THE 1986 AND 1988 DROUGHTS IN GEORGIA

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INTRODUCTION

In making water-resources decisions, especially those related to water supply and wastewater discharge, management agencies rely heavily on low-flow data, typically the 7-day 10-year low-flow statistic. The U.S. Geological Survey, in cooperation with the U.S. Army Corps of Engineers, the Georgia Department of Natural Resources, Environmental Protection Division, and other agencies, collects and subsequently analyzes low-flow data for use by water-management agencies. The two most recent droughts of 1986 and 1988 affected much of the State, and a preliminary analysis of those droughts is presented here. Except where stated otherwise, the term "drought" refers to a hydrologic drought.

PREVIOUS DROUGHTS

Since 1920, Georgia has been affected by at least five droughts of more than one year duration (G.W. Hess and H.G. Golden, U.S. Geological Survey, written commun., 1988). The first extended drought occurred during 1930-35 when about two-thirds of the State experienced severe low-flow conditions. The drought exceeded 25-year recurrence intervals for streamflows over much of the State; only in eastern Georgia were the recurrence intervals less than 10 years. Another major drought began in 1938 and lasted until about 1944. During this drought, streamflows in about half of Georgia had recurrence intervals equal to or greater than 25 years and minimum streamflows in much of the rest of the State had recurrence intervals of between 10 and 25 years. In the early part of the 1950's, one of the most severe droughts in Georgia history occurred. Statewide, the severity of drought conditions, as indicated by minimum streamflows, exceeded 25-year recurrence intervals. Flows measured during 1954, when the drought was most severe, were the lowest of record for most streams and have since been used as design criteria for many water facilities. In 1980, another extended period of low flow began. Drought severity during this period reached its peak in 1981 when nearly all streams in the State again had minimum flows with recurrence intervals greater than 25 years. The most recent low-flow period in Georgia began in 1985; in the north-central part of the State, new record low streamflows were reported. With only mild relief in 1987, less than normal flows returned statewide in 1988. Data collected during the 1986 and 1988 droughts are presented below.

RAINFALL DEFICIENCY AND LOW FLOWS

National Weather Service rainfall records from 1979-88 for sites in south, central, and north Georgia indicate departures from normal rainfall that provide qualitative evidence of the cause for recent drought distributions. Data from Albany, for example, show precipitation was only slightly below normal for the past 4-5 years. Even though total rainfall was not severely deficient, a lack of rainfall at the proper time in the growing season can have very serious implications for agricultural areas such as south Georgia. At Columbus, rainfall records show a general trend of declining rainfall for the past 10 years. At Rome, departures from normal for the past 5 or so years show a substantial shortage of rainfall. In general, rainfall deficiency and drought severity in south Georgia were not as great as experienced in north Georgia.

Streamflow records for the same 10-year period (1979-88) show trends nearly identical to those shown by rainfall records; flows in north Georgia receded to record low levels, whereas flows in south Georgia were less severely affected. The severity of the low flows in north Georgia during the 1980's probably was more noticeable because flows in the 1960's and 70's were greater than normal. The State's population, especially in north Georgia, grew rapidly during the 1960's. During that period of growth, the area became accustomed to the higher low flows. In fact, much of the population became so accustomed to the higher flows that they came to be considered "normal" flows. However, an examination of streamflow records for the past 30 years clearly indicates that these "normal" flows were in fact above normal. Thus, the natural stresses placed on the hydrologic system during these droughts were further amplified by increased demands for water by a growing population.

RECENT DROUGHTS IN GEORGIA

The 1986 drought covered a large part of the southeastern United States. It probably began developing in mid-1985 when rainfall deficits began accumulating. Below normal rainfall in late winter and early spring caused streamflows to recede to low levels before the start of summer. Extreme drought conditions at the height of the low-flow period extended from eastern Mississippi to northern Virginia. Virtually all of the Southeast, with the exception of Florida, was affected by the drought. In Georgia, the most severe conditions (based on the minimum 7-day, 30-day, and 90-day average flows) were recorded at streams in north Georgia. The recurrence intervals associated with those low flows were as great as 100 years (R.F. Carter, E.H. Hopkins, and T.W. Hale, U.S. Geological Survey, written commun., 1989). Prolonged periods of low flow, such as those represented by the minimum 90-day average flow, are good indicators of how long flows remained at seriously low levels.

