P: ISSN NO.: 2394-0344 RNI No.UPBIL/2016/67980 VOL-3* ISSUE-11*(Part-1) February 2019
E: ISSN NO.: 2455-0817 Remarking An Analisation

Analysis of Some Hydrological Parameters of Ghiladhari River, Assam, India

Abstract

River bank erosion has become the major threat and disaster for the river bank dwellers due to continuing change of hydrological aspects of any river. The dynamism of hydrological aspects within the river leads to lateral erosion in the river bank which ultimately enhances the shifting of river channels. Various studies report increasing bank migration rates with either bank full discharge or stream power (Hooke 1979;Walker and Rutherfurd 1999;Alber and Piégay 2017). Now a days, the population pressure on the limited land resources has resulted on the higher settlement density not only in the hazardous riverbank areas but also some of the hazard prone areas. An understanding of the dynamic trend in terms of frequency and magnitude of hydrological variables within a river has become very essential for the implementation of hydrological hazard mitigation strategies. Through this paper an attempt has been made to analyze some of the hydrological aspects of Ghiladhari river to establish the relationship between basin parameters and hydrological parameters.

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Keywords: Hydrological, Hazardous, Magnitude, Mitigation Andincessant.

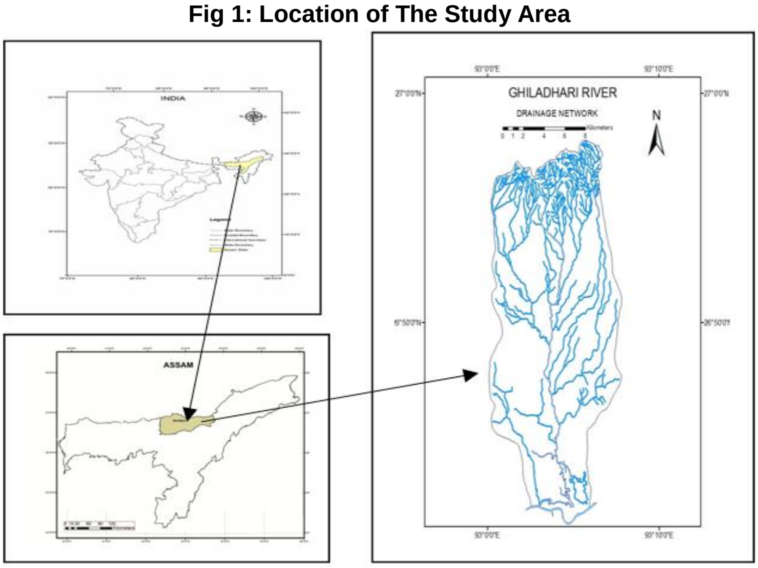
Introduction

The dynamism of hydrological aspects within the river leads to lateral erosion in the river bank which ultimately enhances the shifting of river channels. Various studies report that increasing bank migration rates with either bank full discharge or stream power (Hooke 1979; Walker and Rutherfurd 1999; Alber and Piégay 2017). The present study attempts to highlights the temporal change of stage & discharge magnitude as well as to estimate the future flood magnitude of this river.

Study Area

The location ofthe study area belonged to the Sonitpur district of Assam, India. The Ghi-ladhari river is one of the import-ant tributaryof Brahmaputra River with its original sourcein the foot-hills ofeast Kameng district, Arunachal Pradesh. This river basinextends from $26^{0}42^{/}22^{//}$ N to $26^{0}58^{/}$ N and $93^{0}0^{/}3^{//}$ E to $98^{0}8^{/}24^{//}$ E. having an approximate area of 150.66 Sq. Km.The Ghil-adhari river havehilly origin and flowmostly in the plains ofSonitpur district of Assam (Fig. 1).

Fig 1: Location of The Study Area



Aim of the Study

The main aim of this paper is to study some of the basic hydrological aspects of Ghiladhari River in Assam. The paper will establish the relationship between basin parameters and hydrological parameters in particular at micro level for understanding the fluvio-geomorphic processes in general.

