ABSTRACT

Accurate estimation of evapotranspiration is required for many hydrologic studies. It is usually estimated using reference crop evpotranspiration (ETo) and crop specific coefficient. ETo is, however, a complex and non-linear phenomenon because it depends on several interacting climatological factors, such as temperature, humidity, wind speed, solar radiation. Artificial Neural Networks (ANN) are effective tools to model nonlinear systems. Therefore, the present study focused on the utilization of the ANN in ETo prediction and forecasting. The study was carried out under four broad categories, namely, development of ANN architectures corresponding to the best ranking combination (Penman-Monteith), radiation (FAO-24 Radiation for arid region and Turc method for humid region), and temperature (FAO-24 Blaney Criddle) based ETo estimation methods for individual CIMIS stations; development of generalized ANN architecture corresponding to the above methods, application of generalized ANNs to other stations, which were not considered in the model development and development of ANN architecture for ETo forecasting at 1- and 3-day lead periods.

For the purpose of this study, 10 stations, namely, Castroville, Davis, Fresno, Lodi, Mulberry and WSFS in the state of California, USA (CIMIS stations); Jabalpur, Hoshangabad and Gwalior in MP, India and Pendra in Chhattisgarh, India (IMD stations) were chosen. Daily climatic data for the chosen CIMIS and IMD stations were collected for the period of January 1, 1990 to June 30, 2000 and January 1, 1995 to December 31, 1996, respectively. Also, daily climatic data and corresponding lysimeter measured ETo data were collected for the period of 3 years for Davis.

Several ANN architectures were considered to obtain the best ANN architecture for mapping ETo. In each ANN architecture, the number of nodes in the input layer corresponded to the basic input parameters for ETo estimation by an individual method (e.g. 6 for PM, 4 for FAO-BC etc.), whereas the output layer node corresponded to the Penman-Monteith ETo. Each ANN architecture was tested for 500, 1000, 2000, 3000, 4000, and 5000 learning cycles. Furthermore, three different learning schemes, namely, Standard Back-Propagation with the learning rate of 0.2 (SBPLR2) and 0.8 (SBPLR8) and Back-Propagation Momentum with learning rate of 0.2 and momentum term as 0.95 (BPMLR2) were considered. The best ANNs architecture corresponding to the chosen conventional ETo estimation methods was determined based on minimum WSEE and network architecture.

All three learning methods gave almost similar ETo. The ETo estimation performance of the ANNs was better than the corresponding conventional ETo estimation methods. Furthermore, the generalized ANNs models also performed better than their conventional counterparts and can be used to estimate ETo for the stations, which are not included in the model development. ETo forecasting performance of ANNs was better for 1-day lead period than for 3-day lead period. Based on these results, it can be concluded that the ANN can predict ETo better than the conventional methods.

Key Words: ANN, Evapotranspiration, Forecasting, and Modeling