GEORGIA IRRIGATION, 1970-80: A DECADE OF GROWTH

U.S GEOLOGICAL SURVEY

WATER-RESOURCES INVESTIGATIONS REPORT 83-4177

ARTESIAN WELL AT THE RESIDENCE OF MR. H. W. LLOYD, NEAR BRUNSWICK, GEORGIA, USED TO IRRIGATE A TRUCK GARDEN.

Prepared in cooperation with the

GEORGIA DEPARTMENT OF NATURAL RESOURCES

Cover: Artesian well at the residence of Mr. H. W. Lloyd, near Brunswick, Georgia, used to irrigate a truck garden.

"Mr. H. W. Lloyd's well [is] located two miles north of Brunswick. The well is 485 feet deep and four inches in diameter. The water rises 27 inches above the surface, and is used chiefly for irrigation purposes."

Reprinted from McCallie, S. W., 1908, A preliminary report on the underground waters of Georgia: Geological Survey of Georgia Bulletin No. 15, Plate XV and p. 114.

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Doraville, Georgia

1984

UNITED STATES DEPARTMENT OF THE INTERIOR

WILLIAM P. CLARK, Secretary

GEOLOGICAL SURVEY

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CONVERSION FACTORS

For readers who prefer to use metric units, conversion factors for terms used in this report are listed below:

Multiply	By	To obtain
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.305	meter (m)
acre	0.405	hectare (ha)
gallon per minute (gal/min)	0.063	liter per second (L/s)
million gallon per day (Mgal/d)	0.044	cubic meter per second (m^3/s)
gallon per acre (gal/acre)	9.353	liter per hectare (L/ha)
foot squared per day (ft^2/d)	0.093	meter squared per day (m^2/d)

GEORGIA IRRIGATION, 1970-80: A DECADE OF GROWTH

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ABSTRACT

Irrigation water use in Georgia increased by a factor of 12 from 1970 to 1980, the fastest rate of increase among the Southeastern States. In 1980, one-third of ground water used in Georgia was for irrigation. Droughts, crop-production stability, use of systems for the application of fertilizers, herbicides, and pesticides, and the introduction of center-pivot technology are reasons for the large increase in irrigation water use, which reached 580 million gallons per day in 1980.

The use of irrigation spread across the Georgia Coastal Plain from a center in the southwestern corner of the State. During the last decade, corn became the leading irrigated crop, surpassing the earlier leaders, tobacco and peanuts. Large acreage, high-yield systems such as center pivots replaced many smaller systems, though the choice of system type is influenced by water availability, topography, and crops.

A computer irrigation data base was created through the Georgia Water Use Program, a combined effort of the U.S. Geological Survey and the Georgia Geologic Survey. The data base makes available site-specific information for water-resource managers, researchers, and modelers.

Georgia will continue to experience growth in irrigation water use through the eighties, but the rate of growth may decrease because of more efficient techniques and reevaluation of the cost effectiveness.

INTRODUCTION

This report on the use of water for irrigation in Georgia is one of a series of reports dealing with the quantities of water withdrawn from the State's lakes, streams, and ground-water reservoirs. Two of the reports give general overviews of water use in the State; one contains preliminary estimates of water use for 1980 (Pierce and Barber, 1981), and a revision of this report (Pierce and Barber, 1982) summarizes actual water-use totals for 1980. Also available is a data report that gives water-use statistics by county for 1980 (Pierce and others, 1982). One additional report will be forthcoming on 1980 water use in the State. These reports were prepared as part of the Georgia Water Use Program, a joint effort of the U.S. Geological Survey and the Georgia Geologic Survey Branch of the Environmental Protection Division, Georgia Department of Natural Resources. The program was begun in 1979 as part of the National Water Use Information Program of the U.S. Geological Survey, and seeks to collect, store, and disseminate information on all water users in the State as to their sources of water and amounts of water used. Computer data bases are maintained on municipal, industrial, and irrigation water use, and these will be updated annually using data from the Environmental Protection Division's files.

This report is intended to document the large increases in agricultural irrigation that occurred in Georgia during the period 1970 to 1980. These increases have changed the pattern of water use in the State, affected the State's strategy of water management, and brought recognition of the need for careful study of the State's water resources.

Acknowledgments

The authors gratefully acknowledge the assistance of Robert E. Skinner of the University of Georgia's Cooperative Extension Service, and of his successor, Kerry A. Harrison. Some of the data used in this report, particularly that on the amount of irrigation in the State before 1980, came from periodic irrigation surveys conducted by Mr. Skinner. Information about the first introduction of center-pivot technology to Georgia, and its subsequent spread across the State, came from the late Dr. Merle C. Prunty of the University of Georgia's Geography Department. Thanks also go to Allen B. Fulford (cotton), John M. Woodruff (soybeans), and Frank W. Congleton (corn), all of the Coastal Plain Experiment Station in Tifton, who provided information on the effects that irrigation has on crop yields. Irrigation water-use data for the period 1960-80 were taken from: MacKichan and Kammerer (1961); Murray (1968); Murray and Reeves (1972, 1977); and Solly and others (1983).

1.0 GEORGIA'S PHYSIOGRAPHIC PROVINCES AND THEIR INFLUENCE ON IRRIGATION

In Georgia, the proportion of ground water to surface water utilized varies significantly among the State's physiographic provinces. In the Valley and Ridge and Cumberland Plateau provinces, the underlying rocks are of varying permeability, and the area has a well-developed surface drainage system and ground-water reservoirs of somewhat limited capacity. In these provinces, water can be obtained from both surface-water and ground-water sources. In the Piedmont and Blue Ridge provinces, the underlying rocks generally have low permeability and store and transmit comparatively little water. There, surface water is the primary supply and ground-water withdrawal is limited mainly to domestic and farm wells. The Coastal Plain province, on the other hand, is underlain by permeable sediments that provide large reservoirs for ground water. In this province, ground-water reservoirs are the principal source of water, and wells are more productive than anywhere else in the State, typically yielding from 1,000 to 3,000 gallons per minute.

The underlying rocks and sediments also influence the topography of the various provinces (fig. 1.0-1). The nearly flat-lying, unconsolidated sediments of the Coastal Plain have helped create the relatively flat land surface of south Georgia, and this in turn has contributed to the growth of that part of the State as an important agricultural center. The combination of flat topography and readily available water has encouraged the use of irrigation. Wells commonly are drilled for each irrigation system, eliminating the need to pipe water long distances. This is particularly true in the southwest corner of Georgia, which is the area of most intense irrigation in the State.

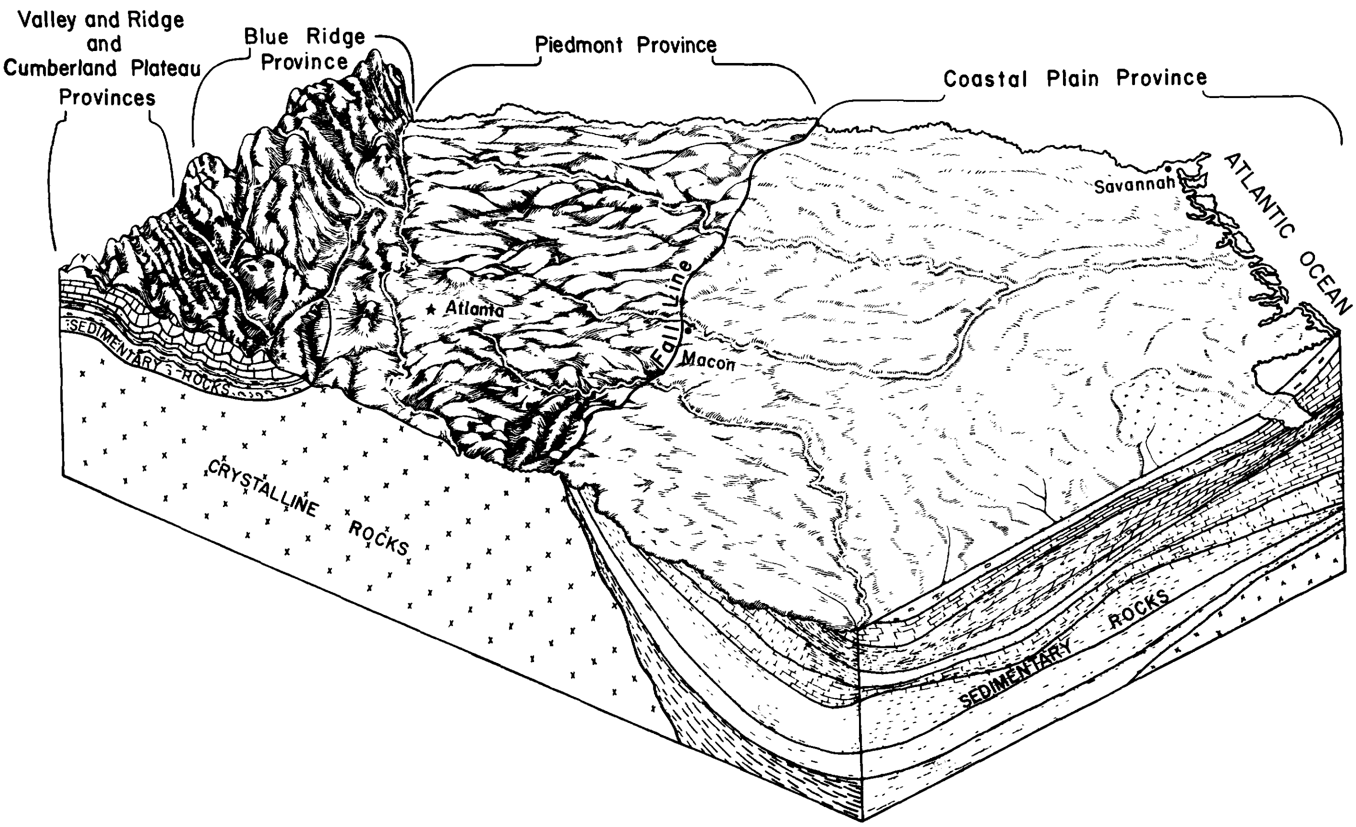


Figure 1.0-1.—Physiographic provinces and relation of underlying rock to topography.

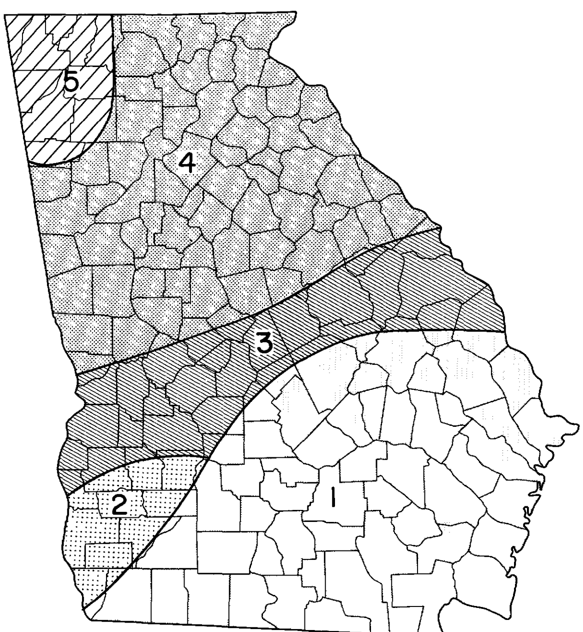


Figure 1.0-2.—Geologic controls on availability of ground water (From Matthews and others, 1981, p. vi).

