Editor's Message
Lack of a conceptual system view of groundwater resources in Mexico

J. Joel Carrillo-Rivera, Associate Editor

Many hydrogeologists and professionals involved in managing water in Mexico are making evaluations of groundwater resources without a system-wide understanding of the groundwater flow system. Since water users obtain more than 70% of their supply from groundwater in Mexico, an evaluation of the consequences of this is needed. The new generation of specialists should avoid the tendency of hydrologists of the middle 1960s "to solve" groundwater problems by constructing another borehole and by running a pumping test, and calculating a water balance.

One difficulty to overcome is the misconception that some of the Mexican hydrologic community has concerning which scientific methods to employ to solve groundwater problems. Perhaps one example is the well-established groundwater "method", or as Possin (2002) suggests, "the recipe book." This has been standard procedure in many countries, including Mexico, since groundwater studies started in the middle of the 1960s under the name of geohydrology. The "cookbook" approach is in strong conflict with a system-wide view of groundwater resources. Aquifer interpretation based solely on local hydraulic response often is inadequate as it neglects chemical, biological, and geological evidence. For example, Mexico City (one of the largest cities in the world) was partly built on a regional aquifer system from which groundwater is withdrawn to supply most of the city's needs. Early studies of this aquifer attributed all vertical flow to the withdrawal area as inflow from an overlaying aquitard. Recent studies of the hydrogeochemistry (e.g., Edmunds et al 2002) have shown that much of the water beneath the city is old water—several thousand years old—and of good chemical quality. Thus, regional flow at depth is a significant source of inflow to wells in addition to drainage from the overlying aquitard, indicating the importance of a large regional flow system in the area (Tóth 1995).

'We need to seek not to know all the answers, but to understand the question.' This is an old saying that implies both thinking and acting, based on correct observations of the problem, thus allowing formulation of the correct questions (Wood 2001). Hydrogeologists in Mexico must clearly understand and appropriately state the question before recommending the correct solution.

It is difficult to establish a new teaching–understanding methodology because it is in conflict with present educational philosophy in which the Mexican student learns principally the "how-to-do-it" method. There is a pressing need first to observe field response and then to search for an understanding of the observations in order to formulate adequate questions. The profusion of computing facilities, related paraphernalia, and of course, the many challenges to hydrologists caused by an increased need of water, have all led to an inappropriate emphasis on arriving at precise answers. One result has been the creation of more powerful and detailed computer models to represent specific groundwater functioning, although the database for these may not exist yet. Many analytical models have been made available in Mexico since the mid 1960s. In many cases, the use of an analytical model provides values for hydraulic conductivity and storage which might not be dissimilar from those obtained from a numerical model (Rathod and Rushton 1991). However, in the calibration process, values used in a computer groundwater model may be over-adjusted in order to reproduce the observed heads needed to obtain a more-exact answer. Indeed, the important issue here is not the exactness of the obtained answer, but how, in the process of obtaining an answer, are the flows and sources actually conceptualized in the particular answer (model).

Thus, a new approach is needed in Mexico, based on a system-wide view of groundwater. In short, the right questions need to be asked based on an understanding of the flow system, rather than on the value of the hydraulic properties involved.

As a matter of fact, many hydrogeologists, Mexican hydrogeologists included, do not notice this predicament. On the one hand, a data-demanding numerical solution has no chance against the more attractive simple pumping-test analytical solution. On the other hand, elaborate modeling is appealing to those who seek to reach a

Published online: 10 July 2003

J. J. Carrillo-Rivera (✉)
Instituto de Geografia, Universidad Naciona, Autonoma de Mexico,
CU, Circuito Investigadores,
04510 Coyoaca, DF, Mexico
e-mail: cigaihsud@mx.inter.net

 DOI 10.1007/s10040-003-0280-6

solution where the water-balance is the final objective, and not the understanding of groundwater flow. Modeling is a tool required for decision-making as long as the observed facts are appropriately represented in the conceptual model.

It appears that many hydrogeologists in Mexico and elsewhere are encouraged to remain an invisible minority group as postulated by Possin (2002). Yet, this group has an obligation to become more visible in the field. In fact, the need for hydrogeologists with a system-wide groundwater view is evident in Mexico where cases of groundwater misuse are the rule rather than the exception. Answers often provided by more visible professionals using "the cookbook" are generally expensive and highly inefficient as compared with those that could be obtained based on an understanding of the groundwater flow as a system. For example, uncontrolled groundwater withdrawal from shallow depths in San Luis Potosi (north-central Mexico) induces an up-welling flow rich in fluoride and sodium, which has proved to be hazardous for human health and agriculture. An appealing recommendation here (and elsewhere) was to build a water-treatment plant. However, an understanding of groundwater flow system has provided an alternative solution of reduced withdrawals for controlling the up-welling, or take advantage of the chemical reactions that control fluoride solubility, in order to precipitate it before it reaches the abstraction well.

This solution is more economical and more environmentally friendly, although it may have lesser technical appeal (Carrillo-Rivera et al. 2002).

In short, most applied technological answers in Mexico have not been a solution to the observed hydrogeological problems. On the contrary, they often have created additional undesirable effects. There must be a call to the new Mexican professionals, as well as to senior Mexican hydrogeologists to acknowledge that in groundwater flow studies, understanding of the question is more valuable than knowing all the answers.

References

Carrillo-Rivera JJ, Cardona A, Edmunds WM, (2002) Using abstraction regime and knowledge of hydrogeological conditions to control high-fluoride concentration in abstracted groundwater: San Luis Potosi basin, Mexico. J Hydrol 261:24–47

Edmunds WM, Carrillo-Rivera JJ, Cardona A (2002) Geochemical evolution of groundwater beneath Mexico City. J Hydrol 258:1–24

Possin BN (2002) The lost tribe of hydrogeologists? Ground Water Editor 40(4):329–330

Rathod KS, Rushton KR (1991) Interpretation of pumping from two zone layered aquifers using a numerical model. Ground Water 29(a4):499–509

Tóth J (1995) Hydraulic continuity in large sedimentary basins. Hydrogeol J 3–4:4–16

Wood WW (2001) Misperception: a challenge for geoscience. Ground Water (Editorial) 39(1):1

 DOI 10.1007/s10040-003-0280-6