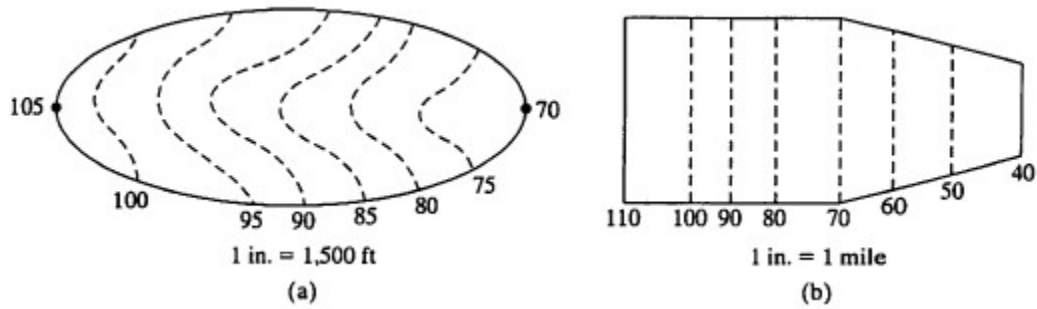


CVG3120, FALL 2016 ASSIGNMENT 2

Due date: Sunday, October 16, 2016, 23:59

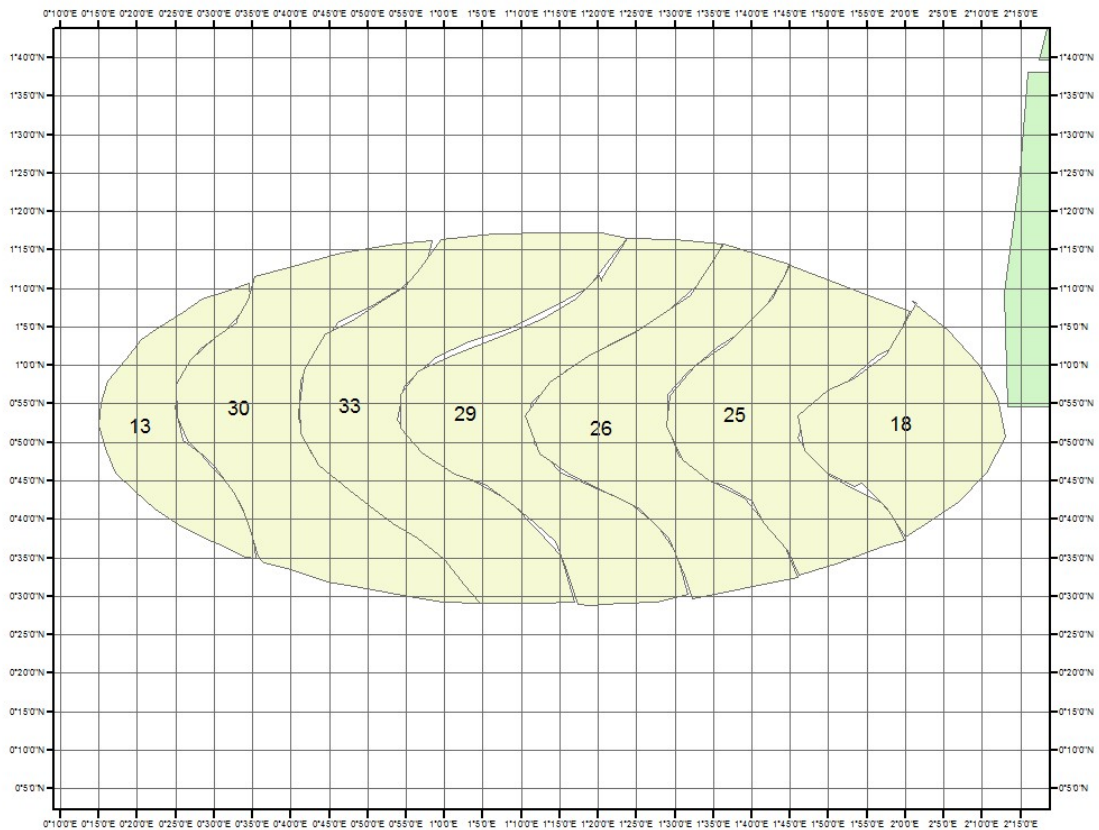
Problem 1

For the following hypothetical watersheds, compute the hypsometric curve and compute D_m , F_p and H_a .



