

CVG3120-FALL 2015 – Assignment 5

Problem 1

The ordinates of a one-hour UH (due to 1 cm ER) are given. Construct an S-hydrograph. Derive a 3-hour UH.

Time(h)	UH(m ³ /s-cm)	Time(h)	UH(m ³ /s-cm)
0	0	6	1.42
0.75	16.42	6.75	1.13
1.5	31.15	7.5	0.85
2.25	27.18	8.25	0.57
3	15	9	0.5
3.75	7.36	9.75	0.42
4.5	3.96	10.5	0.14
5.25	2.27	11.25	0

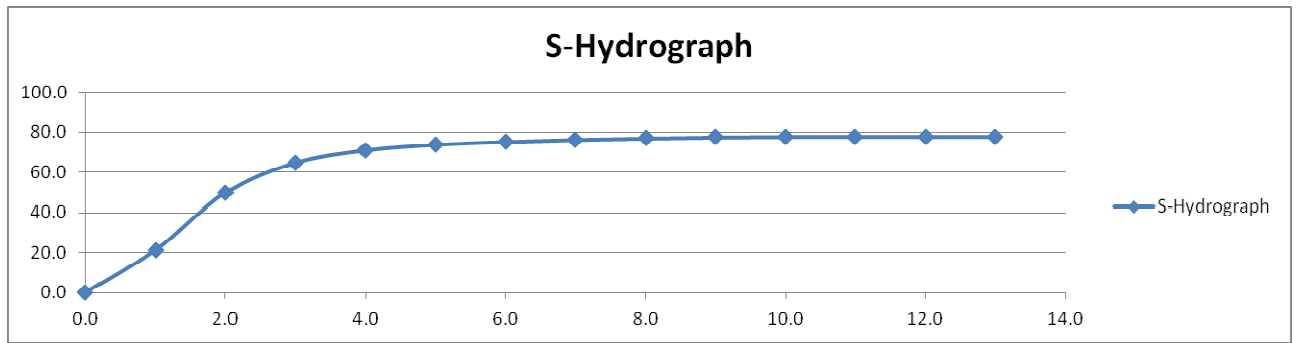
Solution

First step: interpolate the hydrograph at one hour time step:

Time(h)	UH(m ³ /s-cm)
0	0
1	21.33
2	28.50333333
3	15
4	6.22666667
5	2.833333333
6	1.42
7	1.03666667
8	0.663333333
9	0.5
10	0.32666667
11	0.04666667
12	0

Second step: derive the S-hydrograph using the add and lag method:

