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"Vulnerability Assessment and Management of flood hazard in Baralia River (Bhairatolajan): A case study of Khopanikuchi Village of Hajo Revenue Circle, Kamrup District Assam"

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Abstract: Flood is an extreme event. It is called hazard because it destroys properties and lives.Simply, flood means inundation of extensive land area with water for several days in continuation. Generally, flood is considered to be associated with rivers and people conceive flood as the outcome of accumulation of huge volume of water coming out of rivers through overtopping of river banks during peak discharge period. Flood is a component of hydrological cycle of drainage basin. Flood is both natural and human induced phenomena rather it is man accentuated phenomena. It is also considered as geomorphic Hazard. Flood Hazard creates many serious problems in different areas are also notable. Similarly, the study area Khopanikuchi is severly affected by the Baralia River every year.

Keywords: Flood, Vulnerability, Management

I.INTRODUCTION

The river is most important agent of carring running water. It carries a large volume of water from upper to downstream of the earth surface when a large volume of water carries by the river it flow to the both side of the river by some physical and human causes and the flood occurred. During few decades, most of countries of the world suffer from serious river flood. For example the Mississippi River in USA. The Howang-Ho in China, the Nile River of Africa etc. area well known for river flood. The Howang-Ho river of China is called the 'Sorrow of China' for its most devastating flood.

Our country India also faces the serious problem flood by the river like the Ganga, the Yamuna and the Brahmaputra etc. The Brahmaputra and the Barak River are most notorious river in Assam as it occur flood havoc at regular interval. The Brahmaputra river is known for several damage and devastating in Dhemaji and Lakhimpur district of Assam. This river is considerd as vulnerable monster. The rivers takes up a highly meandering course in the extensive flood plain.Due to some causative factors like heavy rainfall, rapid rate of deforestation etc. Every year there is increase of frequency, intensity, spatial dimension and magnitudes of damages, therefore the flood problem is also constantly increase.

Considering, The Baralia River is the sub basin of the Brahmaputra River. This river also cause serious flood problems in the study area every year.The magnitude of damages of lives and property is increases every year.

II.OBJECTIVES OF THE STUDY

The main aims and objectives of study is as follow-

(a) To study the geographical and geomorphological setting of the study area.
(b) To study the probable hydrological components responsible for the flood hazard and consequently effects in the study area.
(c) To study the nature of flood hazard by fore going the village Khopnikuchi.
(d) To study the chronicle flood and occasional flood prone area and to study the human response towards flood.
(e) To study the steps taken by the villages and govt. authority for controlling the flood problem.
(f) To provide some mitigation strategies the damage.

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III. DATABASE AND METHODOLOGY

In a research work, all the data are collected by various methods. There are mainly two types of data are used to collect information. These are-(a) Primary data and (b) Secondary data. The primary data are those which are collected a fresh and for the first time.The primary data are collected by various methods:

1. Observation method.
2. Interview method.
3. Through schedules.

On the other hand, those which have already been collected by someone and which have already been passed through statistical process, these data are called secondary data. These data are either published or unpublished data. The published data are found in books, magazines, newspapers, various publication of central, state and local govt. etc. The sources of unpublished data are diaries, letter, unpublished reports etc.

IV.SIGNIFICANCE OF THE STUDY

Flood is a natural hazard and it becomes disastrous in some times. Specially in a river based morphologicalplace like Assam.The significance of the study is also increases as it related with the people living in the flood region.For these purpose the study is very much significant that helps in many ways from awaring the people of area as well as providing some mitigation for lessen the damage caused by the flood.But river change human behaviour as a whole socio -economic life of human bodies. That makes the study more significant.

V.LOCATION OF THE STUDY AREA

The study area lies between latitude $26^0$17'86.4"N to $26^0$17'87.1" N and longitudes $91^0$30'037"E to $91^0$30'098" E. The study area lies to the right bank of the Bhairatolajan (Baralia River), under Sanyadi GP, of Hajo C.D.Block in Kamrup District of Assam. It is about 100 m form Hajo -Nalbari PWD Road. It covers an area of 3Km^2 and population of about 5243.The Baralia River originates from the Bhutan hills. The river has all characteristics of a flashy river like Pagladia. It also meanders freely and has many loops, the slope being somewhat flatter in the lower reaches. In the upper reach the Baralia River bed is built up of boulders, shingle and sand with steep slope, while lower down it is in the alluvial stage river is extending latitudinal.