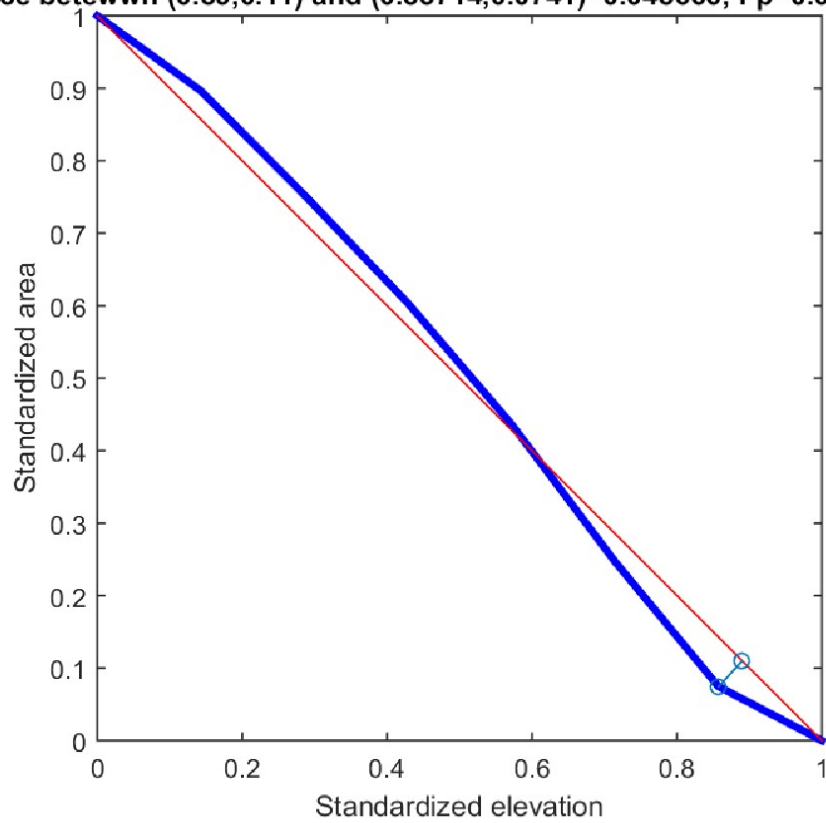
Tip: develop your own grid to measure areas.

Solution problem 1



Lower elevation	Upper Elevation	Area between lower and upper el.	cumulative area	Standardized elevation	standardized area
70	75	18	174	0	1
75	80	25	156	0.142857	0.896552
80	85	26	131	0.285714	0.752874
85	90	29	105	0.428571	0.603448
90	95	33	76	0.571429	0.436782
95	100	30	43	0.714286	0.247126
100	105	13	13	0.857143	0.074713
105	110	0	0	1	0

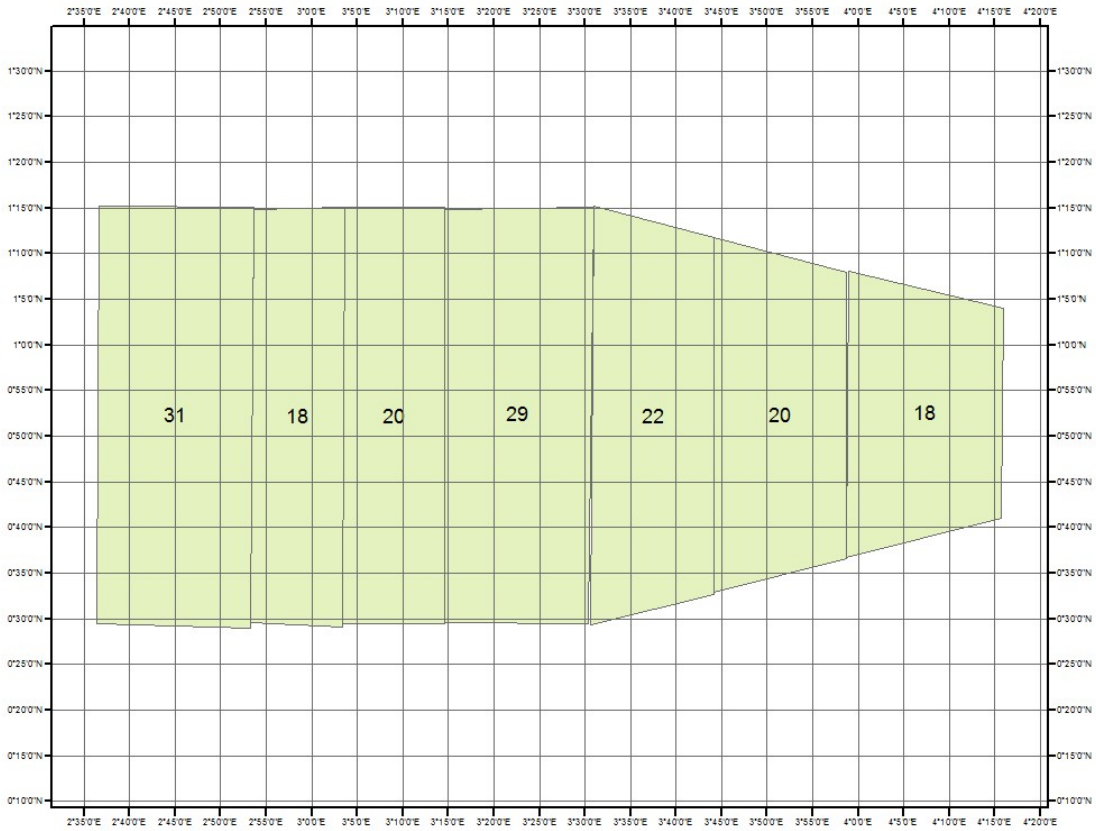
D_m =distance between (0.89,0.11) and (0.85714,0.0741)=0.048666; F_p =0.034412; H_a =0.70



