Flood frequency analysis of flood flow in Periyar river basin

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ABSTRACT: *This paper presents a analytical study on fitting distribution of maximum monthly flood magnitude in Periyar River Basin at Planchode station from the year 1968 to 1979 using several types of mathematical distributions. The Normal, Lognormal, Log pearson type III and Gumbell extreme value type I are proposed and tested together with their single distributions to select the optimal model for maximum hourly rainfall. The selected model will be identified based on the minimum error produced by some criteria of goodness-of-fit (GOF) tests. The results indicate that Log Pearson type III distribution is better than the other distributions in modeling maximum monthly flood magnitude. These results are strongly influenced by their geographical, topographical and climatic changes but however these results can vary between the rain gauge stations. The various hydraulic structures such as dam, bridges, spillways, canals and levees etc,can be designed by planners and designers using this following study.*

Key words- flood frequency, periyar river, Gumbell distribution

1 INTRODUCTION:

Periyar (meaning: big river) is the longest river and the river with the largest discharge potential in the Indian state of Kerala. It is one of the few perennial rivers in the region and provides drinking water for several major towns. The Periyar is of utmost significance to the economy of Kerala. It generates a significant proportion of Kerala's electrical power via the Idukki Dam and flows along a region of industrial and commercial activity. The river also provides water for irrigation and domestic use throughout its course besides supporting a rich fishery. Due to these reasons, the river has been named the "Lifeline of Kerala". Kochi city, in the vicinity of the river mouth draws its water supply from Aluva, an upstream site sufficiently free of seawater intrusion. Twenty five percent of Kerala's industries are along the banks of river Periyar. These are mostly crowded within a stretch of 5 kilometres (3 mi) in the Eloor-Edayar region (Udhyogamandal), about 10 kilometres (6 mi) north of Kochi harbor.

1.1 DATA COLLECTION

The data has been collected with courtesy from Centre for Sustainability and Global Environment web site. The area selected for the present study, the Periyar River Basin, falls within the central part of Kerala and lies between North latitudes 9°15'30" and 10°21'00", East longitudes 76°08'38" and 77°24'32" and spreads in the districts of Idukki, Thrissur and Ernakulam. The main tributaries of Periyar river are Muthirapuzha, Perinjankutty, Idamalayar, Mangalapuzha. Average annual rainfall is 3200mm. Average annual streamflow is 4867.9Mm3

1.2 HYDROLOGY OF STUDY AREA:

The study area for the present work is Periyar river, which is the longest river of Kerala (9º to 10º15' North Latitude and 76º to 77º30' East Longitude). This perennial river is considered to be the lifeline of central Kerala (Figue.1). It originates from the Sivagiri peaks (1830 MSL) in Tamil Nadu with the total length of about 244 Km and catchment area of 5398 Km2. The mean annual flow is estimated to be 11607 Mm3 and the average annual rainfall in the area is about 4870 mm. Periyar discharge its water to Arabian sea at Cochin and has been performing an important role in shaping the economic prospects of Kerala. The river flow has suffered because of impoundments on the upstream side of the dam, which results in the slimming of the river downstream. In Periyar river basin there are 14 major dams impounding 47 % of the net mean annual runoff. Cochin coast (9º 40' 12" and 10º 10' 46" North Latitude and 76º 09' 52" and 76º 23' 57" East Longitude) extends for a length of 56 km and is bounded by the Arabian sea on one side and Cochin back waters on the other side and as a result it forms a narrow strip of land.

2 STEPS INVOLVED IN FREQUENCY ANALYSIS:

List and arrange annual floods (x) in descending order of magnitude.

Assign rank 'm', m = 1 for highest value and so on.

Calculate return period (T) and/or probability of exceedence (P) by equations n + 1/m and m/n +1 respectively. These values together with respective flood magnitude give plotting positions.

Using tabular form calculate x2 and ∑x and Ex2.

Now calculate mean x; squared mean x2; mean of squares x2 and standard deviations.

From the Table 5.6 of frequency factors for Gumbel method read if values for desired return periods (7) and the available sample size.

Using relation x = x + KS calculate flood values for various return periods.

