Estimation of Evapotranspiration of Vizayanagaram District

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Abstract— Estimation of Evapotranspiraion plays a very important role in the planning and design of an effective irrigation system. Several methods are available for estimation of Evapotranspiration. We have considered the agricultural lands in Vizayanagaram district for estimation of evapotranspiration in that region. We have considered three methods for estimation, namely (1) Penman's equation, (2) Blaney- Criddle equation and (3) Thorntwaite equation. The required data is collected from agricultural department of vizianagaram district. Results obtained by various methods are presented. The deviations in the Evapotranspiration obtained by various methods are discussed.

Key words: AET, PET, PWP, FC

I. INTRODUCTION

Accurate estimation of evapotranspiration (ET) is an important aspects of irrigation planning. The water requirement varies widely from crop to crop and also during the period of growth of individual crops. Such estimation of evapotranspiration helps in irrigation management, and forecasting the crop yield etc.., evapotranspiration can be measured in two ways i.e, direct measurement and indirect measurement. In case of direct measurement there should be a special instrument required to measure evapotranspiration. But in case of indirect measurement using weather data we can forecast the evapotraspiration. There are several equations are proposed to estimate evapotranspiration they are as follows.

(1) Penmann's equation
(2) Blaney criddle equation
(3) Thornthwaite equation

II. EVAPOTRANSPIRATION

While transpiration takes place, the land area in which plants stand also lose moisture by the evaporation of water from soil and water bodies. In hydrology and irrigation practice, it is found that evaporation and transpiration processes can be considered advantageously under one head as evapotranspiration.
Generally evapotranspiration is two types

(1) Potential evapotranspiration (PET)
(2) Actual evapotranspiration (AET)

Potential evapotranspiration is occurred if sufficient amount of moisture is available for complete vegetation. Actual evapotranspiration is occurred in a specific situation. They are another two more parameters mainly influences the plant growth are

(1) Field capacity(FC),
(2) Permanent wilting point(PWP)

field capacity is the maximum quantity of water that can retain against gravity. Excess water supplied to The soil is simply drains away. Permanent wilting point is the moisture content of the soil at which moisture is no longer available in sufficient quantity to sustain the plants. The difference between field capacity and permanent wilting point is known as available moisture which influences the plant growth. Evapotranspiration is different for different crops , not only type of crop, soil type and environment and management have to be considered for transpiration.

III. DESCRIPTION OF ESTIMATION METHODS

In present study there are three methods namely, penman's equation, Blaney criddle equation, Thornewaite equation.

A. Penman's equation

Penman's equation is based on sound theoretical reasoning and is obtained by combining of energy balance and mass transfer approach.

$$PET = \frac{A H_n + E_a \gamma}{A+\gamma}$$

PET = daily potential evapotranspiration in mm per day.

A = Slope of saturation vapour pressure Vs temperature curve at the mean air temperature, in mm of mercury per ℃

H_n = net radiation in mm of evaporable water per day.

E_a = parameter including wind velocity and saturation deficit.

Y = Psychometric constant = 0.49mm of mercury/℃ The net radiation is same as used in the energy budget and is estimated by the following equation:

$$H_a(1-r)\left\{a+b\frac{n}{N}\right\}-\sigma\, T_a^4\left(0.56-0.092\sqrt{e_a}\right)(0.10+0.90\frac{n}{N})$$

Where H_a = incident solar radiation in mm/day

a = a constant depending up on the latitude ∅ and is given by a = 0.29 cos ∅

b = a constant with an average value of 0.52

n = actual duration of bright sunshine in hours.

N = maximum possible hours of bright sunshine (function of latitude)

r = reflection coefficient (albedo) given by the user.

σ = Stefan boltzman constant = 2.01 * 10^{-9} mm/day

T_a = Mean air temperature in degrees Kelvin (K) K=273 + ℃

e_a = actual mean vapour pressure in air in mm of mercury

The parameter E_a is estimated as

$$E_a = 0.35\left\{1+\frac{U_2}{160}\right\}(e_w - e_a)$$

U_2 = mean wind speed at 2m above ground in Km/day.

e_w = saturation vapour pressure at mean air temperature in mm of mercury.
e_a = actual vapour pressure

B. Blaney criddle method

This is purely empirical formula based on the data from arid western United States. In this formulae PET is related to sunshine hours and temperature.