- D_m found using Euclidian distance
- $F_p = D_m / 1.41$

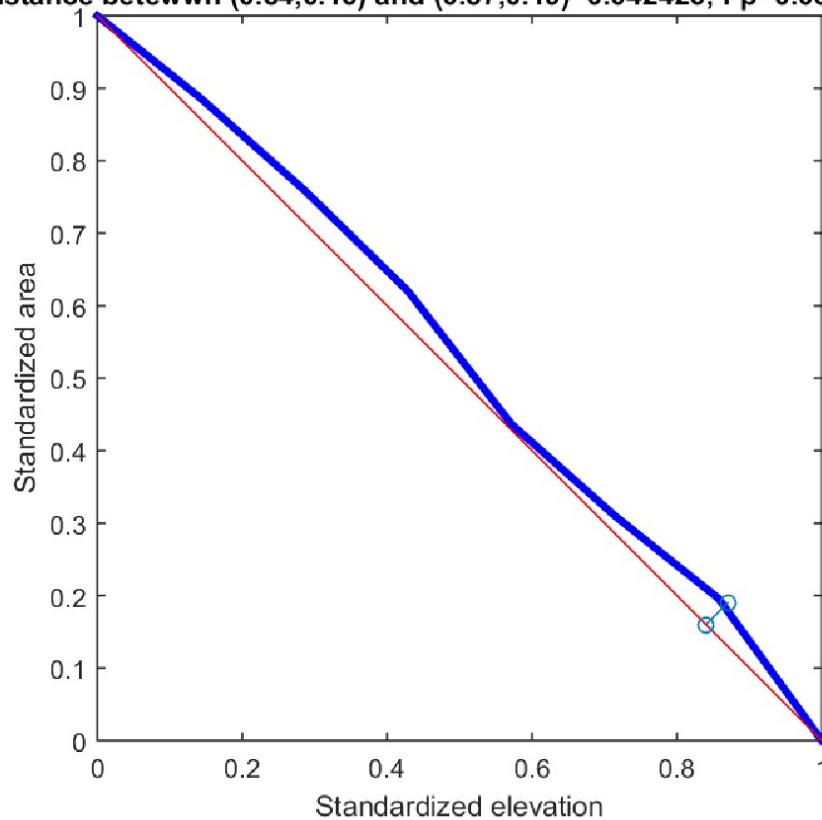
- Ha found using trapezoidal formula

$$\text{formula} = 0.2/2 * (y_1 + 2y_2 + \dots + 2y_{n-1} + y_n)$$



Lower elevation	Upper Elevation	Area between lower and upper el.	cumulative area	Standardized elevation	standradized area
40	50	18	158	0	1
50	60	20	140	0.142857	0.886076
60	70	22	120	0.285714	0.759494
70	80	29	98	0.428571	0.620253
80	90	20	69	0.571429	0.436709
90	100	18	49	0.714286	0.310127
100	110	31	31	0.857143	0.196203
110	120	0	0	1	0

$D_m = \text{distance between } (0.84, 0.16) \text{ and } (0.87, 0.19) = 0.042426; F_p = 0.03; H_a = 0.74177$