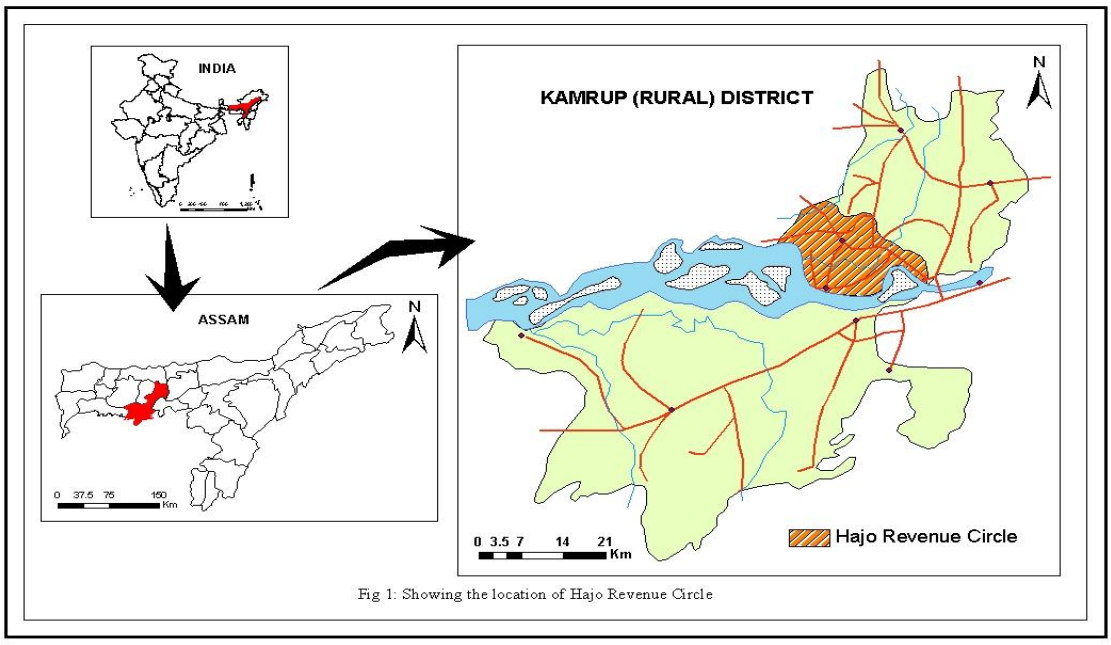

Fig 1: Showing the location of Hajo Revenue Circle

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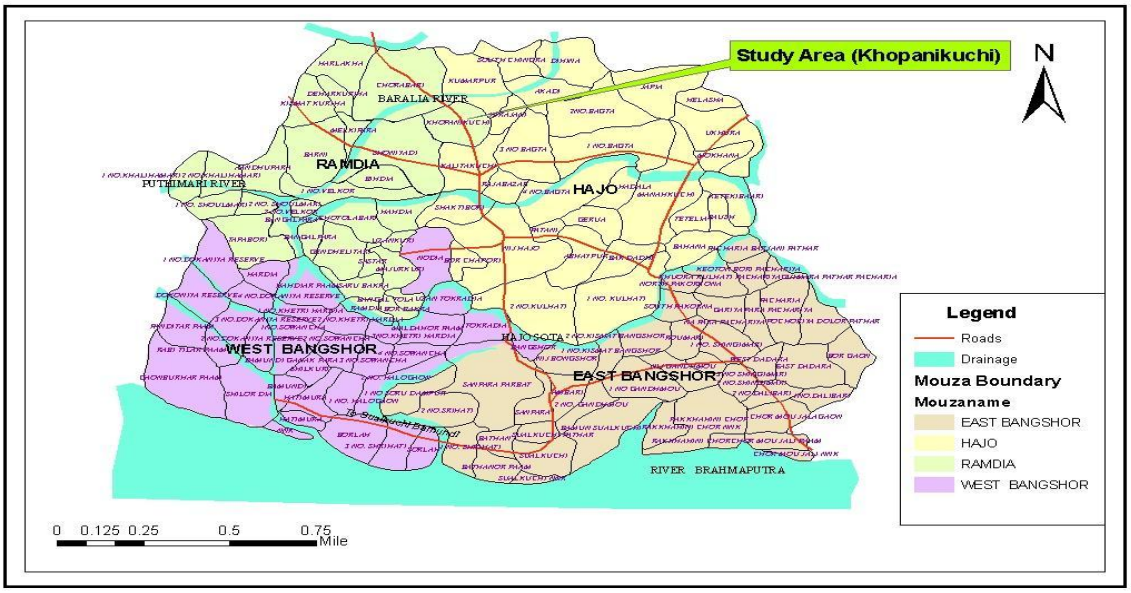

Fig 2: Showing the location of Study Area in the Hajo Revenue Circle.

VI.PHYSIOGRAPHY

The area is a reverie tract along the Baralia River. The Baralia River has developed a crescent shaped relief particularly on the area from Bhutan foot hill to the Bhabar alluvial zone. Relief characteristics of the study area are almost plain. The maximum is 50 m from main sea level and the lowest elevation is only 45-48 m. The slope is decline from north to south.The area under investigation is a flood plain which is mainly composed of tertiary alluvium. Geologically the Baralia River especially its northern margin is closed linked with Himalayan geology. The Baralia River is mainly composed of recent and sub recent deposits. It can be sub divided into-

1. Older alluvium.
2. Newer alluvium.

VII. DRAINAGE

Flood plain is a highly dynamic topography surface. So the flood plain may be of as both a product and functional part of the whole stream environment. The study area is basically controlled by the river Baralia. The river originates from the Bhutan hills, and it flows in southern direction for a few km and it takes westerly turn and after winding its way falls into the Pagladia River. Due to severity of flood hazard in the areas like Dusutimukh, Baulighat, Bhairatola, a Jan of about 15km was constructed in 1985 from Bhairatola to the Velkar and the Jan falls into the Phutimari River.

VIII.CLIMATE AND RAINFALL

As the study area is a part of Assam, this area is also of the tropical monsoonal region of the South-East Asia. The climate condition of the area is change from season to season. The are four distinct seasons:-

1. Summer Season-
   After middle of May to September and first half of October.
2. Retreating of Post-Monson-
   From middle of October to November.
   December to February and half of March.
3. Pre Monson Season-
   From last part of March to May.

