GEORGIA COASTAL SOUND SCIENCE INITIATIVE 2005 — WHAT HAVE WE LEARNED?

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Abstract. Groundwater pumpage has resulted in saltwater contamination of the Upper Floridan aquifer at the northern end of Hilton Head Island, South Carolina, at Brunswick, Georgia, and near Jacksonville, Florida. This saltwater contamination has constrained further development of the aquifer in the coastal area and created competing demands for the limited supply of water.

The Georgia Coastal Sound Science Initiative was initiated during 1999 to provide scientific support for development of the Georgia Department of Natural Resources, Environmental Protection Division's water-management strategy for the Georgia coastal area. Implementation of the water-management strategy is scheduled for January 2006. In support of the Coastal Sound Science Initiative, the U.S. Geological Survey is evaluating groundwater flow, saltwater contamination, and alternative water sources in the Georgia coastal area and adjacent parts of South Carolina and Florida (Fig. 1). Other participants in this multidisciplinary effort include the South Carolina Department of Health and Environmental Control; Skidaway Institute of Oceanography; Georgia Water Resources Research Institute; and several private consulting firms.

The initiative has provided new insight into multilayer groundwater flow systems, provided a better delineation of saltwater contamination in the Floridan aquifer system, and improved our understanding of alternative water sources in the coastal area. From these studies we have learned that:

- *Offshore drilling* near Savannah, Georgia, and Hilton Head Island, South Carolina, indicates that saltwater is entering the Upper Floridan aquifer though paleochannels that have thinned breached the Upper Floridan confining unit and provide a hydraulic connection with seawater or overlying saltwater-bearing units.

- In addition to paleochannel pathways, *porewater analysis* of core samples indicate that saltwater probably is migrating downward through the Upper Floridan confining unit and toward the Upper Floridan aquifer along the hydraulic gradient created by pumping from the aquifer since about 1900.

- *New test wells and water sampling* by the South Carolina Department of Health and Environmental Control indicate that there are three major chloride plumes in the Upper Floridan aquifer at the northern end of Hilton Head Island and in the marshlands behind the island. Previous studies had suggested the presence of only one plume in the northern Hilton Head Island area.

- *Geologic assessment* of Oligocene and younger sediments has provided insight into the depositional environments, lithology, and areal extent of the Brunswick and surficial aquifer systems, which have been identified as potential alternative sources of water; and *aquifer testing* at several sites has provided insight into the water-bearing properties of these aquifer systems.

- *Deep test wells* completed at seven locations have improved characterization of the geology, groundwater quality, and hydraulic properties of the Floridan aquifer system in coastal Georgia. One of the test wells—at St. Simons Island, Georgia—revealed the unexpected absence of the Fernandina permeable zone of the Lower Floridan aquifer—the source of chloride contamination at nearby Brunswick, Georgia.

