Mausam, (1984), **35**, 2, 209-212

551.573

Estimation of weekly potential evapotranspiration

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(Received 17 August 1982)

सार — साप्ताहिक संभावित वाष्पोत्सर्जन का आकलन चार भिन्न-भिन्न विधियों द्वारा किया गया है : (क) पेनमेन के संशोधित सूत्र से आकलित मासिक मानों का अन्तर्वेशन, (ख) मौसम से संबंधित साप्ताहिक सामान्य एवं मापे गए निवल सौर विकिरणों का आगत-आंकड़ों के रूप में उपयोग करके पेनमेन के संशोधित सूत्र से आकलन, (ग) डुरेनबोस एवं प्रुइट्ट (1975) द्वारा दी गई विधि का अनुसरण करके आकलन एवं (घ) मौसम के साप्ताहिक सामान्यों एवं सारणियों से प्राप्त सौर विकिरणों के आंकड़ों का संशोधित पेनमेन सूत्र में उपयोग करके आकलन। इस प्रकार से प्राप्त मानों का वास्तविक वाष्पन से तुलना की गई है। यदि निवल सौर विकिरणों के आंकड़े उपलब्ध न हों, तो जलवायु के आंकड़ों से संभावित वाष्पोत्सर्जन की संगणना में "घ" में बताई विधि उपयोग में लाई जा सकती है।

ABSTRACT. Weekly potential evapotranspiration is estimated by four different methods — (A) Interpolation of monthly values estimated by modified Penman formula, (B) Estimation by modified Penman formula with weekly meteorological normals and measured net solar radiation as input data, (C) Computed following the method given by Doorenbos and Pruitt (1975) and (D) Estimation by modified Penman formula with weekly meteorological normals and solar radiation obtained from tables. Values so obtained are compared with actual evaporation. Method D may be used to compute PE values from climatological data if net solar radiation is not available.

1. Introduction

The quantification of irrigation needs for crop production should be accurately known to determine the most effective use of available water, which depends on the loss due to evapotranspiration (ET). Different methods are used to predict potential evapotranspiration (PE) from climatic variables owing to the difficulty of accurate direct measurements of ET under field conditions. To predict the effect of climate on crop water requirement, Penman's method is used wherever data on temperature, humidity, wind, sunshine and radiation etc are available. Original Penman (1948) equation predicted the loss of water by evaporation from an open water surface. It consists of two terms, *viz.*, (1) the energy (radiation) and (2) ærodynamic (wind and humidity). This equation can be used for direct prediction of PE by incorporating appropriate reflection coefficients for incoming solar radiation, the effect of plant resistance to transpiration and by inclusion of appropriate wind functions which take into account the change in aerodynamic roughness with growth of crop. Using modified Penman formula, Rao *et al.* (1971) computed monthly and annual PE of about 300 stations in and near India. So far, for want of weekly normals, the monthly PE was interpolated into weekly form and use for subsequent computation. Modified Penman method may be devised to get weekly PE values using weekly normals of meteorological records including measured radiation. This is likely to provide satisfactory results to predict the effect of climate on crop water requirements. Doorenbos and Pruitt (1975) also suggested a formula to predict the effect of climate on crop water requirement. This is nothing but the original Penman method (1948) with the inclusion of revised wind function term and an additional correction for day and night time weather conditions, not representative of climates for which the wind function was determined.

An attempt has been made in this study to compare the weekly PE values obtained by these four methods.

2. Data

Four stations : New Delhi, Pune, Nagpur and Jodhpur are used for this study. Weekly meteorological data for a long period and radiation data from 1964 to 1975 are available for these four stations. For the estimation of weekly PE values following four methods are used.

Method 'A' — Estimation of weekly PE by linear interpolation of monthly PE computed by Rao *et al.* (1971).

