HEC-HMS Exercise

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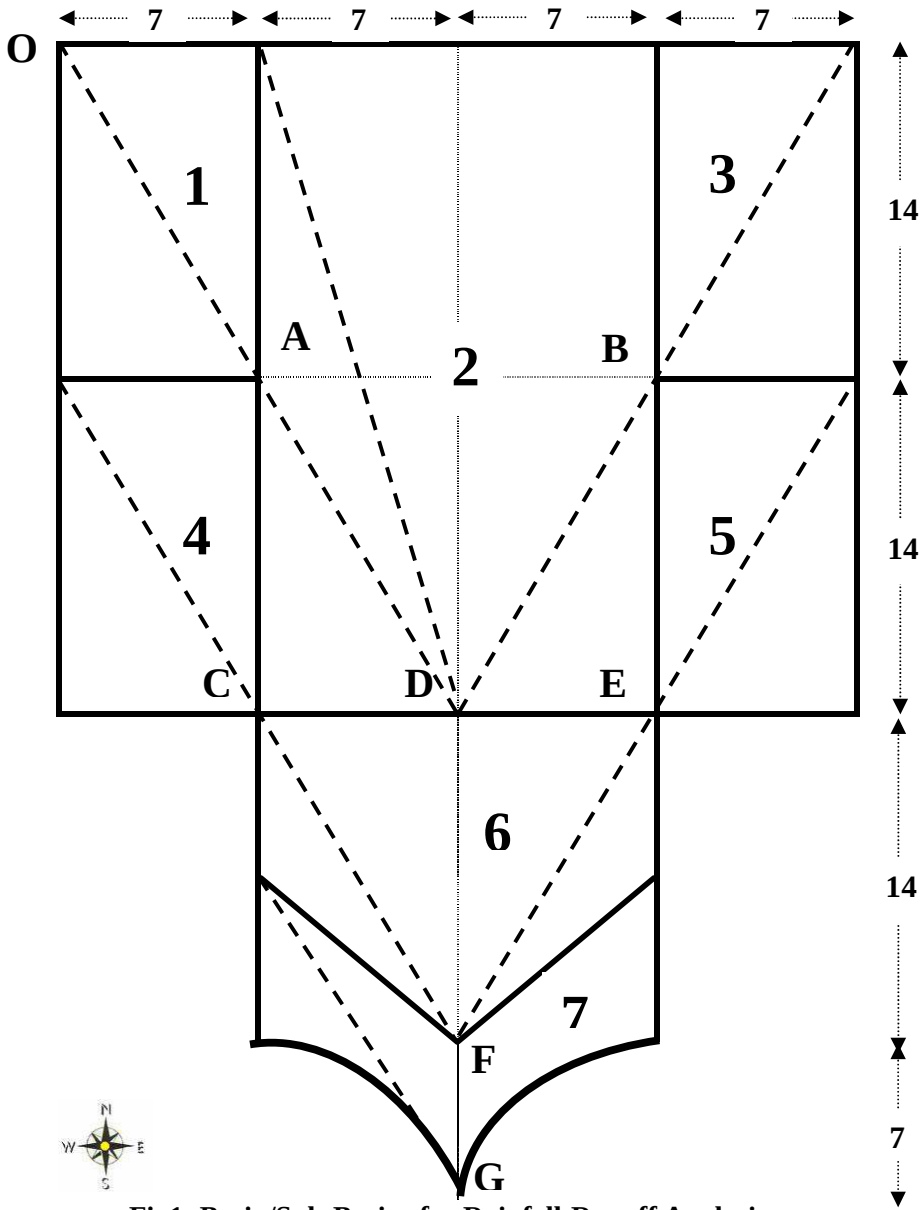

Fig1: Basin/Sub-Basins for Rainfall-Runoff Analysis

Objective: To determine hydrological Response of the given basin for 500 years return period. This analysis consists of following two parts:

1. To estimate the IDF-curve & Design storm applying suggested methodology.
2. To determine the hydrological response of the design storm over the basin using software tool HEC-HMS and to reduce the peak flow by adjusting elevation & length of the spillway.

Table 1: Rainfall Data (Maximum rainfall in 24 hrs. extreme events of the years)

Year	Rainfall mm	Year	Rainfall mm	Year	Rainfall mm
1975	124	1985	54.4	1995	61.9
1976	66.4	1986	63.6	1996	97.5
1977	52.1	1987	52.5	1997	82.4
1978	40.1	1988	29.7	1998	55.5
1979	76.5	1989	112.6	1999	63.6
1980	73.4	1990	42.8	2000	31.3
1981	47.4	1991	46.6	2001	63.5
1982	82.2	1992	48.3	2002	87.1
1983	34.2	1993	230.1	2003	77.7
1984	48.5	1994	67.2	2004	60.1

Table 2: IDF Curve Data

Duration in hrs	Multiplying factor	Intensity mm/hour	Cumulative rainfall. mm	Rainfall. mm	Alt. Block
0.5					
1.0					
1.5					
2.0					
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					
5.5					
6.0					
6.5					
7.0					
7.5					
8.0					
8.5					
9.0					
9.5					
10.0					
10.5					
11.0					
11.5					
12.0					
12.5					
13.0					

