USGS Report: Drought of 1998-2002 in North Carolina

Weaver, J.C., 2005, The drought of 1998-2002 in North Carolina—Precipitation and hydrologic conditions: U.S. Geological Survey Scientific Investigations Report 2005-5053, 88 p.

Abstract

Drought conditions prevailed across much of North Carolina during 1998–2002, resulting in widespread record-low streamflow and ground-water levels in many areas. During this 4-year period, the drought was continuous in areas of western North Carolina, although eastern areas of the state had some periods of relief from tropical storms in 1998 and 1999. The occurrence of dry winters in 2001 and 2002 along with a dry spring in 2002, exacerbated drought conditions across the state and resulted in substantial declines in streamflow and ground-water levels during the summer of 2002.

The drought caused widespread hardship and economic losses across North Carolina. During the latter months of 2002, more than 200 municipalities that included most major cities operated under some form of voluntary, mandatory, or emergency water conservation. Reservoirs across North Carolina were at record or near record-low levels, including some of the largest ones used for multiple purposes (flood control, low-flow augmentation, and/or recreation), and required continuous and careful operation to balance the upstream and downstream needs of users.

Precipitation deficits during the 1998–2002 drought for some locations in North Carolina were among the largest documented since the beginning of systematic collection of weather data. The largest deficits occurred primarily in the western Piedmont and were as much as 60 to 70 inches in some locations during the 4-year period. Cumulative monthly precipitation departures for the period May 1998 through September 2002 at 13 selected precipitation sites across the State ranged from 5.3 inches below normal in Greenville (eastern North Carolina) to 66.7 inches below normal in Hickory (western North Carolina). During the 12-month period October 2002 through September 2003, precipitation departures at 7 of the 13 sites were more than 20 inches above normal, primarily in the western Piedmont. Precipitation data for the period of record were examined for 8 of the 13 sites to compare precipitation deficits during the 1998–2002 drought with those that occurred during selected historical droughts. At three of the eight sites (Hickory, Charlotte, and Mocksville), the average monthly deficit for the 1998–2002 drought exceeded the values computed for the other drought periods. Precipitation records for three other sites (Greensboro, Raleigh, and Fayetteville) were adjusted to remove monthly rainfall values associated with several large tropical storms in 1999. The average monthly deficits for the 1998–2002 drought based on adjusted records for these three sites were then determined to be the highest among the drought periods identified during the available periods of precipitation record.

Daily mean discharges before and after the drought were compiled for 211 continuous-record gaging stations operated in North Carolina in 2002. Of these 211, 150 stations had periods of record that exceeded 10 years. Among these 150 sites, records of lowest daily mean discharge were set at 65 sites during the 4-year drought (55 sites during the 2002 water year alone). A smaller group of 68 sites having 30 years of uninterrupted record through the 2002 water year and not known to be significantly affected by regulation and/or diversions was selected for further analyses to quantify the "daily" percentile and recurrence intervals of 7-day average discharges.

Comparisons of minimum 7-day average discharges at six selected gaging stations with long-term records (two from each physiographic province in the state) provided insight into how the 1998–2002 drought compares with previous droughts. At three of the six sites, all located in the Blue Ridge and Piedmont Provinces, the minimum 7-day average discharges during the 1998–2002 drought became the minimum flows of record. One of these three sites, the French Broad River at Asheville, has the longest period of discharge records in North Carolina. These comparisons confirmed that the deepest effects of the 1998–2002 drought occurred in streams in the Blue Ridge and western Piedmont Physiographic Provinces of North Carolina.

Ground-water levels were recorded in 137 observation wells in North Carolina in 2002. The water-level data from 96 of these wells were used to monitor the effects of human-induced stresses (namely, ground-water withdrawals) and in 41 wells to monitor changes in ground-water storage in response to climate changes. Examination of the ground-water data at sites having at least 5 years of record through the 2002 water year indicates that new record-low water levels for the periods of record were set at 45 of these wells during the 2002 water year alone.

Examination of ground-water records collected by the US Geological Survey and the North Carolina Division of Water Resources resulted in the selection of 21 climate-response wells that were spatially distributed across the state. Record-low water levels were recorded in 13 of these wells during the 1998–2002 water years; record-low levels were set at 11 of the 13 wells during the 2002 water year alone. For the 13 wells in which new record-low water levels were recorded, the difference between the pre-drought water levels and new record-low water levels ranged from 0.05 to 2.85 feet.

Cumulative monthly departures in precipitation, streamflow, and ground-water data were plotted for five pairs of selected surface-water and ground-water monitoring sites in close proximity to each other to compare the time lags associated with the onset of drought conditions in mid-1998 and the drought recovery that began in late 2002. In particular, comparisons of these plots provided some insight into the rapid reversal in hydrologic conditions following above-normal rainfalls that began in August and September 2002. Comparisons of cumulative monthly departures in discharge at two surface-water sites (South Yadkin River and French Broad River) in western North Carolina also indicated that drought recovery was rapid compared with the recovery periods following historical droughts.

The abstract and publication are available at http://water.usgs.gov/pubs/sir/2004/5283/