CVG3120-HYDROLOGY
PROF. SEIDOU OUSMANE

FALL 2010 MID-TERM EXAM

Friday, October 15th 2010, 10:00-11:30
Open book exam
80 min

QUESTIONS (20 pts)

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

1. What parameters of runoff are important for civil engineers
    - Volume
    - Time of concentration
    - Peak
    - Hydrograph
2. Why are we interested in knowing the probability distribution of hydrologic variables?
    - In order to describe the uncertainty associated to their values. Probability distributions are often used to find extreme (high and low) values
3. Why is baseflow assumed to be equal to infiltration? Explain using the system approach (i.e inputs, outputs, storage).
    - When the watershed is in equilibrium, it is assumed that baseflow (the component of the hydrograph that comes from groundwater) is equal to infiltration. If we consider the soil as a system, the only input is infiltration, and the only output is baseflow. Therefore, assuming that there is no variation of storage on the long term, they should be equal.
4. What's interception? Is it more important in the winter or in the summer? Explain
    - Interception is process by which part of the precipitation is caught in vegetation and never reaches the soil surface. It is more important in the winter as snow sticks to obstacles and accumulates more than liquid water.
5. What's the return period of an event?
    - The return period of an event is the inverse of its probability of occurrence. It can also be defined as the mean time between two occurrences of that event.
6. What's the influence of the watershed slope on the time of concentration?
    - The time of concentration decreases with slope.
7. What's the influence of the watershed size on the volume of runoff?
    - Runoff volumes increase with watershed size.
8. What do the circularity ratio tells us?
    - The circularity ratio tells us how close to a circle the watershed size is.
9. What do the elongation ratio tells us?
    - The elongation ratio tells us if the watershed length is ways larger than the watershed width (elongated shape) or not.
10. Which probability distribution best describes the number of floods in a given period?
    - The binomial distribution

PROBLEM 2 (15 pts)

A PVC pipe is used to evacuate water from a parking lot. Given that the slope of the pipe is 0.005:

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1. What's the maximum flow that can be evacuated by a pipe with the following diameters:
    1. 6 inch
    2. 1 ft
    3. 2 ft
    4. 3ft

All we need is to apply the manning equation for a pipe:

$$Q=\frac{1.49}{n}\frac{A^{5/3}}{P^{2/3}}S^{0.5}=\frac{1.49}{n}\frac{\left(\frac{\pi D^2}{4}\right)^{5/3}}{\pi D^{2/3}}S^{0.5}=\left(\frac{1.49}{n.4^{5/3}}\pi S^{0.5}\right)D^{\frac{8}{3}}$$

n=0.01
S=0.005

$$Q=3.28D^{\frac{8}{3}}$$

Diameter (feets)	0.5	1	2	3
Q (cfs)	0.516917	3.282219	20.84079	61.44562

2. Find the diameter of the pipe to evacuate each of the following maximum flows:
    1. 30 cfs
    2. 100 cfs
    3. 500 cfs

From the formula above:

$$Q=3.28D^{\frac{8}{3}}\Rightarrow D=\left(Q/3.28\right)^{\frac{3}{8}}$$

Q(cfs)	30	100	500
Diameter (feets)	2.29276	3.601124	6.584941

The manning coefficient for PVC is 0.01

PROBLEM 3 (35 pts)

The flow entering the pipe in problem 2 is in fact a random variable, and its probability distribution function (PDF) is given by $f(x)=\begin{cases}100e^{-100x} & \text{if } x\geq 0\\ 0 & \text{if } x<0\end{cases}$

1. What the relationship between the cumulative distribution function (CDF) and the probability distribution function (PDF)?
    - The CDF is the integral of the PDF (or PDF is the derivative of the CDF)
2. Find the equation of the cumulative distribution of the flow
    - $F(x)=\int_0^x f(t)dt=\int_0^x 100e^{-100t}dt=\left[-e^{-100t}\right]_0^x=1-e^{-100x}$
3. Find the 100 year event

$$F(x) = 1 - \frac{1}{100} \Rightarrow 1 - e^{-100x} = 0.99$$

- $e^{-100x} = 0.01$

  $x = -\ln(0.01)/100 = 0.046 cfs$

4. Find the diameter of the pipe that can handle the 100 year event
   - The diameter corresponding to 0.046 cfs is $D = (0.046/3.2822)^{3/8} = 0.20\, ft$
5. Assuming a 2ft pipe was used:
   - What's the probability of being flooded next year?
     - D=2ft, then Q=20.84 from problem 2. $P = 1 - F(20.84) \approx 0$
   - What's the return period of the event that will cause a flood?
     - P=0⇨T=Infinity
   - What are the reliability and the risk of the system (assume 50 years life time)?
     - $\text{Re}liability = 1 - P^{50} = 1$
     - $Risk = 1 - 1 - P^{50} = 0$

