Important Clark's Method and Nash Model for IUH (Instantaneous Unit Hydrograph) Formulas PDF

Formulas
Examples
with Units

List of 19
Important Clark's Method and Nash Model for IUH (Instantaneous Unit Hydrograph) Formulas

1) Clark's Method for IUH Formulas

1.1) Inflow at Beginning of Time Interval for Routing of Time-Area Histogram Formula

Evaluate Formula

Formula

$$I_1 = \frac{Q_2 - \left(C_2 \cdot Q_1\right)}{2 \cdot C_1}$$

Example with Units

$$45.3333\,\text{m}^3/\text{s} = \frac{64\,\text{m}^3/\text{s} - \left(0.523 \cdot 48\,\text{m}^3/\text{s}\right)}{2 \cdot 0.429}$$

1.2) Inflow Rate between Inter-Isochrone Area Formula

Evaluate Formula

Formula

$$I = 2.78 \cdot \frac{A_r}{\Delta t}$$

Example with Units

$$27.8\,\text{m}^3/\text{s} = 2.78 \cdot \frac{50\,\text{m}^2}{5\,\text{s}}$$

1.3) Inter-Isochrone Area given Inflow Formula

Evaluate Formula

Formula

$$A_r = I \cdot \frac{\Delta t}{2.78}$$

Example with Units

$$50.3597\,\text{m}^2 = 28\,\text{m}^3/\text{s} \cdot \frac{5\,\text{s}}{2.78}$$

1.4) Outflow at Beginning of Time Interval for Routing of Time-Area Histogram Formula

Evaluate Formula

Formula

$$Q_1 = \frac{Q_2 - \left(2 \cdot C_1 \cdot I_1\right)}{C_2}$$

Example with Units

$$32.1415\,\text{m}^3/\text{s} = \frac{64\,\text{m}^3/\text{s} - \left(2 \cdot 0.429 \cdot 55\,\text{m}^3/\text{s}\right)}{0.523}$$

1.5) Outflow at End of Time Interval for Routing of Time-Area Histogram Formula

Evaluate Formula

Formula

$$Q_2 = 2 \cdot C_1 \cdot I_1 + C_2 \cdot Q_1$$

Example with Units

$$72.294\,\text{m}^3/\text{s} = 2 \cdot 0.429 \cdot 55\,\text{m}^3/\text{s} + 0.523 \cdot 48\,\text{m}^3/\text{s}$$

1.6) Time Interval at Inter-Isochrone Area given Inflow Formula

Evaluate Formula

Formula

$$\Delta t = 2.78 \cdot \frac{A_r}{I}$$

Example with Units

$$4.9643\,\text{s} = 2.78 \cdot \frac{50\,\text{m}^2}{28\,\text{m}^3/\text{s}}$$

2) Nash's Conceptual Model Formulas

2.1) Equation for Inflow from Continuity Equation Formula

Evaluate Formula

Formula

$$I = K \cdot R_{dq/dt} + Q$$

Example with Units

$$28\,\text{m}^3/\text{s} = 4 \cdot 0.75 + 25\,\text{m}^3/\text{s}$$

2.2) Ordinates of Instantaneous Unit Hydrograph representing IUH of Catchment Formula

Evaluate Formula

Formula

$$U_t = \left(\frac{1}{((n-1)!) \cdot \left(K^n\right)} \right) \cdot \left(\Delta t^{n-1} \right) \cdot \exp\left(-\frac{\Delta t}{n} \right)$$

Example with Units

$$0.0369\,\text{cm/h} = \left(\frac{1}{((3-1)!) \cdot \left(4^3\right)} \right) \cdot \left(5\,\text{s}^{3-1} \right) \cdot \exp\left(-\frac{5\,\text{s}}{3} \right)$$

2.3) Outflow in First Reservoir Formula

Evaluate Formula

Formula

$$Q_n = \left(\frac{1}{K} \right) \cdot \exp\left(-\frac{\Delta t}{K} \right)$$

Example with Units

$$0.0716\,\text{m}^3/\text{s} = \left(\frac{1}{4} \right) \cdot \exp\left(-\frac{5\,\text{s}}{4} \right)$$

2.4) Outflow in nth Reservoir Formula

Evaluate Formula

Formula

$$Q_n = \left(\frac{1}{((n-1)!) \cdot \left(K^n\right)} \right) \cdot \left(\Delta t^{n-1} \right) \cdot \exp\left(-\frac{\Delta t}{n} \right)$$

Example with Units

$$0.0369\,\text{m}^3/\text{s} = \left(\frac{1}{((3-1)!) \cdot \left(4^3\right)} \right) \cdot \left(5\,\text{s}^{3-1} \right) \cdot \exp\left(-\frac{5\,\text{s}}{3} \right)$$

2.5) Outflow in Second Reservoir Formula

Evaluate Formula

Formula

$$Q_n = \left(\frac{1}{K^2}\right) \cdot \Delta t \cdot \exp\left(-\frac{\Delta t}{K}\right)$$

