Optimal Search Strategy for the Definition of a Dense Non-Aqueous Phase Liquid (DNAPL) Source

George Pinder and Zoe Dokou
College of Engineering and Mathematical Sciences, University of Vermont, Burlington, Vermont

Abstract. The overall goal of the research presented here is to develop, test and evaluate a computer assisted analysis algorithm that defines how to achieve an acceptable level of DNAPL source-location accuracy using the least possible number of water quality samples. The search strategy includes a stochastic groundwater flow and transport model that is used to calculate the concentration random field and its associated uncertainty. The model assumes a finite number of potential source locations. Each potential source location is associated with a weight determined using a discrete Choquet Integral that reflects our confidence that it is the true source location. After a water quality sample is selected, an optimization algorithm is employed that finds the optimal set of magnitudes that corresponds to the set of potential source locations. The simulated concentration field is updated using the real data and a Kalman filter. The updated plume is compared to the individual plumes (that are calculated using the groundwater flow and transport simulator considering only one source at a time) employing a fuzzy logic related strategy. The comparison provides new weights for each potential source location. These weights define how the concentration realizations calculated by the stochastic groundwater flow and transport model will be combined. The higher the weight for a specific source location, the more concentration realizations generated by this source will be included in the calculation of the mean concentration field. The steps described above are repeated until the weights stabilize and the optimal source location is determined. The algorithm has been successfully tested using various synthetic example problems and at the Anniston Army Depot (ANAD) in Alabama. The contaminant of interest at the site is trichloroethene (TCE).