



Development of a PSO-ANN Model for Rainfall-Runoff Response in Basins, Case Study: Karaj Basin

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Abstract

Successful daily river flow forecasting is necessary in water resources planning and management. A reliable rainfall-runoff model can provide useful information for water resources planning and management. In this study, particle swarm optimization algorithm (PSO) as a metaheuristic approach is employed to train artificial neural network (ANN). The proposed PSO-ANN model is applied to simulate the rainfall runoff process in Karaj River for one and two days ahead. In this regard, different combinations of the input variables including flow and rainfall time series in previous days have been taken under consideration in order to obtain the best model's performances. To evaluate efficiency of the PSO algorithm in training ANNs, separate ANN models are developed using Levenberg-Marquardt (LM) training algorithm and the results are compared with those of the PSO-ANN models. The comparison reveals superiority of the PSO algorithm than the LM algorithm in training the ANN models. The best model for 1 and 2 days ahead runoff forecasting has R2 of 0.88 and 0.78. Results of this study shows that a reliable prediction of runoff in 1 and 2 days ahead can be achieved using PSO-ANN model. Overall, results of this study revealed that an acceptable prediction of the runoff up to two days ahead can be achieved by applying the PSO-ANN model.

Keywords: Particle Swarm Optimization; Metaheuristics ; Neural Networks; Runoff Forecasting.

1. Introduction

Iran is located in an arid and semi-arid region in which water shortage in many parts of this country reached an emergency or even worse conditions. During recent years, several major bodies of water in the region have been dried up, including the Orumieh Lake, Zayandehrood River and Hamoon Lagoon. Tehran, Iran's capital is facing a critical shortage of water. Regarding these problems, applying integrated water resources planning and management as well as taking efficient policies is crucial and essential. Also, successful river flow forecasting is necessary in water resources planning and management. Karaj River is one of the most important rivers in which supplies part of water of Tehran and Alborz Province [1]. As a result, development of accurate models to simulate the rainfall -runoff processing in Karaj basin can help the relevant organizations to manage the problem of water scarcity in the region appropriately.

The rainfall-runoff modelling is a prior issue in any river management and also water resources programs. Development of an appropriate model is a difficult procedure due to the complexity and dynamic behaviour of nonlinear hydrological processes. Most hydrologic processes exhibit a high degree of temporal and spatial variability, and are further plagued by issues of nonlinearity of physical processes, conflicting spatial and temporal scale, and uncertainty in parameter estimates. Over the past years, artificial intelligence techniques have been frequently used to predict nonlinear problems and achieved good results [2-6]. Also, conjunction with wavelet transform enhances ANN popularity which Wavelet-ANN or wavelet-ANFIS models were successfully hired for nonlinear time series forecasting [7-11].

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