South Carolina Coastal Plain Groundwater Availability Model – An Update

Bruce Campbell, Greg Cherry, Jason Fine
US Geological Survey – South Atlantic Water Science Center

Alex Butler and Joe Gellici
South Carolina Department of Natural Resources
“A comprehensive ground-water flow model of the Coastal Plain should be developed and used to predict the effect of future pumping and to determine optimal well spacing's.”
USGS Groundwater Resources Program – Started in 2004

Groundwater Flow Model of the Atlantic Coastal Plain of NC, SC, eastern GA, southern VA

- Calibrated to 2004 conditions
- Revised hydrogeologic framework
- Analysis of GW monitoring networks
- Climate change predictions
Groundwater Model Area

Model Area

EXPLANATION

- GW Model Area Boundary
- Grid Outline

Sources: Esri, HERE, DeLorme, USGS, Intermap, Incremental P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, & OpenStreetMap contributors, and the GIS User Community.
Primary inputs:
- Model Grid
- Hydrogeologic Framework
- Aquifer Properties
- Observation Data
- Boundaries
- Wells – Water Use Data

Primary Outputs:
- Groundwater Levels
- Budgets

Representative GW Flow Model
Focus Area Study / SCDNR Model Update

Combines funding sources:

- Internal USGS Water Census Program / Focus Area Study
- Cooperative funding from South Carolina Department of Natural Resources/USACOE
- Cooperative funding from South Carolina Department of Health and Environmental Control

1) Water Census Program / Focus Area Study:

- Internal USGS funding from the SECURE Water Act
- Southeastern Atlantic Coastal Basins of the Carolinas

2) SCDNR/USACOE Project

Funding to expand groundwater model area to include all of the SC Coastal Plain
Coastal Plain Issues

• Increase in Atlantic Coastal Plain population
• Increased demand on groundwater resources
• Groundwater quality issues
• Increased agricultural withdrawals
• Impact of increased groundwater withdrawals on surface water flows
Objectives

- Overall update the 2010 groundwater flow model
- Activating the entire surficial aquifer model layer
- Recharge from SWB Model
- Adding recent groundwater-related data (2005-2015)
- Refine the model grid from 2 x 2 miles to 2,000 x 2,000 ft
- Incorporate a more detailed representation of the Fall Line area
- Incorporate new MODFLOW packages – Newton Formulation, Multi-Node Well Package, SFR2 Package, etc
- Variable-density offshore boundary
- Re-calibration, and apply the model to a series of 6 scenarios
Figure 1. Generalized hydrogeologic framework of the South Carolina Coastal Plain (Gelciki and Larue, 2000).

Figure 4. Approximate extent of the Upper Floridan aquifer and confining unit, as used in this report.
GWRP Model Grid
10,560 ft x 10,560 ft
Model Update Grid
2,000 ft x 2,000 ft
Simulated Groundwater Level Contours for the Surficial Aquifer
25-ft contour interval
Aiken County Area Surficial Aquifer
Aiken County Area
Gordon Aquifer
Aiken County Area
Crouch Branch Aquifer
Well Locations -
Public Supply
Irrigation
Other
Simulated Surface Water

Locations of Stream gages and basins
A) South Carolina groundwater use, 1983-2016;

Source of Data - SCDHEC
Questions for Stakeholders

- How do you see your future groundwater use changing?
- Do you currently have groundwater-use issues?
- Are you seeing surface water flow problems that could be related to groundwater declines?
- Are you dealing with groundwater quality problems – such as radium or man-made contaminates?
- Do you know the age of your groundwater?
Model Uses

- Water Resources Planning
- Evaluate New Well Permits by Regulatory Agencies
- Simulate Potential Future Climate Variability
Model Scenarios

• Six scenarios
• Will be determined by the State Cooperators
• Will involve additional potential future withdrawals
• Climate variability
• Projected land use changes
Questions?

bcampbel@usgs.gov
803-750-6161
Updates to GWRP Model

- MODFLOW-NWT
- Activate surficial layer
- SWB net recharge
- SFR2 – surface water simulation
- MNW2 – Multi-node well package for SC water-use wells
- SWI2 – Offshore variable density boundary
- New observations – GW levels and baseflows
- Include crystalline rock below Coastal Plain sediments
Report Planning – USGS SIR

- Will split report sections among 4 authors
- Data release and Model Archive
- Report figures
- Use PP 1773 Chapter C as template and update
- Have been looking for reviewers – 1 positive response
- SWB – separate report or Section/Appendix in model report?
Connect to Other FAS Models

• Expect to need some help with this
• Will have georeferenced GW model outputs – water levels and budgets
• Can run “scenarios” with GW model for inputs into Decision Support System(s).
• SCDNR will help conceptualize scenarios
Updates Since Last Review

• Groundwater model is ~ 90% calibrated
• Will finish parameter estimation in the next few weeks
• “Polish” with some trial and error work
• Getting drawdowns in confined aquifers - problematic
• Match on baseflows – better than expected
• Surficial aquifer simulation is good – MODFLOW-NWT
• Spoken about GW modeling effort at numerous forums
• Lot’s of public and advocacy group interest
Coastal Plain Hydrogeologic Framework

Generalized hydrogeologic framework of South Carolina along dip.

Aquifer
Confining unit

This report
Upper Three Runs and updip Gordon aquifers
Downdip Gordon aquifer
Upper Floridan and Middle Floridan aquifers
Crouch Branch aquifer
McQueen Branch and Charleston aquifers
Gamling aquifer

Aucott and others (1987)
Tertiary sand aquifer (upper part)
Tertiary sand aquifer (lower part)
Floridan aquifer system
Black Creek aquifer
Middendorf aquifer
Cape Fear aquifer

not drawn to scale