Method 'B' — Weekly PE values are computed every year by modified Penman formula where input

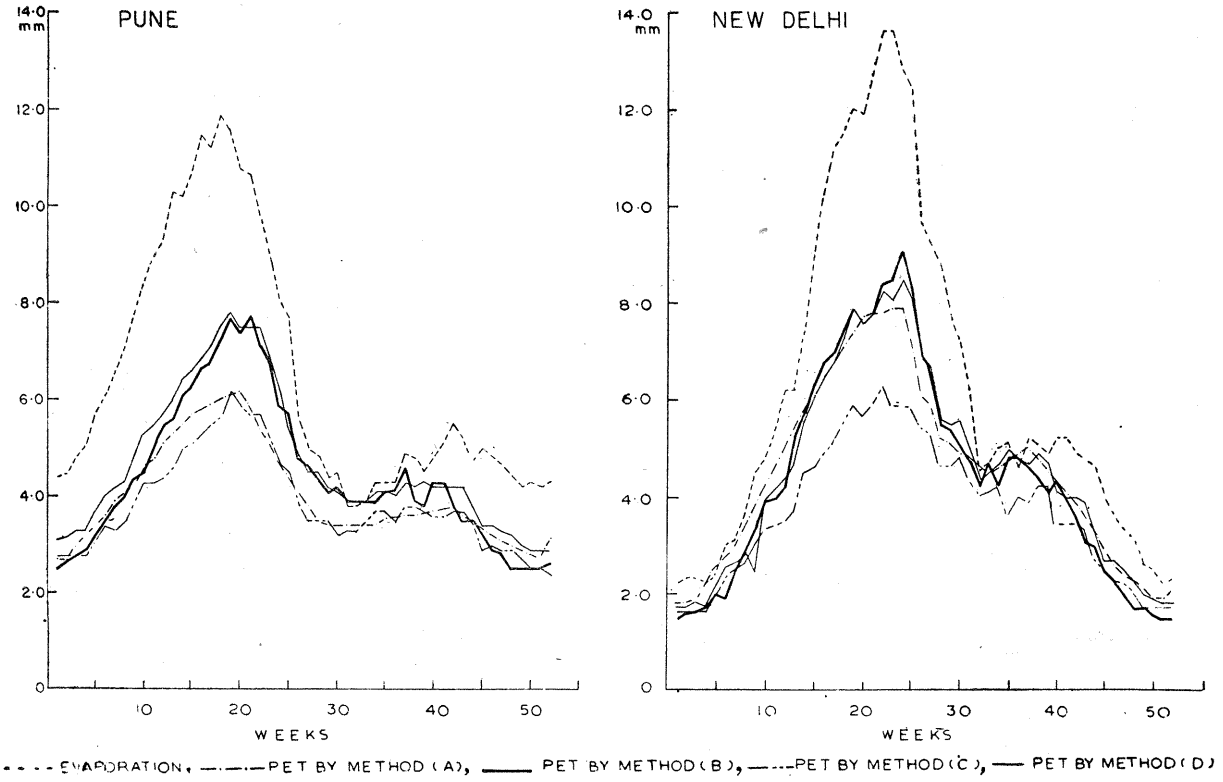

Fig. 1 Fig. 2

Figs. 1 & 2. Weekly mean evaporation and PE estimated by different methods

data are weekly meteorological parameters and measured net solar radiation. For every week PE values thus computed are averaged out over all the years to get the normal weekly PE.

Method 'C' — Weekly PE computed by using method given by Doorenbos and Pruitt (1975).

Method 'D' — PE values are computed by modified Penman formula (Rao *et al.* 1971) using weekly normals of meteorological records and appropriate reflection coefficient for incoming solar radiation (Doorenbos & Pruitt 1975) in place of net radiation records.

3. Discussion

PE values computed by these four methods are presented in Figs. 1-4 for 4 stations, *i.e.,* New Delhi, Pune, Nagpur and Jodhpur respectively.

Fig. 1 gives the mean daily PE values for each week computed by four methods along with pan evaporation for Pune. It is seen that pan evaporation is always higher than that of computed PE values by any method except 31 to 33 weeks (30 July-16 August). Values obtained from methods B and D resemble closely throughout the summer and rainy season (*i.e.,* March-September). Values obtained from methods A and C appear to be under-estimated over most of the time of the year.

Fig. 2 depicts the estimated PE values over Delhi. Pan evaporation is always higher than that of estimated values except 33rd week. At this station PE values from A, B and D do not differ very much but method C gives lower values throughout the year except winter period.

At Nagpur (Fig. 3) pan evaporation is always more than that of estimated values of PE throughout the year. Variation of values obtained from B and D is very little but PE values from method C gives the lowest values throughout the year.

Fig. 4 brings out estimated PE of Jodhpur situated in arid region. At this station values obtained from the methods B and C resemble very closely. The values from A and D are always lower than that from B and C. Pan evaporimeter values are always higher than that of values estimated by any predicted formula.