2.0 TRENDS IN ALL WATER-USE CATEGORIES, 1960-80

From 1960 to 1975, Georgia experienced a steady increase in the overall use of water. Public-supply withdrawals increased steadily, concurrent with the growth in population. The use of water by self-supplied industries also increased over this period, then decreased from 1975 to 1980. This decrease can be attributed in part to increased water conservation by industires, and in part to a change in data-collection techniques. In 1980, the Georgia Water Use Program made an inventory of all self-supplied industries and obtained a more accurate assessment of their water use. Rural water use increased somewhat over the entire period, again related to an increase in population. The sudden increase in the amount of water used for irrigation in the late seventies caused a large jump in the total quantity of water used between 1975 and 1980, despite the drop in industrial water use.

Irrigation has quickly become one of the major uses of water in Georgia, accounting for about 32 percent of all ground water withdrawn, and 8 percent of all water withdrawn. A high percentage of the water used for public supply, industry, and power generation is returned to lakes or streams, but water used for irrigation is largely consumed; that is, the water is incorporated in plants or lost to the atmosphere through evapotranspiration. Thus the impact of increased irrigation withdrawals can be greater than equivalent increases in public-supply or industrial use.

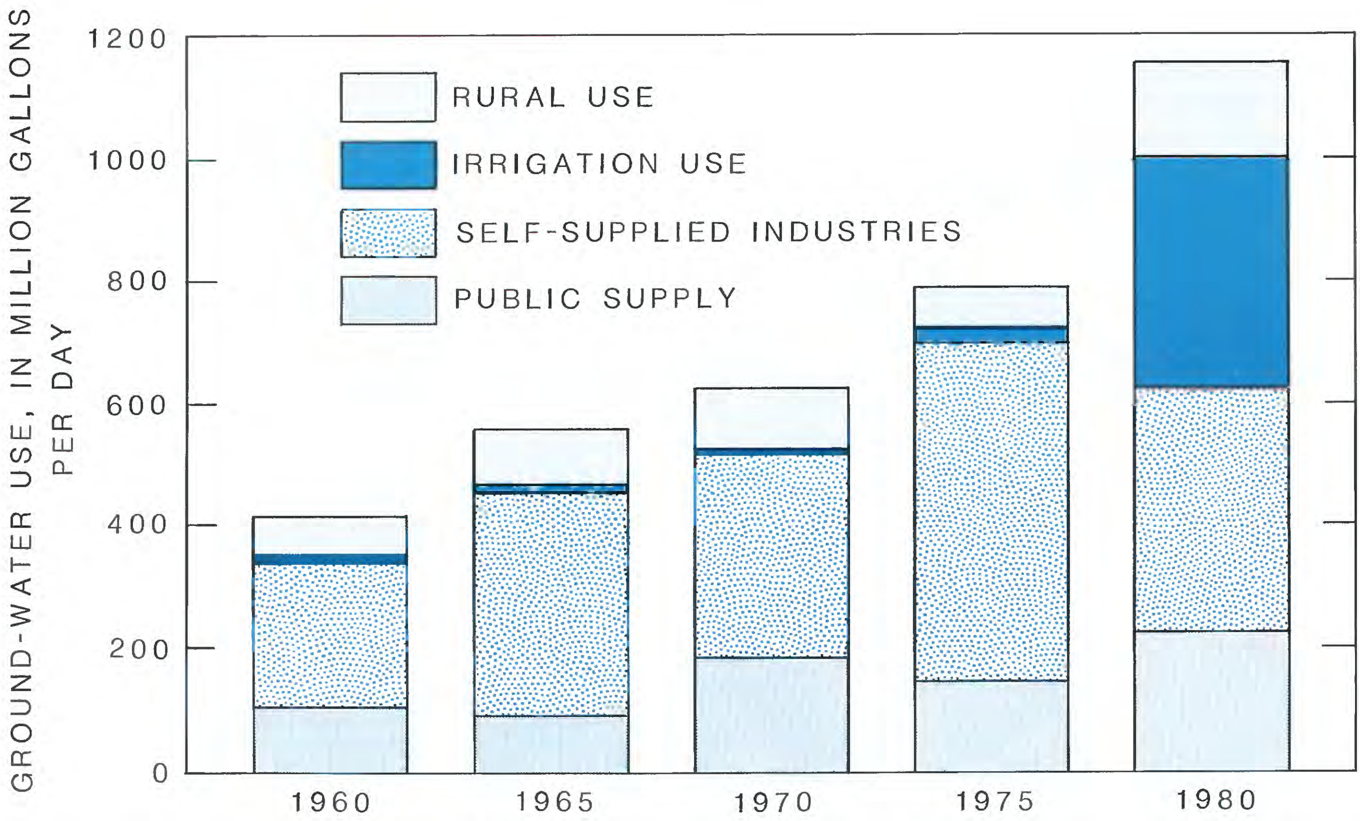


Figure 2.0-1.—Ground-water use in Georgia (excluding power generation), 1960-80

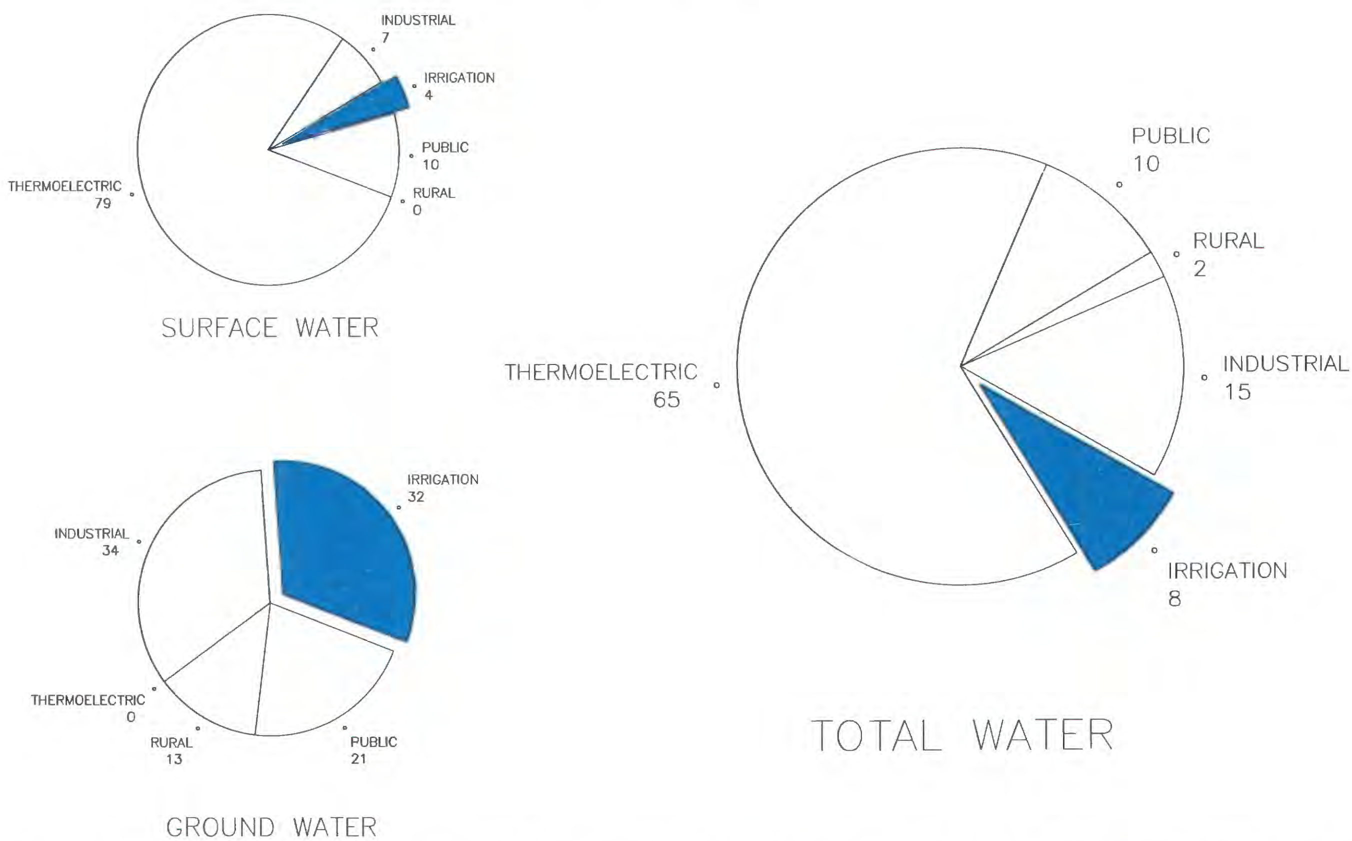


Figure 2.0-2.—Percentage of water withdrawn in Georgia by user type, 1980.

3.0 IRRIGATION WATER USE IN GEORGIA AS COMPARED WITH OTHER STATES

The Southeastern United States experienced a rapid growth of irrigation water use during the decade of the seventies. The line graph shows the higher growth rate in the Southeast as compared to the United States as a whole, particularly in the increasing use of ground water. Despite this increase, more than 90 percent of the ground water withdrawn for irrigation is pumped in the Western States (Solly and others, 1983, p. 18-19). Georgia and the other Southeastern States have been able to take advantage of the technology developed in the Western States, where the major growth in irrigation occurred 10 to 15 years earlier.

Within the Southeast, Georgia is fifth in irrigation water use, behind Arkansas, Florida, Louisiana, and Mississippi. However, the growth rate in Georgia is much greater than in any other State in the region, increasing by a factor of 12 within the decade.

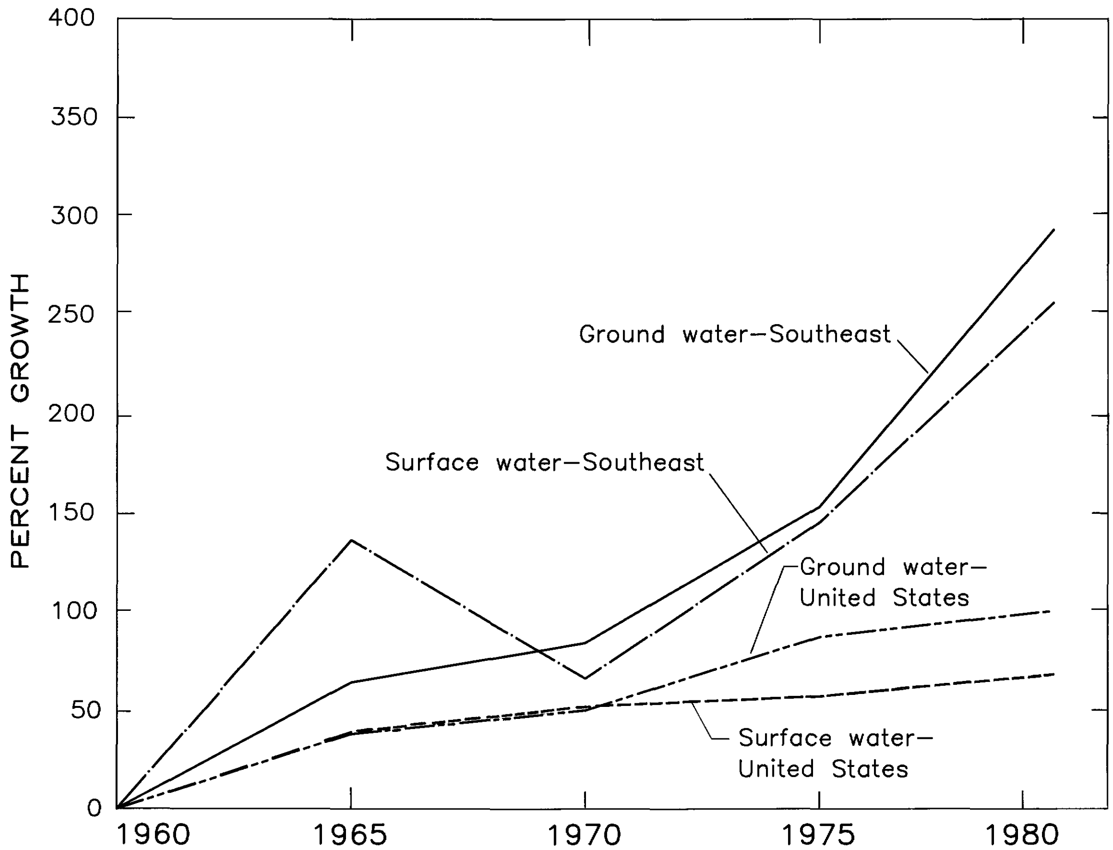


Figure 3.0-1.—Growth of irrigation water use in the Southeast and the United States.