Databaseand Methodology

The different sources of the secondary data relevant to the study include –

1. Survey of India (SOI) toposheets for the year 1971 (Scale-1:50,000) are used to prepare the base map.
2. The relevant hydraulic data are collected from Water resource Department, Government of Assam & IMD websites.
3. Arc GIS software and Microsoft office 2007 have been used to generate the required thematic maps and
4. The primary sourcesinclude the personal visit to the study area for the ground verification of the map.

Objectives

The main objectives of the study are-

1. To highlight the pattern of fluctuations of stages & discharges of Ghiladhari River,
2. To represent the geometric relationship between discharge & cross sectional area and discharge & velocity; and
3. To estimate different flood magnitudes of the river using flood frequency analysis method.

Analysis of Hydrological Parameters

The dynamism of hydrological aspects within the river leads to lateral erosion in the river bank which ultimately enhances the shifting of river channels. Various studies report that increasing bank migration rates with either bank full discharge or stream power (Hooke 1979; Walker and Rutherfurd 1999; Alber and Piégay 2017). The present study attempts to highlight some of the hydrological aspects likethe temporal change of stage & discharge magnitude, hydraulic geometric relationsas well as the estimation of the future flood magnitude of this river.

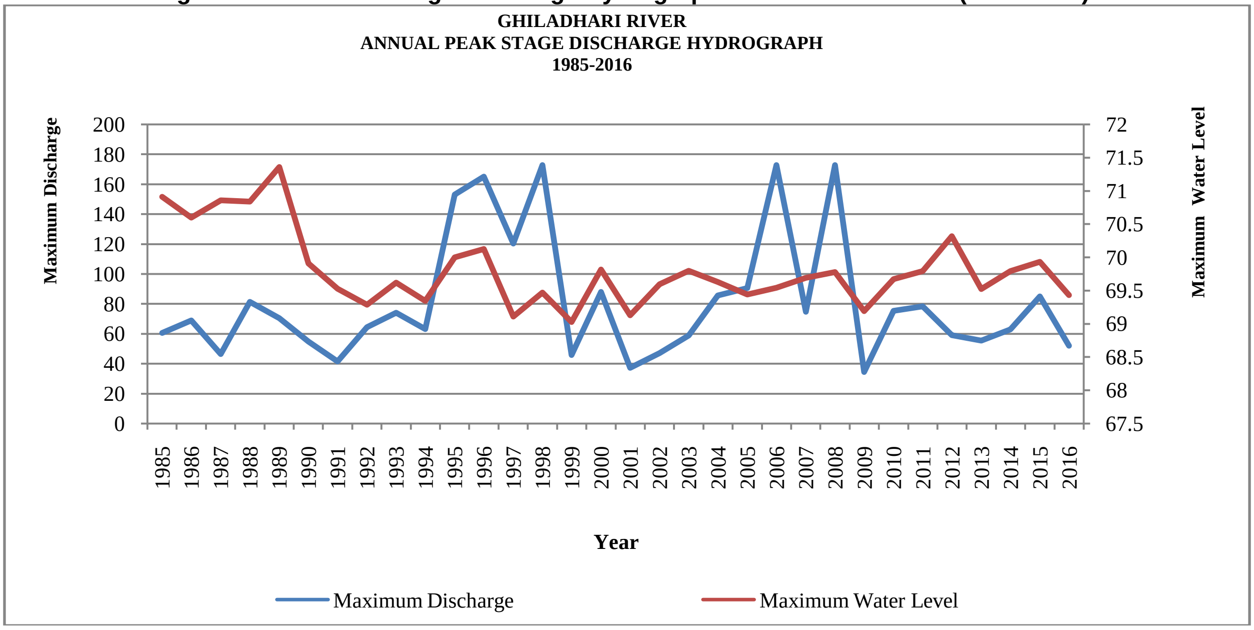
Hydrograph Analysis

The study of Annual Peak Stage Discharge Hydrograph, Annual Maximum and Minimum Discharge Hydrograph & Monthly Average Stage Discharge Hydrograph has been considered to be correlated for analyzing river characteristics associated with river bank erosion.All natural river, irrespective of their drainage basin properties and regime characteristics, experience high flows following heavy precipitation in their catchment areas(Leopold ,1964). The temporal fluctuation of Water Discharge & Stages for the Ghiladhari River is analyzed through

