

EVAPOTRANSPIRATION ESTIMATE OF REFERENCE FOR THE MUNICIPALITY OF VITÓRIA DA CONSQUISTA/BA

Mikaela Oliveira Souza¹, Matheus Ferreira Almeida², Mateus Pires Barbosa³, Leandro Dias da Silva⁴, Raul Antônio Araújo do Bonfim⁵, Paulo Araquém Ramos Cairo⁶

ABSTRACT: The objective of this study was to estimate the reference evapotranspiration (ET_o) for the municipality of Vitória da Conquista/BA. Data from the climatological station for the year 2018, located at the State University of Southwest of Bahia, in the city of Vitória da Conquista/BA, were made available through an automatic station of the National Institute of Meteorology (INMET). The values of the coefficients of determination (R^2), standard error of the estimate (SEE) and the standard error of the adjusted estimate (SEEA) were used. We verified that Priestley-Taylor method obtained the best performance for both periods (dry and humid). Among the methods evaluated for the city of Vitória da Conquista/BA, it was verified that the Priestley-Taylor when compared to Camargo, showed the highest values of determination coefficients, standard error of the estimate and the standard error of the adjusted estimate.

KEYWORDS: Penman-Montheith, semiarid, water management

ESTIMATIVA DA EVAPOTRANSPIRAÇÃO DE REFERÊNCIA PARA O MUNICÍPIO DE VITÓRIA DA CONSQUISTA/BA

RESUMO: O objetivo deste estudo foi estimar a evapotranspiração de referência (ET_o) para o município de Vitória da Conquista/BA. Foram utilizados dados da estação climatológica referente ao ano de 2018, localizada na Universidade Estadual do Sudoeste da Bahia, no

¹ Discente em Agronomia, Departamento de Fitotecnia e Zootecnia, UESB, Estrada do Bem Querer km 04, Caixa Postal, 95, CEP 45031-900, Vitória da Conquista, BA, (75) 98808-4480, e-mail: leodias5@yahoo.com.br

² Discente em Agronomia, Departamento de Fitotecnia e Zootecnia, UESB, Vitória da Conquista, BA.

³ Discente em Agronomia, Departamento de Fitotecnia e Zootecnia, UESB, Vitória da Conquista, BA.

⁴ Pós-Doutorando, Programa de Pós-Graduação em Agronomia, UESB, Vitória da Conquista, BA.

⁵ Discente em Agronomia, Departamento de Fitotecnia e Zootecnia, UESB, Vitória da Conquista, BA.

⁶ Prof. Doutor, Departamento de Fitotecnia e Zootecnia, UESB, Vitória da Conquista, BA.

município de Vitória da Conquista/BA, sendo disponibilizada através de uma estação automática do Instituto Nacional de Meteorologia (INMET). Utilizaram-se os valores dos coeficientes de determinação (R^2), erro padrão da estimativa (SEE) e o erro padrão da estimativa ajustada (SEEA). Verificamos que método de Priestley-Taylor foi que obteve o melhor desempenho para os dois períodos (seco e úmido). Dentre os métodos avaliados para a cidade de Vitória da Conquista/BA, verificou-se que o de Priestley-Taylor quando comparado ao de Camargo, revelou os maiores valores de coeficientes de determinação, erro padrão da estimativa e o erro padrão da estimativa ajustada.

PALAVRAS-CHAVE: variáveis climáticas, Penman-Monteith, manejo hídrico

INTRODUCTION

The reference evapotranspiration (ETo), together with plant-and-soil related coefficients, are used for the proper estimation of crop evapotranspiration, which consists of the main parameter to be management of irrigation systems. Once it totals the amount of water used in the processes of a certain period (Cunha et al., 2013). According to Alencar et al. (2011) evapotranspiration is one of the main componentes of the hydrological cycle, and the choice of the appropriate method to estimate ends on local climatic conditions, hence the importance of establishing a methodology that suits the region in a simple and precise way.

According to Alves Sobrinho et al. (2011), evapotranspiration can be directly measured by specific equipment, as the weighing lysimeter, however the high cost restricts its use to research institutes and for regional calibration of indirect methods (Melo & Fernandes, 2012), hence several authors develop and test empirical methods to estimate evapotranspiration indirectly. According to Tagliaferre et al. (2012), for the State of Bahia, the quantification of evapotranspiration assumes particular importance because the water deficits that occur throughout the year constitute a limitation to agricultural production and a permanent source of risk in agriculture, especially in significant areas, whose characteristics climates are semi-acidity.

Thus, the objective of this work was to compare two estimation methods for ETo , with the Penman-Monteith method, dry and humid seasons of the year for the city of Vitória da Conquista/BA.

