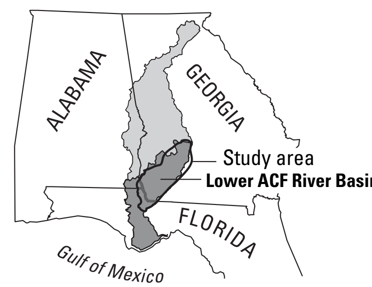
Hydrogeologic Assessment and Simulation of Stream-Aquifer Relations in the Lower Apalachicola–Chattahoochee–Flint River Basin



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Year Started 2000

Problem

Current hydrologic information and ground-water-flow modeling in the lower Apalachicola–Chattahoochee–Flint (ACF) River Basin (inset map) are insufficient to describe effects of time-variant irrigation pumping on streamflow. Therefore, existing models cannot accurately predict ground-water or streamflow conditions during a growing season. The Georgia Department of Natural Resources, Environmental Protection Division (GaEPD) has implemented a hydrologic assessment of the Upper Floridan aquifer in southwestern Georgia to obtain new information and to further understanding of stream-aquifer relations and the effects of ground-water pumping on streamflow in a karst hydrologic setting. The U.S. Geological Survey has engaged in a cooperative effort with GaEPD to develop a ground-water-flow model that can account for stream-aquifer interaction and streamflow reduction caused by agricultural pumping. Information obtained from the model is vital to the State's management of ground-water resources and for providing early indication of low-streamflow conditions that would affect delivery of water to downstream, out-of-state users.

Objectives

- Develop new data for the stream-lake-aquifer system by evaluating well-drilling and aquifer-test information.
- Obtain accurate locations of pumped wells for municipal, industrial, and irrigation purposes.
- Collect and compile ground-water-level, stream-seepage, and off-stream spring-discharge data.
- Synthesize newly collected and existing hydrologic data into a transient finite-element model of ground-water flow that can simulate seasonal ground-water levels, stream-aquifer interaction, and pumpage-induced streamflow reduction, and assess the sensitivity of streamflow to ground-water pumping.

Progress and Significant Results, 2004–2005

Development of hydrogeologic framework revealed that:

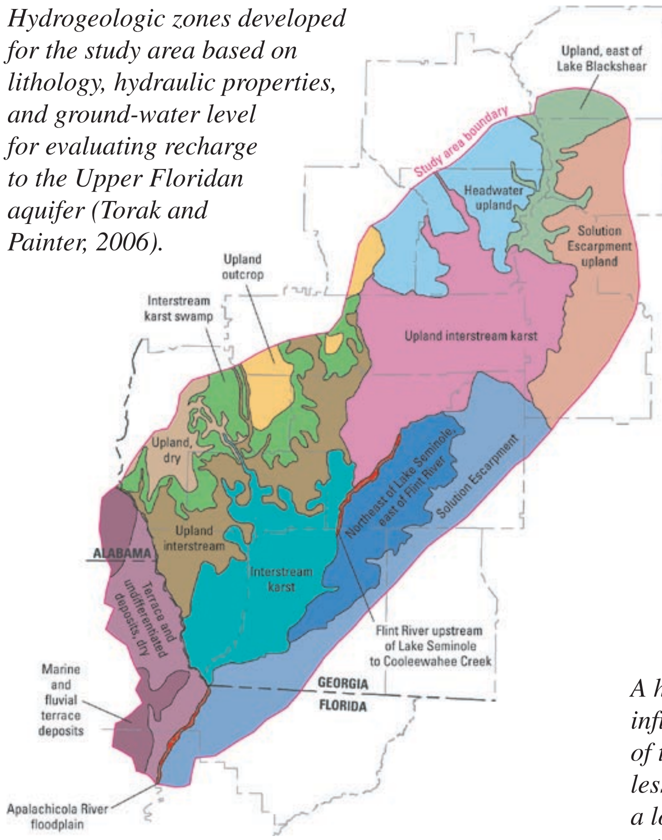
- Recharge to the Upper Floridan aquifer occurs by vertical leakage through a thin veneer of residuum or surficial deposits located in the outcrop areas of the Upper Floridan aquifer along the northwestern basin boundary and in the northern and central parts of the Dougherty Plain (recharge map, facing page).
- Sparse data defining the lithology, hydraulic properties, and ground-water level of the upper semiconfining unit limits the description of recharge to the Upper Floridan aquifer to the delineation of hydrogeologic zones and a general temporal distribution of saturated proportions of total thickness (hydrogeologic zone map, facing page).
- Large variations in hydraulic conductivity of the Upper Floridan aquifer exist at regional scales in the lower ACF River Basin; equally large variations at the local scale are inferred from descriptions of lithologic heterogeneity of limestone penetrated by closely spaced wells.
- Overpumping the Upper Floridan aquifer in specific areas of the lower ACF River Basin can have negative hydrologic effects on the Upper Floridan aquifer basinwide, such as ground-water-level decline, aquifer dewatering, reduced regional (intrabasin) flow and reduced interbasin flow to the east and south (hydrograph, facing page).
- Negative effects of increased pumping can occur where ground-water resources are limited or inadequate to sustain pumpage increases, such as in outcrop areas of the aquifer and downdip, along the Solution Escarpment, where diminished recharge from the outcrop area reduces intrabasin flow.

