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Annual precipitation forecast for west, southwest, and south provinces of Iran using artificial neural networks

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Abstract Rainfed agriculture plays an important role in the agricultural production of the southern and western provinces of Iran. In rainfed agriculture, the adequacy of annual precipitation is considered as an important factor for dryland field and supplemental irrigation management. Different methods can be used for predicting the annual precipitation based on climatic and non-climatic inputs. Among which artificial neural networks (ANN) is one of these methods. The purpose of this research was to predict the annual precipitation amount (millimeters) in the west, southwest, and south of Islamic Republic of Iran with the total area of 394,259 km^2, by applying non-climatic inputs according to the long-time average precipitation in each station (millimeters), 47.5 mm precipitation since the first of autumn (day), $t_{47.5}$, and other effective parameters like coordinate and altitude of the stations, by using the artificial neural networks. In order to intelligently estimate the annual amount of precipitation in the study regions (ten provinces), feedforward backpropagation artificial neural network model has been used (method I). To predict the annual precipitation amount more accurately, the region under study was divided into three sub-regions, according to the precipitation mapping, and for each sub-region, the neural networks were developed using $t_{47.5}$ and long-time average annual precipitation in each station (method II). It is concluded that neural networks did not significantly increase the prediction accuracy in the study area compared with multiple regression model proposed by other investigators. However, in case of ANN, it is better to use a structure of 2–6–6–10–1 and Levenberg–Marquardt learning algorithm and sigmoid logistic activation function for prediction of annual precipitation.

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1 Introduction

These days, world is witnessing a harsh climate fluctuation. This has an important effect typically on the agriculture. Among the different aspects of harsh climate fluctuation, precipitation is the main source of water for the hydrological cycle which is important for agribusiness (Mar and Naing 2008). Rainfed agriculture is an important part of the system of agricultural production in southern and western provinces of Iran. Under these conditions, assuring some degree of yield stability to the farmers has become a priority for agricultural management systems. However, precipitation is extremely variable and unpredictable and does not show such stability. Therefore, precipitation prediction for the approaching season is vital for more rational and productive decisions to be made for rainfed farming management (Nnaji 2001). Levels of annual precipitation variability do indeed exist in Mediterranean-type precipitation pattern right across the regions from Morocco to Jordan (Stewart 1986a, b) and west Africa (Sivakumar 1988). These studies indicate a significant relationship between the date of onset of precipitation and annual amount of precipitation (Hunda 1994; Khalfaoui 1991; Sivakumar 1990). For the rainfed areas in Iran, dryland wheat production was found about 1 $t ha^{-1}$ due to unpredictable precipitation and no fertilizer use. The prediction of annual precipitation can develop information to alleviate these problems, and guidance can be provided to farmers both for reduced-risk selection among alternative crops to plant (barley instead of wheat) and for improving their levels of input, particularly fertilizers, to match precipitation levels for yield maximization per unit of water more