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During summer season the temperature is extremely high ranges between 20 degree to 35 degree C. In the month of December to February (winter season) temperature falls and it is varies from 8 degree to 15 degree C.

The average rainfall of the area is range from 250-260 cm. In the winter season, the amount of rainfall is 40-60 cm. The winter is dry and sometimes rainfall occurs but it is very little. On the other hand, the summer season is wet. The mean annual rainfall is 1093 mm and mean annual temperature is 24.6 degree C.

IX.SOIL

Basically entire study area is formed of Alluvial soil. These soils are derived from the debris brought by the Bralia river from the Bhutan Himalaya. Characteristically the soil is influenced by running water. Similarly, the Hajo circle of Kamrup district is formed mainly by alluvial soils. It is the deposition of alluvial soil carried by the river Baralia.

X.NATURAL VEGETATION

From the site of natural settings the Hajo area is very beautiful and attractive. There are found many important plants and trees. The tropical evergreen and tropical deciduous type of forest are found in the basin area. The important trees which are found in this area are Sal, Gamari, Silikha, Shisu, Bamboo, Sires etc. and the fruits like Mango, Coconut, Jackfruit, Bettlenut etc. But every year the vegetation area are damaged due to flood in the rainy season. The river Baralia changes its courses every year and destroyed the green covered areas mainly the crop fields.

XI.SOCIO-ECONOMIC CONDITION

The people of Khopanikuchi village is mostly depends on primary sector. Most of the people of Khopanikuchi are farmers they run livelihood by cultivation of rice and vegetables .Some of them depends on business and very few are engaged in tertiary activities. But they have to faced the flood problem every year, which effects their cultivation, property and live so their economic growth is very much slow and low in comparison to other villages.

Table 1: Occupation Structures of the Study Area

Occupation	Population (%)
Agriculture	75
Service	10
Business	11
Others	4

XII.HYDROLOGICAL CHARACTERISTICS OF THE RIVER

XII (a).FLOW CHARACTERISTICS

Flow pattern of the Baralia River is not same round the year. It varies from time to time, month to month and year to year. In May, June, July, the peak flow condition is higher. In April, August and September it is found moderate. In case of January to March and October to December the flow condition is minimum.

XII (b).SEDIMENTOLOGICAL CHARACTERISTICS

The perennial river Baralia is flashy in nature. The Upper reach being the boulder region, bears a very steep slope in and around the intersectional boundary. The river bed consist of bolder gravels and coarse, sand etc. It carries along with its water large quantities of these bed materials transport river sediment forms the lesser Himalayan range of Bhutan foothills and deposits as and where the rivers bed slope tends to mild in its reach.

XII (c).STAGE AND DISCHARGE RELATIONSHIPS

Hydrograph is a cartographic method to show relationship between stage and discharge relationship. The shape of a hydrograph resulting from a single short duration storm occurring over the drainage area follows a general pattern.

The river stage has been defined as the height of the water surface in the river at a given section above any arbitrary datum. It is usually expressed in meters.

Discharge is by definition the amount of water passing through the cross-section in a given unit of time. Water discharge of a river is symbolised by Q and expressed in cubic feet or meter per second.

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XII (d). ANNUAL MAXIMUM STAGE DISCHARGE HYDROGRAPH

Table 2: Annual maximum stage and discharge hydrograph 1987-2011

Year	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Discharge in m^3/sec	228.58	278.11	156.58	200.19	212.58	311.57	309.59	269.79	368.92
Max W.L in M	52.10	52.33	51.80	51.95	52.08	52.20	52.50	52.25	52.65
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Discharge in m^3/sec	765.28	443.22	382.11	468.11	1145.33	523.23	423.38	388.99	636.24
Max W.L in M	53.30	52.70	52.52	52.75	53.73	52.90	52.72	52.60	53.10
Year	2005	2006	2007	2008	2009	2010	2011		
Discharge in m^3/sec	534.58	322.44	201.58	310.39	280.29	240.49	220.49		
Max W.L in M	52.81	52.31	51.90	52.25	52.31	52.18	52.10		

Source: Guwahati West W.R Division

From the above water discharge (Q) and stage data in meters of Baralia River at Rangia N.H.Crossing site we found that the in the year 1996 the water discharge is high i.e., 765.28 m^3/s and water level is about 53.30m results in heavy flood and bank erosion in the study area. From the Table 2 and Fig 4, it is also clear that Water discharges increases in the year 2000 and also in 2004 and as a result increase in stage resulting heavy flood and bank erosion in the study area. In the year 1988, 1989, 1990, and in 2007 water discharge is low as a result water level decreases results in less flood and bank erosion in the study area.

