International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 11 | Nov - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Flood Scenario of Lower Basin of Ajoy River with Special Reference to Preparedness, Mitigation and Management Plans

Nani Gopal Mandal

Abstract:

Flood is a most extensive widespread phenomenon in southern parts of west Bengal. Generally flood can be defined in this way it is the overflow of water onto normally dry land caused by rising of water in an existing waterway in lower part of Ajoy river basin mostly inundated in June-September due to the periodic wind of monsoonal rainfall. This project report was emphasizing causes, spatio-temporal scenario, consequences and management of flood hazards in lower basin of Ajoy river. For the visual interpretation and to understand we used different types maps, charts, diagram, plates etc. using MS office word 2013, MS excel 2013 and Q- GIS software.

Keywords: Flood, Causes, Spatio-temporal scenario, consequences, management etc.

1.0 INTRODUCTORY

1.1 Introduction

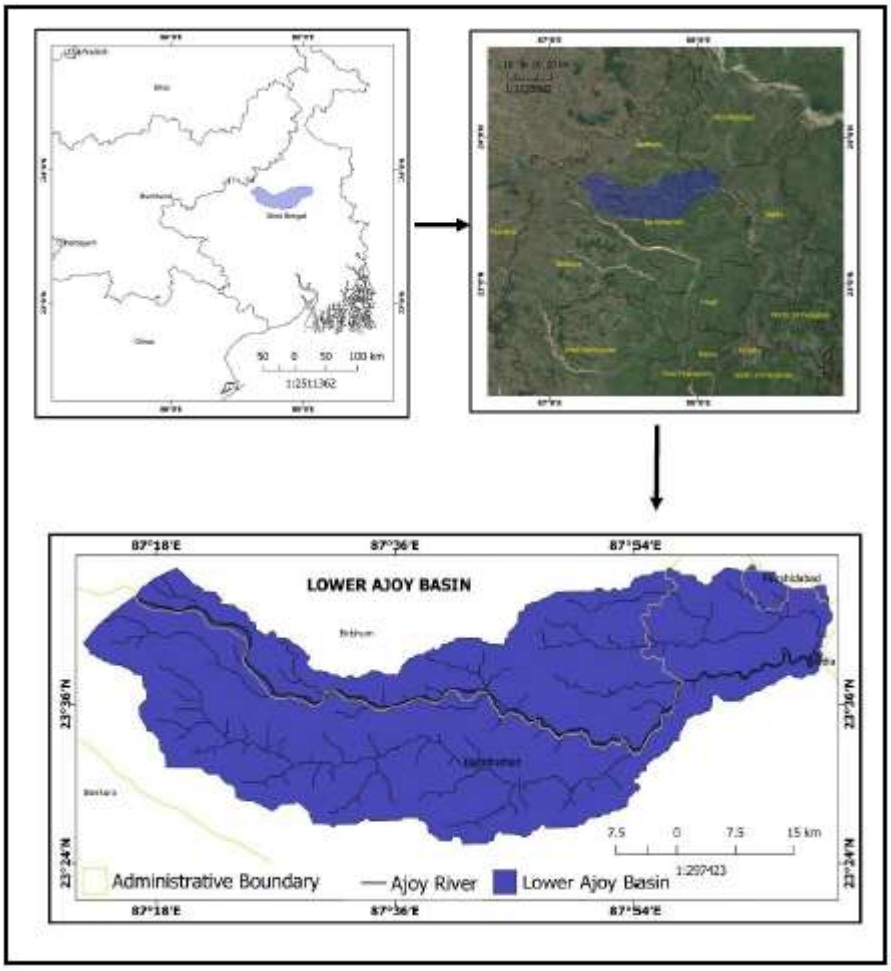
Cumulative atmospheric hazards are those event which are caused due to cumulative effects of weather events which prolong for longer period of time ranging from a few weeks to several years depending upon the nature of the weather events (Singh,2019). Flood is under cumulative atmospheric hazards. Floods occur commonly when water in the form of surface run off exceeds the carrying capacity of the river channels and streams and flows into the neighboring low-lying flood plains (NCERT, 2006). According to Oxford Dictionary flood is- "an overflow of a large amount of water beyond its normal limits, especially over what is normally dry land."
In southern parts of west Bengal are inundated due to monsoonal rainfall in every year but variable intensities. Lower parts of Ajoy River are not exceptional. From the distant past to the present there are so many notable flood records in Ajoy River. The major recorded flood years (Table: 8) are 1971,1973,1978,1984,1995,1999,2000,2005,2007,2008, and 2015 but among these most devastating flood years are 1978, 1995, 1999 & 2000 (Roy, 2012).
Due to the frequent flood condition there are so many losses (Table No.: 1). Therefore, it is necessary to think about the flood issue by emphasizing on the issues of its control in a systematic manner. The preparedness levels of the responded people are determined as a crucial aspect for the flood management (Ghosh, 2020). It is the time to control flood situation and provide assistance among the people in the flood affected areas in the aftermath to assess the damage caused by the floods in study area and return to its normal environment as before.

1.2 OBJECTIVES

I. To study about the Physical and Cultural environment of the study area.
II. To find out the major causes of the flood in lower Ajoy river basin.
III. To show the frequency and Spatio temporal scenarios of the flood hazards.
IV. To find out the flood related problems and possible solutions with special reference to preparedness, mitigation and management plans.

1.3 STUDY AREA

The Ajoy River takes its rise from the eastern fringe of the Chotanagpur plateau in Munger district of Bihar and after traversing the gneissic terrain for a length of 162 km. It encounters the Gondwana sedimentary of the Raniganj -Andal coal fields. Subsequently it flows over the alluvial tract of the west Bengal basin area. For the rest of the course up to the confluence point with the Bhagirathi at Katwa in west Bengal (Niyogi, 1985). The whole basin latitudinally extends from $23^0$25'N to $23^0$45'N longitudinally between 87^0 20'E to $88^0$00'E. Total area of the Ajoy basin is 6221 sq. km but only 2816.65 sq. km area under lower basin of Ajoy river. The lower course of Ajoy River is determined below 80 meter's contours near Pandabeswar where abrupt change in the slope of the long profile is found due to differential geological formation (Mukherjee, 2002). Therefore lower course of Ajoy river basin has been demarcated from Pandabeswar to Katwa and the Lower Ajoy River Basin there are 12 C.D. Blocks which comprise 619 mouzas. Out of 12 C.D. Blocks 5 fall in Birbhum district and rest 7 Blocks are in Burdwan district (Molla, 2011).



