Sentinel-1 SAR Data for Flood Land Identification with analyzing and Its Socio-Economic Consequences in Patashpur-I CD block, Purba Medinipur, West Bengal, India

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Abstract: Synthetic Aperture Radars (SAR) are the active microwave remote Sensing sensor used for terrestrial earth observed from the space platforms. In this paper the SAR microwave satellite imageries are along with the key processing elements and important analysis techniques that are used for the extraction of flooded area, spread of flood water, flood depth, duration of flood dynamics and delineate permanent water bodies using NDWI (Normalized Difference Water Index) through the multispectral Landsat data. This paper presented the potentiality used of the Sentinel-1 SAR images as a powerful tool for used detect the flood water extend and monitor the flood water propagation in the part of Patashpur-I CD block, 2021.This paper describes a threshold method to extract flooded extension area from the SAR images. On the basis of the findings, it is clear that the study shows a simple and effective way to use SAR Remote Sensing and GIS for creating flood inundation map, time series maps of flood extent, monitoring areal changes of inundation and duration of inundation. Sentinel-1 SAR data VV and VH polarization help us to identify the flood area during monsoon cloud cover weather condition. Dem pre-processing and generation for flood depth estimation is very effective for flood land identification. Patashpur-I CD block and its surrounding area is the most effective flood affected area for month of September, 2021.In monsoon season July to September month is heavy rainfall is recommend this flood. Another present study to the related primary data collected through the intensive fieldwork during the post flood period. The collected data tabulated and presented by appropriate cartographic techniques. The study implies heavy rainfall occurred during 4th September to 28th September worth affected on the social-economic condition of the village. In the month of September, 2021, a number of crops contained in 63.8% (111.23 sq. km) Agricultural lands were damage by flood. In spite of this, livestock, shops and households were also affected by the flood disaster during in this year.

Keywords: Sentinel-1 SAR, Threshold method, Flood Identification, Flood depth, NDWI.

I. INTRODUCTION

A. About Flood:

Flood is one of the most devastating natural disasters that affect many regions around the world year after year, causing massive damages to natural and man-made features, loss of lives, damaging economies and human health. More than one third of the world's land area is flood prone, affecting about 82% of the world's population. Due to the increased encroachment in flood plains, the frequency and intensity of flood get increases day by day affecting more population and causing greater economic loss (Alam and Muzzammil 2011).Flood maps provide essential inputs toward assessing the progression of inundation area and the severity of the flood situation (Amarnath and Rajah 2016; Cigna and Xie 2020). During the persistent and long-lasting period of cloud cover in the rainy season, the use of optical sensors are limited for the continuous monitoring of the flood disaster and the surface water bodies' change detection (Bioresita, 2018).In country like India, the main reason for rainfall is the arrival of monsoon wind. As a result of this flood huge loss of live, extensive damages to crop, properties and immeasurable misery to millions of people. The rivers of South Bengal are fed by rain water, rain is one of the causes of flood. The flood situation on the Keleghai River is no exception. The Keleghai River means terrible floods and the cries of flood victims.

B. According to Remote Sensing and GIS:

For the last two decades advancement in the field of remote sensing and geographic information system (GIS) has greatly facilitated the operation of flood mapping and flood risk assessment. Satellite remote sensing with both active and passive sensors operating in visible, infrared, thermal and microwave spectral regions is extensively used for mapping flood event due to their high spatial and synoptic coverage (Kiran et al. 2019; Anusha and Bharathi2020). Various change detection methods and flood extent mapping techniques based on multi-temporal SAR images are used for disaster monitoring and management (Martinez, 2007, Martinis, 2010, Giustarini, 2014, Dasgupta, 2018).Synthetic Aperture Radar (SAR) is an active remote sensing technique capable of penetrating cloud, fog or smoke for acquiring images in all-weather condition both day and night (Shaikh et al. 2018). Timely and accurate mapping of surface water bodies' changes detection and extraction of flooding extent over large geographical areas from satellite imagery has been widely applied in recent years (Clement, 2017).Apart from its all-weather capability the most important advantage of using SAR imagery lies in its ability to sharply distinguish between land and water. Thresholding is one of the most frequently used techniques in active remote sensing to segregate flooded areas from non-flooded areas in a radar image (Liu et al., 1999; Townsend et al., 1998; Brivioet al., 2002). Commonly, a threshold value of radar back scatter is set in decibel (dB) and a binary algorithm is followed to determine whether a given raster cell is 'flooded' or not. Radar back scatter is computed as a function of the incidence angle of the sensor and digital number (DN) (Chen et al., 1999). The threshold values are determined by a number of processes depending on the study area and overall spectral signature of the imagery. Change detection can be used as a powerful tool to detect flooded area in SAR imagery. In the coherence approach areas are generally identified as flooded where the coherence or correlation of radar backscatters from before and after flood imagery are very low (Nicoet al., 2000). Multi-date SAR scenes for the same area can be projected to red, green and blue channels to create a color composite. (Long et al., 2001) used three ERS SAR scenes to produce this kind of composite image. , the inundated areas in the radar image appear darker in contrast to other land areas. These characteristics of SAR add significant values in terms of determining flood extent mapping and accurate measurement of streams, lakes, and wetlands (Ajmar et al. 2017; Amarnath and Rajah 2016; Ohki et al. 2016; Voormansik et al. 2014).The composite image effectively depicts progress of a flood during a specific time period. This methodology is simple to execute and provides an opportunity to readily identify the area that remains water logged for a maximum period of time. Flood maps provide essential inputs toward assessing the progression of inundation area and the severity of the flood situation (Amarnath and Rajah 2016; Cigna and Xie 2020).

Synthetic Aperture Radar (SAR) system is as a widely used, practical and efficient tool in such applications due to collection of data in day-or-night and in different weather conditions with a constant observation of earth surface from the polar orbit (Soria-Ruiz, 2009). During the flood events, time is one of the main factors to flood management activities in terms of minimizing the time delay between data delivery and product dissemination (Twele, 2015). Space-borne microwave remote sensing with its nearly all-weather, day and night capabilities, seems to meet the demand for a worldwide, near real-time flood monitoring system.

