Abstract

The alarming increase in the rate of groundwater contamination has motivated the hydro-geologists to work on identification of groundwater pollution sources. The identification of groundwater pollution sources is the initial step for sustainable management of a groundwater aquifer. The groundwater pollution sources can be identified by using the inverse optimization technique. In this technique, an error function is formulated which minimizes the absolute difference between the observed and the simulated contaminant concentration at observation locations. The observed concentration can be obtained from the field whereas, the simulated concentration is obtained by using groundwater simulation model. Hence, the groundwater simulation model is required to be incorporated to the optimization model. As groundwater simulated model is linked to the optimization model, the technique is called the simulation-optimization model. The model is computationally expensive as the simulation model is repeatedly used by the optimization model. Therefore, the performance of the groundwater source identification model is related to the efficiency of the groundwater simulation model. To overcome this computational burden involved, the artificial neural network (ANN) model can be used as an approximate groundwater simulator. It has been reported that for a large aquifer system, a single ANN model is not sufficient to simulate the flow and transport processes of the aquifer and separate ANN model is required for each of the observation wells to simulate the process. However, use of large number of ANN models will increase the computational complexity of the ANN-based simulation-optimization model. Considering these aspects, an ANN-GA based methodology is proposed for identifying the groundwater pollution sources using optimal number of observation wells. This methodology could successfully identify the pollution sources for large aquifer system. The limitation of this approach is that the number of pollution sources and the locations are known to the problem. However, in real life situation, the number and the locations of the groundwater pollution sources are completely unknown. Henceforth, an iterative based approach using Groundwater Modeling System (GMS) and Genetic Algorithms (GA) has been proposed for identification of groundwater pollution sources where both the source locations and the fluxes are unknown. In this approach, the search process has been initiated considering two pollution sources in the aquifer. The number of pollution sources is then successively increased until the exact number of pollution sources are identified. This algorithm is very efficient in identifying the number of pollution sources.

However, some discrepancies have been seen in prediction of the source fluxes. This is so because the source identification problem is a mixed integer problem comprising discrete variables (source locations) and continuous variables (source fluxes). The genetic algorithm is very efficient in handling discrete variables. On the other hand, the gradient based classical algorithms are efficient in handling the continuous variable problem. Therefore, a modified GA-Gradient based algorithm with a local location search algorithm has been proposed for efficient identification of the number, location and flux of the unknown pollution sources. It has been observed that the efficiency of the algorithm is highly related to the initial solution supplied to the Genetic Algorithms. As such, a methodology has also been suggested for generation of the initial solutions using the information of the velocity field of the aquifer and the observed breakthrough curve. This has enhanced the convergence of the proposed modified GA-Gradient based local search algorithm. The performance of the developed methodologies has been evaluated using different illustrative study areas. After analysing the results, it is seen that the proposed methodologies could effectively identify the groundwater pollution sources.