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Drainage and Floods in the Subarnarekha Basin in Paschim Medinipur, West Bengal, India – A Study in Applied Geomorphology

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Abstract: ***The removal of excess water either from the ground surface or from the root zone is called drainage. In the monsoon period most of the drainage or rivers exceed their normal channel capacity attaining the flood stage and frequently overflows their banks causing great havoc to the life and property of the people. Drainage density, drainage frequencies with relation to morphological and hydrological characteristics of the respected river basin areimportant factors for flood. To asses those relationship a flood seasonality analysis of annual peak flood series for Subarnarekha basin in paschim medinipur district, West Bengal.***

Keywords: Morphology, Run-off Morphology, River Basin, Peak Flood, Drainage Density.

1. Introduction

Flooding represents the greatest weather related hazard in paschim medinipur, state of west Bengal. An understanding of flood seasonality requires information about climatic condition like rainfall, storms; physiographic condition like slope, relief, shape; morphological characteristics like morphology of the river basin, run-off morphology and hydrological characteristics etc. are very important cause for flooding in respected river basin area.

1.1 Objective

1) An understanding, analysis and assessment of the floods of Subarnarekha basin as manifested in someof their characteristics features like magnitude and frequency of flooding, the lag time and the seasonality of flood.
2) An investigate into the causes and controlling variables of the floods as manifested in-
   a) The physical characteristics of drainage basins i.e. drainage area, shape, pattern, drainage density and nature of drainage channels.
   b) Geomorphological and Hydrological setting of the area.
   c) Rainfall duration and intensity, its distribution over the basin.

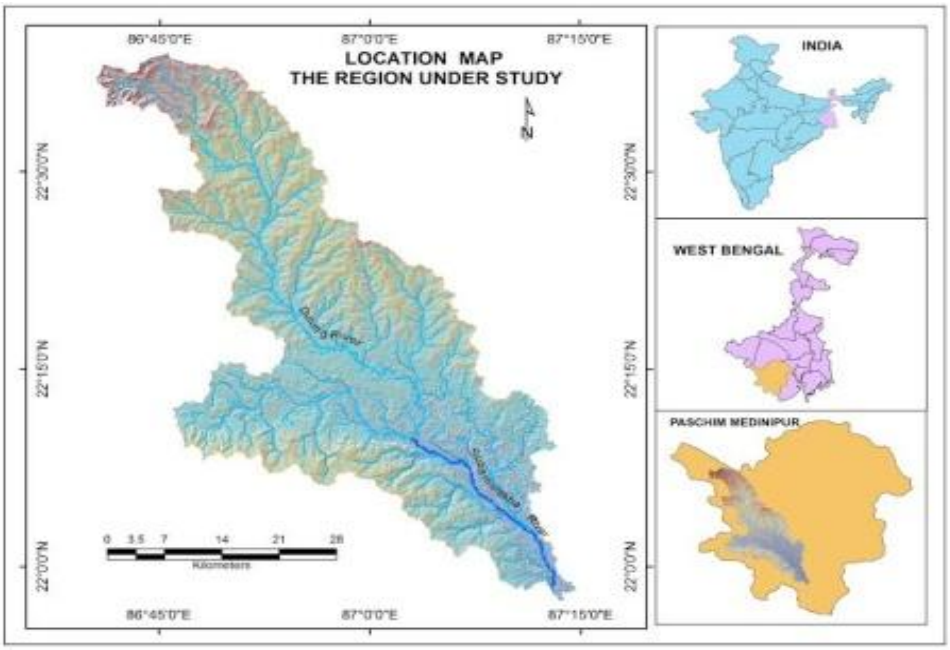
Thus the objectives of the study is to have an interdisciplinary approach that how the fundamental factors from geomorphology, climatology and hydrology are related as responsible for the occurrence of flood in the Subarnarekha river basin.

1.2 Materials and Methodology

- For this purpose the preliminary base maps has been collected from the survey of India toposheets, national atlas, physical and planning series map of paschim medinipur.
- In this study a high resolution CARTOSET DEM, EMT+ sensor of Landsat 7 satellite, Google Earth are used to prepare drainage basin map of Subarnarekha river, drainage density and different morphological characteristics map of the study area.
- The stream gauging records, flood flows, their magnitude and frequency are analysed with the help of various quantitative techniques.
- The characteristics of floods have been shown through step discharge curves and flood hydrograph.