C. Model Use for Flood:

In recent years, research has been focusing on the development of SAR based flood extent mapping techniques (e.g. Martinis et al., 2009). Microwave remote sensing is very useful for flood monitoring for cloudy atmosphere. Applies microwave remote sensing (RADARSAT-1 images) to monitor extent, depth and duration of flood (SanandaKundu ; S. P. Aggarwal ; Nanette Kingma; ArunMondal ; Deepak Khare).This unit less normalized measure is defined as 'backscatter coefficient', 'differential radar cross section' or 'normalized radar cross section' denoted by 'sigma nought'(Woodhouse 2006; Sentinel user guide). Due to the low backscattering response, flooded area appears dark and strong backscattering from rough soil surface and vegetation cause land surfaces appear bright (Manjusree et al. 2012). The threshold method was used to delineate flood extent which was used for calculating flood duration and depth (SanandaKundu ; S. P. Aggarwal ; Nanette Kingma; ArunMondal ; Deepak Khare). The most widely accepted technique in differentiating land pixels vs. water is the intensity thresholding method (López-Caloca et al. 2018).The algorithm discussed here involves the use of shortwave infrared, near-infrared and green spectral bands to develop a suitable band rationing technique for detecting surface water changes. This technique is referred to as Normalized Difference Surface Water Index (NDSWI). The NDSWI-based approach produces the best results for mapping of flood inundated areas when verified with actual satellite data (G. Amarnath). extraction of both vegetated and open water bodies in Western Zambia using sequential Sentinel-1 imagery (Hardy - 2019).remarkable research has been done on large and small scales flood mapping and flood dynamics based on the low return signal behaviour of open water bodies using SAR data along with the threshold method (Liu et al., 2002; Costa, 2004; Rahman, 2006; Song et al., 2007; Schumann et al., 2008; Matgen et al., 2011).

D. Aim & Objectives:

The aim of the study to execute the flood Identification with analyzing and its socio-economic consequences of Patashpur-I CD block.

Specific Objectives:

1. To find out the main causes of flood in the study.
2. To identify the changing spatial pattern of flood affected areas during flood time 04th September to 28th September, 2021 in the region of Patashpur-I CD block.
3. To assess the flood affected areas and the impact of vicinity floods on Social and Economy status in the study area.
4. To management strategy of flood in the study.

E. Study Area

The present study area is located in the Purba Medinipur district of West Bengal, India, which is identified as one of the flood prone areas in the state. Pataspur -1 block is one of the most agricultural block of East Medinipur. Pataspur-1 is a community development block that forms an administrative division in Egra subdivision of Purba Medinipur district. The Pataspur-1 CD block is bounded by Sabang CD block in Paschim Medinipur district in the north, Bhagabanpur-1 and Bhagabanpur -2 CD blocks in the east, Pataspur-2 CD block in the south and Narayangarh and Datan CD block in Paschim Medinipur district, in the west. It is located 54 k.m from Tamluk, the district headquarters Pataspur-1 CD block has an area of 173.7061 sq.km. As per 2011 census of India Pataspur-1 CD block had a total population of 173377. The absolute location 22°58'33.66" to 22°6' 34.64" north latitude and 87°27'8.59" to 87°41'1.84 "east longitude. Summer begins in April and the maximum temperature is 30°C to 37°C and continues till June. The general climate conditions of the area indicate that the maximum and minimum temperatures ranges between 12°C to 39°C, relative humidity 40 to 80 percent and the average annual rainfall 1669.60 mm with maximum rainfall registered in the month of July at 354 mm to minimum rainfall of 5 mm in the month of December. Rainfall decreases in the cold weather months of November and December. A considerable amount of monsoon rainfall occurs in association with the movement of Cyclonic depression from the Bay of Bengal. It rains heavily from June to September. In the figure-2 section, one time the rainfall is increasing maximum 326.00 mm in septembar-2021. After rainfall continuously decreased. But month of september-2021 a huge rainfall had been occurring flood and in this region above 300 mm rainfall in a month is one Cause of flood.

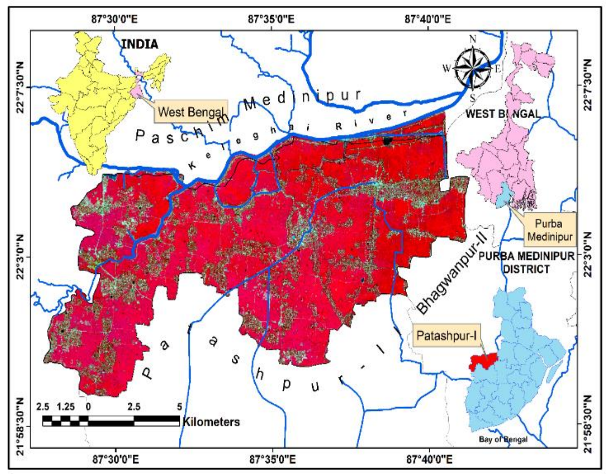

Figure-1; Location map of the study area.

F. Gauge level fluctuation on river Keleghai and Kapaleswari River:

Gauge level in most important parameter for flood level identification. It is indicator to indicate the flood level in river and its surrounding area. The Gauge level increment depends on the rainfall and water discharge in Mukutmanipur Dam and DVC. According to West Bengal Irrigation and Waterways Department, there are 4 gauge level station presents on keleghai river and there surrounding area which gauge levels data indicate the flood occurrence in spatially Patashpur-I CD block at 2021. There 4 gauge stations are Amgachia, Kalimondop, Dehati, Bhakrabad plays an important role before and after flood.In amgachhee gauge station near of the Patashpur-I CD block primary average gauge level is 5.30 mt., D.L is 5.79 mt., E.D.L is 6.4 and AEDL is 0.88 mt. and ADL is mt. in month of septembar-2021. In this graph after 14th September, the gauge level is increase for heavy rainfall in this region and its western part of W.B. On 15thSeptember the gauge level cross the E.D.L (0.3mt.) and 25thSeptember gradually decries and flax Choate depends on rainfall.