1. Annual Peak Stage Discharge Hydrograph (1985 to 2016).
2. Annual Maximum and Minimum Discharge Hydrograph (1985 - 2016).
3. *Annual Peak Stage Discharge Hydrograph (1985 to 2016) :*

The analysis of the annual peak stage discharge hydrograph of Ghiladhari river for the period of 32 years (1985 to 2016)represents the lowest peak discharge value of 37.13 m^3/s (2001) and the highest one is 2172.82 m^3/s (1998). On the other hand the lowest value of peak stage is found to be 69.10 min 2001 and the highest one is 71.36 m in 1998 (fig. 2).

Fig. 2 : Annual Peak Stage Discharge Hydrograph for Ghiladhari River (1985-2016).



Annual Maximum and Minimum Discharge Hydrograph (1985 - 2016):

The analysis of the Annual Maximum and Minimum Discharge Hydrographof Ghiladhari river (fig. 3) for the period of 32 years (1985 to 2016)represents highest discharge magnitude as 172.825m^3/s (1998) and the minimum discharge magnitude as 0.34m^3/s (2004).

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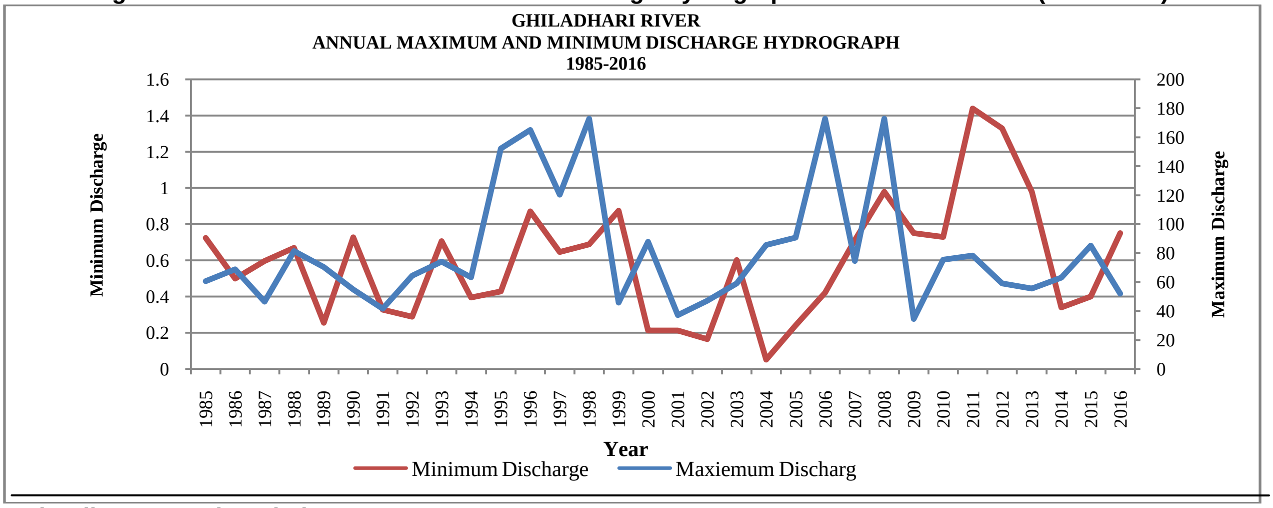
Fig. 3 : Annual Maximum and Minimum Discharge Hydrograph for Ghiladhari River (1985-2016)



Hydraulic Geometric Relation

Hydraulic geometry was coined by Leopold and Maddock (1953) for the quantitative description of how river depth, width, velocity and related properties vary with changing discharge. In this paper analysis has been done to represent the relation between X sectional area &water discharge values and water discharge & velocity values.In the first case, the water discharge and cross sectional data for the period of ,12 years(1994-2016)has been collected and graphically represented through fig. 4. Here we found the value of 'r' (0.62632584) shows a positive relation between the water discharge and cross section area. The dependent variable water discharge plotted against the independent variable cross sectional area.

