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Artificial Neural Network for Modeling Nitrate Pollution of Groundwater in Marginal Area of Zayandeh-rood River, Isfahan, Iran

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Abstract

Excessive use of chemical fertilizers, especially nitrogen fertilizers to increase crop and improper purification, and delivery of municipal and industrial wastewater are proposed as factors that increase the amount of nitrate in groundwater in this area. Thus, investigation of nitrate contamination as one of the most important environmental problems in groundwater is necessary. In the present study, modeling and estimation of nitrate pollution in groundwater of marginal area of Zayandeh-rood River, Isfahan, Iran, was investigated using water quality and artificial neural networks. 100 wells (77 agriculture well, 13 drinking well and 10 gardens well) in the marginal area of Zayandeh-rood River, Isfahan, Iran were selected. MATLAB software and three-layer Perceptron network were used. The back-propagation learning rule and sigmoid activation function were applied for the training process. After frequent experiments, a network with one hidden layer and 19 neurons make the least error in the process of network training, testing and validation. ANN models can be applied for the investigation of water quality parameters.

Keywords: *artificial neural network, contamination, groundwater, nitrates*

1. Introduction

Groundwater reserves are important in natural waters which are exploited by digging deep and semi deep wells, springs and quants. Approximately 97% of the Earth's fresh water is groundwater and only 3% is surface water storage (Hambright, 2006). Relative to most surface water sources, groundwater water quality is generally superior and more consistent. Groundwater in arid regions such as Iran contributed to supply a significant amount of water and agriculture water. Isfahan province, Iran, is located in an arid and semi-arid area and because of drought in recent years, the use of groundwater for irrigation and drinking water is very important (Dorsch, 1984; Acutis, 2000). Pollution of groundwater resources by harmful substances that enter into the natural environment intentionally or non-intentionally by man is important in the future exploitation of groundwater resources. One source of this pollution is related to nitrate. The maximum allowable concentration of nitrate-nitrogen (NO_3-N) is 10 mg/L for drinking water, according to the US Environmental Protection Agency and the World Health Organization, which is approximately equivalent to 45 mg of nitrate (NO_3) per liter. This cut point was determined 50 mg/L nitrate by European Union (EU) (Zhang *et al*., 2013). In Iran, 45 mg/L nitrate is considered as the maximum allowable concentration in drinking water (Sobedji, 2001; Sadek, 2002). Municipal and industrial wastewater discharge in the absorptive wells, and indiscriminate use of chemical fertilizers in agriculture, are the most important factors affecting nitrate pollution. In recent decades, the use of nitrogen fertilizers without considering their effects on soil properties, agricultural products and especially environmental pollution has increased dramatically. When Phosphorus-Nitrogen Compounds enter to lakes and rivers lead to enrich water and consequently uncontrolled growth of aquatic plants. Subsequently, a deficiency of dissolved oxygen in the water leads to aquatic organisms' death (Noh, 2006). Khossravi-Dehkordi *et al.* (2004) investigated the nitrate pollution, distribution and its change in groundwater in a marginal area of Zayandeh-rood River, Isfahan, Iran. The results showed that the average concentration of nitrate nitrogen in water of Baghbadaran, Isfahan, Iran, wells with an average depth of 9 m, Falavarjan area with an average depth of 7.5 m and Varzaneh area, Isfahan, Iran, with an average depth of 6 m was 5.28, 17.63 and 6.35 mg per liter, respectively. Consuming contaminated groundwater is harmful for plants, humans and animals. Thus identification of contaminated water sources and causes of pollution are essential. High concentrations of nitrate in soil and irrigation water cause nitrate accumulation in plants that

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