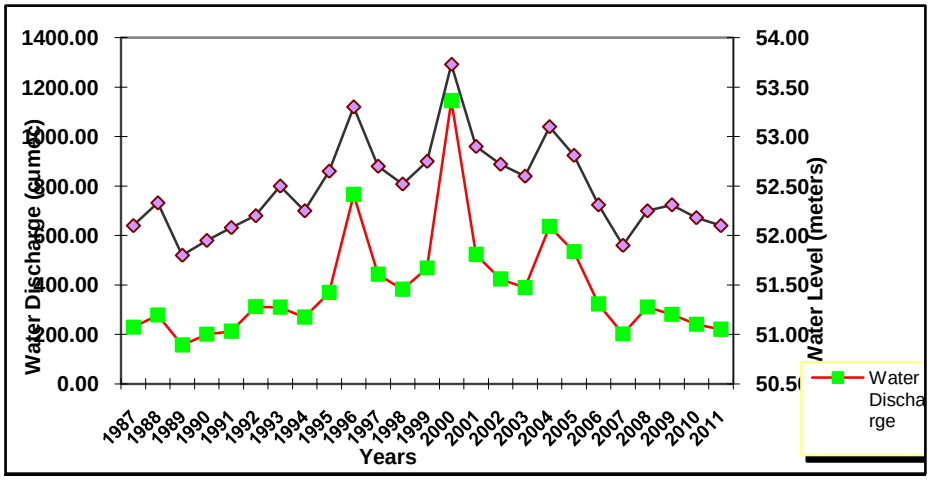

Fig 3: Showing Mean Annual Stage Discharge Hydrograph of Baralia River at Rangia N.H. crossing Site.

XII (e). FLOOD FREQUENCY ANALYSIS

When steam flow peaks arranged in descending order of magnitude, they constitute a statistical array whose distribution can be expressed in term of frequency occurrence.

Let x1,x2……..xn be the independent observations. Let x1,x2,…..xm……xx be the some observation arranged in the some descending order of magnitude such that x1>x2>…..>xm>….>xx.The suffix m in the ordered sequence of observation is called the RANK or the order of observation. This, then mean that the highest value among the observation get a rank of 1,the next highest value get the rank of 2 so on which the last observation gets the rank of n which is the size of sample.

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The value of the annual maximum flood from a given catchment area for large number of successive year constitute a hydraulic data series called the ANNUAL SERIES.The data are then arrange in descending order magnitude and PROBABILITY (P) of its each events being equaled to or exceeded(Plotting Position) is calculated by the PLOTTING –POSITION f0rmula

$$P=m/n+1$$

When ,m=order number of event and n=total number of event data.The RECURRENCE INTERVAL, T (also called the return period or frequency)is calculated as

$$T=1/P$$

The probability of occurrence of a flood (having a recurrence interval T-yr) in any year ,I e, PROBABILITY OF EXCCEDANCE is

$$P=1/T$$

Or the percent chance of its occurrence in any one year,i e, FREQUENCY(F) is

$$F=1/T*100$$

And ,the probability that it will not occurrence in a given year ,i e,the PROBABILITY OF NON OCCURRENCE(P) is

$$P \leq 1-P$$

Estimation of flood frequency:

Different method have been applied to estimate the flood magnitude for a given return period, the most commonly used method are as follows-

1) Weibull's Plotting Position Formula.
2) Log Pearson Type-III Distribution.
3) Gumbel's Extreme Value Distribution.
4) Log Normal Distribution.

WEIBULL'S PLOTTING POSITION FORMULA

In the plotting position method the annual extreme series are arranged in a descending order m.Thus the first entry m=1, for second entry m=2 and so on till the last event for which m=number of years recorded.The probability of an equaled to or exceeded is given by the Weibull's formula.

$$P=m/n+1$$

The recurrence interval

$$T=1/P$$

For the graphic representation of given annual data series the flood magnitude are plotted against its return period in a ORDINARY GRAPH PAPER or in a SEMI LOGERTHEMIC PAPER.In the first case the plotting type is called ORDINARY PROBABILITY PLOT and in second case it is called LOGARTHIMIC PROBABILITY PLOT.Now, the found magnitude forsome return period(say Tr=50,Tr=100,Tr=200) are read from the graph.

TABLE-3: ANNUAL PEAK FLOW DATA USING WEIBULL'S FORMULA (1987-2011)

Sl No.	YEAR	PEAK FLOW (Q)	Q(in descending order)	ORDER (m)	PROBABILITY OF OCCURRENCE(P=m/n+1)	RETURN PERIOD(Tr=n+1/m)
1	1987	228.58	1145.33	1	0.0384	26
2	1988	278.11	765.28	2	0.0769	13
3	1989	156.58	636.24	3	0.1153	8.6667
4	1990	200.19	534.58	4	0.1538	6.5
5	1991	212.58	523.23	5	0.1923	5.2
6	1992	311.57	468.11	6	0.2307	4.3334
7	1993	309.59	4443.22	7	0.2692	3.7142
8	1994	269.79	523.38	8	0.3076	3.25
9	1995	368.92	38899	9	0.3461	2.8889
10	1996	765.28	382.11	10	0.3846	2.6
11	1997	443.22	368.92	11	0.4230	2.3636
12	1998	382.44	322.44	12	0.4615	2.1667
13	1999	468.11	311.57	13	0.5	2
14	2000	1145.33	310.39	14	0.5384	1.8571

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15	2001	523.23	309.59	15	0.5769	1.7334
16	2002	423.38	280.29	16	0.6153	1.625
17	2003	388.99	278.11	17	0.6538	1.5294
18	2004	636.24	269.79	18	0.6923	1.4445
19	2005	534.58	240.49	19	0.7307	1.3684
20	2006	322.44	228.58	20	0.7692	1.3
21	2007	201.58	220.49	21	0.8076	1.2380
22	2008	310.39	212.58	22	0.8461	1.1818
23	2009	280.29	201.58	23	0.8846	1.1304
24	2010	240.49	200.19	24	0.9230	1.0833
25	2011	220.49	156.58	25	0.9615	1.04

