U.S. Department of the Interior
U.S. Geological Survey

Scientific Investigations Map 3465

Introduction

Regional aquifers in the Mississippi embayment (fig. 1) are the principal sources of water used for public and domestic supply, irrigation, and industrial uses throughout the region. An understanding of how water quality varies spatially, temporally, and with depth are critical aspects to ensuring long-term sustainable use of these resources. A boosted regression tree (BRT) model (Kuhn and Johnson, 2013) was used by the U.S. Geological Survey (USGS) to map water quality in the three regional aquifers with the largest groundwater withdrawals in the embayment: the Mississippi River Valley alluvial (MRVA) aquifer, middle Claiborne aquifer (MCAQ), and lower Claiborne aquifer (LCAQ).

The BRT model was used to predict pH to 1-kilometer raster grid cells for seven aquifer layers (fig. 2; one MRVA, four MCAQ, two LCAQ) following the hydrogeologic framework of the Mississippi embayment aquifer system regional MODFLOW model (Hart and others, 2008). The methods and approach used for pH predictions are the same as those used to predict specific conductance and chloride in the aquifers (Knierim and others, 2020). Explanatory variables for the BRT models included variables describing well location and construction, surficial variables such as soil properties and land use, and variables extracted from the groundwater flow model, such as groundwater levels and ages (Haugh and others, 2020). The primary source of pH data was the USGS National Water Information System (NWIS) database (U.S. Geological Survey, 2017); additional data from State ambient groundwater monitoring programs and the Safe Drinking Water Information System also were used (Kingsbury and others, 2020). For wells sampled multiple times, the most recent sample was used. Because groundwater residence times are long (greater than 100 years) throughout much of the study area (Kingsbury and others, 2014), the possible effects of changes in water quality over time were considered small compared to the improvement in overall model accuracy by using available historical data. To maximize the data coverage throughout the MCAQ, LCAQ, and MRVA aquifer, pH values from 3,362 wells for samples collected between 1960 and 2018 were used as training data for the BRT model. An additional 839 samples were used as holdout data to evaluate model performance. One prediction of pH that spans the period of record was made for each of the layers (fig. 3). The predictive performance of the pH model is lower than for the training dataset, as indicated by an r-squared value of 0.89 for the training data and an r-squared of 0.71 for the holdout data. The root mean squared errors for the training and holdout data are 0.32 and 0.50 standard pH units, respectively. Data generated during this study and the model output are available from Kingsbury and others (2020).

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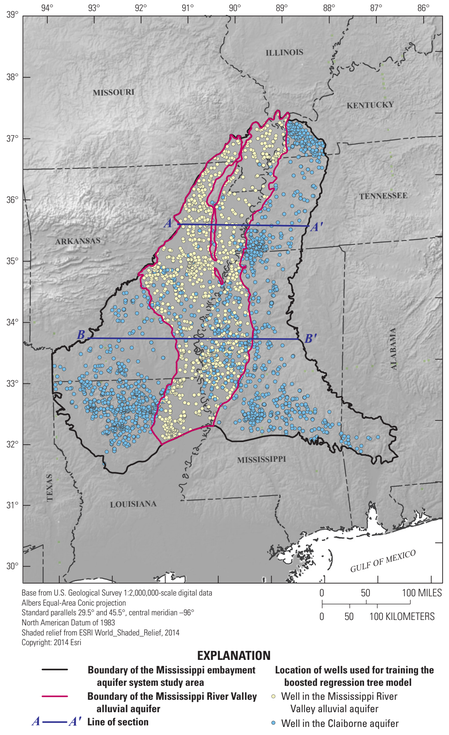

Figure 1. Location of the Mississippi embayment study area and cross sections.

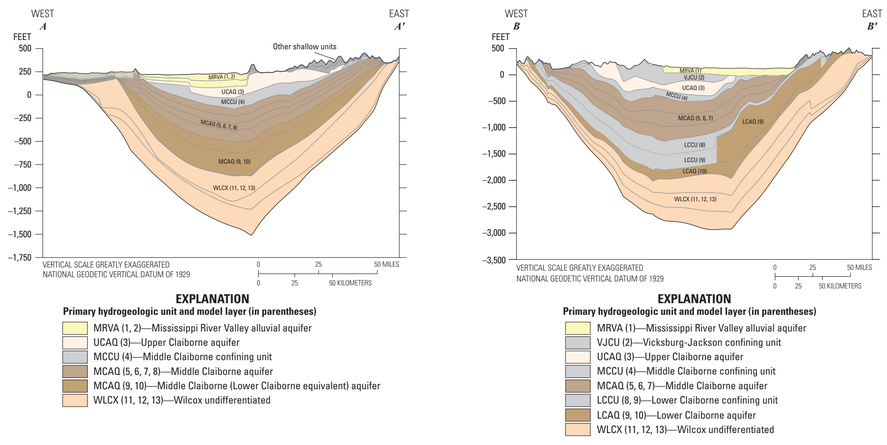

Figure 2. Regional aquifers of the Mississippi embayment and generalized model layers from the groundwater flow model.