2. Study Area

The Subarnarekha has a rapid stream with a sandy bed and its bank is generally high and well defined. It covered seven block namely Gopiballavpur-1 & 2, Sankrail, Keshiary, Narayangarh, Datan-1 and Jamboni in paschimmedinipur district. This river basin extend from 22°33′32″ N to 21°54′34″ N and 86°44′55″E to87°15′00″E.



3. Flood Factors Analysis

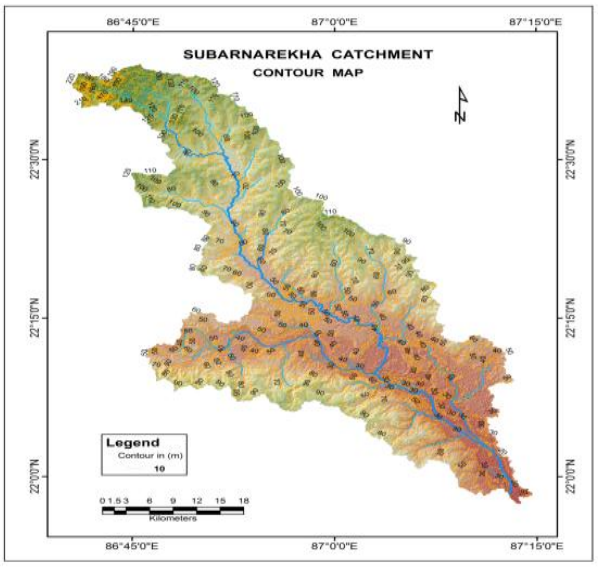
3.1 Morphological characteristics and its bearing on flood

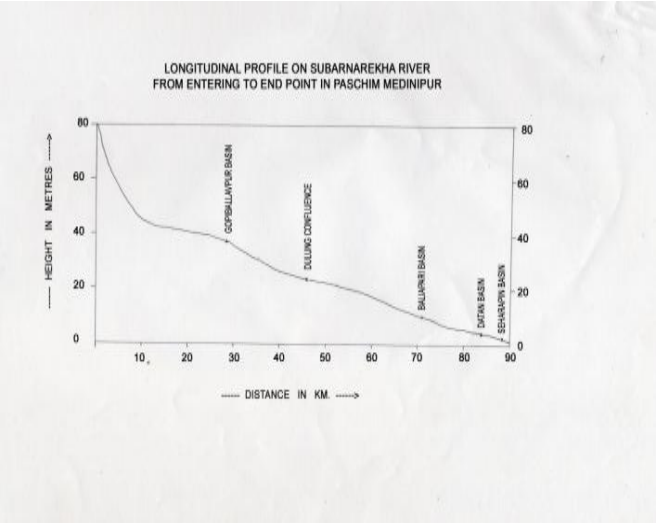
a) Shape of the basin:
The basin of the Subarnarekha is smaller amongst the multistate river basin India. The Subarnarekha river basin is elongated in shape. It is bounded on the north-west by the chhotonagpur plateau, in the south west by Brahmani basin and in the south-east by the Bay of Bengal. So heavy rainfall in chhotonagpur plateau fall in Subarnarekha river and also said river basin rainfall in study area increased the probability of flood.

b) Relief:
The topography of the study area is characterised by an undulating terrain patterns. The study region may be classified into the following physiographic units-

Highland Region: The highland region is situated on the part of west and North West portion of the study region. Maximum elevation is recorded about 300 m.In the north but where Subarnarekha enter the west Bengal in paschimmedinipur district there elevation is 70 to 60 m. above the mean sea level.

Plain region: plain region is situated on the south and south western part of the study region as isolated fluvial pockets. The altitude of this area 15 to 5 m. above the mean sea level. Fertile alluvial soil deposited by Subarnarekha and their tributaries covers the plain area.





c) Morphology
The rolling interfluves of Subarnarekha basins are characterised by pisolithic laterites with non-static water table and massive laterites with seasonal static water table. The large vertical spread of pisoliths within such interfluves

can also again be associated with a lowering water table. The pisolithic are immature form laterite which appears to be developed in the immature planation surfaces. The mature planation surface can be associated with the exposure of underlying massive laterites after removal of pisoliths bearing surface from the top. The older alluviums and underlying gravel beds of the upper terrace of Subarnarekha river banks are laterized in successive stages. The higher parts of the interfluves with hillocks are locally known as 'dungri'. The areas of degraded forest with exposed planation surface laterites of massive structure are locally known a'dahi'. The surface is also extended up to the margins of river valley alluviam deposits.

