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FLOODS IN COOCH BEHAR: NATURE, ANALYSIS AND MITIGATION

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ABSTRACT:
Flood is one of the most severe disasters frequently suffered by human and cattle lives which are caused due to cumulative effects of weather events and it is found as the acute environmental hazard of Cooch Behar district of West Bengal. The flood in Cooch Behar threatens the lives and properties of large number of people almost each year. The reasons for floods are excessive rainfall within short duration in small catchment areas and simultaneous melting of newly formed glacier accumulated on eastern Himalaya and continuous heavy rainfall on downstream area of these rivers namely Teesta, Torsa, Jaldhaka, Kaljani and Raidak caused floods. Moreover in the upper courses of river released a huge amount of water in a short period through these rivers caused devastation flood. Present paper is concerned with the study on the problems of flood of Cooch Behar district. It also includes a detailed discussion on the nature, extent, causes and consequences of floods and here we also discuss the present status of embankments and possible flood prone areas of the catchments for the purpose of analysis of the flood hazards and suggests suitable controlling measures for its revival.

KEYWORDS: Objectives, causes of floods, effects of floods, predictable areas of flood and controlling measures.

IJELLH
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INTRODUCTION:

Flood simply means inundation of widespread land area with water for a number of days in continuation. Cooch Behar district is a land of many perennial rivers and river basins; it's also a flood prone area. There are quite a few big rivers namely Teesta, Jaldhaka, Torsa, Kaljani, Raidak etc. and a number of smaller ones Gadadhar, Kaljani,Dharla, Baniadaha, Giridhari, Dudua, Gilandi, BuriTorsa, Sutunga,etc. which have crossed the district. The rivers inthis district generally flow from northwest to southeast direction. It is a common experience that every year during rainy season when intensity of rainfall is slightly higher than normal and released unbelievable volume of water through the upstream of Torsa, Teesta and Jaldhaka rivers, the surrounding area of these rivers remains under water of considerable period of time creating inconvenience to the inhabitants. So, flood has been considered to be the most devastating natural hazard faced by the flood plains of Cooch Behar district. The problem of flood is more complicated to handle in this district because of two particular aspects, such as: (1) enormous bank erosion of these rivers and (2) many embankments are vulnerable condition.

PROBLEMS:

On the basis of field investigation it has been found that flood and its impact are major problem in the study area. The problem under study is to assess the nature, extent and predictable areas of flood of Cooch Behar district and to determine specifically the causative factors of devastation both natural and anthropogenic, in details through data generated from intensive field work, Indian Meteorological Department (IMD) and Disaster Management Office of Cooch Behar. Moreover the excessive siltation, accumulation of wastes and huge amount of eroded soil particle are gradually loading the bed of river channels, for which nowadays flood has become a major problem in this area. This research work will deal particularly with one of the current issues of effect of floods as well as different problem of human beings related with severe damages.

STUDY AREA:

The Cooch Behar district of West Bengal has been selected for this research study. The study area is bounded by 25º 57′ 4′′ North to 26º 32′ 20′′ North Latitudes and 88º 47′ 40′′ East to 88º 54′ 35′′ East Longitude (Figure 1). The Cooch Behar district covering an area of 3387 sq. km is divided into 5 sub-divisions namely Cooch Behar Sadar, Dinhata, Mathabhanga,

