Geophysical Research Abstracts
Vol. 16, EGU2014-773, 2014
EGU General Assembly 2014

Temporal and Spatial prediction of groundwater levels using Artificial Neural Networks, Fuzzy logic and Kriging interpolation.

Evdokia Tapoglou (1), George P Karatzas (1), Ioannis C Trichakis (1,2), and Emmanouil A Varouchakis (1)

(1) School of Environmental Engineering, Technical University of Crete, Greece (karatzas@mred.tuc.gr), (2) Water Resources Unit, Institute for Environment and Sustainability, Joint Research Centre, European Commission (ioannis.trichakis@jrc.ec.europa.eu)

The purpose of this study is to examine the use of Artificial Neural Networks (ANN) combined with kriging interpolation method, in order to simulate the hydraulic head both spatially and temporally. Initially, ANNs are used for the temporal simulation of the hydraulic head change. The results of the most appropriate ANNs, determined through a fuzzy logic system, are used as an input for the kriging algorithm where the spatial simulation is conducted.

The proposed algorithm is tested in an area located across Isar River in Bayern, Germany and covers an area of approximately 7800 km^2. The available data extend to a time period from 1/11/2008 to 31/10/2012 (1460 days) and include the hydraulic head at 64 wells, temperature and rainfall at 7 weather stations and surface water elevation at 5 monitoring stations.

One feedforward ANN was trained for each of the 64 wells, where hydraulic head data are available, using a back-propagation algorithm. The most appropriate input parameters for each wells' ANN are determined considering their proximity to the measuring station, as well as their statistical characteristics. For the rainfall, the data for two consecutive time lags for best correlated weather station, as well as a third and fourth input from the second best correlated weather station, are used as an input. The surface water monitoring stations with the three best correlations for each well are also used in every case. Finally, the temperature for the best correlated weather station is used. Two different architectures are considered and the one with the best results is used henceforward. The output of the ANNs corresponds to the hydraulic head change per time step. These predictions are used in the kriging interpolation algorithm. However, not all 64 simulated values should be used. The appropriate neighborhood for each prediction point is constructed based not only on the distance between known and prediction points, but also on the training and testing error of the ANN. Therefore, the neighborhood of each prediction point is the best available. Then, the appropriate variogram is determined, by fitting the experimental variogram to a theoretical variogram model. Three models are examined, the linear, the exponential and the power-law. Finally, the hydraulic head change is predicted for every grid cell and for every time step used.

All the algorithms used were developed in Visual Basic .NET, while the visualization of the results was performed in MATLAB using the .NET COM Interoperability.

The results are evaluated using leave one out cross-validation and various performance indicators. The best results were achieved by using ANNs with two hidden layers, consisting of 20 and 15 nodes respectively and by using power-law variogram with the fuzzy logic system.