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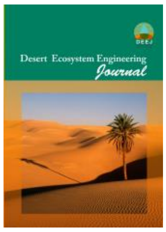

Modeling Groundwater Changes Using Four Different Techniques of Evolutionary Neural Network and climatic data (Case Study of Dasht-Abbas Plain, Ilam Province)

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Extended Abstract

Introduction: Groundwater is one of the main sources of drinking water, agriculture and industry. It is worth noting that groundwater is considered as reserve resources in some areas, while in other areas it may be used for supplying potable water due to their availability (Daliakopoulos et al., 2005; Nayak et al., 2006). Groundwater analysis is an essential factor in maintaining its access. Modeling and predicting the groundwater level for environmental protection, maintaining the balance of the groundwater system, controlling changes in groundwater levels and protecting the escalation of land subsidence are important. Groundwater management techniques and solutions, and control measurements by researchers and operators to address the long-term problems of land subsidence and groundwater conservation (Affandi and Watanabe 2007; Mohanty et al., 2015). The main aim of this study is to evaluate the accuracy of evolutionary neural network models in the monthly groundwater level estimation.

Materials and methods: In this study groundwater level, precipitation, evaporation, annual average temperature and effective influence between 1993 and 2016 were used. The purpose of this study is applying neural networks to estimate the groundwater level. To use the neural network, we must optimize the weights and biases of the network. In this research, weights and network biases were obtained using optimization algorithms such as genetic algorithm, particle swarm algorithm, Imperialist Competitive algorithm and ant colony algorithm.

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Results: Different control parameters have been used for models, and they are compared with each other based on the mean square error and the coefficient of determination. All four models showed the best accuracy for input combinations. Comparison of the results shows that the ANN-GA model has a better performance than the other three models for groundwater level estimation. The advantages of GA are: 1) The nature of the random search of this algorithm in the problem space is in some way a parallel search. Because each of the random-generated chromosomes generated by the algorithm is considered as a new starting point to search for part of the problem-space and searches in all of them simultaneously. 2) Due to the breadth and dispersion of the points to be searched, it yields a satisfactory result in issues of great search space. 3) A kind of random search is targeted and will come from different paths to different answers. In addition, there is no limit to the search and selection of random answers. 4) Because of the competition, the answers and the selection of the best among the population, with a high probability, will reach the optimal level. 5) Its implementation is simple and does not require complex problem-solving procedures. It can be said that this algorithm may be a good candidate for hydrological modeling. Investigating the trend of groundwater level changes in the plain over a period of 22 years shows that from 1993 to 2006, due to excessive withdrawal and droughts, the level of stagnation with a steep slope has fallen. Since then, with the arrival of the water of the Karkheh Dam and the reduction of withdrawal, the groundwater level of the plain table has risen and reaches 14 meters in 2015.

Discussion & conclusion: Most commonly used methods for training neural networks from descending gradients using back propagation are to calculate real gradients. In recent years, some researchers have developed evolutionary techniques for estimating groundwater level changes, including genetic algorithms (Dash et al. 2010, Jalakamali and Jalakamali 2011), Imperialist competition algorithm (Tahershamsi and Sheikholeslami 2011), particle swarm optimization (Xi et al. 2012, Gaur et al. 2013) and comparing these methods with each other (Kisi et al., 2017). In addition to the above-mentioned models, the ANN-ACOR model was also used. Comparison of the results shows that the ANN-GA model has a better performance than the other three models for estimating groundwater level, which contradicts the results of (Xi, 2012) and (Gaur, 2013), and matches with the research (Jalalkamali, 2011) and (Dash, 2010).

Keywords: Groundwater Changes, Evolutionary Neural Networks, Genetic Algorithm, Particle Swarm Optimization, Imperialism Competition Algorithm, Ant Colony Optimization, Modeling