**Supplementary Materials for**

**Ranking of Empirical Evapotranspiration Models in Different Climate Zones of Pakistan**

Mohammed Magdy Hamed1,2, Najeebullah Khan3, Shamsuddin Shahid2, Mohd Khairul Idlan Muhammad2

Table S-1. List of the empirical ET equations and applications (after Muhammad et al., 2018)

|  |  |  |  |
| --- | --- | --- | --- |
| 1. **No** | **Model (Year)** | **Equation** | **Application** |
| 1. 1 | Dalton (1802) | ET = | Bormann (2011), Tabari et al (2013), Valipour (2014), Rezaei (2016) |
| 2 | Trabert (1896) | ET = | Bormann (2011), Tabari et al (2013), Valipour (2014), Rezaei (2016) |
| 3 | Meyer (1926) | ET = | Bormann (2011), Tabari et al (2013), Valipour (2014), Rezaei (2016) |
| 4 | Rohwer (1931) | ET = | Valipour (2014), Rezaei (2016) |
| 5 | Penman (1948) | ET = | Valipour (2014), Rezaei (2016) |
| 6 | Albrecht (1950) | ET = | Bormann (2011), Tabari et al (2013), Valipour (2014), Rezaei (2016) |
| 7 | Makkink (1957) | ET = | Lu et al (2005), Niaghi et al (2013), Rahimikhoob et al (2012) |
| 8 | Ivanov (1961) | ET = | Valipour (2014), Rezaei (2016) |
| 9 | Turc (1961) | ET = | Heydari et al (2013), Lu et al (2005), Xystrakis and Matzarakis (2010) |
| 10 | Hamon (1963) | ET = RHOSAT x KPEC  RHOSAT =  ESAT = | Lu et al (2005) |
| 11 | Jensen Haise (1963) | ET = | Xystrakis and Matzarakis (2010); Heydari et al (2014) |
| 12 | Brockamp & Wenner (1963) | ET = | Bormann (2011), Tabari et al (2013), Valipour (2014), Rezaei (2016) |
| 13 | Papadakis (1966) | ET = | Valipour (2014), Rezaei (2016) |
| 14 | WMO (1966) | ET = | Bormann (2011), Tabari et al (2013), Valipour (2014), Rezaei (2016) |
| 15 | Schendel (1967) | ET = | Bormann (2011), Djaman (2015) |
| 16 | Mahringer (1970) | ET = | Bormann (2011), Tabari et al (2013), Valipour (2014), Rezaei (2016) |
| 17 | Priestley Taylor (1972) | ET = | Bormann (2011), Niaghi et al (2013), Rahimikhoob et al (2012) |
| 18 | McGuinness & Bordne (1972) | ET = | Tabari et al (2013), Heydari et al (2014) |
| 19 | Szasz (1973) | ET = | Rcz et al (2013) |
| 20 | Caprio (1974) | ET = | Oudin et al (2005) |
| 21 | Blaney Criddle (1977) | ET = | Niaghi et al (2013, Heydari et al (2014), Josilva et al (2016), Poyen et al (2018) |
| 22 | Linacre (1977) |  | Josilva (2016) |
| 23 | Kharuffa (1985) | ET = | Heydari et al (2014) |
| 24 | Hargreaves Samani  (1985) | ET = | Heydari et al (2013), Oudin et al (2005), Rahimikhoob et al (2012), Xu and Singh (2002), Xystrakis and Matzarakis (2010), Josilva et al (2016) |
| 25 | Ritchie (1990) |  | Tabari et al (2013) |
| 26 | Abtew (1996) | ET = | Abtew, 1996 |
| 27 | FAO56 PM (1998a) |  | Heydari et al (2013), Niaghi et al (2013), Rahimikhoob et al (2012), Tabari et al (2013), Valipour (2014), Rezaei (2016) |
| 28 | Irmak-Rs (2003) | ET = | Heydari et al (2013), Niaghi et al (2013), Tabari et al (2013), Heydari et al (2014) |
| 29 | Irmak-Rn (2003 | ET = | Heydari et al (2013), Niaghi et al (2013), Tabari et al (2013), Heydari et al (2014) |
| 30 | Trajkovic (2007) | ET = | Djaman (2015) |
| 31 | Ravazzani (2012) |  | Djaman (2015) |

ET is the potential evapotranspiration (mm day−1). ET is in mm day−1 in all equations except Ritchie and McGuinness & Bordne models, ET is in cm day−1. Rn is the net radiation (MJ m−2 day−1). G is the soil heat flux (MJ m−2 day−1). Ra is the extraterrestrial radiation (MJ m−2 day−1). γ is the psychrometric constant (kPa/°C). es is the saturation vapour pressure (hPa). ea is the actual vapour pressure (hPa). es and ea are in hPa in all equations except Papadakis, Rohwer, Penman and FAO56 Penman-Monteith models, es and ea are in kPa. Δ is the slope of the saturation vapour pressure–temperature curve (kPa/°C). λ is latent heat of evaporation (MJ/kg). Tmean is the average daily air temperature (°C). Tmean is in °C in all equations except McGuinness & Bordne model, Tmean is in degree Fahrenheit. U is the mean daily wind speed at 2 m (m s−1). *f(u)* is function of wind speed. Z is the elevation (m). L is local latitude (degrees). Td is dew point temperature (◦C). Tmin is the minimum air temperature (°C). Tmax is the maximum air temperature (°C). TD is maximum and minimum temperature difference (°C). RH is the average relative humidity (%). Rs is the solar radiation. Rs is in MJ m−2 day−1 in all equations except Turc, Makkink, Ritchie and McGuinness & Bordne models, Rs is in Cal/m2 day and Caprio model, Rs is in kJ/m2 day. ema is the saturation vapour pressure at the monthly mean daily maximum temperature (kPa). is monthly consumptive use coefficient which depends on location, season and vegetation type. The average value of k is 0.8 which also requires local calibration (Poyen et al, 2018). is the mean annual percentage of daytime hours for different latitudes that can be obtained from Doorenbos and Pruitt (1977). is expressed as constant (0.274) in Josilva et al (2016). Ld is daytime length in multiples of 12 h. RHOSAT is saturated vapor density (g m−3). ESAT is saturated vapor pressure (mbar). KPEC is calibration coefficient (1.2). α is constant (1.26). α1 is constant (1.1).