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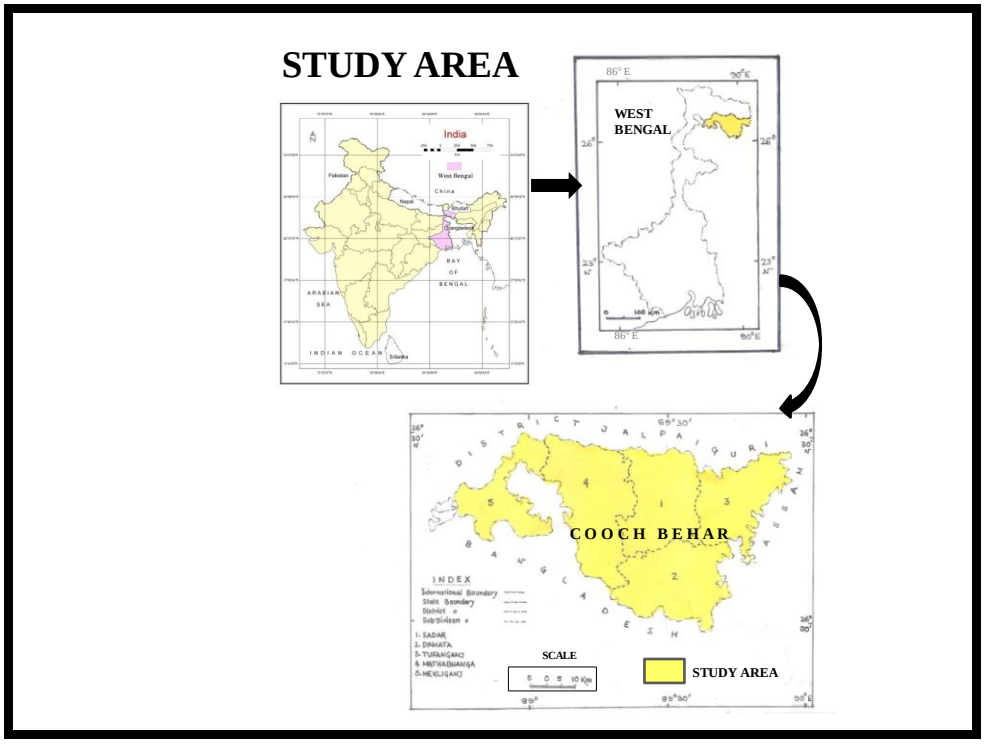
Tufanganj and Mekhliganj. This area represents a zone of transition between Duars (Tarai) land and Bangladesh, and displays the typical characteristics of the formation of cut-offs (Bils), ox-bow lakes, paleo channels and streams which are mostly perennial of nature and flow in their full capacity in rainy season.This area has been formed by sediment deposited by the Tista, Jaldhaka and Torsa rivers.

FIGURE: 1 Study area



OBJECTIVES:

Severe, precise and rational objectives have been chosen for the scientific research of the above mentioned problem of the study area, which are noted below-

1. To draw attention to the problem of flood in the study area.
2. To examine the nature and extent of this.
3. To emphasize the major causes of floods.
4. To evaluate the impact of flood hazard on the socio-economic life of human beings.
5. To highlight the predictable areas of flood.
6. To suggest suitable controlling measures for its revival.

METHODOLOGY:

This research work is based on the empirical study of flood hazard. A systematic methodological principle was followed in this research work. The entire work can be represented into three broad categories which are noted below-

1. **Pre field study:**

At the beginning intensive literature review from related books, journals, articles, government publication, direct investigation etc. has been done to identify the research problem and selecting the study area and topic of this research work. The spatial information has been collected from different govt. office like Water and Irrigation Division, Cooch Behar; Disaster management Office of Cooch Behar and Indian Meteorological Department (IMD) data were also taken in to consideration.

2. **Field study:**

Primary data and secondary data has been obtained through intensive field survey, internet and current News Papers. The study of imperial observation has been done very carefully through measurement and analysis process to know the problem, causes and effects of flood hazard and existing management structure.

3. **Post field study:**

Data and others information available and generating on the field were compiled using appropriate modern techniques on computer and satellite images, topographical map and drainage map of irrigation department. The collected data have been quantified, analyzed and synthesized by using standard statistical methods which are helped to predict flood affected areas of Cooch Behar district.

LITERATURE REVIEW:

After independence some famous scientists and geographers published too many research papers on the nature, problem, impact and mapping of flood hazards. Here are the following articles and books published in the 21st century should also be mentioned of- 'Flood in West Bengal: Nature, Analysis and Solution'-(2002) by Sunil Sen Sarma; 'Floods in West Bengal, 2000- Causes and Consequences' (2002) by Dr. KalyanRudra; 'Flood Problems of Jalpaiguri Town' (2002) by Subir Sarkar; 'Flood Hydrology and Basin Environment of Barak River, Assam' (2002) by Dipanwita Bhattacharya, D. C. Goswami; 'Socio-Economic Impact of Flood in Murshidabad'(2005) by B. Majhi, K. Dey, M. Ghosh, R. Biswas; 'Flood and its Management in the Brahmaputra Basin'(2005) by Subhas Chandra Mukhopadhyay; 'Flood Hazards and Interlinking of Rivers: West Bengal Perspective'(2005) by P. Chakrabarti; 'Flood: As a Climatological Hazard'(2007) by GuruprasadChattopadhyay. According to the official report by Water and Irrigation Division, Govt. of West Bengal, Cooch Behar and Disaster Management Office, Cooch Behar there could be number of reasons for the flood hazard of Cooch Behar district.

