TUTORIAL - 3

USE OF PROBABILITY PAPER

PROBLEM :

Develop a log normal probability paper and plot the annual flood peaks of Narmada river at Garudeshwar on this paper. Estimate the 500 and 1000 years recurrence interval floods from this plot. The annual peak flood series is given below :

S. No-	Year	Flow in cumecs	S. No.	Year	Flow in cumecs
1	1948	23890	17	1964	19560
2	1949	26810	18	1965	15250
3	1950	45630	19	1966	13000
4	1951	10380	20	1967	22670
5	1952	13290	21	1968	58100
6	1953	17100	22	1969	31170
7	1954	28650	23	1970	69400
8	1955	29150	24	1971	19980
9	1956	12810	25	1972	47980
10	1957	26700	26	1973	61350
11	1958	19700	27	1974	27300
12	1959	38800	28	1975	33750
13	1960	21250	29	1976	19500
14	1961	43360	30	1977	22700
15	1962	38880	31	1978	34260
16	1963	15250	32	1979	38200

The following table provides the logarithmic flood peaks arranged in ascending order and the corresponding probability of nonexceedance using Blom's plotting position formula. The standard normal deviate table is also given here.

LOGARITHMIC ANNUAL PEAK FLOW SERIES AT GARUDESHWAR ON RIVER NARMADA FROM 1948-1979

S. No.	Data In Ascending Order Year	Log (Q)	Rank	Probability of non Exceedance	Reduced Variate
1	1951	4.0162	1	0.019	
2	1956	4.1075	2	0.050	
3	1966	4.1139	3	0 081	
4	1952	4.1235	4	0.112	
5	1963	4.1833	5	0.143	
6	1965	4.1833	6	0.174	
7	1953	4.2330	7	0.205	
8	1976	4.2900	8	0.236	
9	1964	4.2914	9	0.267	
10	1958	4.2945	10	0.298	
11	1971	4.3006	11	0.329	
12	1960	4.3280	12	0.360	
13	1967	4.3554	13	0.391	
14	1977	4.3560	14	0.422	
15	1948	4.3782	15	0.453	
16	1957	4.4265	16	0.484	
17	1949	4.4283	17	0.516	
18	1974	4.4362	18	0.547	
19	1954	4.4571	19	0.578	
20	1955	4.4646	20	0.609	
21	1969	4.4937	21	0.640	
22	1975	4.5283	22	0.671	
23	1978	4.5348	23	0.702	
24	1979	4.5821	24	0.733	
25	1959	4.5888	25	0.764	
26	1962	4.5897	26	0.795	
27	1961	4.6371	27	0.826	
28	1950	4.6593	28	3.857	
29	1972	4.6811	29	0.888	
30	1968	4.7642	30	0.919	
31	1973	4.7878	31	0.950	
32	1970	4.8414	32	0.981	

ILLUSTRATIVE EXAMPLE :

PROBLEM :

Develop a lognormal probability paper and plot the annual flood peaks of Sutlej river at Bhakra on this paper. Estimate the 500 years recurrence interval flood from this plot. The annual flood peak series is given below :

ANNUAL PEAK FLOW SERIES OBSERVED AT BHAKRA ON RIVER SUTLEJ**

S. No.	Year*	Flow in cumecs	S. No.	Year	Flow in cumecs
1	1912	6700	23	1934	2460
2	1913	5660	24	1935	4400
3	1914	5660	25	1936	2380
4	1915	4120	26	1937	2860
5	1916	2120	27	1938	4950
6	1917	4530	28	1939	2350
7	1918	1985	29	1940	1725
8	1919	3740	30	1941	2745
9	1920	4100	31	1942	5000
10	1921	3845	32	1943	5275
11	1922	3110	33	1944	2300
12	1923	2640	34	1945	2385
13	1924	6710	35	1946	3820
14	1925	5410	36	1947	7800
15	1926	2720	37	1948	2355
16	1927	4000	38	1949	3040
17	1928	2400	39	1950	4860
18	1929	4580	40	1951	9200
19	1930	4250	41	1952	2365
20	1931	2035	42	1953	4810
21	1932	3830	43	1954	5660
22	1933	2630	44	1955	3670

**Source : Varshney, R.S., 'Engineering Hydrology', Nem Chand & Bros , Roorkee.

*Assumed calender years.

SOLUTION :

The following table indicates that the reduced variate varies between —2.1943 and 2.1943. The abscissa scale is taken in such a manner that in left of reduced variate 0.0 upto —3.0 is marked on the right upto 4.2 is marked. The right range is larger than the left range as we require estimates at higher recurrence intervals. The logarithm of peak values range between 3.2367 and 3.9638. Therefore the ordinate range is marked between 3.0 and 4.2. Logarithmic peak values are plotted against the corresponding reduced variate and a straight line is drawn through these points. The developed probability plot is shown here.