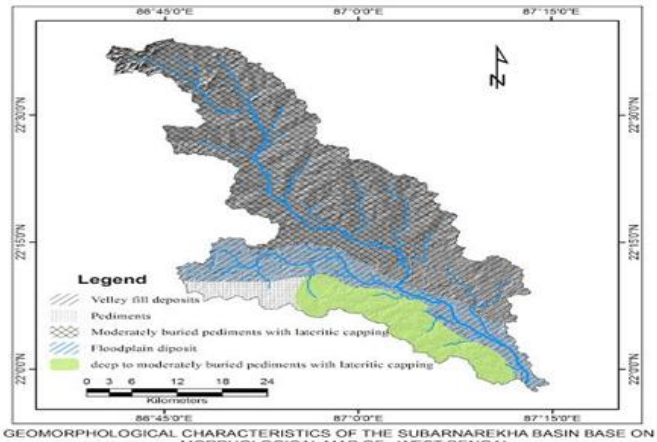
d) Run-off Morphology

The formation of the West Medinipur highlands as well as Jhagram area is lateritic, which occupies nearly the entire area except the river banks(marked by deposition). In the north-western part of the study area schist's crop up from beneath the lateritic flats at some places indicating the characteristics feature of the geological history of the formation of the study area during the Quaternary period (O'Malley3, 1912). Towards the further north grey and bluish-grey micaceous schist's band with gneissose character is found. Other important formations are quartizite, grits, slates etc. The lateritic rocks are the dominating stratigraphic formation of this area. The lateritic highland of this area is remarkable for the development of run-off channels, which often play a vital role for soil erosion of this area.

Table 1: Types of gullies and their morphology

Type	*Morphology*	*Place of observation*
Scour network gully	Run-off water concentrated in rills or depression and channels network extends on to the gently undulating land. The channel floor is normally rugged and degraded. Depth of the channels decreases near the river.	Open forest area and near along the Dulung bank area.
Complex network channel	Run-off water concentrated in rills or depression and channel network extends on to the gently undulating land. The channels become wider near the river. Undulating and gravitational slumping of gully head.	Asui-Dharampur along Subarnarekha river bank.

Source: Field investigation report during different zones.



GEOMORPHOLOGICAL CHARACTERISTICS OF THE SUBARNAREKHA BASIN BASE ON MORPHOLOGICAL MAP OF WEST BENGAL

3.2 Hydrological characteristics and its bearing on flood:

a) Drainage system of the study area:

The Subarnarekha river basin, the smallest of the fourteen major river basins of India, is an inter-state river basin. The Subarnarekha basin extends over 19296 sq.km in which 2160sq.km extends in paschimmedinipur, the state of west bengal. Some of the khal and river are the tributary of the Subarnarekha in her left and right bank, namely-in the left bank dulung river, pochakhali river, bansikhal, kusumikhal, kantayakhal and the right bank shyamtarangi river, sitakhal and ragiyamkhal. All these khalandsriver almost dry in summer season. But in the monsoon period during heavy rainfall all the channel exceed their capacity and all the channel water flow into the Subarnarekha.

Table 2: River system of Subarnarekha

Name of the river	Left bank drainage	Right bank drainage
Subarnarekha	Dulung river	Shyamtarangi river
	Pochakhali river	Sitakhal
	Bansikhal	Ragiyamkhal
	Kusumikhal	
	Kantayakhal	

b) Drainage Density and Drainage Frequency

Drainage frequencies are increased from the severe effected flood prone area to non effected flood prone areas but drainage density increased trend show towards the main river, value is 4.482 to5.602. So all the small stream of the catchment receives monsoon rainfall then the flow come towards the main channel. High density and high frequency shows the flood effected area of the study area.

c) Ground Water

Ground water table are very significantly related to the flood condition. In dry season ground water table is very low and in rainy season as well as monsoon period ground water table rising. During monsoon period with heavy rainfall ground water table increase and most of the rainfall flow as Run-off. Flood plains are interpreted by its typical reddish tone found along the banks of the river course. The flood plain area comprises mainly of sands and silts with minor inter clarified of clays and they act as good aquifer.