MATERIAL AND METHODS

The study was conducted in the city of Vitória da Conquista, located in the state of Bahia, coordinates 14° 53' 17" south latitude, 40° 48' 9" west longitude and 875 m altitude. According to Köppen, the municipality is classified as *Cwb* presenting subtropical altitude climate, with dry winter and mild summer. The warmest month's average temperature is below 22 °C. Data related to climate variables were obtained through an automatic INMET station, located in Vitória da Conquista/BA. ETo estimation calculations were performed using the Penman-Monteith (Allen et al., 1998) (1), Hargreaves and Samani (1985) and Priestley-Taylor (1972) methods.

$$ET_o = \frac{0.408 \Delta(Rn - G) + \gamma \frac{900}{T + 273} u_2 (e_s - e_d)}{\Delta + \gamma(1 + 0.34u_2)} \quad (1)$$

wherein:

ET_o - reference evapotranspiration (mm.d⁻¹); Rn- net radiation at the surface (MJ.m⁻².d⁻¹); G - soil heat flux (MJ.m⁻².d⁻¹); T - air temperature (°C); u₂ - wind speed at 2.0 m height (m s⁻¹); (e_s-e_d) - vapor pressure deficit (kPa); Δ - the slope of the curve saturation vapor pressure (kPa. C⁻¹); γ - psychrometric constant (kPa. C⁻¹).

To compare the ETo values between Penman-Monteith and the other methods, we used the critério proposed by Jensen et al. (1990), which are the standard error of estimation (SEE) (2) and the standard by error of the adjusted estimate (SEEA) (3) coefficients of determination (R²) and standard error of the estimate adjusted by origin (SEEAo) to the evaluation methods.

$$SEE = \left(\frac{\sum(Y_i - Y_m)^2}{n - 1} \right)^{0.5} \quad (2)$$

$$SEEA = \left(\frac{\sum(Y_{ic} - Y_m)^2}{n - 1} \right)^{0.5} \quad (3)$$

wherein:

Y_i - evapotranspiration estimated by the method (mm.d^{-1}); Y_m - evapotranspiration estimated by the standard method (mm.d^{-1}); Y_{ic} - estimate using evapotranspiration, adjusted by coefficients of linear regression (mm.d^{-1}); and n - total number of observations.

RESULTS AND DISCUSSION

The Penman-Montheith method, when compared to the other methods, showed that the Priestley-Taylor method was better when compared to the method proposed by Camargo in the two periods studied (Table 1).

Analyzing the coefficient of determination R^2 , we found that the Priestley-Taylor method showed better results, in addition to the standard error of the estimate (SEE) and the standard error of the adjusted estimate (SEEA), which is approaching zero. According to Silva & Souza (2011) working with the reference evapotranspiration estimate in Pernambuco, they found that the Priestley-Taylor method performed very well, while the Camargo method performed regularly.

In addition, Santos et al. (2010) reported that the Camargo method is mainly analyzed in humid climate regions, not presenting good estimates for dry (semiarid) climate regions, where they tend to be underestimated. Thus, we verified the fact that Camargo method did not present significant values when compared to Priestley-Taylor, since the city of Vitória da Conquista/BA has semiarid characteristics.

Table 1. Determination coefficient (R^2), standard error of estimate (SEE) and standard error of adjusted estimate (SEEA) parameters during the dry and humid period in Vitória da Conquista/Ba.

Penman-Montheith	Vitória da Conquista - Períod Dry		
	R^2	SEE	SEEA
Camargo	0.7951	2.70	2.70
Priestley-Taylor	0.9960	0.09	0.09
Penman-Montheith	Vitória da Conquista - Períod Humid		
	R^2	SEE	SEEA
Camargo	0.7152	4.55	4.54
Priestley-Taylor	0.9998	0.21	0.21

It was found that the best performance was found in the Priestley-Taylor method when related to Camargo (Figure 1). Analyzing the coefficient of determination for the Camargo method in humid period, the value found was 0.7152 highlighting its lower performance.

We can infer that this low value may be related to the region, because during the rainy season, there is a high frequency of cloudiness and insolation may induce errors in the estimation of ETo. According to Santos et al. (2010) the Thornthwaite-Camargo method performed well for January, March, July, and December. In addition, Silva et al. (2005), analyzing the evapotranspiration estimation methods for drainage system optimization, also found a tendency of the Camargo method to provide evapotranspiration estimates lower than those obtained by the Penman-Monteith FAO method.