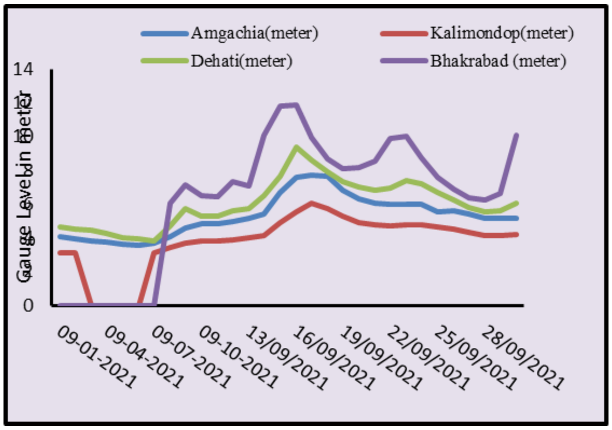

Figure-2; Four Gauge station on Keleghai River

According to West Bengal Irrigation and Waterways Department, Patashpur-I CD block nearby gauge station is amgachhee which four gauge level (GL, D.L, E.D.L, ADL, and AEDL) indicates river water level and duration during flood time, 2021. Based on the gauge station data, flood during time Microwave (sentinel-1) data was collected.

II. DATA USE FOR FLOOD

Data products from Sentinel-1 and Sentinel-2 are freely available on the Copernicus Open Access Hub (https://scihub.copernicus.eu/). Registered users can choose the place, date and other required parameters and download the data. However, download speeds are limited to two datasets at a time per user. Images from Sentinel-2 are accessible from the United States Geological Survey (USGS) Earth Explorer (https://earthexplorer.usgs.gov/). Besides Sentinel-2, other datasets are available on this server.

A. Sentinel-1:

Sentinel-1 is a satellite mission developed by ESA under the Copernicus initiative. It is a constellation of two satellites: Sentinel-1A launched on April 3rd, 2014 and Sentinel-1B launched on April 25th, 2016 (in the future two more units will be launched: Sentinel-1C and Sentinel-1D). Both satellites fly in the same sun-synchronous, near-polar, circular orbit at a height of 693 km, with a 12-day repeat cycle for one satellite, and 6-day for the pair (ESA, 2012, 2013). The SAR instrument operates in C-band, which is within the 4–8 GHz frequency range (7.5–3.75 cm wavelength), in the microwave portion of the electromagnetic spectrum (IEEE-AESS, 2003).

B. Sentinel-1 Data Availability:

The mapping and monitoring of flood located in study area was done by using Sentinel-1A Interferometric Wide Swath (IW) mode Level 1 (L1) GRDH (ground-range Detected, high resolution) product. Analyses are based on acquisitions during the monsoon season from 04th September to 28th September, 2021, which cover the entire Patashpur-I CD Block. During this time period 4gauge rainfall data are collected.

C. Sentinel-2:

Sentinel-2, similar to Sentinel-1, is a satellite mission developed under ESA's Copernicus initiative. It involves two satellites (Sentinel-2A and Sentinel-2B) on opposite sides of sun-synchronous orbit at an altitude of 786 km.Sentinel-2A was launched on June 23rd, 2015 and Sentinel-2B on March 7th, 2017.Twin satellites on the same orbit, 180^{o} apart from each other.

Sentinel-2 covers land and coastal areas from 56^{o}S to 84^{o}N with an orbital swath width equal to 290 km and a revisiting time of 10 days, or 5 for the pair. Sentinel-2 data can be used for such applications as water monitoring, forest and vegetation observation, as well as management of natural disasters and infrastructure, border, and maritime surveillance.

D. Sentinel-2 Data Availability:

In study area Multi Spectral Instrument (MSI) was used to identify the permanent water body, vegetation, build up, and crop land. We can use USGS open source data portal to download 04th September, 2021 Sentinel-2A data "S2A_MSIL1C_20210804T043701_N0205_R033_T45QWF_20170604T044419".

E. Alos Polser DEM (12.5m) data Availability:

To execute flood depth map in the study area we can use ALOSE POLSER high resolution DEM which is 12.5m resolution and topographical data were collected by TOTAL STATION surveying. Flood depth is considered crucial for flood hazard mapping and a digital elevation model (DEM) is considered to be the most effective means to estimate flood depth from remotely sensed or hydrological data. In a flat terrain accuracy of flood estimation depends primarily on the resolution of the DEM (JOY SANYALand X. X. LU).

III. METHODOLOGY

To full fill the objective of the study area we use this methodology.

A. Sentinel-1 Data Pre-processing:

Identifying the flood land sentinel -1 data is useful. Sentinel-1 (L1) data was pre-processed using ESA's open source 'Sentinel-1 Toolbox'. In SNAP software Pre-processing steps include Subset, orbit correction, Thermal Noise Removal, radiometric calibration; re-sampling and Geocoding (see https://sentinel.esa.int/web/sentinel/toolboxes/sentinel-1 for a detailed description of the processing steps). Grid orbit data have been re-sampled to a 10 m grid. The geocoding includes a Range Doppler Terrain Correction based on the ASTER GDEM (GDEM 2) are second (30 m) Digital Elevation Model data and Precise Orbit files provided by ESA from Array's servers (https://qc.sentinel1.eo.esa.int). Since this study is based on the investigation of (low-frequency) seasonal backscattering behavior, speckle filtering was performed by using a (temporal) Lee sigma filter which has the advantage of additionally suppressing high frequency signal (and random noise) components.

B. Sentinel-2 Data Pre-processing:

Pre-processing for the Multispectral Instrument (MSI) Sentinel-2 data we can use Q-GIS semi-Automatic Classification Plugin tool. This tab allows for the conversion of Sentinel-2A and 2B images from DN (i.e. Digital Numbers) to the physical measure of Top of Atmosphere reflectance (TOA), or the application of a simple atmospheric correction using the DOS1 method (Dark Object Subtraction 1), which is an image-based technique. Pan-sharpening is also available.

