Geophysical Research Abstracts
Vol. 13, EGU2011-11678, 2011
EGU General Assembly 2011

Contaminant point source identification by artificial neural network.

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Over the past decades, Artificial Neural Networks (ANN) have become increasingly popular as a problem solving tool and have been extensively used as a forecasting tool in many disciplines.
An ANN consists of a number of interconnected processing elements (Perceptrons) called neurons, which are logically arranged in two or more layers and interact with each other through weighted connections. In particular, the networks Multi Layer Perceptrons (MLPs) used in this work can create a model of a system only on the basis of a suitable set of input/output pairs of example patterns.
The training of the ANN consists in a learning rule that modifies the weights of the connections on the basis of the difference between the calculated output of the network and the desired pattern. The aim of the training is to make the ANN able to generalize the acquired information, i.e. to give the correct output even for examples not included in the patterns of the training set. This aspect is crucial for the application described in this work, because the assumption is to reconstruct the input by inverting the trained ANN. In practice, the network is trained through an input-output relationship. After that, the network is inverted to solve the inverse problem by reconstructing the output-input relationship. In other words, once the output of the system is known, the input is reconstructed by inverting the trained ANN.
The approach is used to identify contaminant point sources (locations and fluxes over time) for groundwater quality problems. It is applied to a real case which deals with the contamination of the Rhine aquifer by carbon tetrachloride (CCl4) due to an accident. This case is well adapted to the problem since numerous concentrations are measured at different piezometers and at different time and the location of the source and the beginning of the contamination are known. The ANN are used to identify the contamination source and the results are compared with the known solution. The ANN appear to be interesting tool for this kind of non-linear optimization problem.