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Estimation of Evaporation with Different Methods for Bapatla Region

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ABSTRACT
The evaporation is basic need for the crop water requirement. When the water manager or formers are going to plan of crop for a particular season kharif, rabi and summer to know the water requirement of the crop to plane the optimization of the allocation of the resource. Accurate estimation of Evapotranspiration is necessary step in water resources management. Evapotranspiration varies spatially and temporally. Recently, the Food and Agricultural Organization has suggested FAO-56 PM method (modified PM method) as a standard method for calculating reference Evapotranspiration (ET0), because this method is applicable to all types of season and different climates and gives more accurate result when compared with the physical methods like Lysimeter and Class A Pan. FAO-56 PM method cannot be debated by any other old methods which require less data for calculating ET0. But FAO-56 PM requires very large amount of meteorological data, which is not available at full climate stations. So there is need to find out the next best suitable method after FAO-56 PM method, which will give ET_O results nearer to FAO-56 PM method. Here four different methods are considered for present study, which are radiation based, temperature based and combine parameters based (FAO-56 modified Penman Monteith, Hargreaves, Blaney-Criddle, Modified penmen are the methods). The present study concern on the Bapatla region it concern most of the area under irrigation for that purpose which they need to give the daily evaporation data. In this study concerned for last 10 years data taken to analyze. Finally the FAO-56 PM has gave the consistence of the evaporation. So further calculation of evaporation for the Bapatla region has follow to the FAO-56 PM method to calculate the evaporation.
Keywords: - *Evaporation, FAO- 56, Modified Blaney- Criddle method, Modified penman method, Hargreaves method.*

INTRODUCTION

Water is continuously lost from the Earth's surface by evaporation. The rate of evaporation depends on many factors such as the nature of soil and vegetation, the temperature and humidity of the air, wind speed etc. For practical purposes, however, it can be expressed as the volume of liquid water evaporated from unit area in unit time. Over a given area this is proportional to the depth of liquid water lost in unit time. Accordingly evaporation is generally measured, as millimeters of water lost per day. The presence or absence of water vapor in the crop canopies exhibits a great influence on the microclimate of the crop. The evaporation rates are controlled by the temperature of the evaporating surface to a great extent. The evapotranspiration rates from vegetation are strongly influenced by the plant

temperature. However, the availability of soil moisture is very important simultaneously.

In crop canopies the evaporation rates of the soil are affected by the dryness of the air and speed and character of the wind. When the overlying air is dry, the vapor decreases upward more rapidly; turbulent eddies then replace moist air neat the surface with dry air from aloft, thus speeding up evaporation rate. The wind speed, regardless of turbulence, directly affects evaporation only when dry air is being transported over wet surfaces.

Geographically Bapatla is located at altitude of 15^0 54^1 N and longitude of 80^0 30^1 E with an altitude of 4.5 m above mean sea level. The experimental site lies in humid sub tropical area. The summers are dry and hot, Where as winter is cool. The experimental site consists of sandy soil and well drained soil. Four methods to calculate ETo which are FAO-56 modified Penman Monteith, FAO-24 Penman Monteith, Hargreaves, Blaney-Criddle, (temperature based, radiation based and standard combination methods) are considered. Their performance based evaluation will be calculated and each method will be compared with FAO-56 PM method which is standard.

METHODOLOGY

Computation of potential Evapo-transpiration approaches

A. FAO-56 Penman Monteith method:

The Food and Agriculture Organization was Developed the model for calculation of Evapotranspiration and it is freely downloadable in the FAO Public demine. The model was windows based it can operate easily and easy to calculate the ET_O.