1.4 METHODOLOGY

This Project report is based on secondary data. A systematic literature review was done, at first we collect our project related literature from library, e-books, various government & non-governmental websites and various sources of free access online journals from journals of global resources, Ethiopian journals of environmental studies and management, International journal of Remote Sensing and GIS and research gate etc. We also collect satellite images and hydro shed data from Bhuvan and USGS (United States Geological Survey). All

are read thoroughly and try to master the idea about the concern area. Major cartographic techniques, chats, diagram and maps was prepared by using MS office word 2013, MS excel 2013 and Q-GIS Software.

1.5 PHYSICAL AND CULTURAL SETTINGS OF THE STUDY AREA

1.5.1 Physical Settings

The study area is a "transitional zone" between Bihar plateau which constitutes a portion of peninsular shield in the west and Ganga Brahmaputra alluvial plain in the north east (district gazetteer, Bardhaman, 1994:15-16). At Pandabeswar there is a fault line from which the geological formation has been changed and slope in the long profile of the river has also been decreased significantly (Mukherjee, 2002).

On the basis of the slope and other morphological attributes four altitudinal zones have been demarcated in the lower Ajay basin (i) Western plain (80 m to 60m): The region covers the laterite upland on the Gondwana rocks in the eastern part of the Raniganj coalfield. It occupies about 46,623.29 hectares that is 16.55% of the total lower basin area. ii) Western Central plain (60 m to 40 m): It lies in between the eastward extending part of lateritic upland and older valleys of the river system. iii) Central Plain (40m to20m): It has an area of 101963.04 hectares or 36.20% of the total area. It bears the lowest quaternary alleviation and younger alluvial silts in the eastern part. iv) Eastern plain (Less than 20m): It is characterized by the new flood plain, channel deposits and some scattered marshy lands of eastern flank of the Ajay - Bhagirathi system (Mukhopadhyay, 2010).

In general, the study area is located under tropical monsoon climate regime with alternative dry and wet periods (Peterson, 1910:21-22). Mean annual temperature ranges10_0 to 35_0 C from winter to summer. *Kalbaishakhi* and *Loo* are the common characteristics of study area that are blowing from April to May. Lowest relative humidity is observed around March to April and highest is around September to October. Natural vegetation is scanty to moderate. The study area has the remnants of tropical dry deciduous forest (Eco Class III) (West Bengal forest department, 2019) to be recognized.

1.5.2 Cultural Settings

Demography refers the distribution, composition and characteristics of population over the space, where birth, death and migration are most important factors and it is so relevant to hazard response study, preparedness and management plan (Ghosh, 2020). Study area is medium to high population density. As per 2011 census study area shares 12.28% population of total West Bengal population (Table No.: 12). Study area shares important settlements like Pandabeswar, Guskara, Illambazar, Ausgram, Bolpur Santiniketan, Nanoor, Natunhat, Mangalkote, Ketugram, Katwa etc.(Table:11). In study area 65-75% people are literate and 35-25% people have no education (Table No.: 11). Agriculture is the main occupation of the people in this area. Paddy cultivation is the major agricultural production in this area. Most of portion in this area (Table No.: 4) is suitable for agriculture. Study area also has good transportation system. Total study area are connected with others portion of the country via roadways, railways and airways. NH2, NH19, state highways 6, 7,13,14,15, eastern railways and HWH-NDLS rail routes are connected with others state, capital city and administrative unit of our country.

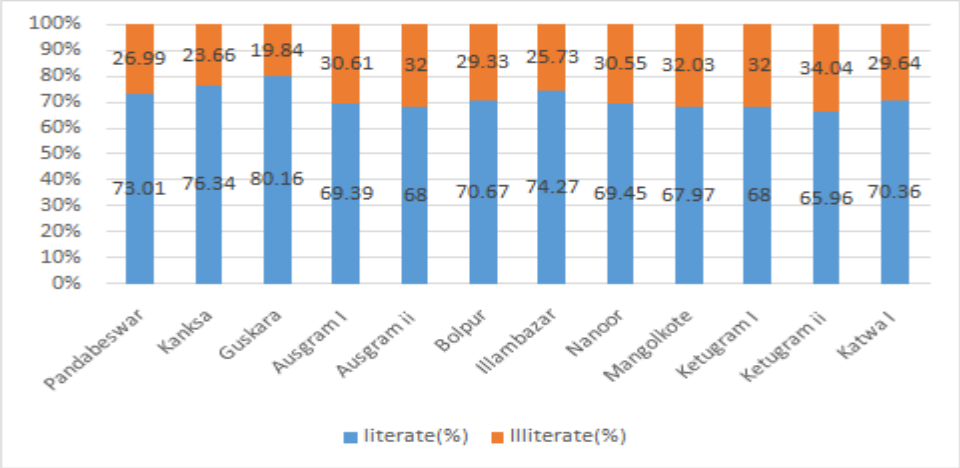


Fig.No.1: Educational Qualification

RESULTS AND DISCUSSION

2.1 CAUSES OF FLOOD

Floods are generally caused by the one or more unfavorable meteorological, physical, human factors so, a combination of unfavorable mentioned factors working together leads a serious flood situation resulting in a disaster (Khullar,2020). Following are the major causes of flood in lower Ajoy basin.

2.1.1 METEOROLOGICAL FACTORS

2.1.1.1 Heavy rainfall

Study area is located in the monsoon climatic regime (Tiwari, 2012) which experience high amount of seasonal rainfall, 1350.7 mm (IMD) as annual average which sometimes more intensified due to the local climatic factors. Generally river Ajoy and their tributaries are more vulnerable to floods in June to September due to heavy monsoonal rainfall (Table No.: 6 &7). In monsoon period upper catchment area (western upland) and lower basin of Ajoy river causes sudden increases in the volume of water downstream. This causes overtopping of river banks by enormous volume of water and consequent inundation and flooding of flood plain areas.

2.1.1.2 Tropical cyclone

Lower Ajoy river basin faces flooding condition due to the heavy cyclonic rainfall. As per previous data analysis the unprecedented flood of the lower basin of Ajoy due to torrential cyclonic rainfall of September 26-29, 1978 explains the impact of high intensity rainfall as potent causative factors of floods. Basically study area faces cyclonic flooding conditions in retreating monsoon period.

