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Comparison of artificial neural networks and prediction models for reference evapotranspiration estimation in a semi-arid region

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Estimation of reference evapotranspiration (ET_o) is essential for determination of crop water requirements. In this research, Penman–FAO (P-FAO) and Penman–Monteith (PM) equations were calibrated and validated by lysimeter-measured ET_o with six and four weather parameters. Furthermore, two input structures (six and four weather parameters) to artificial neural networks (ANNs) were investigated. Results showed that the accuracy of the PM equation is greater than that of the P-FAO equation. An empirical equation was developed to estimate daily ET_o using mean daily temperature and relative humidity, and sunshine hours. The accuracy of the equation to estimate daily ET_o using smooth weather data is greater than that of an equation using original data. Furthermore, ANNs were able to estimate ET_o properly. The accuracy of ANNs with six inputs is higher than that obtained using the P-FAO equation and is similar to that determined using the PM equation. A decrease in number of inputs to ANNs generally decreased the accuracy of estimation, however, ANNs were able to estimate ET_o properly when wind speed and solar radiation were unavailable. Furthermore, the accuracy of ANNs, with four input parameters is greater than that obtained using the PM equation and is similar to that obtained with P–FAO and the developed empirical equations.

Keywords: weighing lysimeter; Penman–FAO; Penman–Monteith; empirical model; smoothed data

Introduction

Evapotranspiration is an important part of the earth's hydrological cycle. Accurate estimation of reference evapotranspiration (ET_o) is important for all hydrological and agricultural applications. Water resources are limited in arid and semi-arid regions and are under danger from over-use. Therefore, accurate estimation of crop water requirements is essential for proper irrigation water planning. Atmospheric evaporation potential regulates the crop water requirement, which is related to climate conditions. The Food and Agricultural Organization (FAO) has presented a method for calculating potential crop evapotranspiration (ET_p) based on reference evapotranspiration (ET_o) and the crop coefficient (K_c) (Doorenbos and Pruitt 1977). This coefficient relates to different factors including type of crop, crop growth stage, density of green cover and soil moisture (Allen et al. 1998; Temesgen et al. 2005). Values of K_c can be determined using a procedure described by Allen et al. (1998).

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