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Frequency Analysis of Daily Rainfall Data of Udaipur District

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Abstract-* *Precipitation may be a prime input for varied engineering style like hydraulic structures, conservation structures, bridges and culverts, canals, storm water sewer and road system. The careful applied math analysis of every region is crucial to estimate the relevant input worth for style and analysis of engineering structures and additionally for crop designing. This study includes applied math analysis i.e. frequency analysis of daily most precipitation information of Udaipur district. The daily precipitation information for an amount of fifty six years is collected to judge designed worth of precipitation exploitation c hance distribution models. Around 07 totally different chance distributions (Gamble's extreme worth kind I, Logpearson kind III, Lognormal, Normal, Exponential, Pearson kind III and Gamma distribution) were accustomed appraise most daily precipitation. Kolmogorov-Smirnov and Chi-squared tests were used for the goodness of work of the chance distributions. Results showed that Lognormal distribution and Gumbel distribution found to be have least essential values for each the tests thence take into account because the best work distribution for given sample population. Additionally most daily mean value of precipitation for varied come back periods were evaluated exploitation all distribution model into account.

I. INTRODUCTION

Analysis of daily most precipitation of various come back periods may be a basic tool for safe and economical designing and style of little dams, bridges, culverts, irrigation and emptying work etc. although the character of precipitation is erratic and varies with time and house, nonetheless it's doable to predict style precipitation fairly accurately sure as shooting comeback periods exploitation varied chane distributions (Upadhaya and Singh, 1998). style Engineers and Hydrologists need in the future most precipitation at totally different frequencies or come back periods for acceptable designing and style of little and medium hydraulic structures like little dams, bridges, culverts, etc. (Agarwal et al., 1998). Chance analysis are often used for predicting the prevalence of future events of precipitation from the obtainable information with the assistance of applied math ways (Kumar and Kumar, 1989). Anaya Kalita et al. (2017) worked on frequency analysis of daily precipitation information of twenty four years to see the annual in the future most precipitation and discharge of Ukiam (Brahmaputra River). Weibull's plotting position Gumbel, Log Pearson and Log traditional chance distribution functions were fitted. For determination of goodness of work chi sq. check was carried out. The results found showed that the Log Pearson and Log traditional were the most effective work chance distribution. Esberto (2018) determined the most effective work distribution of precipitation patterns for event foretelling so as to deal with potential disasters exploitation sixty chance Distribution

Functions
(PDF). Precipitation information were analyzed exploitation Chi-Square and K-S goodness-of-fit tests. Amin et al. (2016) analyzed to search out the best-fit chance distribution of annual most precipitation supported a twenty-four-hour sample within the northern regions of Asian country exploitation four chance distributions: traditional, log-normal, log-Pearson type-III and Gumbel goop. Supported the uncountable goodness of work tests, the conventional distribution was found

to be the best-fit chance distribution at the Mardan precipitation gauging station. The log-Pearson type-III distribution was found to be the best-fit chance distribution at the remainder of the precipitation gauging stations. This project is a trial to summaries the precipitation options for the Udaipur district. the overall precipitation received in a very given amount at a location is very variable from one year to a different. The variability depends on the kind of climate and also the length of the thought of amount. , the applied math inferences found during this study area unit necessary for coming up with optimum control facilities. essentially frequency analysis of precipitation is employed for various functions as mentioned below: Probability of chance for style purposes: The selection of the chance of chance or come back amount for style functions is expounded to the harm the surplus or the shortage of precipitation could cause the danger one needs to simply accept and also the life time of the project.

Probabilities of chance for management functions Information on the precipitation depth which will be expected in a very specific amount below varied climatic conditions is needed for management and designing functions. For rain-fed agriculture, precipitation is that the single most significant agro-meteorological variable influencing crop production.