$E_T = 2.54\ K\ F$

$(F = \frac{\varepsilon\ P_h\ T_f}{100})$

E_T = PET in a crop season in cm

K = empirical coefficient depends on type of crop and its growth.

F = sum of monthly consumptive use factors for the period.

P_h = monthly percent of annual day time hours, depends on the latitude of the place.

T_f = mean monthly temperature in °F.

Values of K depend up on month and locality.

C. Thornthwaite method

This is the empirical formulae developed from eastern USA data. It involves mean monthly temperature and day lengths.

$$E_T = 1.6\ L_d\{(\frac{10\ T}{I_t})\hat{}a\}$$

E_T = Monthly PET in cm

L_a = number of hours of day lights and days depends on latitude.

T = Mean monthly air temperature °C

I_t = the total of 12 months values = $\varepsilon_1^{12}\ i_x$

a = $6.75\ *10^{-7}\ I_t^3 - 7.71 * 10^{-5}\ I_t^2 + 1.792 * 10^{-2}\ I_t + 0.49239.$

IV. Study Area and Data

Evapotranspiration is estimated for entire Vizianagaram district of latitude 17°7° N. Longitude $83^0 25^0$ E. Altitude of 75m, Andhra Pradesh, India. Ten years of monthly maximum and minimum temperature data has been collected from "Indian Meteorological Department", Visakhapatnam

V. Results

As per the obtained data of the vizianagaram district from the "Indian materological department" the results of Evapotranspiration of vizianagaram district by using empirical formula' s i.e penman's equation, Blaney criddle equation, and Thornwaite equation are as follows.

Results Of Penman's Equation		
month	PET(mm/day)	AET(mm/day)
jan	5.653012184	3.137421762
feb	7.95426251	4.414615693
mar	6.82618754	3.788534084
jul	7.379688054	4.09572687
aug	7.369072961	4.089835493
sept	7.012178252	3.89175893
oct	6.183823187	3.432021869
nov	5.179272369	2.874496165
dec	4.209077471	2.336037996

Table 1

Thornthwaite method	
Month	Et in (mm/day)
jan	0.786066813
feb	0.757805899
mar	0.953735286
apr	1.048369878
may	1.142685936
jun	1.077066648
jul	1.039939069
aug	1.027983379
sep	0.947692599
oct	0.890295275
nov	0.776484613
dec	0.718032847

Table 2

Blaney criddle method	**Kharif**	**rabi**
crop	Et in (mm/day)	Et in (mm/day)
Rice	6.144471667	6.378786667
jowar	5.8986928	6.1236352
bajra	3.993906583	4.146211333
maize	3.993906583	4.146211333
ragi	3.993906583	4.146211333
horsegram	4.694376353	4.873393013
greengram	4.669798467	4.847877867
blackgram	4.546909033	4.720302133
redgram	4.669798467	4.847877867
chillies	3.993906583	4.146211333
turmeric	3.993906583	4.146211333
sugarcane	5.5300245	5.740908
onions	1.8433415	1.913636
cotton	3.993906583	4.146211333
mesta	3.993906583	4.146211333
groundnut	5.376412708	5.581438333
sesamum	4.147518375	4.305681
ssunflower	8.780450012	9.115286147
coconut	3.993906583	4.146211333
castor	3.686683	3.827272

Table 3

The average evapotranspiration in kharif season is 4.59mm/day, in rabi season is 4.77mm/day. Kharif season is