Table 3: Terrain units based on run-off potential index

Terrain units	*Area in %*	*Physiography & shape*	*Soil colour, Depth, Texture, Drainage and Erosion*	*Run-off potential index*
A	0.63	Subarnarekha river bank margin, gently to moderately sloping (3-8 %)	Yellowish-brown-dark brown, very deep, sandy clay sand, moderately well drained, slightly-moderately eroded	0.70

Source: compiled by the authors from Technical Bulletin No.9, 1991, AIS & LUS, New Delhi

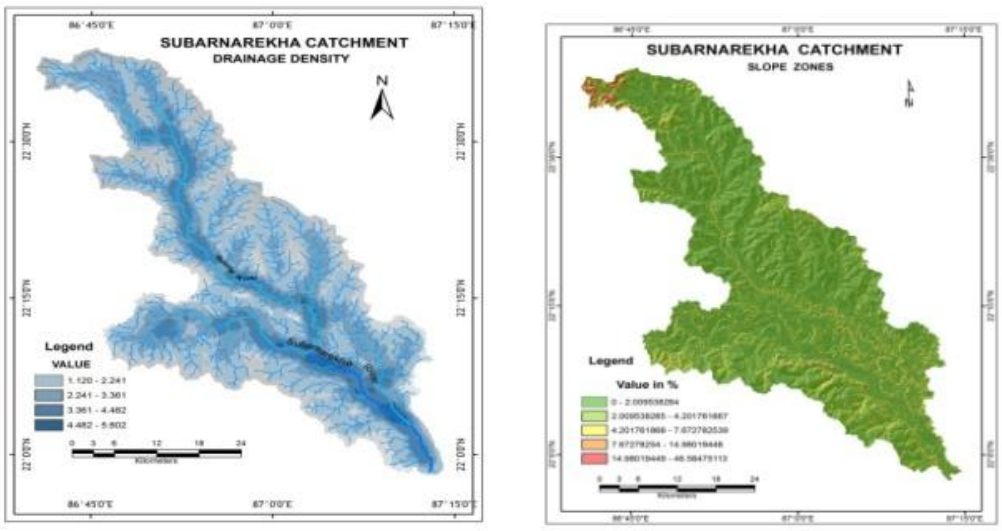


Figure: Correlation between slope and drainage density.

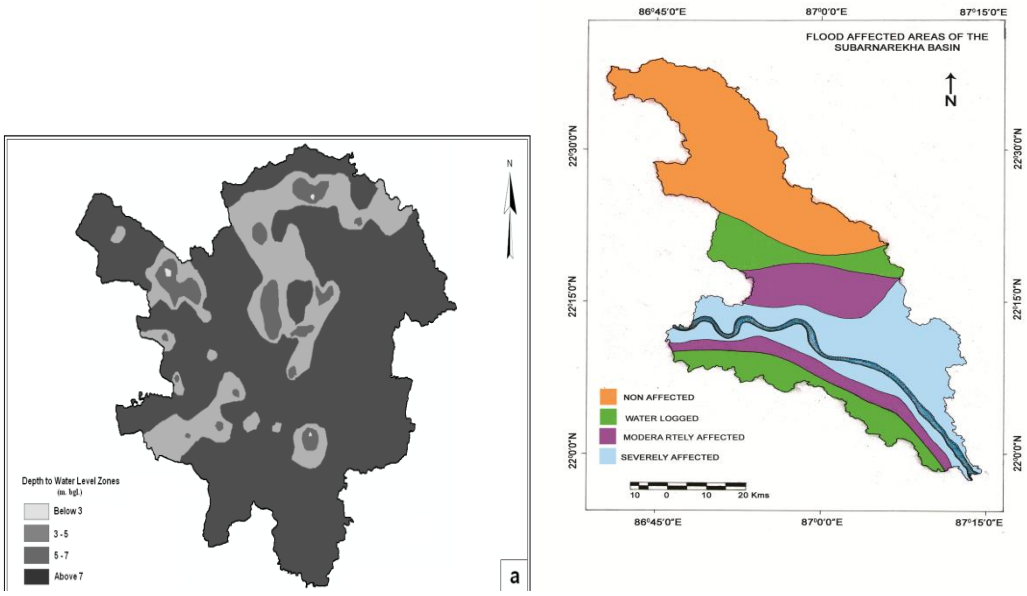


Figure: Correlation between monsoon season ground water level and flood affected areas.