C. DEM data per-processing:

Pre-process the DEM data we can use G.P.S and TOTAL STATION survey in his region to collected elevation data and generate it in DEM with latitude, longitude in particular away. Than IDW in all data set and generate a DEM for flood depth estimation.

D. G.P.S Field Survey with validation:

As geospatial technology-based product are the foundation of natural resource management and decision making process, it is very much useful for mitigate the error and accuracy assessment by using some algorithm. Accuracy is considered to truthiness of the result. Validation the result we can use the field survey, it is very much important for accuracy assessment. GPS base survey is validated the ground data to the image.

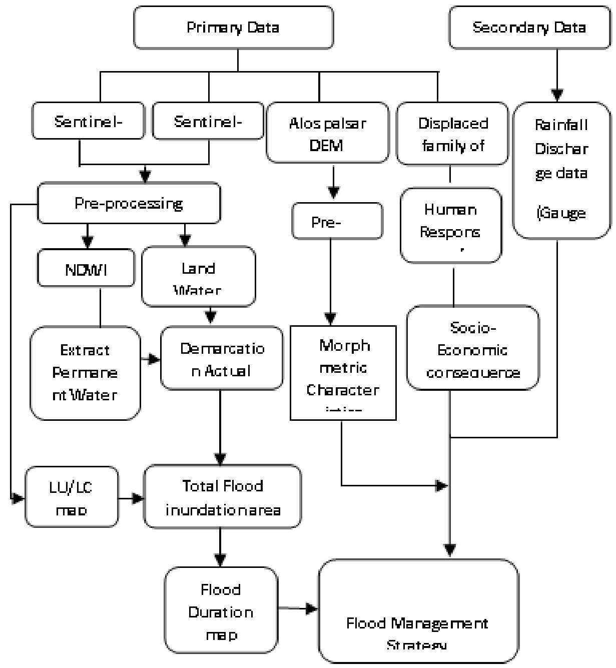

Figure-3; Methodological flow Chart of the study.

IV. RESULTS AND DISCUSSION:

The present study attempts to assess the identification and impact of flood in Patashpur-I CD block, Purba Medinipur, west Bengal using microwave remote sensing. Statistical inference has been made to exploit the use of optical and microwave measures to derived soil moisture status. This chapter summarizes the results obtain in accordance with the objectives.

Table-1; Dates of Sentinel-1A satellite data acquisition.

SL. No	Product Id	Resolution	Date of Acquisition
1	S1A_IW_GRDH_1SDV_20210904T122048	10m	04-09-2021
2	S1A_IW_GRDH_1SDV_20210911T121217	10m	11-09-2021
3	S1A_IW_GRDH_1SDV_20210916T121215	10m	16-09-2021
4	S1A_IW_GRDH_1SDV_20210923T121229	10m	23-09-2021
5	S1A_IW_GRDH_1SDV_20210928T121221	10m	28-09-2021

A. The Cause of the Flood in the Study Area:

Flood is probably the most devastating, widespread and frequent natural disaster. The erosion of the Keleghai river embankment has created intense tension among the local people. Basically Keleghai is a river fed by rain water. Natural cause are not the only ones responsible for the breach of the Keleghai river in addition to natural causes, human causes are one of the most important.

B. Heavy rain:

In almost most regions of the world, there is a close relationship between heavy rains and floods. The Keleghai River has a certain natural water holding capacity. But due to continuous rainfall in Potashpur-1 area from 4th to 23rd September, 2021, the excess water load in Keleghai River exceeded the normal water carrying capacity of the river.

Most common cause of river flooding is excessive or prolonged rainfall in upstream catchment with excess water flow through channels beyond the storage capacity resulting overflow of water crossing the bank and filling low lying lands (Rincon et al. 2018).

C. Silted and narrow riverbed:

Over a long period of time, the sediments from the ground are deposited in the Keleghai River. Then the Keleghai River became stagnant. As a result, the excess water of the monsoon enters the flooded Keleghai River and spreads to the adjacent areas causing floods.

D. Large amount of silt accumulation in Keleghai River:

As a result of this high amount of silt accumulation in the lower part of Keleghai River basin became shallower. As a result, the area is flooded in the lower part of Keleghai, unable to carry excess rainwater.

E. Depletion of forest cover in the upper reaches of the river:

Deforestation upstream of the river in recent times has increased the rate of sediment erosion as a result; flooding is seen in the lower part.

F. Humanitarian Reasons:

Although the government has reformed the river, shops, brick kilns, house have been built on the banks of the river. As a result, the riverbank has gradually narrowed. The risk of flood is increasing every year. Local people complained that the business of illegal excavation and sale of soil from the Keleghai river char was increasing day by day. Keleghai River is not in any one place. None of the Keleghai rivers, including Shilakhali, Mohammadpur, Dedredighi, Kantakhali, Kirtankhali, on the banks of the Kelekhai river in a kilometer after kilometer area with the help of JCBs, tractors and machine vans, the silt of the Keleghai river .Unplanned excavation of earth, construction of mounds, setting up of illegal brick kilns has created a chaotic environment in the vast stretches of the vast Keleghai river char. Some people are torturing the calm and freshwater river Keleghai. On Thursday, 16th September at 1:00 A.M illegal and unbridled torture on the bank of the river near Talchhitkini in Pataspur-I CD caused the dam of Keleghai River to break. As a result Potaspur-1 area of Purba Midnapur was flooded. However, for a few days the local tried to block the river embankment by filling the sacks with soil and throwing triple sacks one after the other.

