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Short Comminucation

Comparison of different methods for evaluating potential evapotranspiration in Chhattisgarh

RAJESH KHAVSE, J. L. CHAUDHARY and SANJAY BHELAWE

Department of Agrometeorology, Indira Gandhi Krishi Vishwavidyalaya, Raipur 492012 (CG).
Email. khavse@gmail.com, jawaharlal_2007@rediffmail.com

Evapotranspiration plays major role in global water balance and significantly influences the global energy balance as well. Hence, the quantification of evapotranspiration is necessary for water resources management, irrigation scheduling and environmental assessment. Potential evapo-transpiration (PET) is defined as the amount of water that can potentially evaporate and transpire from a vegetative surface with no restrictions other than the atmospheric demand (Lu *et al.*, 2005). PET provides a good representation of the maximum possible water loss to the atmosphere. Knowledge of PET rates is essential for a variety of applications, including hydrological modeling, irrigation planning, geo-botanical studies and estimation of sensitive-to-climatic change aridity indices. Penman's combination equation is generally accepted as an appropriate method for estimating potential evapotranspiration. However, as all the climatic data required to calculate Penman's potential evapotranspiration are seldom available, potential evapotranspiration is more commonly approximated as a factor times standard evaporation pan reading. Doorenbos and Pruiit (1977) and Jensen *et al* (1990) provided detailed guidelines for using the various methods for computing potential evaporation and evapotranspiration. Different scientists from India (Khandelwal *et al*, 1999; Kumar *et al*, 1986; Krishnakumar and Prasad Rao, 2006; Kingra and Hundal, 2005) have attempted to compare these methods. Their results were found to differ from place to place. Hence location specific models are to be used.

PET have been estimated by different methods like Modified Penman's method on the lines of Penman equation, Hargreaves method, Turc method, Thornthwaite Method, Blaney- Criddle method, Christiansen method, FAO Penman-Monteith method, Monteith method. Daily data used for estimating and analyzing the PET using different methods of open pan evaporation and other meteorological parameters (air temperature, rainfall, humidity, vapour pressure and wind speed) were collected from the different agrometeorological observatories viz. Ambikapur, Jagdalpur, Raipur and Bilaspur which are representing different agroclimatic zones in Chhattisgarh. The period of data used for Ambikapur, Jagdalpur, Raipur and Bilaspur were 23 (1991-2014), 34 (1980-2014), 43 (1971-2014) and 31(1983-2014) years respectively. The daily value of open pan evaporation were measured by using a U.S.W.B. class A open pan evaporimeter at 0830 and 1430 hours IST in the Agrometeorological Observatory College of Agriculture, Raipur were used. In this investigation weekly and monthly PET values for four stations were computed using the PET v3 software (Bapuji Rao *et al.,* 2013). Based on daily data the weekly and monthly averages PET were worked out and the results are discussed for each station separately.

Annual estimation of PET

Annual estimation of PET computed by all the methods are higher at Raipur and lower at Jagdalpur in Hargreaves method. All the values of PET computed by different methods are over-estimated as compared to pan evaporation data. It seems from the Table 1 that the Turc method closely follows open pan evaporation values at Raipur though they are lower at Jagdalpur, Ambikapur and Bilaspur. Among the 7 methods, Modified Penman values are highest at Raipur while Hargreaves method PET values are highest at Bilaspur and Jagdalpur. Because of these higher estimates, the crop coefficient was more than 1 by all the methods of PET.

Seasonal estimation of PET

Based on the monthly PET values the total PET for *Kharif* and *Rabi* seasons were examined at different stations and shown in Table-2. The total values of PET during *Kharif* season varied from 453 mm to 891 mm. For example these values varied from 485 mm to 883 mm at Raipur. However the open pen values are lower during *Kharif* seasons at all the four stations as compared to PET calculated by different methods and hence the crop coefficients PET/E0 are greater than 1 during *Kharif* season. In the same way the PET values computed by different methods shows that the

Table 1: Annual PET values at different station using different methods

Stations	Modified Penman	Hargreaves	Turc	Thornthwaite	Blaney-Criddle	Christiansen	Open Pan	FAO Penman-Monteitn
Ambikapur	1590	1667	1371	1430	1534	1399	1235	1380
Jagdalpur	1557	1717	1298	1434	1390	1106	951	1372
Raipur	1848	1798	1421	1842	1739	1537	1260	1627
Bilaspur	1521	1735	1378	1768	1553	1301	1157	1297

Tables 2: Seasonal PET values at different station using different methods

Stations	Modified Penman	Hargreaves	Turc	Thornthwaite	Blaney-Criddle	Christiansen	Open Pan	FAO Penman-Monteitn
Kharif (June- Oct.)								
Ambikapur	639	680	557	729	532	564	487	564
Jagdalpur	591	643	499	646	452	365	313	517
Raipur	731	693	556	883	584	618	485	640
Bilaspur	611	682	555	891	539	515	453	541
Rabi (Nov-March)								
Ambikapur	518	573	499	233	556	450	420	439
Jagdalpur	567	678	518	329	566	415	373	499
Raipur	602	653	544	354	658	435	387	525
Bilaspur	521	616	512	320	583	421	389	435

Thornthwaite PET values are lowest at all the four stations and they matched closely with open pan evaporation value. While Hargreaves PET estimates are higher in rabi season at Jagdalpur and Bilaspur while Blaney-Criddle method value of PET during rabi season are highest at Jagdalpur. The lowest Thornthwaite method value of PET is at Ambikapur. Thus there is no trend of PET estimated by different methods in all the 4 stations and it suggested that local variability of meteorological conditions is important for estimation of PET at different locations. But from the analysis for different seasons it was found that Thronthwaite values are lower than any other method but at Jagdalpur Thronthwaite PET value for *Rabi* season are more close to open pan values at Jagdalpur as compared to other stations. Seasonal estimation of PET for Ambikapur indicated that the values in general are less in winter months and high during summer months. On the contrary the PET values were over-estimated during summer months. This is true in case of all the methods. In fact all the methods over-estimated PET values as compared to open pan evaporation in summer months except Turc method in May and June.

Hence, it can be concluded that on overall basis the FAO Penman -Monteith equation seems to be more appropriate in application part as this method is rationalizing the weightage factor of different meteorological parameters.

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