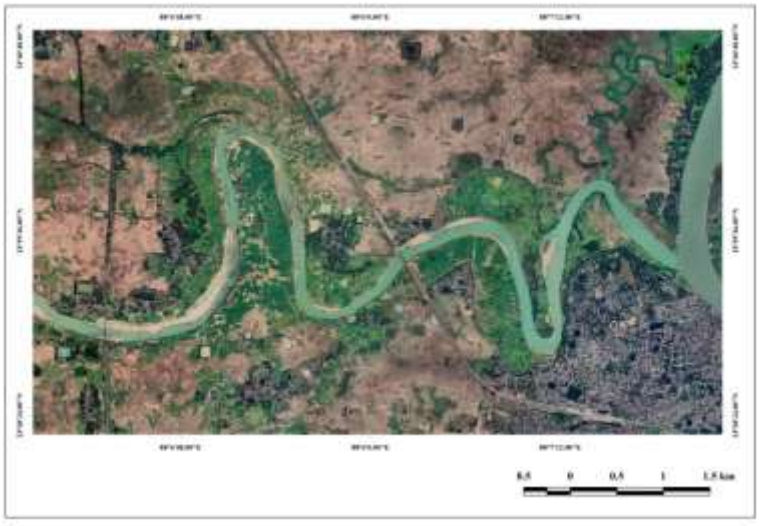
2.1.2 PHYSICAL FACTORS

2.1.2.1 Topographic Causes

Topographically the area, except its north western part, is a flat reverie plain with the height above 20mts. From MSL and remaining portion is below 20mts from MSL. Low variation of topography played a vital role in flood. According to district disaster management and response plan, 2007 in Ajoy River at Katwa was denoted Primary Danger Level (PDL) 13.86mts, Danger Level (DL) 14.40mts and Extreme Danger Level (EDL) 15.00mts respectively. As a result for the change of water level the C.D block of Mangolkote, parts of Ketugram- I and Ketugram- II, Katwa municipality are mostly effected.

2.1.2.2 Sinuous and Meandering Courses

Highly sinuous and meandering courses of the rivers obstructed the normal discharge of water and thus the velocity is reduced which delays the passage of water resulting into stagnation of water so Consequently, meandering valleys are immediately overflow and meander belts and loops are flooded (Singh, 2019). Bottle neck shape (Table No.: 5) of Ajoy river channel is responsible for flood hazards.



Map No. 2: Sinuous Ajoy River Course

2.1.3 HUMAN FACTORS

2.1.3.1 Deforestation

Large scale deforestation in the upper catchments is perhaps the most important anthropogenic factor of the causes of the river floods and large scale deforestation affected by man for various purposes, such as extension of agriculture, supply of raw materials to the factories, domestic uses as firewood, and commercial purposes etc. Decreases infiltration capacity of the cut over land and consequently increases surface runoff which helps tremendously in increasing the magnitude of floods (Singh, 2019). Upper catchment area of Ajoy basin faces such types of problem that leads to flood hazards.

2.1.3.2 Increasing Urbanization

Increasing urbanization also play a great role in flood. Urbanization leads to increase the surface runoff and decreasing infiltration due to the *pucca* construction. Thus the rain water resulting from torrential rainfall is quickly disposed of through the city storm drains to nearby streams and thus the volume of river water is increased causing floods (Singh, 2019).

2.1.3.3 Siltation

Obstruction of river flow due to the bridges across the river human refuse material in river, sewage materials and garbage from nearby urban center refuse in river, gradual encroachment of human settlement towards the channel and lowing areas can help the deposit of slit in river bed. Due to the gradual accumulation of this sediment in the river basin, the river is unable to carry the excess water of its monsoon season and floods its basin area.

Plate No.:2 Katwa Ajoy Rail Bridge.

2.1.3.4 Faulty Agricultural Practices

Due to the faulty cultivation soil particles are highly eroded through the surface runoff. Ultimately eroded materials are deposited in river bed and the navigability of the river is declining. So the river water rises a little water is spreads over the valley sides, inundates the low laying flood plains and helps in aggravating the flood situation.

2.1.3.5 Failure Embankment

Embankment failure is a serious problem in lower Ajoy basin (Table: 10). Gradual erosion of river bank creates such situation. About 5% of the total floodplain of our beloved country is directly affected by this kind of erosion (Samsuzzaman, 2018). River bank erosion has seriously affected the villages of Charsujapur, Rasui, Chorki, Mougram and Billweswar of the Ketugram block II and many parts of Katwa sub division.

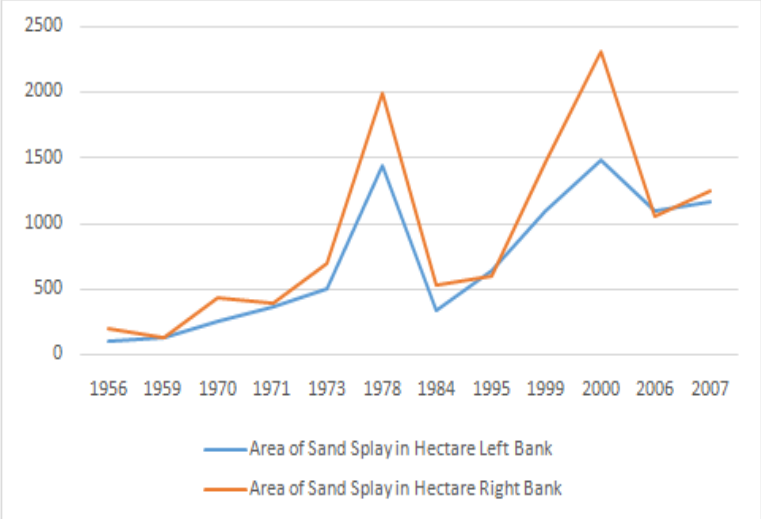
As per general system of river the widths (Table No.: 5) gradually increase toward downstream. But due to the construction of embankment it is interestingly noted that at the upstream points like Pandabeswar (23º44´N, 87º17´E), Palashdanga (23º43´N, 87º23´E) widths of the river are significantly more (1010 m. and 1225 m.) but at downstream near Kogram (23º33´N, 87º57´E) it becomes narrower about 125 m and at the confluence point Katwa it is only 230m. So such saucer shape river course is predominantly convicted for the slow water movement and inundation in the lower course (Mukhopadhyay, 2010).

Plate No.3: Failure embankment near Billweswar

2.2 SPATIO-TEMPORAL SCENARIO OF FLOOD

The nature of the flood in lower Ajoy basin shows typical changing pattern since 1956 to 2007 (Table: 8) most devastating flood year are recorded in lower Ajoy basin are 1978, 1995, 1999 and 2000. The total lower basin can be categorized into four zone, like, highly flood prone area (>60%), moderately affected (40-60%), least affected (<40%) and flood free zone (Table no.: 3). In respect to this zone, there are great variations in left and right bank of the lower Ajay River Basin (bank wise flood variation cartography). In case of highly affected area, in the right bank it extends up to 8 km (in Ausgram block) (Roy, 2012). The vast sand cover (Table:9) deteriorates the soil fertility and agricultural productivity (Table:1,2).The agricultural land of the river aside villages like Gitagram, Bhedia, Brahamandihi, Malocha of Aushgram block; Srikrishnapur, Nutungram of Nanoor, Basudha of Kanska block have been worstly affected(roy,2012).

