GEOINFORMATICS APPROACH TO DELINEATE FLOOD HAZARD ZONES OF MURSHIDABAD DISTRICT, WEST BENGAL, INDIA

Soubhik Karmakar[1], Prafull Singh[1] and Maya Kumari[2]

[1],Amity Institute of Geoinformatics and Remote Sensing, Amity University Sector-125, Noida,
[1]Amity School of Natural Resource and Sustainable Development, Amity University Noida, Sector-125
email-psingh17@amity.edu, soubhikmsd@gmail.com
[2] Assistant Professor (Amity Institute of Natural Resource and Sustainable Development),

Keyword: Remote Sensing, GIS, Weighted Overlay, Flood hazard Zoning Murshidabad

ABSTRACT

Flood is known to be a serious environmental hazard. It causes substantial damage to life and property. Proper monitoring and effective management technique using remotely sensed satellite data and GIS technique is an important way of flood hazard monitoring. In the present study an effort has been made to delineate the flood hazard zone of Murshidabad district of West Bengal. The district is drained by several perennial rivers and associated with huge monsoonal rainfall. The historical record shows occurrence of several flood in the district affecting several blocks of the district. Satellite image and SRTM data have been analyzed using remote sensing and GIS software to identify the flood hazard zone and the major and minor places that are located within high, moderate, low and safe zones of flood hazard. A proper mitigation and effective flood management planning can be adopted using remote sensing and GIS to check the flood problem of the district.

1.INTRODUCTION

Murshidabad is a district in West Bengal which is most diverse in nature from physiographic and socio economic perspective. The district is characterized by several tributaries and distributaries of Bhagirathi river. River Bhagirathi which is the main river of this area passes through the mid of the district and Jalangi river is another river flowing through the study area. The historical perspective of the district shows several devastating flood occurrence. Several factors pertain to this flooding such as huge monsoonal rainfall, siltation of river bed low elevation gentle slope of the land are the major one. According to "Flood Preparedness and Management Plan,2014" flood has occurred 26 times from 1990 to 2016 and mostly affected blocks are Beldanga, Lalgola, and Kandi etc. Study of different hazard problem can be monitored through remote sensing data and GIS tools. These technique not only help in the analysis of the problem but also help to assess the effects of this hazard on people and property as well as can predict the future occurrence of the hazard using statistical modelling. In the current study flood hazard zones of murshidabad district has been delineated using geo informatics approach. The result has been validated with "Flood Preparedness and Management Plan, 2014, Murshidabad, West Bengal". The present study has been carried out in a district which has been affected by flooding several times ranging from low to high magnitude. The main objective of the present study to develop flood hazard zones of Murshidabad district using geo informatics.

2.GEOGRAPHY OF STUDY AREA

The study area Murshidabad is a central district of West Bengal. Murshidabad district is the heart of West Bengal. The study comes under 24^0 50' 20" N to 23^0 43' 30" N and 88^0 46' 00" E to 87^0 49' 17" E. It covers an entire area of 5324 square km. The district comprises the head quarter Berhampore and 26 blocks and 7 Municipalities, Berhampore Municipality being one of them. The total population of the district is 7102430 (2011 census) with population density of 1101 persons/square km, literacy rate is 61.46% for male and 48.33% for female. All administrative works are done in the district head quarter Berhampore only. But this area suffered from chronic flood problem. According to the report of "Flood Preparedness & management Plan, 2014" the district has been flooded 31 times devastatingly coupled with several minor flood starting from 1870 to 2007.