Model of ground-water flow with stream-aquifer interaction in the Upper Floridan aquifer included:

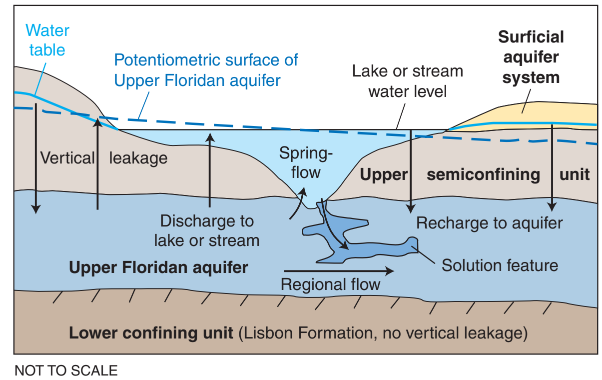
- Simulated pumpage at 3,280 irrigation, municipal, and industrial wells tapping the Upper Floridan aquifer; ground-water and surface-water exchange along 36 streams; recharge by direct infiltration and vertical leakage, and discharge to the upper semiconfining unit; and regional flow across model and basin boundaries.
- Calibration to October 1999, steady-state drought conditions using 275 measured ground-water levels and streamflow gains and losses along 53 reaches.
- Simulated transient conditions of March 2001–February 2002 containing time-varying irrigation pumpage, stream and lake stage, upper-confining unit water level, and recharge by direct infiltration to the Upper Floridan aquifer.

Reference Cited

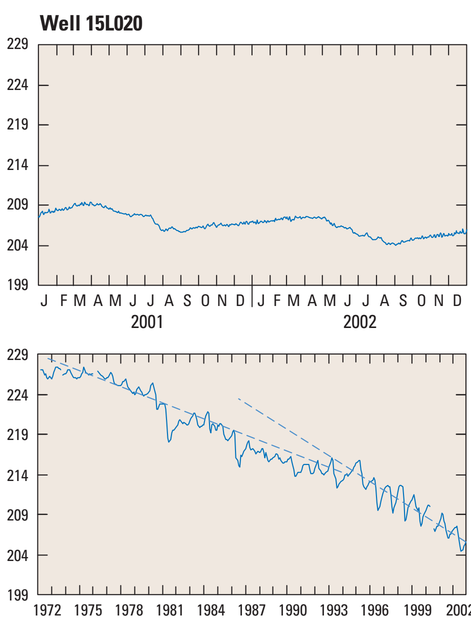
Torak, L.J., and Painter, J.A., 2006, Geohydrology of the Lower Apalachicola–Chattahoochee–Flint River Basin, southwestern Georgia, northwestern Florida, and southeastern Alabama: U.S. Geological Survey Scientific Investigations Report 2006-5070, 67 p. and interactive map, Web-only publication available at *http://pubs.usgs.gov/sir/2006/5070/*.