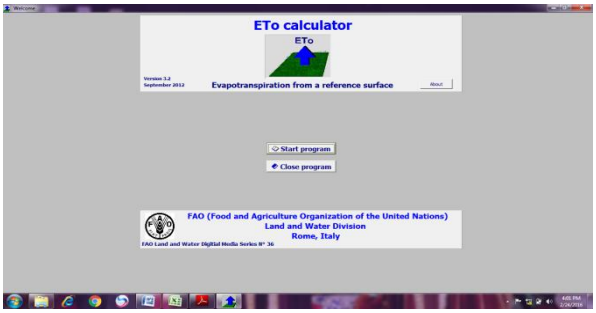

Fig1. Main menu of the FAO Model

Meteorological data

The user specifies:

The type of data (daily, 10-daily or monthly),

The time range (from date - to date). If the meteorological data consists of averages of several years, the data should not be linked to a specific year and the year has not to be specified.

Once the time range is set, the program displays the corresponding number of data records within this range. The number of records should match with the number of rows of the text file containing the meteorological data. Air temperature, Air humidity, Wind speed or Sunshine and Radiation are used to calculate the Evapotranspiration. Select the file which contain the data and it can export to the model then click on to the ET calculator after that the model will give the output shown in fig.3.

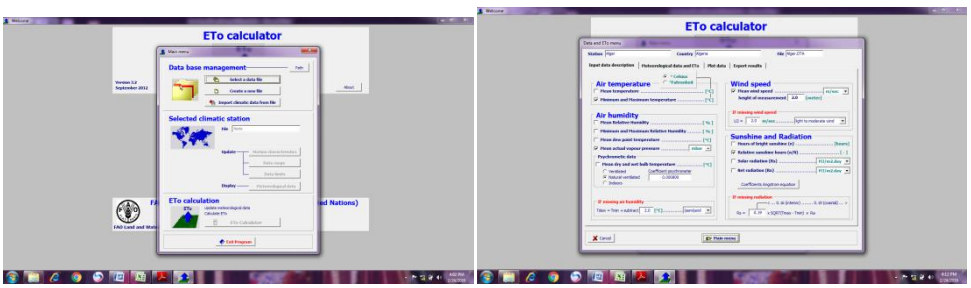

Fig.2.Input File of the model

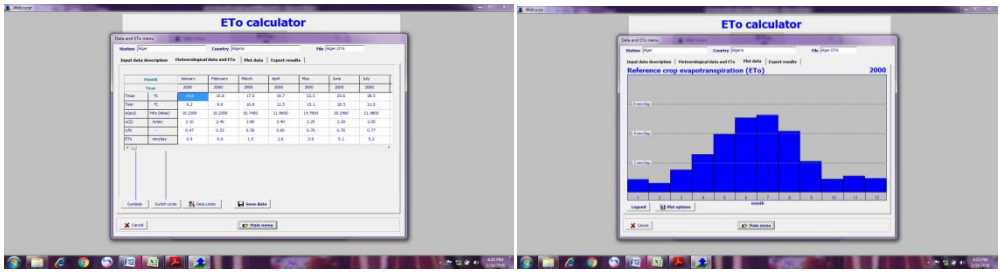

Fig.3. Out put of the Evapotranspiration

B. Modified blaney - criddle method

ETo = C [P (0.46 T + 8)] mm/day

Where,

ET_O = reference crop ET in mm/day for the month considered

T = mean daily temperature in °C over the month considered

P = mean daily percentage of total annual day time in hours

C = Adjustment factor which depends upon minimum relative humidity, sunshine hours and day time wind estimates.

C. Modified penman formulae

Based on intensive studies of the climatic and measured gross ET data from various research stations in the world and the available literature on predictions of ET and ETo Dorenbos and Pruitt (1977) proposed and modified by Penman method, as below for estimating fairly accurate the reference crop ET.

