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FLOOD ESTIMATION OF SARDA RIVER USING WAKEBY DISTRIBUTION IN CHAMPAWAT DISTRICT, UTTRAKHAND

Kiran Rani

Student of Civil Engineering
G.B.P.U.A.T, Pantnagar, Uttarakhand, India

Mrs Jyothi Prasad

Prof. of Civil Engineering
G.B.P.U.A.T, Pantnagar, Uttarakhand, India

Abstract— The Wakeby probability distribution function was applied to estimate extreme flood discharges associated to different return periods with 86 years length of the data in Champawat district of Uttarakhand. This distribution had advantages over other probability distributions because its parameters were found using the probability weighted moments that represent in linear trend the characteristics of present data. Wakeby distribution was a five parameters distribution used more than the other distributions reason for which was that it can attain wider range of distributional shapes as other ones. This study indicated that wakeby five parameter distributions used for analyzing the maximum annual discharge for the present study area. In this study we described the procedure to estimate the Wakeby distribution parameters for analysis of Sarda river discharge.

Keywords— Flood frequency analysis, wakeby probability distribution, growth factors

I. INTRODUCTION

In Hydraulic engineering since more than thirty years design of flood frequency analysis using statistical approaches has become one of the robust and active field of application in research work in water resource engineering. Frequency analysis is the method of estimation which specified us how an event will occur. If the different observed quantities have the similar event frequencies in this case more accurate conclusion we can get by analyzing the all data sample together. In the environmental applications this method is called as regional frequency analysis. The reason of it is that within particular region for measuring the same variable a number of observations are analyzed from a number of sites.

II. STUDY AREA AND DATA AVAILABILITY

The Sarda River originates from the Greater Himalayas at Kalapaani, at an altitude of 3600 m, in the Champawat District of Uttarakhand. The river borders the Nepalese Mahakali Zone and the Indian state of Uttarakhand. Mahakali flows for a

length of 223 km length in Nepal and 323.5 km in India up to its confluence with Ghaghra River.

Sarda, a major tributary of Ghaghara River pierces through the Siwalik Hills and emerges into the Ganga Plain in the vicinity of Tanakpur in the Champawat district of Uttarakhand (as shown in figure).

The maximum annual rainfall data of 86 years provided from Banbsa barrage at Sarda River from (1930-2014). The existing Upper Sarda Barrage at Banbsa at latitude $29^{\circ}4'26.14''$ and longitude $80^{\circ}7'10.61''$

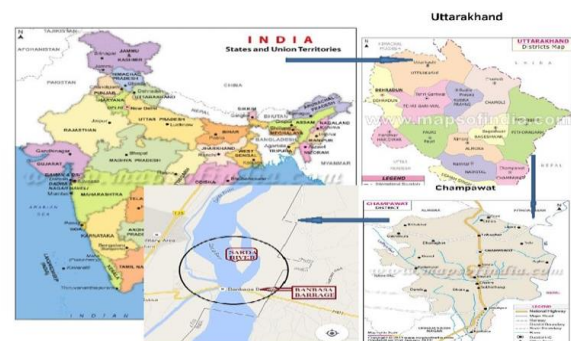


Fig1: Location Map of Banbsa Barrage

III. METHODS AND MATERIAL

Wakeby distribution

Wakeby distribution was a five parameters distribution used more than the other distributions reason for which was that it can attain wider range of distributional shapes as other ones. Inverse form Wakeby (WAK) distribution was expressed as:

$$x(F) = \xi + \frac{\alpha}{\beta} \left\{ 1 - (1-F)^{\beta} \right\} - \frac{\gamma}{\delta} \left\{ 1 - (1-F) - \delta \right\}$$

Where, ξ , α , β , γ , and δ are the parameters of the Wakeby distribution.

IV. RESULTS AND DISCUSSION

Estimated of Parameters for wakeby distribution

Wakeby distribution was a five parameters distribution used more than the other distributions reason for which was that it can attain wider range of distributional shapes as other ones. The estimated parameters of wake by distribution are given below in **Table No 1**.

Distribution	Parameters of the distribution				
WAK	$\zeta = 0.41$	$\alpha = 1.110$	$\beta = 1.307$	$\gamma = 0.081$	$\delta = 0.243$

The values obtained in the *Table no. 1* such as location parameter 0.41 and $\alpha = 1.110$, Scale parameter $\beta = 1.307$, $\gamma = 0.081$ and $\delta = 0.243$ parameters of Wakeby distributions, further used for estimating the design discharge value for annual maximum discharge of Sarda River.

Estimation of growth factors ($Q_T/\bar{Q}$) for wake by distribution

Table 3 shows the growth factor varies for 2 years is 0.979 to 1000 return period as 2.7141. For estimating the quantile function using most suitable distribution for various return periods such as 2, 10, 50, 100, 200, 500 and for 1000 years or multiplying the each growth factor with mean value of annual maximum discharge ($\bar{Q}$) are given in *Table 2*.

