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Effects of Different Meteorological Variables on Reference Evapotranspiration Modeling: Application of Principal Component Analysis

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Abstract : The correct estimation of reference evapotranspiration (ET_o) is required for effective irrigation water resources planning and management. However, there are some variables that must be considered while estimating and modeling ET_o. This study therefore determines the multivariate analysis of correlated variables involved in the estimation and modeling of ET_o at Vaalharts irrigation scheme (VIS) in South Africa using Principal Component Analysis (PCA) technique. Weather and meteorological data between 1994 and 2014 were obtained both from South African Weather Service (SAWS) and Agricultural Research Council (ARC) in South Africa for this study. Average monthly data of minimum and maximum temperature (°C), rainfall (mm), relative humidity (%), and wind speed (m/s) were the inputs to the PCA-based model, while ET_o is the output. PCA technique was adopted to extract the most important information from the dataset and also to analyze the relationship between the five variables and ET_o. This is to determine the most significant variables affecting ET_o estimation at VIS. From the model performances, two principal components with a variance of 82.7% were retained after the eigenvector extraction. The results of the two principal components were compared and the model output shows that minimum temperature, maximum temperature and windspeed are the most important variables in ET_o estimation and modeling at VIS. In order words, ET_o increases with temperature and windspeed. Other variables such as rainfall and relative humidity are less important and cannot be used to provide enough information about ET_o estimation at VIS. The outcome of this study has helped to reduce input variable dimensionality from five to the three most significant variables in ET_o modelling at VIS, South Africa.

Keywords : irrigation, principal component analysis, reference evapotranspiration, Vaalharts
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