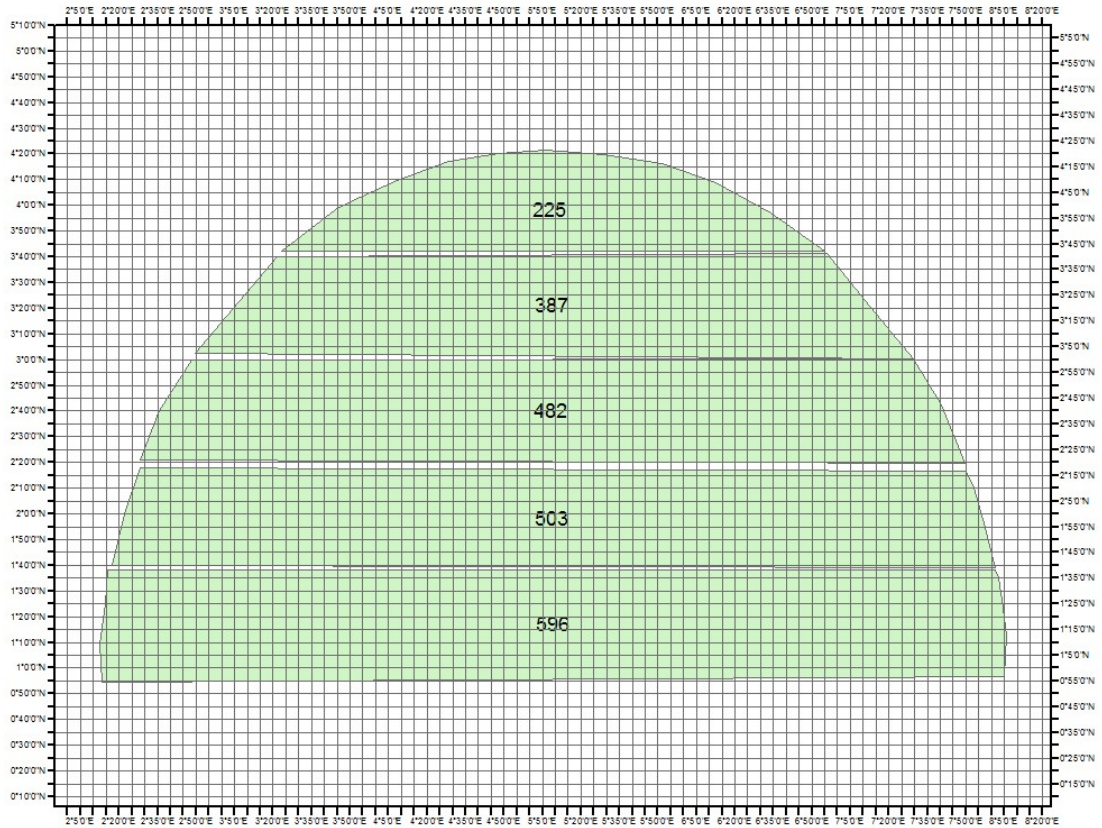
- D_m found using Euclidian distance
- $F_p = D_m / 1.41$
- H_a found using trapezoidal formula $= 0.2/2 * (y_1 + 2y_2 + \dots + 2y_{n-1} + y_n)$

Problem 2

1. Construct a hypsometric curve in standardized form for a semicircular watershed with the outlet at the center point of the circle. Assume a constant slope over the entire watershed.
2. Form a watershed that is a quarter of a circle that has the same total area as the watershed of part (a). Assume a constant slope over the entire watershed. Construct a hypsometric curve in standardized form and plot it on the same graph as the curve of part (a).
3. Comment on the expected flood runoff suggested by the hypsometric curves of the two watersheds.

Solution problem 2 (assume contour lines are straight)

Note: there are two possible solutions for this problem: you can assume the contour lines are straight (as in the solution below), or circular.



Lower elevation	Upper Elevation	Area between lower and upper el.	cumulative area	Standardized elevation	standardized area
0	1	596	2193	0	1
1	2	503	1597	0.2	0.728226
2	3	482	1094	0.4	0.49886
3	4	387	612	0.6	0.27907
4	5	225	225	0.8	0.102599
5	6	0	0	1	0

