

Appendix 1 Methode Makkink Berekeningsmethode voor potentiële evapotranspiratie

A.1 Berekeningsmethode voor potentiële evapotranspiratie

Het KNMI gebruikt de formule van Makkink als standaard voor het berekenen van de potentiële gewasverdamping in Nederland. Deze formule is [1]:

$$E = c \frac{\Delta}{\Delta + \gamma} R_s \quad (1)$$

met

- E = referentie-gewasverdamping (mm/dag)
- R_s = zoninstraling (uitgedrukt in mm/dag verdampt water)
- Δ = helling van verzadigingsdampspannings-temperatuurkromme (mbar/°C)
- γ = psychrometrische konstante (mbar/°C)
- c = correctiefactor = 0,65 voor Nederland

De helling van de verzadigingsdampspanningskromme kan worden berekend met:

$$\Delta = \frac{de_s}{dT} = \frac{e_s}{T^2} (6790,5 - 5,02808 T + 17420910^{-1302,88/T}) \quad (2)$$

met

- e_s = verzadigingsdampspanning (mbar)
- T = absolute temperatuur (°K)

De psychrometrische konstante volgt uit:

$$\gamma = 0,00066 p (1 + 0,00115 t) \quad (3)$$

met

- p = luchtdruk (mbar)
- t = luchttemperatuur (°C)

- [1]: Hooghart, J.C. (editor)
Evaporation and weather,
TNO Committee on Hydrological Research, Proc. and Info., No. 39
The Hague, 1987



Tabel 3.2e Neerslag en verdamping 1996, 1997 en 1998 te Nes (Ameland) en Lauwersoog

Nes (Ameland)

Neerslagsommen in millimeters

periode	1951-1980			
	decade 1	decade 2	decade 3	maand
jan	22.7	20.7	21.2	64.6
feb	17.1	16.4	10.4	43.9
mrt	10.4	15.3	18.5	44.2
apr	17.7	15.8	13.0	46.5
mei	14.6	17.1	14.7	46.4
jun	17.1	18.1	22.3	57.5
jul	22.4	27.9	30.6	80.9
aug	25.6	26.4	32.1	84.1
sep	23.4	26.2	23.2	72.8
okt	27.5	23.6	28.9	80.0
nov	33.3	29.9	26.9	90.1
dec	29.8	27.5	25.6	82.9
totaal				793.9

1996				
decade 1	decade 2	decade 3	maand	
9.1	0.6	0.0	9.7	
0.0	40.8	6.5	47.3	
1.1	0.0	11.3	12.4	
0.0	11.4	0.0	11.4	
32.7	16.7	22.4	71.8	
1.8	8.8	17.1	27.7	
6.8	0.6	13.2	20.6	
7.7	15.5	53.3	76.5	
11.8	23.8	29.9	65.5	
33.4	1.6	35.8	70.8	
50.8	48.2	49.7	148.7	
16.1	25.0	2.2	43.3	
totaal				605.7

1997				
decade 1	decade 2	decade 3	maand	
0.0	1.0	1.6	2.6	
9.8	40.5	19.1	69.4	
9.1	18.1	6.1	33.3	
10.9	1.0	16.4	28.3	
23.0	22.8	11.6	57.4	
37.1	10.7	67.3	115.1	
6.2	19.8	24.6	50.6	
3.9	0.0	46.7	50.6	
35.8	9.8	2.1	47.7	
57.6	35.5	5.0	98.1	
9.9	2.3	12.7	24.9	
36.4	27.3	30.8	94.5	
totaal				672.5

1998				
decade 1	decade 2	decade 3	maand	
45.2	32.1	3.0	80.3	
4.5	0.6	12.6	17.7	
43.1	11.1	6.0	60.2	
57.2	34.0	16.0	107.2	
4.3	0.0	19.7	24.0	
21.2	28.0	50.9	100.1	
9.7	44.7	33.3	87.7	
5.8	0.5	57.5	63.8	
43.1	72.9	0.2	116.2	
40.0	39.3	69.4	148.7	
56.2	13.6	12.9	82.7	
20.2	34.9	33.3	88.4	
totaal				977.0

Lauwersoog (tenzij anders vermeld)

Verdamping in millimeters (Makkink)

periode	1965-1985 Den Helder			
	decade 1	decade 2	decade 3	maand
jan	2.0	3.0	3.0	8.0
feb	5.0	5.0	6.0	16.0
mrt	9.0	11.0	15.0	35.0
apr	15.0	20.0	22.0	57.0
mei	24.0	30.0	32.0	86.0
jun	33.0	33.0	32.0	98.0
jul	34.0	31.0	32.0	97.0
aug	29.0	28.0	27.0	84.0
sep	21.0	17.0	14.0	52.0
okt	11.0	9.0	8.0	28.0
nov	5.0	4.0	3.0	12.0
dec	2.0	2.0	2.0	6.0
totaal				579.0

