Investigation of Effective Factors on Reference Evapotranspiration using Sensitivity Analysis of FAO-Penman-Monteith Equation
(Case-study: Yazd, Tabas and Marvast stations)

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Extended Abstract

Introduction
Most of Iran areas have been located in arid and semi arid climates. Water resource scarcity is one of the problems that has been attended by experts, decision makers and managers of the country. With respect to occurring droughts in recent years, proper management of existing water resources and also achieving to the better solution for their usage are essential. One of the ways that a large volume of water can be losses through the land surface is evapotranspiration (ET) as it has an important role in water resource management. ET of each region is generally affected by different climatic parameters as well as its geographical attributes. To have a proper management of the ET, as a great water losing way, it seems to be necessary to know and study the ET and its effective parameters in each region. Sensitivity analysis is always known as one of these approaches. This approach seeks to attribute uncertain output to specific input parameters. The input parameters are varied in turn and their effects on the model output are quantified.

Materials and Methods
In this study, a sensitivity analysis procedure was accomplished on data of three meteorological stations in Yazd province, central part of Iran. Yazd, Tabas and Marvast have been these studied stations. Appropriate spatial distribution, as well as having extreme values for one (or more) climatic parameter(s) were the major reasons for selection of these stations. Yazd province also was selected due to the importance of its evapotranspiration as a major way for wasting the surface and subsurface water resources.
This sensitivity analysis was focused on maximum temperature ($T_{\text{max}}$), minimum temperature ($T_{\text{min}}$), relative humidity (RH) and wind speed (W), as four input parameters that influence ET, dominantly. For this purpose, successive increase and decrease of these parameters were accomplished in three 10% change intervals. Therefore, $\pm 10\%$, $\pm 20\%$ and $\pm 30\%$ of the input parameters were calculated and inserted in the ET model to yield different evapotranspiration outputs. Employed ET model was CROPWAT, as a most frequently used approach for determination of reference ET. This model calculates reference evapotranspiration based on the FAO-Penman-Monteith equation.

Via the procedure, six different ET values were obtained for successive changes of each input parameter. This sensitivity analysis was separately accomplished for four representative months in all the selected meteorological stations. May, August, November and February were representative months of spring, summer, autumn and winter seasons, respectively. Finally, relative importance and adequacy of different ET input parameters were investigated at different seasons and different stations, independently.

Results and Discussion

The results of this study indicate that maximum reference evapotranspiration belongs to August with 10, 8.5 and 7.5 mm per day for Yazd, Tabas and Marvast stations, respectively. After successive changes of input parameters and consequently, yield of different ET values, relative importance of each input parameter was distinguished. As a preliminary result, order of importance in each season was similar for almost all the independent stations. For example, $T_{\text{max}}$, W and $T_{\text{min}}$ were main three parameters that influence reference ET of spring season, decreasingly. This order was also changed to W, $T_{\text{max}}$ and $T_{\text{min}}$ in summer and RH, $T_{\text{max}}$ and W in winter. Order of importance in autumn was slightly different for Yazd and Marvast stations compared with Tabas. This order was W, $T_{\text{max}}$ and RH for Yazd and Marvast, while it was W, $T_{\text{max}}$ and $T_{\text{min}}$ in Tabas station. Results of the study can also be considered as a different view; main important input parameter that influenced ET was different for each season compared with other ones. For example, main important parameter in spring was $T_{\text{max}}$, while in summer was wind speed. Similarly, wind speed and relative humidity were distinguished as the most important parameters in autumn and winter seasons, respectively. Considering importance of relative humidity as the main parameter in winter season, it seems that precipitation has significantly influenced the reference ET, adversely.

Sensitivity analysis on annual changes of reference ET also showed that $T_{\text{max}}$ and wind speed were the main input parameters for calculation of ET. For instance, after increasing the $T_{\text{max}}$ and W until 30% (as input parameters), reference ET was also increased until 1.3, 0.6 and 0.5 mm per day in Yazd, Marvast and Tabas stations, respectively. Relative humidity also was found as a negligible input parameter in this annual basis sensitivity analysis.

Conclusion

Considering the results for sensitivity analysis of the FAO-Penman-Monteith equation inputs, relative importance of different climatic parameters seems to be more significant compared with other input parameters such as geographical attributes of the studied region.

**Keywords:** Sensitivity analysis, Evapotranspiration, CROPWAT, Climatic parameters, Yazd.