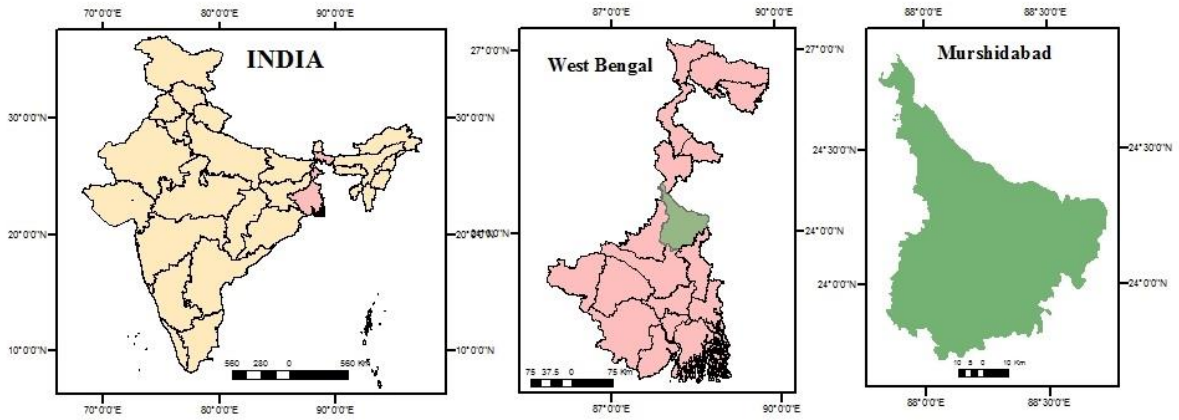

Figure 1: Location Map of the Study Area

2.1. Physiography

The study area is basically an alluvial plain with gentle topography and alluvial deposits. This is why agricultural practices are more developed over this area. Physiographically the region is divided into 'rarh', strip of low lying land', 'bagri', 'klantar'[Physiographic division of done by A.Mitra,1979, Gazteer of India, West Bengal, Census Murshidabad district handbook]. The maximum slope of the region ranges up to $8^0$and its direct towards northwest to south east. Maximum and minimum elevation ranges between 58m to 4m.

2.2. Soil.

Soil are mainly alluvial in nature. These are due to prolong deposition of Bhagirathi, Jalangi and other rivers. Soils are slightly acidic to neutral in reaction and low to medium in fertility (Inventory of soil resource of Murshidabad, WB).

3. METHODOLOGY

Flood Hazard zones of murshidabad district have been delineated using geo informatics approach which include remote sensing data and geospatial technique. Secondary sources of information such as published reports and journals have also been used in the study.

3.1. Data Used

A 30m Digital Elevation Model have been used with 30 m resolution and a Sentinel-2 Image has been used with 10 m spatial resolution for making land use and land cover. Following data have been used:

Table 2: Data Used

Data	Source	Resolution(m)
DEM	earthexplorer.usgs.gov	30
Sentinel-2 24th Feb 2017	earthexplorer.usgs.gov(ESA)	10
Rainfall(mm)	www.worldclim.org	1000

3.2. Software Used

Geospatial software has been used for making the flood hazard map of murshidabad. Arc GIS 10.0 and Erdas Imagine 2013 were used. It has been used to make a land use land cover map of the study area. ArcGIS has been used for making other thematic layers and also integrating all the layers through weighted overlay technique.

2.3. Flow Chart

Mainly data from two sources has been used, remote sensing data and secondary data from published reports and journals. Several flood affecting factors have been decided and its corresponding thematic layers have been generated such as slope drainage density etc. Finally, these all maps have been integrated using weighted overlay

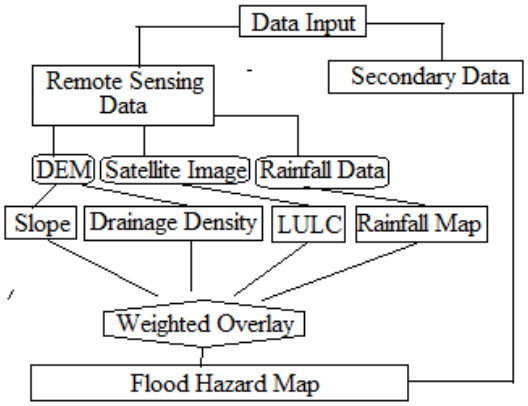

Figure 2: Flow Chart

The Overall weightage of each individual layer are

Factor	Percentage	Class	Value	Scaled
Rainfall	30	296-340	1	3
		340-379	2	4
		379-433	3	5
Slope	20	<1	1	4
		1-2	2	3
		2-4	3	2
		>4	4	1
Land Use/Cover	20	River/Water Bodies	1	5
		Open Bare	2	4
		Agriculture	3	3
		Tree Cover	4	3
		Settlement	5	2
		Sandy Areas	6	4

