GAM run 05-04

by Ali H. Chowdhury
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 936-0834
Jan. 23, 2005

REQUESTOR:

Mr. Larry Land and Mr. David O'Rourke, HDR Inc., and Mr. James Beach, LBG-Guyton Inc., on behalf of Regions L and N and Region H, respectively.

DESCRIPTION OF REQUEST:

The official groundwater availability model (GAM) of the central part of the Gulf Coast aquifer (Chowdhury and others, 2004) can not be used to assess the effects of fully-penetrating wells in the Evangeline aquifer. Chowdhury and others (2004) adjusted hydraulic conductivities in the Evangeline aquifer to account for the partial penetration of most of the existing wells to simulate measured water-level declines in the Wharton County and Kingsville areas. Based on conversations with TWDB staff, HDR Inc. and LBG-Guyton Inc. requested the best-calibrated version of the model that was not adjusted for partial penetration so that they could evaluate water management strategies that involve well fields with wells that fully penetrate the Evangeline aquifer. TWDB staff believe that the best-calibrated version of the fully-penetrating model can be used to estimate water-level declines for these projects.

METHODS:

The best-calibrated version of the fully-penetrating model was calibrated using trial and error to best match water levels for pre-development conditions and for water levels from 1980 through 1999. This model uses distributed hydraulic conductivity values for the Evangeline aquifer obtained from the draft report submitted by Waterstone (2003). The official GAM of the central part of the Gulf Coast aquifer uses zoned hydraulic conductivity to account for partial penetration (Chowdhury and others, 2004).

PARAMETERS AND ASSUMPTIONS:

The best-calibrated version of the fully-penetrating model uses the same hydraulic conductivity, vertical leakance, pumping, and all other calibration parameters as used in the model developed by Chowdhury and others (2004) with the exception of the hydraulic conductivity of the Evangeline aquifer. Here, we have used distributed hydraulic conductivity values of the Evangeline aquifer.

RESULTS

The calibrated version of the fully-penetrating model reasonably reproduces spatial distribution of the water levels in most of the model area with groundwater flowing west to east from the outcrop towards the Gulf of Mexico (Figures 1 and 2). Water-level residuals that record the spatial distribution of the calibration error indicate that the residuals are small (a good fit) in most of the central portion of the model area for the Chicot and the Evangeline aquifers for 1989 (Figure 3). However, the water-level residuals increase (a poorer fit) in the northern and the southern portions of the model area (Figure 3). The root mean squared error (RMSE) that quantifies the average error in the calibration lies within ten percent of the hydraulic-head difference across the model area (Figure 4). Simulated water levels are largely overestimated in the drawdown areas both in 1989 and 1999 (Figure 4). As expected, the model performs better in pre-development times when there was little pumping (Figure 4).

The water budget for the end of the transient calibration in1999 for this model is presented in Table 1. A comparison of this water budget to the water budget for 1999 reported by Chowdhury and others (2004) suggests that changes to the hydraulic conductivity in the Evangeline aquifer results in less hydraulic interaction between the streams and the aquifer resulting in a decrease in flow from and to the aquifer. For example, the net inflow of the stream water into the aquifer reported by Chowdhury and others (2004) was 518,498 acre-ft/yr while in this version of the model the net inflow is 452,671 ac-ft/yr. A proportionate reduction in outflow is also observed in the results from this model. An increase in hydraulic conductivity in the Evangeline aquifer also causes an increase in flow to the Gulf of Mexico.

Table 1. Water budget for 1999.