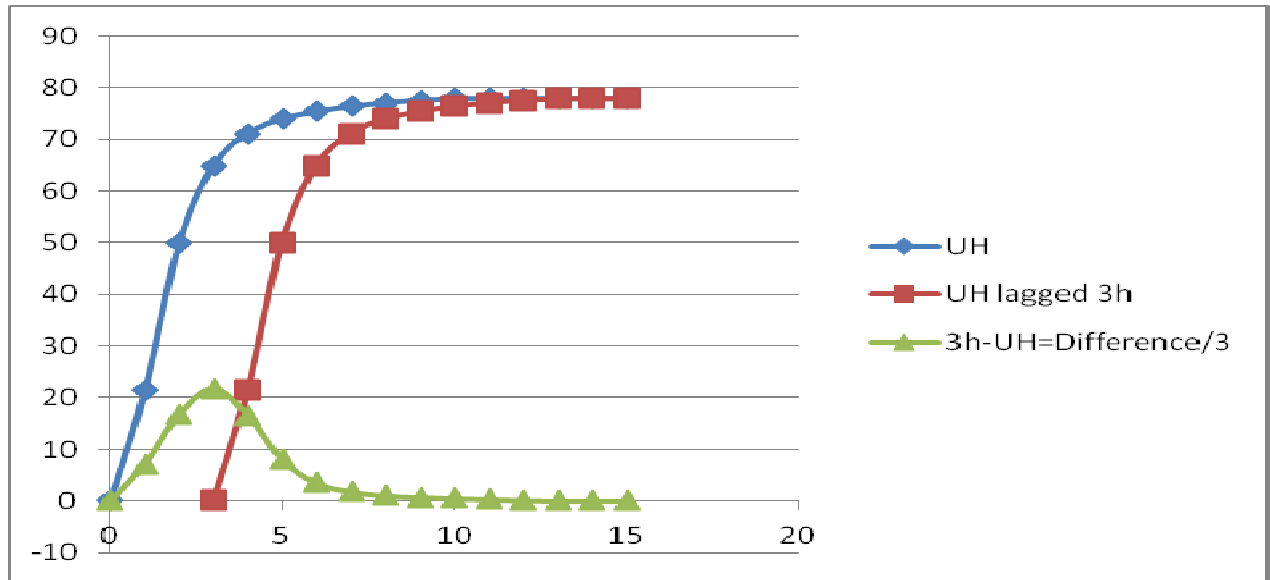
Time	UH	UH	UH	UH	UH	UH	UH	UH	UH	UH	UH	UH	UH	UH	SH=Total multiplied by 1
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.0	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.3
2.0	28.5	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.8
3.0	15.0	28.5	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.8
4.0	6.2	15.0	28.5	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.1
5.0	2.8	6.2	15.0	28.5	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	73.9
6.0	1.4	2.8	6.2	15.0	28.5	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.3
7.0	1.0	1.4	2.8	6.2	15.0	28.5	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	76.4
8.0	0.7	1.0	1.4	2.8	6.2	15.0	28.5	21.3	0.0	0.0	0.0	0.0	0.0	0.0	77.0
9.0	0.5	0.7	1.0	1.4	2.8	6.2	15.0	28.5	21.3	0.0	0.0	0.0	0.0	0.0	77.5
10.0	0.3	0.5	0.7	1.0	1.4	2.8	6.2	15.0	28.5	21.3	0.0	0.0	0.0	0.0	77.8
11.0	0.0	0.3	0.5	0.7	1.0	1.4	2.8	6.2	15.0	28.5	21.3	0.0	0.0	0.0	77.9
12.0	0.0	0.0	0.3	0.5	0.7	1.0	1.4	2.8	6.2	15.0	28.5	21.3	0.0	0.0	77.9
13.0	0.0	0.0	0.0	0.3	0.5	0.7	1.0	1.4	2.8	6.2	15.0	28.5	21.3	0.0	77.9



Step 3: 3 hours UH

Time	UH	UH lagged 3h	3h-UH=Difference/3
0	0		0
1	21.33		7.11
2	49.833333		16.611111
3	64.833333	0	21.611111
4	71.06	21.33	16.576667
5	73.893333	49.833333	8.02
6	75.313333	64.833333	3.493333
7	76.35	71.06	1.763333
8	77.013333	73.893333	1.04
9	77.513333	75.313333	0.733333

10	77.84	76.35	0.49666667
11	77.8866667	77.0133333	0.29111111
12	77.8866667	77.5133333	0.12444444
13	77.8866667	77.84	0.01555556
14	77.8866667	77.8866667	0
15	77.8866667	77.8866667	0



Problem 2

For a storm of 3-hour duration on a watershed of 312000 hectares, the following hydrograph has been observed:

Time (hour)	Discharge (m ³ /s)		
	Day 1	Day 2	Day 3

3 A.M.	17.2	132.0	48.5
6 A.M.	15.8	115.0	43.0
9 A.M.	175.0	100.0	37.0
Noon	270.0	88.0	32.0
3 P.M.	230.0	78.0	26.0
6 P.M.	200.0	68.0	23.0
9 P.M.	172.0	60.0	26.0
Midnight	150.0	54.0	17.0

Assume a constant base flow of 17.00 m³/s. Derive the unit hydrograph for this storm.

