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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 of 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.

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Keywords: Elman, MLP, ANFIS, Runoff simulation, India.

1. INTRODUCTION

The short-term and long-term simulation of runoff is an important task in management of water resources projects and watershed management. The non-linear and complex nature of the runoff makes it difficult to estimate and predict runoff values with high accuracy. Over the past years, hydrologists have developed many different models to estimate runoff. Although applying the empirical models is not difficult, but they are not able to estimate runoff accurately. The physically-based models have been successful to simulate runoff; however they need a lot of information, which may not available in catchments all over the world for modeling. Therefore, there was a need to develop alternative models to simulate runoff precisely using less data. Recently, hydrologists have employed different intelligent models such as the artificial neural networks (ANN) and Adaptive Neuro-Fuzzy Inference System (ANFIS) to simulate hydrological processes. ANNs is one of Artificial Intelligence techniques that mimic behavior of the human brain. There are several features in ANN that distinguish it from the empirical models. First, neural networks have flexible nonlinear function mapping capability which can approximate any continuous measurable function with arbitrarily desired accuracy, whereas most of the commonly used empirical models do not have this property. Second, being nonparametric and data-driven, neural networks impose few prior assumptions on the underlying process from which data are generated. Because of these properties, neural networks are less susceptible to model misspecification than most parametric nonlinear methods. Given the advantages of neural networks, it is not surprising that this methodology has attracted overwhelming attention in many application areas. It has been successfully applied for different hydrological processes such as runoff modeling. Dawson and Wilby [1] studied on neural-network models of rainfall–runoff process. Tokar and Johnson [2] developed an ANN model to predict daily runoff as a function of daily precipitation, temperature, and snowmelt for a watershed in Maryland, USA. Chiang et al [3] compared the static-feed forward and dynamic-feedback neural networks for rainfall–runoff modeling, Tayfur and Singh [4] used ANN and fuzzy logic models for simulating event-based rainfall–runoff, Tayfur et