PROBLEM 4 (30 points)

For the watershed presented on the map below, compute:

1. The watershed area A
2. The watershed length L
3. The watershed slope S
4. The length to the center of area Lca
5. The hypsometric curve
6. The maximum deviation *Dm,*
7. The profile factor *Fp*

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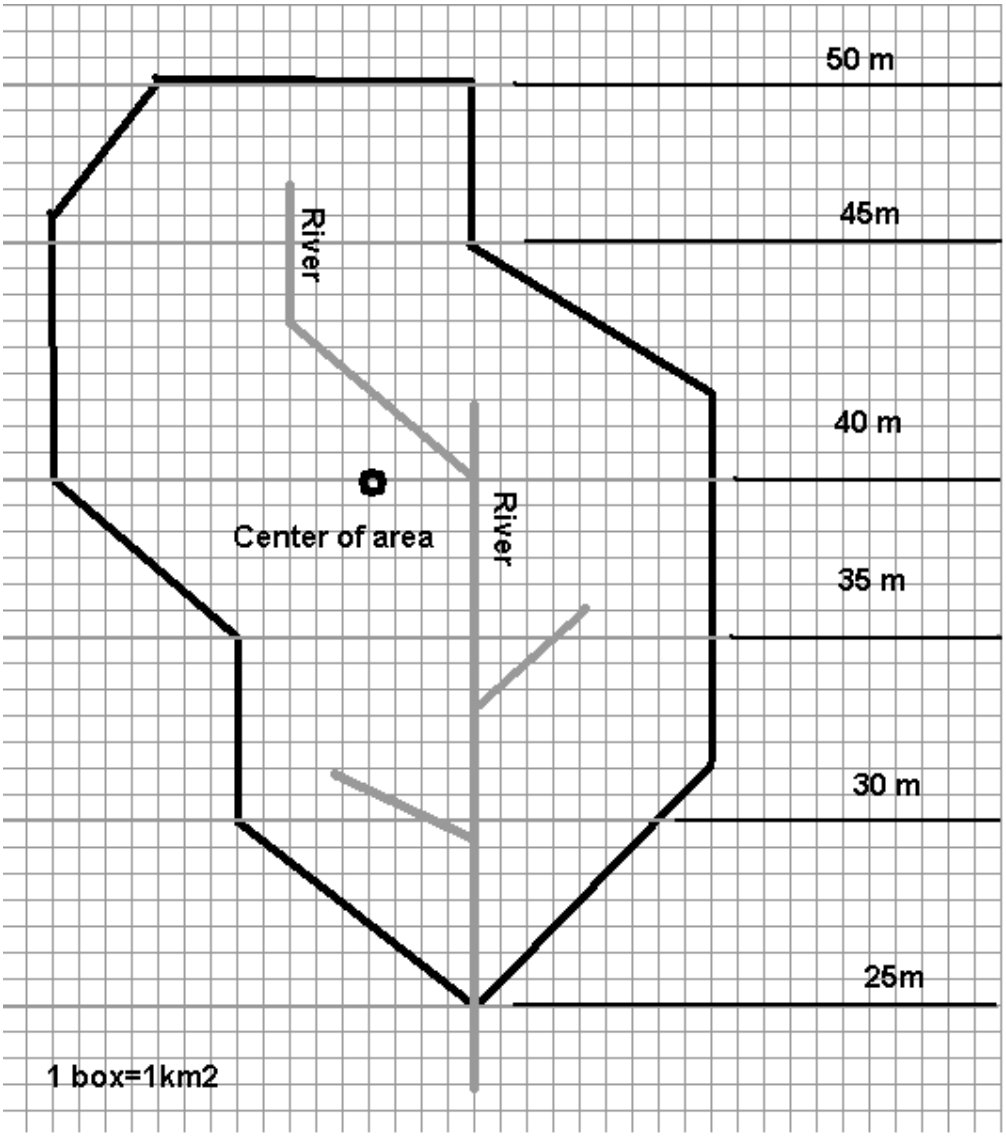
