**E-ISSN:** 2618-0618
**P-ISSN:** 2618-060X
© Agronomy
www.agronomyjournals.com
2024; SP-7(7): 194-200
Received: 25-04-2024
Accepted: 29-05-2024

# Modelling potential evapotranspiration: Statistical analysis for Madurai's water dynamics

**M Radha, Archana A and S Vishnu Shankar**

**M Radha**
Assistant Professor, Department of Agricultural Economics, AC&RI, TNAU, Madurai, Tamil Nadu, India

**Archana A**
Research Scholar, Indian Agricultural Statistics Research Institute, New Delhi, India

**S Vishnu Shankar**
Senior Research Fellow, Indian Agricultural Statistics Research Institute, New Delhi, India

**DOI:** https://doi.org/10.33545/2618060X.2024.v7.i7Sc.1009

## Abstract

Potential evapotranspiration is a comprehensive process encompassing both evaporation and transpiration that helps to determine the removal of water from both the soil and plant surfaces. It serves as a crucial mechanism for returning moisture to the atmosphere. The study specifically concentrates on computing the Weekly Potential Evapotranspiration (PET) for Madurai district. Models such as FAO Penman-Monteith, Modified Penman, Penman, Priestley Taylor, Blaney Criddle and Hargreaves models were compared in this study using Multiple Linear Regression. Performance of the fitted models were compared using accuracy metrics such as Root Mean Squared Error (RMSE), RAE, Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), and the coefficient of determination ($R^2$). The Penman model emerged as the most pertinent model, exhibiting the least bias and the highest $R^2$.

**Keywords:** PET, FAO penman monteith, MLR, RMSE, RSE

## Introduction

Potential evapotranspiration holds significant importance in ecological, hydrological, and drought assessment processes, as well as in the management of agricultural production and irrigation. Its pivotal role extends to influencing hydrological processes, determining water requirements for crops, impacting crop production, and guiding irrigation management practices (Djaman *et al.* 2018) [6]. The calculation of potential evapotranspiration enables a precise understanding of the water demand for crops at specific times and intervals, thereby preventing unnecessary water wastage in agricultural fields. This estimation relies on key meteorological parameters such as temperature, rainfall, relative humidity, wind speed, sunshine hours, and extra-terrestrial radiation (Sriram and Rashmi. 2014) [21]. By taking into account these factors, the calculation of potential evapotranspiration becomes instrumental not only in the efficient management of water resources but also in optimizing nutrient movement within plants and enhancing plant temperature. This parameter assumes a pivotal role in the hydrologic budget and precipitation, serving as a linchpin in maintaining ecological balance and bolstering agricultural productivity. Moreover, potential evapotranspiration plays a critical role in determining the water requirements of crops, facilitating the regulation of water amounts provided to farmers and influencing the design of irrigation schemes (Droogers and Allen 2002) [8]. Various methods, including Lysimeter experiments, water budget analyses, energy balance assessments, field experiments, and open pan evaporimeters, are employed to calculate potential evapotranspiration (Hajare *et al*. 2008) [11]. Recent technological advancements have introduced the application of remote sensing and Geographic Information System (GIS) for estimating potential evapotranspiration, although these methods may not be directly applicable for field measurements. Empirical models, widely utilized, offer an alternative approach for computing potential evapotranspiration.

The determination of water requirements in irrigated areas relies on consumptive use, taking into account monthly temperature, sunshine hours, and the irrigating season, as proposed by Blaney and Criddle in 1950 [4]. Fennessey and Vogel (1996) [9] developed multivariate models based on reference crop evapotranspiration and pan evaporation. Xu and Singh (2000) [22] utilized radiation-based methods to calculate evaporation. Saikia *et al.* (2005) [19] identified the most suitable model for potential evapotranspiration (PET) and pan evaporation through multiple

**Corresponding Author:**
**Archana A**
Research Scholar, Indian Agricultural Statistics Research Institute, New Delhi, India

linear regression (MLR) and correlation analysis. Alkaeed *et al.* (2006) [1] evaluated reference evapotranspiration on a monthly basis, correlating solar radiation-based models and net radiation-based models with FAO Penman Monteith model. Gavilan (2006) [10] compared Hargreaves' model with FAO Penman Monteith across 86 meteorological stations. Chowdhury *et al.* (2010) [5] validated the PET model with pan-derived evapotranspiration. Liu *et al.* (2013) [14] employed regression analysis to identify relevant models by comparing them with empirical models. Rajasekhar *et al.* (2015) [23] assessed the closeness of the FAO Penman Monteith model to other empirical models. Helder *et al.* (2016) [13] compared the FAO Penman Monteith model with other models using multiple linear regression. Sharafi and Galeni (2021) [18] evaluated multivariate linear regression for reference evapotranspiration. Archana *et al.* (2021) [3] focused on predicting potential evapotranspiration on a weekly basis. The study's objective is to determine weekly potential evapotranspiration for Madurai using six empirical models and predict PET values for future weeks based on the best-fitted model using MLR and performance metrics.

