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Hydrologic Routing Formulas

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List of 22 Hydrologic Routing Formulas

Hydrologic Routing

Hydrologic Channel Routing

1) Equation for Linear Storage or Linear Reservoir

Open Calculator

fx $$S = K \cdot Q$$

ex $$100\text{m}^3 = 4 \cdot 25\text{m}^3/\text{s}$$

2) Outflow given Linear Storage

Open Calculator

fx $$Q = \frac{S}{K}$$

ex $$25\text{m}^3/\text{s} = \frac{100\text{m}^3}{4}$$

3) Storage during Beginning of Time Interval for Continuity Equation of Reach

Open Calculator

fx $$S_1 = S_2 + \left(\frac{Q_2 + Q_1}{2}\right) \cdot \Delta t - \left(\frac{I_2 + I_1}{2}\right) \cdot \Delta t$$

ex $$15 = 35 + \left(\frac{64\text{m}^3/\text{s} + 48\text{m}^3/\text{s}}{2}\right) \cdot 5\text{s} - \left(\frac{65\text{m}^3/\text{s} + 55\text{m}^3/\text{s}}{2}\right) \cdot 5\text{s}$$

4) Storage during End of Time Interval in Continuity Equation for Reach

Open Calculator

fx $$S_2 = \left(\frac{I_2 + I_1}{2}\right) \cdot \Delta t - \left(\frac{Q_2 + Q_1}{2}\right) \cdot \Delta t + S_1$$

ex $$35 = \left(\frac{65\text{m}^3/\text{s} + 55\text{m}^3/\text{s}}{2}\right) \cdot 5\text{s} - \left(\frac{64\text{m}^3/\text{s} + 48\text{m}^3/\text{s}}{2}\right) \cdot 5\text{s} + 15$$

5) Storage during end of time interval in Muskingum method of Routing

Open Calculator

fx $$S_2 = K \cdot (x \cdot (I_2 - I_1) + (1 - x) \cdot (Q_2 - Q_1)) + S_1$$

ex $$35.8 = 4 \cdot (1.8 \cdot (65\text{m}^3/\text{s} - 55\text{m}^3/\text{s}) + (1 - 1.8) \cdot (64\text{m}^3/\text{s} - 48\text{m}^3/\text{s})) + 15$$

6) Storage in Beginning of Time Interval

Open Calculator

fx $$S_1 = S_2 - (K \cdot (x \cdot (I_2 - I_1) + (1 - x) \cdot (Q_2 - Q_1)))$$

ex $$14.2 = 35 - (4 \cdot (1.8 \cdot (65\text{m}^3/\text{s} - 55\text{m}^3/\text{s}) + (1 - 1.8) \cdot (64\text{m}^3/\text{s} - 48\text{m}^3/\text{s})))$$

7) Total Wedge Storage in Channel Reach

Open Calculator

fx $$S = K \cdot (x \cdot I^m + (1 - x) \cdot Q^m)$$

ex $$99.11748\text{m}^3 = 4 \cdot \left(1.8 \cdot (28\text{m}^3/\text{s})^{0.94} + (1 - 1.8) \cdot (25\text{m}^3/\text{s})^{0.94}\right)$$

Muskingum Equation

8) Change in Storage in Muskingum Method of Routing

Open Calculator

fx $$\Delta Sv = K \cdot (x \cdot (I_2 - I_1) + (1 - x) \cdot (Q_2 - Q_1))$$

ex $$20.8 = 4 \cdot (1.8 \cdot (65 m^3/s - 55 m^3/s) + (1 - 1.8) \cdot (64 m^3/s - 48 m^3/s))$$

9) Muskingum Equation

Open Calculator

fx $$\Delta Sv = K \cdot (x \cdot I + (1 - x) \cdot Q)$$

ex $$121.6 = 4 \cdot (1.8 \cdot 28 m^3/s + (1 - 1.8) \cdot 25 m^3/s)$$

10) Muskingum Routing Equation

Open Calculator

fx $$Q_2 = C_o \cdot I_2 + C_1 \cdot I_1 + C_2 \cdot Q_1$$

ex $$51.819 m^3/s = 0.048 \cdot 65 m^3/s + 0.429 \cdot 55 m^3/s + 0.523 \cdot 48 m^3/s$$

Hydrologic Storage Routing

11) Coefficient of Discharge when Outflow is Considered

Open Calculator

fx $$C_d = \left(\frac{Qh}{\left(\frac{2}{3}\right) \cdot \sqrt{2 \cdot g} \cdot L_e \cdot \left(\frac{H^3}{2}\right)} \right)$$

ex $$0.659561 = \left(\frac{131.4 m^3/s}{\left(\frac{2}{3}\right) \cdot \sqrt{2 \cdot 9.8 m/s^2} \cdot 5.0 m \cdot \left(\frac{(3m)^3}{2}\right)} \right)$$