Table 1 gives ratio of the estimated PE values and pan evaporation of four different periods at four stations — Pune, New Delhi, Nagpur and Jodhpur

TABLE 1

Ratio of estimated potential evapotranspiration (PE) and Pan evaporation (EP)

Period	Weeks	Method A	B	C	D
		Pune			
Pre-monsson	10-22	0.53	0.62	0.49	0.64
Monsoon	23-40	0.76	0.89	0.76	0.91
Post-monsoon	41-46	0.70	0.69	0.67	0.77
Winter	47-09	0.62	0.58	0.58	0.67
		New Delhi			
Pre-monsoon	10-25	0.68	0.69	0.52	0.67
Monsoon	26-38	0.84	0.84	0.73	0.87
Post-monsoon	39-46	0.78	0.72	0.68	0.79
Winter	47-09	0.86	0.70	0.72	0.77
		Nagpur			
Pre-monsoon	10-23	0.64	0.64	0.46	0.65
Monsoon	24-40	0.75	0.78	0.63	0.78
Post-monsoon	41-46	0.76	0.72	0.61	0.74
Winter	47-09	—	0.73	0.65	0.77
		Jodhpur			
Pre-monsoon	10-25	0.53	0.62	0.47	0.61
Monsoon	26-38	0.64	0.76	0.61	0.76
Post-monsoon	39-46	0.55	0.62	0.62	0.64
Winter	47-09	0.50	0.60	0.55	0.62

TABLE 2

Total PE in mm during monsoon

Station	Evap.	A	B	C	D
Pune	615.30	447.58	535.50	449.61	543.97
Nagpur	748.30	—	567.84	448.91	562.31
New Delhi	823.20	650.02	671.30	550.13	684.46
Jodhpur	1152.90	707.63	832.37	645.19	835.94

respectively. These values are obtained by averaging out weekly ratios of various weeks between onset and withdrawal of monsoon. Ramdas (1972) tried to find out weekly ratios of various weeks between onset and evaporation in the different seasons of the year and found values of the ratios varying from .6 to .85 depending on the season of the year. Table 1 (Pune) shows that ratios computed by the methods B and D varies from .64 to .91 at different seasons of the year. Ratios obtained by the other two methods are comparatively lower.

It is seen that in respect of New Delhi ratios by method B range from .67 to .87. Ratios estimated by method C is somewhat lower than those computed by other three methods.

Range of the values computed by the methods B and D is low (*i.e.*, from .64 to .78) for Nagpur. These values resembled closely throughout the four periods. Values obtained from method C is lower as has been seen in other two cases.

At Jodhpur — a station in arid zone — values obtained by methods B and D are almost the same in various seasons of the year. The highest value is in the monsoon season, *i.e.*, 0.76 by both the methods. Ratios obtained by other two methods vary from 0.47 to 0.64. These seem to be very much low. Radiation plays vital part for evaporation of water either from bare soil or cropped area.

In absence of actual observations, estimated values are used for computation of PE. The result that emerged out from the present study is that computed radiation may be equally important to estimate PE for practical purposes in most of the areas of India.

Table 2 gives the total PE values during monsoon computed by different methods for the four stations along with the normal monsoon period. It is seen that the difference in total PE at Jodhpur computed by methods B and A is about 125 mm whereas difference between the total PE computed by methods B and D and B and C is 3 and 187 mm respectively.

In all the four stations difference between B and D is always less than other two methods. It is evident that the values computed by using actual radiation data is always preferable but most of the cases radiation data are not available. In those places method D could be used for estimation of PE values.

4. Conclusion

The estimated weekly PE values are useful for evaluating irrigation needs and scheduling irrigation. The correct weekly PE values are also essential for many other agroclimatological work. In absence of the meteorological parameters required to compute weekly PE values, monthly values computed by Rao *et al.* (1971) are interpolated and normally used. It is seen that these values are underestimated for most of the period. Among the four methods discussed method D may be used to compute PE values.

