

PARALLEL DEVELOPMENT OF MODFLOW AND SUTRA MODELS IN COASTAL GEORGIA, SOUTH CAROLINA, AND FLORIDA: AN APPROACH TO STUDY REGIONAL GROUND-WATER FLOW AND LOCAL SALTWATER INTRUSION

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Abstract. To characterize regional ground-water flow and localized saltwater intrusion, the U.S. Geological Survey (USGS), in cooperation with the Georgia Department of Natural Resources, Environmental Protection Division (GaEPD) is developing regional-scale ground-water flow models and variable-density flow and solute-transport models for coastal Georgia, and adjacent parts of South Carolina and Florida. The objectives of these models are to predict the effects of future changes in pumping on (1) the regional ground-water-flow system and (2) saltwater intrusion in localized areas where it has been observed or has the potential to occur.

Two regional-scale models are being developed concurrently—one will use MODFLOW (Harbaugh and others, 2000; Hill and others, 2000) to simulate flow, and the other will use SUTRA (Voss and Provost, in press) to simulate flow and variable-density solute transport. The regional models encompass a 37,300-square-mile (96,600 square kilometers) area in Georgia, South Carolina, and Florida (Fig. 1). The MODFLOW model is discretized into 3,803 active cells, each 9.7 square miles (25 square kilometers) (Abu Rumman and Payne, 2003); the SUTRA model is discretized into 4,422 active elements, each roughly 8.5 square miles (22 square kilometers).

The concurrent development of the regional-scale models is facilitated by the use of a common GIS-based interface and is designed to take advantage of the strengths of the two simulation codes used. MODFLOW is a constant-density flow simulator that is widely used and offers integrated parameter-estimation and sensitivity-analysis tools that facilitate model calibration. SUTRA is capable of explicitly simulating the effects of variable fluid density on the position and movement of the saltwater-freshwater interface. Accordingly, model calibration is performed primarily using the MODFLOW model; the SUTRA model is used to assess the effects of variable-density flow on the boundary conditions

used in the MODFLOW model, particularly the condition used to represent the predevelopment, offshore saltwater-freshwater interface.

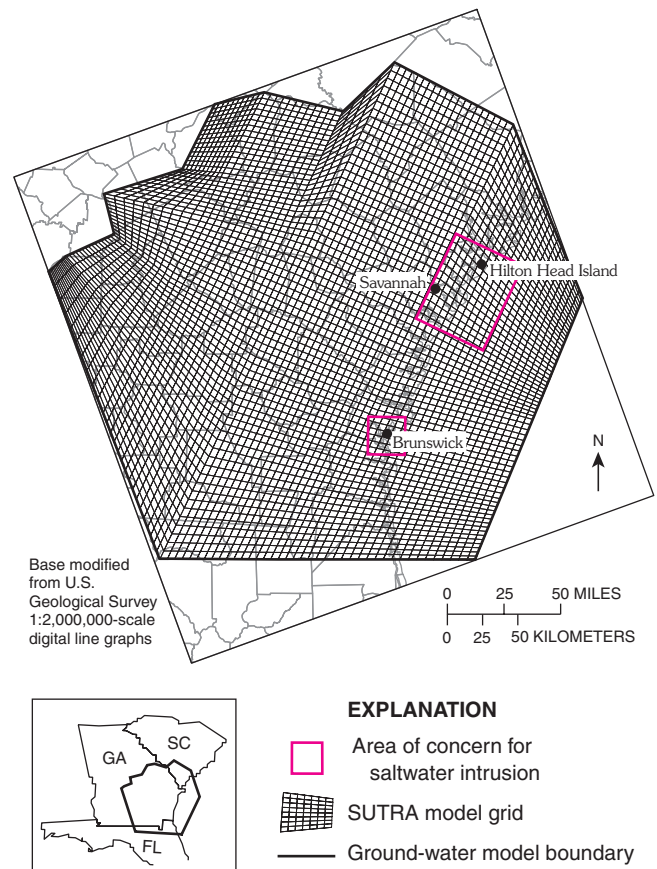


Figure 1. Coastal ground-water model area, including the SUTRA model grid and model boundary.

After the two regional-scale models are developed and calibrated with sufficient consistency, the SUTRA model will be modified by increasing grid density in the areas of greatest concern for saltwater intrusion (in the areas of Savannah-Hilton Head Island and Brunswick), and by decreasing grid density outside of these areas. The results will be used to specify boundary conditions for the local-scale transport models.

LITERATURE CITED

- Abu Rumman, Malek, and D.F. Payne. 2003. Preliminary results of the regional MODFLOW ground-water flow model of coastal Georgia and adjacent South Carolina and Florida. *In* Proceedings of the 2003 Georgia Water Resources Conference, April 23–24, 2003, K.J. Hatcher (ed.), Institute of Ecology, The University of Georgia, Athens, Ga.
- 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.
- Hill, M.C., E.R. Banta, A.W. Harbaugh, and E.R. Anderman. 2000. MODFLOW-2000, The U.S. Geological Survey modular ground-water model—user guide to the observation, sensitivity, and parameter-estimation processes and three post-processing programs. U.S. Geological Survey Open-File Report 00-184, 209 pp.
- Voss, C.I., and A.M. Provost. In press. SUTRA—a model for saturated-unsaturated variable-density ground-water flow with solute or energy transport: U.S. Geological Survey Water-Resources Investigations Report 02-4231.