EXTREME DROUGHT TO EXTREME FLOODS: SUMMARY OF HYDROLOGIC CONDITIONS IN GEORGIA, 2009

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Abstract. The U.S. Geological Survey (USGS) Georgia Water Science Center (GAWSC) maintains a long-term hydrologic monitoring network of more than 317 real-time streamgages, more than 180 groundwater wells of which 31 are real-time, and 10 lake-level monitoring stations. One of the many benefits of data collected from this monitoring network is that analysis of the data provides an overview of the hydrologic conditions of rivers, creeks, reservoirs, and aquifers in Georgia.

HYDROLOGIC CONDITIONS

Hydrologic conditions are determined by statistical analysis of data collected during the current water year[1] (WY) and comparison of the results to historical data collected at long-term stations. During the 2009 WY, Georgia experienced a dramatic change from drought conditions to above-normal streamflows. Maps *A–D* (Fig. 1) indicate that during the first half of the 2009 WY, most streams in Georgia had flows much below normal, but by the end of the year, the majority of streams had flows much above normal. At the start of the 2009 WY, new historic minimum streamflows were recorded at several streamgages with 20 or more years of record, and reservoirs approached historic low elevations. South Georgia received drought relief as a result of historic flooding from March 27–April 3, 2009. North Georgia experienced historic flooding during September 16–22, 2009. During these flood events, GAWSC hydrographers verified peak streamflows and flood levels, and this information was shared with Federal, State, and local agencies for use in protecting life and property. New record peak flows were observed in many creeks and rivers throughout the State during these epic floods, and reservoir and lake elevations approached full pool. Extreme hydrologic conditions, both drought and floods, in the 2009 WY emphasizes the need for accurate, timely data to help make informed decisions by state and local authorities regarding the management and conservation of Georgia's water resources for the protection of life.

On June 10, 2009, Governor Perdue met with the State Drought Response Committee and announced that the Environmental Protection Division issued a non-drought schedule for outdoor water use for the first time since June 2006 (State of Georgia, 2010). This announcement was made as a result of substantial rainfalls and improved water supplies in Georgia. Under a non-drought schedule, household outdoor water use is allowed 3 days a week.

[1] Water year is the period October 1 through September 30 and is designated by the year in which it ends. For example, the 2009 water year began on October 1, 2008, and ended on September 30, 2009.

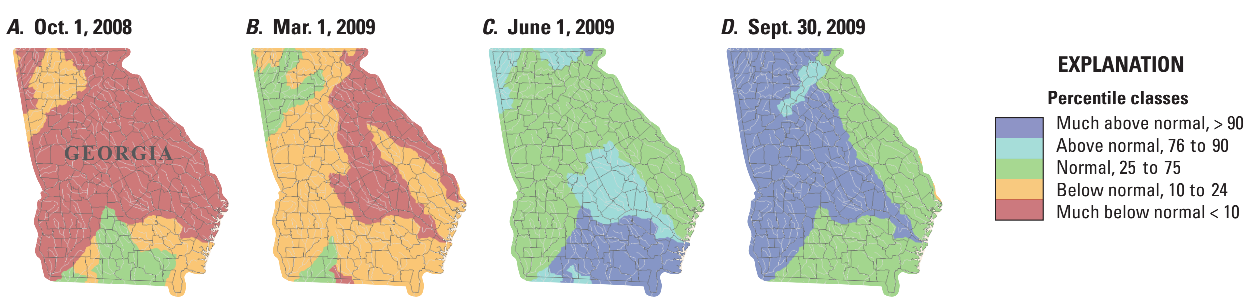

Figure 1. These maps represent hydrologic conditions in the context of available historical data. The colors represent current 7-day average streamflow as a percentile class of long-term averages. Only stations having at least 30 years of record were used (U.S. Geological Survey, 2010b). Because of persistent drought conditions that began in spring 2006, streamflow conditions at the beginning of the 2009 WY in the State were "much below normal" (map *A*). Steady rainfall and spring flooding in south Georgia brought much-needed relief, and 7-day average streamflow conditions improved from "below normal" to "above normal" (maps *B* and *C*). By September 30, 2009, the end of the water year, the 7-day average streamflows throughout most of Georgia were "much above normal" (map *D*).

STREAMFLOW AND GROUNDWATER DATA

Daily, monthly, and yearly streamflow and groundwater statistics from the 2009 USGS Annual Data Report (ADR; U.S. Geological Survey, 2010a) were used to develop this summary. The ADRs for WYs 1999–2009 can be accessed online at *http://ga.water.usgs.gov/publications/pubswdr.html.* A digital map is available at this site to interface with current and historical data, graphics, and photographs from the GAWSC monitoring network.