		Marshy land	7	5
		Road	8	2
Soil	15	Fine Sandy Loamy /Fine sandy	1	1
		Coarse Loamy	2	2
		Fine Loamy	3	3
Drainage Density	15	0-75	1	1
		75-135	2	2
		135-195	3	3
		195-263	4	4
		263-429	5	5

3. FLOOD HAZARD VARIABLE

Flood occurs due to several factors including physical and manmade depending upon the area studied. In Murshidabad district most of the variable for flood is natural which includes rainfall, gentle slope of the land, drainage, and continuous siltation of river bed. The main channel Bhagirathi rive has been shifted significantly. In the current study five variable has been taken flood delineating flood hazard zones of murshidabad these are rainfall, slope, land use land cover, drainage density and soil of the study area.

3.1. Rainfall

Rainfall is a prime factors in causing flood in murshidabad. Huge monsoonal rainfall during July, august and September causes overflow of rainwater through both the banks of the river. Continuous sedimentation of Paleo channel act as an added factor for causing flood. The minimum and maximum rainfall in the district is around 296 mm and 433 mm. The data which have been used in the current study has been obtained from world climate which is an average rainfall condition from 1970 to 2010 with a resolution of 1km. These data have been resample to 10m to match the resolution with other thematic layers. The data have been reclassified in three classes of moderate high and very high. Higher category of rainfall is located in the south western part of the district while the moderate part is found to be in northern part of the district only(fig:4).

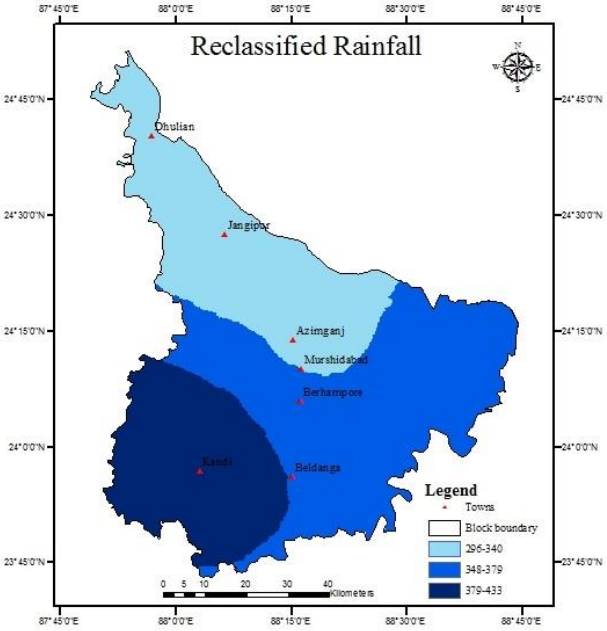

Figure 3 : Rainfall Map

3.2. Slope

Slope map has been prepared from SRTM DEM od 30m resolution. Overall the entire region has a gentle slope which ranges up to maximum 7.8^0 (fig:4). A smaller portion of the district comes under more than $4^0$of slope. Thus the entire district is characterized by very gentle slope, so the over flooded water easily gets spread laterally causing flood

during monsoon season. Slope has given an importance of 20 percent in overall 100 percentage of weightage, judging the relative importance of slope over other factors.

3.3. Land Use/Cover

Land use and land cover map has been prepared from sentinel-2 images of winter season. Overall 11 land use and land cover categories have been find out which includes river or streams, water bodies, open space, agriculture with standing water, sown crop land, tree cover, settlement, current fallow, sandy area, road and marshy area(figure:5). These classes have been reclassified in eight categories identifying contribution of each land use category in flood occurrence, for example river and water bodies have been classified into one category.

