Geophysical Research Abstracts
Vol. 17, EGU2015-407, 2015
EGU General Assembly 2015

Uncertainty analysis of a combined Artificial Neural Network – Fuzzy logic – Kriging system for spatial and temporal simulation of Hydraulic Head.

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

(1) School of Environmental Engineering, Technical University of Crete, Chania, Greece (etapoglou@gmail.com), (2) European Commission, Joint Research Centre (JRC), Institute for Environment and Sustainability (IES), Water Resources Unit, Ispra (VA), Italy

The purpose of this study is to evaluate the uncertainty, using various methodologies, in a combined Artificial Neural Network (ANN) – Fuzzy logic – Kriging system, which can simulate spatially and temporally the hydraulic head in an aquifer. This system uses ANNs for the temporal prediction of hydraulic head in various locations, one ANN for every location with available data, and Kriging for the spatial interpolation of ANN's results. A fuzzy logic is used for the interconnection of these two methodologies. The full description of the initial system and its functionality can be found in Tapoglou et al. (2014). Two methodologies were used for the calculation of uncertainty for the implementation of the algorithm in a study area.

First, the uncertainty of Kriging parameters was examined using a Bayesian bootstrap methodology. In this case the variogram is calculated first using the traditional methodology of Ordinary Kriging. Using the parameters derived and the covariance function of the model, the covariance matrix is constructed. A common method for testing a statistical model is the use of artificial data. Normal random numbers generation is the first step in this procedure and by multiplying them by the decomposed covariance matrix, correlated random numbers (sample set) can be calculated. These random values are then fitted into a variogram and the value in an unknown location is estimated using Kriging. The distribution of the simulated values using the Kriging of different correlated random values can be used in order to derive the prediction intervals of the process. In this study 500 variograms were constructed for every time step and prediction point, using the method described above, and their results are presented as the 95th and 5th percentile of the predictions.

The second methodology involved the uncertainty of ANNs training. In this case, for all the data points 300 different trainings were implemented having different training datasets each time. These datasets were created by choosing randomly 80% of the observed input/output data at every location. In every case, the remaining 20% of the input/output patterns were used for the testing of the corresponding ANN. Moreover, the initial weight values were also randomized at the beginning of every training. All the resulting network trainings were consequently used for the simulation of the hydraulic head spatially and temporally. The results are again presented as the 95th and 5th percentile and represent the 90% confidence interval of the prediction.

These methodologies were implemented for a study area around Munich, Bavaria, Germany, in order to assess the performance of the simulation methodology. The results indicate that the proposed methodology can be applied with good accuracy.

Tapoglou, E., Karatzas, G.P., Trichakis, I.C., Varouchakis, E.A., 2014. A spatio-temporal hybrid neural network-kriging model for groundwater level simulation. Journal of Hydrology, In press DOI:http://dx.doi.org/10.1016/j.jhydrol.2014.10.040