Using the extreme value probability paper plot the x values against respective return periods or P values and join the points to obtain the required frequency curve
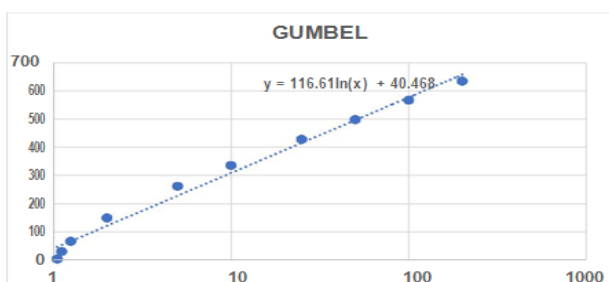
3 METHODS FOR ANALYSIS

3.1 GUMBEL METHOD

The Gumbel method of frequency analysis is based on extreme value distribution and uses frequency factors developed for theoretical distribution. The method utilises general equation given for hydrologic

I	Return Period T (Yr)	Probability P (Percent)	Frequency Factor K	Y = Log (Q)	Flood Discharge Q (M3/S)
1	1.05	95.2	-1.898	1.147	14
2	1.11	90.1	-1.34	1.413	26
3	1.25	80	-0.742	1.698	50
4	2	50	0.184	2.138	138
5	5	20	0.847	2.454	285
6	10	10	1.102	2.576	376
7	25	4	1.313	2.676	475
8	50	2	1.421	2.728	534
9	100	1	1.5	2.766	583
10	200	0.5	1.561	2.795	623

3.3 COMPARISION BETWEEN HAZEN, WEIBULL, CALIFORNIA:
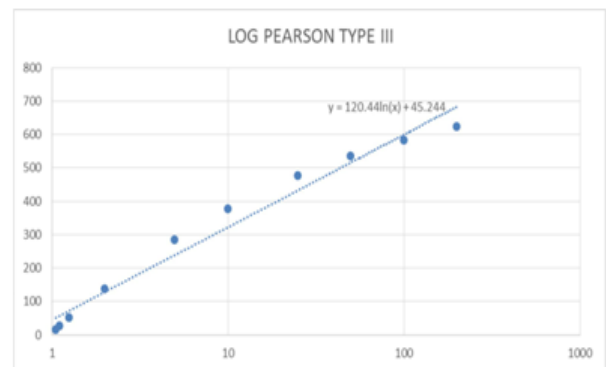
i	Return period T (yr)	Probability P (percent)	Gumbel variate y	Flood discharge Q (m3/s)
1	1.05	95.2	-1.113	3
2	1.11	90.1	-0.838	30
3	1.25	80	-0.476	66
4	2	50	0.367	149
5	5	20	1.5	261
6	10	10	2.25	335
7	25	4	3.199	428
8	50	2	3.902	498
9	100	1	4.6	567
10	200	0.5	5.296	635

Sr No Method	Discharge Q(cumec)	Return period		
		Weibull (n+1)/m	Hazen n/(m-0.5)	california n/m
1	1281	12	22.22	11
2	1105	6	7.33	5.5
3	882	4	4.4	3.66
4	856	3	3.14	2.75
5	846	2.4	2.44	2.2
6	787	2	2	1.83
7	629	1.71	1.69	1.57
8	477	1.5	1.46	1.37
9	88	1.33	1.29	1.22
10	71	1.2	1.15	1.1
11	66	1.09	1.04	1

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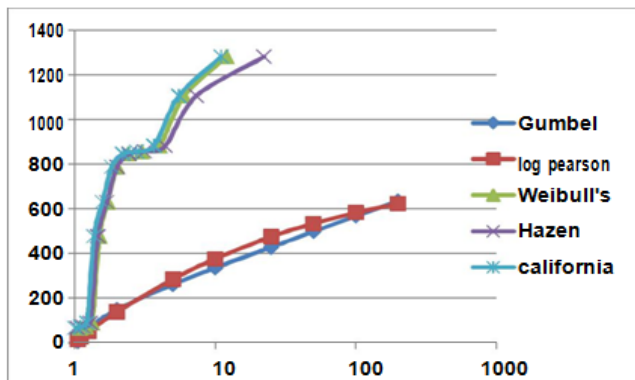
4 RESULTS

The excel sheet was developed for calculation of all statistics and result were prepared. The results and calculations were verified by using Easyfit software. The results have been summarized in Table. The Goodness of fit test was done for all distribution using three methods. The rank has been given on the basis of minimum value of error given by GOF test.

First, we will proceed to give comments on the results of fitting distributions that are based on GOF criteria. Finally the remarks on the estimated parameters for the best model will be made.

Gumbel	0.0436
Log Perason III	0.047

5 CONCLUSION

The search for the best fitting distribution for Maximum monthly flood data amount has been the main interest in several studies. Various forms of distributions have been tested in order to find the best fitting distribution. Different tests of goodness-of-fit have been attempted in the studies. In this study, the Log Pearson Type III distribution has been identified as the best fitting distribution for flood data in PERIYAR RIVER. However the flood data should be further analyzed and corrected for missing data, Historical data and Zero flood value. The study should be further extended to account for outliers involved in the data. Based on this study the Gumbel method has been found as most suitable distribution for analysis of maximum monthly flood data of Periyar river.

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