EXAMPLE DAILY DISCHARGE AND 7-DAY AVERAGE STREAMFOW CONDITIONS, 2009 WATER YEAR

Sweetwater Creek is a major tributary of the Chattahoochee River (U.S. Geological Survey, 1975). For most of the 2009 WY, 7-day average streamflow fluctuated between "much below normal" and "normal" conditions (Fig. 2). New record daily low streamflows were observed for the month of February. During the September 2009 flood, a new annual peak flow for the period of record was recorded on Sweetwater Creek. This peak flow exceeded the 0.2-percent annual exceedance probability (500-year recurrence interval). During the peak of this historic flood, the Interstate 20 bridge crossing over Sweetwater Creek 300 feet downstream from the USGS streamgage was inundated and closed to traffic.

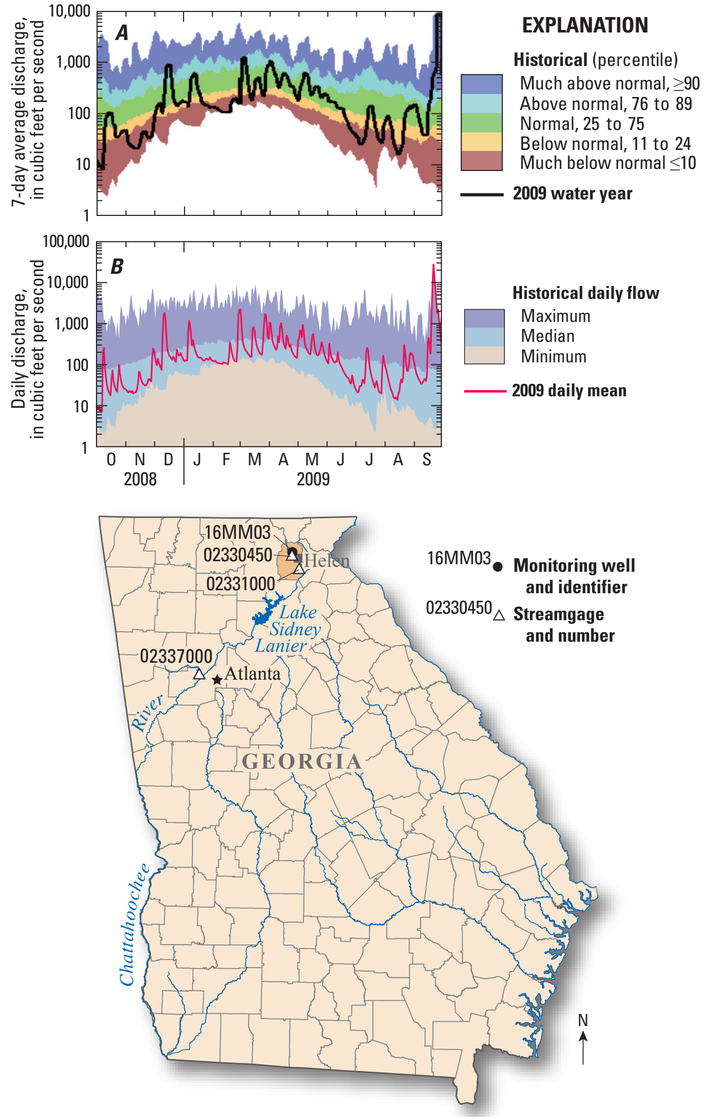

Figure 2. Hydrographs showing 2009 *(A)* 7-day average discharge and *(B)* daily discharge for Sweetwater Creek near Austell, GA (02337000).

CLIMATE RESPONSE NETWORK

The USGS maintains a network of groundwater wells to monitor the effects of droughts and other climate variability on groundwater levels. These wells are part of the Climate Response Network, which is designed to measure the effects of climate on groundwater levels in unconfined aquifers or near-surface confined aquifers where pumping or other human influences on ground-water levels are minimal (U.S. Geological Survey, 2007, 2009a). The national network consists of about 130 wells, of which 15 are located in Georgia. Information obtained for the 2009 WY from four of these wells is summarized in this section. These wells are monitored as part of the USGS Groundwater Resources and Cooperative Water Programs. Current conditions of ground-water wells in the Climate Response Network can be accessed online at *http://groundwaterwatch.usgs.gov*.

GEORGIA'S CLIMATE RESPONSE NETWORK

One example from Georgia's Climate Response Network is well 16MM03, which is in White County in northeastern Georgia and is completed in the crystalline-rock aquifer. Water is stored in the regolith and fractures, and the water level is affected by precipitation and evapotranspiration (Cressler and others, 1983). Precipitation can cause a rapid water-level rise in wells tapping aquifers overlain by thin regolith (Peck and others, 2009). The water level in well 16MM03 responds to seasonal change similarly to streamflow at the nearby streamgage Chattahoochee River at Helen (02330450), which indicates atmospheric, surface-water, and groundwater interactions. The water level in well 16MM03 rarely rose above the historic daily median during the 2009 WY (Fig. 3). The highest water level below land surface occurred in September 2009 when the area received more than 12 inches of precipitation during the month, most of which occurred near the end of September and contributed to the flooding.