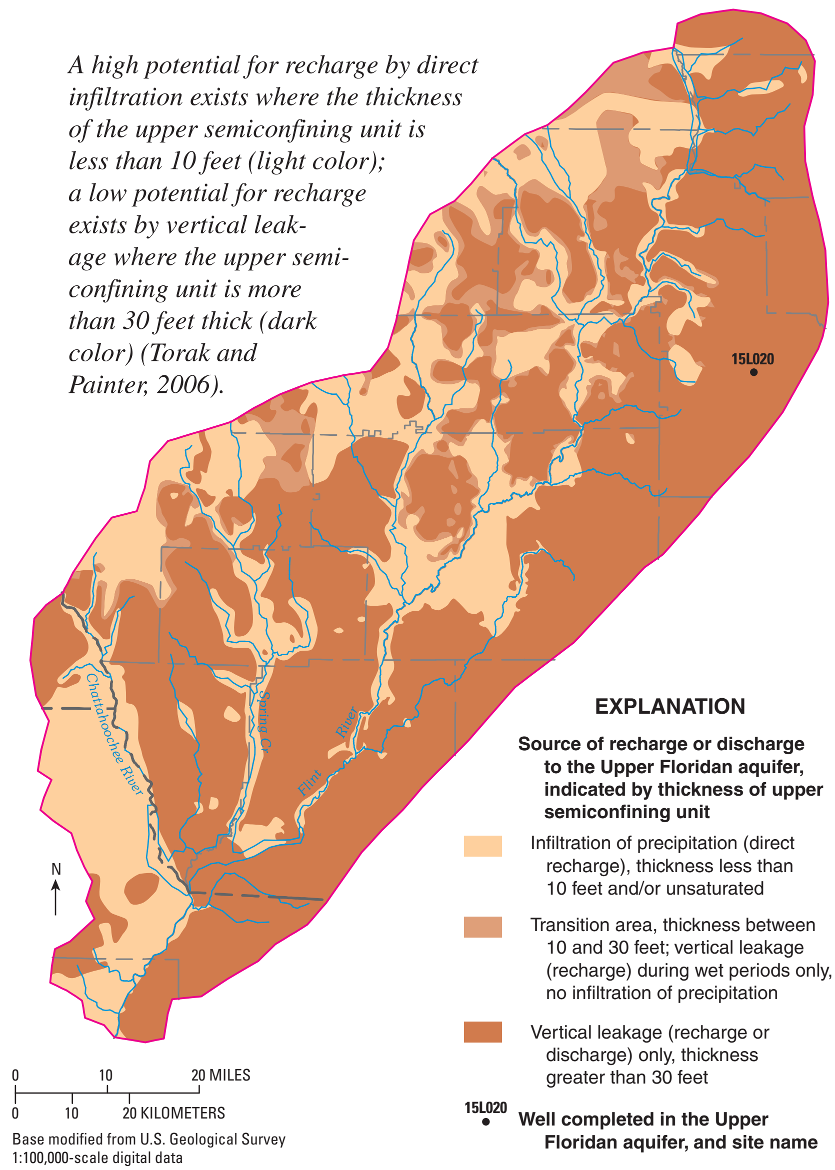
Hydrogeologic zones developed for the study area based on lithology, hydraulic properties, and ground-water level for evaluating recharge to the Upper Floridan aquifer (Torak and Painter, 2006).



Conceptual diagram of ground-water and surface-water flow showing the interconnected stream-lake-aquifer flow system of the lower Apalachicola–Chattahoochee–Flint River Basin (Torak and Painter, 2006).



Hydrograph for well 15L020 showing long-term, regional ground-water-level decline of more than 25 feet since the advent of center-pivot agricultural irrigation in the mid-1970s (Torak and Painter, 2006).



A high potential for recharge by direct infiltration exists where the thickness of the upper semiconfining unit is less than 10 feet (light color); a low potential for recharge exists by vertical leakage where the upper semiconfining unit is more than 30 feet thick (dark color) (Torak and Painter, 2006).