∑ Log X = 202.80977 ∑ Log Y= 113.531871 ∑ Log X = 157.0291313 ∑ Log Y= - 55.9043231
∑ Log X^2= 310.657882 ∑ Log Y^2= 187.682137 ∑ Log X^2= 220.830175 ∑ Log Y^2= 41.2154903
∑ Log XY= 190.939767**r= 0.62632584**∑ Log XY= 190.939767**r=0.919830**

(Source: regression analysis calculator,www.alcula.com)

Fig. 4 : Cross Sectional Area Vs Water Discharge of Ghiladhari River (1994-2016)

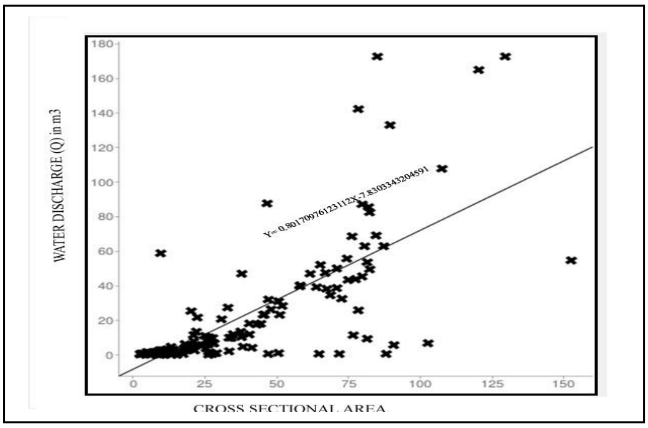
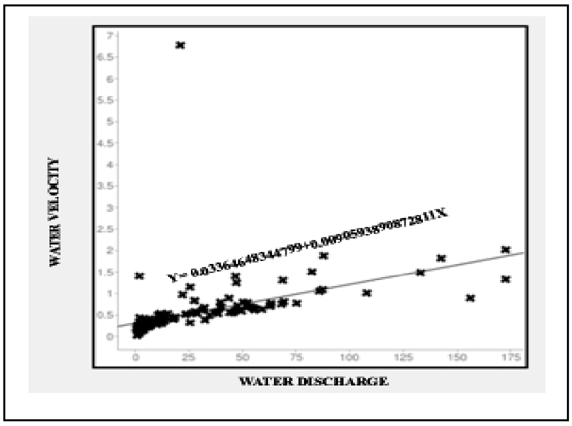


Fig. 5 :Water Discharge Vs Water Velocity of Ghiladhari River (1994-2016)



The second analysis representing the relation between water discharge and water velocity shows a highly positive correlation co-efficient value i. e. r = 0.919830 (fig. 5).

Estimation of Flood Magnitudes

The volume of water discharge is highly correlated with the bank erosion events in most of the rivers.In the monsoonal rivers, high magnitudes floods occur at an interval of several years to decades. Peak discharges are two to four times more then the mean monsoon discharges (Kale, 1998). The value of annual maximum flood from a given catchment area of the large numbers of the successive year constitutes a hydrological data series called the annual series. The data are than arranged in descending order of magnitude and probability of each event is calculated by different methods of flood frequency analysis. The estimation of flood magnitude for Ghiladhari river has been done by using Semi-log plotting position method and Gumbels' Extreme value distribution method (fig. 5 & 6 and table 1,2 & 3).

Findings

The estimated flood magnitudes of Ghiladhari river (1985-2016) for the return period of 20 and 30 and 50 years using semi Log plotting position methodare found as 128 m^3/s, 141 m^3/s and 151 m^3/s.

