

Short communication

**Determination of pan coefficient for estimation of reference evapotranspiration for Jodhpur (Rajasthan)**

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The main problem in estimation of reference evapotranspiration ( $ET_o$ ) is availability of required meteorological parameters. At most of the locations, required parameters are generally not available and sometimes available meteorological data are not reliable. Under such circumstances, pan evaporation data can be used for estimation of  $ET_o$ . Evaporation pans provide a measurement of the integrated effect of radiation, wind, temperature and humidity on evaporation from a specific open water surface. Pan evaporation ( $E_{pan}$ ) is related to reference evapotranspiration by an empirically derived pan coefficient ( $K_p$ ). Thus,

$$ET_o = K_p \cdot E_{pan} \dots\dots\dots(1)$$

where  $E_{pan}$  = pan evaporation ( mm day<sup>-1</sup> ),  $K_p$  = pan coefficient. The Pan Coefficient ( $K_p$ ) is defined as ratio of reference evapotranspiration ( $ET_o$ ) and water loss by evaporation ( $E_{pan}$ ) from open water surface of a pan and depends on type and size of pan and state of the upwind buffer zone (fetch). Pan coefficients for class 'A' pan for different pan siting and environment conditions are available in standard literature. However all the local conditions of pan siting are not accounted

in the available literature. Therefore pan coefficient needs site specific determination for actual estimation of crop water requirement.

The study has been conducted for Jodhpur located in the heart of arid zone of Rajasthan (26°18' N latitude and 73°1'E longitude at 224 m from M.S.L.). This is the most arid part of the state where the annual rainfall varies from 100 to 400 mm (CV>70%) that the entire rain of the year may fall on a single day and the rest of the year may be dry. The weekly records of climatic parameters i.e. temperature, humidity, wind velocity, sunshine hours and pan evaporation have been obtained for 30 years (1967-1999, except for 70,75,76) from Indian Meteorological Department, Pune. The data series for various meteorological parameters for corresponding weeks were added together and average value for 52 weeks have been found and weekly temperature, relative humidity, sunshine hours, wind velocity and pan evaporation have been generated.

**Determination of reference evapotranspiration**

There are several methods described

by Eagleson (1970), Viessman *et al.* (1977), Doorenbos and Pruitt (1977) and others for the estimation of reference evapotranspiration. The main source of error in estimation of  $ET_o$  by empirical methods is application of these methods in areas other than wherever these have been developed. FAO recommended Penman-Monteith combination method for estimation of reference evapotranspiration (Allen *et al.*, 1998).

### Pan Coefficient

Reference evapotranspiration has been estimated on weekly basis by Penman-Monteith method using observed normal meteorological parameters of study area. For each week, value of  $K_p$  has been obtained by computing  $ET_o$  and observed value of  $E_{pan}$  on annual and seasonal basis. The lowest value of pan coefficient (0.59) is observed in 44<sup>th</sup> week while the highest pan coefficient of 0.82 was observed in 34<sup>th</sup> week (Fig.1).

Based on the variation of meteorological parameters, the whole year has been divided into three main seasons. Summer season ranges from 10<sup>th</sup> week to 26<sup>th</sup> week (March to June), Monsoon season from 27<sup>th</sup> week to 44<sup>th</sup> week (July to October) and Winter season from 45<sup>th</sup> week to 52<sup>nd</sup> week and 1<sup>st</sup> week to 9<sup>th</sup> week (November to February) of the year. The seasonal pan coefficients values are 0.640, 0.734 and 0.708 for summer, monsoon and winter season respectively.

Most of the crops are sown in well-defined seasons. Above mentioned seasonal

pan coefficient can be used for improved estimate of crop water requirement for the specific season. Comparison of reference evapotranspiration estimated by seasonal crop coefficient (as determined above) and average pan coefficient (0.75) based on average climatic and pan siting conditions (RHmean 44%; WV 1.91 m s<sup>-1</sup>) is presented in Fig.2. Average pan coefficient overestimates  $ET_o$  in summer by 17 % followed by winter (6 %) and monsoon (2%). Overestimation of crop water requirement specially in case of irrigated crops in not only a wastage of precious resources but can also adversely affect crop yield.