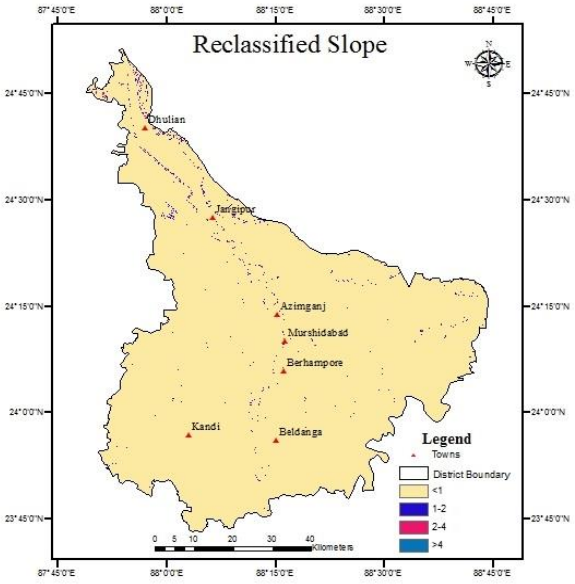

Figure 4: Slope Map

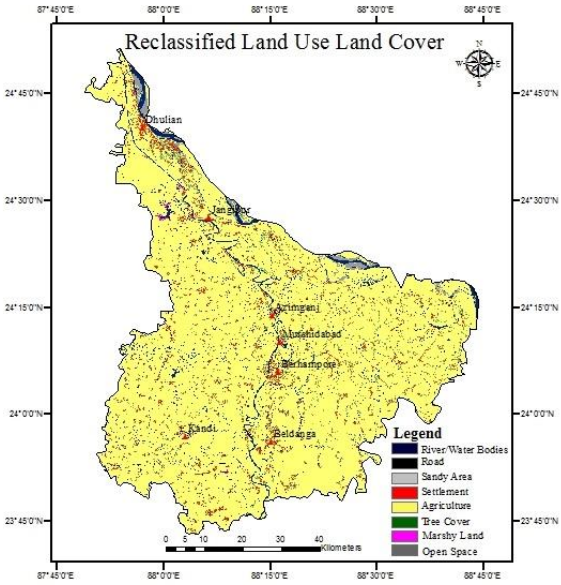

Figure 5: LULC Map

3.4. Soil Map

The major soil categories that have been found in this region are fine loamy sandy, fine sandy, coarse loamy, fine loamy (fig:6). Loamy sandy and sandy sol has low importance in causing flood being more permeable it could transfer the water to subsurface. Thus it allows more infiltration and less subsurface runoff. Whereas fine loamy soil is characterized by fine texture thus has low permeability and high water storing capacity. Thus these category of soil is likely get flooded more compared to other categories.

3.5. Drainage Density

The drainage of the study area have been extracted from automatic drainage extraction technique using GIS tools from DEM. A focal analysis has been run in order to determine the drainage density of the study area. The value ranges from 0 to 429 (fig: 7). Higher the drainage density more the surface is impervious and lower the drainage density more the surface layer is pervious in nature.

Thus drainage density gives an indirect direction of surface layer. The higher drainage density is might be due to huge amount of paleo channel present all over the district. This image has been reclassified into five categories. South western portion shows a relatively higher class of drainage density.

