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Editorial

Applied Groundwater Modelling for Water Resource Management and Protection

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Groundwater models are powerful tools for purposes such as quantifying groundwater systems, examining various management scenarios, and for protection against contamination. In the first few decades of the last century, groundwater models have experienced a big leap from analog models, to simple one-dimensional models then three-dimensional regional models with millions of cells/nodes. With the increase in the computational capabilities of computers, groundwater models have become more sophisticated and capable of handling more complex problems than ever.

Analog models appeared long before the development of any analytical or numerical models. Although the analytical flow-to-well solution was developed in 1935 [1], it was not until 1940 that Hubbert [2] provided a clear understanding of flow problems and identified its potential. Toth [3] derived an analytical solution from the problem conceptualized by Hubbert [2]. Freeze and Witherspoon [4,5] developed numerical models, for the first time, for a steady-state hypothetical case. In the 1980s the rapid development of numerical models was achieved due to the increase in computers' capabilities. In the 1990s, the acknowledgment and statistical treatment of uncertainty started to garner attention in numerical modelling. The past twenty years have witnessed advancement in modelling capabilities, with special attention paid to inverse problems and data science. With the increase in big data and their availability, the focus has now shifted to the application of artificial intelligence and data science to train models.

This Special Issue, "Applied Groundwater Modelling for Water Resource Management and Protection", contains nine papers covering various topics and applications of groundwater modelling.

Ramboug et al. [6] used Adaptive Multiscale Triangulation for model inversion in a case study on alluvial aquifers in southern France. The results showed this method produces plausible values of the calibrated parameters, with low standard deviation.

Almuhaylan et al. [7] used an artificial neural network with MODFLOW to test various scenarios of groundwater pumping.

Cui and Hao [8] compared two unstructured grid-refinement methods—quadtree (Q-tree) and nested grid refinement—to simulate groundwater flow under recharging rivers. They found that Q-tree produces higher precision than the nested grid.

Baalousha et al. [9] compared vulnerability assessments using two models—one based on fuzzy logic, and the other using a DRASTIC approach—and compared the results with a contaminant transport model. The results showed that fuzzy logic is likely to produce a better vulnerability map than DRASTIC.

Shawaqfah et al. [10] used GIS and groundwater-flow modeling to assess various scenarios and land suitability for groundwater recharge of treated wastewater. The results identified the most suitable areas for artificial recharge.

Le et al. [11] used a modified DRASTIC model to explore the susceptibility of soil to salinization in the Mekong Delta in Vietnam. They combined the DRASTIC model with anthropogenic indicators to produce a vulnerability map.

Kapoor et al. [12] used a pilot-point approach to calibrate a groundwater model, with a focus on the placement and quantity of the calibration points.

Tabrizinejadas et al. [13] developed a reactive transport model based on the Nernst–Planck and Poisson (NPP) equations, which produced a better representation of the chemical migration. The developed model was validated using comparisons to benchmark problems.

Jacob et al. [14] developed a regional model for Qatar aquifers. Several scenarios were tested to artificially recharge the aquifer.

The above-mentioned studies cover a wide range of modelling applications and tools which, in most cases, are applied to real problems. This demonstrates the usefulness and the power of modelling to solve actual problems, which vary from water resource management to contaminant transport and groundwater protection.

Conflicts of Interest: The authors declare no conflict of interest.

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