CHAPTER I: INTRODUCTION

1.0 Introduction

Flash floods are rapid and devastating natural phenomena that pose significant threats to both human lives and infrastructure. They occur when an excessive amount of rainfall overwhelms the capacity of the drainage system or when intense rainfall occurs in a short period. Flash floods can arise in various geographical regions, affecting both urban and rural areas, and are known to cause significant damage and loss of life worldwide. The study area, i.e. Alipurduar has a variety of physical characteristics. The northern part of the District shared a boundary with Bhutan Himalaya, and southern border joined with the Coochbehar District. Physically the District is marked by the river Sankos in the eastern part, and the Jalpaiguri District marks the western region. There are many rivers which are flowing through the District. Sources of these rivers are mainly from Bhutan Himalaya. All the rivers are flowing north to south direction. In the last few decades, flash floods have frequently affected the study area, which create aggradations in this area. Flooding is the unusual presence of water on land to a depth that affects normal life. There are many types of floods, like river floods, flash floods, coastal floods, tidal floods, etc. Defining a flash flood is difficult because flash floods are complex phenomena and partly because they are viewed differently by different people., a flash flood is a body of water which rises to overflow land which is not normally submerged and subsides after only a few hours (Roy,1978). River flood and flash flooding usually result from abnormally high rainfall over relatively short period. Flash flood are most frequently associated with violent, convectional storms which tend to be of short duration, often measured in minutes rather than hours (Morgan,1966). There is a term used, hours for flash floods and days for river floods. A flash flood is, in short, a sudden local flood of great volume and short duration which follows within a few (usually less than six) hours of heavy or excessive rainfall, or due to dam or levee failure, or the sudden release of water it takes place in a saturated area where rain has previously fallen or the sudden release of water impounded by an ice log jam. A flash flood can be caused by intense rain, particularly when it takes place in a saturated area where rain has previously fallen or the ground is frozen. In these conditions the additional rain runs off over the surface and accumulates in streams and rivers at a much-accelerated pace. Heavy rain, most frequently connected with convection clouds, cover small regions and are short-lived (from a few minutes to a few hours), but very intense such a 100 mm (or 100 litres per square meter) in the span of an hour or more. Violent rainfall causing flash floods can be accompanied by strong winds and heavy hail formation. They can also appear locally in a large area covered

by rainfall. A flood is the inundation of a normally dry area caused by an increase in water level within rivers, streams, or drainage ditches (NWS,2005). A flash flood is an event in which sections of a waterbody rapidly rise out of their banks within six hours of a rainfall event (Sweeney, 1992). “a flood that rises and falls quite rapidly with little or no advance warning, usually as a result of intense rainfall over a relatively small area”- American Meteorological Society. ‘Generally flash flood occurs due to heavy rainfall in the catchment area but sometime it occurs due to upstream discharge / dam failure’- IMD. A Flash flood is generally defined as a rapid onset flood of short duration with a relatively high peak discharge - World Meteorological Organization. The U.S. National Weather Service employs a more detailed definition - “A rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam). However, the actual time threshold may vary in different parts of the country. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters”. Physical factors of study area mainly effect on flash flood. “Flash flood is floods that happen very suddenly and with little warning. They are very dangerous. A very heavy rain or an accident like a dam break can cause flash flood. Sometimes the ground is too hard or too wet to soak up water. The only place the rain can go is downstream. Usually, rainfall of more than one inch in one hour is needed to cause a flash flood. Sometimes a place can get hit by a flash flood even if it is sunny because it might be rainy on higher ground somewhere” – Leah (Washington DC, USA) August 22, 1997. In the above definition of flash floods ‘heavy rainfall’ and ‘time’ have given great importance. To explain flash floods of Alipurduar District the most suitable definition is- ‘While locally heavy falls of 10 to 20 cm per day occur over wide areas of thousands of square kilometres, falls of 30 to 40 cm per day have been recorded in the neighbourhood of Hills and in coastal areas in the track of storms.’- Parthasarathy (1958), Jagannathan (1970), Pritam Singh (1974) and Harihara Ayar (1974). ‘The reason for flash floods is excessive rainfall within small duration in small catchments and continuous rainfall of several days in bigger catchments.’- (Sarkar, S 2015). The sub-Himalayan Alipurduar District in West Bengal being situated not far from the Himalayan margin and criss-crossed by the sub-Himalayan rivers have always been liable to flash floods. Heavy rainy place of the state is situated in the study area. Some rivers of the District are affected by soil erosion. Sometimes the rivers of the study area cannot accommodate excess volume of water and thereby causing flash flood. The frequency of flash flood is increasing with time. The turbid flood water carries huge amount of load of varied shape and size. As the flood water spread over a comparatively