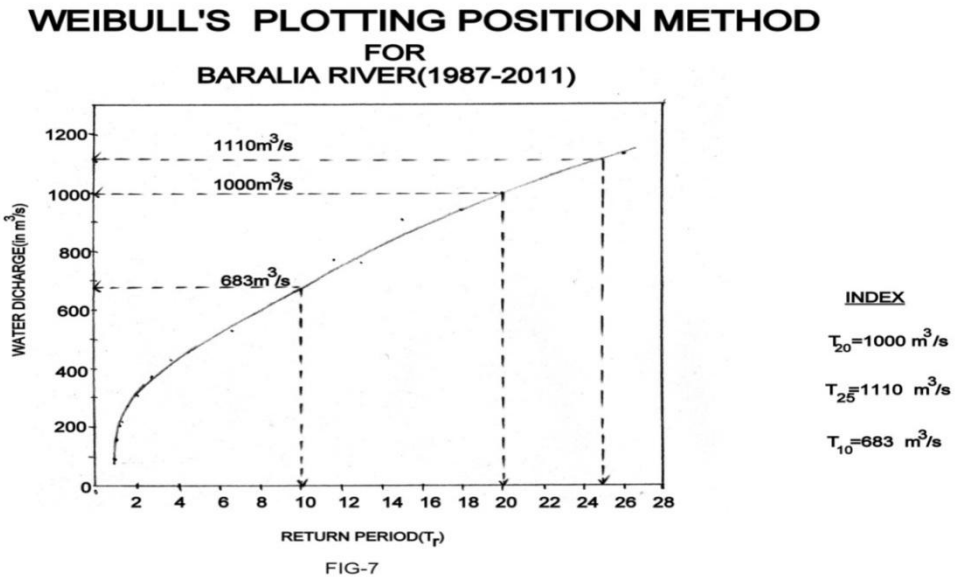

FIG-7

Fig.5

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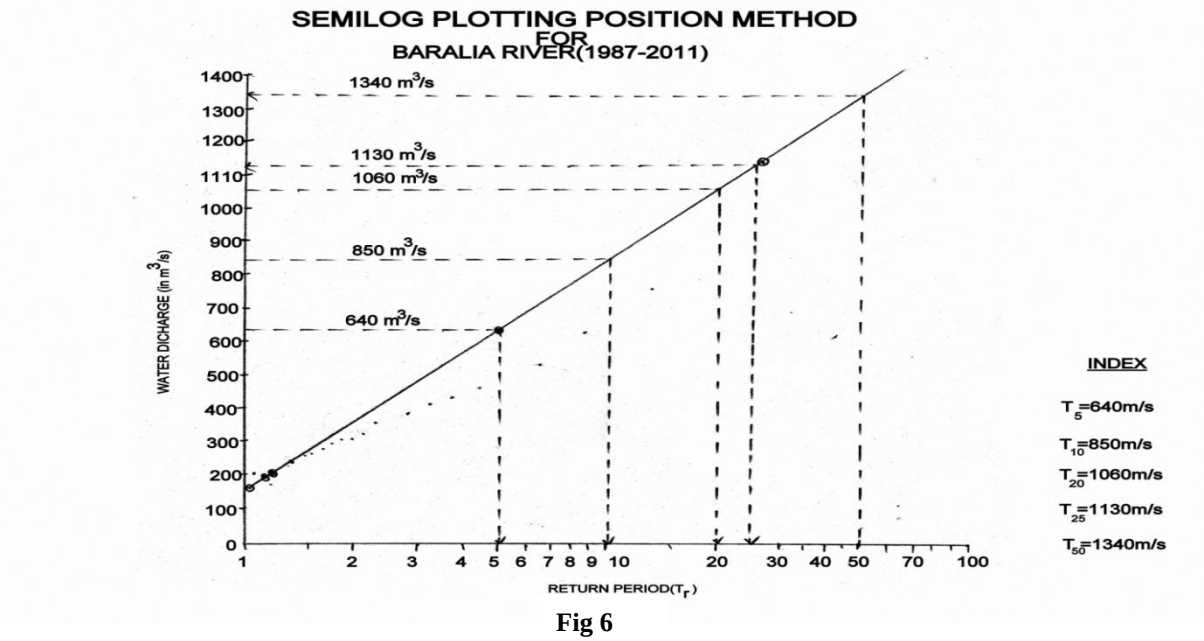

Fig 6

The flood series data of Baralia river for the period of 1987-2011 been plotted .In the ordinary graph paper and semi logarithmic paper using Weibull's Plotting Position formula given in the table-5.In the ordinary graph(fig-5) the estimated flood for return period 10 year,20 year and 25 year flood size is found to be 682m3/s,1000m3/s and 1110 m3/s respectively. Again the mean Annual Flood, Tr=2.33 years is found as 380 m3/s.On the other hand most probable flood of the rivers Baralia is estimated as 150 m3/s.

In the semi logarithmic paper(fig-6) the estimated flood for return period 10 ,20,25 and 50 years flood size is found to be 850 m3/s,1060 m3/s , 1130 m3/s and 1340 m3/s.The mean annual flood Tr=2.33year 380m3/s. On the other hand most probable flood of the river Baralia is estimated at 150 m3/s.

Table 4: Weibull's Plotting position method for Baralia River from the year 1987-2011.