1996				
decade 1	decade 2	decade 3	maand	
1.8	2.0	3.9	7.7	
3.3	2.7	6.3	12.3	
8.8	8.1	12.8	29.7	
14.6	23.3	24.6	62.5	
21.6	18.0	27.3	66.9	
35.2	33.1	16.9	85.2	
28.4	31.8	28.6	88.8	
32.4	30.1	24.7	87.2	
25.6	18.1	12.5	56.2	
12.1	8.3	7.0	27.4	
4.0	3.5	2.0	9.5	
1.4	1.7	2.8	5.9	
totaal				539.3

1997 Hoorn				
decade 1	decade 2	decade 3	maand	
2.0	2.5	3.0	7.5	
3.1	5.7	6.6	15.4	
11.8	7.4	15.5	34.7	
19.8	20.1	19.3	59.2	
23.4	31.2	30.3	84.9	
42.1	33.0	21.1	96.2	
35.3	39.7	30.4	105.4	
40.4	37.6	23.7	101.7	
21.2	19.4	16.0	56.6	
9.0	9.8	8.9	27.7	
4.2	3.6	1.6	9.4	
1.8	1.6	1.8	5.2	
totaal				603.9

1998				
decade 1	decade 2	decade 3	maand	
1.8	2.1	3.3	7.2	
4.2	6.2	5.4	15.8	
8.1	10.1	15.7	33.9	
11.0	17.0	20.9	48.9	
26.0	39.8	24.0	89.8	
24.2	28.5	29.3	82.0	
21.5	26.9	29.6	78.0	
33.2	27.1	20.4	80.7	
12.3	12.5	14.5	39.3	
6.6	8.5	4.7	19.8	
4.0	3.9	3.0	10.9	
2.1	1.6	2.2	5.9	
totaal				512.2



Tabel 3.2a Neerslag en verdamping 1984, 1985 en 1986 te Nes (Ameland) en Lauwersoog

Nes (Ameland)

Neerslagsommen in millimeters

periode	1951-1980				1984				1985				1986			
	decade 1	decade 2	decade 3	maand	decade 1	decade 2	decade 3	maand	decade 1	decade 2	decade 3	maand	decade 1	decade 2	decade 3	maand
jan	22.7	20.7	21.2	64.6	45.9	63.9	11.3	121.1	50.0	7.0	40.0	97.0	18.7	41.1	22.3	82.1
feb	17.1	16.4	10.4	43.9	31.9	3.1	6.8	41.8	2.1	0.6	4.4	7.1	2.7	1.3	0.3	4.3
mrt	10.4	15.3	18.5	44.2	21.0	9.1	28.0	58.1	17.3	11.1	21.1	49.5	12.2	0.7	45.9	58.8
apr	17.7	15.8	13.0	46.5	10.4	2.1	0.0	12.5	21.4	10.4	15.5	47.3	4.4	9.3	15.9	29.6
mei	14.6	17.1	14.7	46.4	10.5	11.2	49.0	70.7	8.9	1.9	28.5	39.3	9.7	8.4	18.5	36.6
jun	17.1	18.1	22.3	57.5	73.9	16.3	8.6	98.8	36.0	68.8	32.3	137.1	41.3	2.1	3.6	47.0
jul	22.4	27.9	30.6	80.9	65.9	26.7	14.5	107.1	17.1	51.8	132.0	200.9	24.4	4.3	55.7	84.4
aug	25.6	26.4	32.1	84.1	11.5	0.9	0.0	12.4	37.1	24.9	22.3	84.3	50.2	15.1	76.2	141.5
sep	23.4	26.2	23.2	72.8	56.0	20.4	76.4	152.8	21.7	14.6	6.7	43.0	34.4	13.5	0.2	48.1
okt	27.5	23.6	28.9	80.0	24.1	13.1	28.4	65.6	36.4	0.3	5.7	42.4	0.4	27.9	86.0	114.3
nov	33.3	29.9	26.9	90.1	7.2	4.3	74.7	86.2	60.5	14.1	23.2	97.8	30.7	31.0	29.0	90.7
dec	29.8	27.5	25.6	82.9	3.1	13.4	23.1	39.6	48.9	34.5	7.0	90.4	5.7	58.5	82.2	146.4
totaal	793.9				866.7				936.1				883.8			

