

CVG3120-HYDROLOGY  
PROF. SEIDOU OUSMANE

**FALL 2011 MID-TERM EXAM**

Wednesday, October 12<sup>th</sup> 2011, 13:00-14:30

Closed book exam

80 min

**QUESTIONS (20 pts)**

Briefly (three lines at most) answer the following questions:

***A-Multiple choice questions***

1. A 15-year rainfall (a) will occur six times in a 90 yr period, (b) has 0.0667 probability of occurring during a 15 year period, (c) can occur only once in any period of 15 years, (d) will occur more frequently than a 10-year rainfall, (e) none of the above. Answer=e
2. A rainfall with exceedance probability of 0.025 (a) will occur on average once every 40 years, (b) has a probability of 0.025 occurrence in any one year, (c) has a larger magnitude than a 25 year rainfall, (d) is a 40 year event, (e) all of the above. Answer=e
3. A rainfall hyetograph shows (a) the total volume of rainfall for a storm event, (b) the cumulative volume of rainfall with time over a watershed, (c) the variation of storm-event rainfall over a watershed, (d) the intensity or volume of rainfall as function of time; (e) none of the above. Answer=d
4. Which one of the following is a discrete random variable? (a) The volume of infiltration; (b) the percentage of urban land use in a watershed; (c) the daily rate of evaporation; (d) the number of floods in a 10 years period. Answer =d
5. The skew of a distribution of measured peak flows would reflect (a) the symmetry of large and small floods around the mean, (b) the closeness of flood peaks to the mean, (c) the uniformity of the distributions of the flood peaks; (d) the magnitude of the mean flow; (e) none of the above; answer=a

***B-short answers (two lines at most):***

1. What's the return period of an event? (average time between two events; inverse of the probability of occurrence)
2. What's the influence of the watershed slope on the time of concentration? (a higher slope means a smaller time of concentration)
3. What's the influence of the watershed size on the volume of runoff? (runoff increase with watershed size)
4. What do the circularity ratio tells us? (how close to a circle the shape of the watershed is)
5. Which probability distribution best describes the number of floods in a given period? (the binomial distribution)

**PROBLEM 2 (20 pts)**

A lake has an area of 20 km<sup>2</sup>. Get the reservoir elevation at the end of July given the following data. Provide all intermediate calculations.

- The level of the lake at the beginning of January is 4.5m.
- The infiltration is given by the following formula:  $I(\text{mm / month}) = 10 * h(m)$  where h is the lake elevation at the beginning of the month.

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- The outflow is given by  $O(m^3 / s) = 2h^{1.5}$

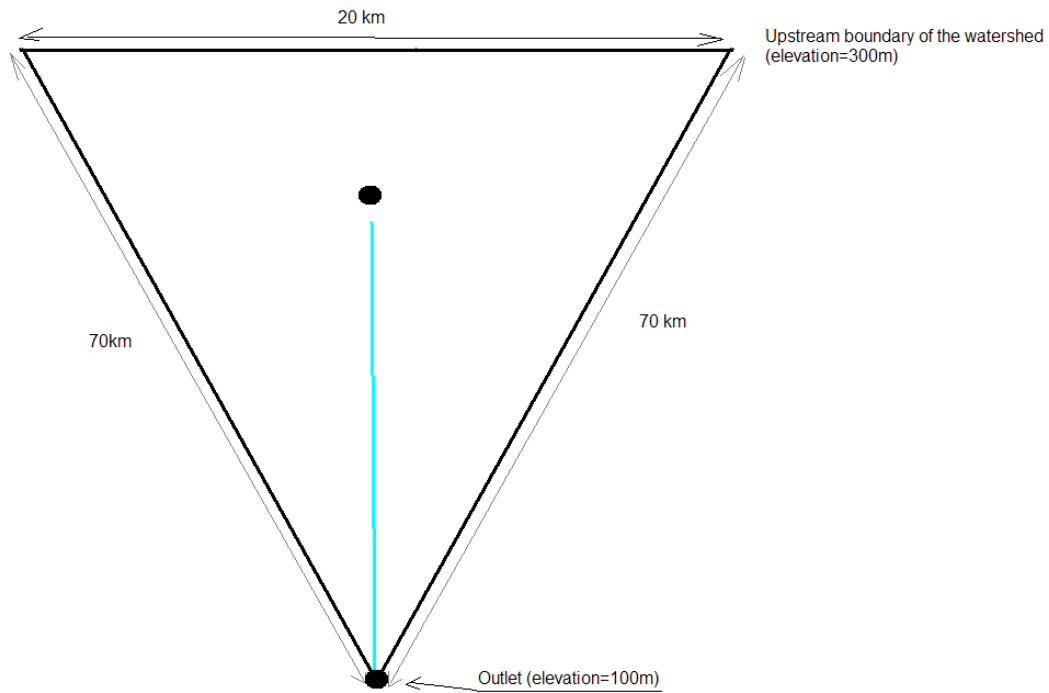
Month	Monthly precipitation (mm)	Monthly evaporation (mm)	Inflow (m3/s)	Outflow(m3/s)	Infiltration (mm)	Lake level at the beginning of the month (m)
Jan	0	100	30			4.5m
Feb	0	100	30			
March	10	120	30			
April	60	150	30			
May	120	120	30			
Jun	150	100	30			
Jul	170	90	30			

$$Level(Month + 1) = level(Month) - (Infiltration(mm) + Evaporation(mm) - Precipitation(mm)) / 1000 - (Outflow(m3 / s) - Inflow(m3 / s)) * 24 * 3600 * 30 / (20 * 1000000)$$