3.3 Meteorological characteristics and its bearing on flood:

a) Meteorological Characteristics of the Basin:

The basin tract experiences a climate of the transitional type of moderately hot and wet conditions having 150 cms. average annual rainfall. The winter months remain almost dry. During the transitional period of the south-west and north east monsoons, a series of depression pass over the region bringing heavy rain, disturbs the weather condition and becomes the cause of flood havoc and drainage congestion. Most of the rain in the catchment occur during June of September i.e. during the prevalance of the South-west monsoon. Keshiary.Mohanpur and Narayangarh are also get cyclonic rainfall in PaschimMedinipur district.

Lowest temperature in the catchment area is recorded in the month of December. May is the hottest month when the temperature rises up to 38^0c in the Basin area. The atmospheric pressure is also controlled be the seasonal shitting of the pressure belts of India. From October to the end of January the prevailing wind direction is from the north east and the reverse order prevails from April to the end of September. Eighty percent (%) of the total rain is received only within four months of the ear i.e. from June to September in the basin.

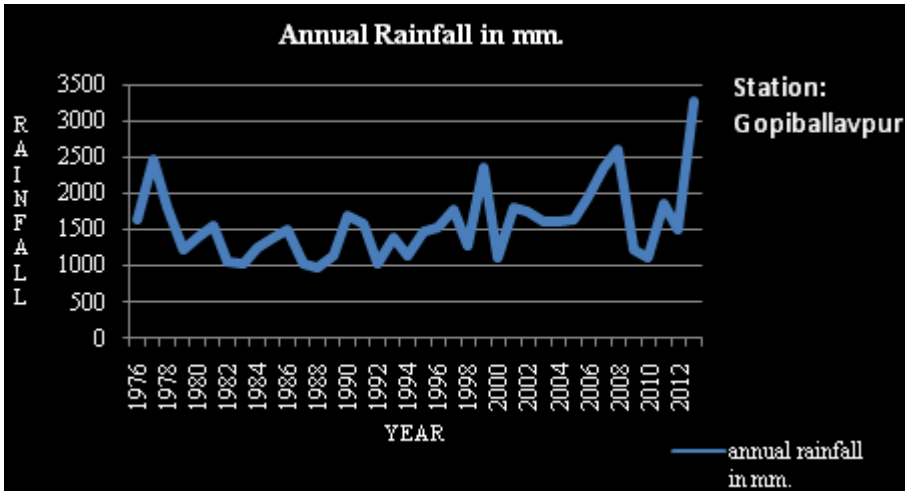
For the percent investigation, the month of June, July, August and September are the most important. In the year of normal rainfall, the distribution of rainfall controls the crop yield, in the years of draught the failure of the rains causes scarcity of water and famine and in the year of excessive rainfall, the amount and distribution of precipitation determine the nature and intensity of the floods. It has been rightly marked that there is an intimate relationship between the occurrence of the maximum discharge in the rivers and the intensity of rainfall and occurrence of storms and depressions in the Bay of Bengal. (sinha, 1970).

Table 4: Normal Rainfall in the Subarnarekha catchment

Section	Rainfall up to may (mm)	Rainfall up to October (mm)	Rainfall during monsoon period (mm)	Yearly average rainfall (mm)
Subarnarekha basin in PaschimMedinipur district`	382.57	1763.25	1014.50	1610.00

b) Rainfall in the catchment area:

The distribution of normal rainfall in the catchment are shown in the table 5.1.The seasonal distribution of normal precipitation in the catchment show that the monsoon rainfall is more than of the total rainfall over the catchment . The maximum rainfall occurs over the upper portion of the Subarnarekha basin and respected study area, in the monsoon period that leads to determine the nature and intensity of flood in lower reaches of Subarnarekha basin. In monsoonal period, during heavy rainfall lowers portion of the Subarnarekha basin i.e. mohanpur, Datan, Narayangarh in PaschimMedinipur district are afraid from flood.



c) Intensity of rainfall in the period preceding the floods. The analysis of the rainfall records and the gauge reading as shown in table 5.3, it is noticed that the precipitation beyond the 5th day preceding the Occurrence of a high flood increase gradually and it is usually the second and third day preceding a flood is effective.