## Materials and methods

The investigation was carried out in Madurai, a district located in Tamil Nadu, India, nestled within the Eastern Ghats. Positioned at a latitude of 9.93° North and a longitude of 78.12° East, the city maintains an average elevation of 101 meters. The study relied on secondary data obtained from the Agro Climate Research Centre at Tamil Nadu Agricultural University in Coimbatore, covering the period of 2020. The dataset comprises crucial parameters such as maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, rainfall, extra-terrestrial radiation, wind speed, and sunshine hours for the specific location of Madurai.

### Correlation Analysis

Correlation measures the association between predicted and predictor variables. By quantifying the strength and direction of the relationship between two variables. The correlation coefficient ranges from 0 to 1, where 0 indicates no correlation or a completely random relationship, and 1 signifies a perfect positive correlation (Shankar *et al*., 2022) [20]. This numerical scale provides insights into the degree to which changes in one variable correspond to changes in another, offering a valuable tool in understanding and assessing statistical associations.

### Empirical models

The focus of this study is on six distinct empirical models utilized for deriving Potential Evapotranspiration (PET) values from various covariates. The FAO Penman-Monteith model, formulated by Howard Latimer Penman and John Monteith, is widely recognized as the standard model for evaluating PET (Allen *et al*., 1998) [2]. However, the Modified Penman model tends to overestimate PET, even in conditions of high wind and low evaporation (Doorenbos and Pruitt, 1977) [7]. H. L. Penman (1948) [16] proposed the Penman Model, a combination of aerodynamics and heat balance methods. Additionally, Potential Evapotranspiration can be estimated using temperature-based methods such as Hargreaves Samani (1982) [12]. The mathematical descriptions of these models are provided in Table 1.

**Table 1:** Empirical Models for Potential Evapotranspiration

| S. No. | PET Empirical Models | |
|---|---|---|
| 1. | FAO Penman Monteith<br>(FAO PM model) | $PET = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$ |
| 2. | Modified Penman (MP model) | $PET = C\ [W.R_n + (1 - W) * f(u) * (e_s - e_a)]$ |
| 3. | Penman model | $PET = \frac{\left(\frac{\Delta}{\gamma}\right) H + E_a}{(\Delta/\gamma) + 1}$ |
| 4. | Priestley Taylor (PT model) | $PET = \alpha \frac{\Delta}{\Delta + \gamma} \frac{R_n}{\lambda}$ |
| 5. | Blaney Criddle (BC Model) | $PET = p(0.46T_{mean} + 8.13)$ |
| 6. | Hargreaves Samani (HS Model) | $PET = 0.0023(T_{mean} + 17.8)(T_{max} - T_{min})^{0.5} R_a$ |

### Multiple Linear Regression

Multiple linear regression is the extension of simple linear regression (Rangaswamy, 2016). It is defined as building the model between dependent and independent variables. It may be a linear or non-linear relationship between the variables. It helps to predict the value of the dependent variable by including the number of independent variables simultan**eously.** If we have n independent variables $X_1, X_2, X_3, \ldots \ldots, X_n$

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_n X_n + e$$

Where,

Y = Dependent variable

$\alpha$ = Intercept

$\beta_1, \beta_2, \beta_3, \ldots, \beta_n$ = Partial Regression Coefficients

$X_1, X_2, X_3, \ldots, X_n$ = Independent variables.

e = Residual term (or) Error term

In this study, a model was developed with the estimated Potential Evapotranspiration (PET) values from various PET models serving as the dependent variable. The independent variables included maximum temperature ($T_{max}$), minimum temperature ($T_{min}$), maximum relative humidity ($RH_{max}$), minimum relative humidity ($RH_{min}$), wind speed (WS), extra-terrestrial radiation ($R_a$), rainfall (RF), and sunshine hours (SSH) for the training set. The dataset was split into an 80% training set and a 20% testing set using R-Software. The aim was to identify the most effective model based on statistical criteria such as Root Mean Squared Error (RMSE), Residual Standard Error (RSE), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE).

## Results and Discussions

In this research paper, the potential evapotranspiration was estimated using six different models for Madurai. Using the standard meteorological week's table, the daily PET converted into weekly PET value by taking averages. The PET value is estimated using the different models were given in the Fig 1. Among these models, FAO Penman-Monteith model considered a standard model for estimating the potential evapotranspiration.

