

Table 1 The basic soil properties around the lysimeter system

Soil depth (cm)	Clay content (%)	Silt content (%)	Sand content (%)	Soil bulk density (g cm ⁻³)	Soil organic matter (g kg ⁻¹)	Porosity (%)	Field capacity (m ³ m ⁻³)	Wilting point (m ³ m ⁻³)
0-10	8.88	60.03	31.05	0.74	145.53	72.13	0.41	0.30
10-20	8.24	67.21	24.52	1.06	72.92	60.02	0.35	0.26
20-30	8.70	67.94	23.34	1.04	51.94	60.68	0.34	0.26
30-40	8.56	66.43	24.99	1.08	43.15	59.30	0.34	0.26
40-50	9.63	68.66	21.69	1.04	42.41	60.62	0.33	0.24

Table 2 Details of selected models for evaluation and input parameters in each model

Type	Formula	Equations (abbreviation)
Bowen ratio-energy balance method	$\lambda ET = \frac{R_n - G}{1 + \beta}$	Bowen
Combination	$ET_0 = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T + 273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$	FAO56 Penman-Monteith (FAO-56PM)
	$\lambda ET_0 = c \left[\frac{\Delta}{\Delta + \gamma} (R_n - G) + 2.7 \frac{\gamma}{\Delta + \gamma} (1 + 0.864u_2)(e_s - e_a) \right]$	FAO24 Penman (FAO-24 Pen)
	$\lambda \cdot ET_0 = \left[\frac{\Delta}{\Delta + \gamma} (R_n - G) + 6.43 \frac{\gamma}{\Delta + \gamma} (a_w + b_w u_2)(e_s - e_a) \right]$ c=1 a _w =1, b _w =0.537	Penman (1963) (Pen-63)
Radiation-based	$\lambda ET_0 = \alpha \frac{\Delta}{\Delta + \gamma} (R_n - G)$	Priestley-Taylor (Nemani et al.)
	$\lambda ET_0 = \frac{\Delta}{0.85\Delta + 0.63\gamma} (R_n - G)$	De Bruin-Keijman (DK)
	$\lambda ET_0 = 0.63 \frac{\Delta}{\Delta + \gamma} R_s$	Makkink
	$ET_0 = 0.7 \frac{\Delta}{\Delta + \gamma} \frac{R_s}{\lambda}$	Makkink (1967)
	$ET_0 = 0.61 \frac{\Delta}{\Delta + \gamma} \frac{R_s}{\lambda} - 0.12$	Makkink (1957)
	$ET_0 = -0.611 + 0.149 \times R_s + 0.079 \times T$ $ET_0 = -0.642 + 0.174 \times R_s + 0.0353 \times T$	IRMAK1 IRMAK2

Temperature based	$ET_0 = 0.0023(TD)^{0.5}(T + 17.8)R_a$	Hargreaves (HAR)
	$ET_0 = 0.408 \times 0.0030(T + 20)(\Delta T)^{0.4}R_a$	Hargreaves1(HAR1)
	$ET_0 = 0.408 \times 0.0025(T + 16.8)(\Delta T)^{0.5}R_a$	Hargreaves2 (HAR2)

Note: ET_0 –reference crop evapotranspiration (mmd^{-1}); R_n –net radiation (MJm^{-2}), G –soil heat flux ($\text{MJ m}^{-2} \text{d}^{-1}$), Δ – Slope of the saturation vapor pressure curve ($\text{kPa}^\circ\text{C}^{-1}$); γ –Psychrometric constant($\text{kPa }^\circ\text{C}^{-1}$); u_2 –Wind speed at 2 m (m s^{-1}); e_s - Saturated vapor pressure (kPa), e_a –Actual vapor pressure (kPa); λ –Vaporizing latent of water(MJ kg^{-1}); T –Mean air temperature ($^\circ\text{C}$); R_s –Total radiation ($\text{MJ m}^{-2} \text{d}^{-1}$); R_a –Extraterrestrial solar radiation (MJm^{-2}), TD–the difference between T_{max} and T_{min} .

