Surface Water Hydrology
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Lecture: 51
Parametric Methods of Frequency Analysis

In this lecture, we are starting with the parametric method of Frequency Analysis.

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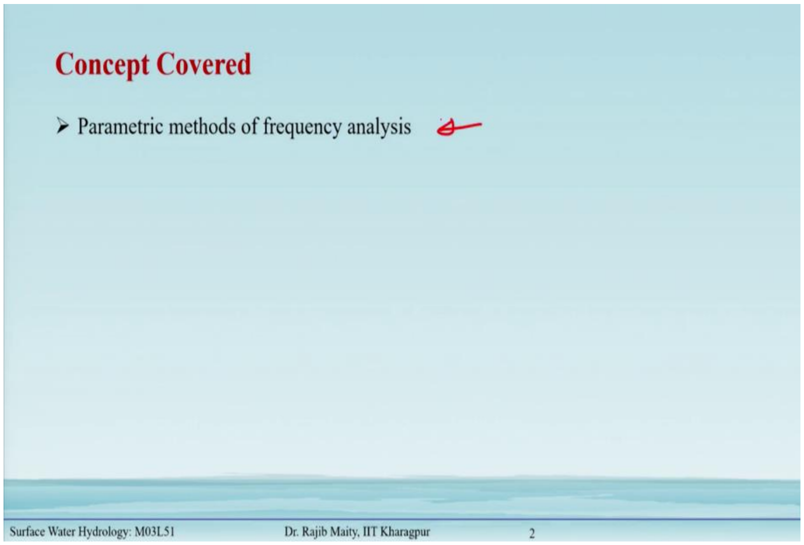

Today we are starting this parametric method of frequency analysis.

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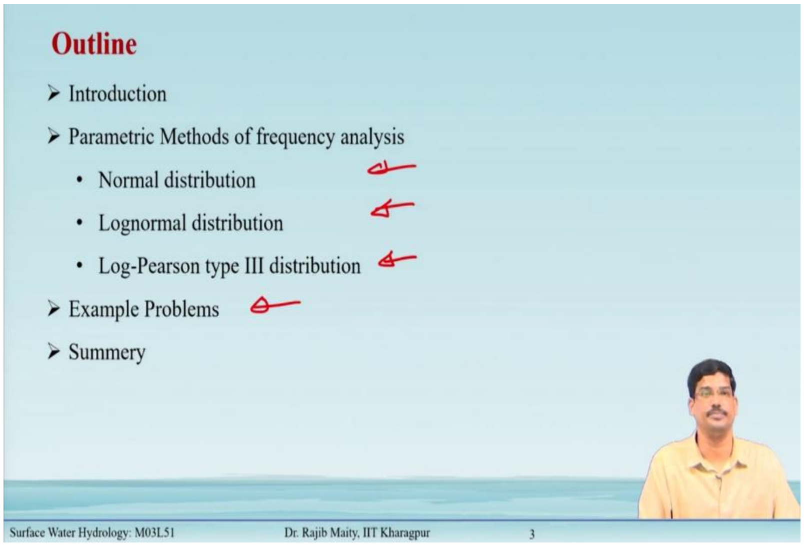

The outline goes like this, the introduction is why this parametric method becomes important for some applications. And after that, some of the parametric methods used in some distributions that we will discuss in today's class are using the normal distribution, log-Pearson type III distribution, and lognormal distribution. And we will take up example problems for each of them before coming to the summary.

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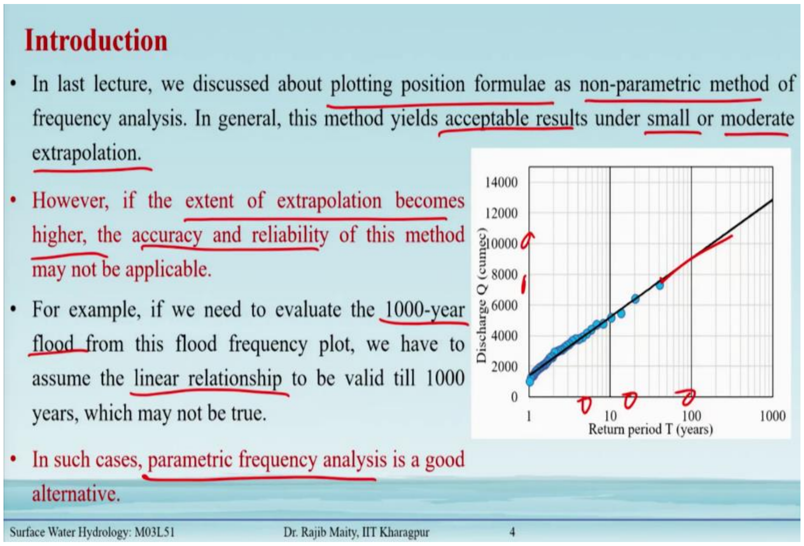

Introduction

In the last lecture, we discussed the plotting position formulae as the non-parametric method of the frequency analysis, and we also concluded that this may yield some acceptable results when you go for the small or moderate extrapolation of this one. Fig.1 also was presented and can go for some sort of extrapolation here to find out what are the different return periods and their corresponding values here. However, if the extent of this extrapolation becomes higher, then the accuracy and reliability of this method may not be applicable.

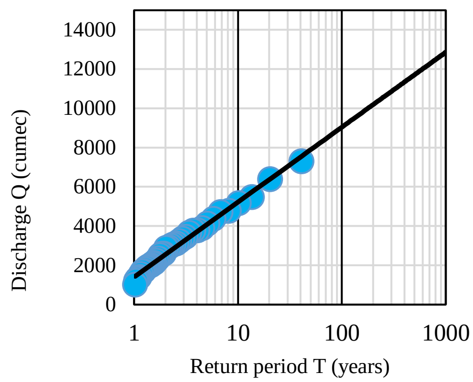

Figure 1 shows the plot between return periods vs. discharge

And in this case, for example, if we just evaluate for these 1000 years of the flood from this flood frequency plot that may not hold any mode of the linear relationship towards the end. So, that may yield a very wrong result. So, in this case, the parametric frequency analysis of course, with some assumptions may provide a better estimate of the extent of results.

