INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY HYDERABAD

R&D SHOWCASE 2021

ESTIMATION OF STANDARDIZED PRECIPITATION EVAPOTRANSPIRATION INDEX FOR DIFFERENT POTENTIAL EVAPOTRANSPIRATION MODELS, HYDERABAD, INDIA.

INTRODUCTION

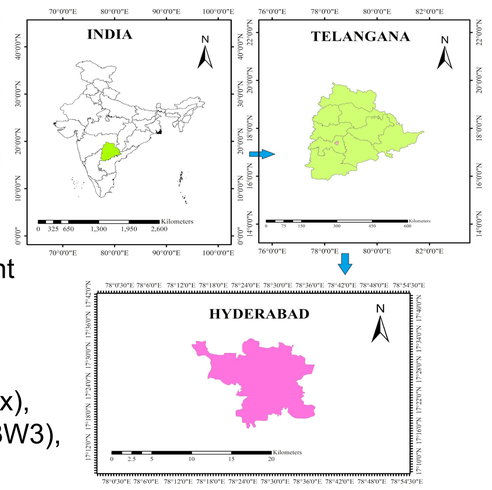
The Standardized Precipitation Evapotranspiration Index (SPEI) is a multiscale drought index based on climatic data, which includes Evapotranspiration (ET_0) along with Precipitation. Evapotranspiration is a complex hydrological variable defined by various climatic variables. This study used SPEI to estimate drought index from Hargreaves, Turc, Priestly-Taylor, and FAO Penman-Monteith methods for a 3, 6, and 12-month timescale. The FAO Penman-Monteith method is considered as a reference method in the present study.

OBJECTIVES

- To calculate SPEI drought index using evapotranspiration empirical methods and compare those values with the reference method.
- To assess the applicability of different evapotranspiration methods for estimating SPEI.

STUDY AREA & METHODOLOGY

The area under study was Hyderabad, the largest city of the Indian state of Telangana which lies between latitude 17.3850^{0}N and longitude 78.4867^{0}E located on the Deccan Plateau in the northern part of South India. Daily meteorological data were used in this study from January 1965 to December 2015 (51 years)



SPEI is mainly based on precipitation and potential evapotranspiration parameters. It is estimated at different timescales by the climatic water balance equation.

$D = P - PET$ (1)

$F(x) = [1+(x-\gamma)^{-\beta}]^{-1}$

The SPEI values can be calculated with the values of F(x),

$SPEI = W - ((C0 + C1W + C2W2) / (1 + d1W + d2W2 + d3W3))$,

Where, $W = -2\ln(p)$ for $p <= 0.5$ (2)

The FAO Penman-Monteith method is generally considered a standard method as it requires more meteorological data. It is given by

$$ET_0 = \frac{0.408D(R_n - G) + g(900/T+273)U_2(es - ea)}{D + g(1 + 0.34U_2)} \quad (3)$$

Where, ET_0 = reference evapotranspiration (mm d^{-1}), D = slope vapor pressure curve [k pa°C^{-1}], R_n = net radiation (MJ m^{-2} d^{-1}), G = soil heat flux (MJ m^{-2} d^{-1}), U_2 = wind speed measured at 2 m height [m s^{-1}], (e_s - e_a) = pressure deficit for measurement at 2 m height [k Pa], T = average temperature at 2 m height (°C), 900 = coefficient for the reference crop [l J^{-1} Kg K d^{-1}], g = psychrometric constant [k pa°C^{-1}], 0.34 = wind coefficient for the reference crop [s m^{-1}].

RESULTS & DISSCUSIONS

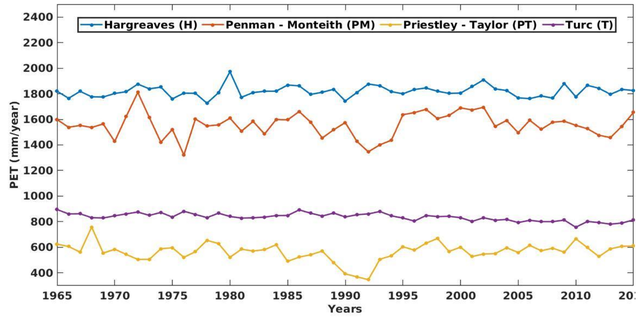


Figure 1: Annual Potential evapotranspiration calculated by various methods for Hyderabad station

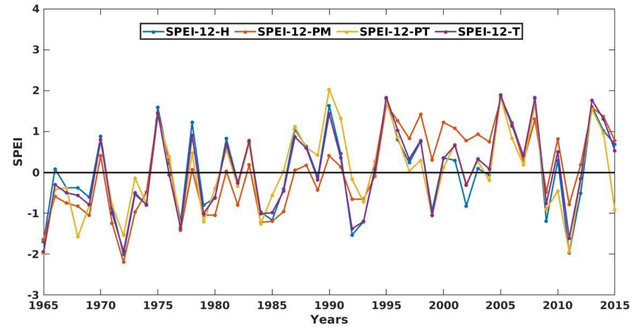


Figure 2. Annual SPEI Values calculated for different PET models for the Hyderabad station

Parameters	T_x	T_n	RH_{mean}	U_2	R_s	ET_o
Maximum	45.5	33.0	139	36.0	14.45	13.16
Minimum	17.6	5.0	10	0	4.00	0.48
Mean	32.37	19.88	60.70	4.69	9.32	3.76
Standard Deviation	4.1	4.79	14.93	4.62	2.44	1.72

Table 1. Statistical Parameters of Hyderabad data set

Method	RMSE (mm) (best is 0.0)	MAE (mm) (best is 0.0)	r (best is 1.0)
Hargreaves	0.624	0.010	0.81
Priestley-Taylor	0.714	0.029	0.73
Turc	0.508	0.003	0.87

Table 2. Performance statistical indicators of SPEI values calculated by various PET methods against reference method

CONCLUSION

- This study compared four versions of SPEI (SPEI-H, SPEI-PM, SPEI-PT, and SPEI-T) to evaluate the performance of PET models by RMSE, MAE, and correlation coefficient (r).
- Hargreaves and Turc method correlate better with the FAO Penman-Monteith method as RMSE values(0.624, 0.508) and MAE values(0.010, 0.003) for these are lower and r values being 0.81 and 0.87 respectively.
- This study concludes that SPEI is not dependent on PET models. It can be reliably assessed for various timescales even if minimum data are available.

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