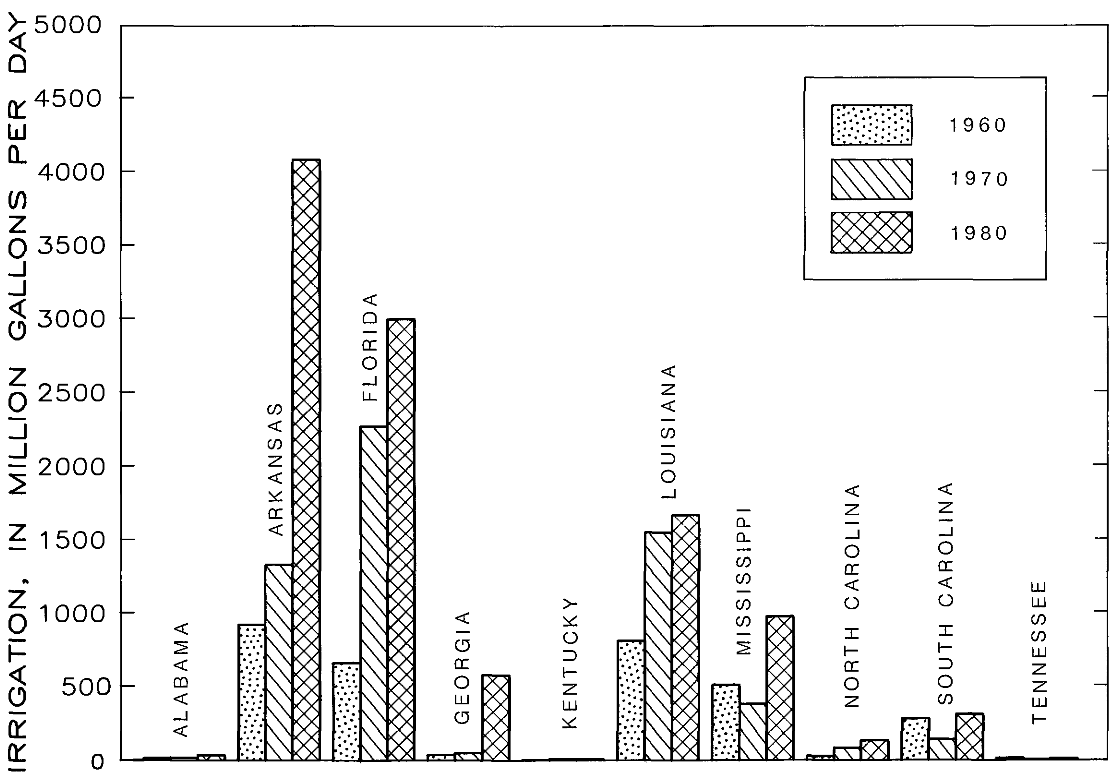


Figure 3.0-2.—Irrigation water use in the Southeast, 1960-80.

4.0 TRENDS IN IRRIGATION

4.1 Irrigation water use, 1960-80

The rapid growth in the amount of water used for irrigation in Georgia was caused by several factors:

(1) a series of agricultural drought years in which high crop yields were obtained mainly from irrigated fields;

(2) farmers' realization that irrigation, by giving more control over when a crop is watered, can improve crop yield even in years having adequate rainfall;

(3) growth in the use of irrigation systems to apply fertilizer, herbicides and pesticides ("chemigation"); and

(4) introduction of high-capacity irrigation-system technology to Georgia. Irrigation water use totaled about 580 million gallons per day in 1980, of which 65 percent was ground water.

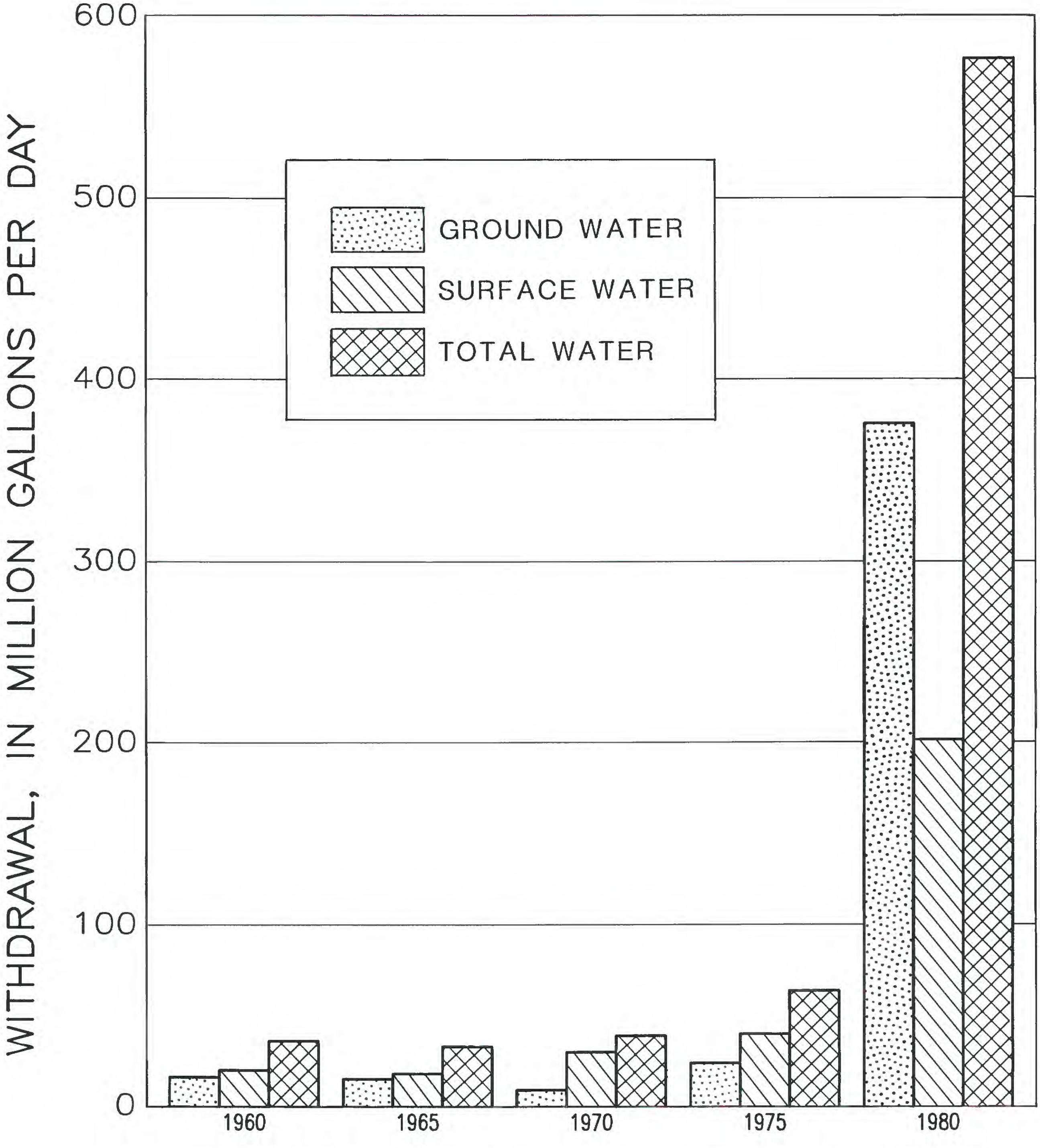


Figure 4.1-1.—Irrigation water use in Georgia, 1960-80.

