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***Short Communication***

# Water resources planning and management using probability distribution

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The fresh water useful for human beings, available in rivers and reservoirs as surface water or groundwater, has remained constant over the year but utility has increased due to population growth, economic development and urbanization etc. Researchers and stakeholders are always interested to understand the behavior of rainfall pattern in a particular region; but the actual prediction and forecasting is difficult task in the absence of sufficient data and without understanding statistical analysis. For the planning, designing, construction and management of any project like dam, lake, canal and urban drainage system an adequate knowledge of extreme events of high return periods is essentially required (Yang *et al*, 2010). Probability and frequency analysis of rainfall data enables us to determine the expected rainfall at different probability level (Kar,2002; Sattar,2010). Rainfall at 80 per cent probability can be taken as assured rainfall, while the median value (50 per cent) as the maximum limit for taking any risks (Vogel and Wilson, 1996). Frequency analysis has also been essential part of the design of hydraulic structures (Karim and Chowdhury, 1993).

In the present study, gridded IMD rainfall data (0.5 x 0.5) for Piperiya watershed situated in Koriya district of Chhattisgarh having an area of 2414 km$^2$and lie between 22°39'25" to 23°35'9" N latitude and 82°3'20" to 82°37'41" E longitude, was used for probability analysis using two and three parameters probability distribution functions for the period 1971-2010 (40 years). Initially, the entire rainfall series was segregated into weekly, monthly and yearly pattern. Ten probability distributions has been adopted for best fit; out of them Beta distribution and Log Normal distribution were found as the best fit distribution for annual as well as monsoon and monthly data respectively (Rigdon and Basu, 2000). Chi-squared ($\chi^2$) test has been adopted for test of significance at different probability levels (10%, 20%, 50%, 70%, 80% and 90%). One single probability distribution has not been found appropriate to represent all the data sets though Log normal and Weibull distribution has been found promising for most of the data sets. Based on this goodness of fit; the Log normal was found to be the most appropriate distribution for describing the monthly rainfall in Piperiya watershed of Koriya district of Chhattisgarh.

The probability distribution of both 2-parameters and 3-parameters were considered to indentify the best fit probability distribution for the region (Olofintoye *et al*., 2009; Topaloglu, 2002). The average annual rainfall in the Piperiya watershed is about 1172 mm. Mean monthly maximum rainfall varies from 7.5 mm in the month of March to 365.8 mm in the month of August. The coefficient of variation of monsoon (June-September) rainfall is 24 per cent.

***Probability analysis***

Two and Three parametric distributions namely Normal, Log normal, Gumbel Min, Gumbel Max, Weibull (2), Gamma, Beta, Log Pearson (3), Gamma (3) and Weibull (3) distribution were fitted in the monthly and yearly series. All the distributions are presented in Table 1 with their probability density function (PDF), range and parameters (Chowdhury *et al.,* 1991).To identify the best model which represents the region, Chi-squared ($\chi^2$) test was carried out in the study (Table1).

As revealed from Table 1, the annual series (Jan-Dec) of the rainfall data is best represented by Beta distribution with a minimum $\chi^2$-value of 3.88, whereas the monthly series reveals that Log Normal distribution is the best fit distribution representing the Piperiya watershed. The monthly rainfall at different probability level by two parameters Log Normal distribution is shown in Fig.1. Rainfall at 75% probability can be taken as assured for the water resources planning in the Piperiya watershed.

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**Table 1:** Probability analysis of monthly rainfall series for the period 1971-2010 using Chi-squared ($\chi^2$) test

| Month | Normal | Log normal | Gumbel Min | Gumbel Max | Weibull (2) | Gamma | Beta | Log-Pearson (3) | Gamma (3) | Weibull (3) |
|---|---|---|---|---|---|---|---|---|---|---|
| Jan-Dec | 8.52 | 8.53 | 26.32 | 26.31 | 323.62 | 11.13 | 3.88 | 8.10 | 8.79 | 5.88 |
| Jan | Inf | 186.13 | Inf | Inf | 18.18 | 127.50 | Ext | NA | 204.64 | Ext |
| Feb | Inf | 65.99 | Inf | Inf | 108.58 | 32.04 | Ext | 46.23 | 56.91 | 2467.18 |
| Mar | Inf | 98.34 | Inf | Inf | 298.31 | 260.42 | Ext | 54.99 | 340.56 | Ext |
| Apr | Inf | 144.26 | Inf | Inf | 480.85 | 1141.37 | Ext | 70.32 | 551.94 | Ext |
| May | Inf | 126.66 | Inf | Inf | 13.96 | 119.65 | 826.25 | NA | 149.86 | Ext |
| Jun | 12.44 | 72.08 | 32.64 | 39.55 | 61.11 | 50.30 | 34.66 | 45.15 | Ext | Ext |
| Jul | 7.95 | 13.16 | 21.52 | 22.15 | 84.28 | 13.15 | 3.74 | 2.52 | Ext | Ext |
| Aug | 6.66 | 17.20 | 22.17 | 22.48 | 98.34 | 13.65 | 7.66 | 8.63 | Ext | Ext |
| Sep | 5.43 | 21.77 | 18.61 | 19.26 | 50.47 | 15.56 | 4.64 | 11.48 | Ext | Ext |
| Oct | Inf | 86.07 | Inf | Inf | 23.14 | 23.41 | 26.32 | NA | Ext | Ext |
| Nov | Inf | 64.08 | Inf | Inf | 9.80 | 68.97 | 764.03 | NA | 10.90 | 827.73 |
| Dec | Inf | 113.39 | Inf | Inf | 14.70 | 228.67 | Ext | NA | 15.53 | 1017.07 |
| Total | Inf | 1009.13 | Inf | Inf | 1261.72 | 2094.70 | Ext | NA | Ext | Ext |

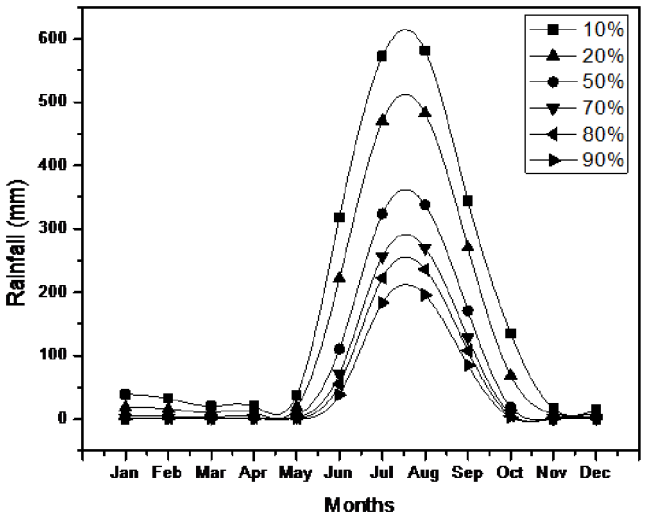


**Fig. 1:** Monthly rainfall at different probability level by Log-normal distribution

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