The extent of flood in some major flood years (Table: 8) is confined along the river astride areas of the basin particularly from the downstream of Pandabeswar to the area up to Illambazar in the left and Basudha in the right bank. The flooded area is suddenly spreaded in the right bank in the east of Illambazar – Panagarh high way. The Bolpur – Natunhat highway, demarcates the last extension of major floods in the left bank. The flood is confined along the narrow strip area of the two banks in the western part of the basin area, particularly in the blocks of Dubrajpur & Illambazar in the Birbhum district and Kanksa of Burdwan district. The areas below Illambazar in the right bank and downstream Bolpur in both the bank the floods of all major years have spreaded vastly. The number of flood-affected mouzas is more in the right bank than the left bank. In 1956 the flood affected mouzas were 93 in the right bank and the left bank accounts for 72. In 1970 it is estimated that in total 221 affected mouzas there were 121 on the right and 101 on the left bank. But gradually the flood area has also been extended in the left bank and the differences in the number of affected mouzas between two banks are being reduced. In the flood year 2000 about 187 mouzas were affected on the right bank and 182 were on the left bank, even in the year 2007 out of total 293 affected villages about 150 mouzas were in right bank and about 143 on the left bank (Mukhopadhyay, 2010).



2.3 CONSEQUENCES OF FLOOD

Flood have both positive and negative effects on human society, which are mentioned in below-

2.3.1 Adverse effects of Floods

There are so many negative impact of flood hazards which are discussed below-

In every year flood in lower basin of Ajoy river around 1/3 % person peoples are worstly effected. Over the selected study area, Mangolkote block was the worst hit by flood events due to the spillover of river Ajoy (Ghosh, 2020). If the aerial view of flood impacts area considered, we observed that Ketugram II block is badly influenced

about 13.64 % gram Panchayat and Katwa municipality are hitted (district disaster management and response plan,2007).

2.3.1.1 Destruction of Settlements

Many people become homeless each year due to flood havocs in this region. According to IMD, Govt. of West Bengal, 2007 statistics in Katwa 22506, Mangolkote 19506 and Ketugram 21382 houses are damaged respectively and among them 27.18 % houses are heavily affected in Ketugram CD block (Plate No.:4).

Plate No.4: Flood affected Village

2.3.1.2 Damage to Agriculture

Millions of hectares of agricultural land and standing crops are submerged (Table No.: 1) under flood water for several days in continuation each year world over and thus farmers suffer heavy losses (Singh, 2019). Not only this, destruction of crops and fodder also adversely affects cattle and even lakhs of cattle are swept away in flood water and are killed every year throughout the world (Singh, 2019).

2.3.1.3 Damage to Infrastructure and Properties

1. Destruction of transport system such as roads and highways, railroads, bridges and culverts.
2. Damage and disruption of communication systems.
3. Damage to supply lines of potable water and electricity.
4. Economic losses through damage and destruction of private and public properties, closure of business establishments, industries and banks etc.
5. Destruction of drainage systems in towns.

2.3.1.4 Environmental Effects

In urban areas, the spillage of municipal sewage pollutes water with several infectious diseases (Singh, 2019). Toxic material such as paints, pesticides, gasoline etc. are released into rivers and flood water in urban so areas thereafter the stinking of filth and garbage's and human excreta pollutes the environment and causes several infectious diseases such as *military fever*, *pneumonic plague*, *dermatopathia, dysentery*, *common cold (type-A), break bone fever* etc.(Singh,2019). There is also spared of a few epidemics such as *cholera* and the stagnant flood water encourages mass breeding of mosquitoes which spread different types of *malaria* (Singh, 2019).

3.0 FLOOD HAZARD: PREPAREDNESS, MITIGATION AND MANAGEMENT PLAN

We cannot escape from the fury of natural disasters and manmade disaster but we could prevent and minimize the loss caused due to the same. There have been plentiful occurrences of disasters throughout the ages. Disaster is negatively correlated with development activities as it slows down the process of development. So now is the time to control the hazards and disasters. But one question is arises how we can control the natural and manmade hazards with systematic manner? So, here we will try to discuss how the flood of Ajoy lower basin can be managed.

Disaster management is a process of comprehensive planning of an organization or a country or a province to protect the life and property of humans from expected or anticipated hazards and disaster rescue and relief facilities to affected people by and also to facilitate recovery and rehabilitation programmes (Singh & Singh, 2010).According to IDNDR (International Decade for Natural Disaster Reduction) major objectives of disaster management was to reduce loss of life, property damage and social and economic disruption caused by natural disasters through concerted international activities and cooperation.

Flood is quasi natural phenomena. Geo-morphologist Savindra Singh encompasses that floods are natural phenomena and one cannot entirely get rid of them but their impact can be minimized by man's technological skill, better warning systems and positive human response to flood warning and various control measures adopted by the governments. In flood management PMP (preparedness, mitigation and prevention) & 3R (Rescue, Relief, Rehabilitation) stages are most important that are mentioned below.

3.1 PRE-FLOOD DISASTER STAGE

Pre flood disaster stage includes 3 stages like flood preparedness, flood prevention and flood mitigation.

3.1.1 Flood preparedness

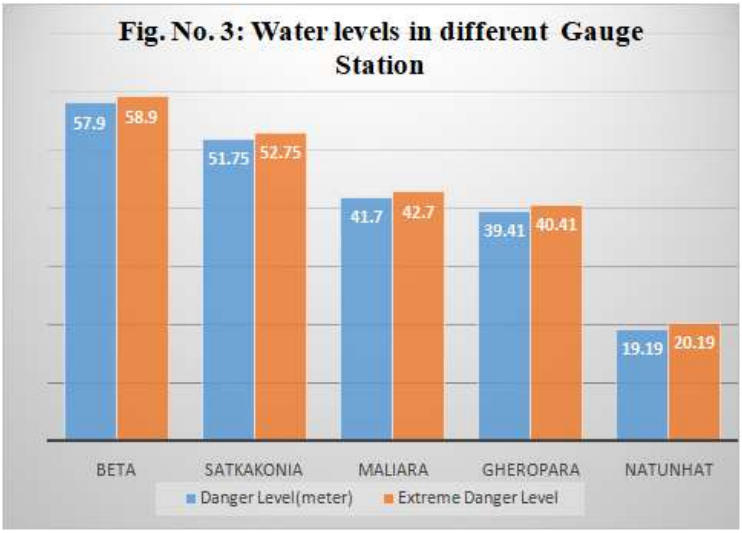
Preparedness means necessary arrangements to meet any eventually if a hazard strikes a locality and community (Singh, 2019).for the better understanding in general singh also sub classified of preparedness level into 5 stages. i.e. –

3.1.1.1 Level and nature of disaster preparedness

To know after the level of disaster people can realize that how much impact of disaster. Governmental preparedness classified in various levels like. Village level, village Panchayat level, development bock level, district level, state level and central government level.