Fig. 5
Flood Frequency Analysis by Semi-log Plotting Position Method for Ghiladhari River, Sonitpur, Assam (1985-2016)

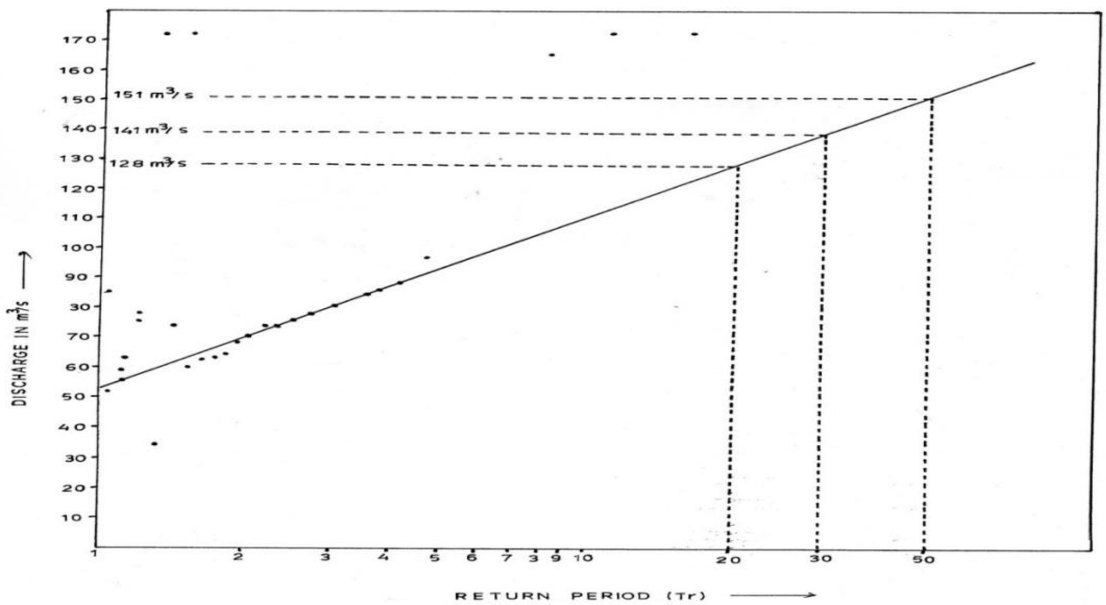


Table 1: Computation of the Return Period and Probability for flood magnitude of Ghiladhari River (1985-2016) by using *WEIBULL'S SEMI LOG PLOTING POSITION METHOD*

Year	Peak Flood	Peak Flood (Descending Order)	Rank	Probability P= $\frac{m}{n}$+1	Return Period Tr = $\frac{n+1}{m}$	Year	Peak Flood	Peak Flood (Descending Order)	Rank	Probability P= $\frac{m}{n}$+1	Return Period Tr = $\frac{n+1}{m}$
1985	60.446	172.825	1	0.0303	33	2001	37.13	68.848	17	0.5151	1.941
1986	68.848	172.79	2	0.0606	16.5	2002	46.976	64.329	18	0.5454	1.833
1987	46.475	172.79	3	0.0909	11	2003	58.935	63.14	19	0.5757	1.736
1988	81.359	165.078	4	0.1212	8.25	2004	85.67	63.01	20	0.606	1.65
1989	70.328	152.131	5	0.1515	6.6	2005	90.63	60.646	21	0.6363	1.571
1990	54.841	120.257	6	0.1818	5.5	2006	172.79	59.05	22	0.6666	1.5
1991	41.472	90.63	7	0.2121	4.714	2007	74.62	58.935	23	0.6969	1.434
1992	64.329	87.888	8	0.2424	4.125	2008	172.79	55.52	24	0.7272	1.375
1993	74.329	85.67	9	0.2727	3.666	2009	34.44	54.841	25	0.7575	1.32
1994	63.14	85.09	10	0.303	3.3	2010	75.41	52.04	26	0.7878	1.269
1995	152.13	81.359	11	0.3333	3	2011	78.37	46.976	27	0.8181	1.222
1996	165.07	78.37	12	0.3636	2.75	2012	59.05	46.475	28	0.8484	1.178
1997	120.25	75.41	13	0.3939	2.538	2013	55.52	45.764	29	0.8787	1.137
1998	172.82	74.62	14	0.4242	2.357	2014	63.01	41.472	30	0.909	1.1
1999	45.764	74.176	15	0.4545	2.2	2015	85.09	37.13	31	0.9393	1.064
2000	87.888	70.328	16	0.4848	2.062	2016	52.04	34.44	32	0.9696	1.031