Table 5: Daily average rainfall (in mm) in the catchment basins during 5 days preceding the floods and two day succeeding the flood of different magnitude observed at their heads.

Name of the river	*Gauging site*	*Date of flood*	*magnitude*	*Gauge height in mt. with date & time*			*Rainfall in mm. for days preceding the flood*	
				Date	*Time*	*Height (mt.)*	*Date*	*Rainfall (mm.)*
SUBARNAREKHA	ASUI-DHARAMPUR	06.07.07	Medium Flood	06.07.2007	6.00AM	45.20	01.07.2007	72.58
					9.00AM	45.42	02.07.2007	84.30
					12.00 PM	45.62	03.07.2007	88.40
					3.00PM	45.82	04.07.2007	130.50
					5.00PM	45.72	05.07.2007	260.10
					6.00Pm	45.58	06.07.2007	26.00
					10.00PM	45.50	07.07.2007	2.00
					12.00PM	45.40	08.07.2007	0.00
SUBARNAREKHA	ASUI-DHARAMPUR	19.06.2008	High Flood	18.06.2008			13.06.2008	42
							14.06.2008	46
							15.06.2008	78
					6.00AM	45.50	16.06.2008	164
					9.00AM	46.62	17.06.2008	97
					12.00PM	46.72	18.06.2008	595
					3.00PM	46.88	19.06.2008	60
					6.00PM	46.90	20.06.2008	1
					7.00PM	46.92	21.06.2008	0.00
					10.00AM	46.35	22.06.2008	4
				19.6.08	6.00AM	46.10		
					7.00AM	45.90		
					9.00AM	45.75		

For the analysis of that two flood the water of river Subarnarekha has touched D.L. is 45.50 mt. at about 10.30 AM on 06.07.2007 and reached maximum level 45.82 mt. at. 2.00 PM on Same day. The water level dropped bellow D.L. at 10.00 PM on the Same day. In the year of 2008 the water of River Subarnarekha has crossed Extreme Danger Level (E.D.L.) is 46.50 mt. at about 46.92 at 7.00 P.M. on 18.06.2008 , rainfall recoded to 18.06.2008 is 595 mm.

water level reduced bellow danger level is 45.50 mt. on 26.06.2008 is 44.22 mt.

The long floods usually occur when the heavy rainfall of over one inches per day occurs for 5 Consecutive days where as for the short duration this is for about three days. Before the arrival of flood water in the Subarnarekha catchment the flood water Comes earlier through their distributaries depending upon the nature of rainfall in their respective catchments. Thus before the arrival of flood water in the Subarnarekha catchment the other drainage channels filled up with the rain during heavy rainfall in monsoon period. This situation along with the low gradient and high underground water table reduces the flood slope and aggravates the flood situation to a great extent.

4. Result Analysis

For the present study of the frequency of flood in the river gauge readings have been taken at their respective head to analyse for a period of approximately thirty five years i.e. from 1978 to 2012. For this purpose, it is assumed that a flood is that stage at which the stream channel becomes filled and overflows its banks. In as much as the banks of a stream vary in height throughout it course, there is no definite stage for the whole stream, above which a river can be said to be in flood and below which it is not in flood. And usually and arbitrary elevation has been established based on the experience at the river head and lower reaches which are usually called as the danger level of the flood and when the river discharge exceeds that danger level, the river is said to be in high flooding .

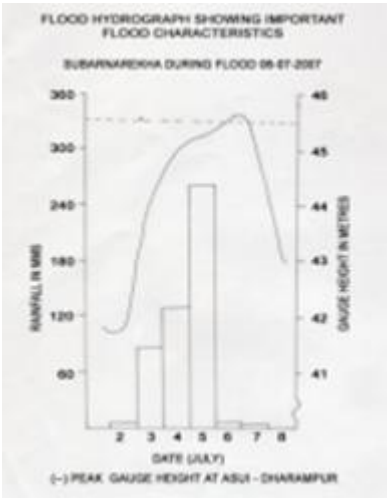
Table 6: Flood stage of the Rivers at their gauging station