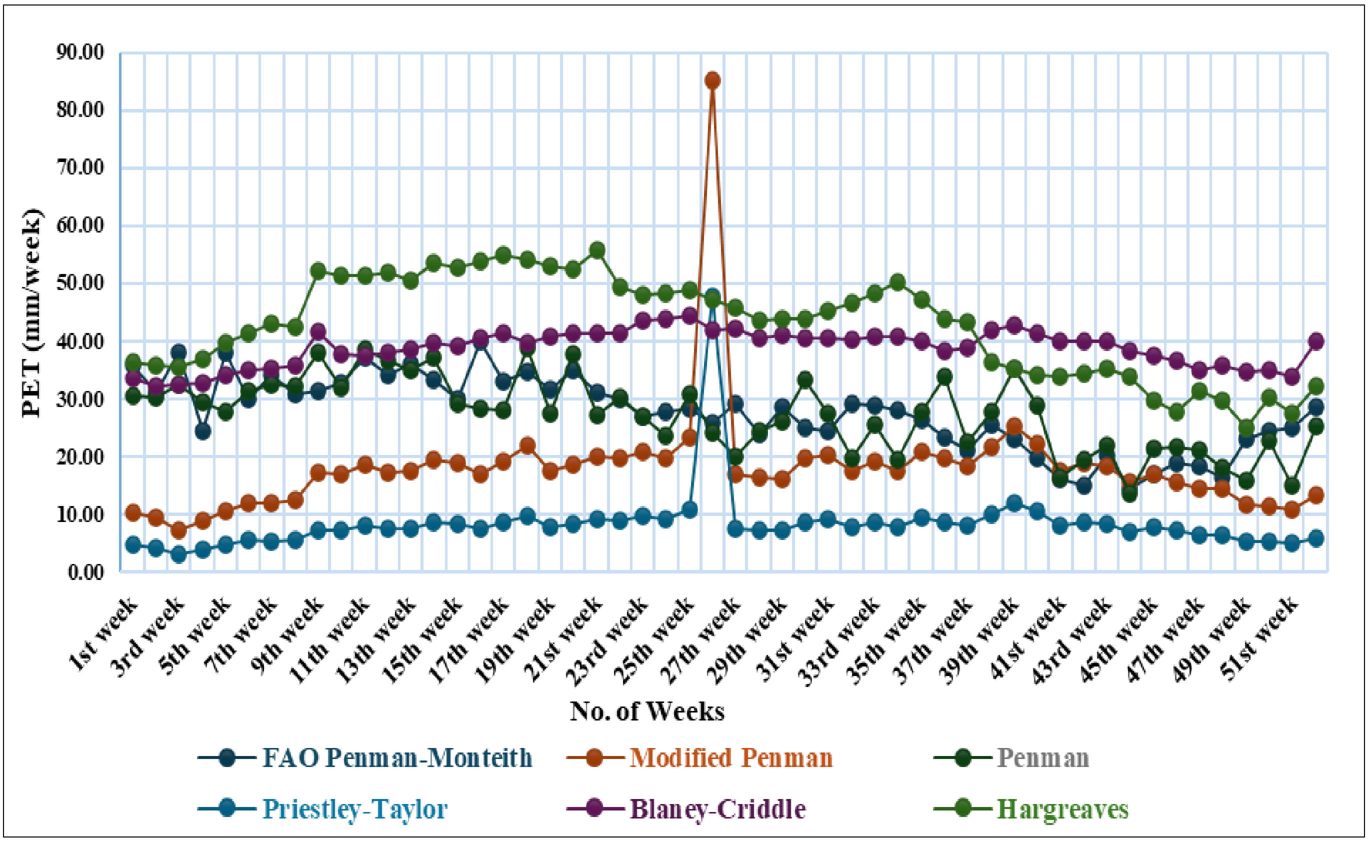

**Fig 1:** Variations of Weekly PET Values using Empirical Models for Madurai

The summary statistics of the meteorological data for Madurai such as Maximum and minimum temperature, maximum and minimum relative humidity, Wind speed, Sunshine hours and radiation was explained in Table 2. The Shapiro Wilk test which is used to test the normality of the variables. The normality of the data were interpreted based on the value of p which was greater than 0.05. The maximum and minimum temperature, maximum and minimum relative humidity, sunshine hours and radiation were normalized except wind speed.

