Important Abstractions from Precipitation Formulas PDF

Formulas
Examples
with Units

List of 30
Important Abstractions from Precipitation Formulas

1) Infiltration Indices Formulas

1.1) W-Index Formulas

1.1.1) Duration of Rainfall Excess given W Index Formula

Evaluate Formula

Formula

$$t_e = \frac{P - R - I_a}{W}$$

Example with Units

$$4\,\text{h} = \frac{118\,\text{cm} - 48\,\text{cm} - 6.0\,\text{cm}}{16.0\,\text{cm}}$$

1.1.2) Initial Losses given W-Index Formula

Evaluate Formula

Formula

$$I_a = P - R - \left(W \cdot t_e\right)$$

Example with Units

$$6\,\text{cm} = 118\,\text{cm} - 48\,\text{cm} - \left(16.0\,\text{cm} \cdot 4\,\text{h}\right)$$

1.1.3) Total Storm Precipitation when W Index Formula

Evaluate Formula

Formula

$$P = \left(W \cdot t_e\right) + R + I_a$$

Example with Units

$$118\,\text{cm} = \left(16.0\,\text{cm} \cdot 4\,\text{h}\right) + 48\,\text{cm} + 6.0\,\text{cm}$$

1.1.4) Total Storm Runoff given W Index Formula

Evaluate Formula

Formula

$$R = P - I_a - \left(W \cdot t_e\right)$$

Example with Units

$$48\,\text{cm} = 118\,\text{cm} - 6.0\,\text{cm} - \left(16.0\,\text{cm} \cdot 4\,\text{h}\right)$$

1.1.5) W-Index Formula

Evaluate Formula

Formula

$$W = \frac{P - R - I_a}{t_e}$$

Example with Units

$$16\,\text{cm} = \frac{118\,\text{cm} - 48\,\text{cm} - 6.0\,\text{cm}}{4\,\text{h}}$$

1.2) Φ-Index Formulas

1.2.1) Duration of Rainfall Excess given Total Runoff Depth Formula

Evaluate Formula

Formula

$$t_e = \frac{P - R_d}{\varphi}$$

Example with Units

$$4.3011\,\text{h} = \frac{118\,\text{cm} - 117.88\,\text{cm}}{0.0279}$$

1.2.2) Duration of Rainfall from Rainfall Hyetograph Formula

Evaluate Formula

Formula

$$D = N \cdot \Delta t$$

Example with Units

$$18\,\text{h} = 6 \cdot 3\,\text{h}$$

1.2.3) Phi Index for Practical Use Formula

Evaluate Formula

Formula

$$\varphi = \frac{I - R_{24\text{-h}}}{24}$$

Example with Units

$$0.0279 = \frac{0.8\,\text{cm/h} - 0.13\,\text{cm}}{24}$$

1.2.4) Phi Index given Total Runoff Depth Formula

Evaluate Formula

Formula

$$\varphi = \frac{P - R_d}{t_e}$$

Example with Units

$$0.03 = \frac{118\,\text{cm} - 117.88\,\text{cm}}{4\,\text{h}}$$

1.2.5) Precipitation given Total Runoff Depth for Practical Use Formula

Evaluate Formula

Formula

$$P = R_d + \left(\varphi \cdot t_e\right)$$

Example with Units

$$117.9916\,\text{cm} = 117.88\,\text{cm} + \left(0.0279 \cdot 4\,\text{h}\right)$$