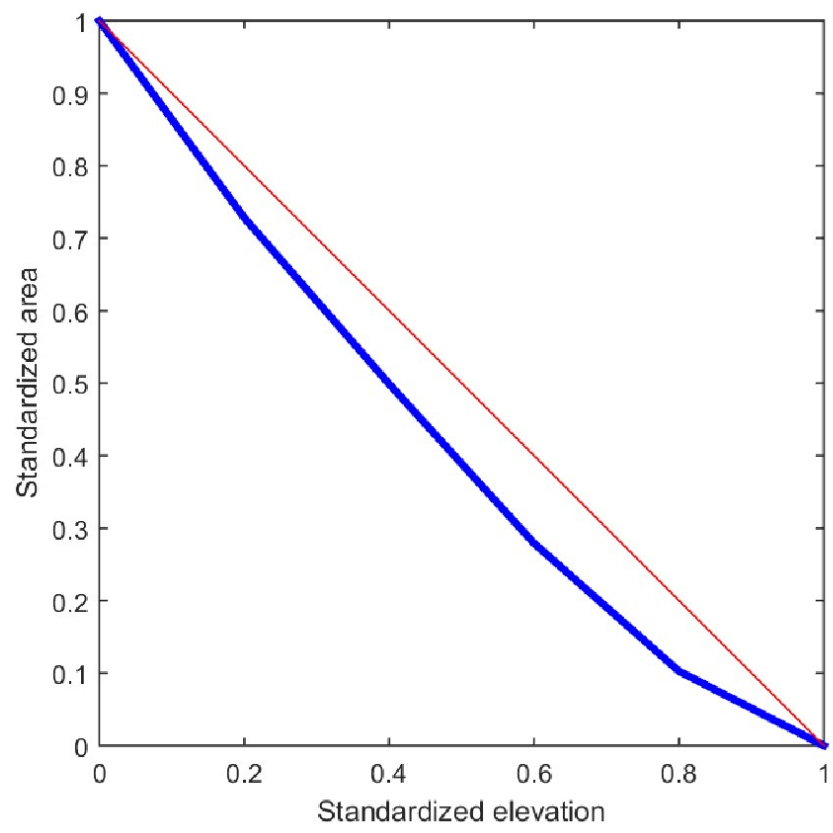
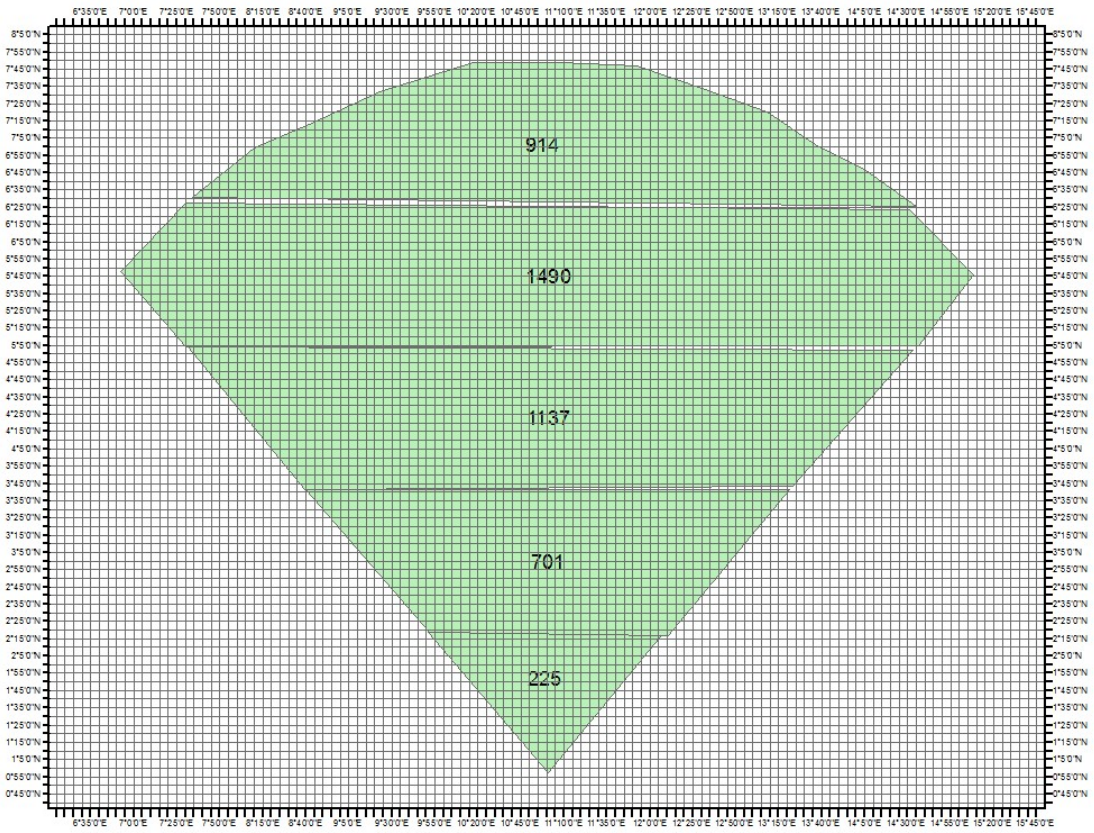


Figure 1: Hypsometric curve, semi-circle



Lower elevation	Upper Elevation	Area between lower and upper el.	cumulative area	Standardized elevation	standardized area
0	2	225	4467	0	1
2	4	701	4242	0.2	0.949631
4	6	1137	3541	0.4	0.792702
6	8	1490	2404	0.6	0.538169
8	10	914	914	0.8	0.204612
10	12	0	0	1	0