Flow term	in (ac-ft/yr)	in (percent)	out (ac-ft/yr)	out (percent)
Storage	259,413	28	21,085	2
Constant head	0	0	0	0
Pumping	0	0	424,973	46
Drains	0	0	2,158	0
Recharge	182,910	20	0	0
Evapo-transpiration	0	0	19,726	2
Lakes	21,894	2	0	0
Gulf of Mexico	1,236	0	91,701	10
Streams	452,671	49	358,478	39
Total	918,124	100	918,121	100

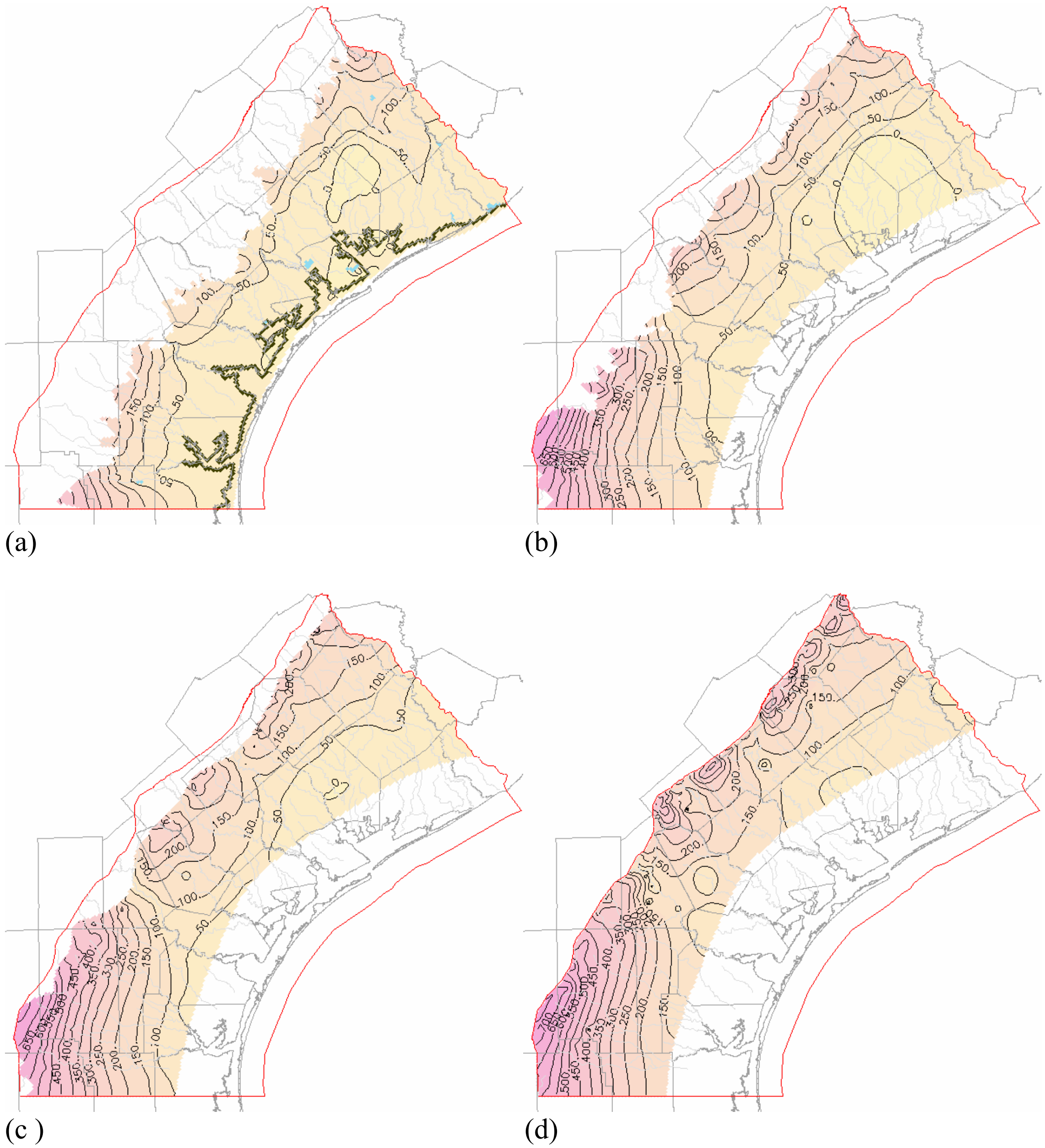


Figure 1. Simulated water levels in 1989 for the (a) Chicot aquifer, (b) Evangeline aquifer, (c) Burkeville Confining System, and (d) Jasper aquifer.