Lauwersoog (tenzij anders vermeld)

Verdamping in millimeters (Makkink)

periode	1965-1985 Den Helder				1984 Ameland				1985 Ameland				1986 Ameland			
	decade 1	decade 2	decade 3	maand	decade 1	decade 2	decade 3	maand	decade 1	decade 2	decade 3	maand	decade 1	decade 2	decade 3	maand
jan	2.0	3.0	3.0	8.0	8.0	8.0	4.0	20.0	1.0	2.0	4.0	7.0	1.0	5.0	5.0	11.0
feb	5.0	5.0	6.0	16.0	6.0	5.0	5.0	16.0	6.0	5.0	3.0	14.0	3.0	5.0	5.0	13.0
mrt	9.0	11.0	15.0	35.0	8.0	11.0	15.0	34.0	5.0	8.0	14.0	27.0	6.0	6.0	12.0	24.0
apr	15.0	20.0	22.0	57.0	13.0	20.0	30.0	63.0	14.0	18.0	22.0	54.0	16.0	15.0	18.0	49.0
mei	24.0	30.0	32.0	86.0	20.0	26.0	22.0	68.0	18.0	26.0	32.0	76.0	28.0	30.0	40.0	98.0
jun	33.0	33.0	32.0	98.0	22.0	32.0	33.0	87.0	32.0	29.0	26.0	87.0	25.0	40.0	48.0	113.0
jul	34.0	31.0	32.0	97.0	28.0	24.0	28.0	80.0	34.0	32.0	30.0	96.0	38.0	36.0	30.0	104.0
aug	29.0	28.0	27.0	84.0	26.0	28.0	29.0	83.0	26.0	26.0	27.0	79.0	34.0	28.0	24.0	86.0
sep	21.0	17.0	14.0	52.0	22.0	15.0	14.0	51.0	21.0	16.0	13.0	50.0	24.0	16.0	13.0	53.0
okt	11.0	9.0	8.0	28.0	10.0	10.0	10.0	30.0	13.0	9.0	6.0	28.0	10.0	9.0	14.0	33.0
nov	5.0	4.0	3.0	12.0	4.0	3.0	6.0	13.0	9.0	2.0	2.0	13.0	9.0	4.0	2.0	15.0
dec	2.0	2.0	2.0	6.0	2.0	2.0	1.0	5.0	3.0	2.0	2.0	7.0	5.0	4.0	5.0	14.0
totaal	579.0				550.0				538.0				613.0			



Tabel 3.2b Neerslag en verdamping 1987, 1988 en 1989 te Nes (Ameland) en Lauwersoog

Nes (Ameland)

Neerslagsommen in millimeters

periode	1951-1980			maand
	decade 1	decade 2	decade 3	
jan	22.7	20.7	21.2	64.6
feb	17.1	16.4	10.4	43.9
mrt	10.4	15.3	18.5	44.2
apr	17.7	15.8	13.0	46.5
mei	14.6	17.1	14.7	46.4
jun	17.1	18.1	22.3	57.5
jul	22.4	27.9	30.6	80.9
aug	25.6	26.4	32.1	84.1
sep	23.4	26.2	23.2	72.8
okt	27.5	23.6	28.9	80.0
nov	33.3	29.9	26.9	90.1
dec	29.8	27.5	25.6	82.9
totaal				793.9

periode	1987			maand
	decade 1	decade 2	decade 3	
jan	44.1	9.6	7.7	61.4
feb	20.4	4.0	8.0	32.4
mrt	25.0	16.8	16.5	58.3
apr	3.0	15.3	0.4	18.7
mei	9.1	25.4	13.2	47.7
jun	44.1	4.6	47.6	96.3
jul	0.0	64.3	63.7	128.0
aug	32.3	10.7	25.6	68.6
sep	40.9	30.3	26.2	97.4
okt	22.7	39.9	22.3	84.9
nov	0.6	74.8	36.0	111.4
dec	11.1	23.3	10.8	45.2
totaal				850.3

periode	1988			maand
	decade 1	decade 2	decade 3	
jan	82.9	11.1	47.7	141.7
feb	71.5	9.7	18.4	99.6
mrt	32.2	35.8	40.8	108.8
apr	0.7	9.1	1.2	11.0
mei	15.6	0.0	39.8	55.4
jun	25.9	0.1	2.8	28.8
jul	53.5	55.7	56.6	165.8
aug	1.3	43.9	71.9	117.1
sep	23.4	21.8	56.2	101.4
okt	86.2	1.2	11.7	99.1
nov	11.7	13.6	21.6	46.9
dec	28.4	16.6	6.5	51.5
totaal				1027.1

periode	1989			maand
	decade 1	decade 2	decade 3	
jan	10.4	9.6	3.1	23.1
feb	7.2	32.1	10.0	49.3
mrt	38.7	25.5	26.8	91.0
apr	11.0	16.2	10.0	37.2
mei	0.0	17.1	2.3	19.4
jun	35.1	0.0	34.3	69.4
jul	14.2	1.7	46.0	61.9
aug	7.0	6.5	33.2	46.7
sep	10.1	9.8	2.9	22.8
okt	41.6	32.5	38.4	112.5
nov	15.8	0.3	11.7	27.8
dec	3.2	70.8	22.1	96.1
totaal				657.2