G. Other Cause:

The river flow has decreased due to excess silt due to the gentle longitudinal slope of the riverbed; it has lost its drainage efficiency. The course of this river has changed drastically over time. River expert K. Rudra, (2002) in an article states that the change in river course across Bengal stimulated the socio-economic system of the time but was temporary. The lack of far-reaching planning is proven today with the help of technology. Because of that observation, it is very important to shed light on the early course of Keleghai River. The Keleghai River originates from a perpetual upward-flowing fresh water source in an underground reservoir at Dudhkundi Mauza near Sardihar in Jhargram district. Then it continued to flow south-east. The flow has widened the basin along the junction of Sabang and Patashpur blocks, touching the Kharagpur, Narayangar blocks. It used to flow through Amgachia and Mangalamaro near Chistipur area of Patashpur and fall into Rasulpur estuary via Itaberia, Kalinagar.This early south-facing basin of the Keleghai River was recorded in Rennel's Atlas of 1777 as well as in 1933 by the Surveyor General officiating Colonel H.J. Coachman D.C.O. Sc. It is also published on the map. Today, the abandoned course of the Keleghai River still exists in the area as the original Keleghai River. However, most of it is lost in roads, bridges, houses and farmland. On the other hand, the confluence of the present highest eastern branch of the river and the Kapaleshwari River has taken the form of Keleghai River. Thus the Keleghai River diverges from its original course for about 15 km at Amagachia. In recent times, the Keleghai Chinnamasta River has been forced by human beings to flow towards the east and join the Kapaleshwari River. This flow of the river was completely opposite to the actual slope by creating a new course. The original shield was Adi Keleghair. So the construction and enclosure of high embankments at Amagachia in the original course of Keleghai River cut off its original course. On the other hand, the cause of the terrible floods in the Keleghai basin is hidden in these two aberrant changes, indicating the course of the Keleghai River in the steep eastward slope.

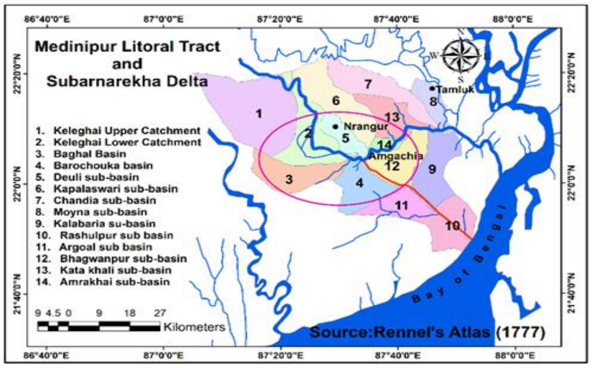

Figure-4; Littoral tract of rivers patterns in the Subarnarekha delta.

H. Flood Land Identification:

After pre-process all the data we demarcating the flood and non-flood land. For proper assessment of the delineated flooded area, a specific flood boundary is required. In the radar image, Water usually appears black as the backscatter value of water reaches nearly zero (Chaouch et al. 2012).Among various methods for boundary delineation, threshold method (Bovolo and Bruzzone, 2005; Temimi et al. 2011; Chaouch et al. 2012) was applied here for demarcating the flooded and non-flooded zone. The backscatter value of flooded water in the study area varies from -13 to -17 dB in different images of 2021 which approximates to the average value of -15 dB was taken as the boundary line between flooded and non-flooded region. Given a class name like flood and non-flooded area, threshold or density slicing division of histograms comprehend into two parts. The boundaries were verified from the field survey. Reclassify the flood and non-flooded area with 1 and 0 in all data.

Table-2; Distribution of flood and non-flooded area.

Dates	Flood Area in km2	% of Flood Area in km2	Non-Flood Area in km2	% of Non-Flood Area in km2	Total Flood Area in km2
04/09/2021	63.0671	36.30678	110.639	63.69322	173.7061
11/09/2021	85.8822	49.44195	87.8209	50.55805	173.7061
16/09/2021	97.53	56.14772	76.1725	43.85228	173.7061
23/09/2021	93.415	53.78025	80.2826	46.21975	173.7061
28/09/2021	72.5624	41.77479	101.1366	58.22521	173.7061

The Patashpur-I CD Block is one of the worst flood-affected regions in the West Bengal, where year of 2008 and 2021 flooded causes by destruction of Embankment and natural flow of the Keleghai River. Hence, day-wise Flood affected area maps signify the most possible areas of damages. The flood water recorded from the north to south and from 4th

September to 28thSeptember-2021.The flood started before 10thSeptemberwith peak flood in 23thSeptember which decreases after 24thSeptember.Highly flood affected north-western, southern part of the study cause very low sloping from North-west to south. The flood archive maximum level in 15 to 23th September, 2021. The flood damage makes disaster holding complexions. On 23th September, 53.78025 % (93.415 km2) area was under flood water affected. The flood recorded, and the entire region was affected by peak flood with 56.14772 % (97.53 km2) area under wateron16thJuly.Thenafter flood area reduced to 41.775% (72.5624 km2) on 28th September.

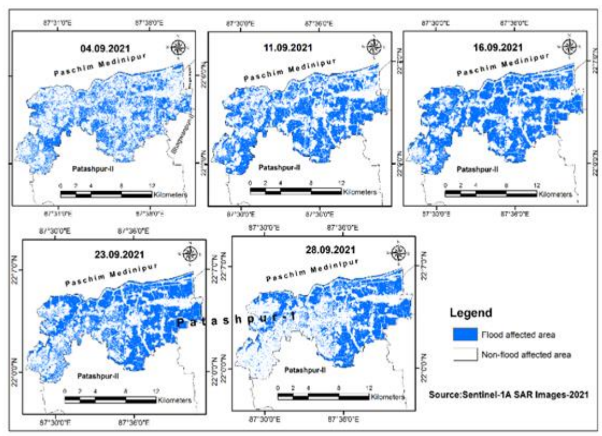

Figure-5; Day Wise Flood Land Identification of the study area

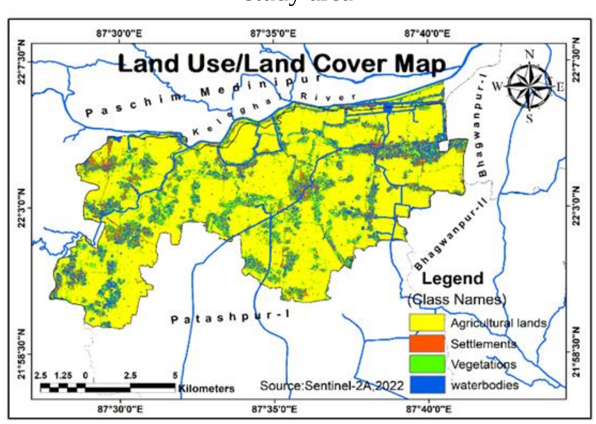

Figure-6; Day Wise Flood area of the study area.

