Shahid Chamran University of Ahvaz

Irrigation Sciences and Engineering **Vol. 41, No. 3, Fall 2018, p. 119-132**

EXTENDED ABSTRACT

Analysis of the Accuracy Comparison of Five Different Models of Valiantzas Equation in the Estimation of Reference Evapotranspiration

S. Mehdizadeh[1], F. Khashaei[2*], J. Behmanesh[3] and R. Delir Hasan Niya[4]

1- Ph.D at Irrigation and Drainage, Urmia University.
2*- Corresponding Author, Ph.D Student of Irrigation and Drainage, Urmia University *(f.khashayi@urmia.ac.ir).*
3- Professor, Department of Water Engineering, Urmia University.
4- Assosiate Professor, Department of Water Engineering, University of Tabriz.

Received: 8 January 2016 Accepted: 19 February 2017

Keywords: Potential evapotranspiration, Valiantzas equations, FAO-Penman-Monteith.

Introduction

Evapotranspiration is one of the most important factors in hydrological cycle. Potential evapotranspiration is used to design in irrigation and drainage networks and hydrological studies (Davis & Dukes, 2010). The conducted studies in different regions of the world have shown that the FAO-Penman-Monteith model can be presented as the most accurate method under various climatic conditions (Irmak et al, 2003, ASCE-EWRI, 2005, Jabloun & Sahli, 2008, Martinez & Thepadia, 2010 and Azhar & Perera, 2011). The calibration of the mentioned equation using lysimetric data in a wide range of climatic conditions and its applicability without the requirement for local calibration in different climatic conditions are the benefits of the FAO-Penman-Monteith equation (Landeras et al, 2008). On the other hand, the Valiantzas model is one of the newest methods for estimating ETo. Advantages of using the Valiantzas equations in the estimation of reference evapotranspiration include simple application for spatial calibration, easy application for temporal distribution of reference evapotranspiration values, easy use for routine hydrological applications and simplicity of equations for other hydrological applications (a, b, c, Valiantzas, 2013). The purpose of this study was to evaluate and compare the accuracy of five different Valiantzas models for estimating reference evapotranspiration at the studied stations located in the northwest of Iran (Urmia Lake basin) including Urmia, Salmas, Mahabad, Takab, Tabriz, Sarab and Maragheh and providing the best version of the Valiantzas as the results of which are the highest concurrence with the FAO-Penman-Monteith method.

Methodology

In this research, the daily mean of meteorological parameters in a 15-year statistical period (1997 to 2011) were used at seven synoptic stations including Urmia, Salmas, Mahabad, Takab, Tabriz, Sarab and Maragheh for calculating annual, seasonal, and monthly evapotranspiration values. Due to the lack of lysimetric information on reference evapotranspiration at the stations studied for validating ETo calculation methods, the FAO-Penman-Monteith method was considered as a standard and reference method. ETo values were calculated using five Valiantzas experimental equations and the results were compared with the values obtained by the FAO-Penman-Monteith method. Finally, for validating the Valiantzas equations with the FAO-Penman-Monteith method, the RMSE and R^2 and the linear equation of the values obtained from the FAO-Penman-Monteith method and the Valiantzas equation were used and their results were analyzed.

Results and discussion

The values of estimated daily evapotranspiration were compared using the five Valiantzas experimental models with the values obtained from the FAO-Penman-Monteith standard equation. The results of statistical indices showed that the best model for estimating reference evapotranspiration in the selected stations was the Valiantzas model 2 (Rs, T, RH, U) and the Valiantzas5 (Rs, T) had the worst accurate compared with others. The results showed that the values of R^2 and RMSE indices in the best estimation of the model for Sarab station were 0.981 and 0.441 mm/day respectively. Also, the most difference in the estimation of reference evapotranspiration models compared to the standard model in the studied area was in the Valiantzas5 (Rs, T) model at Maragheh station with values of performance indicators of 0.898 and 1.517 mm/day for R^2 and RMSE respectively. For example, the values of statistical indices for each of the five Valiantzas models for estimating annual reference evapotranspiration at the stations studied are shown in Table 1.

