WATER USE PATTERNS IN THE WATERSHEDS OF THE GEORGIA RIVERINE ESTUARIES

Merryl Alber[1] and Carrie Smith[2]

AUTHORS: [1]Assistant Professor and [2]Graduate Student, Dept. of Marine Sciences, University of Georgia, Athens, GA 30602.
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Abstract. We examined water use patterns in the hydrologic units that comprise the watersheds of the 5 major coastal rivers in Georgia (Savannah, Ogeechee, Altamaha, Satilla, St. Marys). The data for this analysis were obtained from the Georgia Water Use Program, which regularly surveys both water sources (groundwater and surface water) and water uses (domestic, commercial, industrial, mining, irrigation, livestock, thermoelectric, and hydroelectric) as part of the USGS National Water Use Synthesis. Total water withdrawal in the study area totaled 5749 million gallons per day (mgd) in 1995, with no large changes in either water withdrawal or water use patterns for the last 3 reporting years (1985, 1990, and 1995). Surface water accounted for 91% of the water withdrawal in the region, and much of this was for thermoelectric use in the watersheds of the Savannah and Altamaha Rivers. However, most of the groundwater that was withdrawn was withdrawn in the Coastal Plain. Only 10% of the water withdrawn was actually consumed, with the remainder returned to the surface water. Irrigation represented the largest consumptive use, and much of this occurred in the Coastal Plain.

INTRODUCTION

Information on water use in an area is fundamental for water supply planning. In coastal Georgia, the issue of water supply has received increased attention in recent years in response to problems with salt water intrusion into the Floridan aquifer. The Georgia Environmental Protection Division (EPD) is currently working under an interim strategy that limits groundwater withdrawal in parts of the coastal region, and they have required the development of comprehensive local water supply plans in a 24 county area of southeast Georgia (EPD, 1997). In addition, there has been a great deal of concern over applications for new surface water withdrawal permits in the Savannah, Ogeechee, and Altamaha Rivers.

Water use information is regularly compiled by the Water Resources Division of the USGS as part of a National Water Use synthesis (Solley et al., 1998). These data are generally collected every 5 years and are now readily available (http://water.usgs.gov/watuse/). In Georgia the information is compiled by the Georgia Water Use Program, a cooperative effort between USGS and the Georgia Geologic Survey. Although the data are most often presented by county, the information is also available by hydrologic unit code (HUC). (HUCs are used by USGS to subdivide the watersheds of rivers into stream drainage areas.)

In this paper we distinguish between water withdrawal and water consumption (that which is not available for subsequent use). The laws in Georgia regulate water withdrawal, so these are the most commonly available data. However, if one is interested in water supply planning it is also instructive to look at the amount of the withdrawn water that is consumed versus the amount that is returned to the watershed.

The purpose of this paper was to compile information on water use patterns for the watersheds of the 5 major coastal rivers in Georgia (Savannah, Ogeechee, Altamaha, Satilla, St. Marys). We present information on water source, water use, water consumption, and return flow within each watershed. We also looked at total water use in all 5 systems as well as at water use in those HUCs that lie primarily in the Piedmont versus those in the Coastal Plain (Fig. 1).

METHODS

We obtained data from the Georgia Water Use Program for the relevant HUCs for the watersheds of the Savannah, Ogeechee, Altamaha, Satilla, and St. Marys rivers (Fig. 1). Where appropriate, information from neighboring states (FL, SC, NC) was included. We analyzed data from the 1985, 1990, and 1995 water use surveys. For the most part, however, there were no large changes among years. We therefore present information from 1995 only, although we note where there have been changes.

