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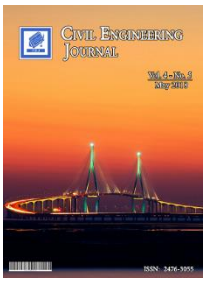

Comparison of Three Intelligent Techniques for Runoff Simulation

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Abstract

In this study, performance of a feedback neural network, Elman, is evaluated for runoff simulation. The model ability is compared with two other intelligent models namely, standalone feedforward Multi-layer Perceptron (MLP) neural network model and hybrid Adaptive Neuro-Fuzzy Inference System (ANFIS) model. In this case, daily runoff data during monsoon period in a catchment located at south India were collected. Three statistical criteria, correlation coefficient, coefficient of efficiency and the difference of slope of a best-fit line from observed-estimated scatter plots to 1:1 line, were applied for comparing the performances of the models. The results showed that ANFIS technique provided significant improvement as compared to Elman and MLP models. ANFIS could be an efficient alternative to artificial neural networks, a computationally intensive method, for runoff predictions providing at least comparable accuracy. Comparing two neural networks indicated that, unexpectedly, Elman technique has high ability than MLP, which is a powerful model in simulation of hydrological processes, in runoff modeling.

Keywords: Elman; MLP; ANFIS; Runoff Simulation; India.

1. Introduction

The short-term and long-term simulations of runoff is of vital interest in management of water resources projects and also watershed management that includes increasing infiltration into soil, controlling excess runoff, managing and utilizing runoff for specific purposes, and reducing soil erosion. The non-linear and complex nature of the runoff process, its variability depending on catchment characteristics and precipitation patterns, and its dependence on various other factors make it difficult to predict and estimate runoff with desirable accuracy. However, over the years, hydrologists have developed several models ranging from empirical relationships to physically-based. The physically-based models have proved to be better for the simulation of runoff, but their data requirements are very high and often intensively-monitored watersheds lack sufficient input data for these models. Therefore, the need to develop alternative models to simulate runoff using available data has taken priority. Recently, pattern-recognition algorithms such as the artificial neural networks (ANN) have gained popularity in simulating the rainfall-runoff processes producing comparable accuracy to those of the physically-based models [1-3].

The theory of Artificial Neural Networks (ANNs) started in early 1940's when the first computational representation of a neuron was developed by McCulloch and Pitts [4]. Basically, ANNs is one of Artificial Intelligence techniques that mimic the behavior of the human brain. In the last decade, ANNs have been successfully employed in modeling a wide range of hydrologic processes, including rainfall–runoff processes; Smith and Eli [5]; Hsu et al [6]; Minns and Hall [7]; Shamseldin [8] and Dawson and Wilby [9] studied on neural-network models of rainfall–runoff process. Tokar and Johnson [10] developed an ANN model to predict daily runoff as a function of daily precipitation, temperature, and

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