**Table 2:** Descriptive Statistics of the Parameters for Madurai

| Statistics | $T_{max}$ | $T_{min}$ | $RH_{max}$ | $RH_{min}$ | WS | SSH | $R_n$ |
|---|---|---|---|---|---|---|---|
| Mean | 34.74 | 17.99 | 79.18 | 51.84 | 5.11 | 6.31 | 2.75 |
| Median | 34.75 | 17.85 | 79.50 | 49.43 | 4.75 | 5.93 | 2.83 |
| Standard Deviation | 3.12 | 3.62 | 6.72 | 12.14 | 1.28 | 2.40 | 0.61 |
| Maximum | 40.20 | 25.90 | 89.43 | 78.00 | 8.81 | 10.29 | 4.17 |
| Minimum | 28.21 | 11.93 | 62.71 | 34.29 | 3.43 | 1.24 | 1.22 |
| Range | 11.99 | 13.97 | 26.71 | 43.71 | 5.38 | 9.04 | 2.95 |
| Skewness | -0.29 | 0.29 | -0.54 | 0.42 | 1.27 | -0.10 | -0.32 |
| Kurtosis | -0.83 | -0.49 | -0.28 | -0.97 | 0.97 | -0.99 | -0.06 |
| CV | 8.97% | 20.09% | 8.49% | 23.43% | 25.05% | 38.07% | 22.39% |
| Shapiro Wilk Test | 0.962 | 0.969 | 0.956 | 0.938 | 0.867 | 0.958 | 0.980 |
| p-value | 0.09 | 0.206 | 0.06 | 0.09 | 0.003 | 0.065 | 0.546 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TMin | 0.58 | 0.11 | -0.02 | -0.62 | -0.25 | 0.1 | 0.78 |
| 0.58 | Rn | 0.77 | 0.65 | -0.09 | -0.62 | 0.05 | 0.22 |
| 0.11 | 0.77 | Ra | 0.9 | 0.08 | -0.71 | -0.19 | -0.3 |
| -0.02 | 0.65 | 0.9 | TMax | 0.2 | -0.62 | -0.27 | -0.44 |
| -0.62 | -0.09 | 0.08 | 0.2 | SSH | 0.04 | 0.05 | -0.72 |
| -0.25 | -0.62 | -0.71 | -0.62 | 0.04 | WS | 0.15 | 0.06 |
| 0.1 | 0.05 | -0.19 | -0.27 | 0.05 | 0.15 | RHmax | 0.31 |
| 0.78 | 0.22 | -0.3 | -0.44 | -0.72 | 0.06 | 0.31 | RHmin |

| | | | | | |
|---|---|---|---|---|---|
| PT Model | 1 | 0.4 | 0.2 | -0.01 | -0.1 |
| 1 | MP Model | 0.46 | 0.25 | 0.02 | -0.09 |
| 0.4 | 0.46 | BC Model | 0.53 | 0.08 | -0.05 |
| 0.2 | 0.25 | 0.53 | HS Model | 0.57 | 0.64 |
| -0.01 | 0.02 | 0.08 | 0.57 | Penman Model | 0.67 |
| -0.1 | -0.09 | -0.05 | 0.64 | 0.67 | FAO PM Model |

**Fig 2:** Heatmaps on correlation analysis for Variables and PET Values

Figure 2 illustrates the outcomes of the correlation analysis among the variables. A notable correlation was observed between the minimum temperature and minimum relative humidity i.e., 0.78. $R_a$ was observed to have high correlation with $R_n$ (0.77) and $T_{max}$ (0.90). The maximum temperature showed negative association with other parameters except SSH, $R_n$ and $R_a$. The estimated weekly Potential Evapotranspiration (PET) values exhibited a range of correlations with each other. Specifically, the Modified Penman model showed a high association with the Priestley Taylor model, while the FAO Penman Monteith model demonstrated close relationships with both the Penman and Hargreaves models. The FAO PM Model was constructed using dependent variables, including the estimated FAO Penman-Monteith PET value, and independent variables such as $T_{max}$, $T_{min}$, $RH_{max}$, $RH_{min}$, wind speed (WS), sunshine hours (SSH), saturation vapour pressure ($e_s - e_a$), slope vapour pressure (Δ), ($R_a$) and net radiation ($R_n$). The developed FAO PM model is given by, $Y_{\text{FAO PM Model}} = -11.49 + 1.07\ T_{max} - 0.06\ T_{min} - 0.13\ RH_{max} - 0.34\ RH_{min} + 2.93\ WS + 0.49\ SSH - 1.66(e_s - e_a) + 8.82\ \Delta + 0.99\ R_a - 0.61\ R_n$

**Table 3:** Regression output of FAO PM Model

| Parameters | Coefficients | Standard error | t-stat | p-value |
|---|---|---|---|---|
| Intercept | -11.49 | 19.70 | -0.58 | 0.56 |
| Maximum Temperature ($T_{max}$) | 1.07 | 1.41 | 0.75 | 0.46 |
| Minimum Temperature ($T_{min}$) | -0.06 | 1.29 | -0.04 | 0.97 |
| Relative Humidity ($RH_{max}$) | -0.13 | 0.07 | -1.75 | 0.09 |
| Relative Humidity ($RH_{min}$) | -0.34 | 0.18 | -1.89 | 0.05** |
| Wind speed (WS) | 2.93 | 0.20 | 14.62 | 0.00** |
| Sunshine Hours (SSH) | 0.49 | 0.22 | 2.21 | 0.04** |
| Saturation Vapour Pressure deficit | -1.67 | 6.09 | -0.27 | 0.78 |
| Slope Vapour Pressure | 8.82 | 242.03 | 0.04 | 0.97 |
| Extra-terrestrial Radiation ($R_a$) | 0.99 | 1.29 | 0.77 | 0.45 |
| Net Radiation ($R_n$) | -0.61 | 1.72 | -0.36 | 0.73 |

Notation: '**' indicates the statistically significant at 5% respectively.