T = 500 years

$$y = -\ln\left(\ln\left(\frac{T}{T-1}\right)\right) \quad y: f(T)$$

$N = 30 \qquad x_n = 0.536 \qquad s_n = 1.112$

Frequency factor

$$k = \frac{y - x_n}{s_n} \quad k: f(T,N)$$

$$P_{24} = \bar{x} - k\sigma$$

Expression of Synthetic IDF

$$I(D,T) = \frac{P_{24}}{24} RF^{\left(\frac{28^{0.1} - D^{0.1}}{28^{0.1} - 1}\right)}$$

I: Intensity (mm/h)
P_{24}: 24 hours rainfall
D: Duration (h)
RF: Regional Factor = 10

Table 3: Spillway elevation Vs Reservoir Area

Elevation (M)	Area (M^2)
0	0
30	250
50	500
70	700
80	900
84	1800
88	3600
92	7200
96	14400
100	28800

$$Tc = 0.3\left(\frac{L}{J^{0.25}}\right)^{0.76}$$

$$T_{lag} = 0.35Tc \cdot 60$$

$$Ia = 0.2S$$

$$S = \frac{25400}{CN} - 254$$

Table 4: Sub-basins

sub-basin	Length (KM)	slope	Area (KM^2)	T_c (Hrs)	T_{lag} (Min)	S (mm)	I_a (mm)	CN
1		0.03						66
2		0.02						71
3		0.03						66
4		0.02						71
5		0.02						71
6		0.01						69
7		0.01						69

Muskingum Equation: S= K[x I + (1-x) Q]
Where, S= storage, I=Inflow, Q=Outflow discharge, K= storage time constant, x= weighting factor.
$K = 0.6Tc$

Table 5: Reaches (Routing)

Reach	Length (KM)	Slope	T_c (Hrs)	Musk. K (Hrs)	Musk. x
AD					0.25
BD					0.25
DF					0.22
CF					0.22
EF					0.22
FG					0.20

Gumbel Extreme Value Distribution

N (number of years)	y_n	σ_n	N	y_n	σ_n
10	0.4952	0.9497	65	0.5536	1.1803
15	0.5128	1.0206	70	0.5548	1.1854
20	0.5236	1.0620	75	0.5559	1.1898
25	0.5309	1.0915	80	0.5569	1.1938
30	0.5362	1.1124	85	0.5578	1.1973
35	0.5403	1.1285	90	0.5589	1.2007
40	0.5436	1.1413	95	0.5593	1.2038
45	0.5463	1.1518	100	0.5600	1.2065
50	0.5465	1.1607	200	0.5672	1.2359
55	0.5504	1.1681	500	0.5724	1.2588
			1000	0.5745	1.2685

SCS Curve Number Estimation

SCS Curve Number Groups

Hydrologic Soil Group	Soil Group Characteristics
A	Soils having high infiltration rates, even when thoroughly wetted and consisting chiefly of deep, well to excessively-drained sands or gravels. These soils have a high rate of water transmission.
B	Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.
C	Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.
D	Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils

Table 5.5 Antecedent Moisture Conditions (AMC) for Determining the Value of CN

AMC Type	Total Rain in Previous 5 days	
	Dormant Season	Growing Season
I	Less than 13 mm	Less than 36 mm
II	13 to 28 mm	36 to 53 mm
III	More than 28 mm	More than 53 mm

LAND USE The variation of *CN* under AMC-II, called CN_{II}, for various land use conditions commonly found in practice are shown in Table 5.6(a, b and c).

Table 5.6(a) Runoff Curve Numbers [CN_{II}] for Hydrologic Soil Cover Complexes [Under AMC-II Conditions]

Land Use	Cover		Hydrologic soil group			
	Treatment or practice	Hydrologic condition	A	B	C	D
Cultivated	Straight row		76	86	90	93
Cultivated	Contoured	Poor	70	79	84	88
		Good	65	75	82	86
Cultivated	Contoured & Terraced	Poor	66	74	80	82
		Good	62	71	77	81
Cultivated	Bunded	Poor	67	75	81	83
		Good	59	69	76	79
Cultivated	Paddy		95	95	95	95
Orchards	With understory cover		39	53	67	71
	Without understory cover		41	55	69	73
Forest	Dense		26	40	58	61
	Open		28	44	60	64
	Scrub		33	47	64	67
Pasture	Poor		68	79	86	89
	Fair		49	69	79	84
	Good		39	61	74	80
Wasteland			71	80	85	88
Roads (dirt)			73	83	88	90
Hard surface areas			77	86	91	93

Table 5.6(b) CN_{II} Values for Sugarcane

[Source: Ref.7]

Cover and treatment	Hydrologic soil group			
	A	B	C	D
Limited cover, Straight Row	67	78	85	89
Partial cover, Straight row	49	69	79	84
Complete cover, Straight row	39	61	74	80
Limited cover, Contoured	65	75	82	86
Partial cover, Contoured	25	59	45	83
Complete cover, Contoured	6	35	70	79

Table 5.6(c) CN_{II} Values for Suburban and Urban Land Uses (Ref. 3)

Cover and treatment	Hydrologic soil group			
	A	B	C	D
Open spaces, lawns, parks etc				
(i) In good condition, grass cover in more than 75% area	39	61	74	80
(ii) In fair condition, grass cover on 50 to 75% area	49	69	79	84
Commercial and business areas (85% impervious)	89	92	94	95
Industrial Districts (72% impervious)	81	88	91	93
Residential, average 65% impervious	77	85	90	92
Paved parking lots, paved roads with curbs, roofs, driveways, etc	98	98	98	98
Streets and roads				
Gravel	76	85	89	91
Dirt	72	82	87	89