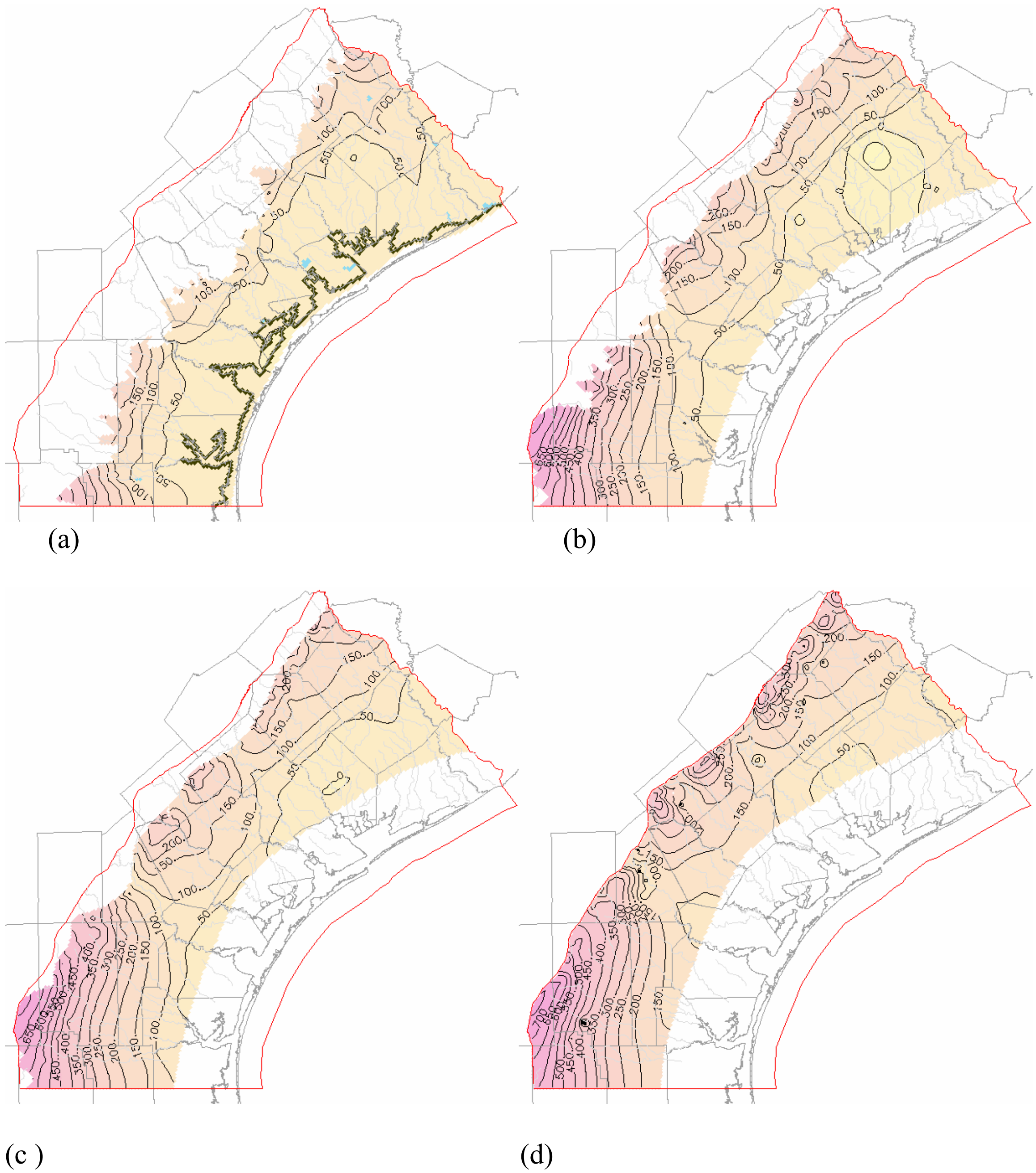
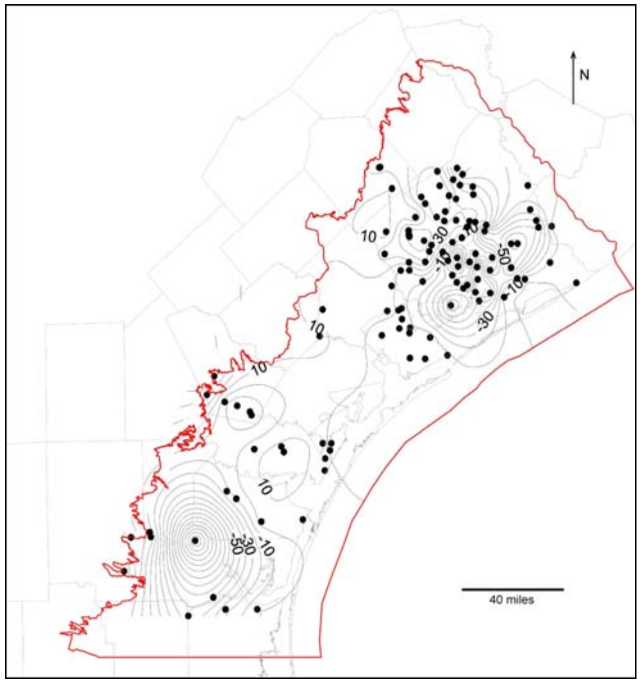