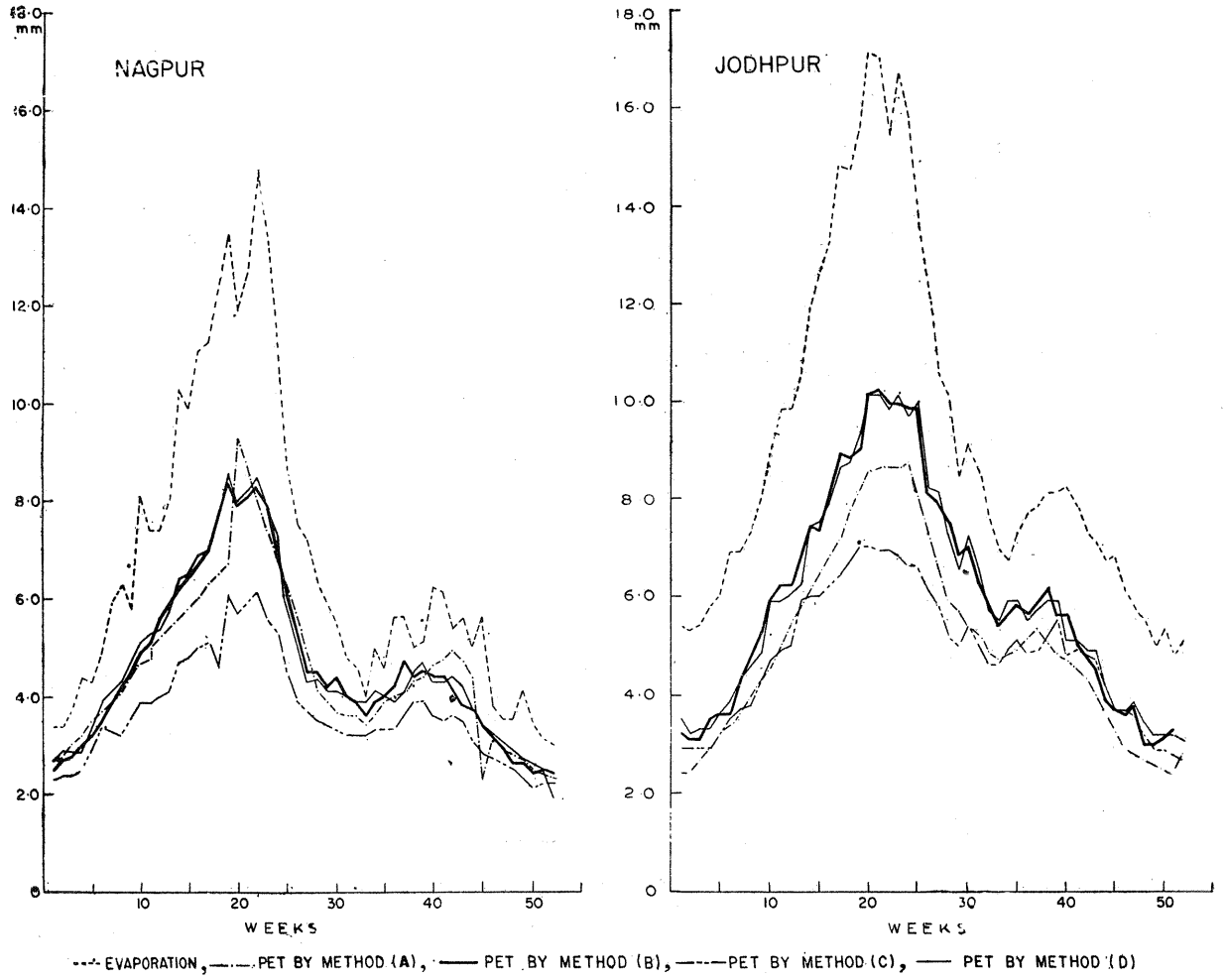

Fig. 3 Fig. 4

Figs. 3 & 4. Weekly mean evaporation and PE estimated by different methods

Ratio of evaporation and potential evapotranspiration computed by method D ranges from .72 to .91. For practical purposes these values may be taken from .75 to .90 in monsoon season. During the post monsoon period these values may be taken from .75 to .80 in the semi-arid zone and in the arid zone it may be taken .65 to .70. Following method D weekly PE is computed for about 100 stations which may be available for the users.

Acknowledgement

The authors wish to express their sincere thanks to Shri S. J. Maske, Director, Division of Agricultural Meteorology for his encouragement. Thanks are also due to the staff of D.F.R. Unit and Drawing Branch.

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