3.1.1.2 Disaster research

To know or better understand the present disaster situation of flood hazards all of us must study the previous records (Table No.: 6, 7, 8) of flood in details.

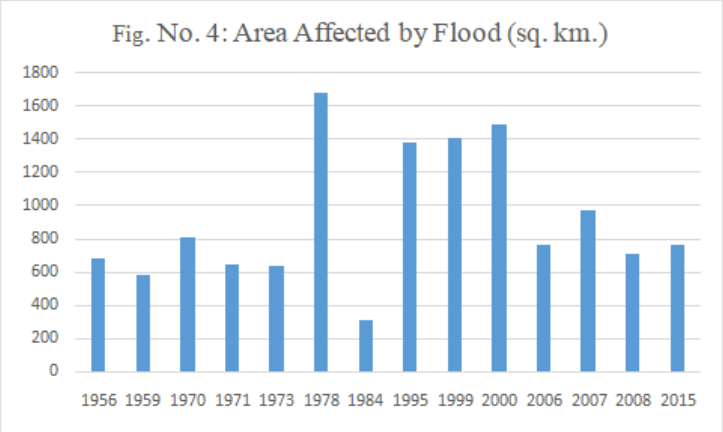


3.1.1.3 Disaster prediction

If we have already know the previous records (Table No.: 8) of flood hazards and flood related information in that particular area so we can easily predicted that intensity and magnitude of present flood situation. Fig. No.4 represents the flood revisit interval and its impacts. It is maximum in the year of 1978 covered 1680 km2 area along the river basin. Year of 1995, 1999 and 2000 was the worse experience of flood, continuous flood affected 1380 to 1488 km2 area of lower Ajoy basin (Department of Irrigation and Waterways, Govt. of West Bengal, 2017**).**

3.1.1.4 Disaster warning system

Disaster warning system (DWS) comprises effective measures to communicate the human community of the area, which is liable to be hit by a particular disaster (Singh, 2019). In case of failure of mobile network, communication may be made through the following procedure; Wireless set may be installed in all the police stations under Purba Bardhaman District through which communication will be continued as well as message will be received from IMD, Alipur as Early warning dissemination System. GPS set may be provided to the Gram Panchayat Offices for continuation of communication. HAM Radio set may be provided to all the Gram Panchayat for continuation of communication Walki talky machine may be provided in the effected places. More concern will be needed on that part of basin area where high propensity of flood vulnarability, more than 60% in 144 villages. 18.75% area of total basin is free from severe flood risk (District Census Handbook, Burdwan and Birbhum, 2001). (Table No.: 3)



3.1.1.5 Disaster Education

The prime goal of disaster education is to educate the people about various aspects of hazards and disasters, such as nature and mode of occurrences, magnitude and severity, nature and magnitude of damage, prediction and warning system of disaster, preparedness and safety measures, adjustment with disaster etc., so that they are least adversely affected by disasters of various sorts (Singh,2019). According to Birbhum district disaster report 2020, Rs 60,000 was sanctioned only Illambazar block for cyclone mock drill.

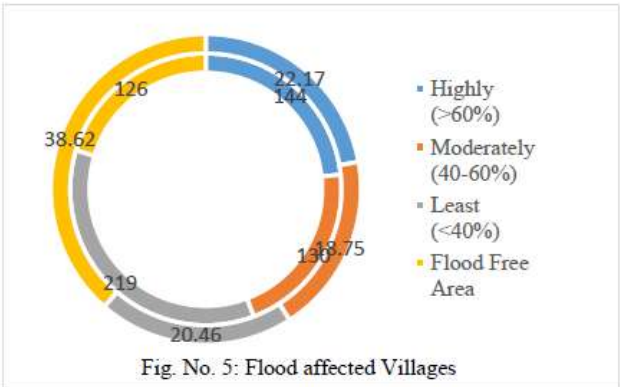


Fig. No. 5: Flood affected Villages

3.1.2 Flood mitigation

Prime goal of disaster mitigation is to minimize the disruptive forces of disaster and to reduce the magnitude of disaster using various measures like mapping, proper land use planning, structural and nonstructural

measures. For the flood mitigation top down (central level) and bottom up (community level) both approach are applicable but bottom up approach is more effective.

3.1.3 Flood prevention

Disaster prevention does not mean to prevent the occurrences of natural disasters rather it means to prevent the adverse impacts of natural disasters by adopting certain measures much in advance of the occurrences of a disaster so it is thus evident that disaster prevention is based on the outcome of disaster preparedness (Singh, 2019).

Plate No.6: measures of water level

3.2 POST FLOOD DISASTER STAGE

Post disaster phase of disaster management reflects the resilience of disaster affected communities towards facing the calamities introduced by a particular or a host of disaster (Singh, 2019). In post disaster stage 3R (rescue& relief work, recovery and rehabilitation) is the most important parameter to minimized the disaster impacts that are elaborated in below-

3.2.1 Rescue & Relief Measures

The moment a disaster occurs in an area, the immediate steps to be taken are to rescue people buried under debris, to provide food, drinking water, shelter, medicines, to restore power and water supplies and communication and transport systems (Singh,2019). Social response and action, participants in relief work, organizational involvement are the important parameter in that stage. WBSEDCL, PHE, PWD, irrigation and waterways department, NGO, police, self-government and transport department of west Bengal play a great role to minimize the flood hazards situation. According to the Purba Bardhaman district disaster management report 2020 rs.60,94,000 amount are sanctioned for sheltering during flood & cyclone among the 400 -500 persons and 36.24 lakh are sanctioned for storing of relief materials. According to Birbhum district disaster management plan 2020, total 76, 38,400 amounts are sanctioned for flash flood (sept-octber-2019).

The blocks are pre stocked with relief items which includes tarpaulin, clothing, food grains etc. Based on the findings of the assessment report, the relief items would be distributed among the affected community.

Govt. will also arrange for the pre stocking of materials which includes requirement of bleaching powder, Halogen tablet, ORS packet, normal saline, AVS by the Dept. of Health. The Dept. of Food & Supply allots special ration allotment in the affected areas with food grains & kerosene oil. PWD, PHE, Electric supply will do all necessary restoration of damage assets in the community, whereas based on the damage assessment report of Horticulture dept., ARD and Agriculture would provide seeds, fodders for restoration of livelihood

in the areas. Temporary flood shelter also opened in primary schools to overcome the hazardous situation throughout the basin area.