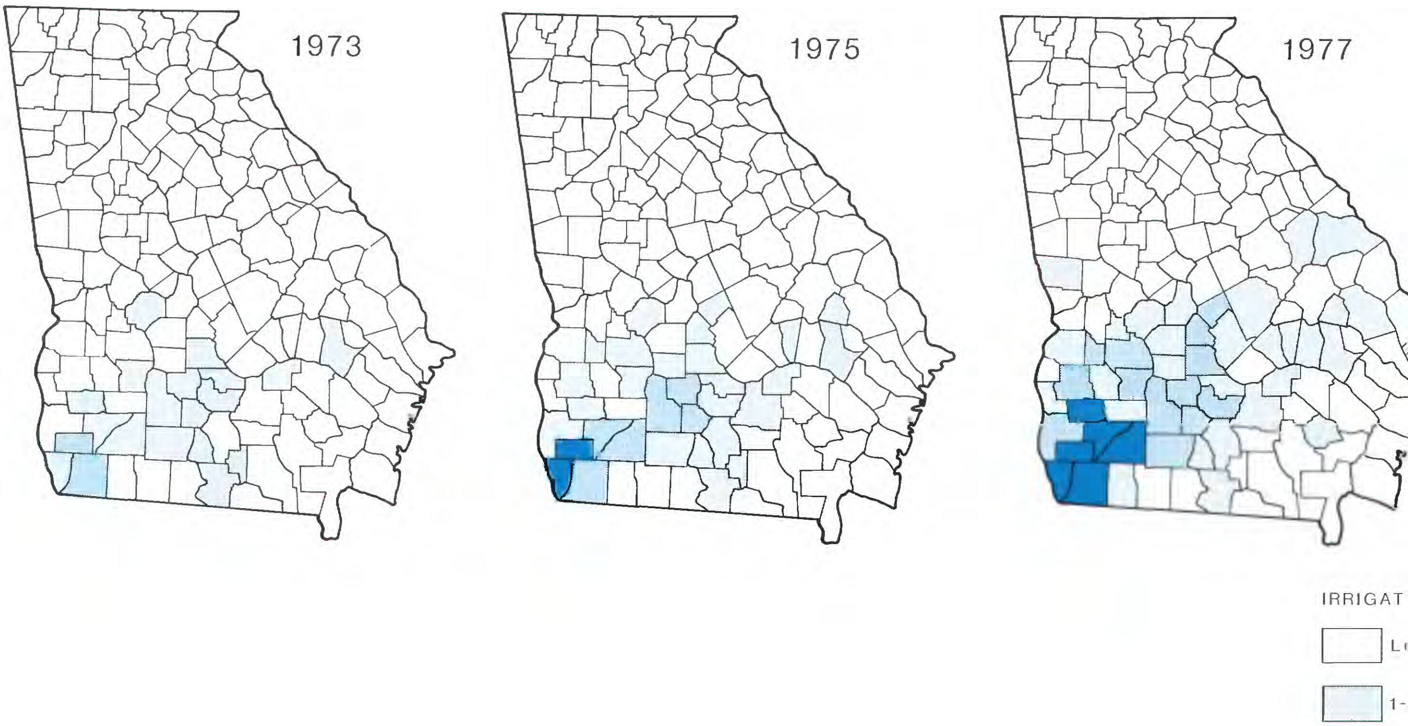
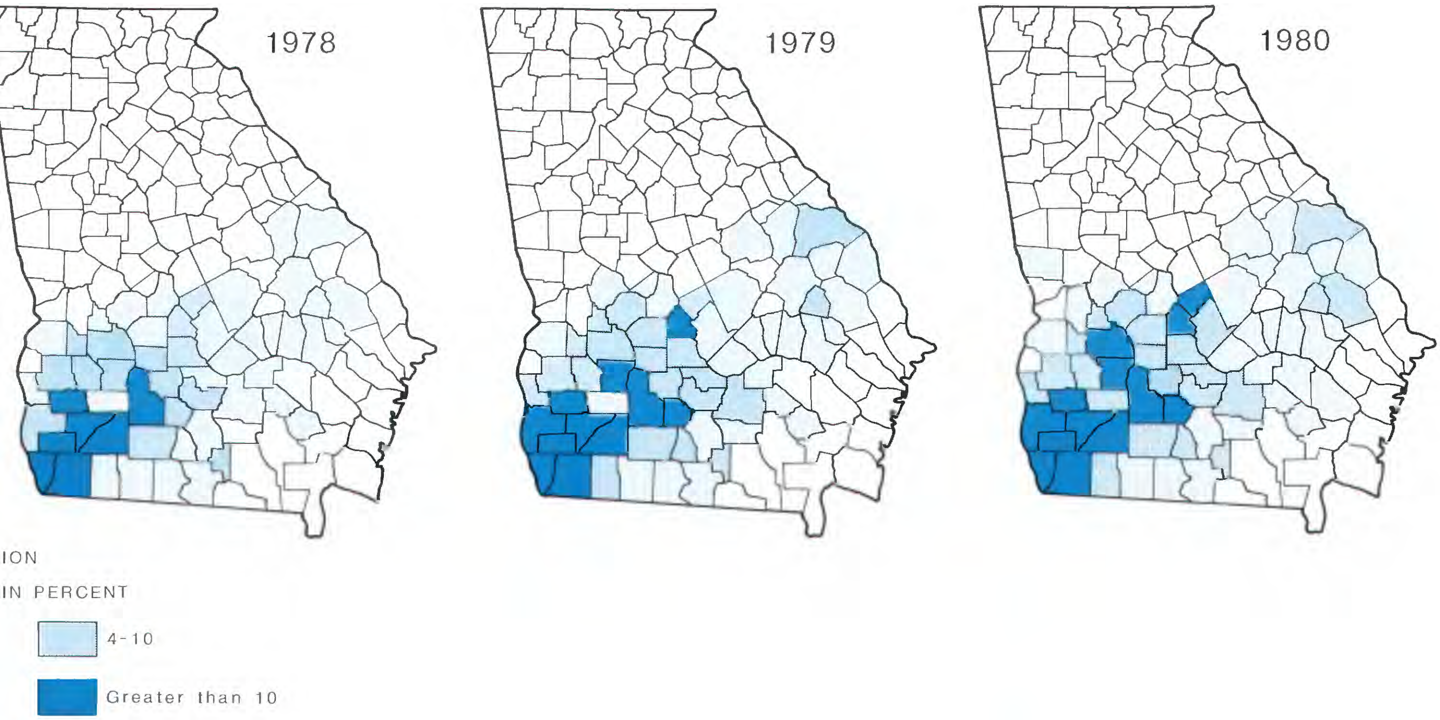


Figure 4.2-1.—Percenta

4.2 Changes in land area and crops being irrigated

The sequence of maps shows irrigated land as a percentage of total land in each county in the State, demonstrating the rapid growth in irrigated land area during the seventies. In 1973, irrigation was well established in southwest Georgia, and by 1978 the extent of significant use of irrigation had spread over most of the Coastal Plain. The intensity of irrigation continued to increase, reaching as much as 30 percent of the total area of the counties in extreme southwest Georgia in 1980.

The percentage of irrigated land used by different crops has also changed during the last decade. In 1969, 75 percent of all irrigated acreage was planted in tobacco, peanuts, and corn. By 1980, corn and peanut acreage alone made up 70 percent of all irrigated land, soybeans were planted in 14 percent of all irrigated acres, and tobacco had dropped to 5 percent from almost 30 percent 10 years earlier.



land irrigated, by county.

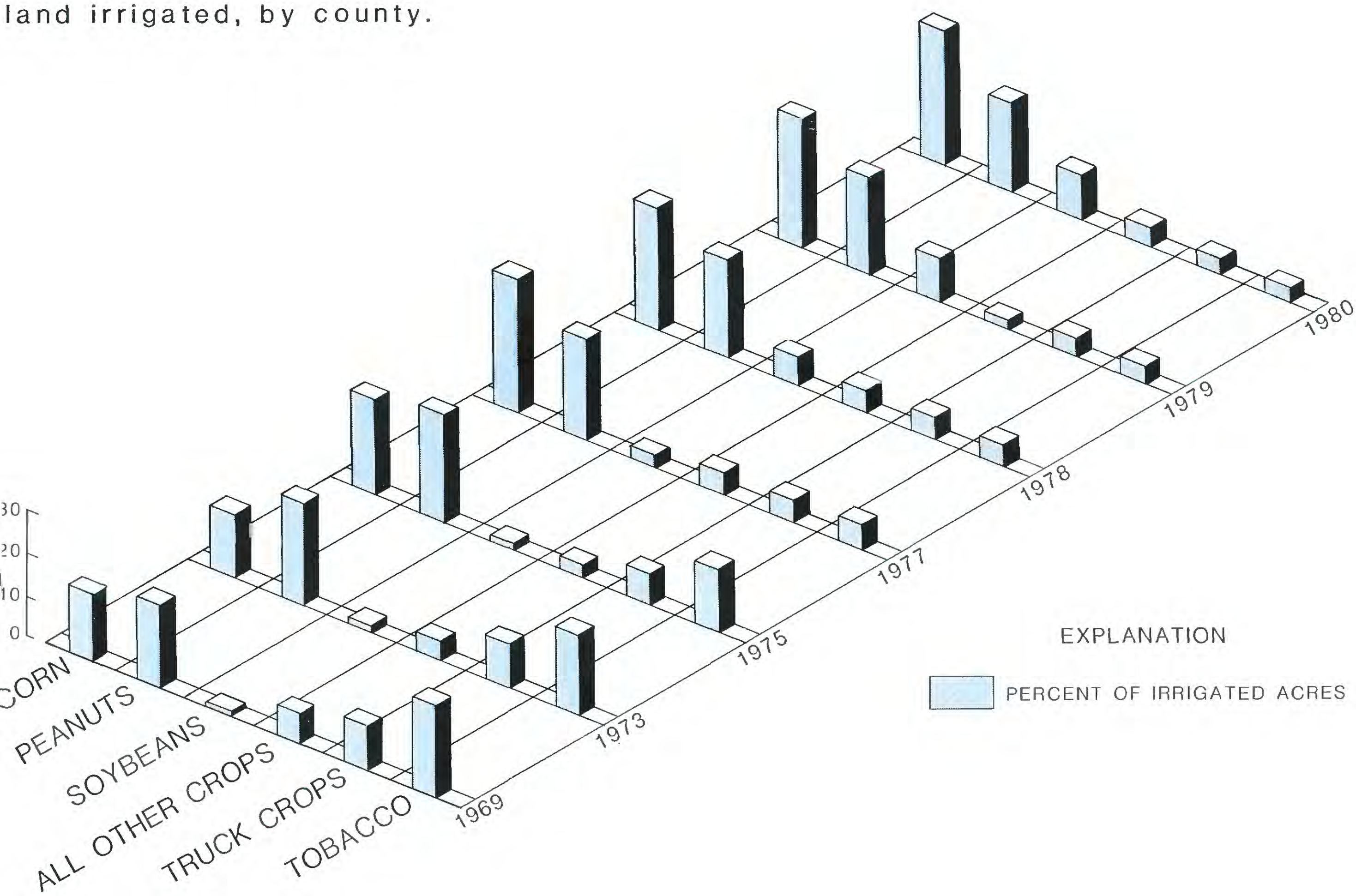
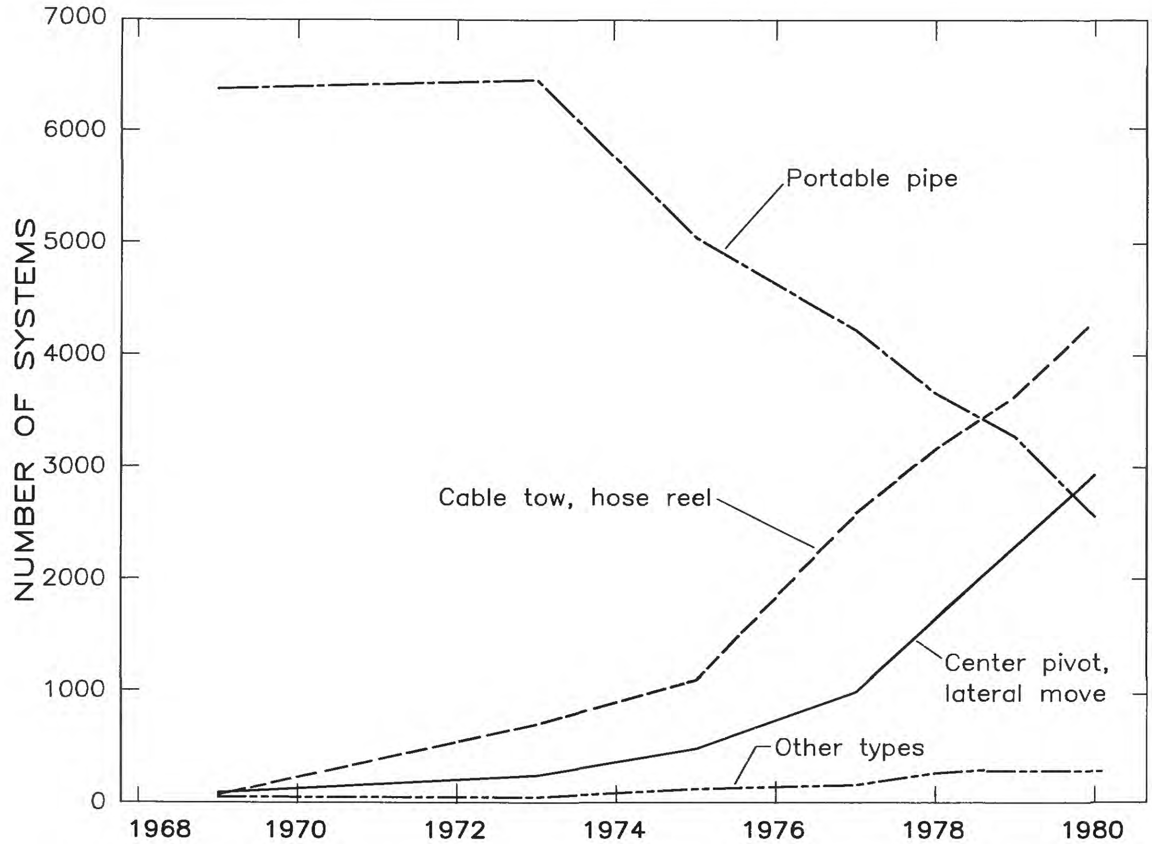


