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Comparison of Solar Radiation Estimation Methods Using Weather Parameters

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K e y w o r d s

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A B S T R A C T

The aim of this study was to estimate solar radiation and reference crop evapotranspiration by using of limited weather parameters. This paper also describes the modification of the original equation with maximum and minimum temperatures for solar radiation. Thus, modifications involved for the corrections associated with climatological parameters and also to determine the accuracy and applicability of a number of existing and newly developed formulae for calculating solar radiation from other weather variables.

Introduction

ET_0 plays an important role in scheduling of irrigation water. Several empirical and semi empirical methods have been developed over the last 50 years to estimate reference evapotranspiration.

The different methods catered for users with different data availability and requiring different levels of accuracy.

The FAO-56 Penman-Monteith (FAO-56 PM) method which requires numerous weather data: maximum and minimum relative air humidity, wind speed at 2 m height and solar radiation (sunshine hours). Hayhoe (1998) recently evaluated the empirical approaches for estimating solar radiation and compared them to stochastic weather generation. He found that an empirical model based on temperature and rainfall provided better estimates than the stochastic model.

Materials and Methods

$R_s = (KT) (R_a) (TD)^{0.5}$ ..... (1)

TD = maximum daily temperature – minimum daily temperature (^{0}C) for weekly or monthly periods,

R_a = Extraterrestrial radiation (mm/day) and

KT = empirical coefficient

$ET_0 = 0.0135\ (KT)\ (R_a)\ (TD)^{1/2}\ (TC+17.8)$ ……. (2)

TD = maximum daily temperature – minimum daily temperature (^{0}c) for weekly or monthly periods,

TC = average daily temperature (^{0}C)

Hargreaves (1994) recommended using KT = 0.162 for interior regions and KT = 0.19 for coastal regions.

Meteorological data were obtained for station (Aduthurai) Climatological parameters are presented in table.1

Results and Discussion

Estimated solar radiation and ET_0 for the observation period shows tremendous increase of value during the year of 1999.

Hence, basic goal attained by reliable estimation of ET_0 only based on the temperature data.

Hargreaves (1994) recommended for using KT = 0.162 for interior regions and KT = 0.19 for coastal regions.

Fig.1 Estimated solar radiation over the year for the month of May

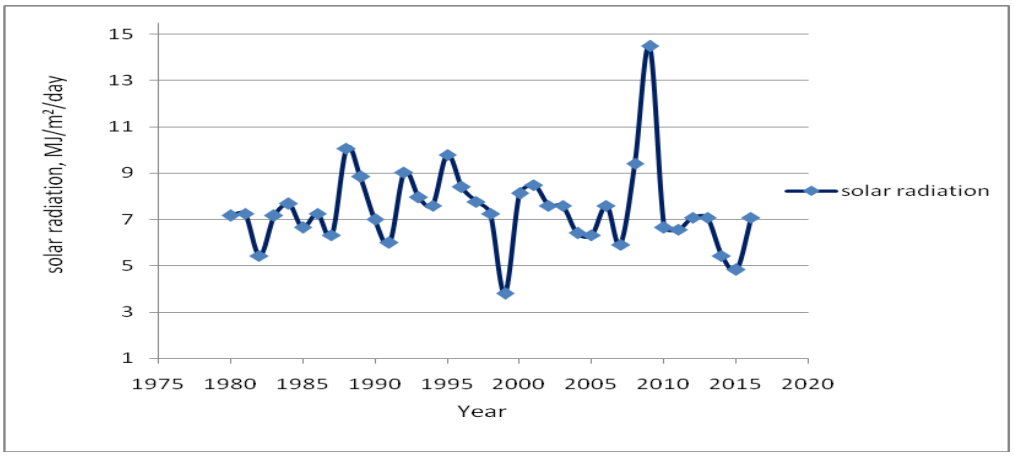

Fig.2 Estimated ET_0 (Reference evapotranspiration) over the year for the month of May

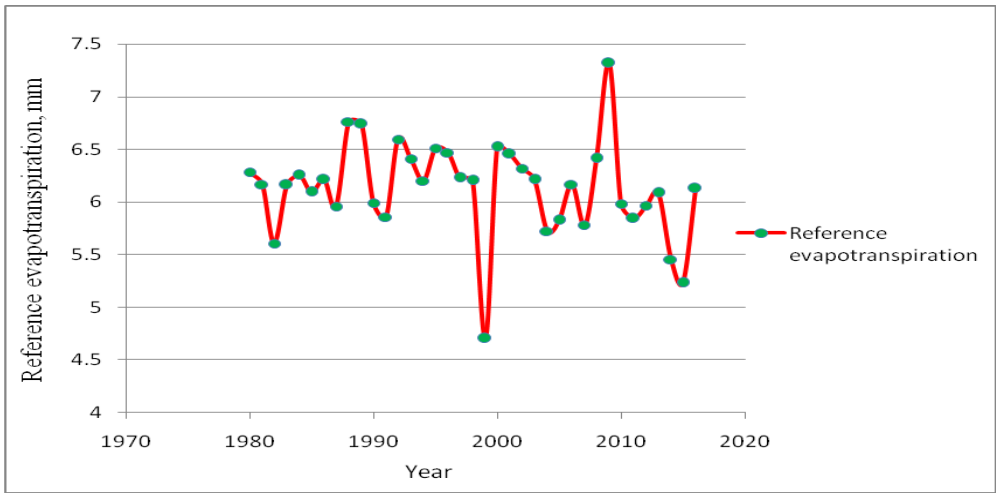

Table.1 Details about the location of study area

Location	Latitude	Longitude	Elevation	Data record
Aduthurai	$11^0$00'55" N	$79^0$28'51"E	20 m	1980-2016

Table.2 Comparison between calculated and estimated values of KT

Station	Elevation	TD^{0}C	KT Allen estimated	KT estimated	KT calculated	Percentage of Error	Percentage of error
Aduthurai	20 m	12.5	0.22	0.15	0.14	65 %	7%

Table.3 Statistical summary of ET_0

Method	MME	MAE	RMSE
Penman-Monteith	0.459	0.199	0.213
Hargreaves	0.931	0.425	0.401
Thornthwaite	0.566	0.375	0.317

MME (Maximum absolute error); MAE (Mean absolute error); RMSE (Root mean square error)

Allen (1995) recommended a correction factor for KT. Allen (1996) suggested using KT =0.17 $(P/P_0)^{0.5}$ for interior regions and KT = 0.2 $(P/P_0)^{0.5}$ for coastal regions to account for proximity of large water body and elevation effects on the volumetric heat capacity of the atmosphere, where P = mean monthly atmospheric pressure of the site and P_0 = mean monthly atmospheric pressure at sea level.

This study evaluated a method to estimate solar radiation by using of limited weather parameters such as maximum and minimum temperature. Maximum error obtained with the proposed modification in estimating solar radiation was 7 %.

Hargreaves and Thornthwaite overestimated the FAO- 56 Penman- Monteith value. Hargreaves and Thornthwaite estimated method recommended for ET_0 of the peak month.

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