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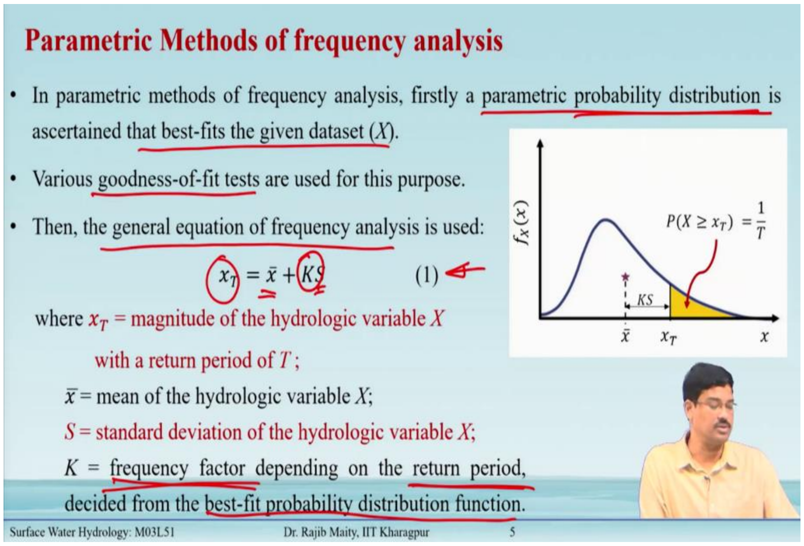

Parametric Methods of frequency analysis

In parametric methods of frequency analysis, firstly a parametric probability distribution is ascertained that best fits the given dataset (*X*).

Various goodness-of-fit tests are used for this purpose.

Then, the general equation of frequency analysis is used:

$$x_T = \bar{x} + KS \tag{1}$$

Where x_T = magnitude of the hydrologic variable *X* with a return period of *T;*

$\bar{x}$= mean of the hydrologic variable *X*;

S = standard deviation of the hydrologic variable *X*;

K = frequency factor depending on the return period decided from the best-fit probability distribution function.

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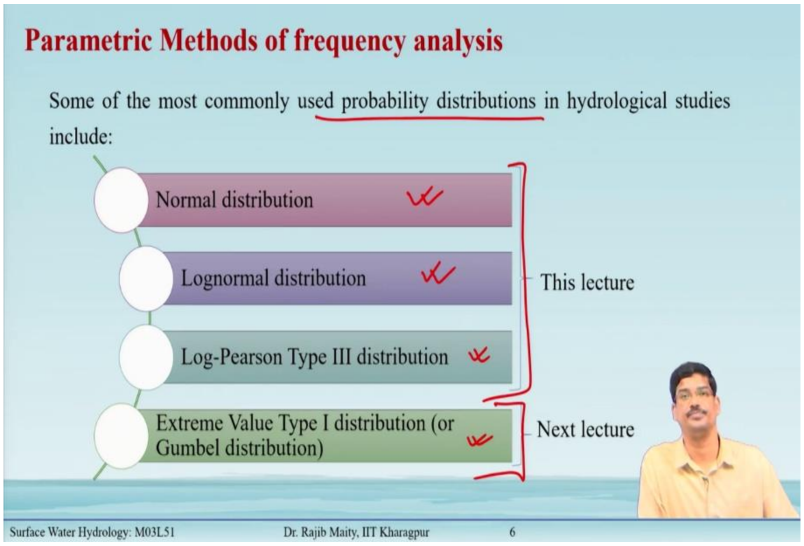

Parametric Methods of frequency analysis

Some of the most commonly used probability distributions in hydrological studies include:

- Normal distribution
- Lognormal distribution
- Log-Pearson Type III distribution
- Extreme Value Type I distribution (or Gumbel distribution)

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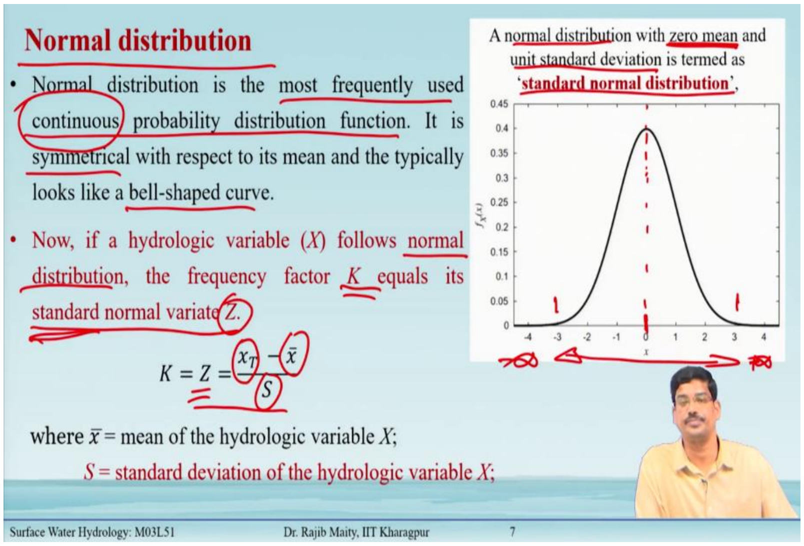

Normal distribution

The normal distribution is the most frequently used continuous probability distribution function. It is symmetrical with respect to its mean and the type looks like a bell-shaped curve.

Now, if a hydrologic variable (X) follows the normal distribution, the frequency factor K equals its standard normal variate Z.

$$K = Z = \frac{x_T - \bar{x}}{S}$$

Where $\bar{x}$= mean of the hydrologic variable X;

S = standard deviation of the hydrologic variable X;

A normal distribution with zero mean and unit standard deviation is termed a 'standard normal distribution',

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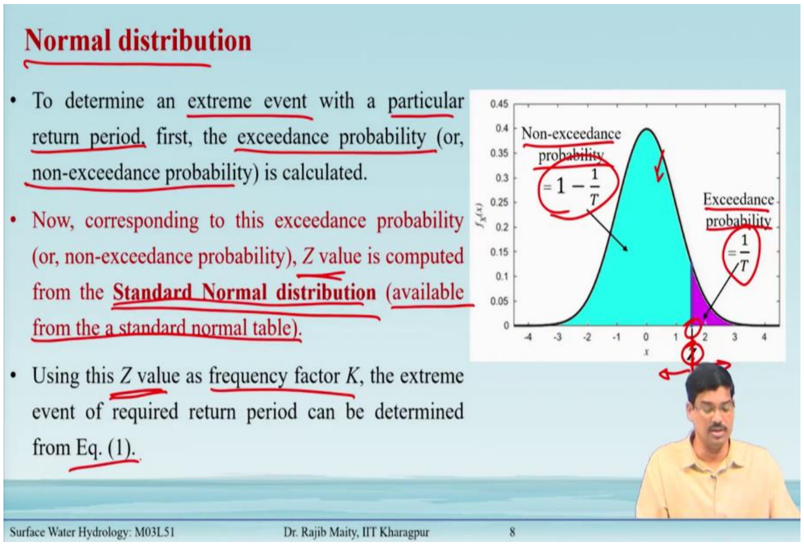

Normal distribution

- To determine an extreme event with a particular return period, first, the exceedance probability (or, non-exceedance probability) is calculated.
- Now, corresponding to this exceedance probability (or, non-exceedance probability), the Z value is computed from the Standard Normal distribution (available from the standard normal table).
- Using this Z value as frequency factor K, the extreme event of the required return period can be determined from Eq. (1).

