COMPARATIVE ASSESMENT OF PAN AND MODIFIED PENMAN METHOD FOR THE ESTIMATION OF REFERENCE CROP EVAPOTRANSPIRATION

*** Dr. Sachin J. Deore**

Information of evapotranspiration of crop of region is needed for design of irrigation project. Knowing the area under each crop and their water requirement, it is possible to plan the water resources for storage and distribution from reservoir, ponds etc. Of the several empirical methods for the estimation of reference crop evapotranspiration (ETo) , modified Penman method has reduced sensitivity to errors. However, it requires wide range of measured data which may not be widely available. In the light of these facts, the present study attempts to access the suitability of pan evaporation method as an alternative to the modified Penman method. The estimates computed by pan as well as modified Penman method have been compared statistically.

With ever increasing need for food, shelter and energy, the subject of maximizing the production from land by agriculture has become most important problem for entire human race. Mostly agriculture in India depends on southwest monsoon which are largely concentrated over the period from June to September. There exists a full realization that except for climate, all other resources can be exploited to a limited extent (Mavi, 1986). A fuller exploitation of weather resources, therefore, is the major hope for greater agriculture production. Economic and efficient management of resources becomes a must, for which precise knowledge of various water balance parameters in a region is necessary. Water balance of a region is determined by the net gain and net loss of water. The precipitation and/ or irrigation represent the gain of water whereas evapotranspiration indicates the water loss.

The combined water loss by evaporation from all surfaces and plant transpiration is called evapotranspiration (ETo). The concept of ETo was first forwarded by Thornthwaite (1948) and Penman (1948). According to Rao et. al. (1971) the Penman method can provide more realistic estimates of ETo. The modified form of Penman equation given by Doorenbos and Pruitt (1977) is widely used in India to estimate ETo necessary for the desigh of irrigation project. However, it requires measured data of temperature, wind, humidity, radiation or duration of sunshine. All surface observatories in India are not well equipped to provide such adequate, representative and accurate data. Besides, computation by this method is complicated and time consuming. It is therefore, necessary to look for an alternative method which is simpler and equally accurate. Since evaporation from free water surface is an integrated effect of all climatological factors and ETo also depends on the same combination of the factors, the present study was undertaken to evaluate suitability of pan method as an alternative to modified Penman method for the region under study.

Materials and Methods -The daily weather data for the parameters viz. temperature, wind, humidity, bight sunshine hours, evaporation etc. recorded at 0830 hours and 1703 hours IST have been obtained for the observatory located at Rajgurunagar, located in the Khed tahesil of Pune district in Maharashtra. The present study is based on the data for the period of 01st January 2001 to 31st December 2009.

Reference crop evapotranspiration (ETo) is computed using equation of modified Penman method as: $ETo = C [(W \times Rn) + (1 - W) f(u) (ea - ed)]$

Where,

C = Adjustment factor for day and night wind velocities and different humidity levels.

W = Weighing factor for altitude and temperature effect on radiation.

Rn = Net radiation in equivalent evaporation in mm/ day.

(1 – W) = Weighing factor for altitude and temperature effect on wind and humidity.

f (u) = Wind function or effect of wind on ETo expressed in terms of equivalent evaporation in mm/ day.

(ea – ed) = Vapour pressure deficit expressed in mbar.

Pan evaporation readings are obtained from the observatory, which are measured by U.S. class A pan. Evapotranspiration of reference crop is obtained by applying pan coefficient 'Kp' to the weekly pan evaporation values in mm/ day (Epan). The relationship I expressed as ETo = Kp x Epan. The comparison of values of ETo by pan method and

*** Hutatma Rajguru Mahavidyalaya, Rajguru Nagar**

modified Penman method is done statistically. The statistical methods used in this study include ratios of values of pan evapotranspiration over Penman evapotra-nspiration, the correlation coefficients and the regression analysis.

Results and Discussions-From the weekly analysis of ETo for 09 years it is noted that, on the basis of weekly variations in meteorological elements the year can be divided into three parts as from 10 to 22nd meteorological week as hot weather season, 23rd to 46th rainy and 47th to 09th as cool weather season. The hot weather season is marked by maximum mean temperature of above 30^{0}c while lowest mean relative humidity of 15 %. It is interesting to note form the figures that weekly rainfall during the rainy season is extremely varying from 0 to 288 mm. The highest mean relative humidity in this season is about 95% while mean air temperature is below 25^{0}c. Minimum mean temperature during cool weather season is around 16^{0}c, wind velocities are very low, below 03 km/hour. The normal weekly ETo estimates made by both the methods are higher in summer, lower in monsoon and moderate in cool weather season.The highest ETo estimates are recorded in hot season during hot sunny and windy weeks. During rainy season the lowest estimates are reported due to the combined effect of reduced radiation and aerodynamic term. The difference between the weekly ETo estimates is less during hot and dry season while it is larger in rainy season. It may be attributed to the high vapour content in the air layer of a considerable height above the evaporating surface that reduces the turbulent transfer of vapour from pan to atmosphere and also to the changes in the micro-meteorological environment in the vicinity of the pan during rainy season. High ratios of 0.92 of pan estimates over modified Penman estimates are found during hot season while low ratios of 0.47 are recorded in rainy season with the mean ratio of 0.74. This indicates that pan estimates are closer to Penman estimates during hot season. High correlation coefficient of 0.94 is reported between the two sets of estimates.

conclusions-Where ever accurate and adequate meteorological data required for modified Penman method are not available pan evaporation would suitably be used to estimate ETo. It is important to note that F.A.O. version of the modified Penman method would offer minimum possible error of 10 % in summer and upto 20 % under low evaporative conditions (Doorenbos and Pruitt, 1977). Against this, the pan evaporation would appear closer in estimating the actual crop requirement than modified Penman method for the design of water distribution system and irrigation scheduling.

Acknoledements-The author is grateful to Dr. Vrishali Deostahli, Reader, Department of Geography, University of Pune for her valuable guidance and support.

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