Sl. No.	Year	Q	Q (in descending order)	Rank	Probability of occurrence	Returning period
1	1987	228.58	1145.33	1	0.0384	26
2	1988	278.11	765.28	2	0.0769	13
3	1989	156.58	636.24	3	0.1153	8.667
4	1990	200.19	534.58	4	0.1538	6.5
5	1991	212.58	523.23	5	0.1923	5.2
6	1992	311.57	468.11	6	0.2307	4.3334
7	1993	309.59	443.22	7	0.2692	3.7142
8	1994	269.79	423.38	8	0.3076	3.25
9	1995	368.92	388.99	9	0.3461	2.8889
10	1996	765.28	382.11	10	0.3846	2.6
11	1997	443.22	368.92	11	0.4230	2.3636
12	1998	382.71	322.44	12	0.4615	2.1667
13	1999	468.11	311.57	13	0.5	2
14	2000	1145.33	310.39	14	0.5384	1.8571
15	2001	523.23	309.59	15	0.5769	1.7334
16	2002	423.38	280.29	16	0.6153	1.625
17	2003	388.99	278.11	17	0.6538	1.5294
18	2004	636.24	269.79	18	0.6923	1.4445

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22	2008	310.39	212.58	22	0.8461	1.1818
23	2009	280.29	201.58	23	0.8846	1.1304
24	2010	240.49	200.19	24	0.9230	1.0833
25	2011	220.49	156.58	25	0.9615	1.04

Table 5: Semi log Plotting position method for Baralia River from the year 1987-2011.

Sl. No.	Year	Q	Q (in descending order)	Rank	Probability of occurrence	Returning period
1	1987	228.58	1145.33	1	0.0384	26
2	1988	278.11	765.28	2	0.0769	13
3	1989	156.58	636.24	3	0.1153	8.667
4	1990	200.19	534.58	4	0.1538	6.5
5	1991	212.58	523.23	5	0.1923	5.2
6	1992	311.57	468.11	6	0.2307	4.3334
7	1993	309.59	443.22	7	0.2692	3.7142
8	1994	269.79	423.38	8	0.3076	3.25
9	1995	368.92	388.99	9	0.3461	2.8889
10	1996	765.28	382.11	10	0.3846	2.6
11	1997	443.22	368.92	11	0.4230	2.3636
12	1998	382.71	322.44	12	0.4615	2.1667
13	1999	468.11	311.57	13	0.5	2
14	2000	1145.33	310.39	14	0.5384	1.8571
15	2001	523.23	309.59	15	0.5769	1.7334
16	2002	423.38	280.29	16	0.6153	1.625
17	2003	388.99	278.11	17	0.6538	1.5294
18	2004	636.24	269.79	18	0.6923	1.4445
19	2005	534.58	240.49	19	0.7307	1.3684
20	2006	322.44	228.58	20	0.7692	1.3
21	2007	201.58	220.49	21	0.8076	1.2380
22	2008	310.39	212.58	22	0.8461	1.1818
23	2009	280.29	201.58	23	0.8846	1.1304
24	2010	240.49	200.19	24	0.9230	1.0833
25	2011	220.49	156.58	25	0.9615	1.04

Table 6: Gamble's extreme value distribution of Baralia river for the year 1987-2011

Sl. no.	Year	Water discharge	Descending order	Rank	Return period	Reduce value
1	1987	228.58	1145.33	1	26	3.2385
2	1988	278.11	765.28	2	13	2.5251
3	1989	156.58	636.24	3	8.667	2.0988
4	1990	200.19	534.58	4	6.5	1.7894
5	1991	212.5	523.23	5	5.2	1.5437
6	1992	311.57	468.11	6	4.334	1.3381
7	1993	309.59	443.22	7	3.7142	1.1594
8	1994	269.79	423.38	8	3.25	1.0004
9	1995	368.92	388.99	9	2.889	0.8559
10	1996	765.2	382.11	10	2.6	0.7225

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11	1997	443.22	368.92	11	2.3636	0.5977
12	1998	382.11	322.24	12	2.1667	1.3387
13	1999	468.11	311.57	13	2	0.3665
14	2000	1145.33	310.39	14	1.8571	0.2571
15	2001	523.23	309.59	15	1.7334	0.1506
16	2002	423.38	280.29	16	1.625	0.0455
17	2003	388.99	278.11	17	1.5294	-0.0591
18	2004	636.24	269.79	18	1.4445	-0.1643
19	2005	534.58	240.49	19	1.3684	-0.2717
20	2006	322.44	228.58	20	1.3	-0.3827
21	2007	201.58	220.49	21	1.2380	-0.5001
22	2008	310.39	212.58	22	1.1818	-0.6269
23	2009	280.29	201.58	23	1.1304	-0.7699
24	2010	240.49	200.19	24	1.0833	-0.942
25	2011	220.49	156.58	25	1.04	-1.1811

Table 7: Gamble's extreme value distribution of Baralia river for the year 1987-2011

Return period	**Reduce return period**	**X**	**Sx**	**Yn**	**Reduced standard deviation**	**KT**	**XT=X+KT.Sn**
2	0.3665					-0.1506	353.03
5	1.4999					0.8877	385.35
10	2.2503					1.5752	717
20	2.9701	348.88	211.44	0.5309	1.0915	2.2347	857.38
25	3.1985					2.4415	901.11
50	3.9019					3.0884	1037.89
100	4.6001					3.7280	1173.12
200	5.2958					4.3654	1307.90

XIII. FLOOD AS A GEOMORPHIC HAZARD

Water is the necessary thing for all living being. Without water no one can alive. But this necessary thing sometime the most vulnerable in nature. This is the flood. The word flood means inundation of extensive land area with water for several days in continuation. The water may be river water or rain water. Generally, the river water is the causes of severe flood.