larger floodplain, there is a loss of competency which is finally responsible for large scale flood deposition. This process of aggradation is related to land building. It has both the good as well as bad effects. The thick pile of deposited coarse material sometimes covers the fertile agricultural land, which the poor land owner can't reclaim for further use and thereby, a good fertile agricultural land turns into a barren land. The opposite side of the same coin is perfect. The finer flood deposited material, counting fine sand, silt, and clay, along with other minerals and nutrients, raise the fertility level of the land and increase the yield rate.

1.1 The Study Area

The study area Alipurduar District is situated in the northern part of West Bengal. This District lies between 26º23'11'' N to 26º52'30''N latitudes and between 89º02'30''E to 89º53'07''E longitude covering an area of 3136.0 sq. km. The District covered with forest 31.09% and tea gardens 16.96% (District Survey Report 2021, Alipurduar District). Bhutan bounds the study area in the North, Assam in the East, Coochbehar District in the South, and West by Jalpaiguri District. The topography of this District and its environs is characterized by uneven elevation. The only hills in the District are the Sinchula hills to the east of the river Torsa, which rise abruptly from 4000 to 6000 feet (Jalpaiguri Gazetteer, 2008, J.F. Gurnning). The two main hilly regions of the District are Buxa and Jayanti. The maximum temperature is 46.2ºC, recorded in 2013 and the minimum temperature is 3ºC, recorded in 2018. The annual mean rainfall of this District is 4099 mm (District Statistical Hand Book 2007). Many rivers are flowing through the District like Torsha, Sankos, Mujnai, Raidakh, Kaljani, etc. they play an essential role in soil formation and effects on soil properties of the District. Topographically, the northern part of the area is adjacent to Bhutan, called Duars and is of higher altitude. The Dooars or Duars are the floodplains and foothills of the eastern Himalayas in northeast India adjacent to Bhutan. Most of the area is covered by tea gardens which interspersed with forests and characterized by the soils of recent formation. The region's western part is slightly undulating and surrounded by cultivated fields and bushey jungles. The soil status of the area is sandy to sandy-loam, having low water holding capacity in the southern part. Some parts of the area are well connected by roads and railways. Mainly northern parts of the study area are bounded by Bhutan, and Bhutan uses the roads and railway to export and import goods and commodities, especially dolomite, cement, wooden items and many others.