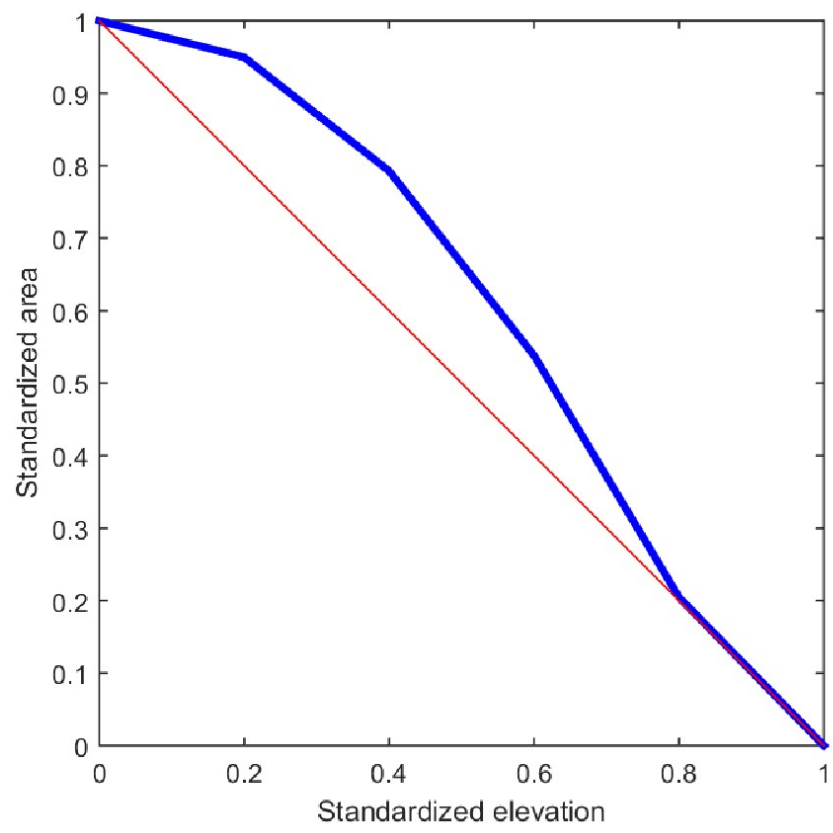


Figure 2: Hypsometric curve, quarter of circle

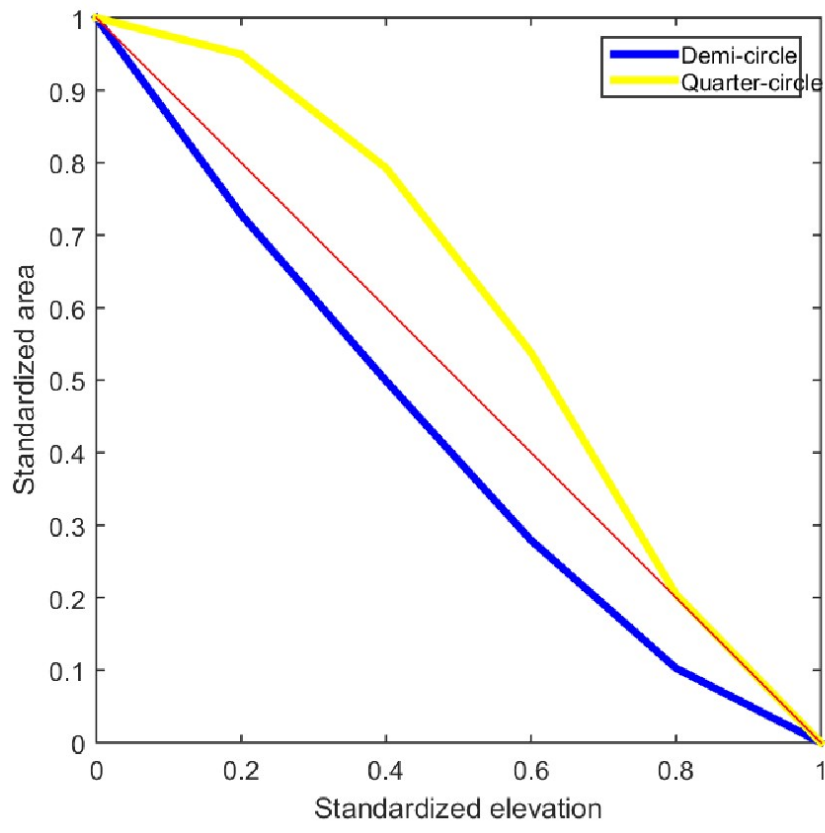
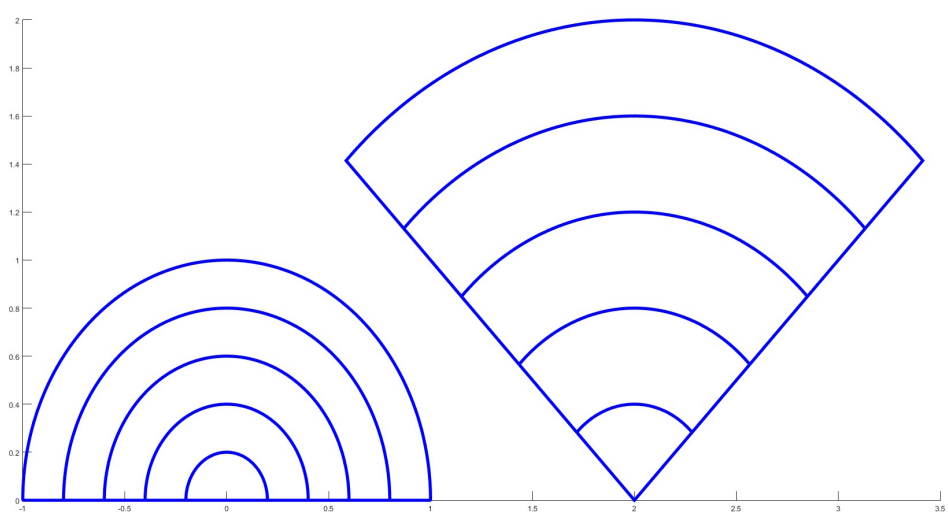