Plate No.7: Local people engage to repair bandh

3.2.2 Disaster Recovery

According to Singh, 2019 it is involves to multiple strategies. Recovery process includes all those action and activities which help the individuals and communities to adjust with the effects of all sorts left behind by a particular disaster (Singh, 2019).community play a vital role to adapt from prerequisite condition to post hazards condition. According to Purba Bardhhaman district disaster report, 2020 Rs.2, 16, 98,787 are sanctioned regarding ex-jamindari bandh (table: 13) over the Ketugram-I, Mangolkote and Katwa-I CD blocks.

3.2.3 Rehabilitation

Rehabilitation (Table:13) process involves renewal of disrupted system, repair of damaged system and reconstruction of houses, buildings, roads, rails, bridges and other items of utilities, relief employment etc.(Singh,2019). In 2021-22 west Bengal economic budget was allocated 928 crore for the management of major irrigation and flood control.

Plate No.8: Damage Road Network near Katwa

4.0 Major findings

From the above discussion we may find out the major causes of flood over the study area. Important causes of flood hazards further point out in below

i. Lower Ajoy river basin is highly sinuous and meandering shape.

ii. Upper portion of the lower Ajoy River is much wider than downwards (up to discharge point of Katwa).

iii. Embankment failure is the major issue in that particular study area.

iv. Siltation problem in river bed due to the throw of urban waste, plastic and others non bio degradable materials in water.

v. Lack of proper disaster education and community based development programme.

vi. To need more afforestation and reforestation in upper catchment of Ajoy river.

vii. To established of water reservoirs & tanks to store rain water to mitigate the flood hazards as well as to supply water for irrigation purpose in dry season.

5.0 Conclusion

For a Long time, geographical literature viewed disaster as a consequence of natural forces and human beings are treated as innocent and helpless victims in front of the Mighty forces of nature (NCERT, 2006). Flood is a quasi-natural process so we cannot totally prevent this issue in that particular area but we can minimize its severity level with significantly. From the above flood management strategy we know that there have lots of structural and nonstructural measures which help to manage the flood severity level. To need afforestation in upper basin of Ajoy that can prevent surface runoff and to encourage more infiltration of rain water. Social forestry along the river embankment is playing a vital role to protect embankment failure. First of all disaster education, mock drill, indigenous knowledge, flood awareness camp, local people consciousness, self-government awareness, self-help group, NGO is most important aspect that can be play important role in disaster management which can able to minimized the flood impact and protect us from the flood hazards.

References

1. Census of India, 2001, 2011.

2. Chakraborty, N. (2022), Hazard and Disaster Management, Nabodaya Publications, Kolkata -700009.

3. Govt. of west Bengal, west Bengal district census handbooks, Burdwan 1951, 61,71,81,91 and 2001.

4. Husain, M. (2021), Geography of India, MC Graw Hill Publications, kundil, Haryana, pp. 17.1-17.60.

5. Khullar, D.R. (2020), India A Comprehensive Geography, Kalyani Publications, New Delhi, pp. 218-220,244-253.

6. Molla, H.R. (2020), Delineation and Zonation of Flood Prone Area in Lower Ajoy River Basin, Journal of Global Resources Volume 6 (01) August 2019-January 2020 Page 148-153.

7. Molla, H.R.(2011), Embankment And Changing Micro-Topography Of Lower Ajoy Basin In Eastern India, Ethiopian Journal Of Environmental Studies And Management Vol. 4 No.4 2011

8. Mukhopadhyay, S. (2010). A Geo-Environmental Assessment of Flood Dynamics in Lower Ajoy River Including Sand Splay Problem in Eastern India, Ethiopian Journal of Environmental Studies and Management, Vol.3(2), pp. 96-109

9. Mukhopadhyay, S. and Mukherjee, M. (2005). Hydrological Characteristic of Flood: A Study in The Lower Ajoy River, River Floods: A Socio technical Approach. ABC Publications, 1st Edition, pp. 51-58.

10. Mukhopadhyay, S.(2010), A Geo-Environmental Assessment Of Flood Dynamics In Lower Ajoy River Inducing Sand Splay Problem In Eastern India, Ethiopian Journal Of Environmental Studies And Management Vol.3 No.2 2010.

11. NCERT, (2006), India: Physical Environment, Pp.76-93.

12. Niyogi, M. (1985). Ground Water Resource of the Ajay Basin, Geographical Mosaic- Professor K.G.Bagechi felicitation Vol., In S.C.Mukhopadhyay (Eds.), Manasi Press, Calcutta, pp.165-182.

13. Office of the district magistrate, Bardhaman (2007), the district disaster management and response plan, Bardhaman.

14. Paul, B.K.(2011),Environmental Hazards and Disaster: Contexts, Perspectives and Management,Willy- Blackwell, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK.

15. Peterson, J.C.K. (1910), Bengal district Gazetteers, Burdwan, Bengal Secretariat book Depot, Calcutta, Reprinted in March 1997.

16. Raskovic, B. & Mrdja, S. (2013), Natural Disaster: Prevention, Risk Factors and Management, Nova Publications, New York.

17. Roy, J., (2020), Gender, Environment and Globalization (Ed.), N.B.Publications, Ghaziabad-201102, Pp. 83-109.

18. Roy, S. (2012), Spatial Variation of Floods in the Lower Ajay River Basin, West Bengal: A Geo-Hydrological Analysis, International Journal of Remote Sensing and GIS, Volume 1, Issue 2, 2012, 132-143.

19. Roy, S.(2012), Spatial Variation of Floods in the Lower Ajay River Basin, West Bengal Volume 1, Issue 2, 2012, 132-143.

20. Singh, S. (2019), Disaster management, Pravalika publications, Allahabad-211002, pp. 155-171.

Web links

21. http://117.252.14.242/Gangakosh/tributaries/ajay.htm

22. http://sdokatwa.in/

23. http://wbdmd.gov.in/pages/district_dm_plan.aspx

24. https://birbhum.gov.in/how-to-reach/

25.https://en.m.wikipedia.org/wiki/Birbhum_district#:~:text=The%20climate%20on%20the%20western,compared%20to%20the%20eastern%20areas.

