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FITTING GENERALIZED LOGISTIC DISTRIBUTION TO FLOOD FREQUENCY DATA OF RIVER INDUS JINNAH BARRAGE (KALABAGH)

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GeneralizedLogistic distribution flood frequency curves for the river Indus at Jinnah (Kalabagh) Barrage have been developed using 6I years (1924-1985) annual maximum flood series. The Generalized Logistic distribution was estimated by the method of moments and Probability Weighted Moment's (PMW's) method. This distribution appeared to be appropriate for modeling the flood data. The flood estimates at various return periods. i.e. 10, 20, 50 and 100 were worked out.

INTRODUCTION

Many problems is hydrology and civil engineering are related to the properties of extreme, like maximum levels or flow rates of rivers etc. The magnitude of extreme events are random quantities whose distribution can be described as Generalized Logistic distribution. The hydrologists are interested to know the' probability of floods with various return Periods. This barrage, located on the Indus river about three miles downstream of Kalabagh village with ThaI Canal on the left, was completed in 1946 and the canal was opened on the 7th January, 1947. The purpose of the Project was to irrigate the Sindh Sagar Doab between the Indus and the Jhelum. A total area of 19.03 Lac acres with gross commanded area of 21.00 Lac acres was proposed to be irrigated by Thai Canal.

The barrage consists of 42 weir bays of 60 feet span with two sets of undersluices each having 7 bays of 60 feet. Total width between the flanks in 78I feet.

The combined structure is capable of passing a super flood of 1100, 000 cusecs safely at a high flood level of 699.0 with and aftlux of 3.0 feet. The right undersluices have a lock channel having a 20 feet clear waterway to pass boats traffic under all conditions of river flow. The undersluices are separated from the weir by divided walls 300 feet long on the upstream and 350 feet on the downstream sides. Two fish-ladders exist, on alongside each divided wall.

Annual maximum flow of floods in river Indus at Jinnah (Kalabagh) Barrage for 61 years, for the period (1924-1985) have been used in the present study to investigate the design probabilities for various return periods. The data (obtained from Director, FF & WL Lahore) were first scrutinised and preliminary analysis was made for the summarization. The basic statistics such as mean, median, standard deviation etc. were calculated and the results have been presented in Table-I.

MATERIAL AND METHODS

In order to model the flood frequency data, Generalized Logistic distribution was considered and their parameters were estimated by the method of moments and by that of the PWM's method respectively.

Table No. 1: Summary Statistics of Annual Maximum Series of River Indus at Jinnah (Kalabagh) Barrage.

N	MEAN	MEDIAN	MIN
61	604612	510619	281965
MAX	SKEWNESS	KURTOSIS	
5354072	7.03336	53.2487	

2.1 Generalized Logistic Distribution:

The Generalized Logistic distribution has distribution function as follows:

$$F(x) = \frac{1}{1+e^{-Y}} \quad (1)$$

where,

$$y = -\log, \{1 - \frac{c(x-a)}{b}\}e^{1}$$

Where, a, b, and c, are the location parameter, scale parameter and shape parameter respectively.

2.2 Method of Moments:

The Method of moments utilize the general equation for calculation of the rth moments about the origin of Inverse distribution function.

$$\mu_r = E\,X(F)$$

$$r = 1,2,.... \quad (2)$$

The method of moments then relate the derived moments to the sample moments and then estimates of the parameter are obtained.

2.3 PWM's Method:

PWM's as introduced by Greenwood *et al.* (1979) can be defined as follows:

$$M_{prs} = E\,[X^P \{F(x)\}^r \{1-F(x)\}^S] \quad (3)$$

Where, p, rand s are real numbers. By taking p = 1 and s =0

Let,

$$\beta_r = M_{1,r,0} = E\,[x\{F(x)\}^r] \quad (4)$$

The sample estimates b, of ~r can be obtained as below:

$$b_r = \frac{1}{n} \sum p^r X \quad (5)$$

where $p = \frac{i-0.35}{n}$

To find PWM's estimates of the parameter of Generalized Logistic distribution the sample estimates b, related to the parameters as helow

$$\hat{c} = \frac{6b_2 - 6b_1 + b_0}{2b_1 - b_0} \quad (6)$$

$$\hat{b} = \frac{2b_1 - b_0}{A(1,e)} \quad (7)$$

$$\hat{a} = b_0 - \frac{\hat{b}}{c}[1-A(1,e)] \quad (8)$$

where, $A(1,c) = \frac{\Gamma(1+c)\ \Gamma(1-c)}{\Gamma 2}$ and ~,b,and C are the PWM's estimates.

RESULTS AND DISCUSSION

The estimates of Generalized Logistic distribution Computed by using the method of moments and PWM,s are given in Table 2. The estimates of flood hy each method with various return periods are given in Table 3 for the data standardized by mean. The data reveals that shape estimates by the PWM's is substantially higher than the methods of moments indicating that the growth curve by the methods of PWM's would be steeper than that of method of moments. This suggested that PWM's estimates would yield higher flood at low

Table No. 2: Estimates of Flood in river Indus at Jinnah (KALABAGH) Barrage

Parameter	Moment's Method	PWM's method
$\hat{a}$	0.787321	0.805071
$\hat{b}$	0,416239	0.134632
$\hat{c}$	-0.282362	-0.566816

Table No. 3: For calculation of Return Period, estimate the x(F).

Return period	Probability	Record Length Period	
		Moment's Method	PWM's Method
10	0.90	2.05	1.39
20	0.95	2.70	1.82
50	0.98	3.74	2.72
100	0.99	4~1	3~8

return period as usually desired by the hydrologists.

Flood estimates at various return period (PWM's) are as under

1. qlOo= 3.78(604612) = 2285433 cusecs
   Where, 606412 is the mean of the data.
2. qso = 2.72(604612) = 1644545 cusecs
3. q20= 1,82(604612) = 1100394 cusecs
4. qlO= 1,39 (604612) = 840411 cusecs

CONCLUSION

Generalized Logistic distribution is recommended for mode ling flood frequency data of river Indus at Jinnah (Ka1abagh) barrage. Estimates of floods at return periods 10, 20, 50 and 100 have been derived and the growth curves to predict flood at any return period by Generalized Logistic distribution has been established. The estimate of 100 years flood has been obtained as 2285,377 cusecs while the barrage was designed to pass a maximum flood of 1100,000 cusecs. The expected flood is substantially higher than the present design of barrage. It is therefore, recommended that the capacity of the barrage should be increased in order to decrease the threat to the structure.

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