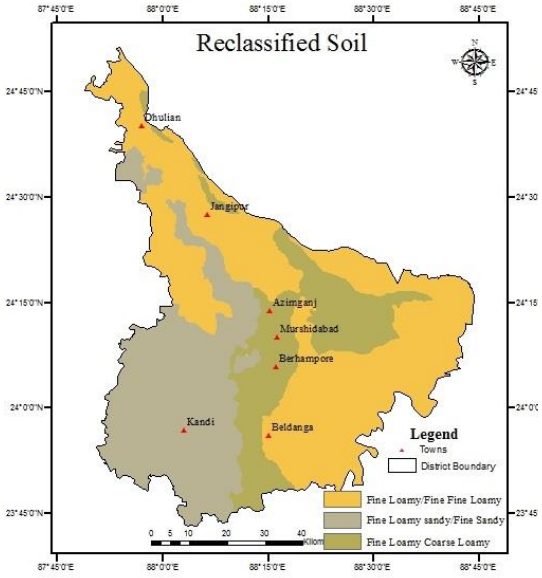

Figure 63: Soil Map

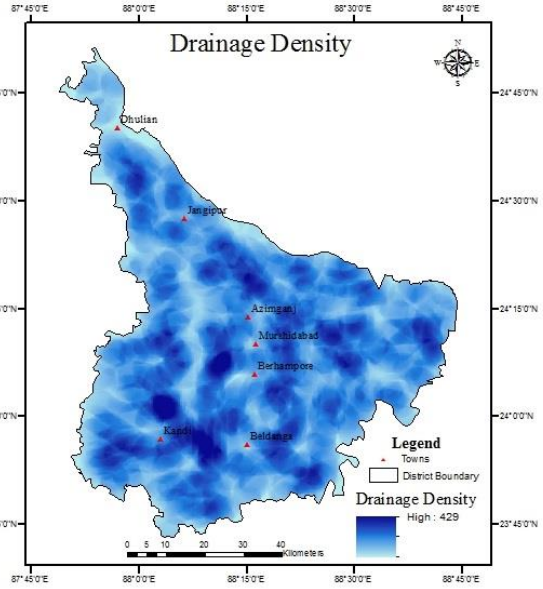

Figure 7: Drainage Density Map

4.

FLOOD HAZARD ZONE

Hazard is a situation where there is a potential threat to human life and property. Murshidabad is prone to moderate to higher flood hazard zone. Several blocks of the have been flooded in several times. The flood hazard zone map of the district have been delineated using a weighted overlay method. Different parameters as well as different classes of each parameter has given different weightage depending upon its importance or contribution to the flood occurrence. Mainly the entire district is falling under low moderate and high flood hazard zone, but a small amount of area is coming under low hazard zone only, larger portions are coming under moderate to high hazard zone. Hariharpara, Bhagawanngola, Murshidabad and Khargram are the blocks which accounts for the maximum high flood hazard zone. Almost all blocks are having a certain portion of the moderate to high hazard zone. The blocks which are more vulnerable to flood area Kandi, Beldanga Bhagawanngola. Thus flood preventing measures should be taken.