IJELLH
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HISTORY OF FLOOD OCCURRENCES IN COOCH BEHAR DISTRICT:

The following are the major incidences of floods in Cooch Behar district.

TABLE: 1.

Types of Flood	Year of Occurrence	Affected Area (In %)	Impact of Life (In %)	Affected Livestock (In '000)
Flash Flood	1993	60	40	90
Flash Flood	2006	30	20	30
Flash Flood	2007	25	10	15
Flash Flood	2008	45	30	50
Flash Flood	2009	20	15	10
Flash Flood	2010	35	20	20

Source: Cooch Behar Irrigation Division (2013), Govt. of West Bengal.

TABLE: 2

Details of Devastating Floods that occurred during 2004-2014

Date	Affected areas	No. of affected Blocks and villages	Affected people	Causes of Flood	River
12July, 2004	Mathabhanga, Santoshpur, Toofanganj Block-I, Arampur Spur-I, Balarampur	341 villages in 10 blocks and 14 wards of two municipalities	69,968 people	Heavy rainfall and embankment creaks.	Raidak-I,Mansai, Kaljani and Gadhadhar
28 July, 2007	Mathabhanga, Kedarhat and Jorshimuli	113 villages and about 500 families	2 people death and 25000 people	Heavy rainfall	Torsa,Mansai and Sankosh
	Mekhliganj,T	All wards in Cooch Behar	Thousands	Torrential	Teesta,

22 July 2008	ufanganj, Mathabhanga, Ghonapara and Mahishkuchi in Tufanganj sub-division	town turnd waterlogged and villages of Mekhliganj and Tufanganj are affected.	of people	rainfall(In the past 24 hours in Cooch Behar is 134mm. 152mm in Tufanganj and 69.80mm in Mathabhanga)	Raidak-II,Mujnai andTorsa.
27 August 2008	Mekhliganj and Cooch Behar Sadar (Rasmela ground, minibus stand and Keshab Road).	wards 1, 2, 3, 6, 7, 10 and 11.	Stagnant water has inundated more than 2,000 housesin Cooch Behar Town.	Heavy rains for the past 24 hours(229.60 mm)in Cooch Behar.	Teesta
17August , 2009	25-Teesta Payosthi, 40-Payosthi, 72-Nijtaraf, Kuchlibari and Paniyarchar at Mekhliganj sub-division	Mekhliganj Block	337 families	Rainfall in the past 24 hoursrecorde d at Tufanganj 300 mm, Cooch Behar 121 mm and Mathabhanga 49 mm	Teesta, Torsa,
17 June, 2012	Tufanganj, Dinhata and Cooch Behar	Tufanganj-I & II, Dinhata-I, Cooch Behar-I & II and Municipalities are	40,000 people	continuous rainfall in past 24hours	Sankosh, Rydak, Kaljani,

	(Sadar) subdivisions.	inundated		(246.5mm)	Torsha and Mansai
17July, 2012	Mekhliganj, Mathabhanga and Cooch Behar town	Cooch behar-I & II, Mathabhanga- I & II and Mekhliganj Blocks	50,000 people	Heavy rainfall, Teestaembankmen has been damaged, Excess water released from the reservoirs of Bhutan and hill areas.	Teesta, Torsa, Jaldhaka, Kaljani and Sankosh
28August 2014	villages of Natabari, Chilakhanaand Bhuchumari.	Tufanganj-I & II, Cooch Behar-I & II	25000 people	Heavy rainfall on 26 August (150 mm)and damaged of embankments.	Kaljani

Source: https://www.google.com

CAUSES OF FLOOD:

The causative factors of flood are classified into two important groups- (A) Natural and (B) Anthropogenic. All these factors are described below-

A. Natural causes:

1. Flood can be caused by heavy rainfall when the intensity is slightly higher than normal. Heavy rainfall in the upper catchment areas of these rivers causes sudden increase in volume of water in downstream. Very heavy rainfall exceeding 256 cm per annum in the catchment area of the rivers.