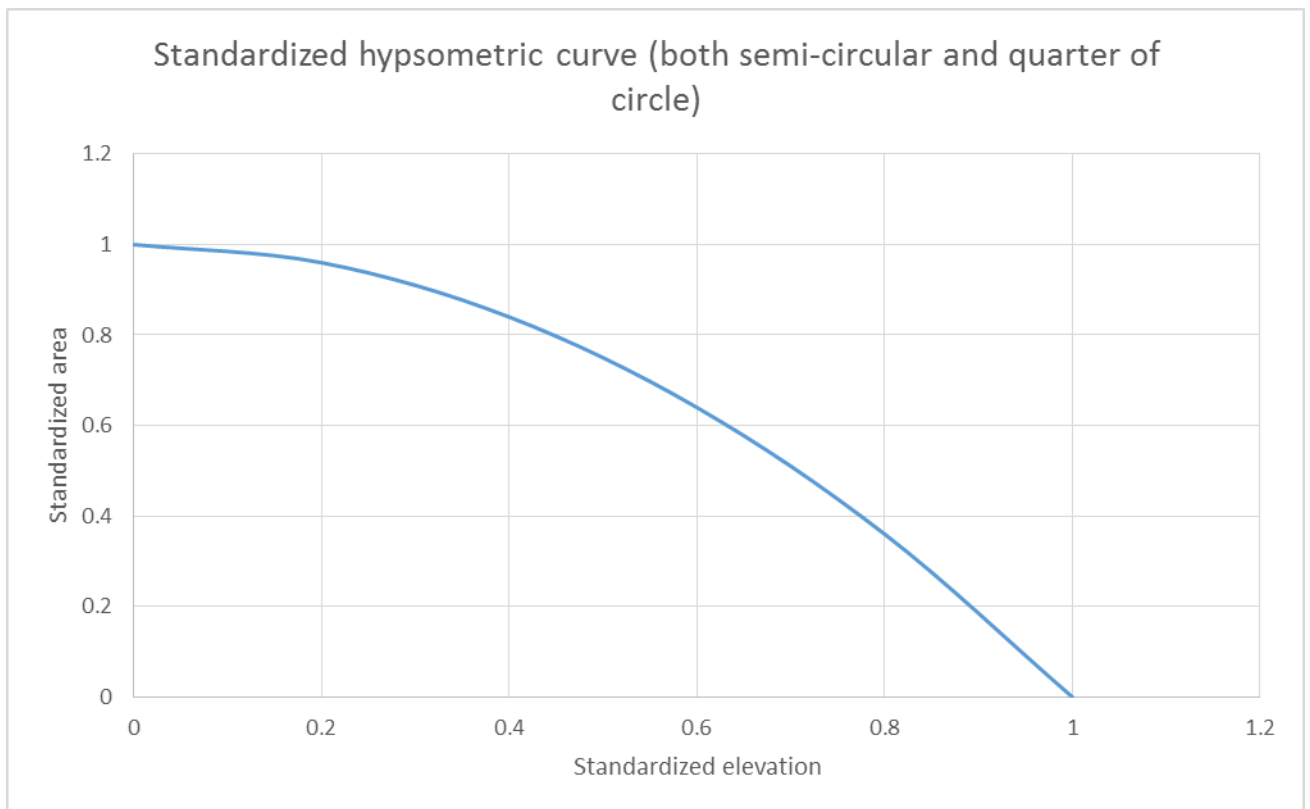
Figure 3: comparison of the two hypsometric curves
 Interpretation: more inundation potential for the semi-circle (slope lower at the outlet).

Solution problem 2 (assume contour lines are circular)



Semi-circle (radius=1, 5 contours, 1m between contours)							
Lower elevation	Upper elevation	Lower radius	Higher radius	Area	Cumulative area	Standardized elevation	Standardized area
0	1	0	0.2	0.0628	1.57	0	1
1	2	0.2	0.4	0.1884	1.5072	0.2	0.96
2	3	0.4	0.6	0.314	1.3188	0.4	0.84
3	4	0.6	0.8	0.4396	1.0048	0.6	0.64
4	5	0.8	1	0.5652	0.5652	0.8	0.36
5	6	1	1.2	0	0	1	0

Lower elevation	Upper elevation	Lower radius	Higher radius	Area	Cumulative area	Standardized elevation	Standardized area
0	1	0	0.4	0.1256	3.14	0	1
1	2	0.4	0.8	0.3768	3.0144	0.2	0.96
2	3	0.8	1.2	0.628	2.6376	0.4	0.84
3	4	1.2	1.6	0.8792	2.0096	0.6	0.64
4	5	1.6	2	1.1304	1.1304	0.8	0.36
5	6	2	2.4	0	0	1	0



Interpretation : both watersheds have the same flooding potential

Problem 3

Compute the channel slope between sections 1 and 6 and for each of the five reaches. Compute the average of the computed slopes for the five reaches and compare it to the estimate for the entire reach. Discuss the results.