Example with Units

$$0.0895\,\mathrm{m^3/s} = \left(\frac{1}{4^2}\right) \cdot 5\,\mathrm{s} \cdot \exp\left(-\frac{5\,\mathrm{s}}{4}\right)$$

2.6) Outflow in Third Reservoir Formula

Evaluate Formula

Formula

$$Q_n = \left(\frac{1}{2}\right) \cdot \left(\frac{1}{K^3}\right) \cdot \left(\Delta t^2\right) \cdot \exp\left(-\frac{\Delta t}{K}\right)$$

Example with Units

$$0.056\,\mathrm{m^3/s} = \left(\frac{1}{2}\right) \cdot \left(\frac{1}{4^3}\right) \cdot \left(5\,\mathrm{s}^2\right) \cdot \exp\left(-\frac{5\,\mathrm{s}}{4}\right)$$

2.7) Determination of n and S of Nash's Model Formulas

2.7.1) First Moment of DRH about Time Origin divided by Total Direct Runoff Formula

Evaluate Formula

Formula

$$M_{Q1} = (n \cdot K) + M_{I1}$$

Example

$$22 = (3 \cdot 4) + 10$$

2.7.2) First Moment of ERH about Time Origin divided by Total Effective Rainfall Formula

Evaluate Formula

Formula

$$M_{I1} = M_{Q1} - (n \cdot K)$$

Example

$$10 = 22 - (3 \cdot 4)$$

2.7.3) First Moment of ERH given Second Moment of DRH Formula

Evaluate Formula

Formula

$$M_{I1} = \frac{M_{Q2} - M_{I2} - \left(n \cdot (n+1) \cdot K^2\right)}{2 \cdot n \cdot K}$$

Example

$$10 = \frac{448 - 16 - \left(3 \cdot (3+1) \cdot 4^2\right)}{2 \cdot 3 \cdot 4}$$

2.7.4) First Moment of Instantaneous Unit Hydrograph or IUH Formula

Evaluate Formula

Formula

$$M_1 = n \cdot K$$

Example

$$12 = 3 \cdot 4$$

2.7.5) Second Moment of DRH about Time Origin divided by Total Direct Runoff Formula

Evaluate Formula

Formula

$$M_{Q2} = \left(n \cdot (n + 1) \cdot K^{2} \right) + \left(2 \cdot n \cdot K \cdot M_{I1} \right) + M_{I2}$$

Example

$$448 = \left(3 \cdot (3 + 1) \cdot 4^{2} \right) + (2 \cdot 3 \cdot 4 \cdot 10) + 16$$

2.7.6) Second Moment of ERH about Time Origin divided by Total Excess Rainfall Formula

Evaluate Formula

Formula

$$M_{I2} = M_{Q2} - \left(n \cdot (n + 1) \cdot K^{2} \right) - \left(2 \cdot n \cdot K \cdot M_{I1} \right)$$

Example

$$16 = 448 - \left(3 \cdot (3 + 1) \cdot 4^{2} \right) - (2 \cdot 3 \cdot 4 \cdot 10)$$

2.7.7) Second Moment of Instantaneous Unit Hydrograph or IUH Formula

Evaluate Formula

Formula

$$M_2 = n \cdot (n + 1) \cdot K^{2}$$

Example

$$192 = 3 \cdot (3 + 1) \cdot 4^{2}$$

Variables used in list of Clark's Method and Nash Model for IUH (Instantaneous Unit Hydrograph) Formulas above

- A_r Inter-Isochrone Area *(Square Meter)*
- C_1 Coefficient C1 in Muskingum Method of Routing
- C_2 Coefficient C2 in Muskingum Method of Routing
- **I** Inflow Rate *(Cubic Meter per Second)*
- I_1 Inflow at the Beginning of Time Interval *(Cubic Meter per Second)*
- **K** Constant K
- M_1 First Moment of the IUH
- M_2 Second Moment of the IUH
- M_{I1} First Moment of the ERH
- M_{I2} Second Moment of the ERH
- M_{Q1} First Moment of the DRH
- M_{Q2} Second Moment of the DRH
- **n** Constant n
- **Q** Outflow Rate *(Cubic Meter per Second)*
- Q_1 Outflow at the Beginning of Time Interval *(Cubic Meter per Second)*
- Q_2 Outflow at the End of Time Interval *(Cubic Meter per Second)*
- Q_n Outflow in the Reservoir *(Cubic Meter per Second)*
- $R_{dq/dt}$ Rate of Change of Discharge
- U_t Ordinates of Unit Hydrograph *(Centimeter per Hour)*
- **Δt** Time Interval *(Second)*

Constants, Functions, Measurements used in list of Clark's Method and Nash Model for IUH (Instantaneous Unit Hydrograph) 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: **Time** in Second (s)
Time Unit Conversion
- Measurement: **Area** in Square Meter (m²)
Area Unit Conversion
- Measurement: **Speed** in Centimeter per Hour (cm/h)
Speed Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m³/s)
Volumetric Flow Rate Unit Conversion

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