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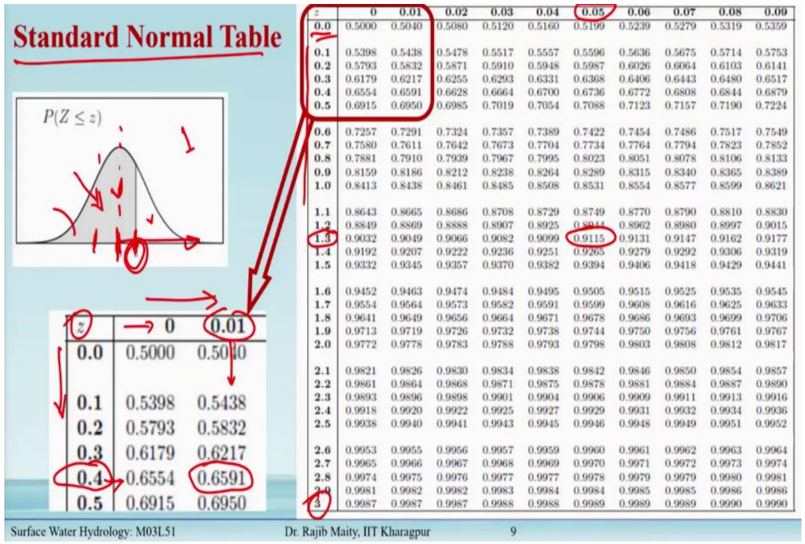
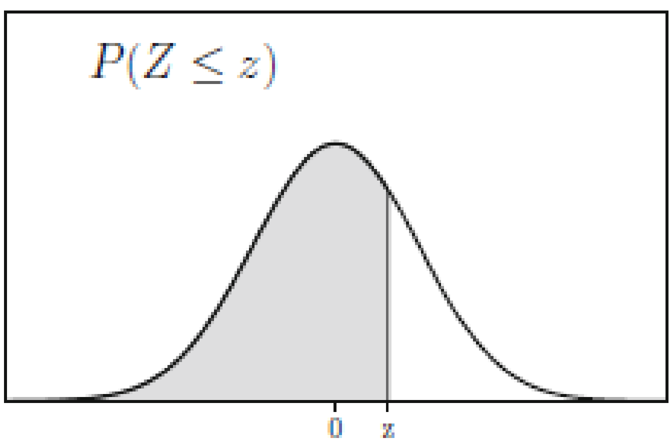


z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990

Standard Normal Table



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2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
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2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990

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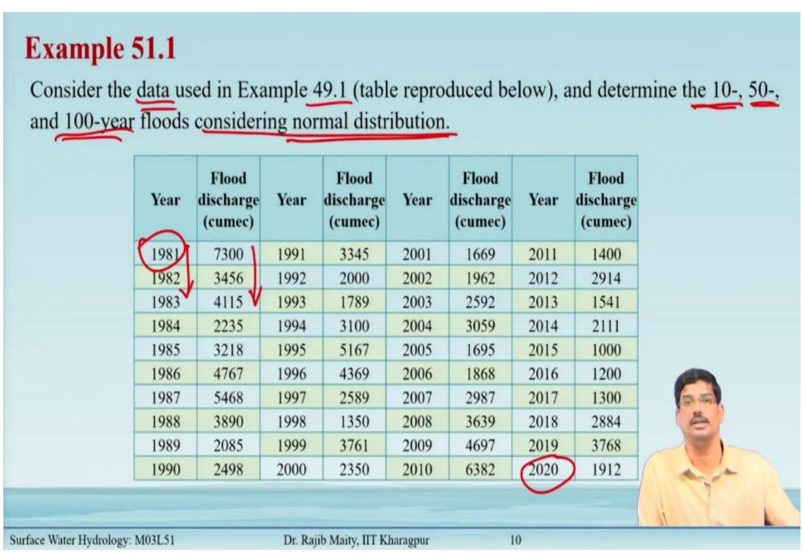

Example 51.1

Consider the data used in Example 49.1 (table reproduced below), and determine the 10-, 50-, and 100-year floods considering normal distribution.

Year	Flood discharge (cumec)	Year	Flood discharge (cumec)	Year	Flood discharge (cumec)	Year	Flood discharge (cumec)
1981	7300	1991	3345	2001	1669	2011	1400
1982	3456	1992	2000	2002	1962	2012	2914
1983	4115	1993	1789	2003	2592	2013	1541
1984	2235	1994	3100	2004	3059	2014	2111
1985	3218	1995	5167	2005	1695	2015	1000
1986	4767	1996	4369	2006	1868	2016	1200
1987	5468	1997	2589	2007	2987	2017	1300
1988	3890	1998	1350	2008	3639	2018	2884
1989	2085	1999	3761	2009	4697	2019	3768
1990	2498	2000	2350	2010	6382	2020	1912

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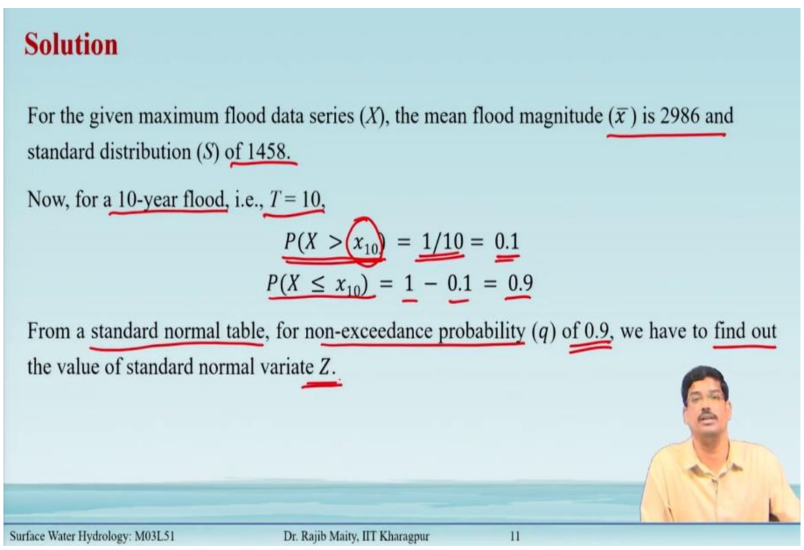

Solution

For the given maximum flood data series (X), the mean flood magnitude ($\bar{x}$) is 2986 and standard distribution (S) of 1458.