26. https://en.m.wikipedia.org/wiki/Category:Railway_stations_in_Purba_Bardhaman_district

27. https://en.m.wikipedia.org/wiki/Paschim_Bardhaman_district

28. https://purbabardhaman.nic.in/how-to-reach/#:~:text=By%20Road,14%20and%20State%20Highway%2015

29. https://simple.wikipedia.org/wiki/Ajay_River

30. https://prsindia.org/budgets/states/west-bengal-budget-analysis-2021-22

LIST OF TABLES

Table 1: Area of sand splay laden cultivated land

Name of the Mouza	Name of the Block	Total amount of cultivated land in hectare	Loss of cultivated land in hectare	% to total cultivated land
Bhedia	Ausgram	335.00	61.66	18.40
Bramhan Dihi		164.00	21.66	13.20
Maloncha		303.46	15.67	5.16
Malaria		286.90	28.68	9.99
Basudha	Kanksa	593.47	140	23.59
Gitgram	Bolpur	110	30.80	28.00
Nutungram		90	40.20	36.54
Rasulpur		110	40.20	36.54
Haripur		60	40.60	67.66
Ghidaha		80.93	25	30.89
Nabagram	Mangolkote	66.60	20.45	30.70
Nathunhat		106	25.43	23.99
Bira	Ketugram	46	18.78	40.82
Bankai		44	10.64	26.60
Narenga		75	22.38	29.84
Srikrishnapur	Nanur	130	80.50	61.92
Husainpur		180	30	16.66
Vepura		50	20	40.00
Gangnara		42	15.50	36.90
Gomra		170	12	7.05
	Total	**3043.36**	**700.15**	**23.01**

Source: Birbhum and Burdwan Zila Parishad,Govt. of West Bengal, 2008-09

Table 2: Soil status report before and after sand splay

Name of the places	Ph		N2(kg./ha)		P2O5(kg./ha)		K2O(kg./ha.)	
	Before	After	Before	After	Before	After	Before	After
Natungram	6.6	7.5	200	49.5	90	7.9	294	46
Gitgram	7.0	7.3	250	30.5	85	4.2	240	65
Maliara	7.1	7.1	280	39.0	21.2	4.2	316	59
Bhedia	6.9	7.1	330	26.4	45.50	3.6	305	72
Srikrishnapur	7.0	8.2	300	35.0	70.00	5.5	220	70

Source: Technical Report: Vol. 7, Department of Soil Science, Palli Siksha Bhavan, Visva-Bharati University.

Table 3: Status of Flood Affected Zone in Lower Ajay Basin

SL No.	Zone	Area(sq.km)	No. of Affected Mouza	% of Basin Area
1	Highly (>60%)	624.46	144	22.17
2	Moderately (40-60%)	528	130	18.75
3	Least (<40%)	576.3	219	20.46
4	Flood Free Area	1087.89	126	38.62

(Source: District Census Handbook, Burdwan and Birbhum, 2001)

Table 4: Land use pattern in Lower Ajoy River Basin

Land use category	Area (hectare)	% to total areas
Irrigated land	113431.66	40.27
Unirrigated land	62852.24	22.31
Forest	37115.44	13.17
Uncultivable land	63294.78	22.48
Cultivated waste	4971.73	1.77

Source: District Census Hand Book, 2001, & Economic Review, West Bengal, 2009,Govt. of West Bengal

Table 5: Width of the Ajay downwards after the Construction of embankment

Name of the Village	Location	Width in meter
Pandabeswar	23°44'N, 87°17'E	1010
Palashdanga	23°43'N, 87°23'E	1225
Loda	23°42'30"N, 87°25'E	950
Kajaldighi	23°38'N, 87°26'30'E	625
Santashpur	23°37'N, 87°28'E	225
Gangapur	23°37'N, 87°31'20"E	400
Mongalpur	23°36'N, 87°33'E	300
Maloncha	23°36'15"N, 87°30'30"E	500
Bilosonda	23°36'30"N, 87°41'E	440
Santla	23°37'N, 87°44'E	175
Karimpur	23°34'40"N, 87°47'E	150
Kogram	23°32'30"N, 87°54'E	125
Srikrishnapur	23°36'20"N,	250

	87°57'E	
Katwa	23°39'N, 88°08'E	240

Source: Report of geological survey of India,2000

Table 6: Highest flood level in different gauge station

Gauge Station	DL (m.) EDL(m.)	1956	1959	1970	1971	1973	1978	1984	1995	1999	2000	2006	2007
Beta	57.90 58.90	61.05	N.S	N.S	59.06	N.S	61.14	58.83	59.75	60.70	61.50	58.70	60.65
Satkakonia	51.75 52.75	54.41	N.S	53.50	53.10	53.48	55.44	53.39	54.42	54.68	54.90	54.38	53.84
Maliara	41.70 42.70	45.37	45.58	44.17	44.47	43.16	45.71	43.28	45.72	44.46	45.86	43.42	44.28
Gheropara	39.41 40.41	40.89	41.31	40.51	40.29	40.63	42.82	39.02	42.50	43.25	42.97	40.22	42.60
Natunhat	19.19 20.19	21.02	21.84	20.40	20.62	20.00	22.42	21.70	22.30	22.89	23.21	20.49	21.37
Total		**44.548**	**36.24**	**39.645**	**43.508**	**39.317**	**45.506**	**43.244**	**44.938**	**45.196**	**45.688**	**43.242**	**44.548**

Source: Irrigation and Waterways Directorate, Mayurakshi S. Canal Division Govt. of West Bengal N.S.= No Spill.

Table 7: Month wise flow level in different gauge stations in monsoon season (June to October)

Year	Station Maliara					Station Gheropara					Station Natunhat				
	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept	Oct.	June	July	Aug.	Sept.	Oct.
1956	40.61	41.90	42.00	45.37	41.28	36.50	37.20	38.40	40.89	39.10	17.60	18.81	19.60	21.02	20.96
1959	40.21	43.22	43.52	44.38	45.58	37.71	38.21	39.80	41.39	38.80	18.10	18.90	19.85	21.18	21.84
1970	42.00	42.45	41.75	44.17	42.09	37.23	39.10	36.40	40.51	39.20	17.12	17.92	18.92	20.40	20.12
1971	39.90	44.08	44.46	44.47	43.19	36.42	37.92	38.60	40.29	37.80	17.42	18.81	19.75	20.62	19.78
1973	N.A	42.60	43.16	43.10	N.A	36.81	38.82	37.21	40.63	38.50	17..91	19.42	21.00	21.67	19.91
1978	43.60	42.15	42.24	45.71	43.28	38.81	37.50	39.95	42.82	39.70	18.60	17.90	19.01	22.42	21.30
1984	39.70	41.75	43.18	42.91	43.28	38.40	38.21	39.02	37.50	37.45	18.19	19.70	21.60	21.70	21.88
1995	40.61	41.72	42.30	45.72	41.60	38.40	36.86	37.19	42.40	37.20	17.92	18.48	20.00	22.30	20.10
1999	40.50	40.82	41.58	40.40	38.40	36.00	37.17	38.00	43.25	39.59	17.51	18.12	19.65	22.89	19.10
2000	40.60	42.10	42.20	45.86	39.30	36.54	38.78	35.96	40.97	37.00	16.80	17.61	19.18	23.56	18.61
2007	40.21	42.34	42.76	43.27	39.40	37.23	38.90	37.58	37.80	38.23	17.67	17.90	19.34	22.56	20.42