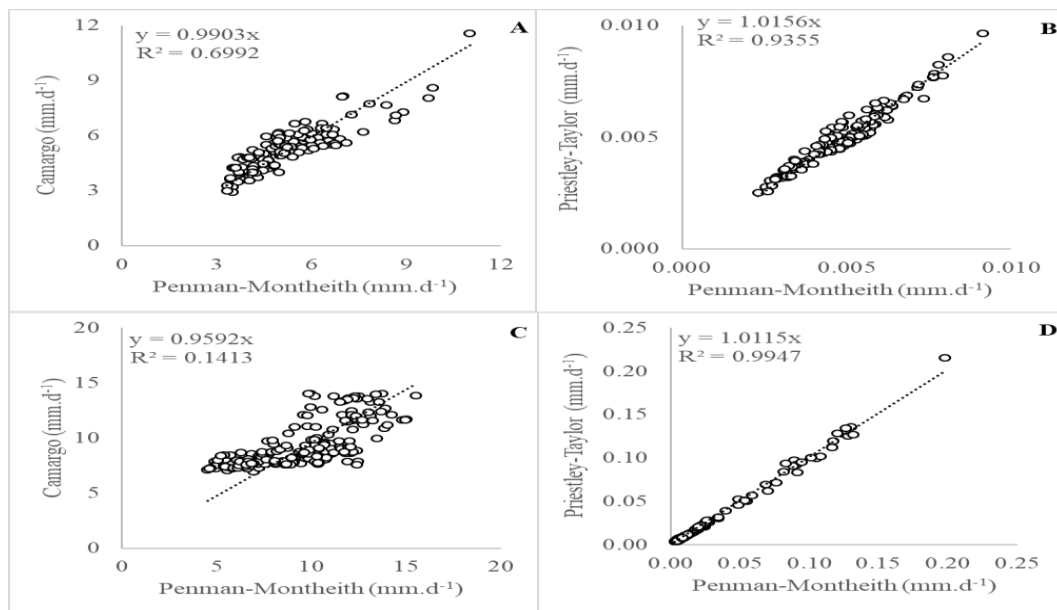


Figure 1. Linear regression between daily values of reference evapotranspiration (ETo) for dry period (A and B) and humid period (C and D), forced by origin, estimated by the Penman-Monteith method in relation to Camargo and Priestley-Taylor for the municipality of Vitória da Conquista/Ba.

CONCLUSIONS

Among the methods evaluated for the city of Vitória da Conquista / BA, it was found that the Priestley-Taylor when compared to Camargo showed the best performance to estimate the ETo.

ACKNOWLEDGEMENTS

To UESB for granting scholarship to the first author. To CNPq, FAPESB and CAPES for the PNPd scholarship.

BIBLIOGRAPHIC REFERENCES

ALENCAR, L.P.; SADIYAMA, G.C.; WANDERLEY, H.S.; ALMEIDA, T.S.; DELGADO, R.C. **Avaliação de métodos de estimativa da evapotranspiração de referência para três localidades no Norte de Minas Gerais**. Engenharia na Agricultura, Viçosa, v. 19, n. 5, P. 437-449, 2011.

ALVES SOBRINHO, T. et al. Estimative of the reference evapotranspiration by artificial neural. **Revista Brasileira de Meteorologia**, v. 26, n. 2, p. 197–203, 2011.

CAMARGO, A. P. **Balanço hídrico no estado de São Paulo**. 3. ed. Campinas: IAC, 1971. 24 p. (Boletim, n.116).

CUNHA, F. F.; MAGALHÃES, F. F.; CASTRO, M. A. **Métodos para estimativa da evapotranspiração de referência para Chapadão do Sul - MS**. Engenharia na Agricultura, Viçosa, v. 21, n. 2, p. 159- 172, 2013.

JENSEN, M.E.; BURMAN, R.D.; ALLEN, R.G. **Evapotranspiration and irrigation water requirements**. New York: ASCE, 1990. 332 p.

MELO, G. L. DE; FERNANDES, A. L. T. Evaluation of empirical methods to estimate reference evapotranspiration in Uberaba, State of Minas Gerais, Brazil. **Engenharia Agrícola**, Jaboticabal, v. 32, n. 5, p. 875–888, 2012.

PRIESTLEY, C.H.B.; TAYLOR, R.J. On the assessment of surface heat flux and evaporation using large scale parameters. **Monthly Weather Review.**, Boston, v. 100, n. 2, p. 81-92, 1972.

SANTOS, W.O.; BATISTA, B.D.O.; DE ASSIS, J.P.; RODRIGUES, W.M.; SOBRINHO, J.E. **Métodos de estimativa da evapotranspiração de referência (ET_o) para a região de Mossoró-RN**. Revista Verde (Mossoró – RN – Brasil) v.5, n.5, (Número Especial) p. 210 – 221, 2010.

SILVA, A.P.N.; SOUZA, L.R. **Estimativa de Evapotranspiração de Referência no Semiárido Pernambucano**. Engenharia Ambiental - Espírito Santo do Pinhal. v. 8, n. 4, p. 003-022, 2011.

SILVA, K.O. da, MIRANDA, J.H., DUARTE, S.N., FOLEGATTI, M.V. Análise de métodos de estimativa de evapotranspiração na otimização de sistemas de drenagem. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v.9, n.2, p.161-165, 2005.

TAGLIAFERRE, C.; SILVA, J.P.; DE PAULA, A.; GUIMARAES, D. ULISSES G.; BARROSO, N.Í. S. Estimativa da evapotranspiração de referência para três localidades do estado da Bahia. **Revista Caatinga**, Mossoró, v. 25, n. 2, p. 136-143, 2012.

and comparison of models. **Journal of Geophysical Research**, Ottawa, v. 90, n. 5. p. 8995-9005. 1985.