Now, for a 10-year flood, i.e., $T = 10$,

$$P(X > x_{10}) = 1/10 = 0.1$$

$$P(X \leq x_{10}) = 1 - 0.1 = 0.9$$

From a standard normal table, for non-exceedance probability (q) of 0.9, we have to find out the value of standard normal variate$Z$.

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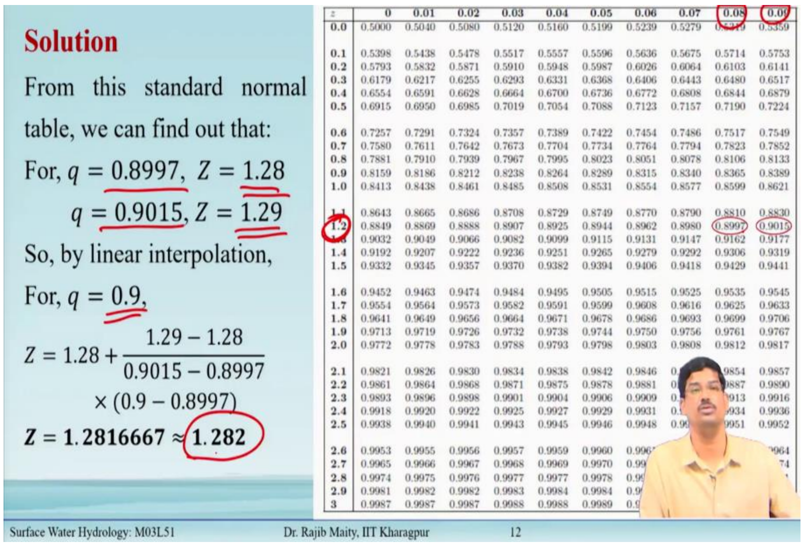

Solution

From this standard normal table, we can find out that:

For, $q = 0.8997,\ Z = 1.28$

$q = 0.9015, Z = 1.29$

So, by linear interpolation,

For, $q = 0.9,$

$$Z = 1.28 + \frac{1.29 - 1.28}{0.9015 - 0.8997} \times (0.9 - 0.8997)$$

$$\boldsymbol{Z = 1.2816667 \approx 1.282}$$

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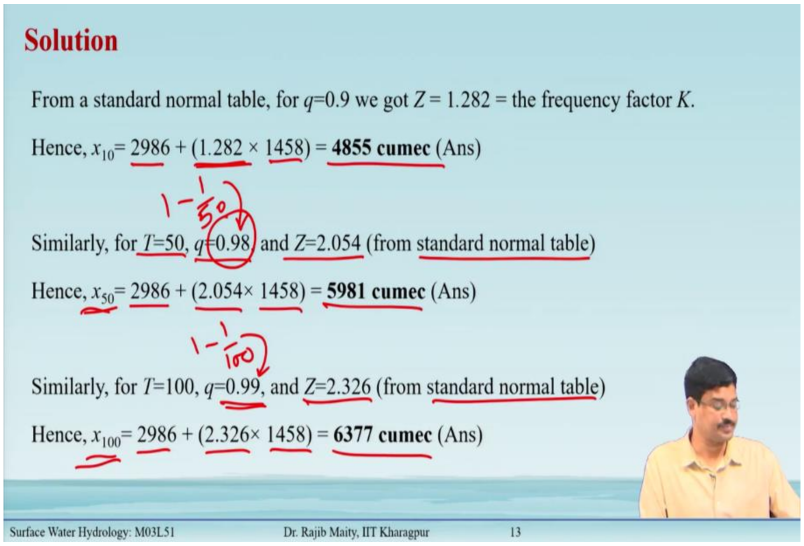

Solution

From a standard normal table, for q=0.9 we got Z = 1.282 = the frequency factor K.

Hence, x_{10}= 2986 + (1.282 × 1458) = **4855 cumec** (Ans)

Similarly, for T=50, q=0.98, and Z=2.054 (from standard normal table)

Hence, x_{50}= 2986 + (2.054× 1458) = **5981 cumec** (Ans)

Similarly, for T=100, q=0.99, and Z=2.326 (from standard normal table)

Hence, x_{100}= 2986 + (2.326× 1458) = **6377 cumec** (Ans)

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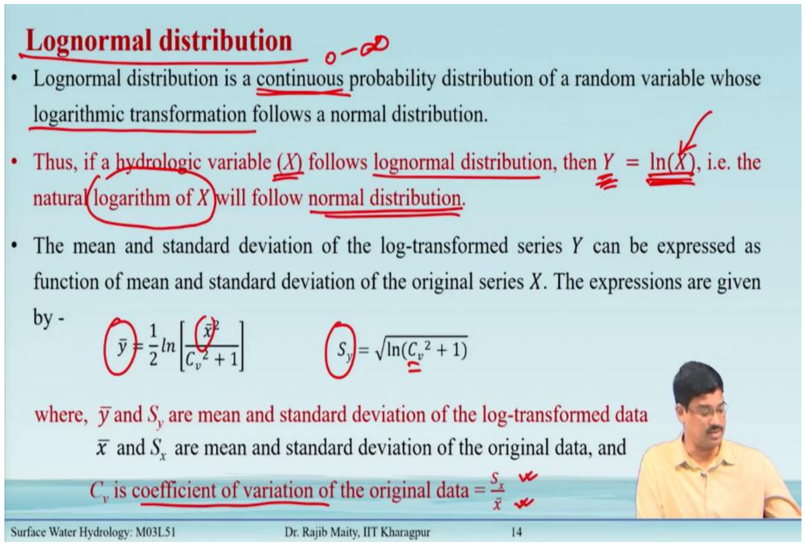

Lognormal distribution

- The lognormal distribution is a continuous probability distribution of a random variable whose logarithmic transformation follows a normal distribution.

- Thus, if a hydrologic variable (X) follows lognormal distribution, then $Y = ln(X)$, i.e. the natural logarithm of X will follow the normal distribution.