The partial regression coefficients of the independent variables and the error term are shown in the following Table 3. Each of the coefficients was interpreted as the estimated change in FAO Penman-Monteith PET values for each of the variables. The significance of the results was determined by interpreting P values of the regression results that were less than 0.05 in value. MP Model were built between PET value of Modified Penman and the independent variable as $T_{mean}$, $RH_{mean}$, f(U), ($e_s - e_a$), and $R_n$. The mean temperature and relative humidity was considerable at statistically significant at 5% respectively which displayed in Table 4.

$Y_{\text{MP Model}} = 104.64 + 11.33\ T_{mean} + 0.27\ RH_{mean} - 707.61\ f\ (U) - 954.13\ \Delta - 2.37\ R_n$

**Table 4:** Result of MLR MP Model

| Parameters | Coefficients | Standard error | t-stat | p-value |
|---|---|---|---|---|
| Intercept | 104.64 | 264.07 | 0.39 | 0.69 |
| Mean Temperature ($T_{Mean}$) | 11.33 | 15.02 | 0.76 | 0.04** |
| Relative Humidity ($RH_{Mean}$) | 0.27 | 0.34 | 0.82 | 0.04** |
| Wind speed (f(U) | -707.61 | 753.75 | -0.94 | 0.35 |
| Slope Vapour Pressure | -954.13 | 1419.96 | -0.67 | 0.51 |
| Net Radiation ($R_n$) | -2.37 | 6.80 | -0.35 | 0.73 |

Notation: '**' indicates the statistically significant at 5% respectively.

Penman Model were constructed between determined Penman PET value and $T_{mean}$, $RH_{mean}$, WS, slope vapour pressure (Δ), H, $E_a$ and $R_n$ were shown in table 4.15. The wind speed and H were found to be significant at 5%. The developed Penman model depicted in Table 5.

$Y_{\text{Penman Model}} = -8.24 + 0.77\, T_{mean} - 0.02\, RH_{mean} - 0.19\, WS - 46.48\, \Delta + 5.39\, H - 0.08\, E_a + 0.03\, R_n$

**Table 5:** Regression Output of Penman Model

| Parameters | Coefficients | Standard error | t-stat | p-value |
|---|---|---|---|---|
| Intercept | -8.24 | 12.28 | -0.67 | 0.51 |
| Mean Temperature ($T_{mean}$) | 0.77 | 1.33 | 0.58 | 0.57 |
| Relative Humidity ($RH_{mean}$) | -0.02 | 0.04 | -0.67 | 0.51 |
| Wind speed (WS) | -0.19 | 0.14 | -1.35 | 0.02** |
| Slope Vapour Pressure | -46.48 | 118.73 | -0.39 | 0.69 |
| Flux density of sensible heat to air (H) | 5.39 | 0.22 | 24.61 | 0.00** |
| Saturated Vapour Pressure ($E_a$) | 0.08 | 0.87 | 0.09 | 0.93 |
| Net Radiation ($R_n$) | 0.03 | 0.77 | 0.04 | 0.97 |

Notation: '**' indicates the statistically significant at 5% respectively.

PT Model were analysed using the predicted variable as evaluated Priestley-Taylor PET values and predictor variable as mean temperature ($T_{mean}$), slope vapour pressure (Δ), and net radiation ($R_n$) were shown in table 6. The mean temperature was considered as significant variables in the PT Model. The Model were built in the form as given below,

$Y_{\text{PT Model}} = -40.93 + 5.06\, T_{mean} - 411.47\, \Delta + 0.02\, R_n$

**Table 6:** Result of MLR PT Model

| Parameters | Coefficients | Standard error | t-stat | p-value |
|---|---|---|---|---|
| Intercept | -40.93 | 50.69 | -0.81 | 0.43 |
| Mean Temperature ($T_{mean}$) | 5.06 | 7.46 | 0.68 | 0.00** |
| Slope Vapour Pressure | -411.47 | 711.99 | -0.58 | 0.57 |
| Net Radiation ($R_n$) | 0.02 | 3.38 | 0.01 | 0.99 |

Notation: '**' indicates the statistically significant at 5% respectively.