Section	Elevation (ft)	Distance from Outlet (ft)
1	134	0
2	141	4,300
3	146	5,600
4	180	7,800
5	235	10,400
6	242	11,300

Solution problem 3

Channel Slope for each Reach

Reach	ΔE	L	Channel Slope ($\Delta E/L$)
1	7	4300	0.00140
2	5	1300	0.00385
3	34	2200	0.01545
4	55	2600	0.02115
5	7	900	0.00778
Sum			0.04963
Entire Reach	108	11300	0.00955752212

The channel slope obtained by calculated each of the individual reaches is more accurate than the one calculated by the entire reach because it takes into consideration the changes in slope for each length. The entire reach gives an average that does not account for the different slopes at each section along the reach.

Problem 4

Compute the predevelopment and post development t_c for the following conditions:

Condition	L (ft)	Slope (%)	n	R _h (ft)
Predevelopment	220	2.6	0.07	0.3
	460	2.2	0.04	0.7
	550	1.9	0.025	1.1
Postdevelopment	620	2.4	0.035	0.6
	590	2.1	0.012	0.9

Solution problem 4

Condition	L	S (%)	S	n	R _h	V (ft/s)	t (s)	t(min)
Predevelopment	220	2.6	0.026	0.07	0.3	1.5	142.9	2.4
	460	2.2	0.022	0.04	0.7	4.4	105.6	1.8
	550	1.9	0.019	0.025	1.1	8.8	62.8	1.0
t _c							311.3	5.2
Post	620	2.4	0.024	0.035	0.6	4.7	132.1	2.2
	590	2.1	0.021	0.012	0.9	16.8	35.2	0.6
t _c							167.3	2.8

Sample calculation for pour L =220 ft

$$V = \frac{1.49}{n} * R_n^{\frac{2}{3}} * S^{\frac{1}{2}} = \frac{1.49}{0.07} * .3^{\frac{2}{3}} * \sqrt{0.026} = 1.54 \frac{ft}{s}$$

$$t_c = \frac{L}{60V} = \frac{220ft}{60 \frac{s}{min} * 1.54 \frac{ft}{s}} = 2.38 min$$

Problem 5

A 40-acre watershed is developed such that 20 acres of residential (1/2 acre lots) lots are interspersed with 12 acres of woodland (good condition) and 8 acres of grassed parkland (good condition). The watershed has C soils.

1. Estimate the runoff volume from this watershed for a 10in precipitation.
2. A playground is built in the parkland and its imperviousness went from 0 to 40%. What's the percentage increase in runoff?
3. What percentage of impervious areas should be disconnected in the residential area to compensate for the playground construction?

Solution problem 5

a)

Land use	Soil class	CN	Area (acres)	Percent area	CN*percent area
Residential 1/2 acre	C	80	20	0.5	40
Woodland (good condition)	C	72	12	0.3	21.6
grassed parkland (good condition)	C	74	8	0.2	14.8
Weighted CN					76.4

$$CNc = 76.4$$

$$CNc = \frac{\sum ACN}{\sum A} = \frac{3056}{40} = 76.4$$

$$P = 10 \text{ in}$$

$$S = 3.09$$

$$S = \frac{1000}{CNc} - 10 = \frac{1000}{76.4} - 10 = 3.09$$

$$\underline{Vq=7.06}$$

$$Vq = \frac{(P - 0.2S)^2}{P + 0.8S} = \frac{(10 - 0.2 * 3.09)^2}{10 - 0.8 * 3.09} = 7.06 \text{ in}$$

b. The value of CN for the grassed parkland will change to:

$$CNw = CNp * (1 - f) + 98f = 74 * (1 - 0.4) + 98 * 0.4 = 83.6$$

Land use	Soil class	CN	Area (acres)	Percent area	CN*percent area
Residential 1/2 acre	C	80	20	0.5	40
Woodland (good condition)	C	72	12	0.3	21.6
grassed parkland (good condition)	C	83.6	8	0.2	16.72
Weighted CN					78.32

$$CNc = 78.32, S = 2.77, P = 10 \text{ in}$$

$$Vq = 7.31$$

$$\text{Percent increase} = \frac{7.31 - 7.06}{7.06} * 100 = 3.5\%$$

c)

From table 3.18 we know the percent imperviousness of the residential area is 25%.

For a given value of R, the CN of the residential area will become

$$CNw = CNp + f(98 - CNp)(1 - 0.5R) \text{ where } CNp=74.$$

Let's try the maximum value for R, which is 1

R						1
% imperviousness, residential						0.25
Land use	Soil class	CN	Area (acres)	Percent area	CN*percent area	
Residential 1/2 acre	C	77	20	0.5	38.5	
Woodland (good condition)	C	72	12	0.3	21.6	
grassed parkland (good condition)	C	83.6	8	0.2	16.72	
Weighted CN					76.82	
S						3.017443374
Q						7.112513878

Disconnecting all impervious areas reduces runoff from 7.31 in to 7.11 in, but does not completely compensate for the playground construction