Geophysical Research Abstracts
Vol. 12, EGU2010-7634-1, 2010
EGU General Assembly 2010

Comparison of artificial neural network and empirical equations for daily reference evapotranspiration estimation from pan evaporation

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Evaporation and Evapotranspiration Process are the major components of the hydrologic cycle which play an important role in agricultural studies such as design of irrigation and drainage systems, and irrigation scheduling. Evapotranspiration is a complex non-linear phenomenon which depends on several climatologic factors. It can be measured directly by high-cost micrometeorological techniques. Hence, many mathematical models and empirical equations were developed to estimate this phenomenon. One conventional method to estimate reference crop evapotranspiration ($ET_{0)}$ is converting the class A pan evaporation (E_{Pan}) into ET_o by using a pan coefficient (K_{Pan}) according to following this equation.

$$ET_o = K_{pan} * E_{pan}$$

Another alternative method to estimate ET_o is the application of mathematical models like artificial neural networks (ANNs). ANNs are mathematical models whose architecture has been inspired by biological neural networks. ANNs are very appropriate for the modeling of nonlinear processes, i.e. the case of ET_o.K_{pan} is the important factor for computation of ET_o from E_{pan}, There for several empirical equations purposed to determine K_{Pan}, using wind speed, relative humidity and fetch length conditions by many researchers. The main objective of this study was to comparison between ability of ANNs and empirical equations for estimation daily ET_0 from E_{pan}. For this object Daily measured weather data for a 16 year (from 1992 to 2007) period were obtained from the Shiraz synoptic station (latitude 29^o $36^{'}$ N, longitude 52^o $32^{'}$ E, elevation 1480 m) that located in Fars province of Iran. The climate in the study area is semi-arid with an average annual rainfall of 346 mm $year^{-1}$. In This paper first, we use seven empirical equations: Cuenca (1989), Snyder (1992), Modified Snyder (1992), Doorenbos and Pruitt (1977), Pereira et al. (1995), Orang (1998) and Raghuwanshi and Wallender (1998) for estimation KPan values and second then we use ANNs for converting Ep_{an} to estimate ET_0 as a function of the wind speed and relative humidity for the mentioned station. The comparisons and performance of both ANN and the conventional method have been based on statistical error techniques, using FAO Penman Monteith method (PM_{56}) daily ET_o values as a reference. The PM_{56} is the standard method for the calibration of other ET_o estimation equations when there is no measured lysimeter data.

The results show that among the seven approaches Snayder (1992) gave a better performance values (R^2=0.45 and RMSE=3.36 mm day^{-1}) and Pereira et al. (1995) gave a poor performance under the case study. ANNs have obtained better results than the seven empirical equations values (R^2=0.901 and RMSE=0.96 mm day^{-1}).

Keywords: evapotranspiration, pan evaporation, ANN, empirical equations, Shiraz