=print)

Clearly, such an assessment of drought severity depends on how drought is defined. Drought is characterized in a number of different ways, each with associated definitions of onset and recovery, duration, and related impacts. For example,
meteorological drought could be measured by numbers of days below a specified precipitation threshold, or departure from a baseline average; an agricultural drought could be measured by soil moisture deficit and impacts on crops; and a hydrological drought could be measured by a period of precipitation deficit and impacts on water supply such as streamflow and surface and subsurface water storages. Spatial and temporal scales must also be considered in defining drought. The variety of ways to define drought makes a simple assessment of drought severity a difficult task.

In this paper, we explore the severity of the 2002 drought, defined by a variety of moisture-related variables including precipitation, snowpack, streamflow, reservoir storage, and tree growth. Although the 2002 drought is considered by some to be the third of a three-year drought, here we focus on 2002 as a single year event. The definition of the year varies somewhat according to variable measured, but in general, we consider it from fall 2001 though summer 2002. Its impact is gauged on the regional to statewide level.

Figure 1 shows the magnitude of the drought as determined by the U.S. Drought Monitor (http://drought.unl.edu/dm/), where the western third of the state is in the highest (“exceptional”) category. In this display, drought has been defined based on the interpretation of available water deficit information by researchers at the National Drought Mitigation Center at the University of Nebraska at Lincoln, as well as input from a variety of experts in the field, including some of the co-authors of this paper. “Exceptional drought” refers to conditions found between once every fifty years or never before on record. This is one assessment of drought that our paper examines using a variety of analysis techniques.

2. An Evolution of the 2002 Drought in Colorado

The drought of 2002, with all of its devastating wildfires, profound water shortages and widespread crop losses, had its beginnings in the autumn of 1999. After a very wet spring in 1999 and a soggy August, precipitation patterns reversed and the fall of 1999 was very dry across most of Colorado. The winter of 1999–2000 followed with below average snow accumulation and much above average temperatures. The mountains of southwestern Colorado were particularly hard hit by a shortage of snow for winter recreation and summer water supply. With a very dry spring and early summer in 2000 over northeast Colorado and the South Platte watershed, drought conditions emerged quickly. In fact, the entire western U.S. was by then engulfed in a severe drought that resulted in the largest severe wildfire season in the last century for the western U.S. (http://www.nifc.gov/stats/wildlandfire-stats.html). A persistently hot summer made the situation worse, as transpiration rates were considerably higher than average over irrigated areas.

The 2001 Water Year was less extreme but still tended on the dry side. Colorado’s northern and central mountains were the driest with respect to average. While spring