BC Model were built between Blaney-Criddle PET value as the regressand and regressors as $T_{mean}$, and p. Table 7 showed that the mean temperature and daily percentage were considered as the significant variables.

$Y_{\text{BC Model}} = -20.19 + 0.85\, T_{mean} + 133.97\, p$

**Table 7:** Regression Output of BC Model

| Parameters | Coefficients | Standard error | t-stat | P Value |
|---|---|---|---|---|
| Intercept | -20.19 | 4.31 | -4.69 | 0.00** |
| Mean Temperature ($T_{mean}$) | 0.85 | 0.07 | 11.69 | 0.00** |
| Mean Daily Percentage (p) | 133.97 | 19.37 | 6.92 | 0.00** |

Notation: '**' indicates the statistically significant at 5% respectively.

HS Model were developed using Hargreaves PET value and predictor variable as $T_{max}$, $T_{min}$, and extra-terrestrial radiation $R_a$. Table 8 depicted that the maximum and minimum temperature and extra-terrestrial radiation were significant at 5%.

$Y_{\text{HS Model}} = -40.62 + 2.26\, T_{max} - 1.14\, T_{min} + 1.81\, R_a$

**Table 8:** MLR Result of Model HS Model

| Parameters | Coefficients | Standard error | t-stat | p-value |
|---|---|---|---|---|
| Intercept | -50.78 | 3.87 | -13.12 | 0.00** |
| Maximum Temperature ($T_{max}$) | 1.83 | 0.13 | 13.78 | 0.00** |
| Minimum Temperature ($T_{min}$) | -0.99 | 0.06 | -16.69 | 0.00** |
| Extra-terrestrial Radiation ($R_a$) | 3.23 | 0.49 | 6.64 | 0.00** |

Notation: '**' indicates the statistically significant at 5% respectively.

### Selection criteria

The accuracy of the model tested using RMSE, RSE, MAE, MAPE, $R^2$ and Adj $R^2$. The Penman model considered as a relevant model which shows the maximum coefficient of determination (0.98) and minimum RMSE (0.81), RSE (0.77), MAE (0.39) and MAPE (1.47%) values. Next to the Penman model, Hargreaves model and FAO PM Model was observed with highest $R^2$ (0.97) and least error values. PT models fails to perform well for the given data.

**Table 10:** Analogy Study of Different MLR Models for Madurai

| S. No. | Model | Multiple $R^2$ | Adjusted $R^2$ | RSE | RMSE | MAE | MAPE |
|---|---|---|---|---|---|---|---|
| 1. | FAO PM Model | 0.97 | 0.96 | 1.04 | 1.30 | 0.93 | 3.85% |
| 2. | MP Model | 0.19 | 0.04 | 0.19 | 9.36 | 4.08 | 20.08% |
| 3. | Penman Model | 0.98 | 0.98 | 0.77 | 0.81 | 0.39 | 1.47% |
| 4. | PT Model | 0.12 | 0.02 | 6.46 | 5.42 | 1.93 | 17.92% |
| 5. | BC Model | 0.94 | 0.93 | 0.93 | 0.96 | 0.55 | 1.90% |
| 6. | HS Model | 0.97 | 0.97 | 1.16 | 1.47 | 0.87 | 2.41% |

