MULTIYEAR-DROUGHT IMPACT ON HYDROLOGIC CONDITIONS IN SOUTH CAROLINA, WATER YEARS 1998-2001

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March 2002

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South Carolina has been in a continuous drought since June 1998, near the end of Water Year 1998. A Water Year (WY) begins October 1 of the previous year and ends September 30 of the current year. Table 1 shows the difference between the 1998-2001 Statewide annual average precipitation and the historical Statewide annual average precipitation (average of 1895-2001) by Water Year. Precipitation has been below average during this multiyear drought except for WY 1998, when there was a very wet period from January through April. The average deficit was less in WY 2000, owing to a series of tropical systems that hit the coastal region with heavy rain. The impact of this multiyear drought on South Carolina's hydrologic system – its streams, lakes, and aquifers – is becoming increasingly apparent.

As a result of the precipitation deficit, streamflows across the State have declined each year. Table 2 shows the annual daily mean flow for 12 unregulated streams in the State. During a dry period, streamflows are sustained by ground water discharge (base flow). Normally, widespread soaking precipitation replenishes the ground water in late winter and spring and increases streamflow by surface runoff and ground water discharge. During the past three years, however, the replenishing winter and spring precipitation has been absent, resulting in the reduced annual mean flows shown in Table 2. The drought's effect can be seen in small streams (Fig. 1) and large rivers (Fig. 2).

Table 1. Annual Statewide average precipitation and departure from historical average (inches)

Water year	Statewide average total	Historical annual average	Departure
1998	62.13	47.87	+14.26
1999	42.19	47.87	-5.68
2000	45.48	47.87	-2.39
2001	36.91	47.87	-10.96

Table 2. Annual daily mean flow (cubic feet per second) for selected unregulated streams in South Carolina

Stream	WY 1998	WY 1999	WY 2000	WY 2001	Historical average
Black River, Kingstree	1,980	569	644	408	975
Coosawhatchie River, Hampton	366	48	35	58	181
Edisto River, Givhans	4,839	1,407	1,560	1,352	2,613
Enoree River, Whitmire	768	334	350	284	569
Gills Creek, Columbia	114	55	57	47	77
Little River, Walhalla	225	114	108	80	177
Lynches River, Effingham	1,856	724	703	437	1,051
Rocky Creek, Great Falls	284	90	72	56	189
Salkehatchie River, Miley	607	248	179	213	346
Stevens Creek, Modoc	645	142	153	169	410
Tyger River, Delta	1,310	630	566	447	1,449
Waccamaw River, Longs	2,248	2,457	2,237	993	1,285

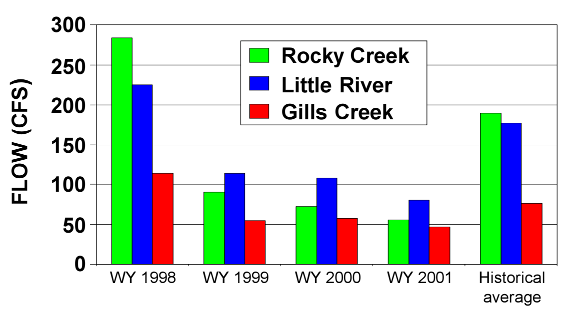

Figure 1. Annual daily mean flow for unregulated small streams in South Carolina.

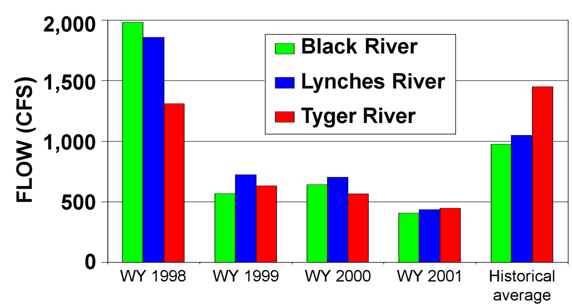

Figure 2. Annual daily mean flow for unregulated large streams in South Carolina.

The trend for the Waccamaw River is different from the rest, owing to heavy precipitation from a series of tropical systems that hit the coastal region of North Carolina, where the river originates, during WY 1999 and WY 2000. For WY 2001, the southwestern part of the lower Coastal Plain received heavy precipitation from numerous thunderstorms. As a result, the Salkehatchie and Coosawhatchie Rivers had greater annual mean flow than in the previous year. The Black River at Kingstree had a wetter winter in WY 2000 than in WY 1999.

It should be noted that the use of average values for precipitation and streamflow understates the actual severity of the drought impact. For example, in the summer of 1999 the upstate region had a "severe drought" designation and small streams ceased flowing, with others at record or near-record low levels, while the Waccamaw River was flooding in Horry County owing to heavy precipitation from three tropical systems that hit the coast. The precipitation deficit in the upstate was far worse than that of the coast; however, the Statewide average precipitation deficit figures shown in Table 1 for WY 1999 and WY 2000 did not depict the severity of drought in the upstate. The Waccamaw River itself had very low flow for periods during WY 1999 and WY 2000; but record high flows, after a tropical system induced heavy precipitation, raised the annual mean flow higher (Table 2), and masked the severity of drought in the area.