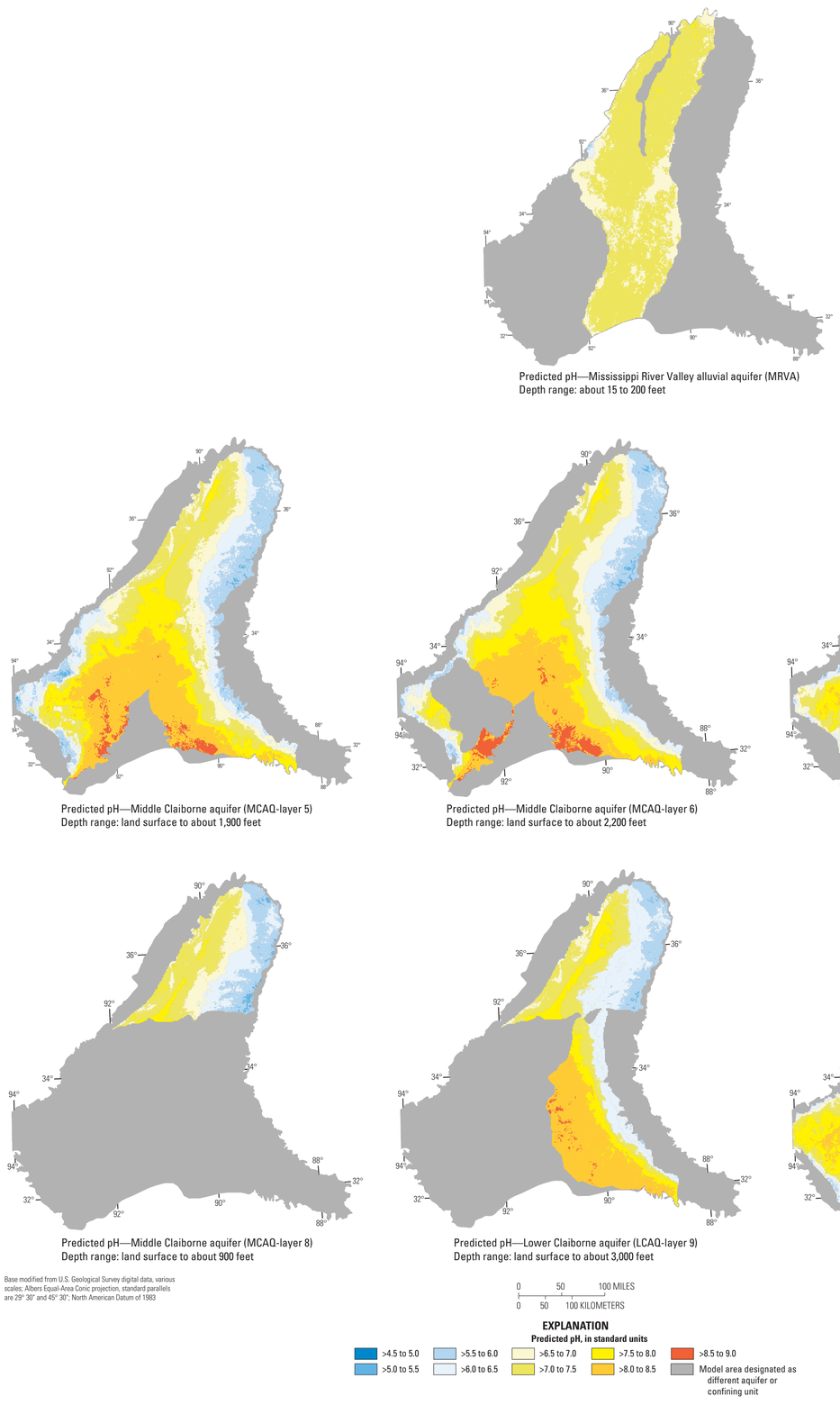

Figure 3. Predicted pH in the Mississippi River Valley alluvial and Claiborne aquifers.

Predicted pH of Groundwater in the Mississippi River Valley Alluvial and Claiborne Aquifers, South-Central United States

By

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