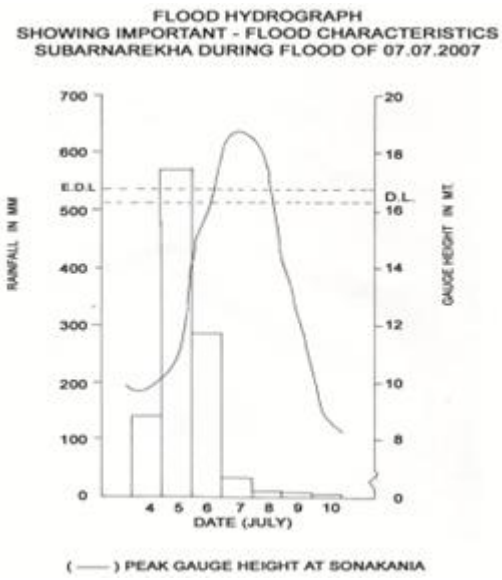
River	Reading station	Danger level in metres	Extreme danger level in metres
Subarnarekha	Asui-Dharampur	45.50	46.50
Subarnarekha	Sonakonia	16.15	16.75

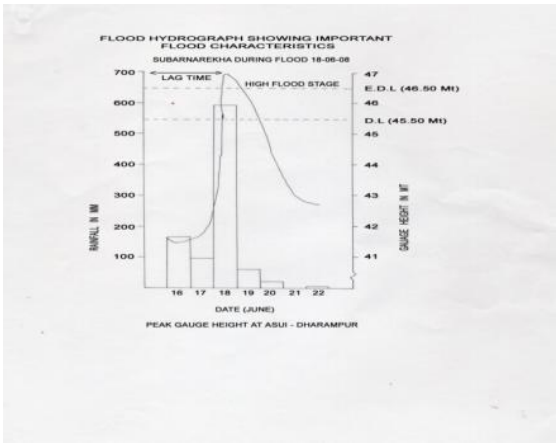
This flood stage has been again categorized into low floods, medium floods and high floods. The Subarnarekha has experienced maximum number of floods i.e. 5 high floods, 8 medium floods and 6 low floods out of the total of 19 floods . The probability of the occurrence of floods i.e. the average return time of a flood of particular intensity has been calculated with the division of total years of record by the total number of floods of that intensity. The time period so obtained gives the probability value i.e. after intervals of that period a flood of that intensity or more is likely to occur. Thus the probability of occurrence of floods of high, medium and low intensity is 7.00, 4.38 and 5.83 years respectively.

Table 7: Flood frequency and Probability of occurrence

River	Total no. of floods	Flood category					
		High		Medium		Low	
		No. of occurrence	Probability of occurrence(years)	No. of occurrence	Probability of occurrence(years	No. of occurrence	Probability of occurrence(years
1	2	3	4	5	6	7	8
	19	5	7.00	8	4.38	6	5.83







References

[1] Abbas, B.M., "control of Floods in East Pakistan", Scientific Problems of the Humid Tropical Zone Deltas and their Implications, UNESCO, 1966, PP. 135-139.
[2] Acharya, B.C., "The Drainage pattern of Mahanadi in the Lower Reaches", (Memiographed), Cuttack.
[3] Acharyaya, B.C., "The Mahanadi and its floods", Selected Papers of Physical Geography. 21st international Geographical Congress, Vol.I, 1970, pp. 165-167.
[4] Assessment of Ground Water potential zone in paschimmedinipur District, West Bengal – A Meso-scale study using GIS and Remote Sensing Approach.
[5] Barry, R.G., "Precipitation", In water, Earth and Man – A synthesis of Hydrology, Geomorphology and socio-Economics Geography, (Ed.) R.J. Chorley, Methuen & Co. Ltd., London, 1969, pp. 113-129.
[6] Barry, R.G., "The World Hydrology Cycle", in water, Earth and man – A Synthesis of Hydrology, Geomorphology and Socio- Economic Geography, (Ed.) R.J. Chorley Methuen & Co. Ltd., London, 1969, PP. 11-30.
[7] Chorley, Richard. J., "The application of Statistical Methods to Geomorphology", in Essays in Geomorphology , (Ed.), G.H. Dury, Heinemann, London, 1970, PP. 275-3870.
[8] Chorley, R.J., (Ed.), Water, earth and Man – A Synthesis of Hydrology, Geomorphology and Socio-Economic Geography, Methuen & co. Ltd., 1969, Pp. 405-572.