Major lakes in the State have been seriously impacted, owing to reduced inflow in the spring and few or no tropical systems in the summer. Since 1998, lake levels have declined 1 to 3 feet per year. Farm ponds, especially ones not fed solely by springs, also dried up because of lowered water tables and heavy irrigation, both of which resulted from the lack of precipitation. Although some lakes have drought-contingency plans, they have not been adequate in combating the effects of the drought on the hydropower-producing installations (Fig.3).

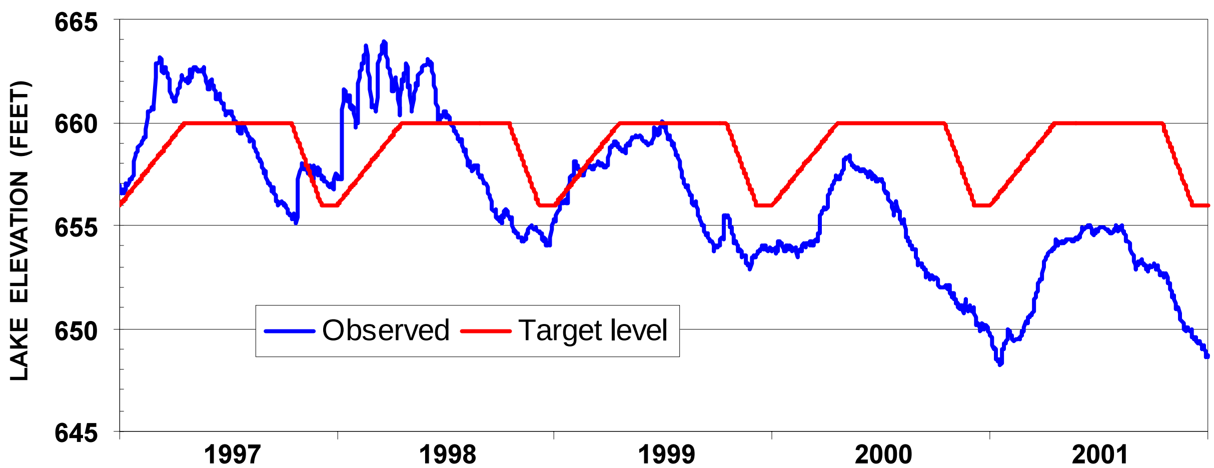

Figure 3. Hartwell Lake water elevations (blue) and target lake levels (red), 1997-2001.

The ongoing drought has also reduced the amount of water stored in shallow and deep aquifers. Table 3 shows the annual mean water-level depths in three observation wells. Regardless of the type and depth of the well, the effect of the current drought can be seen as an overall lowering of the water level since June 1998. Figures 4-6 show daily average water-level depths for the three wells in Table 3. It is clear from Figures 4 and 5 that there has been little recharge (rising of water level) during the multiyear drought and that, overall, the water level is declining compared to the trend before June 1998. The hydrograph of a deep well in a confined sand aquifer (1,045 feet) (Fig. 6) demonstrates the effect of this multiyear drought as a pressure drop in the well. The decline of water level (pressure drop) is due to the lack of precipitation (recharge) and to pumping from wells in the aquifer. A water-level decline caused by pumping at a major power plant, as well as other pumping, is estimated to be about 45 percent of the total decline observed. More than half of the water-level decline is attributable to a lack of precipitation in this aquifer's recharge area.

In summary, the hydrologic effects shown here are due, directly or indirectly, to the multiyear drought. While streamflows can increase quickly after rainfall, and lakes and ponds can be replenished by a tropical system, the recovery of ground water takes considerably longer. It will, therefore, take several consecutive normal or wet periods for ground water levels to recover from this multiyear drought and return to normal conditions.

Table 3. Annual mean water-level depth (feet below measuring point) in selected observation wells

	GRV-709 Greenville	AIK-849 Aiken	BRN-349 Barnwell
	rock well	shallow sand well	deep sand well
1998	29.95	41.10	11.79
1999	32.42	41.87	13.54
2000	34.96	42.80	15.09
2001	36.84	43.04	16.36
Pre-1998 average	29.93	41.34	10.55