II. MATERIALS AND METHODS

Table 1. Formula of Statistical Parameters

Sr.No.	Parameter name	Formula
1	Arithmetic mean	$\overline{X} = \frac{\Sigma_{N}^{i=1} X_i}{N}$
2	Standard deviation	$S = \sqrt{\frac{\sum_{i=1}^{N} X_i}{N-1}}$
3	Coefficient of variation	$C_v = \frac{S}{\overline{X}}$
4	Coefficient of skewness	$C_s = \frac{N\sum(X-\overline{X})^3}{(N-1)(N-2)S^3}$

$\overline{X}$ is the arithmetic Mean, X_i is Variate, N is the total number of observations, S is Standard Deviation, C_v is the coefficient of Variation and C_s is the Coefficient of skewness.

A. Tests for Goodness of Fit (Verification of Sample Population)

The goodness of fit of a statistical model describes how well it fits a set of observations. Measures of goodness of fit typically summarize the discrepancy between observed values and the values expected under the model in question.

In stochastic hydrology there are two ways whether or not a particular distribution adequately fits a set of observation-

- Compare observed relative frequency with theoretical relative frequency.
- Using probability papers.

Two tests were used to compare observed relative frequency with theoretical relative frequency

1) Chi-square test
2) Kolmogorov-Smirnov test

1) Chi-square test

The chi-squared test is used to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories.

$$\chi_c^2 = \sum_{i=1}^{N} (N_i - E_i)^2 / E_i$$

Where N is the total number of observations, N_i is the observed relative frequencies, and E_i is the theoretical or probable relative frequencies. If $\chi_c^2 = 0$, it indicates that observed and theoretical frequencies agree exactly while if $\chi_c^2 > 0$, they do not agree exactly. The hypothesis that the data follows a specific distribution is accepted if,

$$\chi^2_{data} < \chi^2_{\alpha-1,K-p-1}$$

Where α is the significance level and K-P-1 is the degree of freedom. Test is carried out at 10% significance level. Critical values of chi-square test for a particular degree of freedom and at particular significance level can be obtained from Chi-square distribution table.

2) Kolmogorov-smirnov test

In statistics, the Kolmogorov–Smirnov test is a nonparametric test of the equality of continuous (or discontinuous), one-dimensional probability distributions that can be used to compare a sample with a reference probability distribution (like Chi-square Test), this is the alternative to Chi-square test. The absolute difference between theoretical cumulative probability F(x) and calculated cumulative probability P(x) is calculated. The Kolmogorov-smirnov test statistics Δ is the maximum of this absolute difference calculated in step 4.

Δ= Maximum |P(x)-F(x) |

The critical value of kolmogorov-smirnov test statistics Δ_α is obtained from the Kolmogorov-smirnov table for 10% significance level. If $\Delta < \Delta_\alpha$, accept the hypothesis. For sample size more than 50, use following formula for critical values of Kolmogorv-smirnov test statistics.

(1.4) $\Delta_\alpha = 1.22/\sqrt{N}$ (α=10 %,)

3) Probability plot method

Table 1. Plotting position parameters for probability plotting

Sr..No.	Probability Distribution	Parameter Plotted on Abscissa	Parameter Plotted on Ordinate
1	Normal Distribution	Z (Normal Z Value)	(x)Rainfall in mm
2	Log Normal Distribution	Z (Normal Z Value)	(Logx)Rainfall in mm
3	Gumbel's Distribution	Y_t (*Reduced Vaiate*)	(x)Rainfall in mm
4	Log Pearson Type III Distribution	K_t (Frequency Factor)	(Logx)Rainfall in mm
5	Gamma Distribution	$\Gamma^{-1}(p)$ (Gamma Parameter)	(x)Rainfall in mm
6	Exponential Distribution	-Log(1-f(x))	(x)Rainfall in mm
7	Pearson Type III Distribution	K_t (Frequency Factor)	(x)Rainfall in mm

B. Frequency Distribution Models

1. Gumbel's extreme value distribution model

Gumbel found that the probability of occurrence of an event, equal or larger than a value is given by the equation,

(1.5) $P(X > x_0) = 1 - e^{-e^{-y}}$

(1.6) $y_t = -(\ln\ln\frac{T}{T-1})$

(1.7) $X_T = \overline{X} + K\sigma_{n-1}$

For N=56 the values for $\overline{y_n}$ and σ_n are 0.551 and 1.1696 respectively from standard tables (Ghanshyamdas, 2014)

2. Log-Pearson type lll distribution

(1.8) $z = \log x$

For any recurrence interval T above equation can be expressed as

(1.9) $z_t = \log x_t$

Applying general equation chow, Z_T data series can be expressed a

(1.10) $z_T = \bar{z} + K_f \sigma_z$

The value of K can be determined from the normal probability table.