2. Heavy local rainfall also caused large scale inundation at the municipalities of Cooch Behar district.

TABLE: 3

AMOUNT OF MONTHLY (JUNE - SEPTEMBER) RAINFALL DATA (IN CM) AS RECORDED AT COOCH BEHAR FROM 2006 TO 2012

Year	Monthly Rainfall in cm				Total Rainfall in cm	Highest Rainfall	
		July	August	September		Rainfall in cm	Date
2006	53.57	69.12	14.38	50.65	256.00	19.06	30/05/2006
2007	48.65	61.83	50.53	54.72	280.83	16.50	07/09/2007
2008	84.87	66.87	117.17	27.95	378.86	34.57	14/06/2008
2009	53.58	36.05	85.66	23.86	273.47	20.57	13/08/2009
2010	70.72	94.99	59.37	59.66	374.10	21.98	22/07/2010
2011	43.75	92.13	53.49	38.72	289.80	23.92	18/09/2011
2012	11.77	94.63	42.92	59.24	391.53	25.20	06/07/2012

Source: Cooch Behar Irrigation Division (2013), Govt. of West Bengal.

3. Narrowness of the river valleys obstructs the normal discharge of water which causesof flood.
4. Excessive siltation has raised the river bed considerably which has reduced the capacity, competency and discharge of river water.
5. Enormous bank erosion or channel shifting and creaks of embankments caused floods in study area.
6. Highly sinuous, meandering and braided channel patterns of these rivers obstruct the normal discharge of flood water which delays the passage of water resulting into stagnation of water in flood plain.

B. Anthropogenic causes:

1. Human interference namely construction of bridges, culverts and buildings caused devastating floods.
2. Excess water released from the reservoirs of Bhutan dam during rainy season.
3. Growing habitation in the flood plain area also helps in increasing the surface run-off and therefore dimension and magnitude of floods.

4. High rate of deforestation is perhaps the most important anthropogenic factor of the causes of floods in the upper catchment area of these rivers.
5. Lack of appropriate water management plan.

TABLE: 4

Maximum Gauge Reading in different rivers of Cooch Behar district from 2002-2012

Year	River Torsa at Cooch Behar D.L./Y-42.07 M E.D.L./R-42.68 M		River Raidak at Tufanganj D.L./Y-47.00 M E.D.L./R-47.90 M		River Mansai at Mathabhanga D.L./Y-47.90 M E.D.L./R-48.40 M	
	Highest Gauge Reading (in metre)	Date	Highest Gauge Reading (in metre)	Date	Highest Gauge Reading (in metre)	Date
2002	42.38	24/7/02	35.93	22/7/02	49.32	24/7/02
2003	42.54	01/7/03	35.18	08/7/03	49.35	01/7/03
2004	41.75	08/7/04	36.34	09/9/04	48.72	08/7/04
2005	42.18	19/7/05	35.01	17/7/05	48.68	19/7/05
2006	41.36	28/6/06	35.13	28/6/06	48.97	07/7/06
2007	42.62	07/9/07	36.13	08/9/07	49.85	07/9/07
2008	41.90	29/8/08	35.60	30/8/08	47.94	29/8/08
2009	42.02	20/8/09	35.85	06/7/09	48.18	20/8/09
2010	42.34	21/7/10	35.04	22/8/10	48.00	21/7/10
2011	41.28	10/7/11	34.81	20/7/11	47.40	01/07/11
2012	41.88	15/7/12	36.09	27/6/12	48.05	15/07/12

Source: Cooch Behar Irrigation Division (2013), Govt. of West Bengal.