Data Source : Water Resource Department, Govt. of Assam, India.

This extreme value distribution was introduced by Gumbel (1994) and it is commonly known as Gumbel's distribution. It is one of the most widely used probability distribution functions for extreme values in hydrologic and meteorological studies for prediction of flood peaks, maximum rainfall, maximum wind speed etc. This method has been applied for the present study for the estimation of flood magnitude of Ghiladhari river for the period of 32 years (fig. 6 and table 2 &3).

Table 2. Computation of the Return Period and Probability for flood magnitude of Ghiladhari river (1998- 2016) by using *"GUMBELL´S EXTREME VALUE DISTRIBUTION METHOD.*

Year	Peak Flood (m^3/s)	Peak Flood in Descending Order	Order (m)	$(x-x)^2$	Return Period $T_r = \frac{n\pm1}{m}$	Reduced Variate YT = $-[\ln.\ln\frac{Tr}{Tr-1}]$	Year	Peak Flood (m^3/s)	Peak Flood in Descending Order	Order (m)	$(x-x)^2$	Return Period $T_r = \frac{n\pm1}{m}$	Reduced Variate YT = $-[\ln.\ln\frac{Tr}{Tr-1}]$
1985	60.446	172.825	1	8317.26	33	3.457	2001	37.13	68.848	17	163.27	1.941	0.323
1986	68.848	172.79	2	8310.87	16.5	2.78	2002	46.976	64.329	18	299.18	1.833	0.237
1987	46.475	172.79	3	8310.87	11	2.35	2003	58.935	63.14	19	341.73	1.736	0.153
1988	81.359	165.078	4	6964.24	8.25	2.052	2004	85.67	63.01	20	346.55	1.65	0.071
1989	70.328	152.131	5	4970.95	6.6	1.808	2005	90.63	60.646	21	440.16	1.571	-0.011
1990	54.841	120.257	6	1492.35	5.5	1.606	2006	172.79	59.05	22	509.67	1.5	-0.094
1991	41.472	90.63	7	81.07	4.714	1.434	2007	74.62	58.935	23	514.88	1.434	-0.178
1992	64.329	87.888	8	39.21	4.125	1.281	2008	172.79	55.52	24	681.52	1.375	-0.261
1993	74.329	85.67	9	16.35	3.666	1.144	2009	34.44	54.841	25	717.44	1.32	-0.348
1994	63.14	85.09	10	11.99	3.3	1.02	2010	75.41	52.04	26	875.33	1.269	-0.439
1995	152.131	81.359	11	0.07	3	0.902	2011	78.37	46.976	27	1200.62	1.222	-0.533
1996	165.078	78.37	12	10.60	2.75	0.0794	2012	59.05	46.475	28	1235.59	1.178	-0.636
1997	120.257	75.41	13	38.64	2.538	0.691	2013	55.52	45.764	29	1286.08	1.137	-0.749
1998	172.825	74.62	14	49.08	2.357	0.594	2014	63.01	41.472	30	1612.34	1.1	-0.874
1999	45.764	74.176	15	55.51	2.2	3.08	2015	85.09	37.13	31	1979.89	1.064	-1.033
2000	87.888	70.328	16	127.64	2.062	0.411	2016	52.04	34.44	32	2226.52	1.031	-1.253

Table 3 : Computation of flood magnitude for different Return Periods by Gumbels' Extreme Value Distribution Method for Ghiladhari River (1985-2016).

