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1 Implementation of Artificial Neural Networks as an alternative to local calibration of temperature and relative humidity- based equations for daily reference evapotranspiration estimation.

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The determination of reference evapotranspiration (*ETo*) is a key factor of the hydrologic cycle. *ETo* plays an important role in planning and management of water resources and irrigation scheduling. The combination equation of Penman-Monteith modified by Allen et al. in 1998 (FAO-56 PM) is the reference equation for the estimation of evapotranspiration and calibration of other equations and mathematical models. The most serious obstacle to widely using this method is the numerous required data that are not available at many weather stations. In situations with a meteorological data lack, the use of *ETo* alternative equations is recommended, but even more so if these equations have been previously calibrated (using FAO-56 PM) in the same place where the estimation of *ETo* is required or in the nearest one. The local calibration of *ETo* equations improves the performance of the equations, and is a useful tool, not only for real-time *ETo* estimation but for the realization of historical studies of *ETo*. In addition to the utilization of calibrated *ETo* equations, the adoption of Artificial Neural Network models (ANNs), as models of estimation of daily *ETo* un-

der situations of presence of only temperature and relative humidity data, has been evaluated in this study. Three temperature based *ETo* equations (Hargreaves-Samani (HS), and Priestley-Taylor and Makkink with temperatures- based estimated solar radiation (PT_{Rsest}, MK_{Rsest}), and one temperature and relative humidity- based *ETo* equation (Turc with temperatures based estimated solar radiation (T_{Rsest})) have been evaluated and local calibrated in four locations of Alava region (northern Spain) for the period 1999-2001. As an alternative to the utilization of these equations, four multilayer perceptron Artificial Neural Networks (ANNs) with different combination of inputs (temperatures (NN1), temperatures and relative humidity (NN2), Hargreaves-Samani values (NN3), and Hargreaves-Samani values and relative humidity (NN4)) have been implemented for the same period 1999-2001. The period 2002-2003 has been used for the evaluation of the performance of the calibrated *ETo* equations, and the implemented ANNs. FAO-56 PM daily *ETo* values have been used as a reference for the calibration (lineal regressions), the implementation of ANNs and the evaluation of the models (based on error statistical techniques). Instead of the improvement of the performance of the four *ETo* equations after the local calibration process, three of the four ANNs have obtained lower values of RMSE (0.385 (NN2), 0.440 (NN4), 0.538 (NN1)) than the four local calibrated *ETo* equations (0.558 (T_{Rsest}), 0.570 (HS), 0.623 (MK_{Rsest}), 0.646 (PT_{Rsest}). ANNs have shown their ability to estimate evapotranspiration in situations of presence of only temperature and relative humidity sensors improving the performance of the traditional *ETo* equations. The implementation of ANNs is an interesting alternative to the local calibration of *ETo* equations under situations with a lack of the appropriate meteorological sensors for FAO-56 PM application.