Figure 4.2-2.—Percentage of irrigated land by type of crop and year. (Data from Robert E. Skinner, Cooperative Extension Service, written commun., 1981)

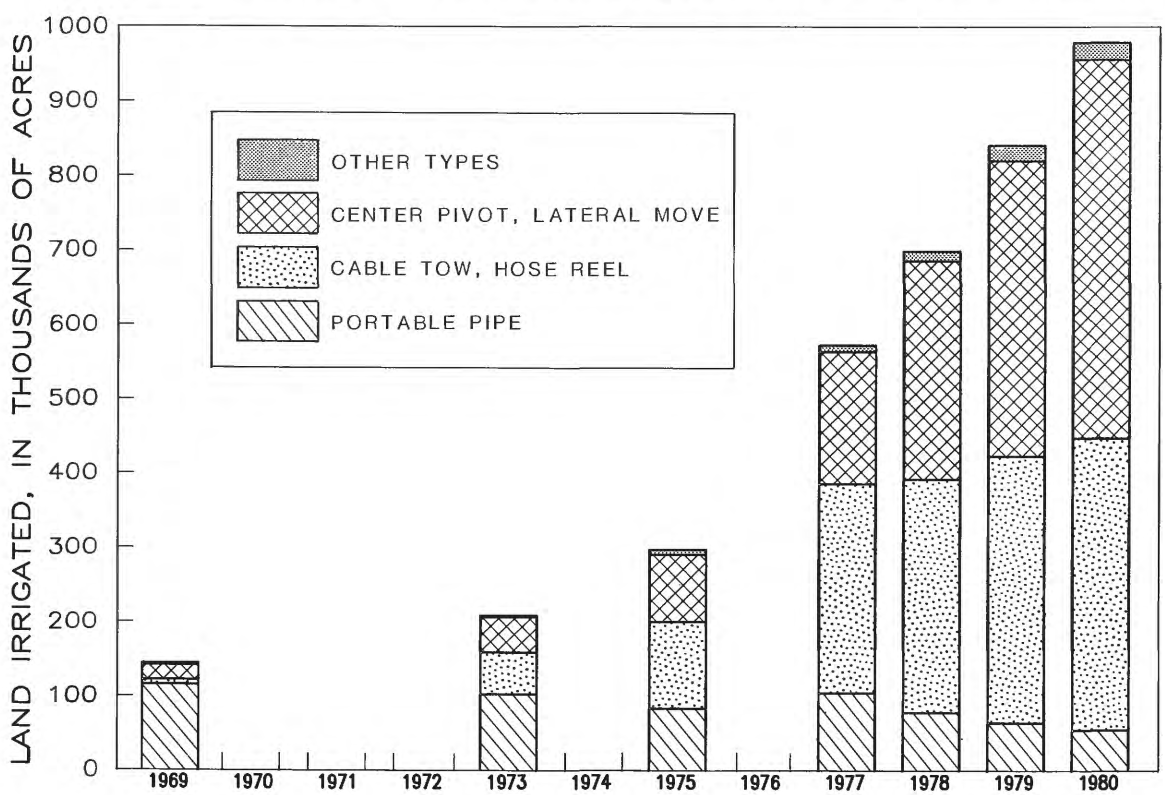
4.3 Changes in number and types of systems

The methods of irrigation used in Georgia changed during the decade 1970-80, as cable-tow and center-pivot systems were introduced into the State. In 1969, the dominant type of system was portable pipe, which was suitable for small fields (usually planted in tobacco). As the size of cultivated fields increased and the use of irrigation spread, this type of system became unwieldy and labor-intensive. With the production of cable-tow systems, followed by center pivots, the number of portable-pipe systems dropped off rapidly.

The first center-pivot systems in the State were installed in 1967 in southwest Georgia, and from there the technology spread to the rest of the Coastal Plain (M. C. Prunty, University of Georgia, written commun., 1982). During the late seventies, there was a rapid increase in the use of cable tows and center pivots, which can cover significantly more area than portable-pipe systems and cost less per acre to use, despite a higher initial investment. By 1980, more than 50 percent of all irrigated acres in the State were under center-pivot systems, with an average field size of 177 acres. Some center-pivot systems cover more than 400 acres (M. C. Prunty, University of Georgia, written commun., 1982). In contrast, the average area irrigated by cable tows in 1980 was 91 acres, and by portable-pipe systems was 21 acres (R. E. Skinner, University of Georgia Cooperative Extension Service, written commun., 1982).



A.—CHANGES IN NUMBER OF EACH SYSTEM TYPE USED IN GEORGIA.



B.—ACRES IRRIGATED BY TYPE OF SYSTEM.

Figure 4.3-1.—Irrigation by system type, 1960-80. (Data from Skinner, 1974 to 1981)

5.0 SURVEY OF IRRIGATION SYSTEMS IN 1980

5.1 Locations of irrigation systems in 1980

The U.S. Soil Conservation Service, under contract to the U.S. Geological Survey, conducted a survey of irrigation systems within a 62-county area of the Coastal Plain that was designated the High Irrigation Water-Use Zone. The survey, done as part of the Georgia Water Use Program, was a field inventory which involved locating irrigated fields and water sources on topographic maps and then collecting information on each system including equipment type, water source, pump and system capacities, and other relevant data. The information from this survey was placed in an automated data file, creating a data base of site-specific information on irrigated lands as of the spring of 1980. A microcomputer accesses the data base to generate maps, such as figure 5.1-1, plotting the location of every system in the study area. It also provides summaries of irrigation by county, water source, system type, river basin, or other specified parameters.

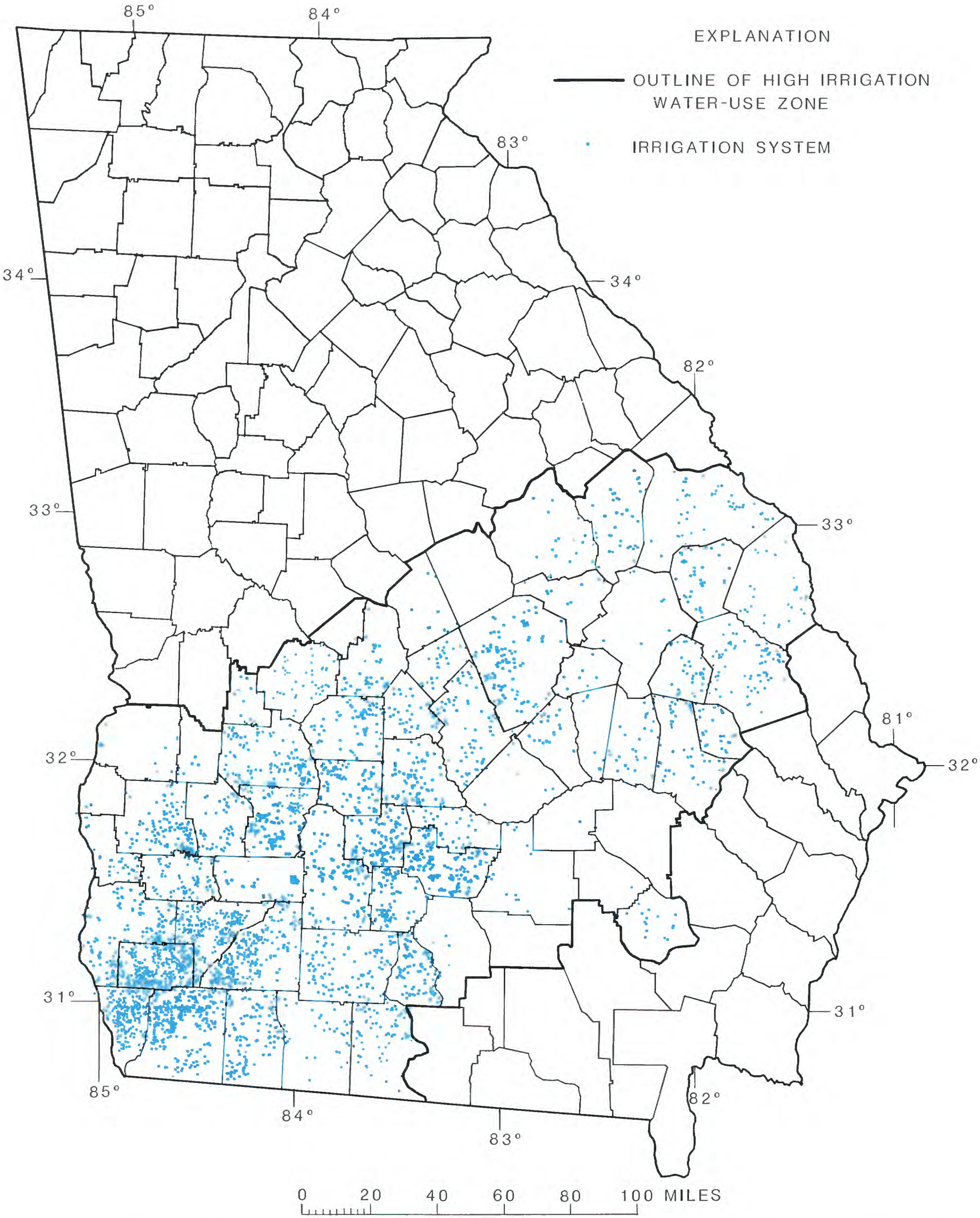


Figure 5.1-1.—Locations of irrigation systems within the High Irrigation Water-Use Zone, 1980.

5.2 Factors influencing the distribution of irrigation system types

The source of water used by irrigation systems depends on the availability of water at the site. Ground water is preferable to surface water because of its purity, and the greater dependability during short droughts. In the Dougherty Plain (fig. 5.2-1), for example, ground water is readily available. An 8- to 10-inch diameter, 200-foot-deep well will provide adequate water to run a high-capacity, center-pivot system. The availability of ground water is reflected by the maps showing the tight concentration of ground-water systems (fig. 5.2-2) in the Dougherty Plain and the small number of surface-water systems (fig. 5.2-3). In other parts of the Coastal Plain, deeper wells are necessary. The initial investment for a deep well is greater and the pumping cost is higher, making ground water less attractive. In these areas, a small pond can provide a reservoir of water for a system. Commonly a farmer will install a low-yielding well to pump into a pond or irrigation pit.

Center-pivot systems (fig. 5.2-4) are concentrated in the Dougherty Plain area because of favorable topography and an abundant ground-water supply. For center pivots to work properly, slopes must be gentle enough for the self-propelled systems to move evenly across the field, reducing the problems of keeping the systems alined. The Dougherty Plain is extremely flat and has few drainage lines that require bridging. These characteristics combined with readily available ground water make this area suitable for center-pivot irrigation systems.

Cable-tow and portable-pipe systems have less stringent requirements. Both need smaller pump capacities to operate, and so can be supplied directly by lower yielding wells. Because these system types are more labor-intensive, they are generally used where center pivots are not feasible: In smaller, oddly shaped fields, or where the water supply is inadequate to run a high-capacity system, or where the terrain is too steep. Another factor governing the type of system to be used is cost. Center pivots require a large investment for the system itself and for a high-capacity well or a large pond. Cable tows are less expensive and do not need as great a flow of water, but will require more time on the part of the farmer to move the system from row to row. Portable-pipe systems need even less water flow and cost less, but are very labor-intensive and are used mainly on small fields.