Lauwersoog (tenzij anders vermeld)

Verdamping in millimeters (Makkink)

periode	1965-1985 Den Helder			maand
	decade 1	decade 2	decade 3	
jan	2.0	3.0	3.0	8.0
feb	5.0	5.0	6.0	16.0
mrt	9.0	11.0	15.0	35.0
apr	15.0	20.0	22.0	57.0
mei	24.0	30.0	32.0	86.0
jun	33.0	33.0	32.0	98.0
jul	34.0	31.0	32.0	97.0
aug	29.0	28.0	27.0	84.0
sep	21.0	17.0	14.0	52.0
okt	11.0	9.0	8.0	28.0
nov	5.0	4.0	3.0	12.0
dec	2.0	2.0	2.0	6.0
totaal				579.0

periode	1987 Ameland			maand
	decade 1	decade 2	decade 3	
jan	4.0	2.0	1.0	7.0
feb	3.0	4.0	3.0	10.0
mrt	11.0	11.0	11.0	33.0
apr	15.0	14.0	25.0	54.0
mei	22.0	21.0	31.0	74.0
jun	25.0	29.0	22.0	76.0
jul	38.0	27.0	25.0	90.0
aug	25.0	20.0	21.0	66.0
sep	20.0	18.0	15.0	53.0
okt	13.0	12.0	5.0	30.0
nov	5.0	7.0	2.0	14.0
dec	2.0	1.0	1.0	4.0
totaal				511.0

periode	1988 Terschelling			maand
	decade 1	decade 2	decade 3	
jan	1.9	2.3	2.5	6.7
feb	4.7	5.4	5.9	16.0
mrt	8.9	10.4	10.2	29.5
apr	15.9	22.9	24.3	63.1
mei	24.6	36.5	34.4	95.5
jun	23.6	27.4	21.4	72.4
jul	29.7	22.6	31.2	83.5
aug	30.9	28.4	23.5	82.8
sep	21.0	12.8	14.2	48.0
okt	11.0	8.0	6.9	25.9
nov	5.3	4.1	2.5	11.9
dec	1.9	1.8	2.5	6.2
totaal				541.5

periode	1989 Nes			maand
	decade 1	decade 2	decade 3	
jan	1.7	3.0	4.4	9.1
feb	5.0	6.5	6.6	18.1
mrt	7.5	8.3	18.2	34.0
apr	14.2	13.5	18.0	45.7
mei	31.1	35.5	47.3	113.9
jun	26.8	50.0	33.8	110.6
jul	32.0	30.1	30.2	92.3
aug	26.2	28.0	22.5	76.7
sep	22.9	18.6	15.0	56.5
okt	11.6	9.5	6.3	27.4
nov	5.1	5.5	3.6	14.2
dec	2.7	1.1	1.5	5.3
totaal				603.8



Tabel 3.2c Neerslag en verdamping 1990, 1991 en 1992 te Nes (Ameland) en Lauwersoog

Nes (Ameland)

Neerslagsommen in millimeters

periode	1951-1980			maand
	decade 1	decade 2	decade 3	
jan	22.7	20.7	21.2	64.6
feb	17.1	16.4	10.4	43.9
mrt	10.4	15.3	18.5	44.2
apr	17.7	15.8	13.0	46.5
mei	14.6	17.1	14.7	46.4
jun	17.1	18.1	22.3	57.5
jul	22.4	27.9	30.6	80.9
aug	25.6	26.4	32.1	84.1
sep	23.4	26.2	23.2	72.8
okt	27.5	23.6	28.9	80.0
nov	33.3	29.9	26.9	90.1
dec	29.8	27.5	25.6	82.9
totaal				793.9