- The mean and standard deviation of the log-transformed series Y can be expressed as a function of the mean and standard deviation of the original series X. The expressions are given by -

$$\bar{y} = \frac{1}{2} ln \left[\frac{\bar{x}^2}{C_v{}^2+1}\right] \qquad S_y = \sqrt{\ln(C_v{}^2 + 1)}$$

Where, $\bar{y}$ and S_y are the mean and standard deviation of the log-transformed data

$\bar{x}$ and S_x *is* the mean and standard deviation of the original data, and

C_v is the coefficient of variation of the original data = $\frac{S_x}{\bar{x}}$

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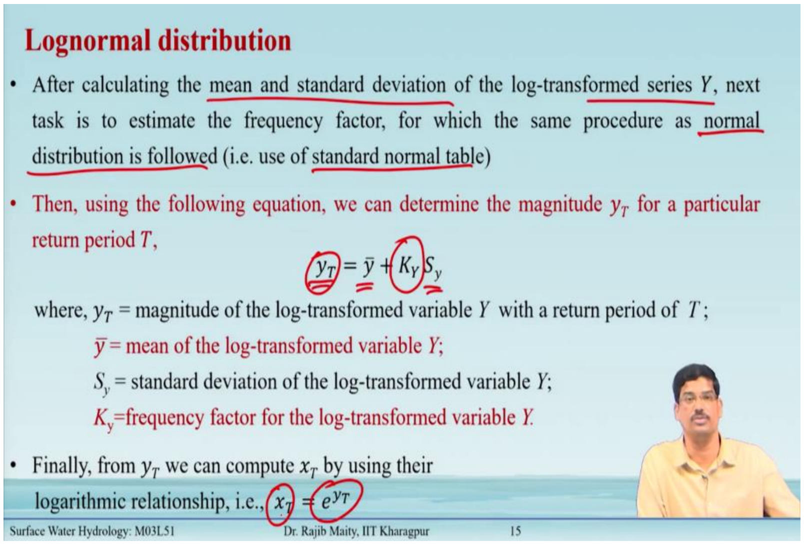

Lognormal distribution

After calculating the mean and standard deviation of the log-transformed series Y, the next task is to estimate the frequency factor, for which the same procedure as normal distribution is followed (i.e. use of standard normal table)

Then, using the following equation, we can determine the magnitude y_T for a particular return period T,

$$y_T = \bar{y} + K_Y S_y$$

where, y_T = magnitude of the log-transformed variable Y with a return period of T;

$\bar{y}$ = mean of the log-transformed variable Y;

S_y = standard deviation of the log-transformed variable Y;

K_y=frequency factor for the log-transformed variable Y.

Finally, from y_T we can compute x_T by using their logarithmic relationship, i.e., $x_T = e^{y_T}$

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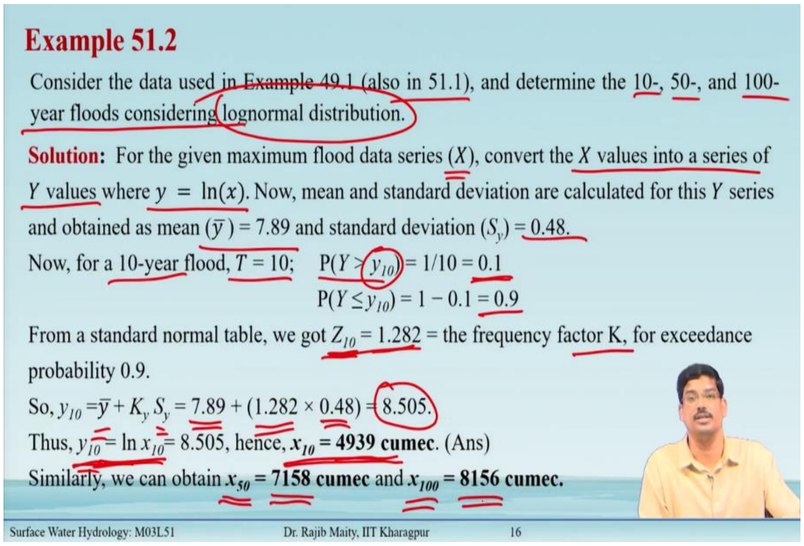

Example 51.2

Consider the data used in Example 49.1 (also in 51.1), and determine the 10-, 50-, and 100-year floods considering lognormal distribution.

Solution: For the given maximum flood data series (X), convert the X values into a series of Y values where $y = ln(x)$. Now, the mean and standard deviation are calculated for this Y series and obtained as the mean ($\bar{y}$) = 7.89 and standard deviation (S_y) = 0.48.

Now, for a 10-year flood, $T = 10$; $P(Y > y_{10}) = 1/10 = 0.1$

$$P(Y \leq y_{10}) = 1 - 0.1 = 0.9$$

From a standard normal table, we got $Z_{10} = 1.282$ = the frequency factor K, for exceedance probability 0.9.

So, $y_{10} = \bar{y} + K_y S_y = 7.89 + (1.282 \times 0.48) = 8.505$.

Thus, $y_{10} = \ln x_{10} = 8.505$, hence, $\boldsymbol{x_{10}}$ **= 4939 cumec**. (Ans)

Similarly, we can obtain $\boldsymbol{x_{50}}$ **= 7158 cumec** and $\boldsymbol{x_{100}}$ **= 8156 cumec.**

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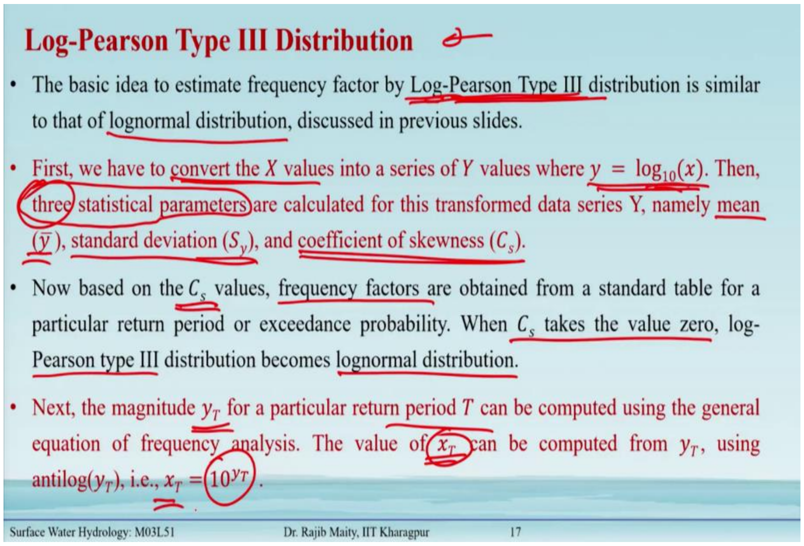

Log-Pearson Type III Distribution

- The basic idea to estimate frequency factor by Log-Pearson Type III distribution is similar to that of the lognormal distribution, discussed in previous slides.

- First, we have to convert the X values into a series of Y values where $y = log_{10}(x)$. Then, three statistical parameters are calculated for this transformed data series Y, namely mean ($\bar{y}$), standard deviation (S_y), and coefficient of skewness (C_s).

- Now based on the C_s values, frequency factors are obtained from a standard table for a particular return period or exceedance probability. When C_s takes the value zero, the log-Pearson type III distribution becomes a lognormal distribution.