$ET_O = C [W.Rn + (l - W) f (u) (e_a-e_d)]$

ETo = reference crop ET in mm/day

W = temperature related weighting factor for the effect of radiation on ETo

Rn = net radiation = Rns – Rnl

Rns = the net incoming short wave solar radiation

Rns = Ra (l-x) (0.25 + 0.50 n/N)

Ra = extraterrestrial radiation expressed in equivalent evaporation in mm/day, n/N is the ratio between actual duration of brightsunshine hours (n) and maximum possible duration of bright sunshine hours (N) x= reflection coefficient

Rnl = the net long wave radiation = f (t) $f(e_d)$ F (n/N)

(1-W) = a temperature and elevation related weighing factor for the effect of wind and Humidity on ETo

f(u) = a wind related function

e_a = saturation vapor pressure in m bar at the mean air temperature in °C

e_d = mean actual vapor pressure of the air in m bar = e_a x RH (% mean) 100

C = adjustment factor to compensate for the day and night weather effects

D. Haregreves Method

ET_O /PET = 0.0023 Ra (TD) ^{½} (T + 17.8)

Where in Ra = Extra terrestrial radiation

TD = Difference in daily maximum and minimum temperature

T = Mean temperature °C.

RESULTS AND DISCUSSION

The calculation of evaporation with various models FAO-56 Penman Monteith method, Modified Blany-credible method, Hargreaves method and Modified penman methods. The calculation methods was demonstrate in the methodology section as per that meth fallowed to calculate evaporation for the Bapatla region from 2006 to 2015 for last 10 years and analyzed in this section.

A. Evaporation Calculated using FAO-56 Penman Monteith method

The evaporation was calculated by the FAO-56 Penman Montieth method using the Model developed by the FAO for calculation of evaporation in Bapatla Region from 2006 to 2015.

Table 1: Estimation of Evapotranspiration using Penman Monteith method

Months	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	AVERAGE (mm/day)
January	4.07	4.07	4.06	4.09	4.08	3.83	3.94	4.05	4.06	4.16	4.041
February	4.74	4.54	4.6	4.68	4.61	4.62	4.52	5.3	4.67	4.66	4.694
March	5.62	5.39	5.53	5.63	5.63	5.55	5.53	5.83	5.66	5.76	5.613
April	6.4	6.45	6.23	6.83	6.65	6.13	6.42	6.67	6.72	6.78	6.528
May	7.55	8.68	9.28	7.62	7.66	7.87	8.03	7.78	8.05	8.93	8.145
June	7.57	6.88	7.95	9.37	7.6	8.58	8.57	7.82	8.96	6.83	8.013
July	8.58	7.05	7.1	9.15	6.27	7.22	6.95	6.77	7.94	8.02	7.505
August	7.47	5.9	6.04	7.36	5.78	6.64	6.59	6.6	6.94	6.48	6.58
September	6.06	5.97	6.4	6.51	5.89	6.52	6.06	6.04	6.4	6.16	6.201
October	5.47	5.23	5.56	5.75	5.4	5.32	5.45	5.23	5.67	5.56	5.464
November	4.38	4.53	4.6	4.53	4.51	4.66	4.5	4.49	4.47	4.68	4.535
December	4.03	4.21	4.05	4.15	3.97	4.22	4.08	4.02	4.05	4.15	4.093

The table 1. Was shows that the evaporation in Bapatla by panman montieth method was more in the month of May was 8.145 mm/day and minimum in the month of Janury was 4.041 mm/day for the last 10 years of period from 2006-2015.