periode	1990			maand
	decade 1	decade 2	decade 3	
jan	6.1	5.3	38.9	50.3
feb	43.3	36.0	14.2	93.5
mrt	31.6	19.4	8.6	59.6
apr	7.1	33.2	9.8	50.1
mei	5.2	27.3	0.0	32.5
jun	27.4	7.4	14.5	49.3
jul	32.5	0.0	0.9	33.4
aug	10.1	36.3	5.3	51.7
sep	38.1	38.1	72.2	148.4
okt	22.3	0.5	41.3	64.1
nov	41.2	57.2	57.9	156.3
dec	2.4	16.5	47.3	66.2
totaal				855.4

periode	1991			maand
	decade 1	decade 2	decade 3	
jan	45.9	16.1	3.8	65.8
feb	0.4	1.0	5.1	6.5
mrt	17.8	11.5	8.1	37.4
apr	17.7	3.9	9.9	31.5
mei	16.0	9.8	0.6	26.4
jun	10.2	33.3	55.0	98.5
jul	4.7	14.3	12.1	31.1
aug	1.6	10.6	5.9	18.1
sep	2.7	7.0	52.7	62.4
okt	26.5	45.8	7.6	79.9
nov	66.4	37.0	14.9	118.3
dec	0.3	29.9	20.0	50.2
totaal				626.1

periode	1992			maand
	decade 1	decade 2	decade 3	
jan	34.3	4.8	1.6	40.7
feb	9.1	19.5	7.1	35.7
mrt	12.1	35.5	27.3	74.9
apr	3.7	41.6	21.0	66.3
mei	54.1	6.9	0.2	61.2
jun	43.5	3.8	0.0	47.3
jul	18.9	42.8	5.2	66.9
aug	22.1	42.5	74.9	139.5
sep	56.6	8.6	1.2	66.4
okt	0.4	65.7	63.1	129.2
nov	18.4	73.6	46.7	138.7
dec	24.4	20.6	0.0	45.0
totaal				911.8

Lauwersoog (tenzij anders vermeld)

Verdamping in millimeters (Makkink)

periode	1965-1985 Den Helder			maand
	decade 1	decade 2	decade 3	
jan	2.0	3.0	3.0	8.0
feb	5.0	5.0	6.0	16.0
mrt	9.0	11.0	15.0	35.0
apr	15.0	20.0	22.0	57.0
mei	24.0	30.0	32.0	86.0
jun	33.0	33.0	32.0	98.0
jul	34.0	31.0	32.0	97.0
aug	29.0	28.0	27.0	84.0
sep	21.0	17.0	14.0	52.0
okt	11.0	9.0	8.0	28.0
nov	5.0	4.0	3.0	12.0
dec	2.0	2.0	2.0	6.0
totaal				579.0

periode	1990 Terschelling			maand
	decade 1	decade 2	decade 3	
jan	1.3	2.2	3.1	6.6
feb	5.6	5.6	7.1	18.3
mrt	8.5	16.8	19.0	44.3
apr	21.1	17.8	29.8	68.7
mei	35.3	24.9	40.5	100.7
jun	29.1	25.7	33.2	88.0
jul	26.6	39.2	37.9	103.7
aug	35.0	27.6	29.7	92.3
sep	15.8	14.6	11.5	41.9
okt	11.2	9.4	8.9	29.5
nov	4.9	3.1	2.7	10.7
dec	2.3	1.7	2.1	6.1
totaal				610.8

periode	1991 Den Helder/Lauwersoog			maand
	decade 1	decade 2	decade 3	
jan	2.6	3.6	3.1	9.3
feb	3.9	5.3	5.6	14.8
mrt	7.6	12.0	18.3	37.9
apr	17.8	25.1	23.7	66.6
mei	19.9	25.5	25.7	71.1
jun	24.1	19.6	23.7	67.4
jul	41.1	28.9	39.2	109.2
aug	29.4	27.0	35.2	91.6
sep	21.2	17.9	10.2	49.3
okt	10.8	8.2	7.9	26.9
nov	4.7	3.3	2.1	10.1
dec	2.0	1.9	1.9	5.8
totaal				560.0

periode	1992			maand
	decade 1	decade 2	decade 3	
jan	1.9	1.8	3.1	6.8
feb	4.1	5.2	5.6	14.9
mrt	10.4	9.2	11.4	31.0
apr	16.5	16.6	17.8	50.9
mei	21.8	35.5	50.5	107.8
jun	31.4	40.3	41.1	112.8
jul	34.8	30.1	37.7	102.6
aug	30.5	19.9	22.8	73.2
sep	18.8	16.2	16.0	51.0
okt	10.2	8.0	6.6	24.8
nov	4.5	2.9	3.5	10.9
dec	2.1	1.8	1.9	5.8
totaal				592.5

jan.-maart: Den Helder
april-dec.: Lauwersoog