Table 3 Summary of statistics for daily ET_0 between lysimeter measurements and model estimates during the whole study period(data points = 393)

Model	Values of ET_0 (mm d^{-1})			Difference in ET_0			
	Max	Min	Mean	RMSE (mm d^{-1})	MAE (mm d^{-1})	PE (%)	R^2
Measured	8.00	0.01	2.33				
Bowen	5.66	-0.16	1.93	0.98	-0.40	17.13	0.86
FAO-56PM	4.79	0.06	2.07	1.27	-0.26	11.01	0.76
Pen-63	5.38	0.04	2.30	1.19	-0.02	1.00	0.75
FAO-24 Pen	5.05	-0.02	2.14	1.19	-0.19	7.99	0.77
PT	5.93	-0.17	2.27	1.02	-0.06	2.56	0.80
DK	6.02	-0.19	2.34	1.03	0.01	0.57	0.79
Makkink	6.38	0.45	2.57	1.38	0.24	10.27	0.65
Makkink(1967)	5.97	0.47	2.82	1.36	0.50	21.35	0.69
Makkink(1957)	5.08	0.29	2.34	1.34	0.01	0.59	0.69
IRMAK1	4.70	-0.83	2.19	1.32	-0.14	5.86	0.66
IRMAK2	4.81	-0.05	2.43	1.42	0.11	4.62	0.62
HAR	5.95	-0.18	2.73	1.47	0.40	17.37	0.62
HAR1	5.72	-0.01	2.92	1.47	0.59	25.54	0.59
HAR2	6.27	-0.31	2.84	1.48	0.51	22.05	0.59

Table 4 Summary of statistics for daily ET_0 between lysimeter measurements and model estimates during growing season(data points = 189)

Model	Values of ET_0 (mm d^{-1})			Difference in ET_0			
	Max	Min	Mean	RMSE (mm d^{-1})	MAE (mm)	PE (%)	R^2

	d ⁻¹)						
Measured	8.00	0.35	4.14				
Bowen	5.66	0.16	3.34	1.31	-0.79	19.17	0.64
FAO-56PM	4.79	0.62	3.04	1.58	-1.10	26.59	0.60
Pen-63	5.38	0.57	3.36	1.38	-0.78	18.86	0.58
FAO-24 Pen	5.05	0.43	3.21	1.46	-0.93	22.48	0.59
PT	5.93	0.14	3.59	1.22	-0.55	13.31	0.59
DK	6.02	0.14	3.67	1.19	-0.47	11.41	0.59
Makkink	6.38	0.79	3.51	1.47	-0.63	15.13	0.40
Makkink(1967)	5.97	1.27	3.87	1.28	-0.27	6.45	0.47
Makkink(1957)	5.08	0.99	3.25	1.55	-0.88	21.37	0.47
IRMAK1	4.70	0.99	3.27	1.54	-0.87	20.95	0.50
IRMAK2	4.81	0.89	3.30	1.55	-0.84	20.29	0.43
HAR	5.95	1.53	3.99	1.43	-0.15	3.56	0.32
HAR1	5.72	1.85	4.25	1.42	0.12	2.81	0.32
HAR2	6.27	1.59	4.18	1.42	0.04	1.07	0.32

Table 5 Summary of statistics for daily ET₀ between lysimeter measurements and model estimates during non-growing season (data points = 204)

Model	Values of ET ₀ (mm d ⁻¹)			Difference in ET ₀			
	Max	Min	Mean	RMSE (mm d ⁻¹)	MAE (mm d ⁻¹)	PE (%)	R ²
Measured	4.31	0.01	0.65				
Bowen	2.62	-0.16	0.62	0.52	-0.03	-5.03	0.64
FAO-56PM	3.60	0.06	1.17	0.90	0.53	81.21	0.21
Pen-63	3.29	0.04	1.33	1.00	0.68	104.73	0.25
FAO-24 Pen	3.03	-0.02	1.15	0.86	0.50	77.72	0.28
PT	3.11	-0.17	1.04	0.80	0.40	61.06	0.34
DK	3.28	-0.19	1.11	0.84	0.46	71.43	0.34
Makkink	3.82	0.45	1.69	1.29	1.04	160.58	0.26
Makkink(1967)	4.28	0.47	1.85	1.44	1.20	185.83	0.27
Makkink(1957)	3.61	0.29	1.49	1.11	0.85	130.57	0.27
IRMAK1	3.66	-0.83	1.19	1.07	0.54	83.42	0.26
IRMAK2	4.04	-0.05	1.63	1.30	0.98	151.95	0.23
HAR	4.89	-0.18	1.56	1.47	0.92	141.24	0.19
HAR1	4.71	-0.01	1.69	1.51	1.04	159.98	0.17
HAR2	5.14	-0.31	1.60	1.54	0.95	146.20	0.17