- Next, the magnitude y_T for a particular return period T can be computed using the general equation of frequency analysis. The value of x_T can be computed from y_T, using antilog(y_T), i.e., $x_T = 10^{y_T}$.

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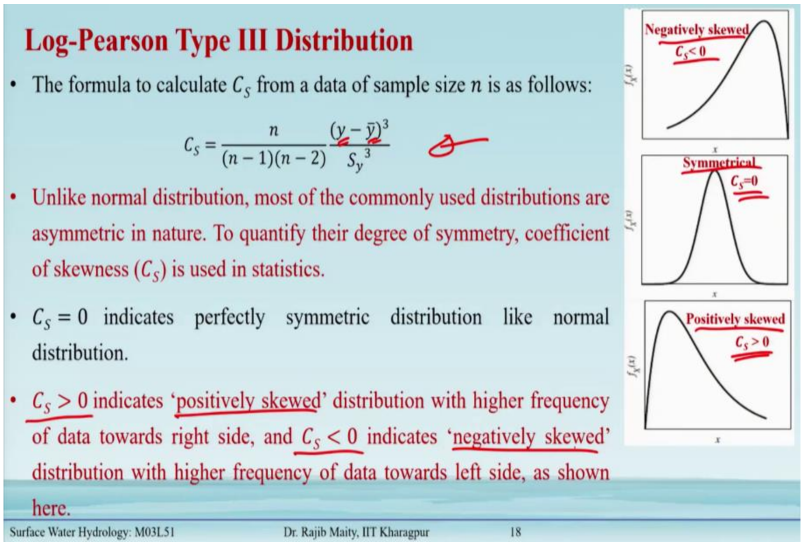

- The formula to calculate C_S from a data of sample size n is as follows:
  - $C_S = \frac{n}{(n-1)(n-2)} \frac{(y-\bar{y})^3}{S_y{}^3}$
- Unlike the normal distribution, most of the commonly used distributions are asymmetric in nature. To quantify their degree of symmetry, the coefficient of Skewness (C_S) is used in statistics.
- $C_S = 0$ Indicates a perfectly symmetric distribution like a normal distribution.
- $C_S > 0$ Indicates a 'positively skewed' distribution with a higher frequency of data toward the right side, and $C_S < 0$ indicates a 'negatively skewed' distribution with a higher frequency of data toward the left side, as shown in fig.1.

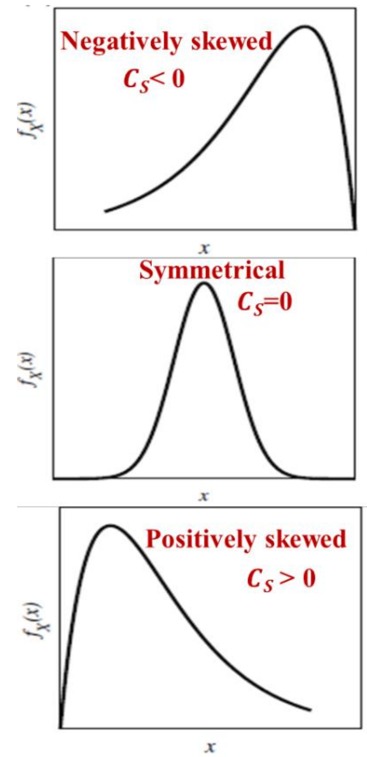

Figure 2 shows the Skewness distribution with respect to Cs

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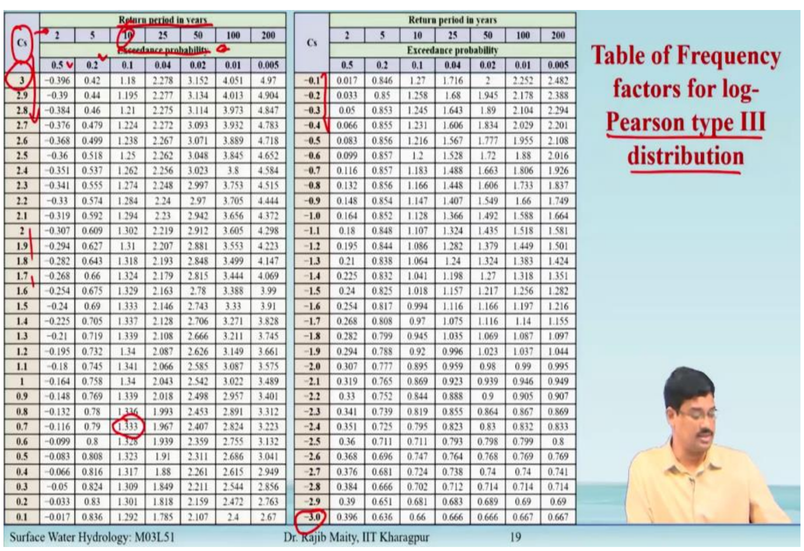

Cs	Return period in years: 2	5	10	25	50	100	200
	Exceedance probability: 0.5	0.2	0.1	0.04	0.02	0.01	0.005
3	−0.396	0.42	1.18	2.278	3.152	4.051	4.97
2.9	−0.39	0.44	1.195	2.277	3.134	4.013	4.904
2.8	−0.384	0.46	1.21	2.275	3.114	3.973	4.847
2.7	−0.376	0.479	1.224	2.272	3.093	3.932	4.783
2.6	−0.368	0.499	1.238	2.267	3.071	3.889	4.718
2.5	−0.36	0.518	1.25	2.262	3.048	3.845	4.652
2.4	−0.351	0.537	1.262	2.256	3.023	3.8	4.584
2.3	−0.341	0.555	1.274	2.248	2.997	3.753	4.515
2.2	−0.33	0.574	1.284	2.24	2.97	3.705	4.444
2.1	−0.319	0.592	1.294	2.23	2.942	3.656	4.372
2	−0.307	0.609	1.302	2.219	2.912	3.605	4.298
1.9	−0.294	0.627	1.31	2.207	2.881	3.553	4.223
1.8	−0.282	0.643	1.318	2.193	2.848	3.499	4.147
1.7	−0.268	0.66	1.324	2.179	2.815	3.444	4.069
1.6	−0.254	0.675	1.329	2.163	2.78	3.388	3.99
1.5	−0.24	0.69	1.333	2.146	2.743	3.33	3.91
1.4	−0.225	0.705	1.337	2.128	2.706	3.271	3.828
1.3	−0.21	0.719	1.339	2.108	2.666	3.211	3.745
1.2	−0.195	0.732	1.34	2.087	2.626	3.149	3.661
1.1	−0.18	0.745	1.341	2.066	2.585	3.087	3.575
1	−0.164	0.758	1.34	2.043	2.542	3.022	3.489
0.9	−0.148	0.769	1.339	2.018	2.498	2.957	3.401
0.8	−0.132	0.78	1.336	1.993	2.453	2.891	3.312
0.7	−0.116	0.79	1.333	1.967	2.407	2.824	3.223
0.6	−0.099	0.8	1.328	1.939	2.359	2.755	3.132
0.5	−0.083	0.808	1.323	1.91	2.311	2.686	3.041
0.4	−0.066	0.816	1.317	1.88	2.261	2.615	2.949
0.3	−0.05	0.824	1.309	1.849	2.211	2.544	2.856
0.2	−0.033	0.83	1.301	1.818	2.159	2.472	2.763
0.1	−0.017	0.836	1.292	1.785	2.107	2.4	2.67

