Geophysical Research Abstracts
Vol. 13, EGU2011-4244-4, 2011
EGU General Assembly 2011

Groundwater flow model of the transboundary Guaraní Aquifer System

Leticia Rodriguez (1), Luis Vives (2), Andrea Gomez (1,3), and Stela Dalta Santos Cota (4)

(1) Centro de Estudios Hidroambientales-CENEHA, Facultad de Ingeniería y Ciencias Hídricas, Universidad Nacional del Litoral, CC 217 - 3000 Santa Fe, Argentina (leticia@fich1.unl.edu.ar/ +54 342 4575224), (2) Instituto de Hidrología de Llanuras, Universidad Nacional del Centro de la Provincia de Buenos Aires y Comisión de Investigaciones Científicas de la Provincia de Buenos Aires, Italia 780, 7300 Azul, Provincia de Buenos Aires, Argentina, (3) Consejo Nacional de Investigaciones Científicas y Técnicas - CONICET - Argentina, (4) Centro de Desenvolvimento da Tecnologia Nuclear,Comissao Nacional de Energia Nuclear (CNEN), Brasil

The Guaraní Aquifer System (GAS) is the largest transboundary aquifer system in South America. It extends for some 1200000 km2 over four countries: Brazil, Argentina, Paraguay, and Uruguay. The aquifer is formed by sandstones and confined by basalts in about 90 % of its extent. Sandstones outcrop along aquifer edges, deepening toward the center of the basin, where they can reach a maximum thickness of some 600 m and depths of 2200 m. The GAS contains an enormous volume of water. However, it is not well known, so that it is hard to assess the impact of exploitation. This is a sensitive issue because the aquifer is shared by four countries.

To address this and other issues, the four countries developed the Environmental Protection and Sustainable Development Project for the GAS, a multidisciplinary effort that culminated with a series of technical/management products. One of the outcomes of the project was the regional groundwater flow model for the entire aquifer, presented in this paper.

The GAS was simulated as a single continuous sandstone unit with no flow interactions either with overlaying basalts nor with underlying permic deposits. These conceptual simplifications about the layer structure of the GAS imply an essentially two dimensional flow regime. Moreover, no information was available regarding head variations along the vertical. The code TRANSIN II, which allows automatic parameter calibration, was used in the study.

Recharge was applied in outcropping areas along the aquifer boundaries, while local and regional discharge was simulated through the aquifer boundaries and along numerous stream reaches in contact with the aquifer. The hypothesis that the GAS may discharge through selected reaches along the Uruguay and Paraguay Rivers was also tested. Pumping amounted to 1040 hm^3/year. The calibration strategy consisted on automatically calibrating hydraulic conductivity and recharge rates using 114 measured piezometric levels, aiming at obtaining a good match between simulated and measured levels and conductivity values coherent with the current knowledge of the aquifer.

In this work, five zonations were defined to parametrize conductivity, each producing an alternative conceptual model. The number of zones ranged from one, i.e. homogeneous case, to thirty one.

Simulated piezometric levels were within the calibration target defined according to the quantity and quality of available data. The best fit between measured and simulated levels was obtained for the largest number of conductivity zones. The model water balance indicated that flows through the system are small compared to the water volume in storage and to the annual discharge of the Paraná and Uruguay Rivers.

Calibrated conductivities for all five scenarios were higher in the central region of the modeled area, with values above the range typically expected for sandstones, even considering scale effects. This result would indicate the need for the model to conduct flows in that area through, for instance, a preferential flow zone or a connection with overlying geologic units. Therefore, two additional simulations representing geologic structures were evaluated: first by introducing a hydraulic connection between the GAS and overlying basalts, second by incorporating two regional geologic structures into the thirty one hydraulic conductivity zoning configuration with the aim at reproducing the compartamentalization concept introduced recently by several authors. As a result, calibration errors were reduced, flow patterns modified locally and conductivity values better adjusted to reality.

Despite the significant progress done on the conceptual model, and particularly in the numerical model, it is necessary to continue and deepen the analysis of the geology and structures, as well as recharge and discharge of water flows, to increase the reliability of the conceptual model and therefore the numerical model.