Solution

Step 1: calculate direct runoff volume after removing baseflow:

Time (h)	Discharge (m³/s)	Direct runoff (Discharge-baseflow)	Direct runoff Volume (m³)
3	17.2	0.2	0
6	15.8	0	1080
9	175	158	854280
12	270	253	3073680
15	230	213	5590080
18	200	183	7728480
21	172	155	9553680
24	150	133	11108880
27	132	115	12448080
30	115	98	13598280
33	100	83	14575680
36	88	71	15407280

39	78	61	16120080
42	68	51	16724880
45	60	43	17232480
48	54	37	17664480
51	48.5	31.5	18034380
54	43	26	18344880
57	37	20	18593280
60	32	15	18782280
63	26	9	18911880
66	23	6	18992880
69	26	9	19073880
72	17	0	19122480

Step 2: calculate the direct runoff depth in cm

$$\text{Depth} = 19122480 \text{ m}^3 / (312000 \text{ ha} * 10000 \text{ m}^2/\text{ha}) = 0.00612 \text{ m} = 6.12 \text{ mm}$$

Step 3: Get the unit hydrograph by dividing the direct runoff by 6.12

Time (h)	Discharge (m ³ /s)	Direct runoff (Discharge-baseflow)	Unit hydrograph=Direct runoff/6.12
3	17	0	0
6	16	0	0
9	175	158	26
12	270	253	41
15	230	213	35
18	200	183	30
21	172	155	25
24	150	133	22
27	132	115	19
30	115	98	16
33	100	83	14
36	88	71	12
39	78	61	10
42	68	51	8
45	60	43	7
48	54	37	6
51	49	32	5
54	43	26	4
57	37	20	3
60	32	15	2
63	26	9	1
66	23	6	1
69	26	9	1
72	17	0	0

Problem 3

A 2-hour unit hydrograph is given by a rectangle whose base is 4 hours and height is 0.25 cm/hr.

Derive a 4-hour unit hydrograph using the given 2-hour unit hydrograph.

Solution

Time	2hUH	2h-UH (lagged two hours)	4h-UH=Total/2
1	0.25		0.125
2	0.25		0.125
3	0.25	0.25	0.25
4	0.25	0.25	0.25
5		0.25	0.125
6		0.25	0.125

Problem 4

Given is a unit hydrograph of a watershed as a result of a 4-hour rainstorm. Find the peak flow resulting from four successive 4-hour periods of rainfall producing 3, 1, 7, and 0.5 cm of runoff, respectively. Ignore base flow.

Time(h)	UH (m ³ /s-cm)	Time(hr)	UH(m ³ /s-cm)
0	0	8	6.09
1	0.45	9	4.67
2	1.64	10	3.45
3	4.9	11	2.54
4	9.54	12	1.7
5	12.46	13	1
6	11.33	14	0.45
7	8.07	15	0

Solution

Time(h)	3*UH	1*UH	7*UH	0.5*UH	Total
0	0				0
1	1.35				1.35
2	4.92				4.92
3	14.7				14.7
4	28.62	0			28.62
5	37.38	0.45			37.83
6	33.99	1.64			35.63
7	24.21	4.9			29.11
8	18.27	9.54	0		27.81

9	14.01	12.46	3.15		29.62
10	10.35	11.33	11.48		33.16
11	7.62	8.07	34.3		49.99
12	5.1	6.09	66.78	0	77.97
13	3	4.67	87.22	0.225	95.115
14	1.35	3.45	79.31	0.82	84.93
15	0	2.54	56.49	2.45	61.48
16		1.7	42.63	4.77	49.1
17		1	32.69	6.23	39.92
18		0.45	24.15	5.665	30.265
19		0	17.78	4.035	21.815
20		0	11.9	3.045	14.945
21		0	7	2.335	9.335
22			3.15	1.725	4.875
23			0	1.27	1.27
24			0	0.85	0.85
25			0	0.5	0.5
26			0	0.225	0.225
27			0	0	0
28				0	0
29				0	0
30				0	0
31				0	0