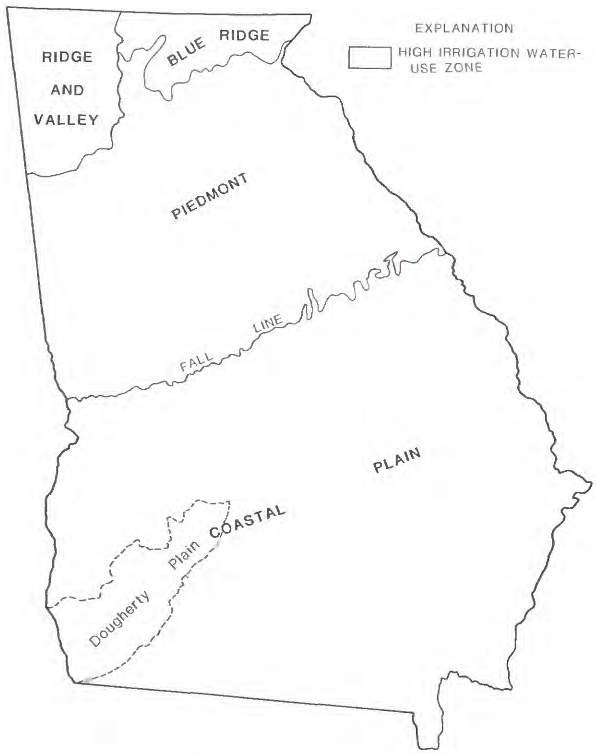


Figure 5.2-1.—Physiographic provinces and the High Irrigation Water-Use Zone.

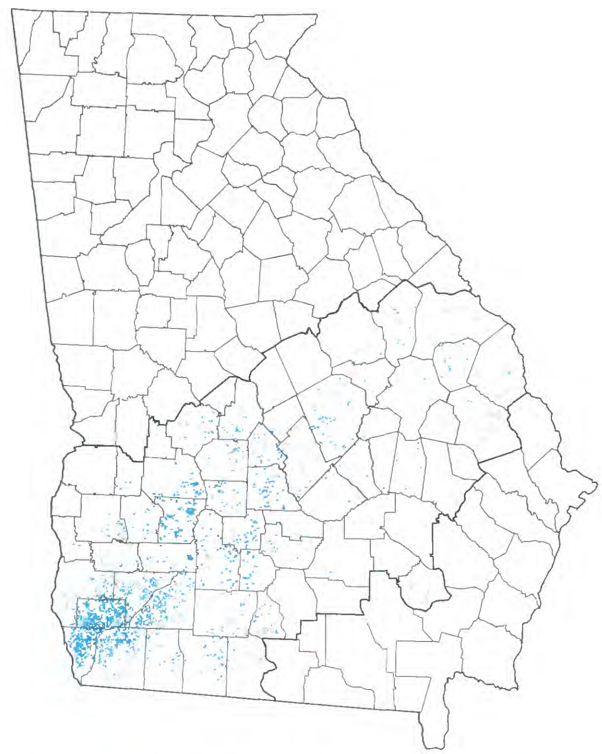


Figure 5.2-2.—Locations of irrigation systems using ground water within the High Irrigation Water-Use Zone, 1980.

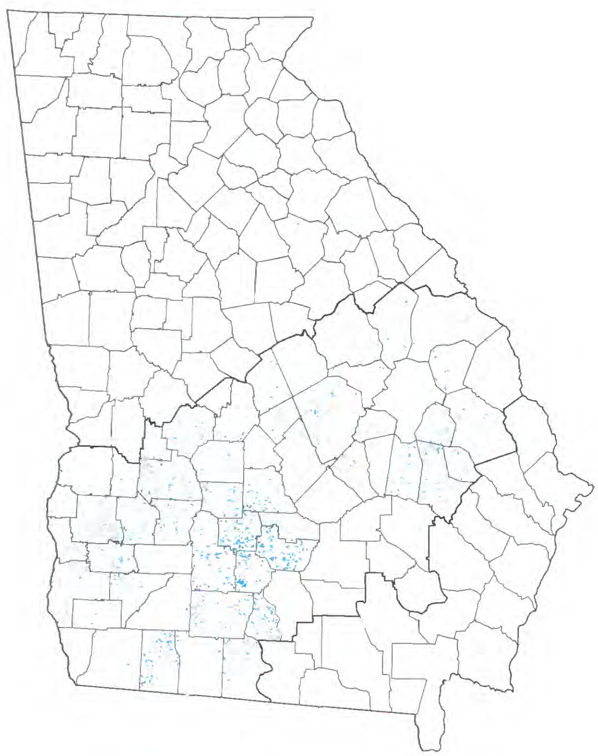


Figure 5.2-3.—Locations of irrigation systems using surface water within the High Irrigation Water-Use Zone, 1980.

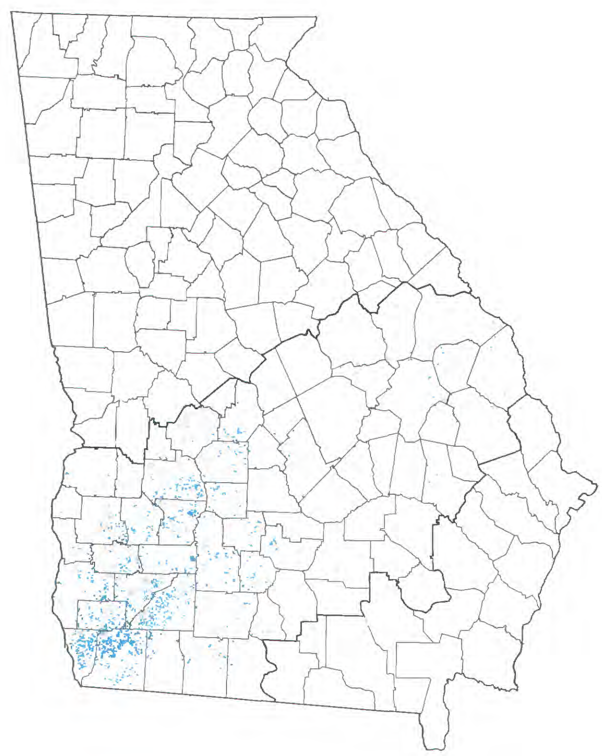


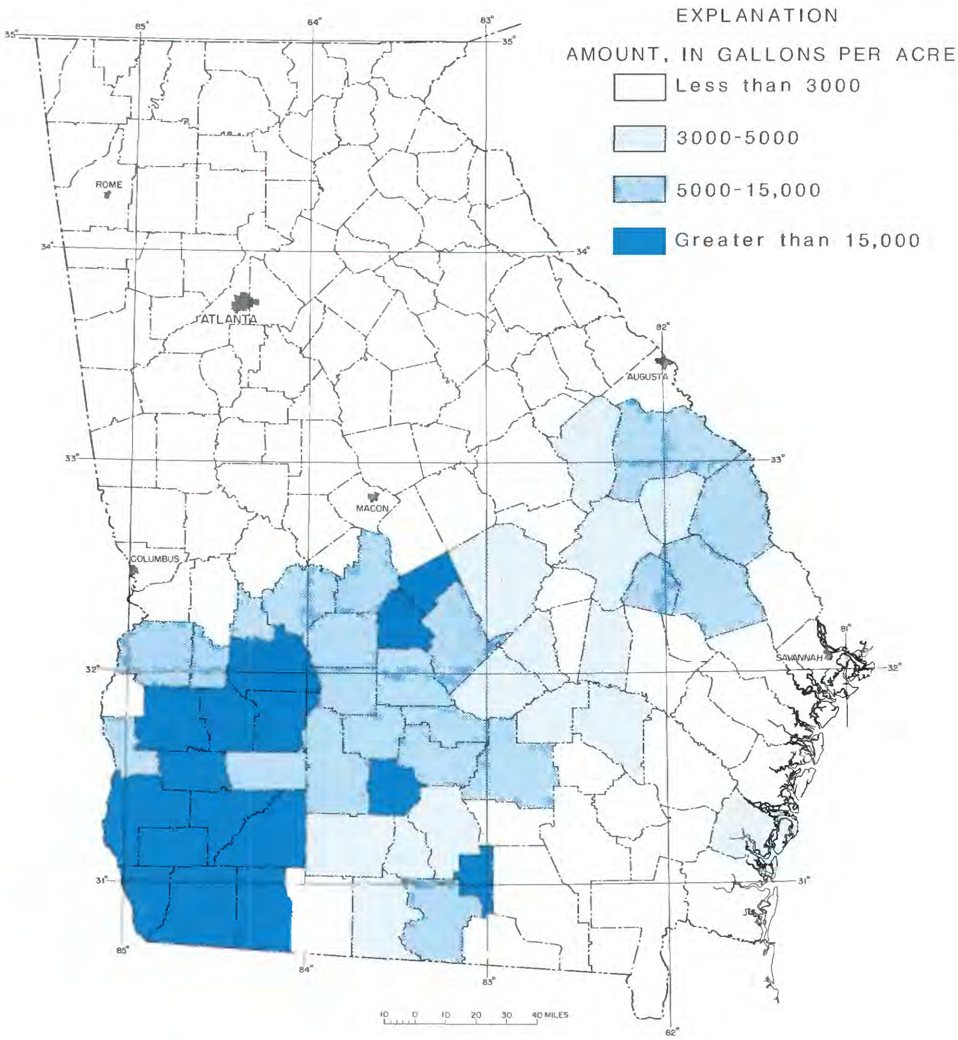
Figure 5.2-4.—Locations of center-pivot irrigation systems within the High Irrigation Water-Use Zone, 1980.

6.0 APPLICATIONS OF SITE-SPECIFIC IRRIGATION INFORMATION

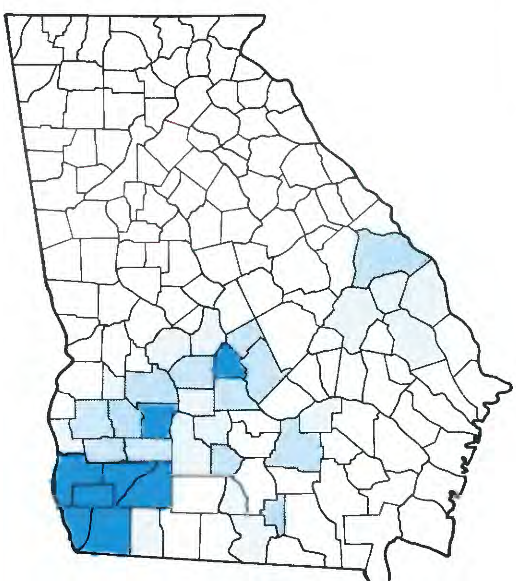
6.1 Quantities of water used for irrigation, by county

Site-specific information from the Soil Conservation Service survey and data collected annually by the Cooperative Extension Service of the University of Georgia on numbers and types of irrigation systems in each county (R. E. Skinner, Cooperative Extension Service, written commun., 1981) were used to estimate the actual amount of water used for irrigation in each county. (See table 6.1-1 at end of report.) Information on system type is important because the different systems vary as to the amount of water they need to operate. Center pivots generally require 1,000 to 1,200 gallons per minute (gal/min), cable tows about 500 gal/min, and portable-pipe systems 200 to 300 gal/min. In addition to the information on system type, water source, and acreage irrigated, data on crop types and the average number of irrigation applications made to that crop during the year of interest are required.