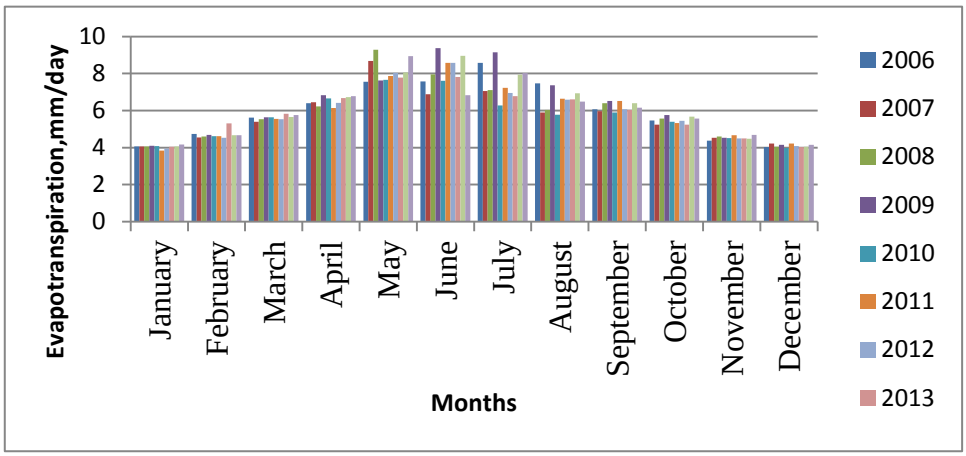

Fig 4: Grapical reprasentation of monthly Evapotranspiration

The Table.1. showed that the monthly evaporation of bapatla region from 2006 to 2015 for last 10 years using the FAO-56 Penman Monteith method. The fig.4. showed that the monthly evaporation from last one decay. From the figure the evaporation was sligtly inceases and in all the months.

Modified Blany credible Method

The evaporation was calculated by the Blany-credible method using the for calculation of evaporation in Bapatla Region from 2006 to 2015.

Table 2: Estimation of Evapotranspiration using Blany credible Method.

Months	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	AVERAGE (mm/day)
January	4.89	4.86	4.92	5.30	5.02	4.89	4.87	5.03	4.95	4.91	4.96
February	5.02	4.98	5.15	5.50	5.08	5.06	5.03	5.75	5.01	5.02	5.16
March	5.56	5.50	5.50	5.89	5.70	5.52	5.68	5.54	5.52	5.60	5.60
April	6.06	6.01	6.00	6.39	6.27	6.01	6.17	6.16	6.15	6.10	6.13
May	6.50	6.81	6.96	7.12	6.67	6.71	6.85	6.78	6.69	6.79	6.79
June	6.54	6.40	6.62	7.16	6.58	6.71	6.79	6.54	6.95	6.40	6.67
July	6.53	6.33	6.39	6.84	6.17	6.39	6.33	6.21	6.50	6.60	6.43
August	6.12	5.76	5.97	6.50	5.81	6.06	6.04	5.99	6.08	6.17	6.05
Septemeber	5.93	5.97	6.04	6.36	5.96	6.11	6.12	5.97	6.05	6.04	6.06
October	5.64	5.58	5.67	5.99	5.70	5.72	5.63	5.65	5.74	5.74	5.71
November	5.13	5.15	5.21	5.48	5.27	5.26	5.14	5.19	5.14	5.28	5.23
December	4.78	4.86	4.86	5.16	4.75	4.86	4.84	4.75	4.76	4.86	4.85

The table 2. Was shows that the evaporation in Bapatla by Blany- credible method was more in the month of May was 6.79 mm/day and minimum in the month of December was 4.85 mm/day for the last 10 years of period from 2006-2015.