Table 1- The values of statistical indices of five different Valiantzas models for estimating reference evapotranspiration in annual scale

Method	index	Station						
		Maragheh	Sarab	Tabriz	Takab	Mahabad	Salmas	Urmia
Valiantzas 1 (R_s, T, RH, U)	R^2	0.994	0.988	0.994	0.989	0.989	0.981	0.988
	RMSE (mm day^{-1})	0.850	0.622	0.754	0.800	0.756	0.851	0.742
	S	1.156	1.155	1.144	1.159	1.142	1.170	1.139
Valiantzas 2 (R_s, T, RH, U)	R^2	0.988	0.981	0.988	0.986	0.983	0.977	0.987
	RMSE (mm day^{-1})	0.575	0.441	0.487	0.513	0.513	0.570	0.483
	S	1.088	1.087	1.072	1.086	1.077	1.092	1.076
Valiantzas 3 (R_s, T, RH)	R^2	0.938	0.944	0.942	0.961	0.906	0.938	0.935
	RMSE (mm day^{-1})	0.700	0.594	0.649	0.527	0.785	0.604	0.766
	S	0.966	1.082	0.972	0.958	0.994	0.970	0.904
Valiantzas 4 (R_s, T, RH)	R^2	0.924	0.928	0.925	0.950	0.882	0.921	0.917
	RMSE (mm day^{-1})	0.819	0.552	0.780	0.674	0.861	0.723	0.924
	S	0.920	1.020	0.919	0.907	0.945	0.913	0.862
Valiantzas 5 (R_s, T)	R^2	0.898	0.883	0.891	0.920	0.837	0.916	0.891
	RMSE (mm day^{-1})	1.517	0.723	1.389	1.218	1.305	1.178	1.268
	S	0.739	0.914	0.755	0.765	0.795	0.763	0.777

Conclusion

In this research, the annual, seasonal and monthly amounts of reference evapotranspiration were calculated using five Valiantzas models and the daily weather data for seven synoptic stations including Urmia, Salmas, Mahabad, Takab, Tabriz, Sarab and Maragheh. The values were compared with the obtained results from the FAO-Penman-Monteith method. To evaluate and compare the relationships, two statistical indicies including RMSE and R^2 were used. The results showed that the best model for calculating reference evapotranspiration in the study area was the Valiantzas2 (Rs, T, RH, U) method and the Valiantzas5 (Rs, T) had the worst results. Also, Valiantzas1 (Rs, T, RH, U) and Valianthas3 (Rs, T, RH) methods in the second and third priorities can be used to calculate reference evapotranspiration.

References

1-ASCE-EWRI. 2005. The ASCE standardized reference evapotranspiration equation. In: Allen, R. G., Walter, I. A., Elliot, R. L., et al.(Eds.), Environmental and Water Resources Institute (EWRI) of the American Society of Civil. Engineers, ASCE, Standardiza-tion of Reference Evapotranspiration Task Committee Final Report. American Society of Civil Engineers (ASCE), Reston, VA, 213pp.

2-Azhar, A. H. and B. J. C. Perera. 2011. Evaluation of reference evapotranspiration estimation methods under Southeast Australian Conditions. Irrigation and Drainage Engineering, 137(5):268–279.

3-Davis, S. L. and M.D. Dukes. 2010. Irrigation scheduling performance by evapotranspiration-based controllers. Agricultural Water Management, 98(1):19–28.

4-Irmak, S., Irmak, A., Allen R. G. and J.W. Jones. 2003. Solar and net radiation-based equations to estimate reference evapotranspiration in humid climates. Irrigation and Drainage Engineering, 129(5):336–347.

5-Jabloun, M. and A. Sahli. 2008. Evaluation of FAO-56 methodology for estimating reference evapotranspiration using limited climatic data application to Tunisia. Agricultural Water Management, 95(6):707–715.

6-Landeras, G., Ortiz-Barredo, A. and J. J. Lopez. 2008. Comparison of artificial neural network models and empirical and semi empirical equations for daily reference evapotranspiration estimation in the Basque Country (Northern Spain). Agricultural Water Management, 95:553–565.

7-Martinez, C. J. and M. Thepadia. 2010. Estimating reference evapotranspiration with minimum data in Florida, USA. Irrigation and Drainage Engineering, 136(7):494–501.

8-Valiantzas, J.D. 2013a. Simple ET_o forms of Penman's equation without wind and/or humidity data. I: theoretical development. Irrigation and Drainage Engineering, 139(1):1-8.

9-Valiantzas, J.D. 2013b. Simple ET_o forms of Penman's equation without wind and/or humidity data. II: comparisons with reduced set-FAO and other methodologies. Irrigation and Drainage Engineering, 139(1):9-19.

10-Valiantzas, J.D. 2013c. Simplified reference evapotranspiration formula using an empirical impact factor for Penman's aerodynamic term. Hydrologic Engineering, 18(1):108–114.