IJELLH
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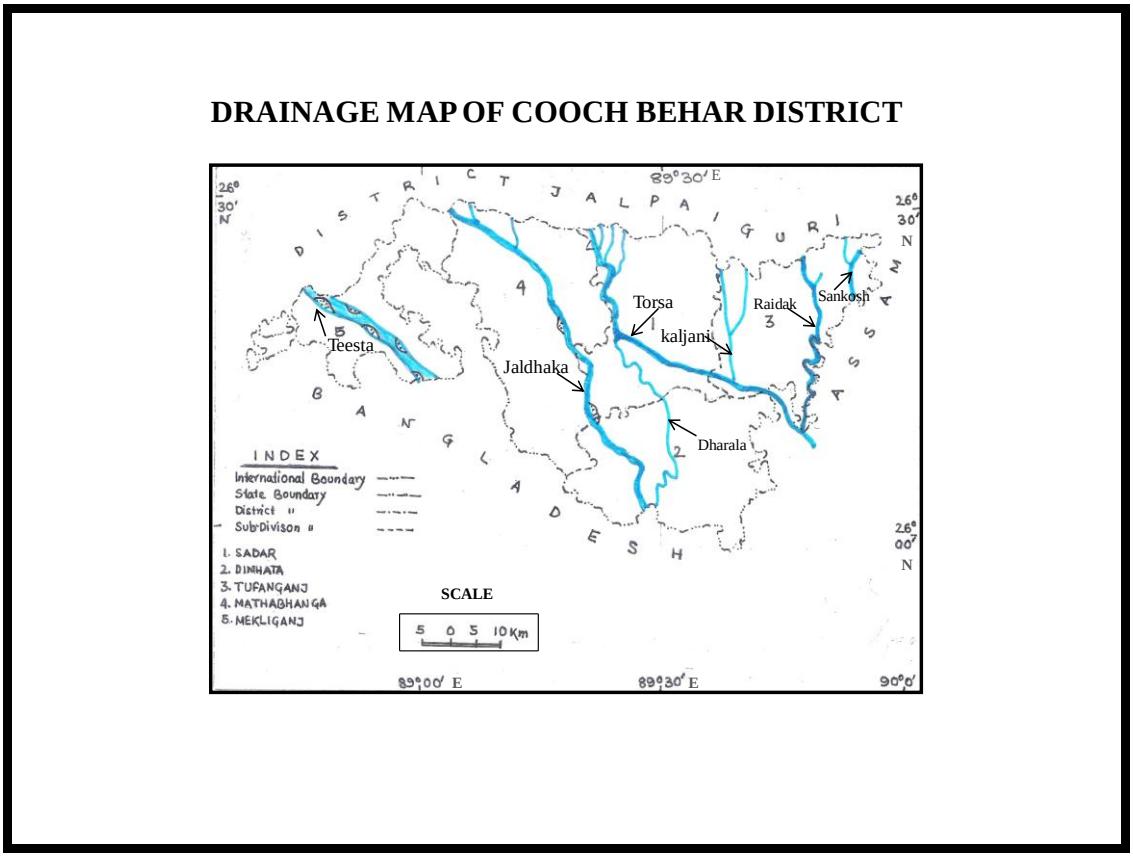
FIGURE: 2

Drainage map of Cooch Behar district



RESULTS AND DISCUSSION:

All sub-divisions of Cooch Behar district are more or less affected by flood. Flood has damaged socioeconomic effects and also affected significantly the socio economic spheres of the people of the locality. This is a perennial and one of the most intensive problems at flood plain of Cooch Behar.

According to Cooch Behar Irrigation Division, all flood plain areas of Cooch Behar are inundated almost every year. In the previous year, Cooch Behar was the worst sufferer as the district received over 34 cm rainfall in a day. The given map (figure: 3) illustrate the major flood prone areas of Cooch Behar district.

After flood a considerable number of people become homeless some of them lose their only agricultural land or their vegetable garden and crops due to the massive bank erosion of Tista, Mansai, Torsa and Dharla rivers. Not only that a number of cattle even villagers died in last flood occurred on 1993, 2001 and 2007. During flood period, humans can lose so much. About thousands of people are directly affected each year by flood in the study area.