The Palmer Drought Severity Index (PDSI) is used frequently as a means of describing the seriousness of low-flow events. The PDSI basically is a composite description of soil-moisture deficiency. Values of the PDSI are categorized into qualitative descriptors such as "severe" and "extreme." The geographic extent of the area characterized by "extreme drought" values of the PDSI are shown in Figure 1 for six periods during the peak of the 1986 drought (Golden and Lins, 1988). The area of extreme drought was relatively small in April but expanded rapidly, reaching its greatest extent in August. Rainfall in early August brought some relief from the unusually dry summer, and before the end of August, the area with extreme drought conditions had decreased in size.

Although flows in 1988 began at higher levels than those in 1986, they receded quickly. Rainfall in early April 1988 caused flows to increase, but by the end of April, the flows had receded to the late March levels, and the recession that was evident in the first 3 months of 1988 continued, virtually unaffected by the April rains. The principal conclusion is that April rainfall had little effect on either soil-moisture deficiency or ground-water storage. During the 1988 drought, minimum flow conditions occurred in August, again, 2 months earlier than normal. Some relief to the dry conditions came in August and September, but by October 1988, flows began to recede. Monthly mean flows in December were only marginally greater than the record minimum December monthly flow. About a third of the December, 1988 daily flows were lower than previously recorded minimum daily flows for December. The December, 1988 flows are of concern because they were substantially lower than those in January, 1988.

Minimum daily flows recorded at gaging stations in Georgia for the four most recent low-flow periods show that no single drought was the most severe of record, statewide. Generally, flows measured during 1954 have been used in Georgia for many years for design criteria because they were, for the most part, the minimum flows of record throughout most of the State. Minimum flows for the 1986 and 1988 droughts generally were not the lowest of record for streams with drainage basins in the coastal plain; however, many streams that drain areas north of the Fall Line had minimum flows in 1986 and 1988 that were lower than the 1954 record minimum flows. Flows for only a few streams set record lows during 1981.

Recent droughts have been severe in north Georgia and have been of particular concern for the growing population, especially that of metropolitan Atlanta. In 1986 and 1988, record low flows were measured for major tributary streams to the reservoirs that supply metropolitan Atlanta with water. For example, in the upstream basins of the Chestatee River, which flows into

