Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2021.27812

242 (2021) 226–234
December

A novel method of the water quality system assessment: genetic algorithm optimized back-propagation neural networks evaluation model

Yueqing Ding[a,†], Wei Hong[b,†], Jianhua Yang[a,*]

[a]*School of Automation, Northwestern Polytechnical University, Xi'an 710072, PR China, email: yangjianhua@nwpu.edu.cn (J. Yang)*
[b]*College of Urban and Environmental Sciences, Northwestern University, Xi'an 710069, PR China*

Received 26 August 2021; Accepted 23 September 2021

ABSTRACT

Water quality pollution has become a primary environmental global concern as society is changing. The pollution of environmental resources is an issue of social concern worldwide, particularly the deterioration of water quality. Groundwater quality deterioration has been the focus in the water quality field. A precise predictive model is needed to obtain a clear understanding of the factors controlling groundwater quality conditions, to assess how to reduce risk and to optimize urban water quality management for the purpose of improving water quality in urban groundwater systems. Therefore, how to improve the accuracy of rating prediction calculated by the water quality systematic assessment model becomes the focus of this study. Combining back-propagation (BP) neural network with a genetic algorithm, this paper proposes the water quality, systematic assessment model, based on genetic algorithm optimized BP neural networks and its potential application to a typical urban groundwater quality system assessment in northwest China. In this study, nine main factors were used as indicators of qualifying water quality that encompasses pH, ammonia, chloride, nitrite, dissolved solids, chemical oxygen demand and fluoride ions. The method is illustrated with water quality of 223 variables data from a surveillance system of fifteen groundwater water monitoring sites in Xi'an, Shaanxi Province, China during the 1996–2015 period. Firstly, using Shannon entropy (information gain) to classify the recorded data into five categories. Referring to (in terms of) the groundwater quality criterion in 2017 (GB/T14848-2017), following data pre-processing to provide more abundant information for recognition. Second, correlations were analyzed using the Spearman correlation. Water quality ratings were significantly highly correlated with statistical measures of the chloride, nitrite, dissolved solid and fluoride ions. Then principal component analysis methods are deployed for dimension reduction. On this basis, the evaluation index is refined; the basic structure of the back-propagation neural network (BPNN) is introduced, and a genetic algorithm is used to improve BP neural network. The results indicated that a genetic algorithm-back propagation neural network (GA-BPNN) model accounted for an accuracy of 90.91%, which was much higher than 63.64% on accuracy by BPNN. And thus, it is important to develop GA-BPNN modeling methods to enhance the evaluation accuracy of water quality parameters. This method can be used as a decision support tool to evaluate the impact of urban groundwater utilization on water quality.

Keywords: Groundwater quality; Shannon entropy; Spearman correlation; Back-propagation neural network; Genetic algorithm; Water quality systematic assessment

* Corresponding author.

† These authors contributed equally to this work.