Georgia Water Use data were obtained primarily from EPD, which requires municipal and industrial

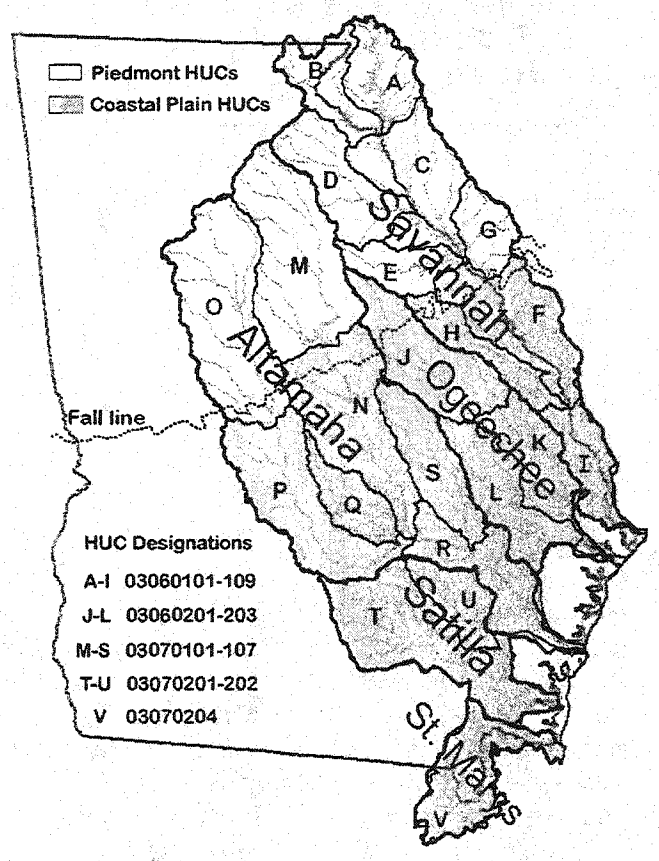

Fig. 1. Watershed and HUC boundaries of the Georgia coastal rivers.

users that withdraw more than 100,000 gallons of water per day (gpd) to report monthly withdrawals. This information was augmented by other sources. For example, irrigation use was estimated from data obtained by the UGA Cooperative Extension Service Irrigation Survey, and domestic use by individuals that use household wells was based on census data and an estimate of per capita use (75 gpd). More complete information on methods can be found in the Georgia Water Use reports (Turlington et al. 1987; Fanning et al. 1992, 1997).

The Water Use program provides estimates of the amount of water withdrawn from surface and groundwater sources. Once it is withdrawn, there are eight categories of offstream water use (water that is conveyed to its place of use). These are: thermoelectric (cooling water used by electric power plants), irrigation, domestic, commercial, industrial, livestock, mining, and public supply. However, water withdrawn for public supply is distributed to domestic, commercial, and industrial users, so we have incorporated it into each of those categories and it is not presented separately.

Each category of water use has characteristically

Table 1. Water withdrawal in millions of gallons per day from the watersheds of Georgia coastal rivers in 1995.

	Surface Water	Groundwater	Total
Savannah	3685	139	3824
Coastal	1092	118	1209
Piedmont	2593	21	2615
Ogeechee	18	48	66
Altamaha	1494	275	1769
Coastal	129	225	354
Piedmont	1365	50	1414
Satilla	11	32	43
St Marys	3	44	47
All Watersheds	5211	538	5749
Coastal	1253	467	1720
Piedmont	3958	71	4029

different proportions of consumptive use. Essentially all of the water withdrawn for livestock is consumed, whereas most of the water used by thermoelectric power plants is returned. Consumptive use was estimated by the Georgia Water Use Program based on a combination of local data and guidelines from the National Water Use program. This information is likely less reliable than withdrawal estimates, but it provides a first order look at water consumption in the region. Note that we have used the term consumption to represent the total of both consumptive and conveyance losses.

WATER WITHDRAWAL

Amounts and Sources

The amount of water withdrawn from the study area in 1995 is shown in Table 1. Most of the withdrawals occurred in the watersheds of the two largest rivers: 66% were from the Savannah, and 31% from the Altamaha. The remaining 3% of withdrawals were from the watersheds of the three smaller, Coastal Plain rivers (Ogeechee, Satilla, St. Marys) (Table 1). Most withdrawals (70%) occurred in the Piedmont as compared to the Coastal Plain. The total amount of water withdrawn in all 5 watersheds in 1995 was 5749 million gallons per day (mgd.)