Cs	Return period in years: 2	5	10	25	50	100	200
	Exceedance probability: 0.5	0.2	0.1	0.04	0.02	0.01	0.005
−0.1	0.017	0.846	1.27	1.716	2	2.252	2.482
−0.2	0.033	0.85	1.258	1.68	1.945	2.178	2.388
−0.3	0.05	0.853	1.245	1.643	1.89	2.104	2.294
−0.4	0.066	0.855	1.231	1.606	1.834	2.029	2.201
−0.5	0.083	0.856	1.216	1.567	1.777	1.955	2.108
−0.6	0.099	0.857	1.2	1.528	1.72	1.88	2.016
−0.7	0.116	0.857	1.183	1.488	1.663	1.806	1.926
−0.8	0.132	0.856	1.166	1.448	1.606	1.733	1.837
−0.9	0.148	0.854	1.147	1.407	1.549	1.66	1.749
−1.0	0.164	0.852	1.128	1.366	1.492	1.588	1.664
−1.1	0.18	0.848	1.107	1.324	1.435	1.518	1.581
−1.2	0.195	0.844	1.086	1.282	1.379	1.449	1.501
−1.3	0.21	0.838	1.064	1.24	1.324	1.383	1.424
−1.4	0.225	0.832	1.041	1.198	1.27	1.318	1.351
−1.5	0.24	0.825	1.018	1.157	1.217	1.256	1.282
−1.6	0.254	0.817	0.994	1.116	1.166	1.197	1.216
−1.7	0.268	0.808	0.97	1.075	1.116	1.14	1.155
−1.8	0.282	0.799	0.945	1.035	1.069	1.087	1.097
−1.9	0.294	0.788	0.92	0.996	1.023	1.037	1.044
−2.0	0.307	0.777	0.895	0.959	0.98	0.99	0.995
−2.1	0.319	0.765	0.869	0.923	0.939	0.946	0.949
−2.2	0.33	0.752	0.844	0.888	0.9	0.905	0.907
−2.3	0.341	0.739	0.819	0.855	0.864	0.867	0.869
−2.4	0.351	0.725	0.795	0.823	0.83	0.832	0.833
−2.5	0.36	0.711	0.711	0.793	0.798	0.799	0.8
−2.6	0.368	0.696	0.747	0.764	0.768	0.769	0.769
−2.7	0.376	0.681	0.724	0.738	0.74	0.74	0.741
−2.8	0.384	0.666	0.702	0.712	0.714	0.714	0.714
−2.9	0.39	0.651	0.681	0.683	0.689	0.69	0.69
−3.0	0.396	0.636	0.66	0.666	0.666	0.667	0.667

Table of Frequency factors for log-Pearson type III distribution

Cs	Return period in years						
	2	5	10	25	50	100	200
	Exceedance probability						
	0.5	0.2	0.1	0.04	0.02	0.01	0.005
3	−0.396	0.42	1.18	2.278	3.152	4.051	4.97
2.9	−0.39	0.44	1.195	2.277	3.134	4.013	4.904
2.8	−0.384	0.46	1.21	2.275	3.114	3.973	4.847
2.7	−0.376	0.479	1.224	2.272	3.093	3.932	4.783
2.6	−0.368	0.499	1.238	2.267	3.071	3.889	4.718
2.5	−0.36	0.518	1.25	2.262	3.048	3.845	4.652
2.4	−0.351	0.537	1.262	2.256	3.023	3.8	4.584
2.3	−0.341	0.555	1.274	2.248	2.997	3.753	4.515
2.2	−0.33	0.574	1.284	2.24	2.97	3.705	4.444
2.1	−0.319	0.592	1.294	2.23	2.942	3.656	4.372
2	−0.307	0.609	1.302	2.219	2.912	3.605	4.298
1.9	−0.294	0.627	1.31	2.207	2.881	3.553	4.223
1.8	−0.282	0.643	1.318	2.193	2.848	3.499	4.147
1.7	−0.268	0.66	1.324	2.179	2.815	3.444	4.069
1.6	−0.254	0.675	1.329	2.163	2.78	3.388	3.99
1.5	−0.24	0.69	1.333	2.146	2.743	3.33	3.91
1.4	−0.225	0.705	1.337	2.128	2.706	3.271	3.828
1.3	−0.21	0.719	1.339	2.108	2.666	3.211	3.745
1.2	−0.195	0.732	1.34	2.087	2.626	3.149	3.661
1.1	−0.18	0.745	1.341	2.066	2.585	3.087	3.575
1	−0.164	0.758	1.34	2.043	2.542	3.022	3.489
0.9	−0.148	0.769	1.339	2.018	2.498	2.957	3.401
0.8	−0.132	0.78	1.336	1.993	2.453	2.891	3.312
0.7	−0.116	0.79	1.333	1.967	2.407	2.824	3.223
0.6	−0.099	0.8	1.328	1.939	2.359	2.755	3.132
0.5	−0.083	0.808	1.323	1.91	2.311	2.686	3.041
0.4	−0.066	0.816	1.317	1.88	2.261	2.615	2.949
0.3	−0.05	0.824	1.309	1.849	2.211	2.544	2.856
0.2	−0.033	0.83	1.301	1.818	2.159	2.472	2.763
0.1	−0.017	0.836	1.292	1.785	2.107	2.4	2.67