The word Geomorphic Hazard may be defined as these extern events either natural or human induced, which exceed the tolerable magnitude within or beyond certain time limits, make adjustment difficult, result in catastrophic losses of property, income and lives.

So, the flood is an extreme event. But when it is causes of various damages, losses of property and lives it is called Hazard. The flood is like a most vulnerable monster. It affect not only on the people but on the nature also. The flood destroyed the ecosystem of the forest and river. Many wild animals loss their habitable place and they go to near high place.

The damages of flood are seen on human. The houses and living or unloving property are losses by flood. The people are loss their sweet home and take shelter in the schools and other save place. The communication line is also stopped. The road and railway are damages by flood. So, all of the damages is occurred by flood. Flood is the causes of many losses. Therefore, it is cause Hazard.So, the flood is the Geomorphic Hazards.

XIV. FLOOD OCCURRENCE PATTERN TEMPORAL AND SPATIAL

Flood is a natural hazard. It covers a wide range of phenomena. Which area are covered by drainage channel or situated in coastal area, there flood occur. The area which are situated near the drainage, there flood occur every year.

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These areas are called chronically flood affected areas. And where flood occurs not frequently but sometimes is known as occasionally flood affected area.

Floods are mainly occur in rainy season. The pattern of flood are divided into two types of flood occurrence are as follows-

- ***Temporal:*** The word is mainly related with time. Flood also related with time. The duration of flood time is related with temporal flood occurrence pattern. Mainly flood occur in rainy season.

In my study area, from **table: 8**, it is clearly shown that, flood is mainly occur in the month of June and July. In intensity of flood is more than that of June. In last year 2012, the flood inundation duration is about 20 days. Maximum flood occur in this period, and in last five years the flood inundation duration is about 30 days.

In the year 2012, the depth of the flood is about avg. 3.15 feet and in last 5 years, the depth of the flood is about 2.59 feet.

If we compare the inundation duration period of flood in my study area Khopnikuchi in last year 2012 and last 5 years, the inundation period of flood is more in 2012, comparatively. The depth of flood is also more in 2012 than of the last 5 years avg. comparatively. In both the flood periods flood occur in June-July months. The inundation duration of flood in last 5 years is 30 days and last year 2012 is 20 days from above data we can assume that the affects of flood is more in last year 2012.

Table 8: Flood inundation pattern of village khopnikushi of Hajo circle in the flood of 2012 & last 5 years.

Flood period	Month	Inundation duration (days)	Depth of flood avg. (feet)
Last year	June-July	20	3.15
Last 5 year	June-July	30	2.59

- ***Spatial:*** The word 'spatial 'is concerned with space/ place. Flood is closely related with place.Hajo circle is a actively flood affected area. Flood occurs in this area are occasionally.

Though it is an occasionally flood affected area, then also some villages of these area are chronically affected. Some villages are occasionally affected and some other villages are occasionally flood affected villages.

Villages affected by Flood are:

Akadi ,Khopanikuchi, Dakhin Singra, Melkipara, Andhupara,Natun Dihina and Adhiyarpara

All of these villages are mostly flood affected villages of Hajo area.

XV.FACTORS OF FLOOD CAUSATION

The physiographic condition is one of the main causes of flood in Hajo area. Physiographically the river basin is differs from place to place. Due to variation of physiography , the flood hazard may occur each and every river basin. The study area extends latudinally $26^0$17'864"N to $26^0$17'871"Nand longitudinally $91^0$30'037"E to $91^0$30'098"E. Basically this area has been characterised by slightly shallow depressions marked by swamps, marshes and beels etc. bending of river with some meandering has rendered a significant role of flood in this area.

The area is like other area of Brahmaputra valley has four district climate environment signified by characteristics rainfall, temperature, humidity etc. it is been from the geographical point of view These are as given below-

1. Pre-monsoon: March to May
2. Autumn season: October to November
3. Winter season: December to February.

The pre-monsoon which starts from March to continue up to May has been marked by atmospheric instability with the North Western region known as " Kalbaisakhi " or locally knows as "Bordoichila". In that time the rainfall occurs and the intensity of rainfall is very much high causes flood sometimes.

Water discharge is one of another cause of flood hazard in the study area. Water discharge shows variation from time to time. The water discharge of Baralia is very low from the month of October to the month of March and

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April. Water discharge is very high in the monsoonal period, in the month of June and July. Whenever the water discharge rises up to 200 m^3 it causes flood in the area.

Sediment discharge by the river is also one important factor for the causation of flood in the region. The rivers erosional activity increases the amount of sediment discharge that cause inclination of the river bed and it also causes flood in Hajo area.

Besides the natural factor, the human induced factors are also highly responsible for devastation flood in the Baralia River as well as study area. Deforested and uncaused tree falling on the surrounding area is the important causes of flooding in the plains i.e. the study area. The absence of protective cover of vegetation accelerates soil erosion and finally results in silling up of the beds.

Flood problems has become more serious due to some other human induced factor like large scale human occupancy in the study area i.e. flood plain, destruction of wetland and the poorly managed embankment network. In recent years, increasing encroachment on the flood plain for habitation and cultivation has significantly aggravated the flood problem. Moreover, the structural measures of flood control, specially the partly managed embankments also cause sudden floods. This flood water coming across embankment through overtopping or breaching, eventually remains stagnant in a locality for days together and cause grass damage.