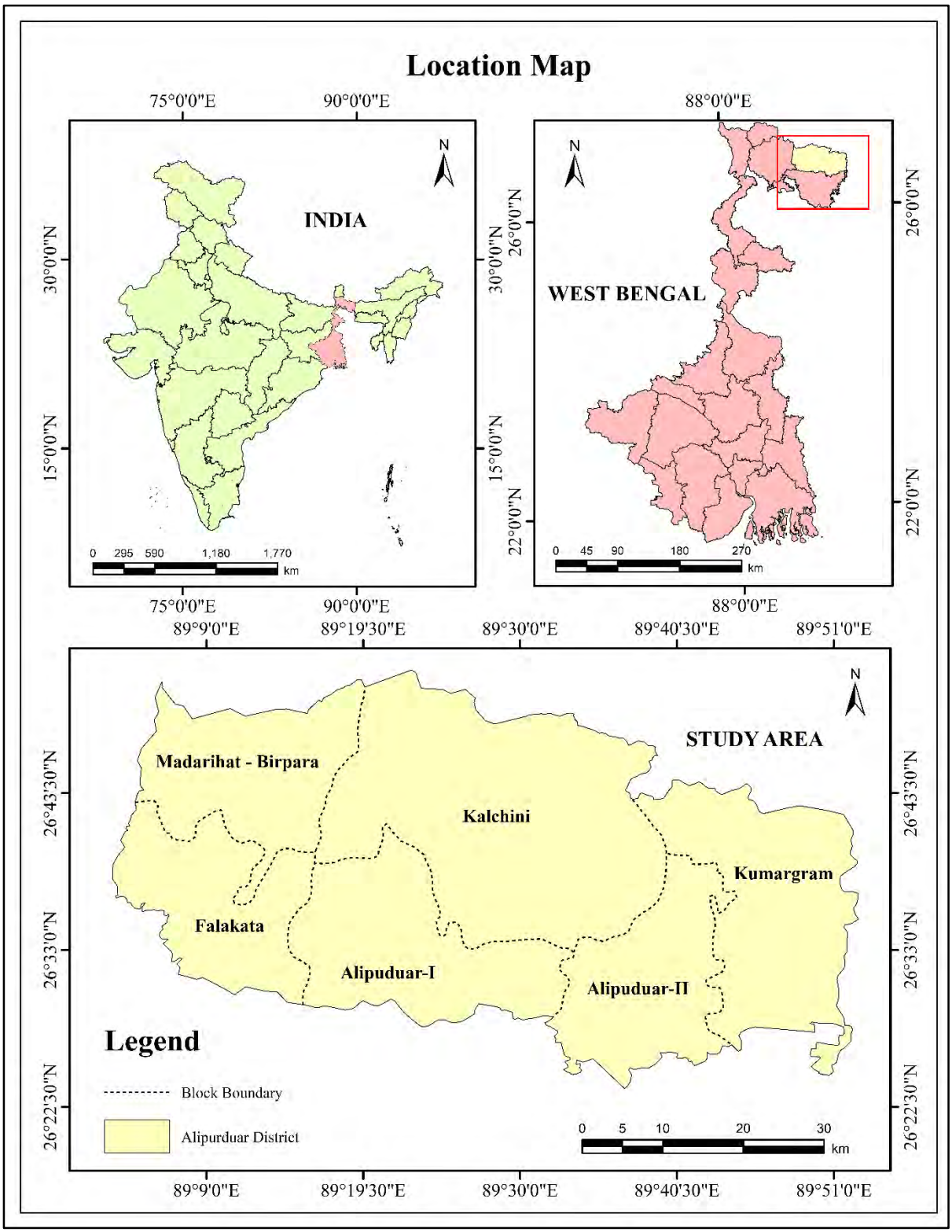

Figure 1.1 Location map of the study area.

1.2 The problems

Many changes in socio-economic activities have been experienced in the study area in the last few years. Through this progress there has changed the land use pattern. Many construction activities in different parts of the area build in recent year. Deforesting rate is increasing day by day and its effects on soil erosion and play a role to decrease river depth. The river running through the study area are chocked up with sediment as a result of soil erosion, mining quarrying etc. when severe flash flood occur in the study areas are occupied by humans, they can create natural disasters which involves the loss of human life and property plus serious disruption to the ongoing activities of large urban and rural communities (smith, et al, 1998).

When flash flood occurs, daily socio-economic activities disrupted, and due to its frequency and number of areas and people affected, it certainly has an adverse effect in Alipurduar District. High intensity rainstorm indeed flush flood is a common phenomenon in the Himalayan foreland of eastern Duars. In 1993, such an event occurred in Alipurduar District. When a high intensity rainstorm recorded between July 19-21 with rainfall recorded as high as 1606 mm in 24 hours of 21st July caused flash flood in entire eastern Duars caused devastation (L. Starkel, S. Sarkar, R. Soja, P. Prokop,2008). Such a catastrophic meteorological event often caused devasting flash flood in the piedmont region and caused prolonged inundation in the plain region further south i.e., Kochbehar and Bangladesh (S. Sarkar. 2004). Recently a devastating flash flood has been occurred in the District on 12th August of 2017. As a results 8 people have been died and thousands of settlements have been affected. On that specific day, there was an average rainfall of 520 mm within a 24-hour period in the District. The areas of Bandapani, Lankapara, Totopara, Ballalguri, Hasimara, Satali, Mechpara, Chuapara, Rangamati, Jayanti, Rahimabad, Sankosh and Newlands in the northern part of Alipurduar District experience frequent flash floods almost every year. These floods cause significant damage to numerous houses and properties in these areas. The areas of Madarihat-Birpara block like, Lankapara, Tulsipara, Dalmore, Hantapara, Makrapara, Bandapani etc. have been severely affected by the dolomite mining in the Pagli area of Bhutan. The mining of dolomite has a profound impact on the river water, soil quality, tea plantations, and forests in these areas. The detrimental consequences arise when flood water, mixed with dolomite, enter these regions, exacerbating the negative effects.