Where, K_f is the frequency factor, C_z is the coefficient of skewness, $\bar{z}$ is the mean of the representative variate sample z, σ_z is the standard deviation of the representative variate sample z. value of K_f can be determined by using the standard table for a specific value of C_z and recurrence interval T.

3. Log normal probability distribution method
The flood or rainfall of any return period which follows the log normal probability law is computed from:

(1.11) $Q_T = \overline{Q} + K\sigma_n$
Where K is log normal frequency factor. A function of skewness coefficient, given by

(1.12) $C_s = 3C_v + C_v^3$
Where C_v is a coefficient of variation and given by

(1.13) $C_v = \frac{\sigma}{Q}$

4. Normal distribution

(1.14) $X_T = \overline{X} + K_T\sigma$

(1.15) $K_T = Z = \frac{X_T - \overline{X}}{\sigma}$

(1.16) $K_T = w - \frac{2.515517+0.80285w+0.010328w^2}{1+1.432788W+0.189269w^2+0.001308w^3}$

5. Gamma distribution
Gamma distribution – a distribution of sum of b independent and identical exponentially distributed random variables.

(1.17) $f(x) = \frac{\lambda^{\beta}(x-\varepsilon)^{\xi-1}e^{-\lambda(x-\varepsilon)}}{\Gamma(\beta)}$

Γ=Gamma function

$$\Gamma(\eta) = \int_0^{\alpha} t^{n-1} e^{-t} dt$$

6. Pearson type III
Named after the statistician Pearson, it is also called three-parameter gamma distribution. A lower bound is introduced through the third parameter (e).

(1.18) $f(x) = \frac{\lambda^{\beta}(x-\varepsilon)^{\xi-1}e^{-\lambda(x-\varepsilon)}}{\Gamma(\beta)}$

7. Exponential distribution
In hydrology, the inter arrival time (time between stochastic hydrologic events) is described by exponential distribution.

(1.19) $f(x) = \lambda e^{-\lambda x} \quad x \geq 0, \lambda = \frac{1}{x}$

Variance = $1/\lambda^2$

III. RESULT AND DISCUSSION

Table 2. Goodness of fit result summary

Sr.no.	Distribution Model	Test Performed	Calculated values for χ_c^2 & KS test	Degree of freedom	Critical values at 10 % significance level	Result
1	Gumbel's distribution	Chi-square Test	9.406	7	12.02	Accepted
		Kolmoorov-Smirnov Test	0.092		0.163	Accepted
2	Log-Pearson Type-III distribution	Chi-square Test	22.793	6	10.64	Rejected
		Kolmoorov-Smirnov Test	0.175		0.163	Rejected
3	Normal distribution	Chi-square Test	20.851	7	12.02	Rejected
		Kolmoorov-Smirnov Test	0.159		0.163	Accepted
4		Chi-square Test	8.444	6	10.64	Accepted

	Lognormal distribution	Kolmoorov-Smirnov Test	0.082		0.163	Accepted
5	Exponential distribution	Chi-square Test	48.331	8	13.362	Rejected
		Kolmoorov-Smirnov Test	0.338		0.163	Rejected
6	Pearson-III distribution	Chi-square Test	54.742	6	10.64	Rejected
		Kolmoorov-Smirnov Test	0.248		0.163	Rejected
7	Gamma distribution	Chi-square Test	10.163	7	12.02	Accepted
		Kolmoorov-Smirnov Test	0.098		0.163	Accepted