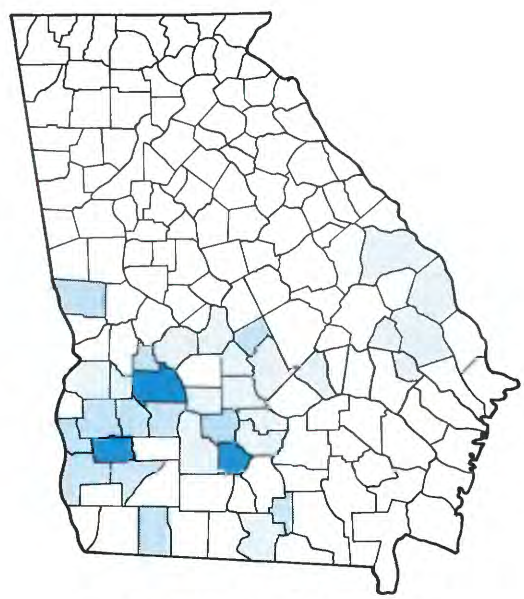
Irrigation water-use data were used to generate maps of the State showing water-use data by county (fig. 6.1-1). Four ranges of values were selected, and each county was assigned a value range based on the amount of irrigation use in that county. Each range was then assigned a color, and the map was colored accordingly. This type of map is useful to Georgia's water-resources managers who may need a broad comparison of ground-water versus surface-water use for irrigation, or an overview of all water use for irrigation to compare with other categories of water use.



ALL SOURCES OF WATER



GROUND WATER



SURFACE WATER

Figure 6.1-1.—Amounts of water withdrawn for irrigation, 1980.

6.2 Other applications of site-specific irrigation information

Ground-water levels in several areas of Georgia are declining, even though precipitation has been above normal for most of the last decade. The graph shows the amount that precipitation was above or below normal for 1971-80 at a recording station in southwest Georgia. Only during 1978 and 1980 was precipitation below normal. Despite this, the water level in a test well in the same area showed a steady decline during the last half of the decade. To understand why this occurred, hydrologists are using models to study the affected aquifers.

Site-specific water-use information is a critical input to hydrologic models. Because agricultural water users are exempt from legislation requiring major water users to have permits[1], no precise information was available on irrigation until the U.S. Soil Conservation Service-U.S. Geological Survey field survey in 1979-80. Hydrologists from the U.S. Geological Survey and the Georgia Geologic Survey who are modeling ground- and surface-water resources thus find the Water Use Program's irrigation data base an important tool.

The Dougherty Plain in southwest Georgia is being closely studied to calculate the effects of increased withdrawals. In this area, irrigation pumpage from the principal artesian aquifer has increased from approximately 129 million gallons per day in 1977 to about 208 million gallons per day in 1980 (Hayes and others, 1983). Hydrogeologic data obtained from test wells and historical records were used to construct a two-dimensional finite-difference model of the ground-water flow system. To incorporate the effects of current irrigation pumping on the aquifer, the site-specific data from the irrigation data base were totaled for each "square" of the model's grid (fig. 6.2-2). This was done directly by the microcomputer, saving the modeler time and effort and eliminating possible errors in data transcription. When combined with hydrogeologic data such as transmissivity, leakance, drawdowns, and measured heads, and with data on water users in the study area, a model can be constructed to simulate how the aquifer will behave under specified conditions (Hayes and others, 1983). Using this model, hydrologists can better answer questions on what effects prolonged drought and additional pumpage will have on the aquifer.

1. Amendments to these laws passed in 1981 require major irrigation water users to report their water use, but still exempt them from permit requirements.

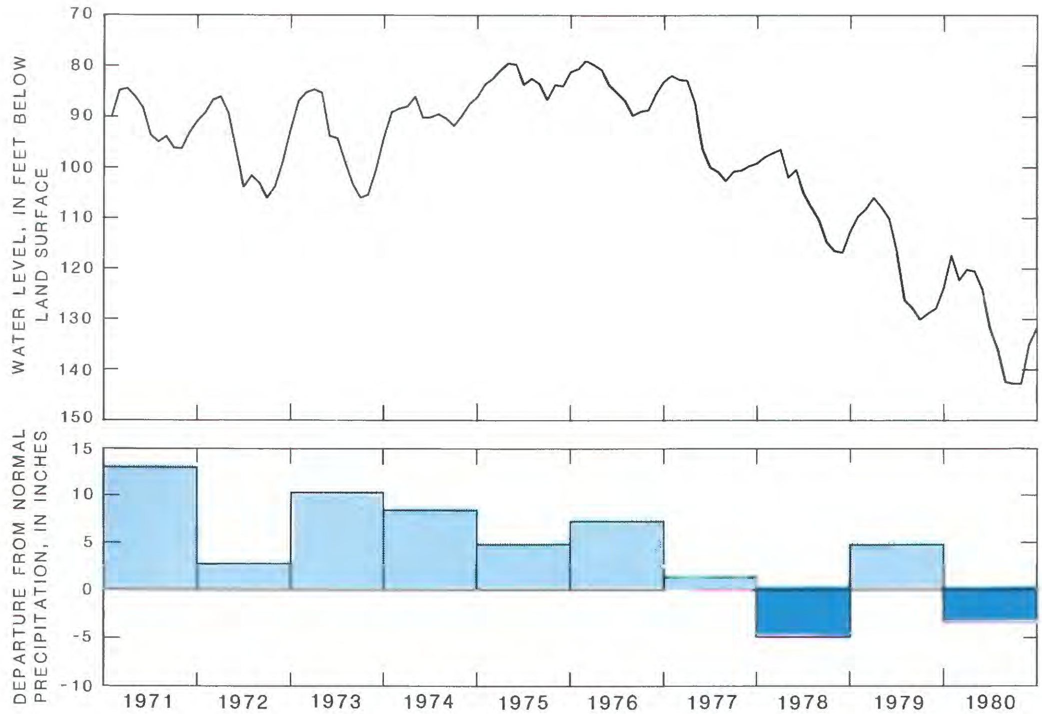


Figure 6.2-1.— Water-level fluctuations in a south Georgia test well and departure from normal precipitation.

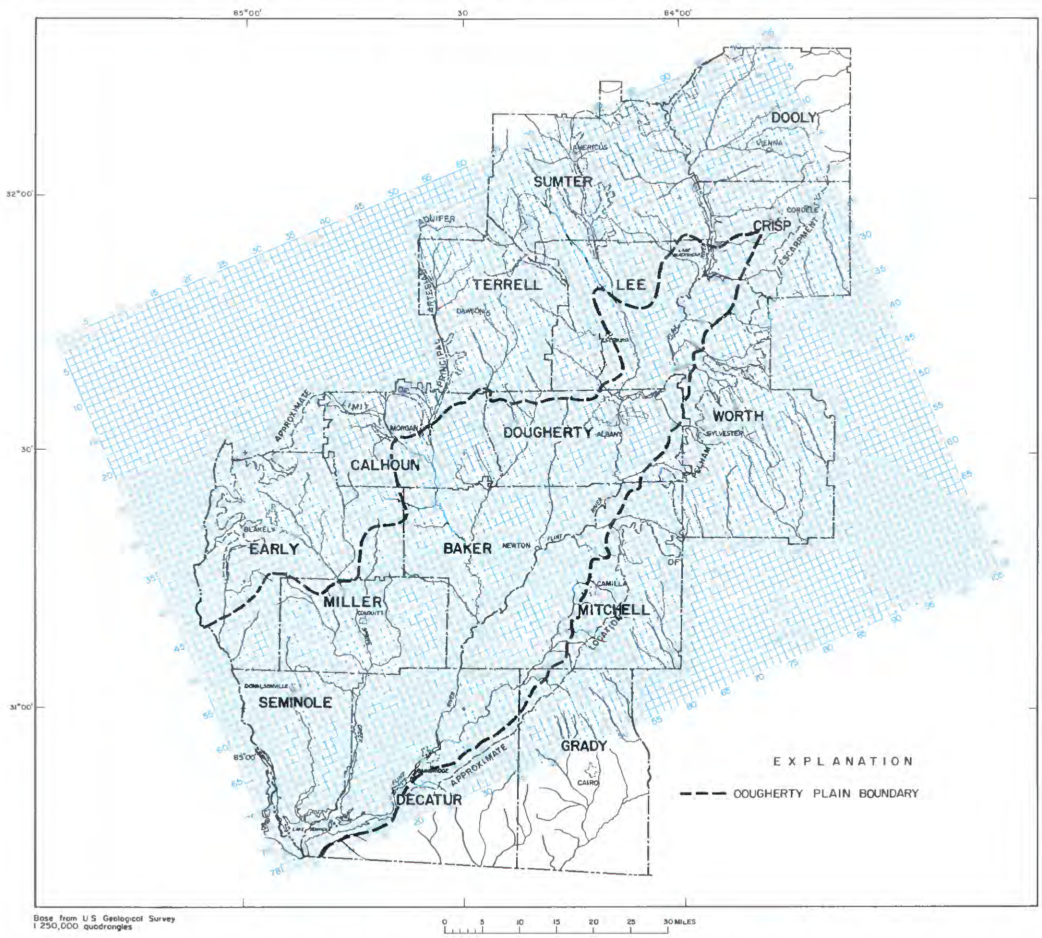


Figure 6.2-2.— Example of a model grid: Dougherty Plain model area showing study area and model grid. From Hayes and others (1983).

7.0 IRRIGATION WATER USE IN THE NEXT DECADE

The growth of irrigation water use in Georgia over the past decade has been exponential. The factors that led to this growth--increased crop yields, reduced risks, and land that is favorable for irrigation--are still significant. Irrigated land produces a higher yield per acre for most crops, even in years having normal rainfall. In Georgia, soybeans that are irrigated show a per-acre increase of 18 to 20 bushels (J. M. Woodruff, Cooperative Extension Service, oral commun., 1982), and cotton has a per-acre increase of 200 to 300 pounds (A. B. Fulford, Cooperative Extension Service, oral commun., 1982). Irrigation removes some of the risk of growing a crop in that the farmer need not depend on precipitation, but can supply the correct amount of water at precisely the right time. Georgia still has a great deal of prime agricultural land that is not being irrigated. The Soil Conservation Service estimates that the southwestern part of Georgia has 5 to 10 times more land that would respond favorably to irrigation than is now being irrigated (U.S. Soil Conservation Service, 1982). If all three of these factors continue unabated and the growth of irrigation water use continues at its current rate, amounts of water used for irrigation in the next decade may be at levels shown in graph "A".

A more realistic projection of the amount of irrigation water use in the next decade might look more like graph "B". Several other factors are beginning to check the rate of growth in irrigation water use. The first of these is very high interest rates, which result in an increase in the fixed costs of owning an irrigation system. The increase in crop yield must be significant to cover the mortgage costs for a $70,000 to $80,000 center-pivot system. On many farms, the system can only be justified by double- and triple-cropping to spread out the increased fixed costs. A second factor slowing the growth rate is the realization that irrigation does not always lead to increased yields--in fact, lower yields can result. For example, if a farmer irrigates just before a rainstorm and he has a crop such as peanuts which is susceptible to fungus, the increased water may lead to severe disease problems which will reduce his yield. A third factor acting to slow the growth of irrigation water use is the water supply itself. Successive years of hydrologic drought reduce the availability of surface water as streams and farm ponds dry up in summer and do not receive enough rainfall in winter to recover. Ground-water reservoirs are also under increased stress as shown by rapidly declining water levels in wells, and in some areas of the State the reservoirs may have insufficient water to satisfy everyone's needs. Many farmers are now carefully evaluating the cost and benefits of irrigation before deciding whether or not to purchase a large irrigation system. The more realistic picture in graph "B" shows significant growth in irrigation during the next decade, but at a slower rate than the exponential growth shown in graph "A".