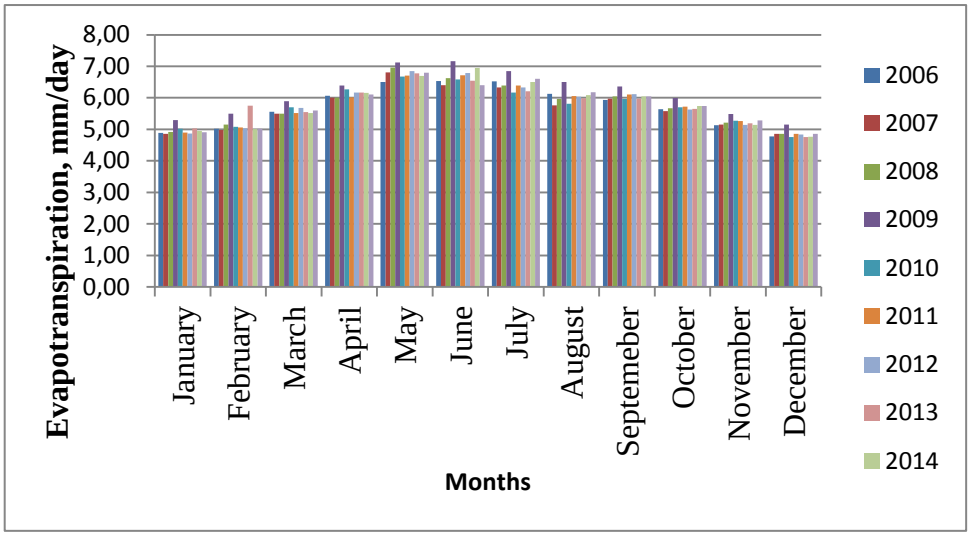

Fig 5: Grapical reprasentation of monthly Evapotranspiration

The Table.2. showed that the monthly evaporation of bapatla region from 2006 to 2015 for last 10 years using the Modified Blany credible Method method. The fig.5. showed that the monthly evaporation from last one decay. From the figure the evaporation was sligtly inceases and in all the months.

Hargreaves Method

The evaporation was calculated by the Hargreaves method using the for calculation of evaporation in Bapatla Region from 2006 to 2015.

Table 3: Estimation of Evapotranspiration using Haregreves Method.

Hrgrevies	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	AVERAGE (mm/day)
January	4.26	4.30	4.13	4.16	3.94	4.12	3.89	4.14	3.99	4.20	4.11
February	5.15	4.70	4.25	4.76	4.60	4.79	5.02	1.54	4.57	4.89	4.43
March	5.09	4.88	5.01	5.22	4.97	5.33	5.18	5.25	5.16	5.25	5.13
April	5.00	5.11	5.03	5.32	4.80	4.91	5.05	5.06	5.60	5.07	5.10
May	5.58	6.74	7.19	5.71	5.50	5.94	6.52	5.79	5.93	6.07	6.10
June	5.81	5.37	5.88	6.51	5.32	5.99	6.35	5.93	6.29	5.24	5.87
July	5.61	5.39	5.31	5.65	4.57	5.40	5.20	4.82	5.47	6.01	5.34
August	5.65	4.11	4.29	6.33	3.77	5.04	4.50	5.34	4.82	4.89	4.87
Septemeber	4.81	4.40	4.77	4.97	4.37	5.18	4.91	4.74	4.85	4.86	4.79
October	4.43	4.09	4.45	4.58	4.18	4.58	4.44	4.05	4.76	4.81	4.44
November	3.86	4.29	4.06	3.83	3.67	4.14	4.07	4.06	4.15	4.27	4.04
December	4.15	4.08	4.01	3.95	3.72	4.17	3.98	4.08	4.07	4.17	4.04

The table 3. Was shows that the evaporation in Bapatla by Hargreaves method was more in the month of May was 6.10 mm/day and minimum in the month of December was 4.04 mm/day for the last 10 years of period from 2006-2015.