LAKES AND RESERVOIRS

Major lakes and reservoirs throughout Georgia are managed, primarily by the U.S. Army Corps of Engineers and Georgia Power Company, to provide water for public and industrial use,

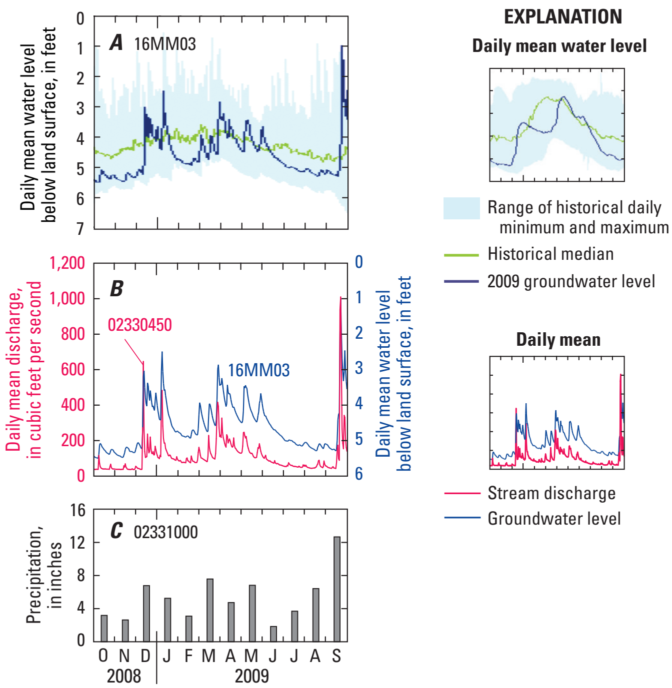

Figure 3. Hydrographs showing *(A)* water level in well 16MM03, *(B)* stream discharge (02330450) and water level in well 16MM03, and *(C)* precipitation at 02331000, White County, GA.

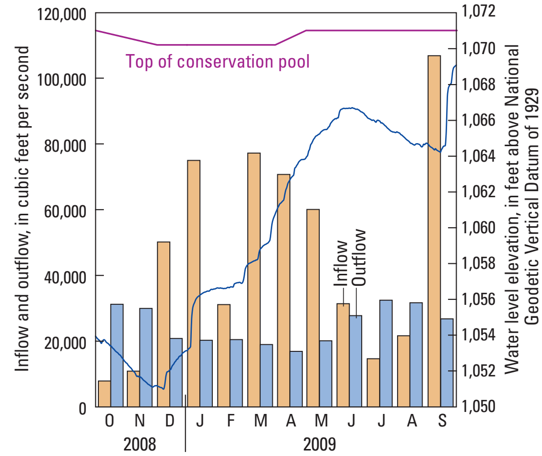

Figure 4. Lake Sidney Lanier had 80 percent more inflow than outflow during the 2009 WY, and lake elevation increased more than 18 feet from December 2008 through September 2009.

flood protection, power generation, wildlife management, and recreation. Managing lakes and reservoirs requires computer models that predict changes in climate and water demands and rely on USGS data. During the first half of the 2009 WY, lakes and reservoirs in Georgia continued to have record minimum levels as a result of the lengthy drought that began in 2006. Emergency water-conservation efforts by both State and local authorities were in place at the beginning of the 2009 WY. After an extremely wet spring, however, State climatologists declared an end to the drought and the entire State returned to a non-drought outdoor watering schedule in June 2009 as lake and reservoir elevations approached full pool.

Lake Sidney Lanier (Lake Lanier) on the Chattahoochee River is the primary drinking-water source for the Atlanta metropolitan area. Lake Lanier is the most upstream reservoir in a series of reservoirs that include West Point Lake, Walter F. George Lake, and Lake Seminole. Lake Lanier had 80 percent more inflow than outflow during the 2009 WY, and lake elevation increased more than 18 feet from December 2008 through September 2009 (Fig.4). Flooding in the watershed in September 2009 contributed a large amount of inflow—50 percent more than in June, July, and August combined, and the lake elevation increased 4.5 feet from September 19 to September 30. Approximately 150 river miles downstream, the elevation of West Point Lake also increased 4 feet during the September floods, but released discharge was nearly equal to the inflow, which resulted in the lake elevation being maintained at pre-flood levels. The volume of Lake Lanier is nearly 14 times greater than the volume of West Point Lake, which remains near full pool elevation even in times of drought. West Point Dam provides flood protection and hydroelectric power to Troup County, and construction was authorized by the Flood Control Act of 1962 (U.S. Army Corps of Engineers, 2009b).