Month	Monthly precipitation (mm)	Monthly evaporation (mm)	Inflow (m3/s)	Outflow(m3/s)	Infiltration (mm)	Lake level at the beginning of the month (m)
Jan	0	100	30	19.09	45.00	4.50
Feb	0	100	30	27.71	57.69	5.77
March	10	120	30	28.72	59.08	5.91
April	60	150	30	28.70	59.05	5.90
May	120	120	30	28.84	59.25	5.92
Jun	150	100	30	29.51	60.15	6.02
Jul	170	90	30	29.90	60.69	6.07

**PROBLEM 3 (20 pts)**

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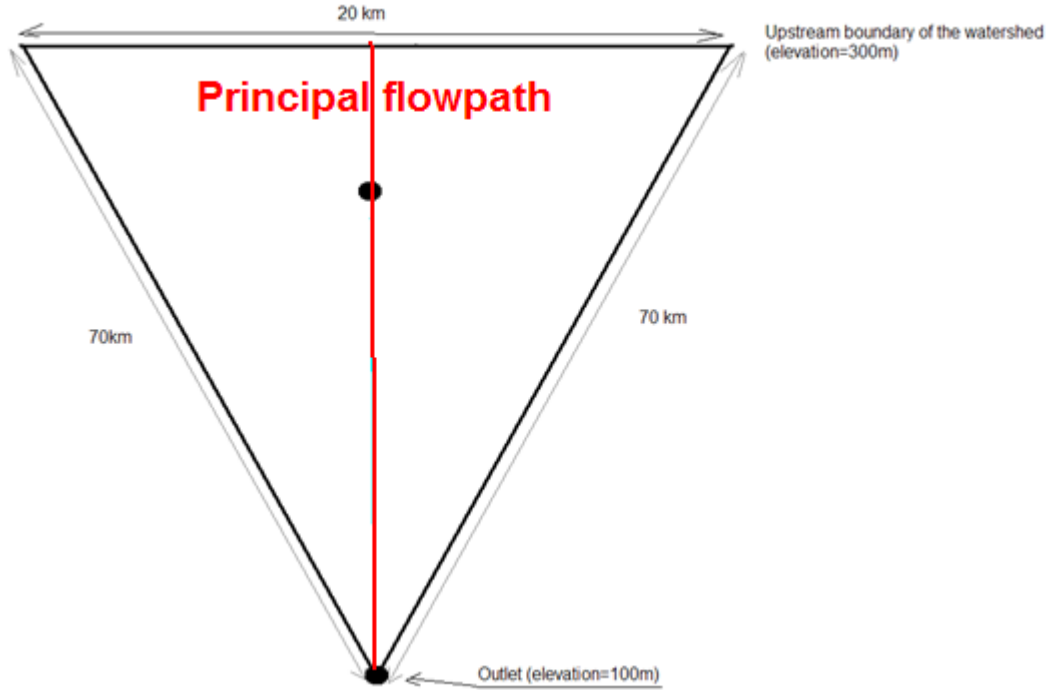


Given the watershed geometry presented on the above figure:

1. Draw the principal flowpath (
2. Calculate the watershed length
3. Calculate the length to the center of Area (The center of area of a triangle is located at  $\frac{2}{3}$  of the watershed length from the outlet)
4. Build the hypsometric curve assuming a constant slope along the principal flowpath). Do it analytically or take 5 elevations between the outlet and the upstream boundary of the watershed.

Principal flowpath:

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Watershed length:

$$L^2 + (20/2)^2 = 70^2$$

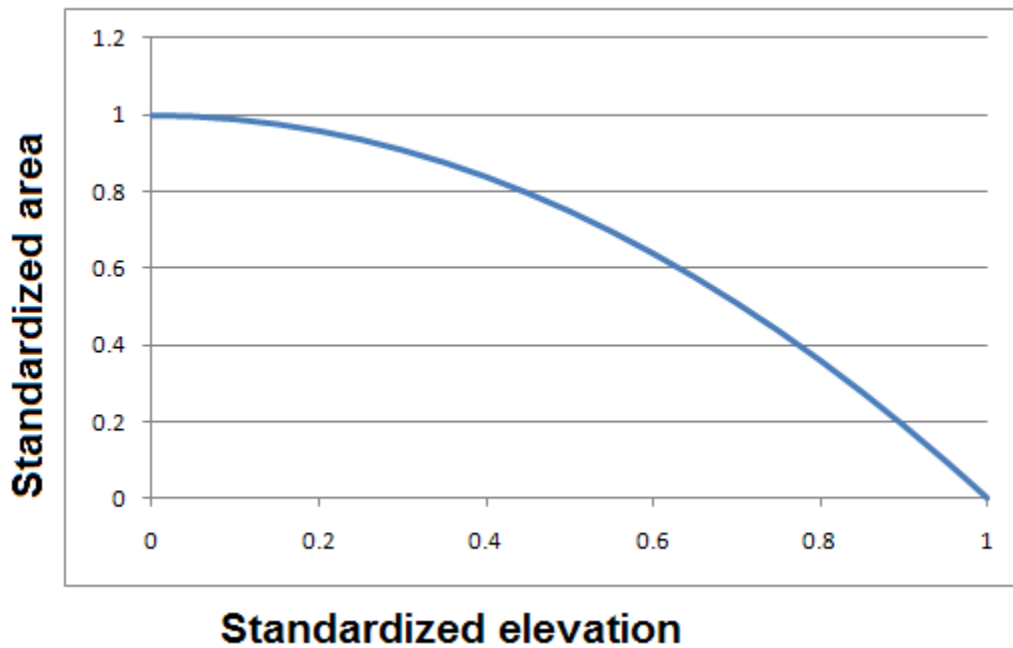
$$L = \sqrt{70^2 - (20/2)^2} = 69.28 \text{ km}$$

Length to the center of area

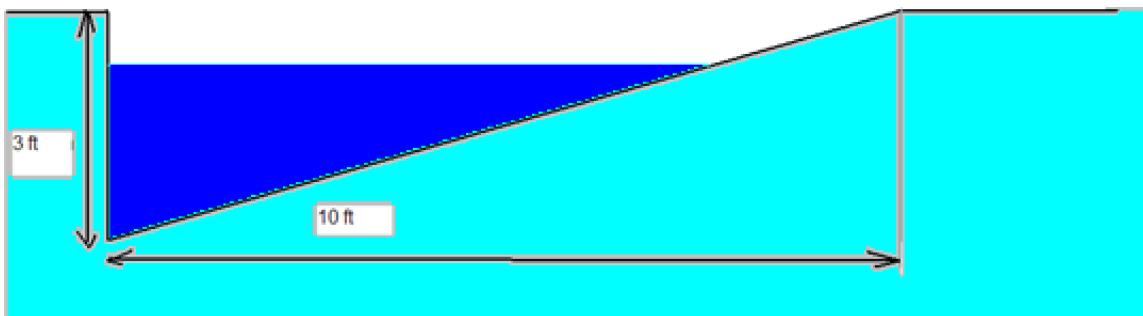
$$L_{ca} = 2L/3 = 46.18 \text{ km}$$

$$A(h) = 10L \left( 1 - \left( \frac{h-100}{300-100} \right)^2 \right)$$

$$a(h) = 1 - (\Delta h)^2$$



**Problem 4 (40 pts)**



1. Using the Manning equation, calculate the maximum flow that can be discharged by the above open channel given that the channel is made of earth, is clean and recently completed. The longitudinal slope is 0.01
2. After some time, some grass and a few weeds will grow in the channel. Calculate the new channel capacity.
3. At the end of its life, the channel will be occupied by some dense weeds. Calculate the new channel capacity.
4. The flow coming in the channel follows a normal distribution with a mean of 100 cfs and a standard deviation of 40 cfs. What is the probability of having too much flow in each of the three cases above?

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1) Maximum flow

$$A = 3 \text{ ft} \times 10 \text{ ft} / 2 = 15 \text{ ft}^2$$

$$P = 3 \text{ ft} + \sqrt{3^2 + 10^2} = 13.44 \text{ ft}$$

$$Q = \frac{1.49}{n} (A/P)^{2/3} S^{0.5} A$$

$$n = 0.017$$

$$Q = 140.69 \text{ cfs}$$

2) After some time,  $n=0.225$

$$Q = 106.29$$

3) End of life:  $n=0.32$

$$Q = 74.74$$

4)

Situation 1

$$P(Q \geq 140.69) = P(z \geq \frac{140.69 - 100}{40}) = 0.15$$

Situation 2

$$P(Q \geq 106.29) = P(z \geq \frac{106.29 - 100}{40}) = 0.44$$

Situation 2

$$P(Q \geq 74.74) = P(z \geq 74.74) = 0.74$$

Q	(Q-100)/40	P(z < (Q-100)/40)	P(z > (Q-100)/40)
140.69	1.02	0.85	0.15
106.30	0.16	0.56	0.44
74.74	-0.63	0.26	0.74