Cs	Return period in years						
	2	5	10	25	50	100	200
	Exceedance probability						
	0.5	0.2	0.1	0.04	0.02	0.01	0.005
−0.1	0.017	0.846	1.27	1.716	2	2.252	2.482
−0.2	0.033	0.85	1.258	1.68	1.945	2.178	2.388
−0.3	0.05	0.853	1.245	1.643	1.89	2.104	2.294
−0.4	0.066	0.855	1.231	1.606	1.834	2.029	2.201
−0.5	0.083	0.856	1.216	1.567	1.777	1.955	2.108
−0.6	0.099	0.857	1.2	1.528	1.72	1.88	2.016
−0.7	0.116	0.857	1.183	1.488	1.663	1.806	1.926
−0.8	0.132	0.856	1.166	1.448	1.606	1.733	1.837
−0.9	0.148	0.854	1.147	1.407	1.549	1.66	1.749
−1.0	0.164	0.852	1.128	1.366	1.492	1.588	1.664
−1.1	0.18	0.848	1.107	1.324	1.435	1.518	1.581
−1.2	0.195	0.844	1.086	1.282	1.379	1.449	1.501
−1.3	0.21	0.838	1.064	1.24	1.324	1.383	1.424
−1.4	0.225	0.832	1.041	1.198	1.27	1.318	1.351
−1.5	0.24	0.825	1.018	1.157	1.217	1.256	1.282
−1.6	0.254	0.817	0.994	1.116	1.166	1.197	1.216
−1.7	0.268	0.808	0.97	1.075	1.116	1.14	1.155
−1.8	0.282	0.799	0.945	1.035	1.069	1.087	1.097
−1.9	0.294	0.788	0.92	0.996	1.023	1.037	1.044
−2.0	0.307	0.777	0.895	0.959	0.98	0.99	0.995
−2.1	0.319	0.765	0.869	0.923	0.939	0.946	0.949
−2.2	0.33	0.752	0.844	0.888	0.9	0.905	0.907
−2.3	0.341	0.739	0.819	0.855	0.864	0.867	0.869
−2.4	0.351	0.725	0.795	0.823	0.83	0.832	0.833
−2.5	0.36	0.711	0.711	0.793	0.798	0.799	0.8
−2.6	0.368	0.696	0.747	0.764	0.768	0.769	0.769
−2.7	0.376	0.681	0.724	0.738	0.74	0.74	0.741
−2.8	0.384	0.666	0.702	0.712	0.714	0.714	0.714
−2.9	0.39	0.651	0.681	0.683	0.689	0.69	0.69
−3.0	0.396	0.636	0.66	0.666	0.666	0.667	0.667

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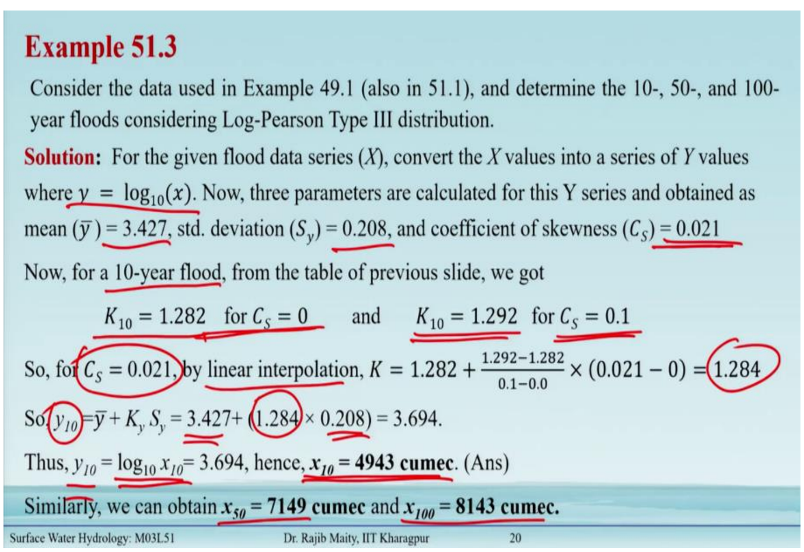


Example 51.3

Consider the data used in Example 49.1 (also in 51.1), and determine the 10-, 50-, and 100-year floods considering Log-Pearson Type III distribution.

Solution: For the given flood data series (X), convert the X values into a series of Y values where $y = log_{10}(x)$. Now, three parameters are calculated for this Y series and obtained as mean ($\bar{y}$) = 3.427, std. deviation (S_y) = 0.208, and coefficient of skewness (C_S) = 0.021

Now, for a 10-year flood, from the table of the previous slide, we got

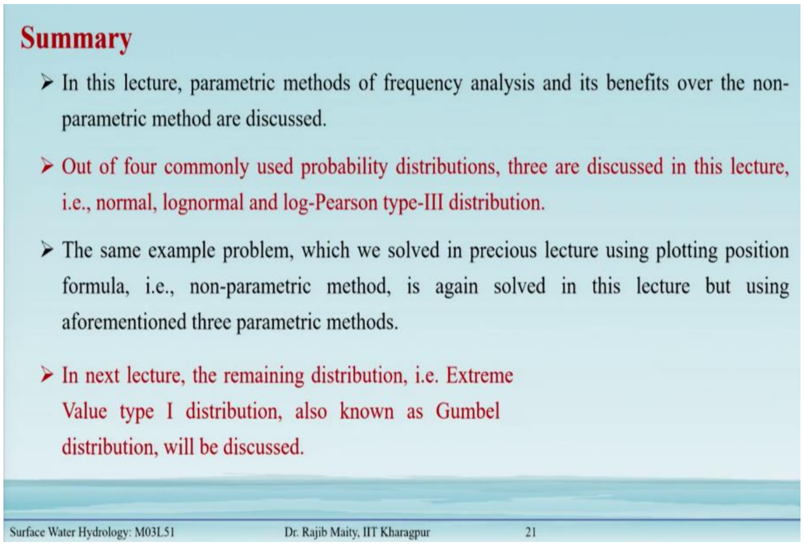
$$K_{10} = 1.282 \quad \text{For } C_S = 0 \qquad \text{and} \qquad K_{10} = 1.292 \quad \text{for } C_S = 0.1$$

So, for $C_S = 0.021$, by linear interpolation, $K = 1.282 + \frac{1.292-1.282}{0.1-0.0} \times (0.021 - 0) = 1.284$

So, $y_{10} = \bar{y} + K_y S_y$ = 3.427+ (1.284 × 0.208) = 3.694.

Thus, $y_{10} = \log_{10} x_{10}$= 3.694, hence, $\boldsymbol{x_{10}}$ **= 4943 cumec**. (Ans)

Similarly, we can obtain $\boldsymbol{x_{50}}$ **= 7149 cumec** and $\boldsymbol{x_{100}}$ **= 8143 cumec.**



Summary

In summary, we learned the following points from this lecture:

- In this lecture, parametric methods of frequency analysis and their benefits over the non-parametric method are discussed.
- Out of four commonly used probability distributions, three are discussed in this lecture, i.e., normal, lognormal, and log-Pearson type-III distribution.
- The same example problem, which we solved in the previous lecture using the plotting position formula, i.e., non-parametric method, is again solved in this lecture but using the aforementioned three parametric methods.
- In the next lecture, the remaining distribution, i.e. Extreme Value type I distribution, also known as Gumbel distribution, will be discussed.