I. Land Use /Land Cover Map:

The LULC map use in this project is generated from Sentinel-2A image by unsupervised classification. This map is very useful for identify the special object in Patashpur-I CD block. This LULC image is classified into 4categories are vegetation, water bodies, agricultural land, and settlement in denoted. In these LU/LC categories maximum area of agricultural lands is occupied 63.88% (111.23 km2) area in the study. Others land categories such as; vegetation and water bodies are covered 15.89% (27.68 km2), 11.91% (20.74 km2) area respectively, these are mainly found middle and northern part of the study area. Very low areas like Settlement are occupied only 8.32% (14.49 km2) area and found mainly eastern, western and along the road side of the study area.

Table-3; Area of LU/LC categories of the study area.

Sl. No.	LULC types	Area in km2	% of Area in km2
1.	Vegetation	27.6751	15.89344681
2.	water bodies	20.7398	11.91059502
3.	Agricultural lands	111.2251	63.87511558
4.	Settlements	14.489	8.320842594
Total		174.129	100

J. Permanent Water Bodies:

Extract permanent water bodies we can use sentinel-2B Multi-spectral Image (MSI) data. For pre-processing the data, Q-GIS semi-Automatic Classification Plugin tool is applied. After pre-process the data, we use Green and Near Infer Red band (band 3 and 8) for NDWI method. Using NDWI method and Google earth we demarcating permanent water bodies before flood.

NDWI= (GREEN-NIR) / (GREEN+NIR)… (1)

For proper estimation of water bodies using a threshold value in NDWI method and extract permanent water bodies. Maximum area of agricultural lands is occupied 63.88%.

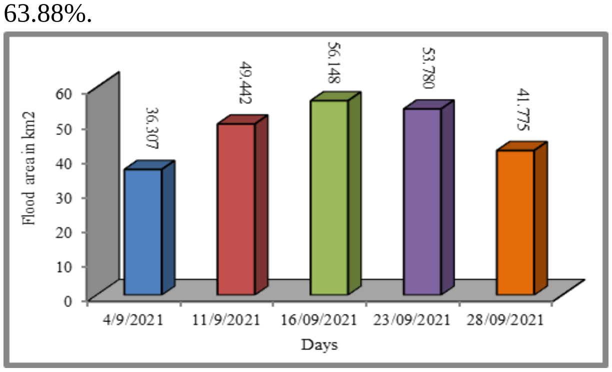

Figure-7; Land Use / Land Cover map of the study area.

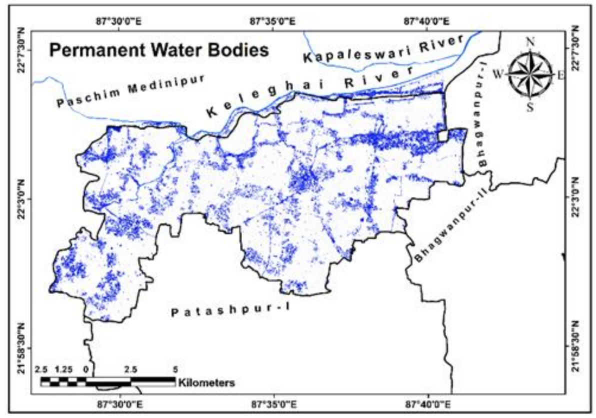

Figure-8; Permanent Water bodies of the study area.

K. Flood Depth:

For flood depth map extraction we use high resolution Alos Polser DEM (12.5 m) image. The DEM was projected into UTM projection zone 45, and WGS 84 was the horizontal and vertical datum. The DEM had negative height information because the WGS84 datum is approximately 5 m higher above the mean sea level (MSL). Using field survey data the highest elevated region of the study area where the flood had occurred was taken as the maximum flood water level is 5.3mt.

Flood Depth image = Equal flood height map-DEM image………………………… (2)

In flood depth map western part of the rive Keleghai river flood depth is very high above the 3.6 mt. and Eastern part is gradually less than western part. The maximum flood depth bellow 0.3 mt. is occupied 43.48 % (75.51km2) and found mainly northern and southern part of the study area. Flood depth in-between 0.3-0.9 mt., 0.9-1.8 mt. and 1.8-3.6 mt.area are occupied 28.087% (48.788 km2), 9.981 % (17.338 km2) and 4.698 % (8.161 km2) respectively.

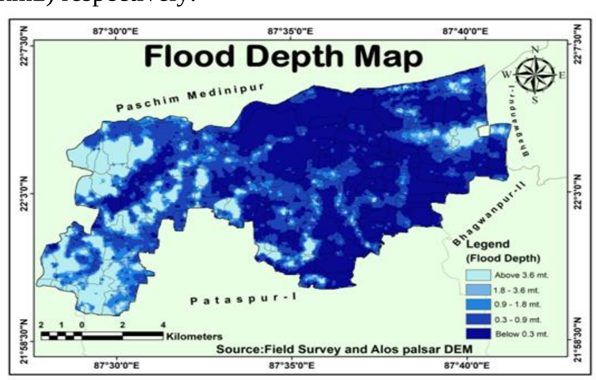

Figure-9; Flood Depth map of the study area.