FLOODING IN NORTH GEORGIA, SEPTEMBER 2009

Flooding in North Georgia occurred over several days, during September 18–22, 2009, as a result of precipitation totals that were as high as 20 inches in some areas (Fig. 5). GAWSC field crews were mobilized and made 118 discharge measurements before, during, and after (September 16–30, 2009) the flood. These measurements were made in a timely manner sometimes during perilous peak-flow or close to peak-flow

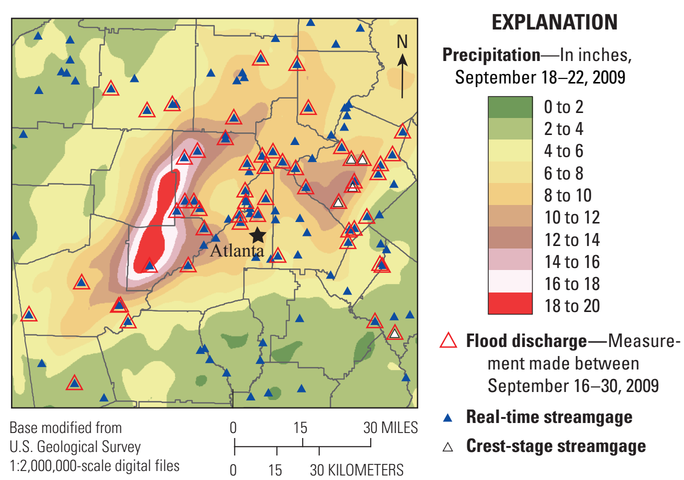

Figure 5. Flood measurements at streamgage network during heavy precipitation accumulation in the Atlanta area, September 16–30, 2009 (precipitation data from National Weather Service, 2010b).

conditions and were used to extend or verify streamflow ratings. Although 20 USGS streamgages throughout the northern part of the State were destroyed during the flood, all were restored to active status within 5 days. At several streamgages, temporary instrumentation was installed hundreds of feet away from the main channel. Peak flows that exceeded the 0.2-percent annual exceedance probability (500-year recurrence interval) were recorded at 15 streamgages throughout the flooded area (U.S. Geological Survey, 2010c).

The Federal Emergency Management Agency reported that nearly $220 million in flood damage claims were submitted as a result of this flood event, and 14 counties declared Federal disaster areas (The Atlanta Journal-Constitution, 2009). Eleven fatalities were attributed to this flood, many of which occurred during early morning hours when drivers attempted to cross flooded roads. Significant damage to hundreds of roads and bridges across the region severely affected traffic conditions for months after the event (National Weather Service, 2010).

FLOODING IN SOUTH GEORGIA, MARCH–APRIL 2009

Flooding in South Georgia during March–April 2009 resulted in the highest streamflows recorded since 1948 on several rivers and since 1929 on a few others. Rainfall totals ranged from 5.6 to 14.0 inches during the 6-day event across southern Georgia (National Weather Service, 2010a; Fig. 6). Seven USGS field crews worked extensively for 10 days and made 84 flood measurements in south Georgia. These measurements were used to extend or verify the highest streamflow ratings. Six streamgages in the flooded area had peak streamflows that exceeded the 1-percent annual exceedance probability (100-year recurrence interval). The Federal Emergency Management Agency declared 46 counties in Georgia as disaster areas as a result of the flooding (U.S. Geological Survey, 2009b).

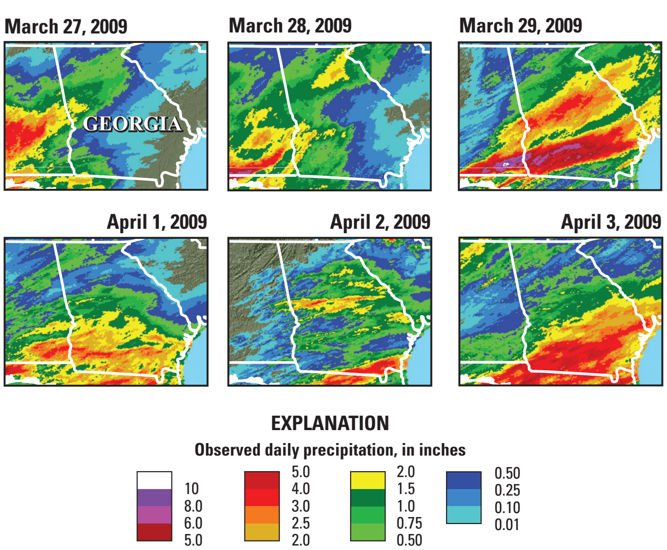

Figure 6. Daily precipitation accumulation in South Georgia, March 27–April 3, 2009 (precipitation data National Weather Service, 2010a).

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