Table 2: Values of the growth factors ($Q_T/\bar{Q}$) for wake by distribution

Distribu- tion	Return period (Years)							
	2	10	25	50	100	200	500	1000
	Growth factors							
WAK	0.979	1.46 9	1.64 4	1.78 5	1.94 7	2.13 5	2.43 7	2.71 4

Table 3: Design Values of Maximum Discharge Using Growth Factors

Return period	Growth factors	Maximum discharge= Growth factor*mean(7906.3) m ³ /s
2	0.979	7740.268
10	1.469	11614.350
25	1.644	12997.960
50	1.785	14112.750
100	1.947	15393.570
200	2.135	16879.950
500	2.437	19267.650
1000	2.714	21457.700

It was found that the discharge vary for 2 years as 7740.268m³/sec and for 1000year return period 21457.7m³/sec are shown in *Table 4*.

Table 4: Floods of various return periods estimated using Wake by Distribution

S. No.	Return period (years)	Flood in (m ³ /s)
1	2	7740.268
2	10	11614.350
3	25	12997.960
4	50	14112.750
5	100	15393.570
6	200	16879.950
7	500	19267.650
8	1000	21457.700

V. GRAPHICAL REPRESENTATIONS

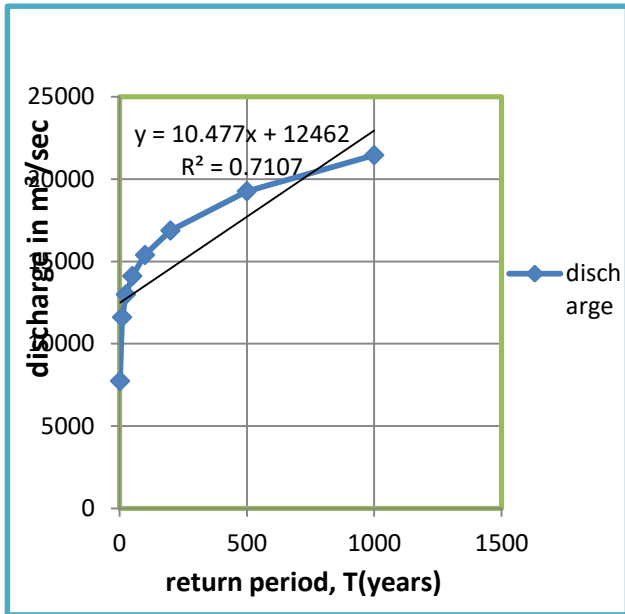


Fig2: Plot of predicted discharge vs. return period

Fig2 shown a graphical representation between design discharge and return period, discharge vs. Non-exceedence probability.

Figure.2 shown trend line equation between discharge and coefficient of determination $R^2 = 0.7107$ and figure 3 shown the relation between discharge and probability of non exceedence and coefficient of determination $R^2 = 0.5877$ lies between the expected value for coefficient of determination (between 0 to 1).

Hence for predicting expected flow in Sarda River the Wakeby is the best suitable distribution.

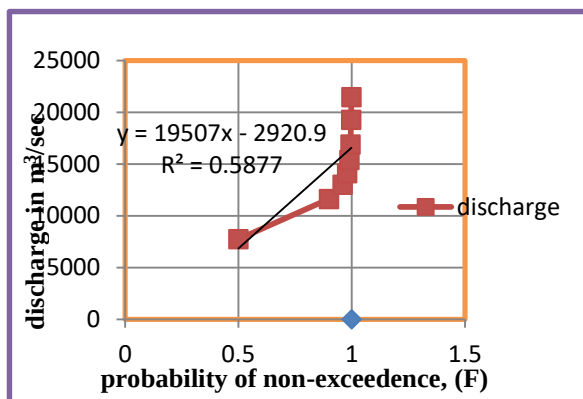


Fig3: Plot of predicted discharge vs. non exceedence probability

VI. SCOPE FOR FURTHER STUDY

1. The present study has taken up only one site of Sarda river Catchment area hence for regionalization more gauging sites data need to be studied.
2. The wakeby probability distribution further can be used for estimates the design values of discharge which are useful for design hydraulic structures such as, canals, irrigation ditches, dam and other hydrologic studies.
3. Measuring the density of gauging network for a river basin which provides the possibility of planning and development water resources for a country.
4. More number of distributions needs to be applied so that proper recommendations may be given for use of distributions.
5. The study has a good application in flood hazard mapping of any region. The results presented in this study need to be revised by including more stations with additional data lengths.

VII. CONCLUSION

In this study 86 years maximum annual discharge data for single site (Sarda river maximum discharge at Banbsa barrage) analyzed using wakeby five parameter distribution was the best fit for study the annual maximum discharge of Sarda River.

VIII. ACKNOWLEDGEMENT

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