from july to October, and rabi season is from October to march

VI. GRAPHS

A. Penman's equation

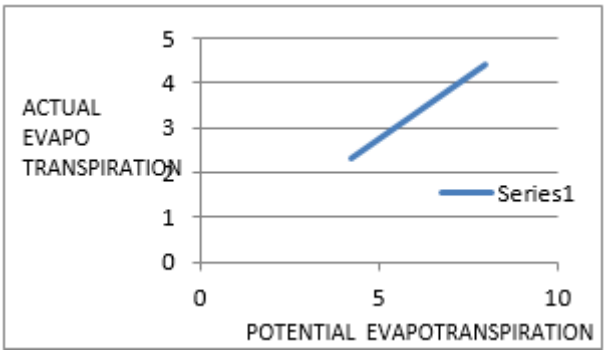

Fig. 1

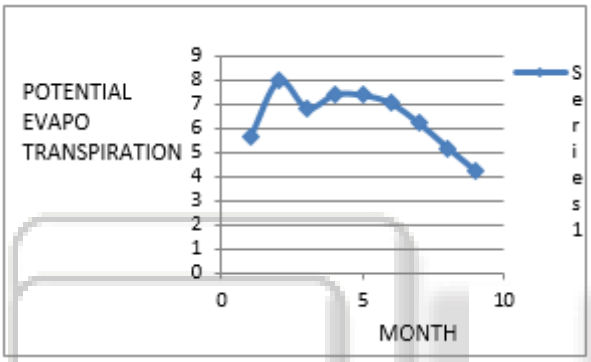

Fig. 2

B. Thornwaite equation

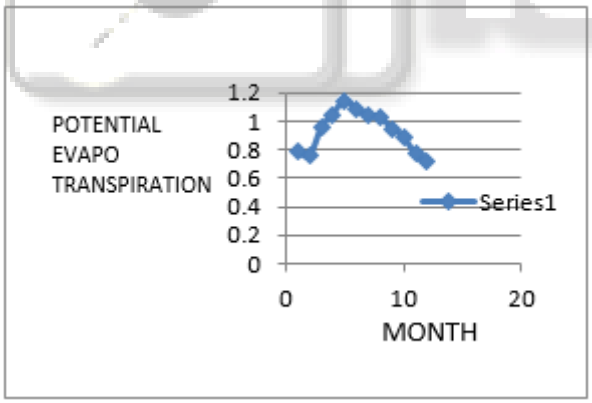

Fig. 3

C. Combination of Penmann and Thornwaite

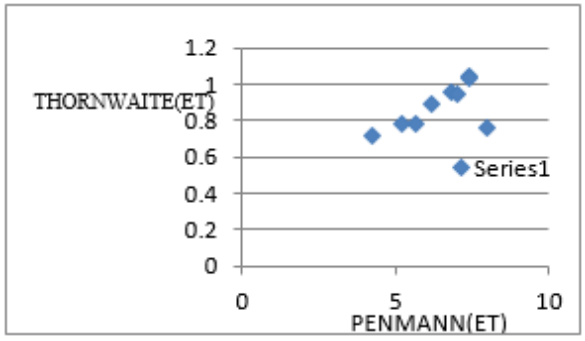

Fig. 4

VII. COMPARISION OF EVAPOTRANSPIRATION MANUALLY WITH SOFTWARE NAMED CROPWAT

The calculated average Evapotranspiration of vizianagaram district is 6.41mm/day using penmann's equation which is compared with the software named "CROPWAT" which is used for calculating amount of water supplied to the crops. By using this software we estimated evapotranspiration of vizayanagaram district, it shows 7.04mm/day which is shown in the figure 5. From this result the accuracy of estimation of PET is up to 95% .

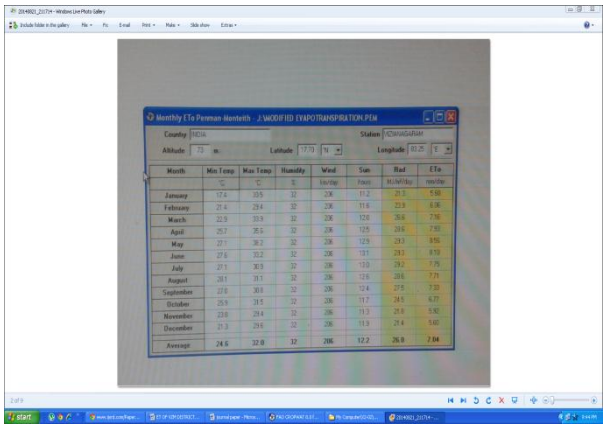

Fig. 5

VIII. CONCLUSIONS

From the available data of the vizianagaram district estimation of Evapotranspiration of entire vizaanagaram district has been carried out using empirical formulas and graphs have been developed. The study area is studied under detailed understanding of type of crop growing, and its climatic conditions, etc.., There is a huge variation in the ET of the region, so further review is required to decide the best method. However we understood that penmann method may be suitable since it include more number of parameters in the estimation. By using the above results we can able to estimate accurate amount of water supply to the crops by minimising more amount of losses.

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