IJELLH
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TABLE: 5

Total no. of household likely to be affected by Flood in Cooch Behar District

Name of the Blocks	Name of the River	Flood prone areas	Total no. of affected household
Mathabhanga-I	Mansai, Sutunga, Dharlla and Nenda	Mathabhanga Municipality Ward no. 3,5,7,9,10,11&12. Kedarhat ,Gopalpur, Nayarhat, Hazrahat, Sairagirhat, Pachagarh, Shikarpur, Kurshamari and Jorepatki Gram Panchayet.	12,110
Mathabhanga-II	Dudua, Gilandi, Jaldhaka, Torsa, BuriTorsa and Mansai	Fulbari, Lotapota, Ruidanga and Linishabisha	5,550
Sitalkuchi	Mansai and Dharlla	Bhowarthana, ChhotoSalbari and Cawardara	6,055
Mekhliganj	Jaldhaka, Teesta	Mekliganj Municipality Ward no.3,7,8 and 9. Uchalpukuri, Ranirhat	3,770
Haldibari	Teesta	Haldibari Municipality Ward no. 1,2,5,8 and 11. Boxiganj and Per- Mekhliganj	4,200
Tufanganj-I & II	Raidak-I & II, Sankosh	Mahishkuchi- I & II, Rampur-I & II, Falimari and Barokodali-I & II,	76,698
Cooch Behar-I & II	Raidak- I & II, Gadadhar, Kaljani, Torsa and Ghargharia	Chilakhana- I & II, Natabari- I & II, Maruganj, Deocharai, Balarampur- I & II and Balabhut.	11,135
Dinhata- I & II	Singimari, Dharla, Baniadaha	Salbari-I & II, Gosanimari-I & II, Petla, Okranbari, BoroSoulmari, Atiabari-I & II, Gitaldaha- I &II	21,836
Sitai	Singimari&Giridhari	Adabari	1,225

Source: Cooch Behar Irrigation Division (2013), Govt. of West Bengal.

IJELLH
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Flash flooding in the Himalayan rivers in a flood plain morphology is very common due to locational instability of the channel network, covering Cooch Behar district.