XVI.FLOOD DAMAGE MAGNITUDE AND THEIR IMPACT

According to our collected data the flood prone area under Hajo area is occasionally flood affected area then it also faces some timed hazardous flood. We may understand the damage pattern of flood by seeing the table 9 flood hazard pattern of the village Khopnikushi of Hajo, Kamrup in the flood 2012 and last 5 years.**Table 9:** Flood hazard pattern of village Khopnikushi of Hajo, Kamrup in the flood of 2012 & last 5 years.

Flood period	Damaged crop land (Bigha)	Cattle lost (Nos)	Total loss in Rs.	Life loss	Population effects	School days lost	Man days lost	Expenditure Rs.
Last Year	30	12	100000.00	0	20	30	40	24700.00
Last 5 years	55	25	300000.00	0	125	90	90	90000.00

From the above table we can understand that the magnitude or amount that causes by flood in last year 2012 in last 5 years average.

The flood in Hajo area has great impact in the area and into the people through the erosion done by river. The flood causes various damages in the area like damage of crops land, damage of crops, damage of property and life, school days lost due to flood, mans days lost due to flood etc. the tally of the damage is clearly given in the table on account of the school the agriculture land is also affected because flood causes sediment deposition and siltation in agriculture land that damage the land. From the table 10 sediment pattern of village Khopnikushi in the flood of 2012 and last 5 years.

Table 10: Sediment pattern of village Khopnikushi of Hajo, Kamrup in the flood of 2012 & last 5 years.

Period	Sediment deposition over cropland (Bigha)	Thickness (inchs)	Over bank deposition	Breaching/cut
2012	7	3		
Last 5 years	23	7		

XVII. HUMAN ADJUSTMENT WITH FLOOD

XVII (a). GENERAL ADJUSTMENT

The flood in the river is most serious problem for human beings. People of villages adjust themselves with flood by observing the nature of flood every year. They go to high place to save their food, cattle and themselves. They take shelter in school, embankment and roads during flood time. People make rafts to travel in flood time. Flood often damages their food and cultivation so they have to depend on fisheries after flood.

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XVIII (b).AGRICULTURE AND OCCUPATION ADJUSTMENT

The people of village mainly depend upon agriculture. They can give their life for agriculture, these is their tradition. But, due to flood every year the agriculture field is damaged. Due to siltation the rice is cannot grow on land. So people cultivate the crops like cabbage, ginger, potato, etc. on that land. These are also important for man. They can also grown banana on those lands. Thus they can adjust with agriculture.

The agricultural occupation is not useful I economic side. The crop land is damage by flood. Therefore, the villagers are also doing wages and business of various things.

The people are also go to city for their new occupation. Because, with the agriculture they cannot live. Thus the villagers adjust with occupation.

XIX.SUGGESTIVE MEASURES

To control the flood there are various measures are taken now-a days. These are various types of flood mitigation measures:

1. Making of high and strong embankment into the rivers.
2. Proper observation of the river characteristics.
3. Establishment of flood shelter for man as well as animals.
4. Regular collection of garbage from the river.
5. Curb side inlets or nets on house hold drain.
6. Ban on dumping, quarrying and falling of trees.
7. Solid waste management.
8. Newly constructed houses to be away from the river.
9. Base of houses should be uplifted.
10. Large scale a forestation programme.
11. General people awareness. Etc.

XX. MITIGATION STRATEGIES ADOPTED BY GOVERNMENT/N.G.O./OTHERS

During the flood period the people of village adjusted themselves with flood. Now, there are various mitigation strategies are taken by govt. N.G.O. and the villagers themselves. Till today embankment are widely adopted as a measure of flood control. During flood, the villagers are helpless. They shelter in the school, roads or other high places, but other necessary things are near them. At that time the N.G.O. and other people help them. Govt. announced to give their needs necessary things, but these come very late. The relief funds which are adopted by Govt. are small these cane not provide all the villagers. These means that, the villagers get all necessary things and maximum help by the N.G.O. and other organisation at the early time, later Govt. also provide relief.

XXI.FUTURE GOVT. PLAN TO CHECK THE FLOOD HAZARD

The Water Resources Department, Govt. of Assam has been adopting a policy to take up flood control measures such as construction of embankment, anti-erosion and flood control measures etc. in the study area. No central agencies or aid are playing any role so far in construction of the embankment, anti-erosion measures etc which probably are the most important aspect to be attended for backward and flood prone state like Assam. The state Govt. of Assam and Central Govt. of India are the only agencies involved in the process of embankment activities.

Another important measures to check flood is floodplain joining. The study area which is frequently visited by devastating flood and erosion cause tremendous damage to crop is a regular feature. So, floodplain zoning is very important which includes regulation of landuse, changing of crop pattern etc.

The ravaging flood and erosion hazard always causes great damage to standing crops. The changing in the cropping pattern and proper land use regulation may be a suitable strategy to adjust with hazard. The area may be divided into some regions according to hazard intensity.

- Erosion free area.
- Slightly erosion affected area.
- Moderately erosion affected area
- Severely erosion affected area.

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Besides these other measures used to check bank erosion are boulder protection, solid stone spurs, timber pile spurs, river revetment, marginal embankments, porcupine made of bamboos and other short term devices.

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BIOGRAPHY

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