1.3 Hypothesis

For the present research work following hypothesis has been considered

1. There is a relationship between high intensity rainstorm and flash flood.

2. Flash flood plays an important role on river aggradations in the study area.
3. The flash flood has detrimental effect on the socio-economic environment of the study area.
4. Mining & quarrying activities on upper catchment of the study area affects water quality and aggradations.
5. Flash flood affects tea gardens and forest in the study area.
6. Flash flood has negative impact on socio-economic development in Alipurduar District.

1.4 Objectives

Following aims and objectives are associated with the undertaken study

1. To know the nature of river basins and their role on flash flood.
2. To discuss the amount and intensity of rainfall and its effects on flash flood.
3. To know how quarrying and mining activities of upper catchment area is responsible for flash flood in Alipurduar.
4. To know how flash flood affects socio-economic condition of the study area.
5. To suggest the methods for the management of flash flood induced degradation.

1.5 Methodology

Following are the methodology to be followed for carrying out the proposed research work.

1. Based on SOI Topo-sheet and Satellite Imageries drainage map of the study area will be prepared by using GIS tools. To know about more information of river erosion some interview methods are to be applied in different parts of the study area. To know about river shifting, some comparative analysis based on Topographical sheet and satellite Imageries of different years will be consulted. Satellite image available from NRSC (LISS III & LISS IV), Google Earth has also been complied for systematic quantitative analysis of the basins.
2. The help of National Bureau of Soil Survey and Land Use Planning (ICAR), Kolkata has been taken to know about the soil of the study area and to prepare the soil map.
3. The drainage map has been prepared using the satellite imageries of IRS 1C and 1D, LISS III and LISS IV, Survey of India Topo-sheets (Sheets no. 78 F/5, 78 F/6, 78 F/10, 78 F/11 and 78 F/14). Drainage maps are prepared with the help of software like QGIS, ArcGIS, and Global Mapper etc. Google Earth has been used to determine the length of the rivers in the District and the size of the catchment area.

4. Flash flood probability (P) and recurrence interval (T) are determined based on the discharge data. The method for determining the recurrence interval (T) is- Probability (P) = (m/n+1), Recurrence Interval (T) = 1/P, where, P = Probability, m = Rank (Highest Discharge), n = No. of Years, and T = Recurrence Interval.
5. Patton and Baker's formula is followed to calculate the Flash Flood Magnitude Index (FFMI). The formula for determining FFMI is – $FFMI = X^2/(N-1)$, where, X= Xm – m, Xm = Annual discharge (m^3s^{-1}), N= Number of years of record. X, Xm and m are shown in logarithm values. The formula of S. Ghosh (2015) was used to calculate the temporal variation of FFMI.
6. The pH, Nitrate, Organic carbon calculated using 2 grams of soil and Phosphate, Potassium calculated using 5 grams of soil. Soil pH was calculated by Kuhn's colourmetric method. Determination of Organic carbon was calculated by Walkly and Blaz's rapid traditional method and Phosphte, Potassium and Nitrogen was analysis by soil kit box. Estimation of available Phosphate was calculated by Olsen's method.
7. After that the water quality index (WQI) has been determined with the help of Weighted Arithmetic Water Quality Index (WAWQI) method from that table. Steps to determine Water Quality Index are- firstly, eight parameters were determined in order of importance. Then the weightage value of those eight parameters is determined according to their importance. The sum of weightage values should always be 100%. In this case, the researcher selected the weightage value considering the importance of dolomite mining. Assign weightage values are pH (20%), TA (18%), EC (8%), TDS (10%), Calcium (15%), Chloride (7%), TH (12%) and Sulphate (10%).
8. The formula for determining the normalized value is (Actual value – Minimum value/Maximum Value-Minimum value) × 100. Then the Sub-Indices value of each parameter is determined. In this case the formula is – Sub-Indices = (normalized value × assigned %). Then the sum up value is determined by adding the sub-indices values of all the parameters. Then the Water Quality Index (WQI) is determined. The formula for determining the WQI value is- WQI = (Sum of Sub-Indices/ Total Weightage Value) × 100. Finally, a water quality rating or category table is prepared based on the WQI values through WAWQI method. In this case researcher has divided water quality category into four categories.
9. Data and information book of WHO (1981) is followed for flash flood forecasting. Modern methods of WHO, USNWS, Scofield (1977) and Mongli (1978) have been followed for detailing the various stages of flash flood forecasting.

