ABSTRACT

1.0 INTRODUCTION ,

While planning an irrigation system, a reasonable accurate estimation of irrigation requirement for the cropping pattern is essential. The relevance of such planning is more pronounced in regions, where shortage of water for crop will be felt during most part of the year, such as the area of this case study. The principal factors that influences the amount of irrigation water required by plants depends upon several climatic parameters. A numbers of empirical formulae are available for estimating evapotranspiration of crops which are site specific. Testing the accurracy of the methods under a new set of conditions is time consuming and costly. However, before adopting any other prediction method, it is also necessary to check its accuracy for a particular region. The four methods presented by FAO and other methods developed by well known research workers, therefore required to be checked for the applicability for a particular region.Looking to the complexity, accuracy and data requirement of the prediction methods, it is also necessary to develop simple equations for local region.

2.0 OBJECTIVES OF THE PRESENT STUDY

Following objectives have been set for the present study.

(i) To develop equations for reference crop evapo-transpiration (ETo), based on which evapo-transpiration for any crop (ETC) can be obtained after knowing the crop co-efficients, which gives accurate results with a minimum data,which will hold good for Agroclimatic zones of Saurashtra, North and

Central Gujarat.

(ii) To analyse and compare the various prediction methods for ETo for their applicability for Agroclimatic zones of Saurashtra, North and Central Gujarat.

3.0 FORMULATION OF PROBLEM AND METHODOLOGY USED

3.1 Data of five agrometeorological stations viz. Dantiwata, Anand, Vadodara, Rajkot and Junagadh, were collected and analysed for 10-30 years. Data is observed twice a day for (i)Maximum and minimum temperatures.(ii) Wet and Dry Bulb Temperatures.(iii)Sun shine hours.(iv) Evaporation and (v) Wind velocity

3.2 The Methodology used is as under

(i) For each parameter data observed for various years daily two times is collected from five stations, and weekly averages of each parameter are calculated. From weekly averages an average of a particular week is worked out.

(ii) Such a voluminous data is used to calculate ETo by different methods. The methods used are (a) Blaney-Criddle method (FAO) (b) Radiation method (FAO) (c) Penman method (FAO) (d) Pan Evaporation method (FAO) (e) Thornthwaite method (f) Hargeaves method (g) Jensen Haise method

Using above relationship ETo values are worked out for all stations. An average ETo representing mean value of all methods is worked out for 52 weeks.

(iii) Weekly average values of each climatic parameters are available for 52 weeks for all stations. Regression analysis is carried out for mean temperature, mean humidity, sun shine hours, and wind velocity with the mean ETo values of different equations. Finally an equation is derived for all stations and for whole region basedon four climatic variables.

(iv) The developed equation requires four climatic variables for estimating ETo. Another attempt is made to develop equation

for estimation of ETo using one or two measured climatic variables. The variation pattern of temperature and ETo for entire year is almost identical except monsoon period during which ETo curve is supressed. This may be due to lowest values of sunshine during that period. This lead to develop the equation for estimating ETo as a function of temperature and sunshine.

(v) The principal atmospheric variables affecting the evaporation are related to reference crop evapotranspiration. A correlation have been developed between observed values of pan evaporation and calculated values of ETo. A good correlation have been observed.

(vi) Another attempt has been made to simplify the procedure further using ETo calculated for five stations by six methods.It can be concluded that the ETo follows a specific variation throughout the year as a function of a specific day of a year. Thus ETo is analysed as a function of week of a year. Equations are developed for all the stations and for the regions accordingly. For developing week based relationship various alternative using least square technique were tried. Finally a five degree polynomial equation has been developed which fits best.

4.0 ANALYSIS & RESULTS

4.1 Inspite of a few deviations in the distribution of all meteorological data in a span of year, it can be seen that the parameters are uniformly following a pattern throughout year. Analysis made for climatic variables for each station

and also for each variable stationwise shows that except one or two cases good correlation is maintained amongst them.

4.2 Effect of location on ETo

An attempt is made to know ETo variations among different stations for a particular method. From the above analysis it can

be said that effect of location on ETo values is less in case of temperature and the Radiation base methods.For combination method and the Panevaporation method the results of different locations are not in close proximity with each other.

4.3 Comparision of ETo

An attempt is made to compare the results of various prediction methods for five stations and for regional average.

4.4 Lysimetric value for Cotton, kharif Groundnut, Tobacco,Maize,Bajara and Mug are collected. These crops are the major crops of the region under study. The observed values are compared with calculated values by T-n method.

5.0 CONCLUSIONS

This study provides an useful tool in planning,design and operation of irrigation and water resources systems. Major findings of the study are summarised below.

(1) Data of climatological factors collected and analysed for long records of 10 to 30 years reveals that for all five stations located in different part of the state, the pattern of variation and distribution throughout year is uniform.

(2) Evapotranspiration (ETo) is calculated by different seven methods. Results shows that the pattern of ETo variations throughout year is uniform for all the stations. It can be concluded that for five stations located under different agro-climatic zones of the state, a good agreement has

been found amongst the estimated values by methods under study except Pan evaporation method.

(3) For each station estimated ETo by different methods is compared.Variation amongst each method is negligible except Thornthwaite method.This method gives lower values in Rabi season and higher values in mid year compared to other methods.

(4) Above discussions gives an answer to the need of an equation for the region under study.A relation between basic climatic parameters and ETo is developed as under

$$ETo = C1\ T + C2\ n + C3\ RH + C4\ U$$

The equations are simple which can be solved without using tables or charts. Observed data can directly be used. Various constants and correction factors are evaluated for various sub- regions.

(5) Relationship developed using temperature in combination with bright sunshine hours gives a good corelation with ETo. The recommended relationship is

T-n Equations

$$ETo = C + C1\ T^2\ n$$

To take care of over prediction of about 5 % in Rabi season a correction factor of 0.95 is suggested. For all sub-regions under study, various constants and correction factors are suggested. Computation of evapotranspiration by this equation is easier and realistic because of the involvement of simple mathematical calculations of climatic data which are recorded directly in the field.

(6) Considering the fact that the panevaporation data gives integrated effect of radiation, wind, temperature and Humidity equation in following form is developed.

Pan-Ev Equations

$$ETo = C + C1\ E_{pan}$$

Analysis shows that these linear regression model gives good corelation with average of ETo estimated by other prediction methods.

(7) A simple equation developed in following form is recommended when climatic data are not available.

$$ETo = Co + \sum_{n=1}^{n} Cn\ W^n \quad \ldots\ldots\ldots (7)$$

Values of constants for various regions are derived. This equation predicts good results. However calibration of such equations are necessary for each 10 years Period.

(8) Field corelation :

The predicted evapotranspiration (ETc) values using T-n equation closely relates to the observed values of evapotranspiration by lysimeter. The values are in close conformity with directly observed ETc of various crops viz. Bajra,Tobacco, Groundnut, Maize and Cotton. These are the major crops grown in the area under consideration. Thus results of T-n equation gives good corelation with directly observed values of major crops of state and therefore can be used for getting accurate, handy and easy solution for evapotranspiration of reference crop (ETo).