FIGURE: 3

Flood Prone area of Cooch Behar District

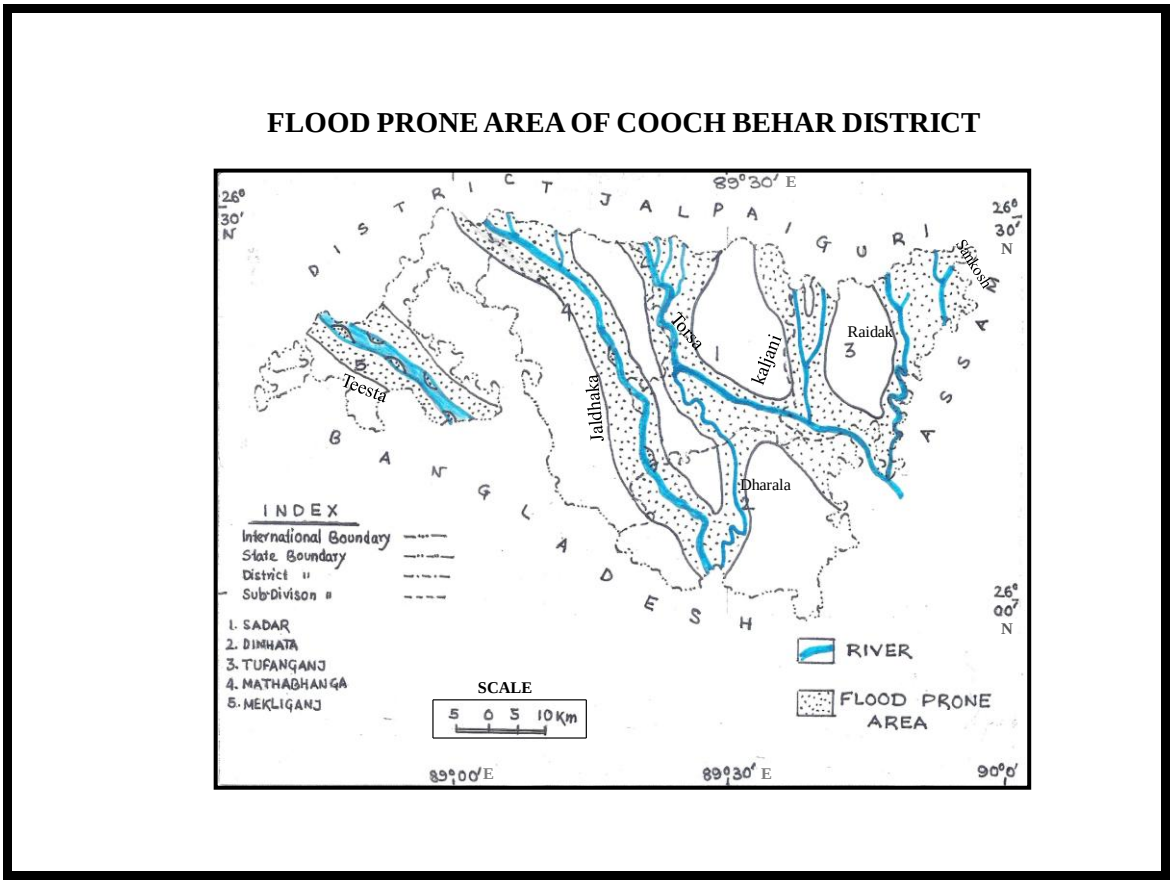

Table: 6

River Catchments and its Flood affected area in the Cooch Behar district

Major Rivers	**Block likely to be affected by Flood**
Teesta	Mekliganj and Haldibari
Jaldhaka/ Mansai	Mathabhanga-I& II, Dinhata- I and Sitai
Torsa	Cooch Behar-I and II
Kaljani	Cooch Behar-I and II, Tufanganj- I and Dinhata-II
Raidak-I	Tufanganj- I
Raidak- II	Tufanganj- II
Sankosh	Tufanganj- II

Source: Cooch Behar Irrigation Division (2013), Govt. of West Bengal.

Flood has great impact on agriculture. Every year, flood has damaged the agricultural crops at study area. Flood destroys the agricultural crops like paddy, jute, etc in affected areas which create the economic problems of the farmers because of their miserable economic condition. Now the flood plain of Cooch Behar will be severely affected in future flood occurrence, if no serious measures are taken immediately.

Table: 7

VULNERABLE AREA WITH WEAK EMBANKMENTS

Name of the Blocks	**Name of the River**	**Bank**	**Length of damage portion(in metre)**	**Affected embankments**
Cooch Behar- I, II & Municipality	Torsa	LB	1300	PurbaGuriahati- Lankabar, Hanskhowa, RajarhatGhierhari and Tapur hat embankments
Cooch Behar - I	Mansai	LB	900	Chhederjhar-Sibpur, Hardev-Chhederjhar area in PutimariFuleshwari G. P. and BairatiJagatjilly embankments
Mathabhanga-II	Torsa	RB	500	Khopaduli
Mathabhanga-II	Mansai	LB	1200	Dewanbose embankment
Mathabhanga-II	Dharala	RB	200	panaguri embankment
Mathabhanga-I	Mansai	RB	100	Bhangamore- Chatkhaterbari embankment
Tufanganj- I	Kaljani	RB	700	Katierkuthi, Chhatowa and Shouldhukri embankments
Tufanganj- I	Kaljani	LB	450	Chilakhana Bandar and Panishala
Tufanganj- II	Raidak-I & II	RB	600	MahishKuchi Spur and Manindrasetu
Tufanganj- I	Gadadhar	LB	450	Santoshpur and Gadadharembankments
Sitai	Mansai	RB	200	Adabariembankment
Mathabhanga-II	Dudua	RB	200	Uttar Doribose

Source: Cooch Behar Irrigation Division (2013), Govt. of West Bengal.

RECOMMENDATION:

Flood is a threatening problem for the people of study area and for the economy of the region as well. The damages of flood are severe. As our country, the study area is densely populated and most of them are directly or indirectly dependent on agriculture with appropriate measures for flood control that are poorly needed. The following recommendations are prepared on the basis of the analysis of this research-

1. Flood is a regular and common phenomenon at Cooch Behar district. Every year, some areas of these subdivisions are getting affected by flood and riverbank erosion. So, a comprehensive flood management Policy should be made.
2. A mass awareness should be made to reduce the tendency of deforestation, agricultural practices and habitation in the flood plain of these rivers.
3. It is so important to make an artificial diversion or a flood wall in the channel bed to get down the velocity.
4. Simultaneously it is also to be said that the anthropogenic effects on river course should be reduce to allow it to flow freely in its own course, otherwise it is quite impossible to make success by adopting a scientific river training management system.
5. Proper steps for relief and rehabilitation for affected areas should be taken. Also, an emergency fund for the flood-induced can be created by the government.
6. Affected people should be consulted before taking any type of flood control measures.
7. Appropriate and sporadic maintenance of the above mentioned protective measures should be mentioned properly.
8. Rescue work should be undertaken immediately after flood situation as per the instructions.