1.6 Data sources

1. To know about the geological setup and its influence on flooding, the data and information was collected from Geological Survey of India's Reports, Memories, Maps, etc. The researcher studied the topographical maps of the study area. The SOI maps no. are 78B/9, B/13, B/14 and 78F/1, F/5, F/9 and F/10. Through the topographical sheets and with the help of GIS tools, the researcher prepared maps of the study area.
2. Information and data was collected from DM office to know details about Alipurduar District. Census handbook 2011 of Jalpaiguri District was used to represent the population status of Alipurduar District. Population details of Alipurduar District have been extracted separately by adding village wise population from Jalpaiguri District census handbook of 2011. A sample survey was conducted by researcher to find out socio-economic status of the study area.
3. The secondary data of rainfall was collected from Irrigation and Waterways Department, Alipurduar; DBITA, Binnaguri, Jalpaiguri; Tea gardens; Block Agricultural Seed Farms; CWC, Jalpaiguri and many other offices.
4. Daily Discharge data of Raidak- I, Raidak-II and Torsa Rivers were collected from CWC, Jalpaiguri. Daily water level data was collected from CWC, Jalpaiguri and Irrigation and waterways Dept., Alipurduar. Some information and data about flash flood of 1993, 1998, 2000, 2004, 2007 and 2010 is taken from Uttarbanga Sambad, Anandabazar Patrika, The Statesman, Pravat Khabar etc.
5. A random method field survey was conducted across different parts of the study area to know the impact of flash flood of 1993 & 2017. Data and information were collected from senior citizens and various former government officials through this field survey. A household survey was conducted randomly selected flash flood affected areas in different parts of Alipurduar District from 2017 to 2019. Through this household survey researcher got information about effects of flash flood on tea gardens, forests, agriculture, socio-economic conditions.
6. To collect primary data of soil types of low laying and high elevated land, the researcher conducted direct field observation at different parts of the study area. In this context an extensive field work was carried out frequently. Through this observation, the researcher was able to know about different characteristics of aggregational soils through different parts of the study area. To indicate the low laying areas of the study area, the researcher will use Global Mapper, MapInfo and NBSS & LUP, GIS software.

7. To measure the differences of production in agriculture year to year, the secondary data was collected from government offices and through some field observation and questionnaire. Different data and information of tea garden was collected from DBITA, Binnaguri and Tea Gardens.
8. To collect the primary data of soil, the researcher conducted an intensive field survey. Samples of soil collected from field were tested in the laboratory of the Department of Geography and Applied Geography and Department of Tea Management of North Bengal University. Data and information about soil erosion was collected from DBITA, Jalpaiguri, Agricultural Department and Tea Gardens.
9. To know the impact of flash flood on forests, data and information was collected from the office of the District Forest Officer and others Government Offices, articles of Sarkar, S. A field survey was also conducted by researcher to find out the impacts of flash flood on forest.
10. In order to know the effects of mining and quarrying on river water in Alipurduar District, water was collected from different rivers through direct field observation and tested them. The water samples were collected through random method from different rivers. Field observation for collection of water samples were carried out during pre-monsoon and monsoon period. Some information and data was collected from the articles of Sarkar, S and Paul, S. P.
11. To know the destructiveness and damages by flash flood, the secondary data was collected from District Disaster Management Cell and DM office, Alipurduar; Blocks Disaster Management Cell, CWC integrated data book and many others offices. To know about health condition after flood, data and information was collected from the offices of Health Department.
12. A field survey was conducted from 2015 to 2022 to know the status of river bed rising of different rivers in Alipurduar District. This survey was done mainly through random method. Basically, few numbers of rods buried in different rivers before the monsoon was collected by measuring them after the monsoon. The measuring rods were fixed in 2-3 places of every recording site. In some rivers, rising of river bed data was collected through bridge pillars and electricity poles. I this case, a particular section of the bridge and electricity pole was marked before the monsoon to measure how much it had changed after the monsoon.