Probability Plot Results

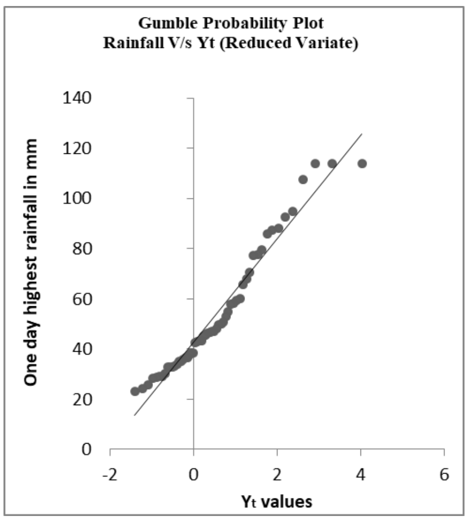

Fig 1. Gumble probability plot

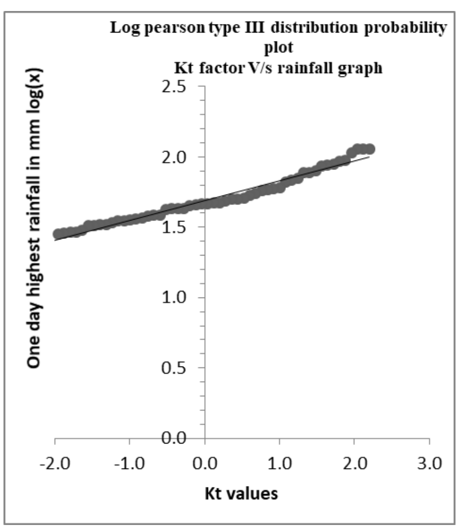

Fig 2. Logpearson type III probability plot

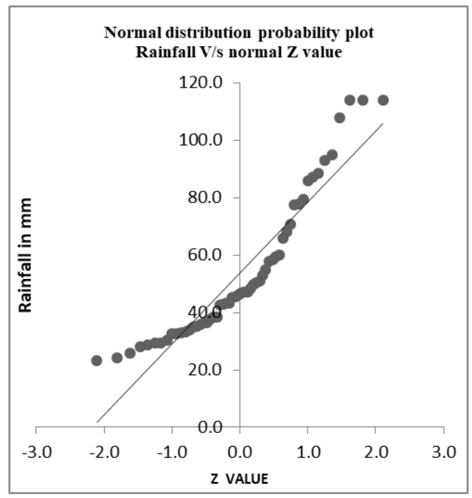

Fig 3. Normal probability plot

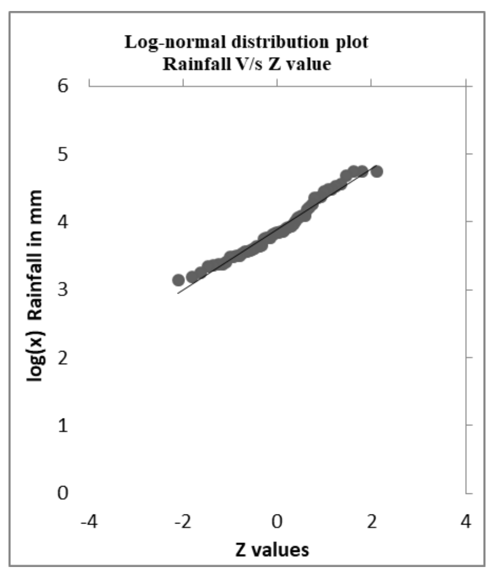

Fig 4. Lognormal probability plot

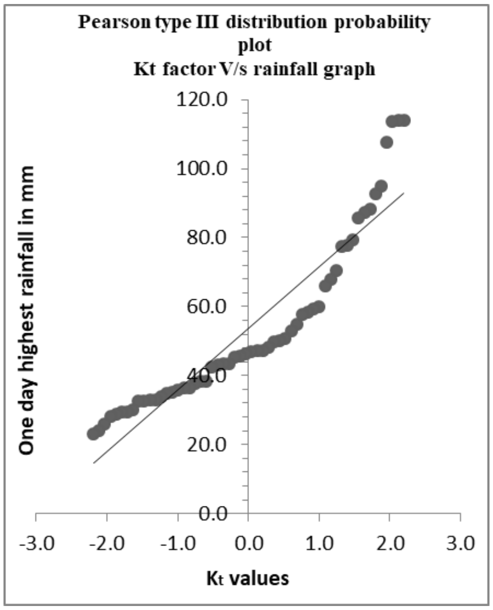

Fig 5. Pearson type III probability plot

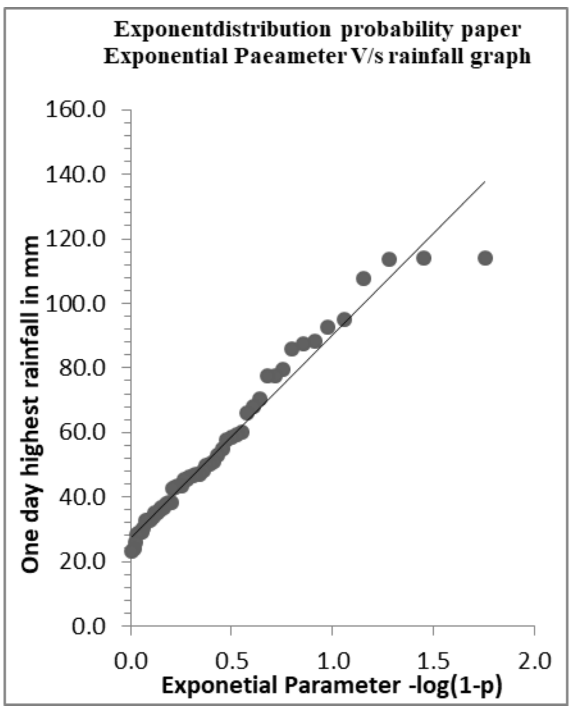

Fig 6. Exponential probability plot

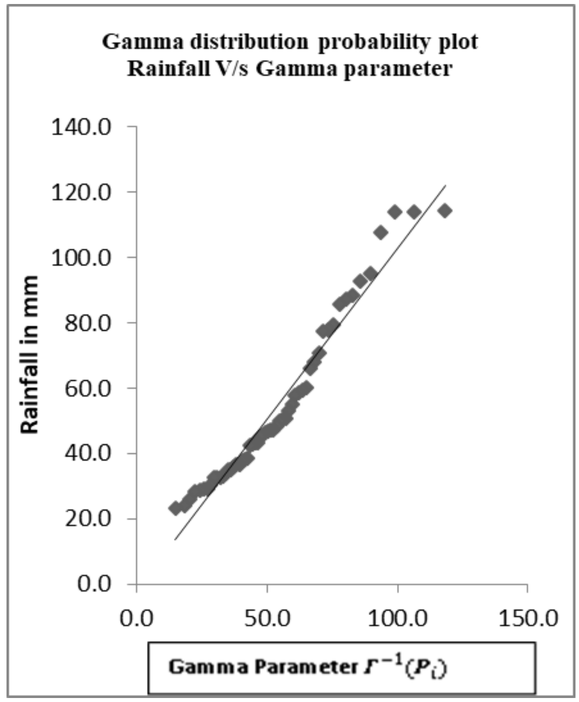

Fig 7. Gamma probability plot

A. Probability plot result summary

Table 3. Probability plot result summary

Sr.No.	Probability Plot	Correlation Coefficient	Result
1	Gumbel's distribution	0.981	Accepted
2	Logpearson type III distribution	0.984	Accepted
3	Normal distribution	0.942	Accepted
4	Log-normal distribution	0.986	Accepted
5	Exponential distribution	0.984	Accepted
6	Pearson type III distribution	0.977	Accepted
7	Gamma distribution	0.980	Accepted

B. Magnitude of Daily Rainfall (mm) For Various Distribution Models

Table 4. Magnitude of designed value of daily rainfall for various distribution models and return periods.