1.2.6) Pulses of Time Interval from Rainfall Hyetograph Formula

Evaluate Formula

Formula

$$N = \frac{D}{\Delta t}$$

Example with Units

$$7 = \frac{21\,\text{h}}{3\,\text{h}}$$

1.2.7) Rainfall Intensity for Phi Index of Practical Use Formula

Evaluate Formula

Formula

$$I = \left(\varphi \cdot 24\right) + R_{24\text{-h}}$$

Example with Units

$$0.7996\,\text{cm/h} = \left(0.0279 \cdot 24\right) + 0.13\,\text{cm}$$

1.2.8) Runoff for Phi Index for Practical Use Formula

Evaluate Formula

Formula

$$R_{24\text{-h}} = I - \left(\varphi \cdot 24\right)$$

Example with Units

$$0.1304\,\text{cm} = 0.8\,\text{cm/h} - \left(0.0279 \cdot 24\right)$$

1.2.9) Runoff to Determine Phi Index for Practical Use Formula

Evaluate Formula

Formula

$$R_{24\text{-}h} = \alpha \cdot I^{1.2}$$

Example with Units

$$38.2541\,\text{cm} = 0.5 \cdot 0.8\,\text{cm/h}^{1.2}$$

1.2.10) Time Interval of Rainfall Hyetograph Formula

Evaluate Formula

Formula

$$\Delta t = \frac{D}{N}$$

Example with Units

$$3.5\,\text{h} = \frac{21\,\text{h}}{6}$$

1.2.11) Total Direct Runoff Depth Formula

Evaluate Formula

Formula

$$R_d = P - \left(\varphi \cdot t_e\right)$$

Example with Units

$$117.8884\,\text{cm} = 118\,\text{cm} - \left(0.0279 \cdot 4\,\text{h}\right)$$

2) Modelling Infiltration Capacity Formulas

2.1) Infiltration Capacity Equation Formulas

2.1.1) Darcy's Hydraulic Conductivity given Infiltration Capacity Formula

Evaluate Formula

Formula

$$k = f_p - \left(\frac{1}{2}\right) \cdot s \cdot \frac{t^{-1}}{2}$$

Example with Units

$$14.75\,\text{cm/h} = 16\,\text{cm/h} - \left(\frac{1}{2}\right) \cdot 10 \cdot \frac{2\,\text{h}^{-1}}{2}$$

2.1.2) Darcy's Hydraulic Conductivity given Infiltration Capacity from Philip's Equation Formula

Evaluate Formula

Formula

$$k = \frac{F_p - \left(s \cdot t^{\frac{1}{2}}\right)}{t}$$

Example with Units

$$2.9289\,\text{cm/h} = \frac{20\,\text{cm/h} - \left(10 \cdot 2\,\text{h}^{\frac{1}{2}}\right)}{2\,\text{h}}$$

2.1.3) Equation for Infiltration Capacity Formula

Evaluate Formula

Formula

$$f_p = \left(\frac{1}{2}\right) \cdot s \cdot t^{-\frac{1}{2}} + k$$

Example with Units

$$6.4655\,\text{cm/h} = \left(\frac{1}{2}\right) \cdot 10 \cdot 2\,\text{h}^{-\frac{1}{2}} + 2.93\,\text{cm/h}$$

2.1.4) Infiltration rate by Horton's equation Formula

Evaluate Formula

Formula

$$f_p = f_c + \left(f_0 - f_c\right) \cdot \exp\left(-\left(K_d \cdot t\right)\right)$$

Example with Units

$$19.4449\,\text{cm/h} = 15\,\text{cm/h} + \left(21.0\,\text{cm/h} - 15\,\text{cm/h}\right) \cdot \exp\left(-\left(0.15 \cdot 2\,\text{h}\right)\right)$$

2.1.5) Kostiakov Equation Formula

Evaluate Formula

Formula

$$F_p = a \cdot t^{b}$$

Example with Units

$$20.0818\,\text{cm/h} = 3.55 \cdot 2\,\text{h}^{2.5}$$

2.1.6) Philip's Equation Formula

Evaluate Formula

Formula

$$F_p = s \cdot t^{\frac{1}{2}} + k \cdot t$$

Example with Units

$$20.0021\,\text{cm/h} = 10 \cdot 2\,\text{h}^{\frac{1}{2}} + 2.93\,\text{cm/h} \cdot 2\,\text{h}$$

2.1.7) Sorptivity for Cumulative Infiltration Capacity is from Philip's Equation Formula

Evaluate Formula

Formula

$$s = \frac{F_p - k \cdot t}{t^{\frac{1}{2}}}$$

Example with Units

$$9.9985 = \frac{20\,\text{cm/h} - 2.93\,\text{cm/h} \cdot 2\,\text{h}}{2\,\text{h}^{\frac{1}{2}}}$$

2.1.8) Sorptivity given Infiltration Capacity Formula

Evaluate Formula

Formula

$$s = \frac{\left(f_p - k\right) \cdot 2}{t^{-\frac{1}{2}}}$$

Example with Units

$$36.9675 = \frac{\left(16\,\text{cm/h} - 2.93\,\text{cm/h}\right) \cdot 2}{2\,\text{h}^{-\frac{1}{2}}}$$

