Rainfall Runoff Processes

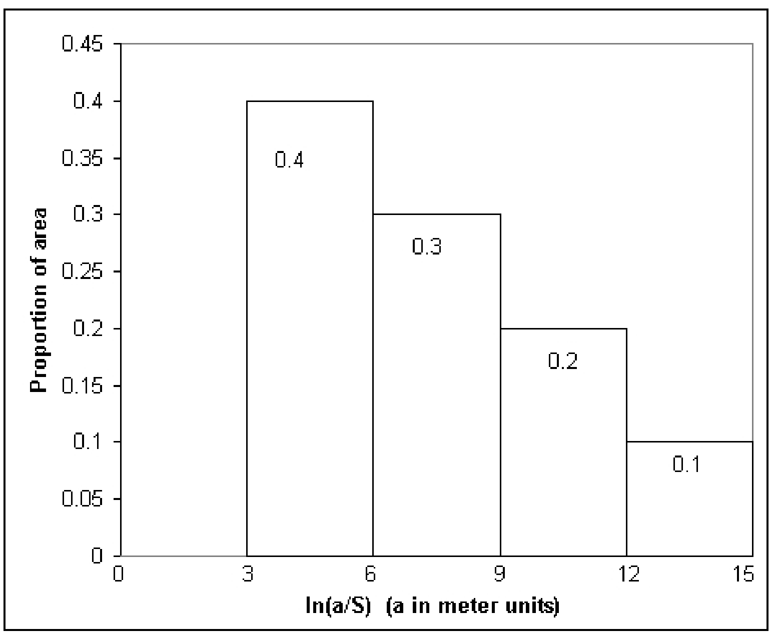
Results and Feedback from Quiz

Name: Karun Joseph
Total Points: 0 / 8 = 0%
Date started: 11/9/2016 11:12:22 AM
Date finished: 11/9/2016 11:12:26 AM

Module: Default
Score: 0 / 8 = 0%

Question 1.

The probability distribution of wetness index represented by a histogram is sufficient to describe the hydrologic response of a watershed using TOPMODEL. Consider a watershed that has TOPMODEL wetness index ln(a/S) distributed according to the histogram shown



The watershed has TOPMODEL parameters: Spatially homogeneous K_o= 4 m/hr, f= 2 m^{-1}, antecedent baseflow Q_b = 12 m^3/s, drainage area = 400 km^2, effective porosity of unsaturated zone = 0.2.

a) Estimate the TOPMODEL $\bar{\lambda}$ parameter for this watershed by averaging the histogram above.
ln(m)

b) Estimate the recharge parameter r by dividing baseflow by the drainage area and expressing the result in m/hr.
m/hr

c) In TOPMODEL locations with wetness index ln(a/S) greater than a threshold are saturated to the surface. This threshold can be obtained from setting D=0 in equation (82) or (83) and solving for ln(a/S). Report the threshold ln(a/S) above which saturation occurs for the antecedent conditions given.

d) The fraction of watershed that is initially saturated is obtained by integrating the histogram over values larger than the threshold determined in (c). Report the fraction of watershed that is initially saturated.
e) Following infiltration of rainfall the saturated area expands to encompass all locations where D was less than the rainfall. Use equation (82) or (83) to determine the threshold ln(a/S) corresponding to D=0.025 m (25mm).
f) Integrate the histogram over values larger than the threshold determined in (e) to determine the fraction of watershed that is saturated at the end of a 25 mm rainstorm.
g) Estimate the volume of runoff from 25 mm of rain, by summing the runoff from the initially saturated area and the area that becomes saturated during the storm. Report your answer on a per unit total area basis.
mm
h) Equation (88) gives the baseflow in terms of average soil moisture deficit $\bar{D}$. This decreases by 25 mm due to infiltration during the storm and this equation may be used to calculate the corresponding increase in r which corresponds to an increase in baseflow. Use equation (88) to determine the baseflow that you expect after the direct runoff hydrograph from the 25 mm of rainfall has receded. Report your result in m^3/s.
m^3/s.

Points for Question: 0/8

Feedback:

Answers:

a. $\bar{\lambda}$ is the average of ln(a/S). From the histogram this is
0.4 x 4.5 + 0.3 x 7.5 + 0.2 x 10.5 + 0.1 x 13.5 = **7.5** ln(m)

b. The per unit area baseflow is r = 12/400 x 10^6 = 3 x 10^{-8} m/s = 0.000108 m/hr

c.
$T_o = K_o/f = 4/2 = 2\ m^2/hr$.
Setting D = 0 in equation (83) gives

$$\ln\left(\frac{a}{S}\right) = \ln\left(\frac{T_o}{r}\right) = \ln\left(\frac{2}{0.000108}\right) = 9.83$$

Saturation occurs for ln(a/S) greater than 9.83

d. Referring to the histogram the area fraction initially saturated is
(12-9.83)/3 x 0.2 + 0.1 = **0.245**

e. Solving equation (83) for ln(a/S) gives

$$\ln\left(\frac{a}{S}\right) = -\frac{D}{m} - \ln\left(\frac{r}{T_o}\right)$$

with m = θ_e/f=0.2/2 = 0.1 and D=0.025 this gives

$$\ln\left(\frac{a}{S}\right) = -\frac{0.025}{0.1} - \ln\left(\frac{0.000108}{2}\right)$$

=9.58 so following 25 mm of rainfall the threshold ln(a/S) for saturation is 9.58.

f. Referring to the histogram the area fraction that this corresponds to is
(12-9.58)/3 x 0.2 + 0.1 = **0.261**

g. Rainfall on area fraction 0.245 all becomes runoff. Rainfall on area fraction 0.245 to 0.261 becomes runoff after saturation has been reached. Because the histogram is flat (linear) across this range the net runoff from this area is 12.5 mm. Area average runoff is therefore
25 x 0.245 + 12.5 x (0.261-0.245) = **6.3 mm**

h.

Let $\bar{D}_o$ represent average deficit before the storm and $\bar{D}_1$ represent the deficit after the storm.
Then we have

$r_o = T_o e^{-\bar{D}_o/m} e^{-\bar{\lambda}}$

and

$r_1 = T_o e^{-\bar{D}_1/m} e^{-\bar{\lambda}}$

Dividing

$r_1 / r_o = e^{-(\bar{D}_1-\bar{D}_o)/m} = e^{-(-0.025)/0.1} = 1.28$

Baseflow therefore increases by a factor of 1.28 and is r=0.000138 m/hr corresponding to Q_b=**15.4 m³/s.**

Done

Back to Workbook Sections

(...) >> Simulation Resources >> Section 6 Quiz

National Weather Service COMET Outreach Program

Karun Joseph Logged In 11/9/2016

[User Preferences] [Log Out]