Distribution model	Return period in years									
	5	10	25	50	100	200	300	400	500	1000
Gumbel distribution	73.85	89.77	109.88	124.80	139.61	154.37	162.99	169.10	173.84	188.55
Log-Pearson Type-III distribution	69.40	86.03	109.52	128.96	150.09	173.21	180.03	187.12	188.73	235.95
Normal distribution	74.60	85.52	97.17	104.69	111.45	117.64	121.04	123.37	125.14	130.40
Lognormal distribution	70.16	84.74	103.63	118.01	132.65	147.62	156.57	163.00	168.05	184.04
Exponential distribution	86.53	123.79	173.06	210.32	247.59	284.86	306.65	322.12	334.12	371.38
Pearson-III distribution	72.53	86.97	104.41	116.79	128.70	140.28	143.41	146.54	149.66	165.29
Gamma distribution	72.74	86.95	103.95	115.96	127.48	138.62	144.99	149.46	152.89	163.42

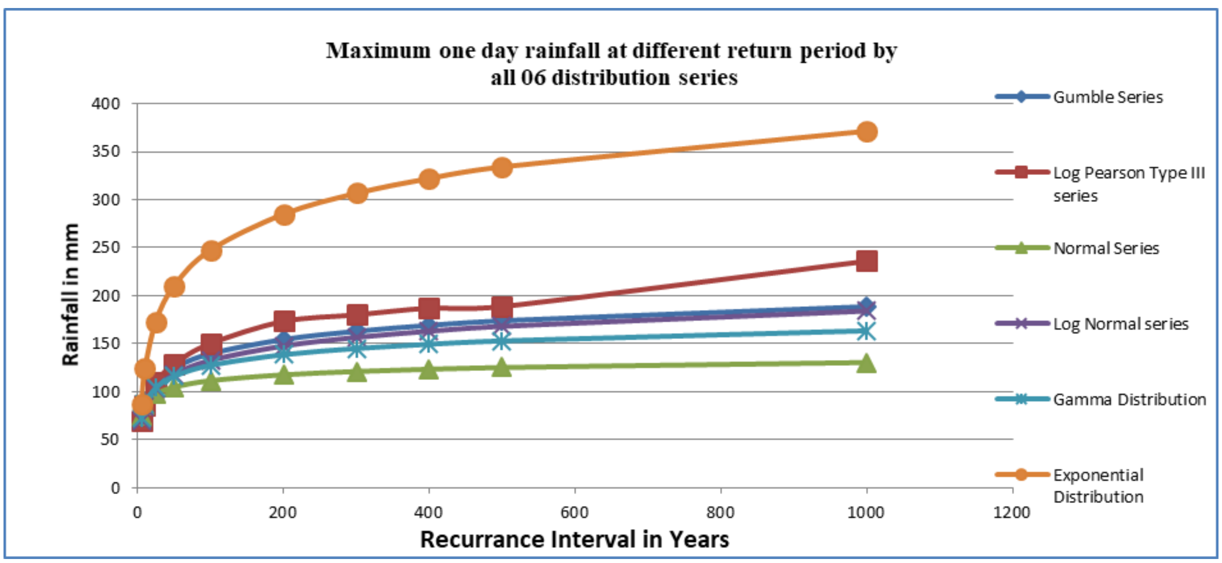

Fig.8 Comparison of different Probability distribution model of annual maximum daily rainfall

IV. CONCLUSION

56 years of daily downfall information is taken from the IMD manual revealed in 2014. For the series of daily downfall information,
annual most daily downfall information is organized.

The seven likelihood distributions were subjected take a look at|to check} from 2 goodness of match tests (Kolmogorov-smirnov test and Chi-squared test) .Further sample information is additionally tested by likelihood plotting i.e. plotting sample information with distribution parameter and calculate coefficient of correlation. the aim of the study was to search out the best-fit likelihood distributions for district Udaipur. the most values of expected downfall or downfall estimates calculated employing a likelihood distribution that doesn't offer the best-fit might yield values that ar higher or under the particular values. These calculations could also be accustomed influence choices regarding native eco nomic science and hydrologic safety systems. Both the tests were performed at 100 percent significance level. Out of 07 models 04 models have passed in one or additional tests. The Log-normal distribution and Gumbel distribution provided the best-fit likelihood distribution with the smallest amount score for each the take a look at. The expected values of styleed downfall or downfall estimates calculated victimisation the best-fit likelihood distributions at the downfall gauging stations may well be utilized by style engineers to soundly and feasibly design hydrologic comes.

REFRENCES

[1] Agarwal, M.C., Katiyar, V.S. and Babu, R... Likelihood analysis of annual most daily downfall of U.P. Himalaya. Indian journal of conservation, 16(1): 35-43, 1995.