L. Flood Extent & Intensity:

Estimation of flood extent is a very important process for identifying flood hazard zones and for the management purposes. Hence, flood extent maps signify the most possible areas of damages. The study area is one of the worst flood-affected regions in West Bengal, where almost year of 2008 and 2021 flood causes destruction embankment of Keleghai River. Thus, it is essential to demarcate flooded area here for controlling probable damages in future. Flood water extent of 2021 is illustrated in the Fig. 4.

The eastern part was the most affected part of the region along with the south-west and some parts in the north. The northwest part is affected by flood stage water.

Table-5; Area of flood extent and intensity of the study area.

Sl. No.	Flood Intensity	Area in km2	% of Area in km2
1.	Low	27.6715	38.838
2.	Moderate	29.2339	41.030
3.	High	14.3439	20.132
	Total	71.2493	100

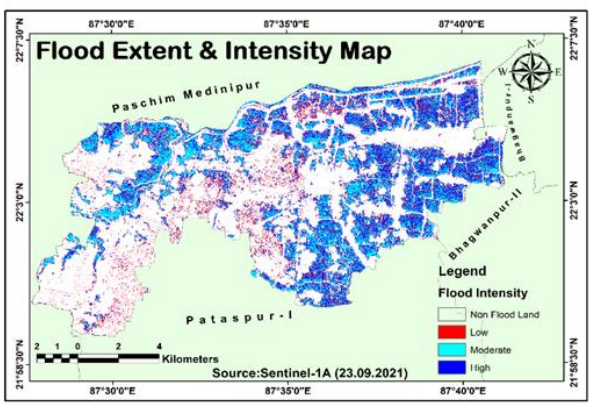

Figure-10; Flood Extent and Intensity map of the study area

In the flood extent and intensity map (Fig. 19), are categories as; Low, Moderate and High. High flood intensity area is occupied about 20.132% (14.3439 km2) and covered southern-eastern and northern part of the study area. Respectively Moderate, Low intensity graph is distributed was 41.030 % (29.23 km2), 38.84% (27.67km2) respectively and they are mainly found eastern and some part of southern part of the study area.

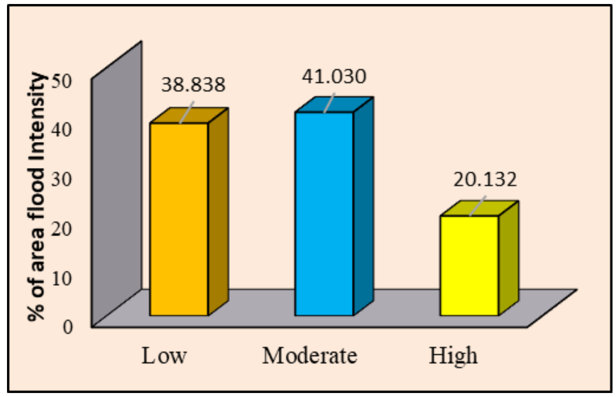

Figure-11; % of Flood Extent and Intensity map of the study area.

M. Block wise Flood Effect:

The Patashpur-I CD block consist with 127 gram sansad, 140mouza and 182inhabited villages and 9 gram panchayats. In this project result, they are affected by flood in 3 categories as; Low, Moderate and High. In his map is highly effected the village Bagdiband to Uttar Rayband (Table-, Sl.No.1-36) by the flood of 2021. After that moderately affected to the village Agarpara to Pania (Sl.No.114 -184) and Agabar Chak to Tota Nala (Sl.No.37 -113) is low effected area in cause of upstream flow.

In table - 7; Village wise flood affected represent per sq.kms and percentage wise flood effect.

Table-4; Area of flood depth of the study area.

Sl. No.	Flood Depth (mt.)	Area in km2	% of Area in km2
1.	Bellow 0.3	75.519	43.475
2.	0.3-0.9	48.788	28.087
3.	0.9-1.8	17.338	9.981
4.	1.8-3.6	8.161	4.698
5.	Above 3.6	23.898	13.758
	Total	173.705	100.000

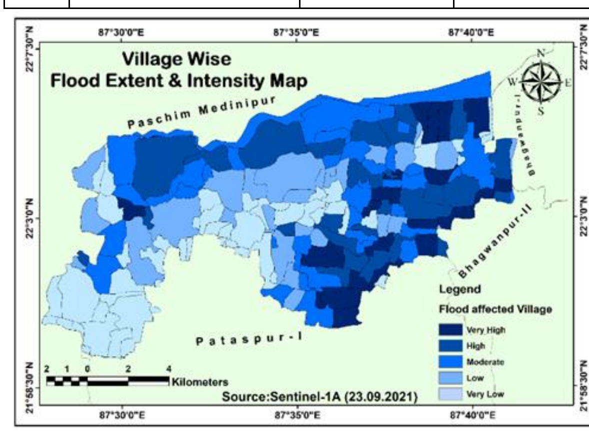

Figure-12; Village Wise flood affected and Intensity Map of the study area.

N. Human Response to Flood Problem:

Flood and erosion are the main geomorphic problems faced by the people living in the flood plains. Different human communities are found to respond differently to these problems. Patashpur-I CD block is one of the flood prone areas. The study area is one of the extremely flood prone zone of the right bank of the Keleghai River. The furious flood and embankment erosion of year 2008 and 2021, affected the activities of the flood plain dwellers resulting to marked changes to the ecology of the areas. The loss of property is increasing at an alarming rate in the study area. Potashpur-I CD Block had a total population of 173,377 (Census-2011), of which 166,977 were rural and 6,400 were urban population, here were 89,555 (52%) males and 83,822 (48%) females. Population below 6 years was 19,008. Scheduled Castes numbered 24,341 (14.04%) and Scheduled Tribes numbered 1,124 (0.65%) and therefore people have no option to inhabit. The people of the affected villages have experiences about flood and they know how to live with it. But in recent years, attraction to modern life and culture tends to make the people insensitive to their own indigenous techniques which were most essential for survival in these riverine areas.