1.7 Previous Works

Many researcher and Government employees have worked some macro level studies on this topic through different parts of the world. Especially some researcher worked on flash flood of Himalayan region. In 2007, D.D. Sharma has studied on flash flood entitled, "Floods and flash floods in Himachal Pradesh". In 2004 S. Sarkar, works on entitled, "Effects of the 1993 extreme flood on the channel morphology of Jayanti River, India". In 2010, Showkat Iqbal has studied on, "Floods and erosion induced population displacement: A socio-economic case study in the Gangetic Riverine Tract at Malda District, West Bengal, India". In 2012 L. Kristen has worked on, "A flash flooding storm at the steep edge of high terrain disaster in the Himalayas". Danicle Norbiato in 2008 studied on, "Flash flood warning based on rainfall thresholds and soil moisture conditions: An assessment for gauged and ungauged basins". Bidhan Kanti Das in 2009 worked on, "Flood disasters and forest villagers in sub-Himalayan Bengal". In 2011 S. Roy worked on, "Flood hazards in Jalpaiguri District and its management". In 2013 S. Chakrabarty and K. Dutta worked on, "Causes and Consequences of Fluvial Hazards- A Hydro-Geomorphic Analysis in Duars Region, India". In 2017 L. Bagchi and S.R. Chakraborty worked on, "Impact of Climate Change and Resultant Urban Flooding in Alipurduar Town, West Bengal- Its Vulnerability and Mitigation". In 2015 P. Gupta, A. Khanna & S. Majumder worked on, "Disaster Management in Flash Floods in Leh (Ladakh): A Case Study". A. B. Shrestha & S. R. Bajracharya worked on, "Flash Flood Risk Management in the Hindu Kush Himalayan Region". A very important work on flash flood in India has been done by P. Singh, A.S. Ramanathan and V.G. Ghanekar. In 1974 they worked on, "Flash Floods in India". In 2014 D. Ghosh and S. Saha worked on, "Channel bed aggradation in relation to channel Morphology: A case study of river Jainti, Jalpaiguri, West Bengal". Another important work on flash flood in India has been done by R. Singh and Others in 2015. They worked on, "Brief Communication: Climate, meteorological and topographical causes of 16-17 June 2013 Kedarnath(India) natural disaster event". In 2013 S. Ghosh worked on, "Estimation of Flash Flood Magnitude and Flood Risk in the Lower Segment of Damodar River Basin, India". In 2017 K.H.V. Durga Rao and Others worked on, "Flash flood disaster theat to Indian rail bridges: a spatial simulation study of Machak River flood, Madhya Pradesh". In 2018 Pankaj G and Anand S worked on, "Flash Flood and its Mitigation: A Case Study of Almora, Uttarakhand, India". In 2015 I. Elkhrachy worked on, "Flash Flood Hazard Mapping Using Satellite Images and GIS Tools: A case study of Najran City, Kingdom of Saudi arabia(KSA)". In 2011 D.K. Mandal worked on, "Management of Flood Disaster in West Bengal". In 2014 S. Sarkar worked on, "Land Degradation in Bhutanese Himalaya and its Impact on Fluvial

Dynamics in Birpara-Madarihat block in Jalpaiguri District". The most reliable work on flash flood in the study area was done by S. Sarkar in 2015. S. Sarkar has studied on flash flood entitled, "Flush Flood and Related Problems in Sub-Himalayan Eastern Duars of Alipurduar District, West Bengal". Some other scholars also worked on flash floods and floods are Roy (1978); Panda (1994); Betal (2002); Smith & Tobin (1979); Sarkar (1997); Mollah (2015); Sil Sharma (2011); Roy & Deb (2014); A. Basak & Das (2014); etc.

1.8 Limitation of the study

For the present study following limitation are identified

1. Data on aggradations is not readily available.
2. Non availability of published materials on flash flood at micro level study.
3. Proper data is not available about mining activities.
4. Soil data, particularly chemical analysis data are not adequately available on the study area.
5. It is not possible to reach the study area at that moment when the flash flood event occurs.

1.9 Conclusion

Flash flood is a major problem of the study area. This chapter tend to highlights concept on flash floods, literature review, location of the study area, hypothesis, objectives, database and methodology, limitations of the study etc.

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