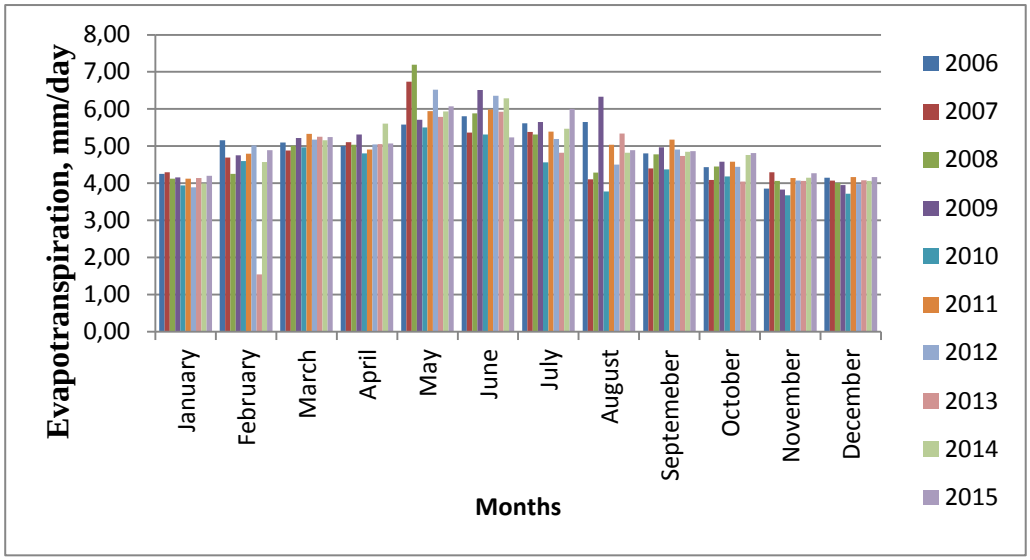

Fig.6.Grapical reprasentation of monthly Evapotranspiration

The Table.3. showed that the monthly evaporation of bapatla region from 2006 to 2015 for last 10 years using the Modified Blany credible Method method. The fig.6. showed that the monthly evaporation from last one decay. From the figure the evaporation was sligtly inceases and in all the months.

Modified Penman method

The evaporation was calculated by the Modified Penman method using the for calculation of evaporation in Bapatla Region from 2006 to 2015.

Table 4: Estimation of Evapotranspiration using Modified Penman method.

Months	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	AVERAGE (mm/day)
January	4.46	4.33	4.59	3.64	4.00	4.15	4.01	4.17	4.08	4.45	4.19
February	5.45	5.34	5.03	4.26	5.13	5.25	5.06	5.31	5.14	5.55	5.15
March	5.83	4.32	4.80	3.80	3.92	4.20	3.89	4.13	3.96	4.30	4.32
April	5.80	4.35	4.72	3.84	3.34	3.84	3.47	3.64	3.67	3.81	4.05
May	5.80	4.99	6.13	2.93	4.34	4.55	4.36	4.50	4.27	4.55	4.64
June	5.20	3.84	4.49	4.57	3.97	4.11	3.94	4.14	3.94	4.35	4.25
July	6.00	4.28	4.20	4.84	3.76	3.88	3.69	3.86	3.67	4.07	4.22
August	6.10	3.75	3.00	2.40	3.50	3.67	3.50	3.66	3.50	3.82	3.69
Septemeber	5.76	3.64	4.43	3.36	3.80	3.99	3.83	4.09	3.82	4.26	4.10
October	5.01	3.42	4.07	3.34	3.36	3.53	3.32	3.43	3.27	3.65	3.64
November	4.31	3.09	3.45	2.48	2.86	3.00	2.89	3.03	2.97	3.16	3.12
December	4.12	3.15	3.26	2.72	3.38	3.53	3.36	3.53	3.36	3.68	3.41

The table 4. Was shows that the evaporation in Bapatla by Modified Penman method was more in the month of May was 4.64 mm/day and minimum in the month of November was 3.12 mm/day for the last 10 years of period from 2006-2015.

