

Estimation of Evaporation from Different Meteorological Parameters

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Abstract : Simple correlations between different meteorological parameters and evaporation, measured from US Class A open pan evaporimeter, were worked out. The highest correlation value (0.85) was obtained with maximum air temperature, followed by wind speed (0.82). The coefficient of determinates for minimum air temperature, relative humidity and bright sunshine hours were 0.70, -0.56 and 0.15, respectively. The highest coefficient of determination was 0.92, when all these meteorological parameters were considered together.

Key words : Evaporation, meteorological correlation, evaporimeter, temperature, wind, coefficient, humidity sunshine.

The measurement or estimation of evaporation is useful for scheduling of irrigation and water management conservation in any region. The rate of evaporation depends on meteorological factors such as radiation, temperature of air, wind speed and relative humidity at or near the evaporation surface.

There are several simple devices and empirical methods for estimating evaporation. Evaporation measurements using evaporimeter tanks or pan are further controlled by the size, depth, shape, material and colour of the tank or pan and nature of exposure. Small containers of different kind can measure evaporation more accurately but the measurements of evaporation from the surface of large water bodies, crop fields are also required and, therefore, several workers have used different methods for estimating evaporation.

Linacre (1967) evaluated that the evaporation rate can be estimated only from radiation measurements ignoring humidity and wind. Tanner (1968) observed that radiation methods for estimating evaporation are among the better empirical methods. Singh *et al.* (1992) made an attempt to find the relationship between meteorological parameters and observed values of evaporation from an open pan evaporimeter. They used one year data, taking weekly average of different meteorological parameters, for developing regression equations. But, in the

present study, 14 years monthly average data of different meteorological parameters have been used for developing regression equations, to estimate evaporation and the calculated values were compared with observed values.

Material and Methods

The meteorological parameters, viz., maximum and minimum air temperatures ($^{\circ}\text{C}$), wind speed (km h^{-1}), relative humidity (%), duration of bright sunshine (h) and rate of evaporation (mm), recorded daily at agro-meteorological observatory, installed at Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar (Latitude $29^{\circ}10'N$ and Longitude $75^{\circ}46'E$) during 1980 to 1993, were utilised. The daily evaporation is measured with the help of US Class A open pan evaporimeter (Hook Gauge Type). The meteorological data were analysed to calculate the monthly average values of different parameters, (i) maximum air temperature and evaporation, (ii) minimum air temperature and evaporation, (iii) relative humidity and evaporation, (iv) wind speed and evaporation, and (v) bright sunshine hours and evaporation. A multiple correlation was also computed amongst all these meteorological parameters together and evaporation. The monthly average evaporation rates, calculated from various developed regression equations, were compared with observed evaporation rates.

Results and Discussion

Relation between evaporation and meteorological parameters

Out of five meteorological parameters considered, four had a significant influence on the evaporation rate (Table 1). The relationship between bright sunshine hours and evaporation was non-significant. Singh *et al.* (1992) had also reported the non-significant correlation between these two parameters. The highest correlation was found between maximum air temperature and evaporation rate (0.85), followed by that of wind speed and evaporation rate (0.82). The evaporation rate was negatively correlated with relative humidity (0.56). Singh *et al.* (1992) and Vamadevan (1971) had observed that relative humidity had an inverse correlation with the evaporation rate. The rate of evaporation is also highly influenced by minimum air temperature, as the coefficient of determination between these

two parameters was 0.70. Raney (1959) noticed that evaporation was influenced by wind speed, humidity, temperature and soil moisture.

After considering all these meteorological parameters together, a multiple regression equation has been developed for the calculation of evaporation for Hisar region. The equation is :

$$Y = 26.679 - 0.585 T_{\max} + 0.653 T_{\min} - 0.277 Rh + 0.215 Ss + 0.336 Ws$$

$(R^2 = 0.92)$

where,

Y = evaporation rate (mm month^{-1})

T_{\max} = maximum air temperature ($^{\circ}\text{C}$)

T_{\min} = minimum air temperature ($^{\circ}\text{C}$)

Rh = relative humidity (%)

Ss = sunshine (h)

Ws = wind speed (km h^{-1})

The maximum value of coefficient of determination ($R^2 = 0.92$) was obtained when all

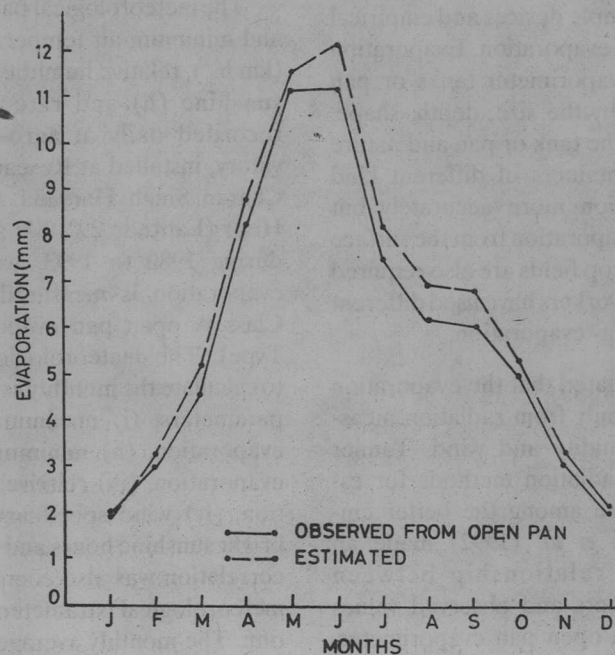


Fig. 1. Observed evaporation from open pan evaporimeter and estimated evaporation using multiple regression based on different meteorological parameter (Average 1980-93).

Table 1. Simple regression equations developed between evaporation and different meteorological parameters

Meteorological parameters	Regression equations	R ²
Maximum air temperature (°C)	Y = -7.74 + 0.432 * X	0.85
Wind speed (km h ⁻¹)	Y = -0.52 + 1.120 * X	0.82
Minimum air temperature (°C)	Y = 0.50 + 0.330 * X	0.70
Relative humidity (%)	Y = 15.09 - 0.156 * X	0.56
Sunshine (h)	Y = 2.87 + 0.357 * X	0.15

five meteorological parameters were considered together to see the combined effect on evaporation rate.

Comparison between observed and estimated evaporation

The estimated evaporation rates from multiple regression equation developed from different meteorological parameters, were compared with observed evaporation rates from open pan evaporimeter (Fig. 1). The estimated values were very close to the observed values of evaporation. However, the estimated values obtained from regression equations of maximum temperature and wind speed are also very close to observed evaporation as compared to other regression equations. The estimated evaporation obtained from the simple regression equations, using relative humidity and sunshine hours, overestimated evaporation during winter season and underestimated during summer and rainy seasons. Similar

results have been reported by Iruthayaraj and Morachan (1978).

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