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L-Moments (LM) are linear functions of ordered statistics having less biasing, less effected by sampling variability and are more robust than conventional moments. The L-moments for the order statistics is:

Three probability distributions are used, two of them are three parametric (GEV and LP3) and one is two parametric (Gumbel). The aptness of the distributions is investigated by various tests like Kolmogorov-Smirnov (KS), Anderson-Darling (AD) and the Chi-Squared [4].

Generalized Extreme Values (GEV)

Generalized extreme value distribution is the combination of Weibull, Gumbel and Frechet probability distributions, it has three parameters; location parameter (z), scale parameter (α) and shape parameter (k). Probability distributions having more number of parameters will be considered as more efficient specially in hydrological engineering even two parametric distributions sometimes have good results but in case of small sample size [5-8].

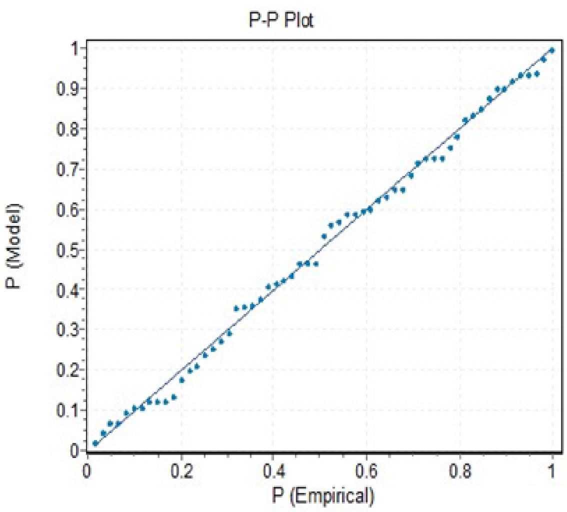
Log Pearson Type- III distribution (LP3)

Similar to GEV, log pearson Type-III also uses three parameters: Location parameter (μ), scale parameter (σ) and shape parameter (γ), it belongs to the family of Pearson type-III.

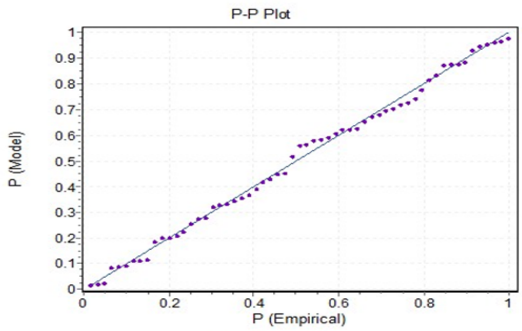
Gumbel distribution (EV1)

Gumbel distribution is a two parametric distribution, location parameter (z) and scale parameter (α). Standard error of two parametric distributions like (EV1) are smaller but biasing is large as compared to 3 or 4 parametric distributions (Figure 2) [9-12].

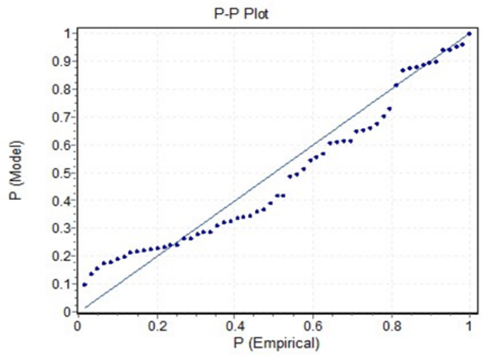
$$\lambda_r = I/r \sum_{k=0}^{r-1} (-1)^k \binom{r-1}{k} E(X_{r-k:r})$$



(a) Generalized extreme value



(b) Log-Pearson



(c) Gumbel Max

Figure 2. P-P plot of three stations.

Results

Goodness of fit tests

Various tests (parametric and non-parametric) are used to check the efficient fitting of probability distribution to the given data, in these tests, test statistics are calculated and analyzed. Here we use non-parametric tests like Kolmogorov-Smirnov, Chi-Square and Anderson-Darling (Table 1) [13].

Table 1. Parametric and non-parametric tests.

Station	Distributions	Sample size	Kolmogorov-Smirnov		Chi-Square	Anders on-darling	
			Statistics	p-Value	Statistics	p-Value	Statistics
I Sangum	Generalized Extreme Value	59	0.06857	0.90131	2.9735	0.70213	0.2228
	Log-Pearson III	59	0.0716	0.901	2.376	0.795	0.22142
	Gumbel		0.1239	0.1239	4.884	0.299	0.42365
II Ram Munshi Bagh	Generalized Extreme Value	59	0.0548	0.99023	2.3259	0.80245	0.1625
	Log-Pearson III	59	0.05429	0.99122	1.2423	0.94076	0.1531
	Gumbel		0.05516	0.98948	2.3142	0.80419	0.16677
III Asham	Generalized Extreme Value	59	0.05892	0.97913	2.6497	0.75381	0.19416
	Log-Pearson III	59	0.06357	0.95869	0.903	0.97	0.18036
	Gumbel	59	0.07675	0.85148	1.143	0.95022	0.3523

Discussion

L-Moment Ratio Diagram (LMRD)

An additional mode to check the fitting of distributions is the (LMRD), it the diagram which represents the relationship between L-Skewness and L-Kurtosis (T3, T4) of data plotted against points and constant lines. Actually LMR Diagram is the visual check of the necessary fitting of the distribution (Figure 3) [14].

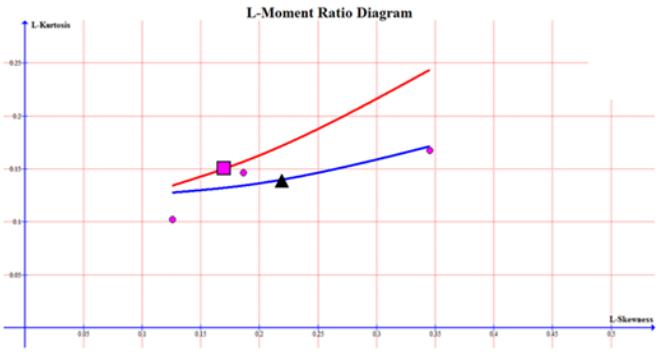


Figure 3. L-Moment ratio diagram. Note: Origional values, GEV, Log Pearson III, Average Value, Gumbel III

Return period

The return period (year) of three gauging stations using Log Pearson's probability distributions (LP3) (Table 2) [15].

Table 2. The return period (year) of three gauging stations.

Return period (Year)	Station I (Sangum)	Station II (Ram-MunshiBagh)	Station III (Asham)
2	549.54	602.55	732.34
5	1000	977.24	1114.36
10	1348.96	1174.89	1344.61
25	1819.7	1479.11	1606.69
50	2137.96	1698.24	1781.77
100	2511.88	1862.08	1940.9
200	2884.03	2041.74	2086.54

Conclusion

L-moment method provides better estimation with less biasing of unknown parameters of important probability distributions using in hydrological system. Throughout the world, arbitrating the trends of extreme hydrological situation are main constraints, so that economical and human losses may be reduced. Knowing the key factors involving the system and using the proper statistical techniques we may be able to establish a reliable system that predicts and monitor the situations. Here we see that the Log Pearsons-3 distribution shows better results with support of non-parametric tests, L-Moment Ratio Diagrams (LMRD) which is an additional way to measure goodness of fit to supports the claims. Log Pearsons-3 distribution are used globally for flood forecasting.

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