Most of the water withdrawn in the study area (91%) came from surface water sources (Table 1). This is the result of heavy surface water use in the entire watershed of the Savannah River, as well as in the Piedmont region of the Altamaha River. In contrast, all three Coastal Plain rivers were highly dependent on

Table 2. Water use and consumption patterns for the watersheds of Georgia coastal rivers in 1995. Abbreviations: Savannah (SAV), Ogeechee (OGE), Altamaha (ALT), Satilla (SAT), St. Marys (STM), Coastal Plain (Coast), Piedmont (Pied).

	Water use (mgd)								Consumption (mgd)							
	SAV	OGE	ALT	SAT	STM	Coast	Pied	Total	SAV	OGE	ALT	SAT	STM	Coast	Pied	Total
Domestic	98	20	184	11	6	129	191	320	19	4	33	1	2	24	35	59
Commercial	24	4	47	3	1	37	42	80	4	1	8	1	0	7	7	14
Industrial	344	8	187	3	37	509	69	579	43	1	23	1	2	60	9	69
Mining	0	0	6	1	0	7	0	7	0	0	1	0	0	1	0	1
Irrigation	27	37	116	21	2	184	19	203	27	37	116	21	1	184	19	203
Livestock	17	1	14	2	0	7	27	34	8	1	13	2	0	7	17	24
Thermoelectric	3325	0	1153	0	0	861	3617	4478	87	0	57	0	0	96	48	144
Net Export	0	0	61	2	1	0	63	63	0	0	61	2	1	0	63	63
Total	3836[a]	70[a]	1768	43	47	1734[a]	4029	5764	187	44	313	28	6	379	198	577

[a] Where total water use exceeds withdrawal (Table 1), there was a net import into the system.

groundwater, which accounted for 72% of the water withdrawn in the Ogeechee, 75% in the Satilla, and 94% in the St. Marys. The Coastal Plain region of the Altamaha was also mainly dependent on groundwater. Although surface water was more heavily used than groundwater, most of the groundwater (87%) that was withdrawn was taken from the Coastal Plain.

Water Use Patterns

The water use patterns in each of these rivers were unique (Table 2). In the Savannah, withdrawal for thermoelectric use dominated (87%), with industrial use second (9%). This is a case where use patterns have changed over time, as industrial withdrawals in the watershed decreased from 980 mgd in 1985 to 408 in 1990 to 344 in 1995. Much of this reduction is the result of changes in the operation of the Savannah River Plant in Aiken County, SC (HUC 03060106). However, total withdrawal in the watershed decreased by only 86 mgd, due in large part to increases in thermoelectric withdrawals (from 2806 mgd in 1985 to 3032 in 1990 to 3325 in 1995). In the Altamaha, thermoelectric use was again dominant (65%), although in this case there was a net decrease of 164 mgd between 1985 and 1995.

In the three coastal plain rivers there were no thermoelectric withdrawals. In both the Ogeechee and the Satilla, irrigation accounted for approximately half the water withdrawal, with domestic use second. In the St. Marys, industrial withdrawal was dominant (78%), and there was a much lower proportion of irrigation than in the other Coastal Plain rivers (5%). The watershed of the St. Marys includes a large proportion of wetlands that are not suitable for agriculture.

In the region as a whole, there was a net decrease in industrial water use (572 mgd) and a concurrent increase in thermoelectric use (354 mgd) between 1985 and 1995, in large part due to the changes described above. As of 1995, thermoelectric was the largest water use in the region, accounting for 78% of the total water withdrawn. Most of this was withdrawn in the Piedmont, although there were also large thermoelectric withdrawals in the Coastal Plain region of the Savannah. When thermoelectric use is excluded, the prime water use in the region becomes industrial, accounting for 45% of the total, with domestic and irrigation accounting for 25% and 16%, respectively. However, the picture differs between the Piedmont and the Coastal Plain. Without thermoelectric use, the prime water use in the Piedmont is domestic (47%), and in the Coastal Plain the prime use is industrial (58%).