12) Effective Length of Spillway Crest when Outflow is Considered

Open Calculator

fx $$L_e = \frac{Qh}{\left(\frac{2}{3}\right) \cdot C_d \cdot \sqrt{2 \cdot g} \cdot \frac{H^3}{2}}$$

ex $$4.996672\text{m} = \frac{131.4\text{m}^3/\text{s}}{\left(\frac{2}{3}\right) \cdot 0.66 \cdot \sqrt{2 \cdot 9.8\text{m}/\text{s}^2} \cdot \frac{(3\text{m})^3}{2}}$$

13) Head over Spillway when Outflow is Considered

Open Calculator

fx $$H = \left(\frac{Qh}{\left(\frac{2}{3}\right) \cdot C_d \cdot \sqrt{2 \cdot g} \cdot \left(\frac{L_e}{2}\right)}\right)^{\frac{1}{3}}$$

ex $$2.999334\text{m} = \left(\frac{131.4\text{m}^3/\text{s}}{\left(\frac{2}{3}\right) \cdot 0.66 \cdot \sqrt{2 \cdot 9.8\text{m}/\text{s}^2} \cdot \left(\frac{5.0\text{m}}{2}\right)}\right)^{\frac{1}{3}}$$

14) Outflow in Spillway

Open Calculator

fx $$Qh = \left(\frac{2}{3}\right) \cdot C_d \cdot \sqrt{2 \cdot g} \cdot L_e \cdot \frac{H^3}{2}$$

ex $$131.4875\text{m}^3/\text{s} = \left(\frac{2}{3}\right) \cdot 0.66 \cdot \sqrt{2 \cdot 9.8\text{m}/\text{s}^2} \cdot 5.0\text{m} \cdot \frac{(3\text{m})^3}{2}$$

Goodrich Method

15) Inflow at Beginning of Time Interval

fx Open Calculator

$$I_1 = \left(\left(2 \cdot \frac{S_2}{\Delta t} \right) + Q_2 \right) - \left(\left(2 \cdot \frac{S_1}{\Delta t} \right) - Q_1 \right) - I_2$$

ex $$55\text{m}^3/\text{s} = \left(\left(2 \cdot \frac{35}{5\text{s}} \right) + 64\text{m}^3/\text{s} \right) - \left(\left(2 \cdot \frac{15}{5\text{s}} \right) - 48\text{m}^3/\text{s} \right) - 65\text{m}^3/\text{s}$$

16) Inflow at End of Time Interval

fx Open Calculator

$$I_2 = \left(\left(2 \cdot \frac{S_2}{\Delta t} \right) + Q_2 \right) - \left(\left(2 \cdot \frac{S_1}{\Delta t} \right) - Q_1 \right) - I_1$$

ex $$65\text{m}^3/\text{s} = \left(\left(2 \cdot \frac{35}{5\text{s}} \right) + 64\text{m}^3/\text{s} \right) - \left(\left(2 \cdot \frac{15}{5\text{s}} \right) - 48\text{m}^3/\text{s} \right) - 55\text{m}^3/\text{s}$$

17) Outflow at Beginning of Time Interval

fx Open Calculator

$$Q_1 = (I_1 + I_2) + \left(2 \cdot \frac{S_1}{\Delta t} \right) - \left(\left(2 \cdot \frac{S_2}{\Delta t} \right) + Q_2 \right)$$

ex $$48\text{m}^3/\text{s} = (55\text{m}^3/\text{s} + 65\text{m}^3/\text{s}) + \left(2 \cdot \frac{15}{5\text{s}} \right) - \left(\left(2 \cdot \frac{35}{5\text{s}} \right) + 64\text{m}^3/\text{s} \right)$$

18) Outflow at End of Time Interval

Open Calculator

fx
$$Q_2 = (I_1 + I_2) + \left(\left(2 \cdot \frac{S_1}{\Delta t}\right) - Q_1\right) - \left(2 \cdot \frac{S_2}{\Delta t}\right)$$

ex
$$64\text{m}^3/\text{s} = (55\text{m}^3/\text{s} + 65\text{m}^3/\text{s}) + \left(\left(2 \cdot \frac{15}{5\text{s}}\right) - 48\text{m}^3/\text{s}\right) - \left(2 \cdot \frac{35}{5\text{s}}\right)$$