O. Socio-Economic Impact of Flood:

Flood as an important geomorphic event that occurs due to several causes like heavy precipitation, sudden release of water resulting from dam etc. It is a catastrophic agent which causes erosion, deposition and changes the physiographic character of the river valley. Thus, the flood in the study area problems like damage to crops, settlements, losses of lives of human and live stocks, erosion and deposition of thick sand over agricultural land, etc.

The occupation status of our flood prone areas. It is a rural area here major person are involved to primary activity. Primary worker is include farmer 40.741%, secondary worker are includes labour and shopkeeper 42.593%. But percentage of tertiary worker are observe very low (16.667%).The monthly income of every family here, primary worker is mostly dominated so monthly income is very low. Here 42.59% families' monthly income under 5000/-, (25.926%) 5000 – 10000/-, 10000 – 15000/- (9.259%), 15000 - 20000/- (11.111%), 20000 – 25000/- (407%) & 25000 – 30000/- (3.704%) respectively.

The percentage of respondent families of major environmental problem like-

- Loss of bar is effected said not very concerned 44.444%, neutral 50%, somewhat concerned 5.555% of families.
- Damage to plant & animal said somewhat concerned 46.296%, very concerned 53.704% of families.
- Reduced access to coast said not at all concerned 12.963%, not very concerned 24.074%, neutral 25.926%, somewhat concerned 20.370% & very concerned 16.666% of families.
- Reduced quality of recreation said not at all concerned 31.481%, not very concerned 25.926%, neutral 38.889% &somewhat concerned 3.704% of families.
- Road closer is effected said somewhat concerned 53.704%, very concerned 46.296% of families.
- Pollution is effected said somewhat concerned 50% & very concerned 50% of families.
- Damage to private land & property said somewhat concerned 42.592% & very concerned 57.407% of families.
- Interruption of utilities said neutral 18.519%, somewhat concerned 66.667%, and very concerned 14.815% of families.

V. MANAGEMENT

A. Digging Canals:

A reduced number of drainage canals in catchment areas increases the water pressure on the river considerably and increases the likelihood of flooding. To deal with problem, the water pressure is balanced by digging new canals in the river basin areas and dispersing the excess water of the river over a wide area. This greatly reduces the possibility of flooding in large parts of the basin.

B. Embankments of River:

Weak river dam play a major role causing flood. These weak embankments can be reinforced with concrete, boulders or stones to with sand the high-water pressure.

3. Construction of Wall along the Embankment:

Keleghai River embankment concrete walls can be constructed on both sides of river embankments to prevent rapid erosion, increase stability or ensure flood safety in catchment areas.

C. Creation or Reservoirs:

After the arrival of the monsoon, the excess water cannot be held by the river due to heavy rainfall during the monsoon season. Therefore, numerous stable reservoirs can be constructed along the course of Keleghai River to handle the excess water load.

D. Increase the Navigability of River:

Over a long period of time the Keleghai river channel has been filled with excess silt, sand, mud etc. So its navigability has decreased considerably. Therefore, efforts can be made to reduce the flood potential by removing excess silt through artificial dredging.

E. Impediment of surface flow:

Excessive surface run off caused by heavy rainfall generally in the Keleghai river basin region directly increases flood susceptibility. Special emphasis can be placed on balanced slope management in river basins to delay such flash floods.

F. Afforestation:

The simplest and best flood prevention strategy is planned afforestation along the Keleghai river banks. As a result, the water holding capacity of river Keleghai will increase; similarly the amount of river bank erosion will be reduced to a considerable extent. As a result, the possibility of river bursting and flooding will be greatly reduced.

G. Mapping of Flood plains:

Mapping of flood prone areas is very important to implement proper land use planning in Keleghai River flood prone areas. In this case, first of all various data of past floods in Potaspur-1 region are collected. After this with the help of Geographic Information System a map of the flood-prone area of Keleghai River can be created by surveying the nature of the local water table, sediment layer and embankment. With the help of such maps, people are cautioned against building settlements in the most flood-prone areas of the respective region. By this, it is possible to deal with the Keleghai flood situation.

H. Establishment of flood forecasting center:

After risk assessment of Keleghai flood prone areas multiple flood forecasting stations can be established along the respective river basin. By this people can be warned before the flood. As a result, the amount of flood damage is reduced.

VI. CONCLUSION

The present study demonstrates the uses of geo-spatial technology for analysis to identify the land and its socio-economic impacts on Patashpur-I CD block is the low elevation plain land. These flood land identified and impacts analysis can be used to take multiple measurement in Patashpur-I CD block. Flood affected area were identified and map prepared using SAR satellite data. The study flood extent and intensity is very high for his river pattern and its plain land condition. The research showed the flood intensity and damage in the study area during the year of 2021 flood. In western and northern part of the study area, the slope is very high so flood water stagnant in this region. In this region at first, down slop area was flooded by the over flow of western part of the Keleghai river, Kapaleswari river and Bague river than stage by the heavy rainfall and discharge water of the damage embankment. For this huge stage water Keleghai River, Kapaleswari River and Bague River cannot carry the huge water at short time. Than it is communalizing a flood disaster.SAR data is very helpful in monsoon season to collect data contempt the cloud. The result of this paper flood extent is commonly increase in long time duration and flood depth is estimated in 10m and basis of this highly; moderately and low inundated density area is highly affected.

In another to achieve the goal of Socio-Economic Consequences in the Keleghai river. In the study different parameters have been used in order to have a scientific explanation of various components of socio-economic Consequence such as; affected on transportation facilities, shops and kiosks, milk production, basic facilities of the village, livestock of the village, houses and households etc. The village had also noticed health problems during the flood period. Like negative socio-economic consequences, positive consequences are also observed in the study region. They are increase in the fertility of the land, increase in the ground water level and mitigation of the problem of siltation.

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ABBREVIATIONS

P.D.L: Primary Danger Level, D.L: Danger Level, E.D.L: Extreme Danger Level, H.F.L: High Flood Level, D.F.O: Dartmouth Flood Observatory, NDWI: Normalized Difference Water Index, S.N.A.P: Sentinel

Application platform, NIR: Near Infrared, GPS: Ground positioning system.

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