WATER CONSUMPTION

The amount of water that was actually consumed (577 mgd) amounts to approximately 10% of the total withdrawn (Table 2). Most of this (87%) was consumed in the watersheds of the Altamaha (313 mgd) and the Savannah (187 mgd). In the Altamaha, the largest water consumption was for irrigation, which accounted for 37% of the total. Interestingly, 20% of the water consumption in the Altamaha was due to export. (Exported water is withdrawn in one watershed and used in another.) Most of the water was exported to the watershed of the Chattahoochee River from HUC 03070103 in southeastern metropolitan Atlanta. In the Savannah, the largest water consumer was thermoelectric (46%). Water consumption in the Ogeechee and Satilla was largely due to irrigation, and in the Saint Marys it was about equally divided among

industrial, domestic, and irrigation use. However, water consumption in the three smaller rivers accounted for only 13% of the total for the region.

When taken together, the largest consumer of water in the region was irrigation, which comprised 35% of the total. Although thermoelectric was the largest withdrawer of water, it consumes proportionately little and accounted for only 25% of the total consumption. Industrial, domestic, and export accounted for 12, 10, and 11% each, with the remaining uses (livestock, commercial, and mining) accounting for a combined total of 7%.

There is more agricultural land in the Coastal Plain than in the Piedmont, and this is reflected in water consumption patterns. In the Coastal Plain, water consumption totaled 379 mgd and irrigation accounted for 49% of the total. In the Piedmont, water consumption was about half that of the Coastal Plain (198 mgd), and the largest portion (32%) was exported out of the study area.

RETURN FLOW

Return flow is withdrawn water that is not consumed. Return flow amounted to 95% of the total withdrawals in the Savannah and 82% in the Altamaha (due to large returns from thermoelectric withdrawals). Return flow accounted for 39% of the withdrawals in the Ogeechee, 35% in the Satilla, and 89% in the St. Marys (see Fig. 2). When taken as a whole, return flow averaged 90% of water withdrawal (78% in the Coastal Plain and 95% in the Piedmont).

Return flow, whether it was withdrawn from surface or groundwater, is assumed to return to the surface water of the watershed from which it was taken (via direct discharge, surficial groundwater flow, or overland runoff). In the Savannah and Altamaha rivers the total returned amounted to 99 and 97% of the surface water removed, respectively. This is because some water that is withdrawn as groundwater is returned as surface water. In the three Coastal Plain Rivers, which rely heavily on groundwater, the amount of water returned was actually greater than the amount of surface water removed (especially in the St. Marys).

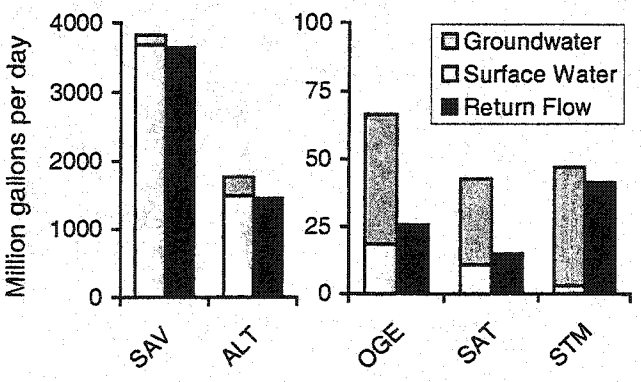

Fig 2. Total water withdrawal and return flow for the watersheds of Georgia coastal rivers for 1995. Abbreviations as in Table 2. (Note scale change.)

RECOMMENDATIONS

The Georgia Water Use Program provides essential information for water supply planning and these data should continue to be collected. Although there have been no large changes in water withdrawal since 1985, the data presented here represent a baseline against which to evaluate future water withdrawal decisions. The results of the 2000 survey will be added to this analysis when they become available.

The State should consider using not only withdrawal but also consumption as a means of assessing water availability in the region. In order to do this, additional resources would be necessary to improve consumption estimates.

It is useful to compile water use information by HUC as this provides an overview of water use within a watershed. However, HUCs are units for surface water drainage and not groundwater. It would also be interesting to look at water usage within an aquifer.

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