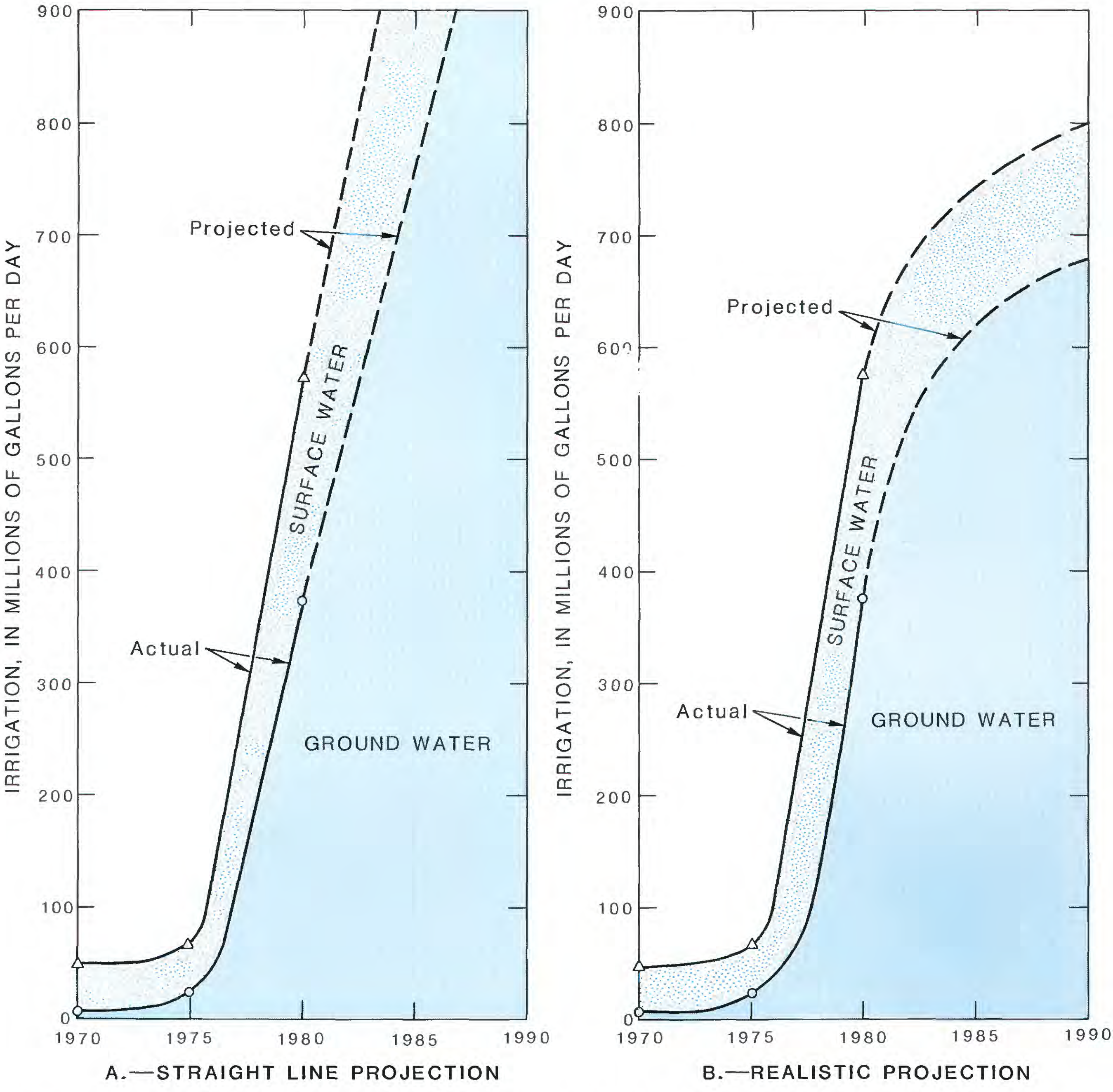


Figure 7.0-1.—Increase in water used for irrigation in Georgia, 1970-80, with projections to 1990.

Table 6.1-1.--Water used for irrigation, by county, in 1980

County	Acres irrigated	Withdrawal in million gallons per day		
		Ground water	Surface water	Total
Appling	4,550	2.66	0.05	2.71
Atkinson	3,401	1.01	0	1.01
Bacon	3,005	1.44	.06	1.50
Baker	50,000	26.51	5.05	31.56
Baldwin	105	0	.21	.21
Banks	80	.02	.06	.08
Barrow	41	0	.02	.02
Bartow	345	.11	.22	.33
Ben Hill	9,216	1.21	1.81	3.02
Berrien	8,540	2.46	.16	2.62
Bibb	293	.08	.25	.33
Bleckley	15,788	5.42	4.43	9.85
Brantley	900	.41	.13	.27
Brooks	7,591	1.38	1.33	2.71
Bryan	3	.01	0	.01
Bulloch	24,990	3.81	5.96	9.77
Burke	29,278	10.21	6.25	16.46
Butts	301	0	.09	.09
Calhoun	20,207	4.63	8.60	13.23
Camden	38	.07	.01	.08
Candler	7,460	1.31	2.54	3.85
Carroll	584	0	.39	.39
Catoosa	235	0	.38	.38
Charlton	155	0	.05	.05
Chatham	276	.29	.25	.54
Chattahoochee	--	0	0	0
Chattooga	105	0	.02	.02
Cherokee	108	0	.19	.19
Clarke	349	.03	.04	.07
Clay	6,040	1.29	2.62	3.91
Clayton	12	0	.03	.03
Clinch	274	.10	.05	.15
Cobb	427	.05	.76	.81
Coffee	23,365	8.49	.35	8.84
Colquitt	19,221	2.35	2.35	4.70
Columbia	154	0	.16	.16
Cook	6,800	1.82	.43	2.25
Coweta	62	0	.06	.06
Crawford	771	.04	.23	.27
Crisp	9,371	1.93	2.67	4.60
Dade	2	0	0	0
Dawson	--	0	0	0
Decatur	67,216	40.20	2.57	42.77
DeKalb	620	.17	1.07	1.24
Dodge	13,070	5.86	3.44	9.30
Dooly	16,200	6.90	1.83	8.73
Dougherty	9,093	7.05	.37	7.42
Douglas	201	0	.25	.25
Early	35,649	15.20	6.21	21.41
Echols	1,070	.09	.25	.34
Effingham	569	.08	.25	.33
Elbert	256	0	.10	.10
Emanuel	10,135	4.83	1.29	6.12
Evans	3,073	.16	.98	1.14
Fannin	172	0	.03	.03
Fayette	428	0	.25	.25
Floyd	1,265	.03	.29	.32
Forsyth	268	0	.10	.10
Franklin	217	0	.14	.14
Fulton	1,093	.73	1.49	2.22

County	Acres irrigated	Withdrawal in million gallons per day		
		Ground water	Surface water	Total
Gilmer	30	0	0.01	0.01
Glascock	151	0	.06	.06
Glynn	1,300	1.93	.42	2.35
Gordon	483	0	.21	.21
Grady	17,025	3.95	8.38	12.33
Green	92	.03	.03	.06
Gwinnett	91	.03	.19	.22
Habersham	708	0	1.32	1.32
Hall	609	0	.24	.24
Hancock	--	0	0	0
Haralson	19	0	.03	.03
Harris	3,225	.81	5.42	6.23
Hart	73	.02	.02	.04
Heard	257	0	.20	.20
Henry	484	0	.24	.24
Houston	8,650	2.51	2.13	4.64
Irwin	19,641	1.06	3.36	4.42
Jackson	49	.02	.05	.07
Jasper	72	0	.01	.01
Jeff Davis	7,625	3.35	.07	3.42
Jefferson	11,633	2.18	2.77	4.95
Jenkins	5,107	2.15	1.31	3.46
Johnson	3,031	.59	.76	1.35
Jones	304	.07	.36	.43
Lamar	425	0	.24	.24
Lanier	4,771	3.12	2.66	5.78
Laurens	9,958	2.24	2.15	4.39
Lee	31,009	15.20	8.18	23.38
Liberty	107	.17	.04	.21
Lincoln	3	0	0	0
Long	500	0	.10	.10
Lowndes	5,470	4.69	4.33	9.02
Lumpkin	14	0	0	0
McDuffie	819	.32	.80	1.12
McIntosh	0	0	0	0
Macon	12,578	3.25	2.56	5.81
Madison	232	.02	.08	.10
Marion	2,354	.12	1.66	1.78
Meriwether	--	0	0	0
Miller	58,391	42.78	.87	43.65
Mitchell	54,200	32.59	1.01	33.60
Monroe	--	0	0	0
Montgomery	3,085	.32	.88	1.20
Morgan	1,760	0	.37	.37
Murray	11	0	.02	.02
Muscogee	60	0	.12	.12
Newton	--	0	0	0
Oconee	312	.14	.17	.31
Oglethorpe	170	0	.15	.15
Paulding	306	0	.39	.39
Peach	1,862	.74	.05	.79
Pickens	5	0	.01	.01
Pierce	4,967	1.74	.02	1.76
Pike	235	0	.04	.04
Polk	6	.01	0	.01
Pulaski	16,500	7.26	1.38	8.64
Putnam	28	0	.06	.06

Table 6.1-1.--Water used for irrigation, by county, in 1980--Continued

County	Acres irrigated	Withdrawal in million gallons per day: Ground water	Surface water	Total	County	Acres irrigated	Withdrawal in million gallons per day: Ground water	Surface water	Total
Quitman	651	0	0.21	0.21	Towns	14	0.02	0	0.02
					Treutlen	538	.07	.09	.16
Rabun	102	0	.02	.02	Troup	659	.20	.17	.37
Randolph	25,154	5.00	9.72	14.72	Turner	16,897	1.93	5.49	7.42
Richmond	485	.30	.39	.69	Twiggs	1,246	.15	.49	.64
Rockdale	3	0	.01	.01					
					Union	--	0	0	0
Schley	4,103	.19	3.00	3.19	Upson	606	0	.39	.39
Screven	16,210	5.38	5.17	10.55					
Seminole	46,030	31.25	.32	31.57	Walker	370	0	.31	.31
Spalding	228	0	.23	.23	Walton	47	0	.08	.08
Stephens	--	0	0	0	Ware	796	.13	.09	.22
Stewart	10,310	1.96	3.80	5.76	Warren	6	0	.01	.01
Sumter	32,374	7.49	15.22	22.71	Washington	4,282	.81	1.43	2.24
					Wayne	5,285	.97	.83	1.80
Talbot	740	0	.18	.18	Webster	5,815	1.52	1.64	3.16
Taliaferro	--	0	0	0	Wheeler	5,298	1.07	1.91	2.98
Tattnall	5,956	.13	2.04	2.17	White	112	.06	.08	.14
Taylor	2,814	.30	.75	1.05	Whitfield	332	0	.17	.17
Telfair	5,155	2.31	.15	2.46	Wilcox	20,000	4.07	2.71	6.78
Terrell	14,965	5.10	5.09	10.19	Wilkes	460	.03	.12	.15
Thomas	5,473	1.49	.37	1.86	Wilkinson	383	.07	.34	.41
Tift	35,585	3.82	7.77	11.59	Worth	17,820	5.26	3.96	9.22
Toombs	4,065	.89	1.38	2.27					

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