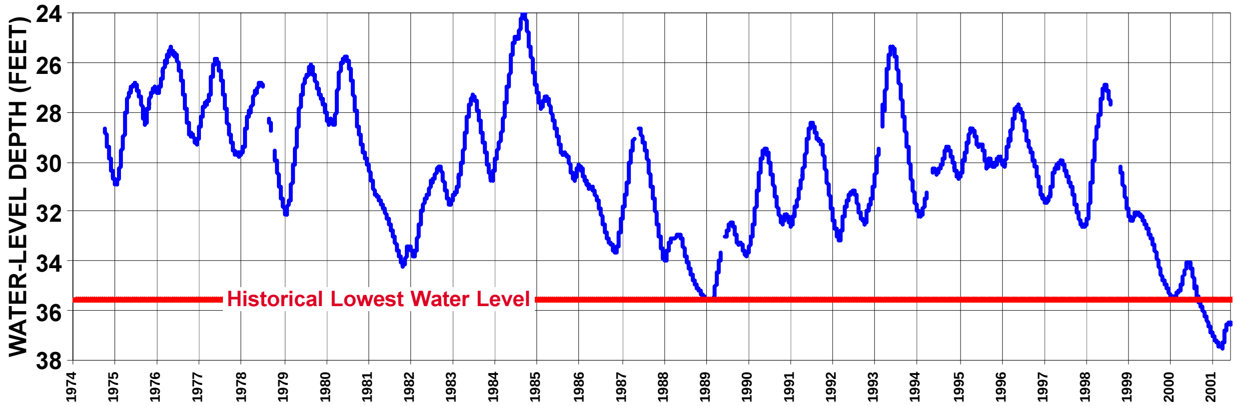

Figure 4. Hydrograph of an 80-ft rock well (GRV-709) in Greenville County, S.C., 1974-2001.

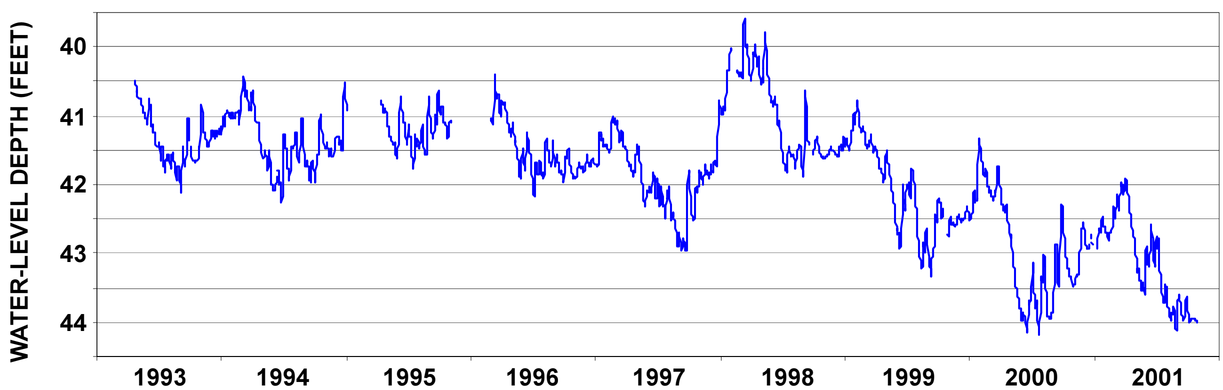

Figure 5. Hydrograph of a 97-ft sand well (AIK-849) in Aiken County, S.C., 1993-2001.

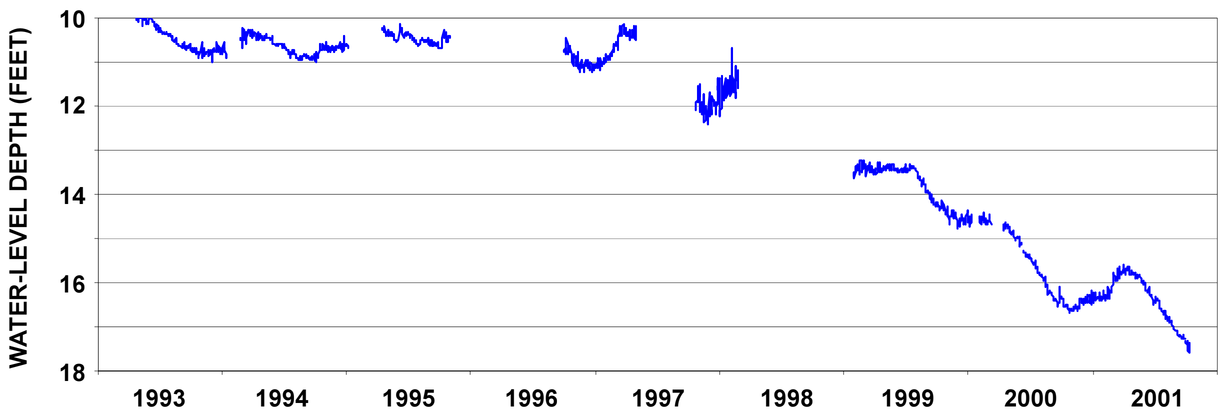

Figure 6. Hydrograph of a 1,045-ft sand well (BRN-349) in Barnwell County, S.C., 1993-2001.

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