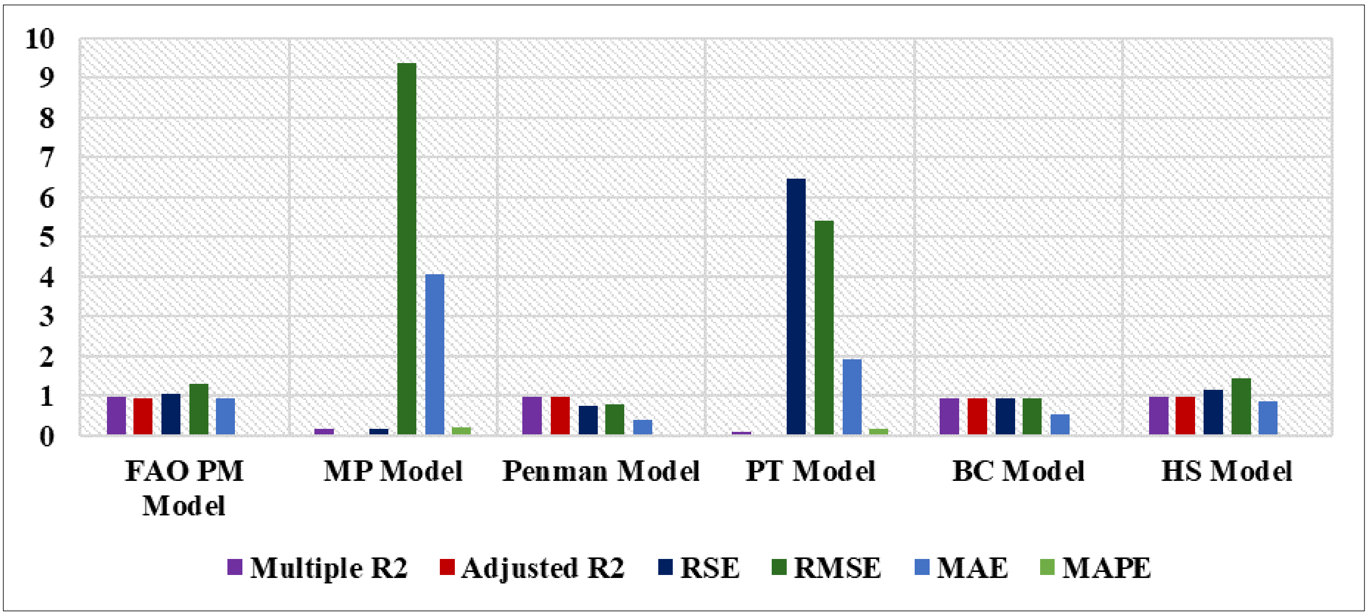

**Fig 5:** Comparative Study of MLR Models for Madurai

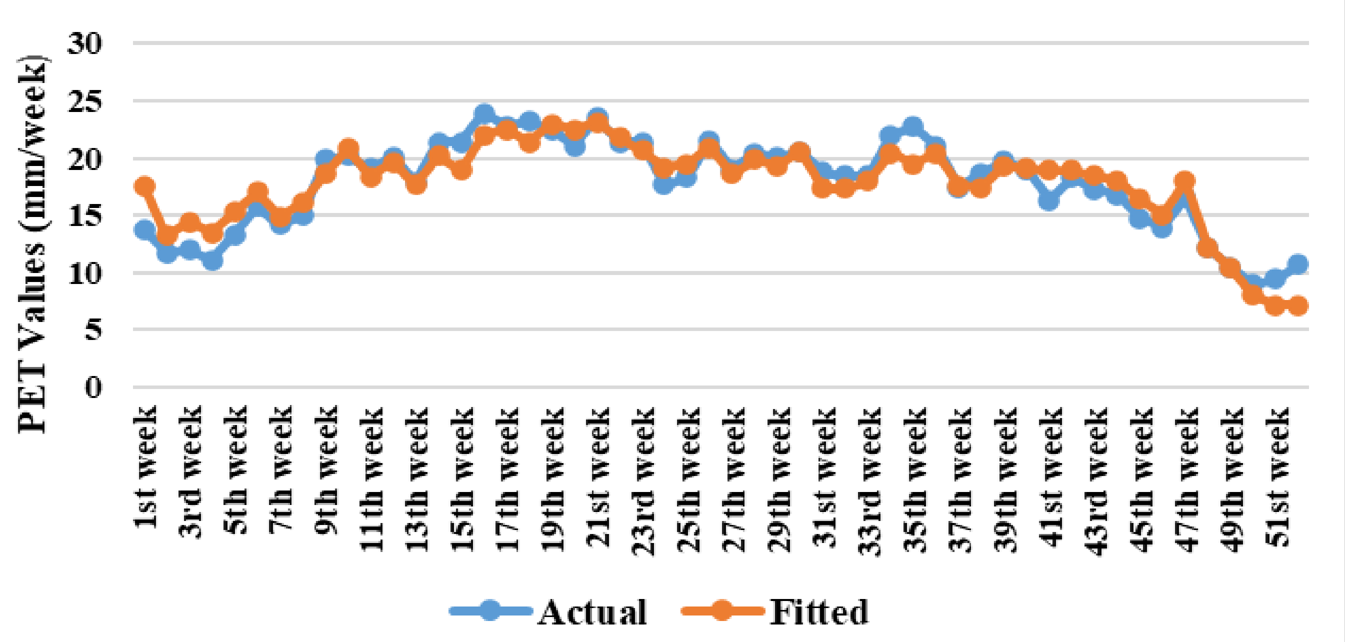

**Fig 6:** The actual and fitted values of Best performed Model (Penman Model)

### Conclusion

In this study, the Potential evapotranspiration was estimated using six different empirical models for Madurai district which can be utilized to determine the crop water requirement for the farmers. The estimated PET value intrepreted that the highest PET value indicates the influence of temperature and relative humidity and lowest PET values show the effect of wind speed. The descriptive statistics of the variables gives the overall information about the data. The maximum temperature was found to have negative association with minimum temperature, maximum and minimum relative humidity and wind speed. The minimum temperature was correlated positively with minimum relative humidity (0.78). The best MLR model has been detected using measures of accuracy from which Penman Model was considered as the best fit model with the lowest RMSE (0.81), RSE (0.77), MAE (0.39) and MAPE (1.47%) values. The FAO Penman Monteith and Hargreaves model were observed as a relevant model which shows high coefficient of determination and least error values next to Penman Model.