Return Period (T_r)	X	S_x	Frequency Factor $K_T = YT - \frac{Yn}{Sn}$	$X_T = X + K_T.S_x$
10	81.62	45.47	1.5306	151.2346
20			2.1834	180.922
50			3.0232	219.1150
100			3.4049	236.4740
200			3.6380	247.0749

The estimated flood magnitude for the return period of 10, 20, 50 & 100 yearsare 151.2346 m^3/s, 180.922 m^3/s, 219.1150 m^3/s and 236.4740 m^3/s.

FLOOD FREQUENCY ANALYSIS
BY GUMBELE'S EXTREME VALUE DISTRIBUTION METHOD
GHILADHRI RIVER, SONITPUR, ASSAM
1985-2016

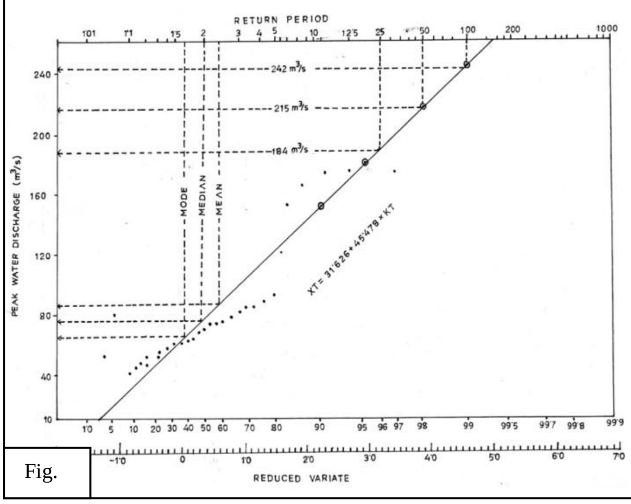


Fig.

Conclusion

The present paper tries its best to outline the frequency variation of stage & discharge of Ghiladhari River, the representative hydraulic geometrical relationship in between cross sectional area, velocity and water discharge and flood magnitude estimation. The main objectives of this paper are fulfilled in the foregoing representations and analysis of relevant data as indicated in different tables and figures.The precise representation of different aspects of the topic as mentioned in different sections of the paper will be useful to the environmentalists, planners as well as research workers.

References

Abernethy, B. and Rutherfurd, I.D. (1999) : Guidelines for stabilisation stream banks with riparian vegetation. Cooperative Research Centre for Catchment Hydrology. Department of Geography and Environmental Studies, The University of Melbourne, Parkville, Victoria, 3163.

Sarmah, J. N. : Axomor Nad Nadi, Dibrugarh University.

Hazarika U.M (2003): Problem of flood, erosion and sedimentation in Jiadhal River Basin, Dhemaji District, Assam: A Geo Environmental Study, Unpublished Ph.D Thesis

Hooke 1979; Walker and Rutherfurd 1999; Alber and Piégay 2017 -"Characterizing and modelling river channel migration rates at a regional scale: Case study of south-east France", Article in Journal of Environmental Management 202(Pt 2) · November 2016

Hooke, J. M. - "Analysis of the Processes of River Bank Erosion"Article in Journal of Hydrology 42(1):39-62 · June 1979.

Jain and Singh (1986,): A Comparison of Transformation method for flood frequency analysis. AWAR, Water Resource Bulletin, Volume 22.

Kinghton, D.(1984): Fluvial Forms and Processes ; Edward Arnold, Ltd. London

Leopold andWolmen and Miller (1969): Fluvial Processes in Geomorphology, W.H Freman and Company, San Francisco

Leopold L.B.1964: "Fluvial processes in Geomorphology".

Roy, S and Mistri, B (2013): Estimation of Peak Flood Discharge for an Ungauged River": A Case Study of the Kunur River, West Bengal

Sarma R.K. (1993): "A Text Book of Hydrology and Water Resource," Third Edition, pp, 239,260- 317, published by Dhanpath Rai and Sons, Delhi, Jlandhar'