2.1.9) Green-Ampt Equation (1911) Formulas

2.1.9.1) Capillary Suction given Infiltration Capacity Formula

Evaluate Formula

Formula

$$S_c = \left(\frac{f_p}{K} - 1\right) \cdot \frac{F_p}{\eta}$$

Example with Units

$$9.2308 = \left(\frac{16\,\text{cm/h}}{13\,\text{cm/h}} - 1\right) \cdot \frac{20\,\text{cm/h}}{0.5}$$

2.1.9.2) Cumulative Infiltration Capacity given Green-Ampt Parameters of Infiltration Model Formula

Evaluate Formula

Formula

$$F_p = \frac{n}{f_p - m}$$

Example with Units

$$20\,\text{cm/h} = \frac{40}{16\,\text{cm/h} - 14}$$

2.1.9.3) Darcy's Hydraulic Conductivity given Infiltration Capacity from Green-Ampt Equation Formula

Evaluate Formula

Formula

$$K = \frac{f_p}{1 + \frac{\eta \cdot S_c}{F_p}}$$

Example with Units

$$13.913\,\text{cm/h} = \frac{16\,\text{cm/h}}{1 + \frac{0.5 \cdot 6}{20\,\text{cm/h}}}$$

2.1.9.4) Green Ampt Equation Formula

Evaluate Formula

Formula

$$f_p = K \cdot \left(1 + \frac{\eta \cdot S_c}{F_p}\right)$$

Example with Units

$$14.95\,\text{cm/h} = 13\,\text{cm/h} \cdot \left(1 + \frac{0.5 \cdot 6}{20\,\text{cm/h}}\right)$$

2.1.9.5) Infiltration Capacity given Green-Ampt Parameters of Infiltration Model Formula

Evaluate Formula

Formula

$$f_p = m + \frac{n}{F_p}$$

Example with Units

$$16\,\text{cm/h} = 14 + \frac{40}{20\,\text{cm/h}}$$

2.1.9.6) Porosity of Soil given Infiltration Capacity from Green-Ampt Equation Formula

Evaluate Formula

Formula

$$\eta = \left(\frac{f_p}{K} - 1\right) \cdot \frac{F_p}{S_c}$$

Example with Units

$$0.7692 = \left(\frac{16\,\text{cm/h}}{13\,\text{cm/h}} - 1\right) \cdot \frac{20\,\text{cm/h}}{6}$$

Variables used in list of Abstractions from Precipitation Formulas above

- **a** Local Parameter a
- **b** Local Parameter b
- **D** Duration *(Hour)*
- f_0 Initial Infiltration Capacity *(Centimeter per Hour)*
- f_c Final Steady State Infiltration Capacity *(Centimeter per Hour)*
- f_p Infiltration Capacity at Any Time t *(Centimeter per Hour)*
- F_p Cumulative Infiltration Capacity *(Centimeter per Hour)*
- **I** Intensity of Rainfall *(Centimeter per Hour)*
- I_a Depression and Interception Losses *(Centimeter)*
- **k** Hydraulic Conductivity *(Centimeter per Hour)*
- **K** Darcy's Hydraulic Conductivity *(Centimeter per Hour)*
- K_d Decay Coefficient
- **m** Parameter 'm' of Infiltration Model by Green-Ampt
- **n** Parameter 'n' of Infiltration Model by Green-Ampt
- **N** Pulses of Time Interval
- **P** Total Storm Precipitation *(Centimeter)*
- **R** Total Storm Runoff *(Centimeter)*
- $R_{24\text{-}h}$ Runoff in Cm from 24h Rainfall *(Centimeter)*
- R_d Total Direct Runoff *(Centimeter)*
- **s** Sorptivity
- S_c Capillary Suction at Wetting Front
- **t** Time *(Hour)*
- t_e Duration of Rainfall Excess *(Hour)*
- **W** W-Index *(Centimeter)*
- **α** Coefficient Depending on Soil Type
- **Δt** Time Interval *(Hour)*
- **η** Porosity

Constants, Functions, Measurements used in list of Abstractions from Precipitation Formulas above

- Functions: **exp**, exp(Number)
  n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- Measurement: **Length** in Centimeter (cm)
  Length Unit Conversion
- Measurement: **Time** in Hour (h)
  Time Unit Conversion
- Measurement: **Speed** in Centimeter per Hour (cm/h)
  Speed Unit Conversion

- φ Φ-Index

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