Alternatively, an attempt has also been made to develop regression model for the estimation of reference evapotranspiration using measured pan evaporation data without pan coefficient. Linear regression has been used to describe association between computed value of  $ET_o$  (Penman-Monteith) and observed Pan evaporation ( $E_{pan}$ ). The developed equation is as follows

$$ET_o = 0.787 + 0.583 * E_{pan} \quad (r=0.982) \quad \dots\dots\dots(2)$$

A value of 'r' close to unity indicates a high degree of association between two parameters. The test of significance between two parameters was also estimated at P=0.05. The above mentioned equation has very high degree of association, therefore can be reliably used to estimate reference evapotranspiration from measured pan evaporation for the Jodhpur arid area.

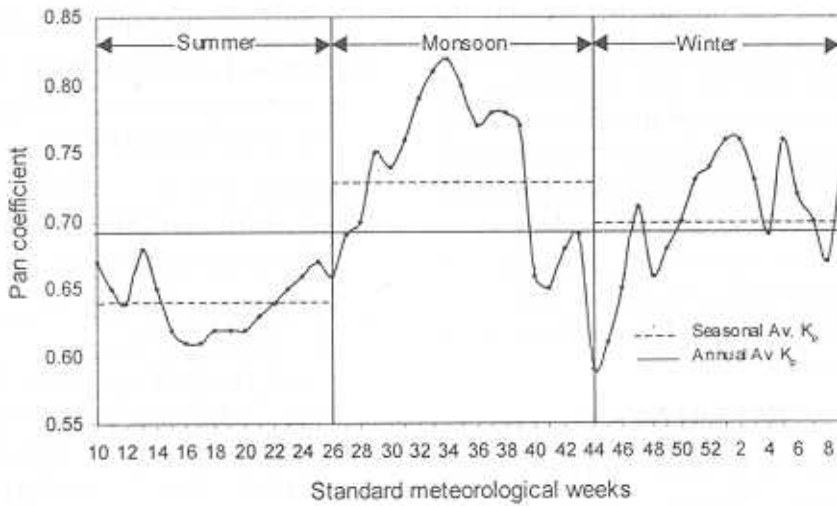


Fig. 1: Variation of weekly pan coefficient ( $K_p$ ) throughout a year

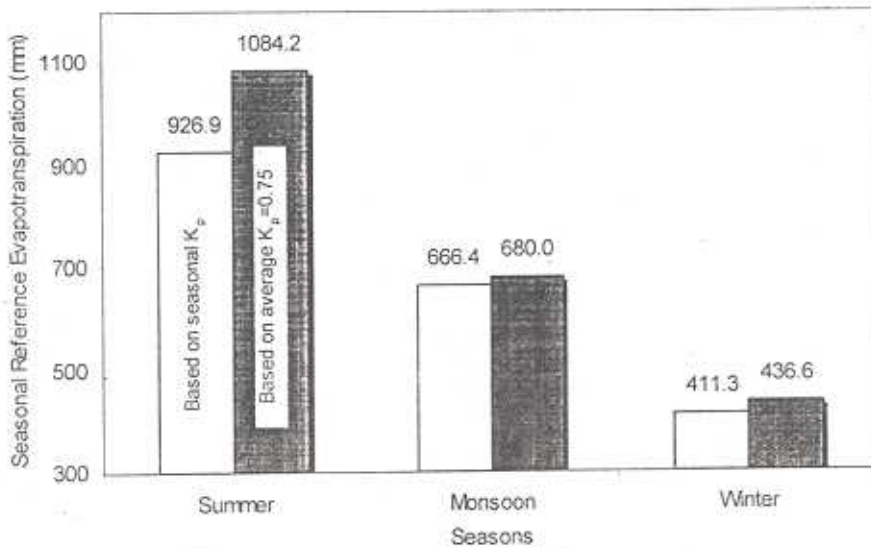


Fig. 2: Comparison of  $ET_o$  estimated by seasonal pan coefficient and average pan coefficient (0.75)

The present study provides an updated weekly and seasonal pan coefficients for Jodhpur with respect to standard Penman-Monteith method for estimation of reference evapotranspiration. Estimation of crop water requirement is of immense use for future planning and management of water resources. In arid areas where water is a very scarce commodity, use of weekly and seasonal pan coefficient will be more rational than use of an average pan coefficient.

#### REFERENCES

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