LOGARITHMIC ANNUAL PEAK FLOW SERIES AT BHAKRA ON RIVER SUTEJ FROM 1912–1955

S. No.	Data In Ascending Order Year	Log (Q)	Rank	Probability of non-Exceedance	Reduced Variate
1	1940	3.2367	1	0.014	—2.1943
2	1918	3.2977	2	0.037	—1.7904
3	1931	3.3086	3	0.059	—1.5608
4	1916	3.3263	4	0 082	—1.3925
5	1944	3.3617	5	0.105	—1.2564
6	1939	3.3710	6	0.127	—1.1402
7	1948	3.3719	7	0.150	—1.0376
8	1952	3.3738	8	0.172	—0.9450
9	1936	3.3766	9	0.195	—0.8598
10	1945	3.3775	10	0.218	—0.7804
11	1928	3.3802	11	0.240	—0.7057
12	1934	3 3909	12	0.263	—0.6347
13	1933	3.4199	13	0.285	—0.5668
14	1923	3.4216	14	0.308	—0.5014
15	1926	3 4345	15	0.331	—0.4381
16	1941	3.4385	16	0.353	—0.3765
17	1937	3.4564	17	0.376	—0.3163
18	1949	3.4828	18	0.398	—0.2573
19	1922	3.4927	19	0.421	—0 1992
20	1955	3.5646	20	0 444	—0.1418
21	1919	3.5728	21	0.466	—0 0849
22	1946	3.5820	22	0.489	—0.0282
23	1232	3.5832	23	0.511	0.0282
24	1921	3.5849	24	0.534	0.0849
25	1927	3.6020	25	0.556	0.1418
26	1920	3.6128	26	0.579	0.1992
27	1915	3.6149	27	0.602	0.2573
28	1930	3.6283	28	0.624	0.3163
29	1935	3.6435	29	0.647	0.3765
30	1917	3.6561	30	0.669	0.4381
31	1929	3.6609	31	0.692	0.5014
32	1953	3.6821	32	0.715	0.5668
33	1950	3.6866	33	0.737	0.6347
34	1938	3.6946	34	0.760	0.7057
35	1942	3 6989	35	0.782	0.7804
36	1943	3.7222	36	0.805	0.8598
37	1925	3.7332	37	0.828	0.9450
38	1913	3.7528	38	0.850	1.0376
39	1914	3.7528	39	0.873	1.1402
40	1954	3.7528	40	0.895	1.2564
41	1912	3.8261	41	0.918	13925
42	1924	3.8267	42	0.941	1.5608
43	1947	3.8920	43	0.963	1.7904
44	1951	3.9638	44	0.986	2.1943

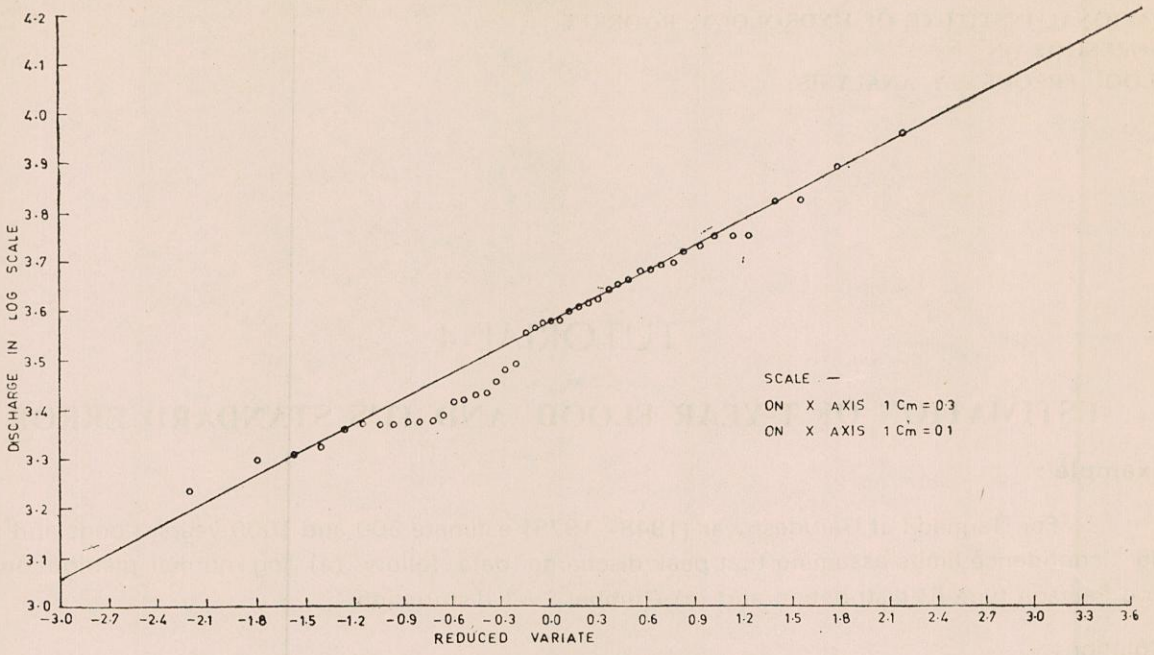

Fig. T 3-1 Log Normal Probability Plotting

ESTIMATION OF 500 YEAR RETURN PERIOD FLOOD :

The probability of exceedance $= \frac{1}{T} = \frac{1}{500} = .002$

From the standard normal deviate table it is found that the corresponding $y = 2.88$

Corresponding to this standard normal deviate it is found from the straight line fit given in the graph, that the log Q value is 4.0750. The value of Q in the original domain is 11885 cumecs.