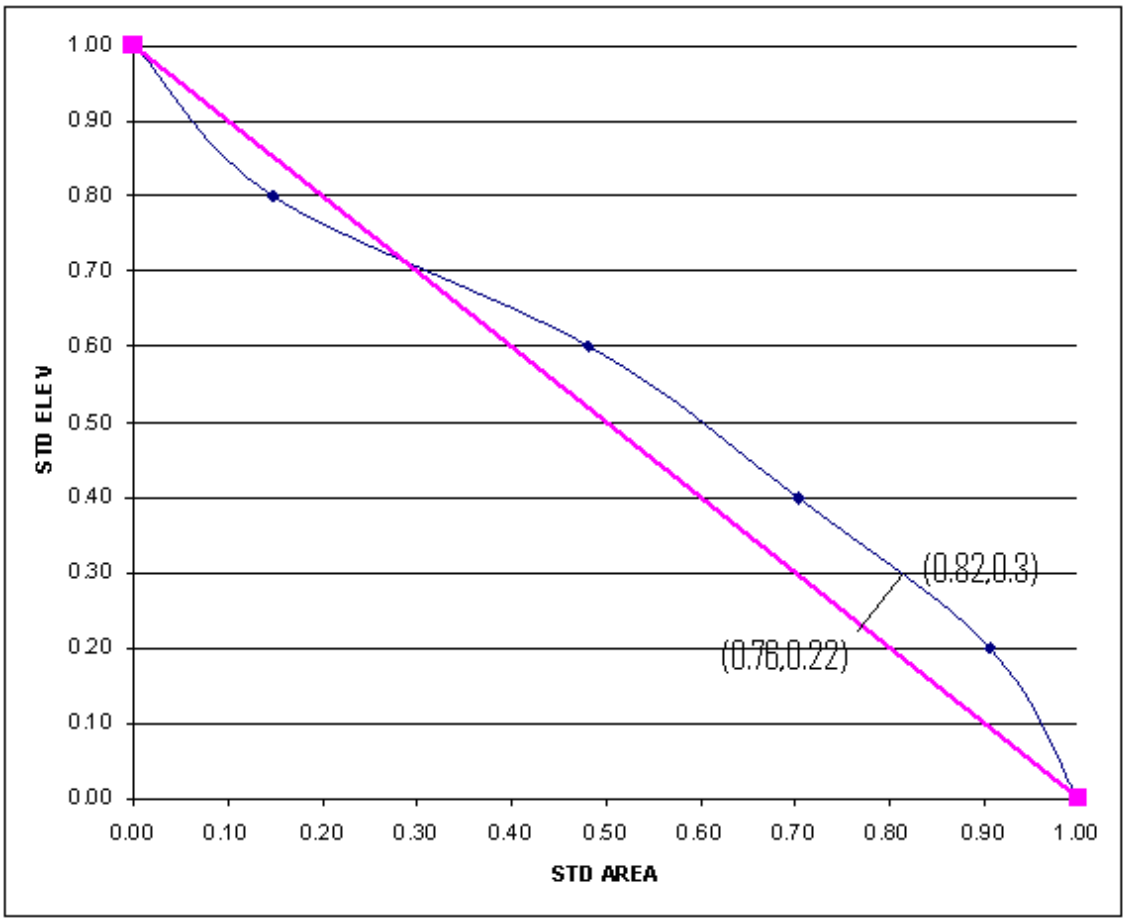


- Area=599 km2
- L=38km
- LCA=20km

ELEVATION	AREA BETWEEN CONTOUR LINES	AREA ABOVE	STD AREA	STD ELEV
50.00	0.00	0.00	0.00	1.00
45.00	88.70	88.70	0.15	0.80
40.00	200.11	288.81	0.48	0.60
35.00	132.78	421.59	0.70	0.40
30.00	121.66	543.25	0.91	0.20
25.00	56.25	599.50	1.00	0.00



- $Dm = \sqrt{(0.82 - 0.76)^2 + (0.3 - 0.22)^2} = 0.1$
- $Fp = 0.1/\sqrt{2} = 0.07$