Determination of the most influential weather parameters on reference evapotranspiration by adaptive neuro-fuzzy methodology

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ABSTRACT

The adaptive neuro-fuzzy inference system (ANFIS) is applied for selection of the most influential reference evapotranspiration (ET0) parameters. This procedure is typically called variable selection. It is identical to finding a subset of the full set of recorded variables that illustrates good predictive abilities. The full weather datasets for seven meteorological parameters were obtained from twelve weather stations in Serbia during the period 1980–2010. The monthly ET0 data are obtained by the Penman–Monteith method, which is proposed by Food and Agriculture Organization of the United Nations as the standard method for the estimation of ET0. As the performance evaluation criteria of the ANFIS models the following statistical indicators were used: the root mean squared error (RMSE), Pearson correlation coefficient (r) and coefficient of determination (R2). Sunshine hours are the most influential single parameter for ET0 estimation (RMSE = 0.4398 mm/day). The obtained results indicate that among the input variables sunshine hours, actual vapor pressure and minimum air temperature, are the most influential for ET0 estimation. The maximum relative humidity and maximum air temperature are the most influential optimal combination of two parameters (RMSE = 0.2583 mm/day).

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1. Introduction

Evapotranspiration (ET) is a physical process that refers both to evaporation from soil and vegetative surface and transpiration from plants. Allen et al. (1998) defined reference evapotranspiration (ET0) which represents a complex nonlinear process. Its accurate estimation is needed for water resource planning and management, irrigation system design and irrigation scheduling. In recent years, ET0 plays a crucial role in the drought characterization by using in drought indices (Tsakiris et al., 2007; Vicente-Serrano et al., 2010; Gocic and Trajkovic, 2014a, 2015). In addition, report from the Intergovernment Panel on Climate Change (2014) states global warming is causing irreversible environmental change. At present researchers have limited understanding on the far reaching impact of such changes on human race.

Numerous methods have been proposed for estimating ET0, which can be categorized as combination-type, pan evaporation based, radiation based and temperature-based (Trajkovic, 2010). Extensive researches have reported the superiority of the FAO-56 Penman–Monteith equation (FAO-56 PM) for estimating ET0 (Pereira and Pruitt, 2004; Lopez-Urrea et al., 2006; Gavilan et al., 2007; Tabari et al., 2013a; Dejonge et al., 2015). Therefore, the FAO-56 PM equation is incorporated in this study.

Artificial neural networks (ANNs) approaches have been successfully applied in ET0 estimation in the last decades (Trajkovic et al., 2000; Kumar et al., 2002; Kisi, 2006, 2007; Rahimi Khoob, 2007; Landeras et al., 2008; Shiri et al., 2014), Kumar et al. (2011) discussed the ANNs in ET modeling including performance criteria, selection of training algorithm and ANN architecture. Recently, the new soft computing methods have been successfully applied in ET0 estimation such as genetic algorithm (Aghajanloo et al., 2013; Kim and Kim, 2008; Irmak and Kabale, 2009; Shiri et al., 2012, 2015; Traore and Guven, 2013), fuzzy-logic (Kisi and Cengiz, 2013; Shiri et al., 2013), support vector machines (Kim et al., 2012; Tabari et al., 2013b; Kisi, 2013), and wavelet regression technique (Cobaner, 2013). The development of soft computing methods and their applications in biological and agricultural...