Figure 2. Simulated water-levels in 1999 for the (a) Chicot aquifer, (b) Evangeline aquifer, (c) Burkeville Confining System, and (d) Jasper aquifer.

(a)



(b)

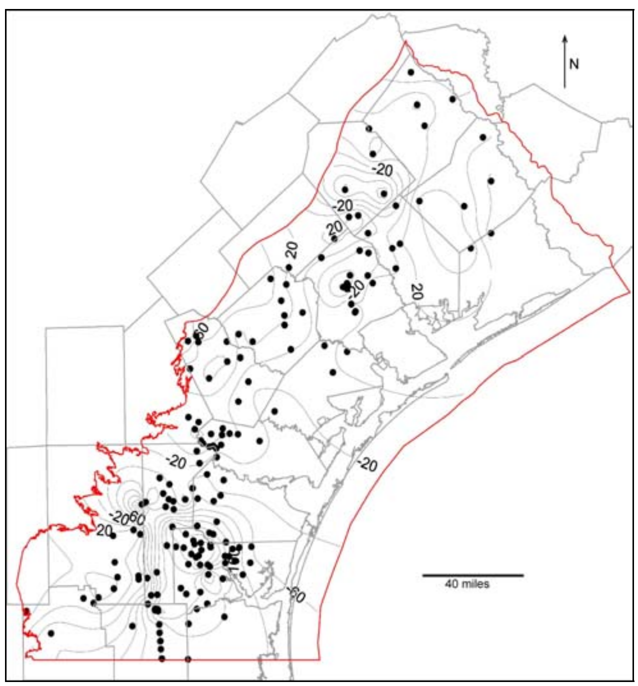
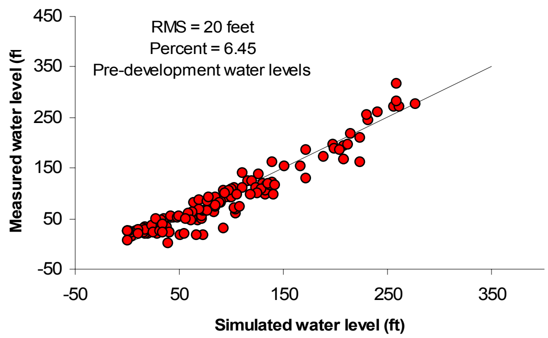
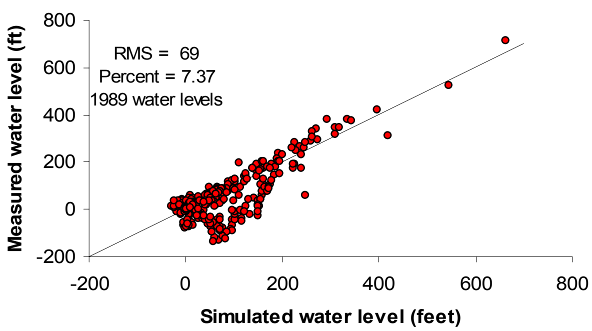