Flood hazard specific instructions:

Before flood:

1. Listen to the radio or TV for information.
2. Keep a stock of dry foods, drinking water, essential medicines and liquid fuel or emergency cooking arrangements.

During flood:

1. Supply of safe drinking water, dry foods and essential medicines to the affected areas.

2. Do not try to cross a flowing river where water is above knee level.
3. Do not drive into flooded areas.
4. Follow suggested evacuation routes.
5. Shut down the main electric supply, if any damage is noticed to the electric equipments.

After flood:

1. After flood there is a possibility of spread of water borne diseases; hence medical treatment should be taken immediately.
2. Destroy the foods that have been affected by flood-water.
3. Do not hold live electronic equipment in damp areas.
4. Do not go near the vulnerable riverbank even after the flood-water has receded.
5. Do not follow any shortcut process for rescue work.
6. After flood stay tuned to radio.
7. Proper arrangement for supply of food, shelter and clothing to affected people.
8. Speedy re-establishment of different transport and communication system namely roads, railways, postal services, etc.

CONTROLING MEASURES:

It is very important to follow some mitigation measures to prevent future damages. Looking at the previous floods, the Central and State governments took planned steps to control the floods at Cooch Behar. Through a number of measures have already been taken by the government, such as embankment has made, revetment concept has also been introduced. But still the situation is not under control. Huge damage has done at the downstream of rivers due to high rate of scouring mainly in rainy season or at the time of high water level. The flood plain areas of these rivers in the subdivisions of Cooch Behar district are more prone and vulnerable to floods. Proper step should be initiated to control further flood in the flood plain areas. There are several steps to control or minimize the menace of floods, which are as follows-

1. Flood forecasting is crucial and very helpful for taking timely action to prevent loss of many lives and moveable properties.
2. The channels of Teesta, Jaldhaka and Torsa rivers more prone to flood improved by deepening and widening.

3. Legislative measures are taken to restrict the construction of residential units and other economic activities in the flood prone areas. Under legislative commitment, constructions are not allowed in flood plain.
4. Reduction of surface run-off is one of the very effective methods of flood hazard management. This can be done by large scale afforestation in the upper catchment area of the rivers. Run-off reduction helps in reducing soil erosion which leads to reduced streams sediment load and helps in maintaining the capacity, competency and discharge of these rivers.
5. Floods can be controlled by construction of dams. Dams has the capacity of holding huge amount of water during flood and also help in reducing peak water level of river channels.
6. Construction of additional dykes and embankment along the river. Construction of embankment is still considered to be one of the very successful devices against inundation of the inhabited areas and agricultural land areas.
7. The volume of water during flood period of a river may be reduced through a series of engineering techniques such as, construction of flood control storage reservoirs.
8. People involvement through education and consciousness among the potential victims are also proposed as a mitigation measure for reducing flood damage.

FINDINGS:

From the above comprehensive study I have assembled several important aspects, which are noted below-

1. Loss of many human and cattle lives.
2. Damage and destruction of many human constructions, namely earthen buildings, roads or highways, bridges, etc.
3. A large number of people become homeless some of them lose their only agricultural crops due to these floods.
4. Flood creates bank erosion and embankments failure which may inundate the vast flood plain area.
5. Every year lots of inhabitants are suffered by flood in flood prone area.
6. According to my research, after 1993 flood, excessive bank erosion has taken place in flood plain of river Torsa, Teesta, Jaldhaka and Dharala.

7. After flood, in the river Teesta, Jaldhaka, Torsa and Dharla are seen enormous bank erosion which also damages lots of production every year; moreover, loss live stocks, cultivated land, housing land and vegetation cover of this area.

CONCLUSION:

From the above discussion it is clear that the flood has great impact on people's livelihood along with these rivers. In view of the ever-increasing problem of flood hazard in Cooch Behar district, local residents as well as the illiterate people must be made conscious of the possible dangers that they are inviting due to their careless dealing with nature. Natural occurrence such as flash flood cannot be completely stopped from happening but its frequency can be reduced through the success of full management planning and commitment from the policy planners. Keeping in view the intensity of the problems, it is the high time that people from all walks of life should sit jointly to take required precautionary measures.

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