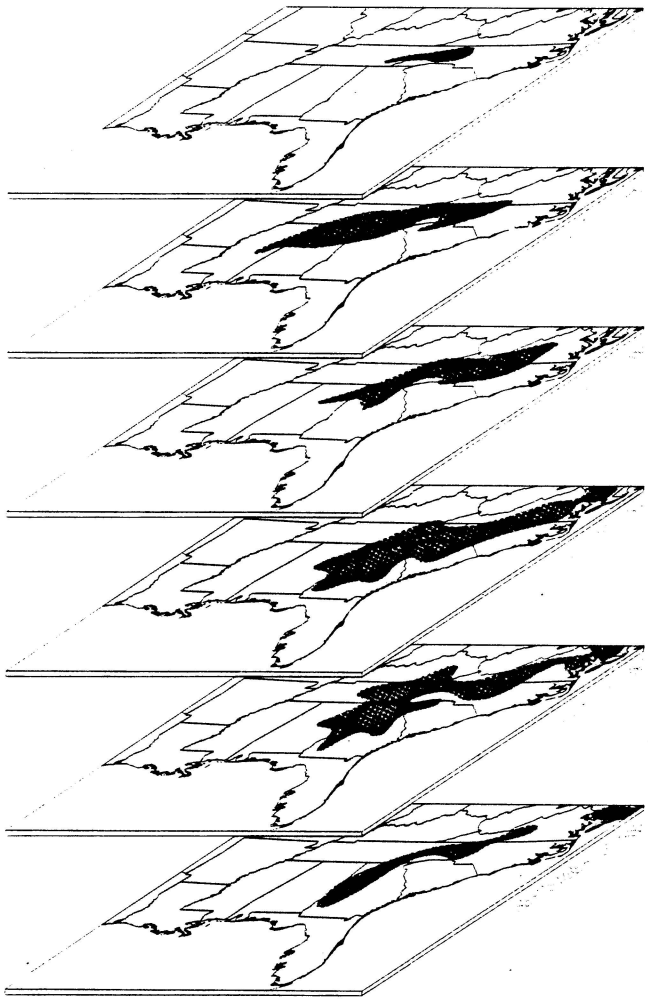

Figure 1.--Area of extreme drought in the Southeastern United States, April 12, 1986, to September 13, 1986, as defined by the long-term Palmer Drought Severity Index. (Source: Data from National Oceanic and Atmospheric Administration and U.S. Department of Agriculture Joint Agricultural "Weekly Weather Crop Bulletin.") [From Golden and Lins, 1988].

Lake Lanier, and the Etowah River, which flows into Lake Alatoona, record low flows were recorded at gaging stations during the past 2 years.

HOW DO RECENT DROUGHTS COMPARE?

To help put the severity of the two most recent droughts into perspective, monthly mean flows are shown in Figure 2 for the gaging station on the Etowah River near Canton. The top of the solid bars illustrates the monthly mean flows that are expected to occur 50 percent of the time. The bottom of the bars represents flows that will be exceeded 75 percent of the time (or conversely, 25 percent of the time the flows will be less than this value). The bottom of the T-bars shows the flows will occur only 10 percent of the time. The lowest monthly flows of record, prior to 1986, are shown by the squares. Monthly flows for 1986 clearly indicate that previous record lows were surpassed, and that the lowest flows occurred about 2 months earlier than historic lows. Rainfall in early August 1986 caused flows to increase dramatically, and by October, flows exceeded median flows. Flows during the 1988 drought have similar characteristics to the flows during the 1986 event. A noteworthy point about the timing of both the 1986 and 1988 droughts -- streamflows reached their lowest levels between the end of July and early August, with minimum daily flows being near to record lows at many gaging stations. Historically, minimum flows nearly always occur in September or early October; thus, if the rainfall of early August had not occurred, the drought of 1986 could have been even more severe. Another point about the 1986 drought -- the rate of streamflow recession in July was much greater than the rates experienced during the historic droughts where the minimum flows occurred in September or October. The high evapotranspiration rates during July contributed to these "steep recessions." The use of historic records to predict minimum flows in 1986 was not successful because of differences in the recession rates.

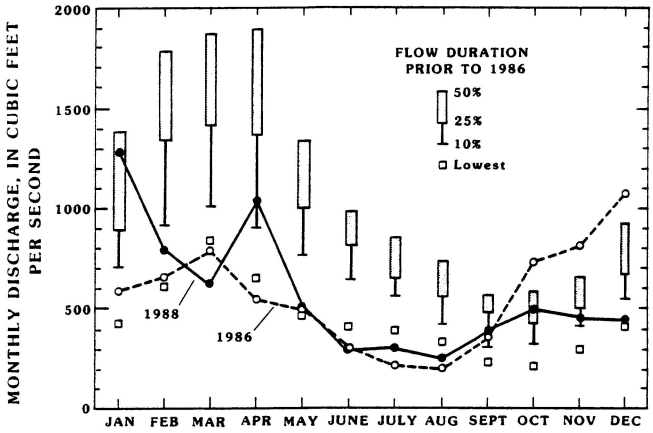

Figure 2.--Monthly mean discharges from 1986 and 1988 and flow duration statistics, Etowah River near Canton, Georgia.

THE OUTLOOK FOR 1989

Flow conditions at the beginning of 1989 are much lower than those recorded at the outset of the 1988 drought. Rainfall amounts in winter and spring 1989 will determine whether Georgia recovers from current low-flow conditions or continues to experience another year of drought. Rainfall in early 1989 is generally deficient in north Georgia.

SELECTED REFERENCES

Golden, H.G., and Lins, H.F., 1988, Drought in the Southeastern United States, 1985-86: in National Water Summary 1986 -- Hydrologic Events and Ground-Water Quality, U.S. Geological Survey Water-Supply Paper 2325, p. 35-41.