Source: Irrigation and Waterways Directorate, Mayurakshi South Canal Division Govt. of West Bengal

Table 8: Flood-Affected Areas of Lower Ajay River Basin from 1956-2015

Year	Affected Area in sq. km.	% of total area	Entirely Affected	Partially Affected	Total	Extent of Sand Splay in Hectares	Maximum Extension of sand Splay from River Embankment (Distance in km)
1956	680	24.14	153	32	185	231.45	0.38
1959	584.34	20.74	120	27	147	269.63	0.38
1970	812.24	28.83	186	36	222	693.48	0.47
1971	642.71	22.81	130	31	161	762.11	0.78
1973	639.02	22.68	124	36	160	1193.2	1.12
1978	1680	59.64	307	67	374	3421.32	2.42
1984	305.72	10.85	78	20	98	865.55	0.68
1995	1380.82	48.99	227	49	276	1245.67	1.4
1999	1408	49.98	237	60	297	2567.23	2.12
2000	1488	52.82	263	106	369	3788.25	2.57
2006	764.23	27.12	152	46	198	2143.56	1.35
2007	972.79	34.53	214	79	293	2421.57	1.76
2008	706.54		136	39	175		
2015	764.23		152	46	198		

(Source: Department of Irrigation and Waterways, Govt. of West Bengal, 2017)

Table 9: Sand Splay Distribution in Two Bank of the Ajay River

Year	Cumulative Number of Sand Splay		Cumulative Total Number	Area of Sand Splay in Hectare		Total Areas in Hectare
	Left Bank	Right Bank		Left Bank	Right Bank	
1956	2	3	5	102.2	199.25	231.45
1959	3	5	8	133.42	136.21	269.63
1970	5	7	12	248.76	444.72	693.48
1971	6	9	15	368.93	393.18	762.11
1973	6	11	16	497.66	695.54	1193.2
1978	9	18	27	1432.32	1989	3421.32
1984	9	18	27	335.23	530.3	865.55
1995	10	19	29	643.27	602.2	1245.67
1999	10	24	34	1097.74	1469.49	2567.23
2000	15	32	47	1478.98	2309.29	3788.25
2006	17	32	49	1087.67	1055.89	2143.66
2007	19	34	53	1165.88	1255.69	2421.57

(Source: Department of Irrigation and Waterway, Mukhopadhyay, 2010)

Table 10: Present State of the Embankment Right Embankment

Segment of embankment	Covering Police Station	Length (km)	Present status
Gotholu to Kherobari	Faridpur to Kanksa	14.0	Earthen embankment, reinforced by boulders in places.
Kherobari to Kotalpukur	Kanksa	4.5	Embankment made of sandy soil
Satkahonia to Kogram	Kanksa, Ausgram, Mangolkote	47.0	It is long and continues embankment primarily made of earthen material, In places of Malancha, Maliara Kogram, previously breached portions are repaired by boulders
Joykrishnapur to Kherua	Mangolkote	8.3	Through some boulders are used to reinforce the embankment but recommended height and width of the embankment are not maintained properly, Embankment is very much affected by human activities.

Left Embankment

Segment of Embankment	Covering Police Station	Length(km)	Present Status
Bhimgara to Parulbana	Khoyrasole	4.80	Earthen embankment
Santashpur to Pratappur	Illambazar	4.50	Earthen embankment partially supported by boulders to reinforce the embankment
Joydev-kenduli to Tikarbeta	Illambazar	2.0	Earthen embankment partially supported by boulders to reinforce the embankment
Nelegarh to Sahebdanga	Illambazar	3.0	Embankment made of sandy soil
Halsidanga to Ramcharanpur	Illambazar, Bolpur	7.55	Embankment made of sandy soil, near Senkapur, bank erosion has made the embankment most vulnerable
Nurpur to Gheropara	Bolpur	1.72	Embankment made of sandy soil, partially reinforce by boulders. Gap between left and right embankment ids only 718 meters
Gheropur to Nutungram	Bolpur	7.62	Embankment made of sandy soil. Previous breached portions are repaired by boulders.
Nutungram to Chorkhi	Bolpur, Nanur, mangolkote, Katwa	3.17	Embankment made of sandy soil.

Source: Directorate of irrigation and Waterways Department, West Bengal – 2008

Table 11: population data over the study area

CD block	Area (Km2)	Total population (2011)	Population density (km2) (2011)	Literacy (%)
Pandabeswar	97.8	161891	1700	73.01
Kanksa	279.44	178125	640	76.34
Guskara	21.15	35888	1700	80.16
Ausgram I	222.34	119363	420	69.39
Ausgram ii	360.4	150896	420	68.00
Bolpur	334.6	202553	610	70.67

Illambazar	261.5	168709	650	74.27
Nanoor	311.83	218654	700	69.45
Mangolkote	365.44	263240	720	67.97
Ketugram I	193.98	165408	852	68.00
Ketugram ii	160.03	118567	741	65.96
Katwa I	168.94	173087	1024	70.36

Source: https://www.census2011.co.in

Table 12: population related data over the study area with state population data

Name	Area Km2	Total population (2001)	Total population (2011)	Population density (2001)	Population density (2011) (km2)	Population growth (2001) (%)	Population growth (2011) (%)	literacy (2001) (%)	literacy (2011) (%)
West Bengal	88752	80176197	91276115	903	1028	17.84	13.84	68.64	76.26
Bardhhaman	7024	6895514	7717563	982	1099	13.96	11.92	70.18	76.21
Birbhum	4545	3015422	3502404	663	770	17.99	16.15	61.48	70.68

Source: https://www.census2001.co.in,

Table 13: report regarding ex-jamindari bandh

Name of block	Name of GP	Proposed no. of scheme	Vetted no. of schemes	Estimated amount in Rs.
Ketugram-ii	billeswar	1	1	41,08,160
Mangolkote	Mangolkote	1	1	15,62,800
	Bhalugram	10	10	17572320
	Jhiloo –I	7	7	11386514
	Majhigram	17	17	48135687
	Shimulia-ii	2	2	4385004
Katwa- I	Koshigram	5	5	1,60,27,827

Source:Purba Bardhaman district disaster management plan report, 2020