[2] Al-suhili, R.H., and Khanbilvardi, R... Frequency Analysis of the Monthly downfall information at Sulaimania Region, Iraq. Yank Journal of Engineering analysis (AJER), 03(05): 12-222, 2014.

[3] Amin, T.A., Rizwan, M. and Alazba, A.A. A best-fit likelihood distribution for the estimation of downfall in northern regions of Islamic Republic of Pakistan. Open natural science, 11:432-440, 2016.

[4] Arvind, G., Kumar, A.P., Girishkarthi, S. and Suribabu, C.R. applied math Analysis of thirty Years downfall Data: A Case Study. IOP Conf. Series: Earth and bionomics, 80(2017):01-09, 2017.

[5] Bhakar, S. R., Bansal, A.K., Chhajed N. and Purohit, R. C.Frequency Analysis of Consecutive Days most downfall at Banswara, Rajasthan, India. ARPN Journal of Engineering and Applied Sciences, 31(3): 64-67, 2006.

[6] Bhavyashree, S. and Bhattacharya, B. Fitting likelihood Distributions for downfall Analysis of Mysore, India. International Journal of Current biology and Applied Sciences, 7(3): 1498-1506, 2018.

[7] Dirk, R. Frequency Analysis of downfall information. Note Submitted To Department of Earth And surroundings Science, Katholieke Universiteit, Belgium, 2013.

[8] Esberto, M.D.P.. likelihood Distribution Fitting of downfall Patterns in Philippine Regions for Effective Risk Management. surroundings and Ecology analysis, 6(3): 178-86, 2018.

[9] Ghnshyamdas. geophysics and conservation Engi neering:Including Watershed Management, letter Learning personal restricted.9 9-123p, 2014.

[10] Ghosh, S., Roy, M. K., and Biswas, S. C. Determination of the simplest match likelihood distribution for monthly downfall information in Bangladesh. yan k Journal of arithmetic and Statistics, 6(4):170–174, 2016.

[11] Kalita, A., Bormudoi, A. and Saikia, M.D. likelihood Distribution of downfall and Discharge of Kulsi geographical region. International Journal of Engineering and Advanced Technology (IJEAT), 6(4): 31-37, 2017.

[12] Kumar, A. likelihood Analysis for Prediction of Annual most Daily downfall for Pantnagar. Indian Journal of conservation, 27(2):171-173, 1999.

[13] Kumar, D. and Kumar, S. downfall Distribution Pattern victimisation Frequency Analysis. Journal of Agricultural Engineering, 26(1):33-38, 1999.

[14] Kumar, R. and Bhardwaj, A. likelihood analysis of come back amount of daily most downfall in annual information set of Ludhiana, Punjab. Indian Journal of Agricultural analysis, 49(2):160-164, 2015.

[15] Latitude and line of longitude of Udaipur. (https://www.google.co.in/maps/place/Udaipur,+Rajasthan/@24.5873424,73.6407606,23152m/data=!3m1!1e3!4m2!3m1!1s0x3967e56550a14411:0xdbd8c28455b868b0!6m1!1e1).

[16] Nemichandrappa M., Balakrishnan and Senthilvel. likelihood and Confidence Limit Analysis Of downfall In Raichur Region. Karnataka .journal of Agriculture Science, twenty three (5):(737-741), 2010.

[17] Sharma, M.A. and Singh, J. Use of likelihood Distribution in downfall Analysis. ny Science Journal 3(9): 40-49, 2010.

[18] Singh, O.P., Singh, S.S. And Kumar, S. downfall Profile For Udaipur District, meteoric Centre, Jaipur, IMD Department national capital, 2013.

[19] Sreedhar, B.R. Fitting of likelihood Distribution for Analyzing the downfall information within the State of state, India. International Journal of Applied Engineering analysis, 14(3): 835-839, 2018.

[20] Upadhaya, A. and Singh, S.R. Estimation of consecutive day's most downfall by varied ways and their comparison. Indian Jornal of conservation, 26(3):193-200, 1998.rainfall of U.P. Himalaya. Indian journal of Soil Conservation, 16(1): 35-43, 1995.