Water budget

Slide#15 solution)

The control volume is the lake.

Input processes

$Q_{in} = 1.5\ m^3/s$

P = 9.1 cm/month

No seepage in, no runoff into the lake

Output processes

$Q_{out} = 1.25\ m^3/s$

E = 19.4 cm/month

No transpiration, no seepage out

Water budget

$$\frac{\Delta S}{\Delta t} = (Q_{in} + P) - (Q_{out} + E)$$

Need a unit of m/month

$$\frac{\Delta h}{\Delta t} = \frac{\Delta S}{A_{lake}\Delta t}$$

$$= \frac{(1.5-1.25)\ m^3/s \times 86400\ s/day \times 30\ days/month}{708000\ m^2} + (9.1 - 19.4)\ cm/month\ \times 10^{-2}\ m/cm$$

$$= 0.8\ m$$

$$h = h_0 + \frac{\Delta h}{\Delta t} \cdot \Delta t = 19.0\ m + 0.8\ m = \mathbf{19.8\ m}$$

Runoff coefficient

Slide#21 solution)

The control volume is the watershed.

Input processes

P = 77.7 cm/year

No other input processes for a watershed

Output processes

Q_{out} *= 39.6* m^3/s *(this is the "runoff" from the watershed!)*

$I_{out} = 9.2 \times 10^{-7}$ *m/s*

E_T *= 45 cm/year*

Runoff coefficient

$$\frac{\Delta S}{\Delta t} = P - (Q_{out} + I_{out} + E_T)$$

$$= (77.7\ cm/year - 9.2 \times 10^{-7}\ cm/s\ \times 86400\ s/day\ \times 365\ days/year - 45\ cm/year)$$

$$10^{-2}\ m/cm \times 4530\ km^2\ \times\ 10^6\ m^2/km^2 - 39.6\ m^3/s\ \times\ 86400\ s/day\ \times 365\ days/year$$

$$= \mathbf{-1.08 \times 10^9\ m^3/year}$$

Converting the Q_{out} into cm/year:

$$\frac{39.6\ m^3/s \times 86400\ s/day \times 365\ days/year}{4530\ km^2 \times 10^6\ m^2/km^2} \times 10^2\ cm/m = 27.6\ cm/year$$

Runoff coefficient = $\frac{27.6\ cm/year}{77.7\ cm/year} = \mathbf{0.36}$

Groundwater flow

Slide#38 solution)

i) ***h_A = 18 m, h_B = 17.5 m***

ii) ***A to B***

iii) $i = \frac{\Delta h}{L} = \frac{0.5\ m}{100\ m} = \mathbf{0.005}$

iv) $v = K \cdot i = 5.2 \times 10^4\ m/s\ \times 0.005 = 2.6 \times 10^{-6}\ m/s = \mathbf{0.225\ m/day}$

v) $Q = v \cdot A = 0.225\ m/day\ \times 925\ m^2 = \mathbf{208\ m^3/day}$

vi) $v' = \frac{v}{n} = \frac{0.225\ m/day}{0.3} = \mathbf{0.75\ m/day}$