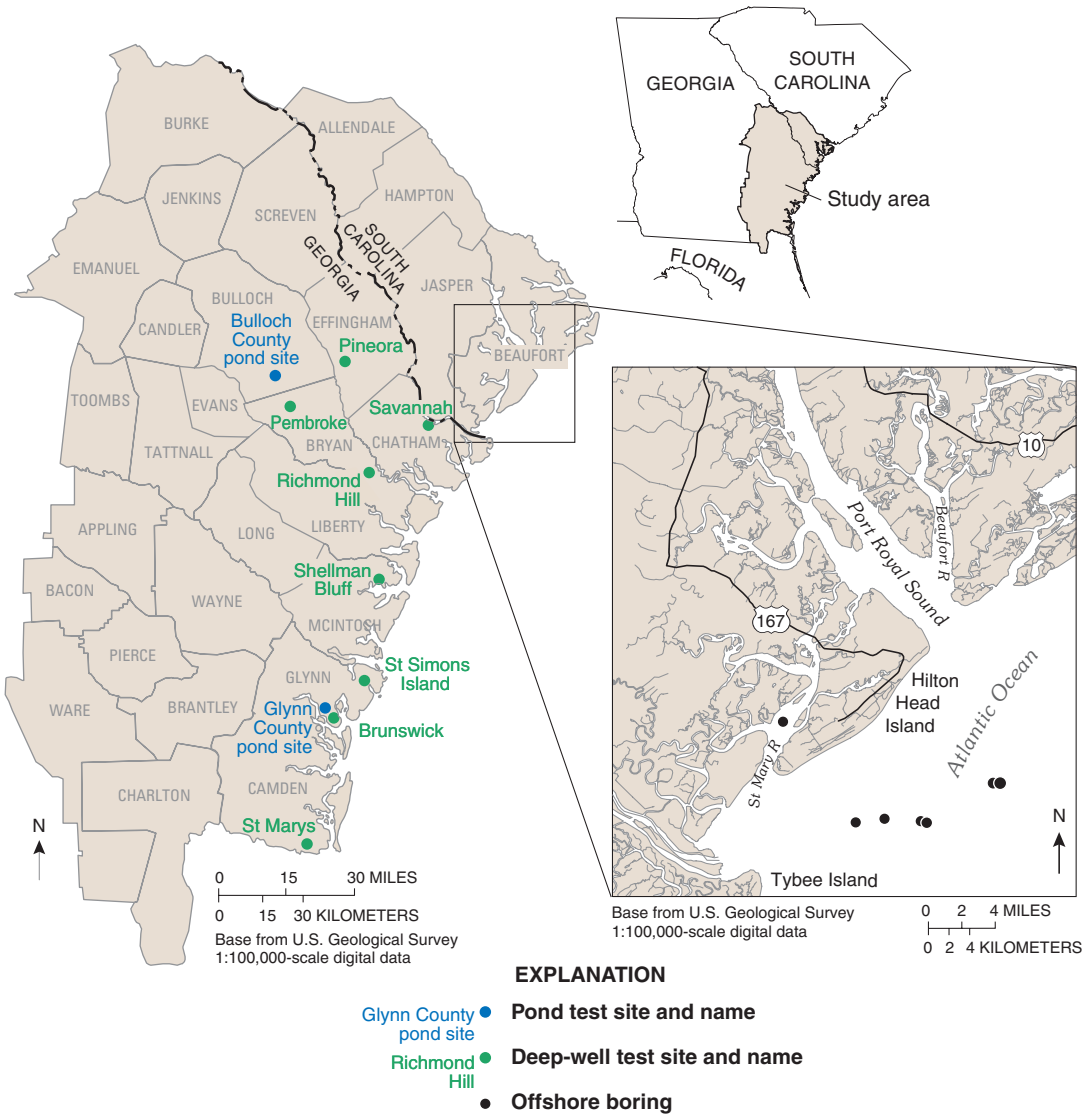

Figure 1. Coastal Sound Science Initiative study area and location of offshore drilling sites, deep test wells, and pond test sites.

- Studies conducted at *seepage pond test sites* in Glynn and Bulloch Counties, Georgia, indicate that excavated seepage ponds may provide small quantities of water for irrigation supply, with quantities limited by pond-storage volume and low net groundwater seepage rates during periods of low precipitation. Maximum estimated rates of groundwater seepage during pond-pumping tests conducted at each site ranged from 15 gallons per minute (gal/min) at the Bulloch County pond to 103 gal/min at the Glynn County pond. Pumps withdrawing 1,000 gal/min for 10 hours per day eventually would drain each pond under dry conditions similar to those observed during the pond-pumping tests—at the Glynn County site, the pond would drain within 30 days; at the Bulloch County site, the pond would drain within 3.5 days.

- *Compilation of aquifer test and laboratory analyses* indicates that hydraulic properties of the Floridan aquifer system are highly variable because of the heterogeneity and degree of confinement of the aquifer system.

  - Transmissivity of the Upper Floridan aquifer is lowest within and north of the Gulf Trough, a geologic feature characterized by low-permeability deposits (generally less than 10,000 feet squared per day [ft^2/d]), and highest in the lower Coastal Plain, where the aquifer consists of carbonate rock (greater than 20,000 ft^2/d, with some values exceeding 100,000 ft^2/d in the southeastern part of area).

- In the Lower Floridan aquifer, transmissivity also is low in the area north of the Gulf Trough, where clastic sediments comprise the aquifer (generally less than 10,000 ft^2/d), and highest in the lower Coastal Plain where the aquifer consists of carbonate rock (values exceeding 10,000 ft^2/d, with some values exceeding 100,000 ft^2/d in the southeastern part of the area).

- *Assessment of stream-aquifer interaction* using hydrograph separation indicates that mean-annual baseflow during 1971–2001 at 14 streamflow sites ranged from 39 to 74 percent of annual streamflow, with a higher percentage of groundwater contribution during the drought years of 1981 and 2000. Baseflow estimates also indicate that in a given year, baseflow contribution generally is greater in the upper parts of stream basins than in lower parts. Baseflow estimates during 1971–2001 indicate that groundwater recharge probably ranged from 4.4 to 10 inches per year.

- *Digital groundwater models* are a crucial tool used for synthesizing field data and characterizing groundwater flow and localized saltwater intrusion in the Savannah, Georgia – Hilton Head Island, South Carolina, and Brunswick, Georgia areas.

  - A regional groundwater flow model using MODFLOW2000 (Harbaugh and others, 2000) encompasses an area of about 42,000 square miles in coastal Georgia, South Carolina, and Florida. This model simulates flow in the Brunswick aquifer system and in the Upper and Lower Floridan aquifers.

  - A saltwater transport model for the Savannah–Hilton Head Island area, using SUTRA2D/3D (Voss and Provost, 2002) simulates seawater entering the Upper Floridan aquifer in areas where the overlying confining unit is thin or has been breached.

  - Saltwater transport models for the Brunswick area using SUTRA2D/3D simulate various working hypotheses for transport of in situ saltwater from deeper parts of the Lower Floridan aquifer upward into the main permeable zones of the Upper Floridan aquifer.

  - Several hypothetical pumping scenarios have been simulated using models to provide insight into the regional and local characteristics of the groundwater flow system.

The Coastal Sound Science Initiative is described in more detail at *http://ga2.er.usgs.gov/coastal/*, which includes a listing of project reports and links to online publications. Information from this study is being using by the State of Georgia to manage water resources while considering the effects of saltwater contamination on coastal groundwater resources, thereby helping the State evaluate the consequences of various water-use alternatives. Knowledge gained from this study also can be used to better understand the complex processes of saltwater intrusion and the effects of water withdrawal on coastal water resources in other parts of the Nation.

LITERATURE CITED

Harbaugh, A.W., E.R. Banta, M.C. Hill, and M.G. McDonald. 2000. MODFLOW-2000, The U.S. Geological Survey modular ground-water model—User guide to modularization concepts and the ground-water flow process: U.S. Geological Survey Open-File Report 00-92, 121 pp.

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