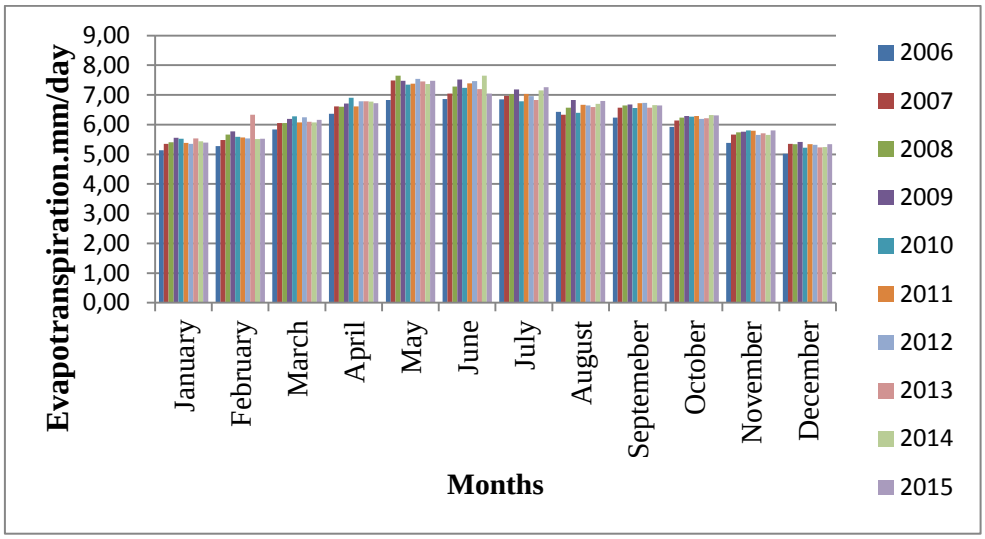

Fig 7: Grapical reprasentation of monthly Evapotranspiration

The Table.4. showed that the monthly evaporation of bapatla region from 2006 to 2015 for last 10 years using the Modified Blany credible Method method. The fig.7. showed that the monthly evaporation from last one decay. From the figure the evaporation was sligtly inceases and in all the months

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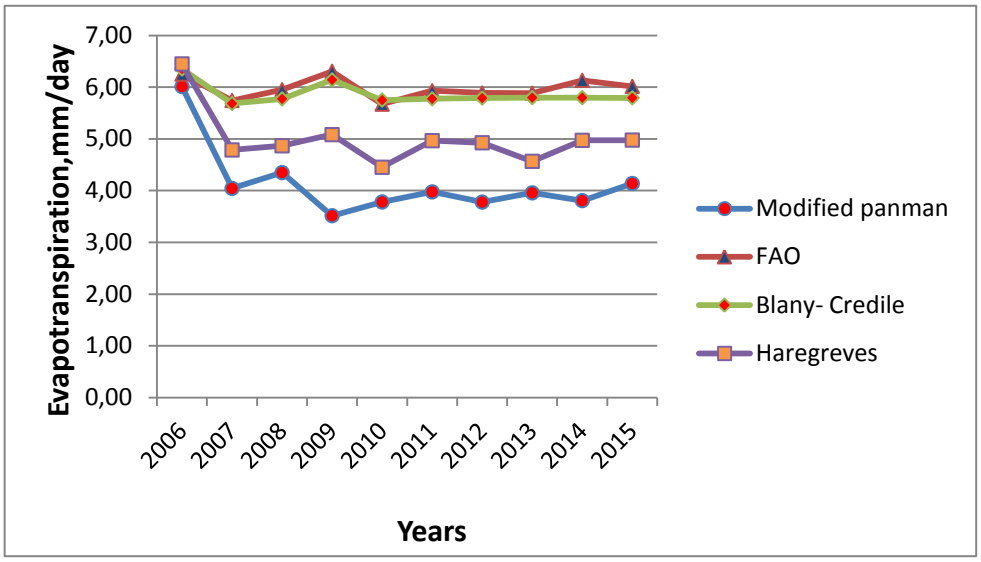

Fig 8: Grapical reprasentation of Yearly Evapotranspiration

The fig.8. showed that the eavporations in Bapatla region was signficantly less different to all four method but blany credile and FAO-56 has the same trent followed to all the 10 years from 2006 to 2015. The present study FAO-56 model was taken standart (Venkatesh. B.,*et al.*2012) for the bapatla region fowllows the same trent of the evapotranspiration. It is very usefull for the future pediction of the data for crop water requirement.

Conclusions

Based on monthly and yearly amounts of estimated ET0, it was concluded that evaluation on the basis of seasonal sums is very sensitive to systematic differences between daily model results. Differences of the order of even several hundred millimeters can evolve during a growing season. Nevertheless, the highest sums were provided by the Blaney-Criddle, Penman-Monteith-FAO-56, Modified penman methods and Hargrove method, while the lowest amounts were provided by the Modified penman methods and Hargreaves methods.

This study will be beneficial for all farmers as well as people coming under this command area. During non availability of meteorological data, if characteristics of one command area (with calculated ETo) match with other, then we can apply same ETo values to that area where data is missing. After finding out the crop water requirements, water will be applied as per the requirement of that crop and hence water balance system can be developed. Irrigation requirements are calculated with the help of crop water requirement of each crop. That is nothing but the water required for that crop to fulfill their need. Water required for that crop from sowing process to harvesting process.

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