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Estimating groundwater pollution source location using neural networks and noisy breakthrough curve data

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Groundwater is a valuable natural resource for the mankind; however in the recent years, more and more aquifers are getting contaminated. It is important to identify the pollution sources in order to take punitive or remedial measures. Identifying the sources causing pollution in the aquifers has been the subject of research for many decades. Traditionally, hydrologists have relied on the conceptual methods for the identification of groundwater pollution sources, which requires a thorough understanding of the groundwater flow and contaminant transport processes and inverse modeling procedures that are highly complex and difficult to implement. Artificial neural networks (ANNs) have been proposed as efficient tools for modeling, forecasting, classification, and control of the complex engineering systems. Recently, some researchers have used ANNs for the identification of pollution sources in aquifers also. The breakthrough curve data available from observation wells are normally erroneous due to various reasons. The ANNs apparently posses the ability to be efficient when presented with noisy information and may be useful in groundwater pollution source identification with data containing measurement and other type of errors.

This paper presents the results of a study aimed at identifying the location of a pollution source from an observation well using ANNs when presented with increasing level of noise in the data. The ANN models were developed using simulated data generated for conservative pollutant transport through a homogeneous aquifer. The feed-forward multi-layer perceptron (MLP) type neural networks trained using the back-propagation training algorithm in incremental mode, were employed in this study. The ANN model consisted of an input layer, one hidden layer, and an output layer. The ob-

served breakthrough curve was presented at the input layer and the output neuron in the output layer represented the distance of the pollution source from the observation well. The observed breakthrough curve consists of 73 concentration values and therefore the ANN model has a structure of 73-N-1. The breakthrough curve data were perturbed by adding noise to assess the ANNs' ability in estimating the distance of the pollution source with increasing level of noise. The results obtained in this study indicate that the performance of the ANN model developed on noisy data in terms of certain standard statistical parameters e.g. correlation coefficient, Nash-Sutcliffe efficiency, average absolute relative error, etc. was comparable to the ANN models developed using accurate data. This study is able to demonstrate that the ANNs offer an exciting alternative to the problem of groundwater pollution source identification with noisy data.