Figure 3: Water-level residuals (measured values minus simulated values) for 1989 in the (a) Chicot and (b) Evangeline aquifers. Closed circles represent well control points where water-level residuals were calculated. We contoured water levels using the Point Kriging method in Surfer. Water-level contours are at 10 feet intervals for the Chicot aquifer and at 20 feet intervals for the Evangeline aquifer. Extent of the Chicot and the Evangeline aquifers within the model area are shown in red.

(a)



(b)



(c)

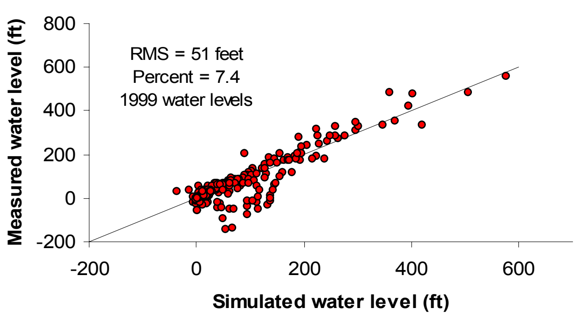


Figure 4. Plot of measured and simulated water levels for (a) the pre-development model, (b) the transient model in 1989, and (c) the transient model in 1999. Note that the model overestimates water levels in a large number of wells in Kleberg County, an area with large measured water-level declines. In the rest of the model area, the fit between the measured and simulated water levels is reasonable.

LIMITATIONS

This version of the GAM for the central part of the Gulf Coast aquifer represents the full vertical extent of the Evangeline aquifer. <u>This model should only be used to evaluate drawdowns from fully penetrating wells in the Evangeline aquifer.</u>

A regional flow model constructed with a grid size of one mile by one mile is best suited to answer regional-scale groundwater issues such as predicting aquifer-wide water-level fluctuations under various pumping or recharge conditions. The model in its current state may not predict water-level declines around a single well in a community. The model relies on estimates of aquifer properties and stresses and the small-scale spatial variability in storativity and/or hydraulic conductivity present in the aquifer could not be translated to the scale of the model. The predicted water–level declines should, however, be accurate at the scale of tens of miles when a group of wells or water levels in an entire county is considered. This model, like most groundwater models, is more appropriate to determining relative changes to water levels from application of pumpage reflecting varying water-management scenarios rather than assessing actual water–level elevations.

REFERENCES:

Chowdhury, A. H., Wade, S., Mace, R., E., and Ridgeway, C., 2004, Groundwater availability model of the central Gulf Coast Aquifer System: Numerical simulations through 1999, Texas Water Development Board, Model Summary Report, 113 p.

Waterstone, 2003, Groundwater availability of the central Gulf Coast aquifer—Numerical simulations to 2050, Central Gulf Coast, Texas: contract draft report submitted to the Texas Water Development Board, Austin, Texas, variously paginated.