## References

1. Alkaeed O, Flores C, Jinno K, Tsutsumi A. Comparison of several reference evapotranspiration methods for Itoshima Peninsula area, Fukuoka, Japan. Memoirs of the Faculty of Engineering, Kyushu University. 2006;66:1-14.
2. Allen RG, Pereira LS, Raes D, Smith M. Crop evapotranspiration - Guidelines for computing crop water requirements - FAO Irrigation and Drainage Paper 56. FAO, Rome; c1998.
3. Archana A, Radha M, Dheebhakaran GA, Vanitha G. Assessment and comparison of potential evapotranspiration for the district of Coimbatore using statistical modelling approach. The Pharma Innovation Journal. 2021;SP-10(10):530-539.
4. Blaney HF, Criddle WB. Determining water requirements in irrigated areas from climatological and irrigation data. USDA Agricultural SCS-TP. 1950;96.
5. Chowdhury S, Nanda MK, Saha G, Deka N. Evaluation of different methods for evapotranspiration estimation using automatic weather station data. Journal of Agrometeorology. 2010;12(1):85-88.
6. Djaman K, O’Neill M, Owen CK, Smeal D, Koudahe K, West M, Allen S, Lombard K, Irmak S. Crop evapotranspiration, irrigation water requirement and water productivity of maize from meteorological data under semiarid climate. Water. 2018;10:405.
7. Doorenbos J, Pruitt WO. Guidelines for predicting crop water requirements. FAO Irrigation and Drainage Paper 24. FAO, Rome, Italy. 1977.
8. Droogers P, Allen RG. Estimating reference evapotranspiration under inaccurate data conditions. Irrigation Science. 2002;16:33-45.
9. Fennessey NM, Vogel RM. Regional models of potential evaporation and reference evapotranspiration for the northeast USA. Journal of Hydrology. 1996;184(3-4):337-354.
10. Gavilan P, Lorite IJ, Tornero S, Berengena J. Regional calibration of Hargreaves equation for estimating reference evapotranspiration in a semiarid environment. Agricultural Water Management. 2006;81:257-281.
11. Hajare HV, Raman NS, Dharkar JM. New technique for evaluation of crop water requirement. WSEAS Transactions on Environment and Development. 2008;4(5):436-446.
12. Hargreaves GH, Samani A. Estimating potential evapotranspiration. Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers. 1982;108(IR3):225-230.
13. Helder JF da Silva, Marconio S, dos Santo, Jório B Cabral Junior, Maria HC, Spyrides. Modeling of reference evapotranspiration by multiple linear regression. Journal of Hyperspectral Remote Sensing. 2015;6:44-58.
14. Liu H, Li Y, Zhang R, Huang G. Evaluation and modification of potential evapotranspiration methods in Beijing, China. International Journals of Agriculture and Biological Engineering. 2013;6(4).
15. Penman HL. Estimating evapotranspiration. Transactions of the American Geophysical Union. 1956;37:43-46.
16. Penman HL. Natural evaporation from open water, bare soil and grass. Proceedings of the Royal Society of London, Series A. 1948;193:120-146.
17. Priestley CHB, Taylor RJ. On the assessment of the surface heat flux and evaporation using large-scale parameters. Monthly Weather Review. 1972;100:81-92.
18. Sharafi S, Galeni MM. Evaluation of multivariate linear regression for reference evapotranspiration modeling in different climates of Iran. Theoretical and Applied Climatology. 2021;143:1409-1423.
19. Saikia US, Satapathy KK, Goswami B, Lama TD. Estimation of PET by empirical models for northeastern hill region of Meghalaya. Journal of Agrometeorology. 2005;7(2):268-273.
20. Shankar SV, Ajaykumar R, Prabhakaran P, Kumaraperumal R, Guna M. Modelling of tea mosquito bug (*Helopeltis theivora*) incidence on neem tree: A zero inflated count data analysis. Journal of Agrometeorology. 2022;24(4):409-16.
21. Sriram AV, Rashmi CN. Estimation of potential evapotranspiration by multiple linear regression method. IOSR Journal of Mechanical and Civil Engineering. 2014;11(2):65-70.
22. Xu C-Y, Singh VP. Evaluation and generalization of radiation-based methods for calculating evaporation. Hydrological Processes. 2000;14:339-349.
23. Rajasekhar K, Suresh SN, Manjithaya R, Govindaraju T. Rationally designed peptidomimetic modulators of Aβ toxicity in Alzheimer's disease. Scientific reports. 2015 Jan 30;5(1):8139.