Modified Pul's Method

19) Storage at Beginning of Time Interval in Modified Pul's Method

Open Calculator

fx
$$S_1 = \left(S_2 + \left(Q_2 \cdot \frac{\Delta t}{2}\right)\right) - \left(\frac{I_1 + I_2}{2}\right) \cdot \Delta t + \left(Q_1 \cdot \frac{\Delta t}{2}\right)$$

ex
$$15 = \left(35 + \left(64\text{m}^3/\text{s} \cdot \frac{5\text{s}}{2}\right)\right) - \left(\frac{55\text{m}^3/\text{s} + 65\text{m}^3/\text{s}}{2}\right) \cdot 5\text{s} + \left(48\text{m}^3/\text{s} \cdot \frac{5\text{s}}{2}\right)$$

20) Storage at End of Time Interval in Modified Pul's Method

Open Calculator

fx
$$S_2 = \left(\frac{I_1 + I_2}{2}\right) \cdot \Delta t + \left(S_1 - \left(Q_1 \cdot \frac{\Delta t}{2}\right)\right) - \left(Q_2 \cdot \frac{\Delta t}{2}\right)$$

ex
$$35 = \left(\frac{55\text{m}^3/\text{s} + 65\text{m}^3/\text{s}}{2}\right) \cdot 5\text{s} + \left(15 - \left(48\text{m}^3/\text{s} \cdot \frac{5\text{s}}{2}\right)\right) - \left(64\text{m}^3/\text{s} \cdot \frac{5\text{s}}{2}\right)$$

Standard Fourth-Order Range Kutta Method

21) Water Surface Elevation at i'th step in Standard Fourth-Order Runge-Kutta Method

Open Calculator

fx
$$H_i = H_{i+1} - \left(\left(\frac{1}{6} \right) \cdot (K_1 + 2 \cdot K_2 + 2 \cdot K_3 + K_4) \cdot \Delta t \right)$$

ex
$$10 = 18 - \left(\left(\frac{1}{6} \right) \cdot (1.61 + 2 \cdot 1.98 + 2 \cdot 1.28 + 1.47) \cdot 5\text{s} \right)$$

22) Water Surface Elevation in Standard Fourth-Order Runge-Kutta Method

Open Calculator

fx
$$H_{i+1} = H_i + \left(\frac{1}{6} \right) \cdot (K_1 + 2 \cdot K_2 + 2 \cdot K_3 + K_4) \cdot \Delta t$$

ex
$$18 = 10.0 + \left(\frac{1}{6} \right) \cdot (1.61 + 2 \cdot 1.98 + 2 \cdot 1.28 + 1.47) \cdot 5\text{s}$$

Variables Used

- **C_1** Coefficient C1 in Muskingum Method of Routing
- **C_2** Coefficient C2 in Muskingum Method of Routing
- **C_d** Coefficient of Discharge
- **C_o** Coefficient Co in Muskingum Method of Routing
- **g** Acceleration due to Gravity *(Meter per Square Second)*
- **H** Head over Weir *(Meter)*
- **H_i** Water Surface Elevation at i'th Step
- **H_{i+1}** Water Surface Elevation at (i+1)th Step
- **I** Inflow Rate *(Cubic Meter per Second)*
- **I_1** Inflow at the Beginning of Time Interval *(Cubic Meter per Second)*
- **I_2** Inflow at the End of Time Interval *(Cubic Meter per Second)*
- **K** Constant K
- **K_1** Coefficient K1 by Repeated Appropriate Evaluation
- **K_2** Coefficient K2 by Repeated Appropriate Evaluation
- **K_3** Coefficient K3 by Repeated Appropriate Evaluation
- **K_4** Coefficient K4 by Repeated Appropriate Evaluation
- **L_e** Effective Length of the Spillway Crest *(Meter)*
- **m** A Constant Exponent
- **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)*
- **Qh** Reservoir Discharge *(Cubic Meter per Second)*
- **S** Total Storage in Channel Reach *(Cubic Meter)*

- **S_1** Storage at the Beginning of Time Interval
- **S_2** Storage at the End of Time Interval
- **x** Coefficient x in the Equation
- **ΔSv** Change in Storage Volumes
- **Δt** Time Interval *(Second)*

Constants, Functions, Measurements used

- Function: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Acceleration** in Meter per Square Second (m/s^2)
  Acceleration Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m^3/s)
  Volumetric Flow Rate Unit Conversion

Check other formula lists

- **Basic Equations of Flood Routing Formulas**
- **Clark's Method and Nash Model for IUH (Instantaneous Unit Hydrograph) Formulas**
- **Hydrologic Routing Formulas**

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