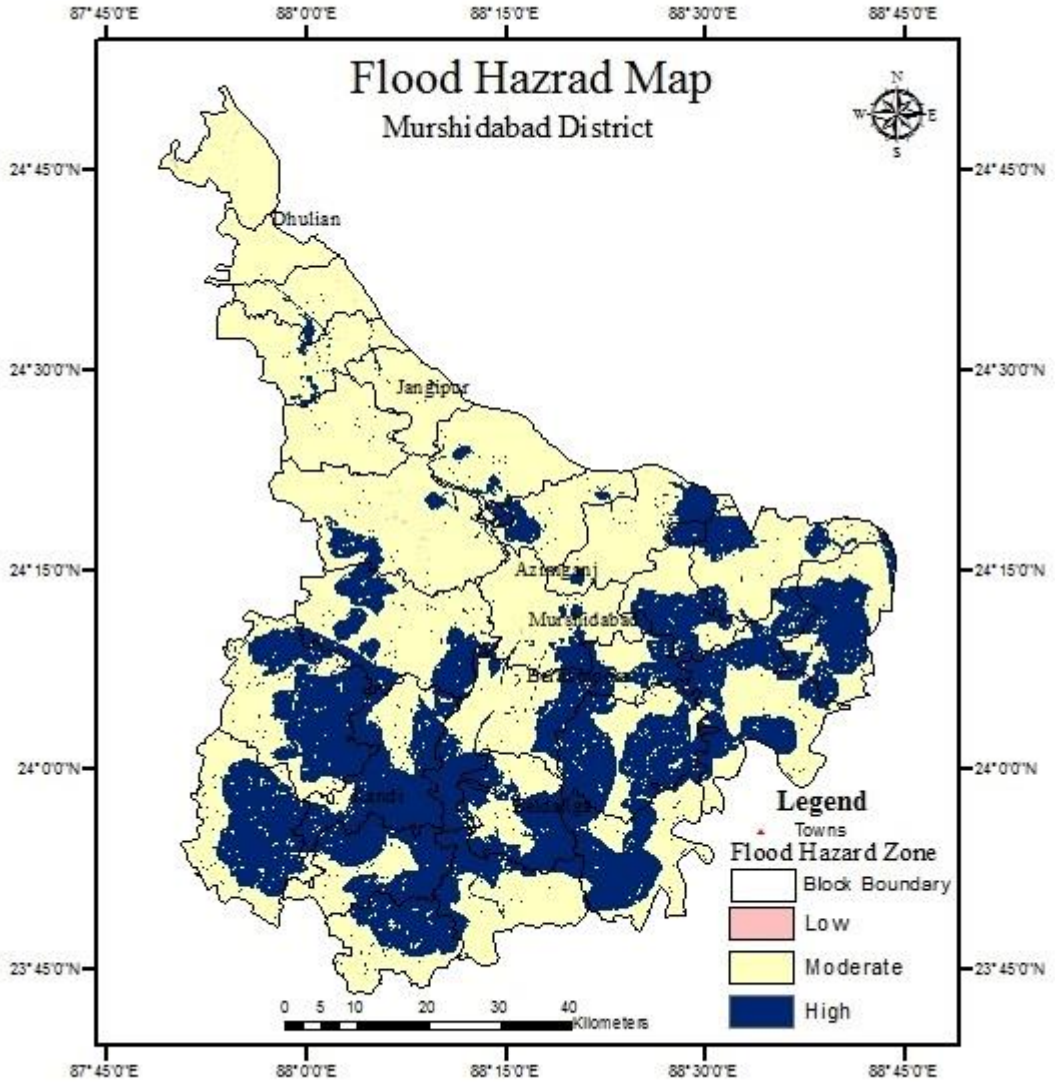

Figure 8: Flood Hazard Zone Map

4.CONCLUSION

Flood hazard can be proved to be dangerous causing substantial loss to human life and culture. And Murshidabad district is a flood prone district of West Bengal. The river system, reduced depth of river channel along with the monsoon rainfall together has caused severe flood several times. Thus a detailed study, assessment and precautions are required for the management of flood. A remote sensing and GIS based analysis has been done in the current study to identify major flood hazard zone and assessment of flood assessment. The study shows all the blocks of the district are coming under high and moderate flood hazard zone. Several measures such as rejuvenation of paleo channel through dredging, effective crop management technique, identification of more vulnerable zones as well as construction of check dams may be effective in managing the flood scenario of the district.

5. REFERENCE

Andi Besse Rimba, Martiwi Diah Setiawati, Abu Bakar Sambah and Fusanori Miura. Physical Flood Vulnerability Mapping Applying Geospatial Techniques in Okazaki City, Aichi Prefecture, Japan,Urban Science 2017; Urban Sci 2017,1,7.

Flood Preparedness & Management Plan, 2014; Government of West Bengal, Office of the District Magistrate, Murshidabad.

Dr. Sunando Bandopadhyay, Swati Mollah. Significance of Rainfall in the Occurrence of Flood in Murshidabad district, West Bengal, India, Indian Journal of Spatial Science 2013; Vol-4.0 No.-2 Winter Issue 2013 pp. 19-24.

Mukhopadhyay, Sutapa Pal, Swades. Trend of Flood at Riverine Bengal Basin of Kandi Block of Murshidabad District: A Hydrogeomorphological Overview. Indian Journal of Geography and Management, 2011; Vol.12, 2011.

Mitra, A. (1979): Gazzateer of India, West Bengal Census, West Bengal District Handbook, Murshidabad. pp: 7.

Narantzis Kazakis, Ioannis Kougias, Thomas Patsialis. Assesment of flood hazard areas at a regional scale using an index-base approach and Analytical Hierarchy Process: Application in Rhodope-Evros region, Greece, Science of the Total Environment 2015; 538 (2015) 555-563.

N.A. Mayaja, C.V. Srinivasa. Flood hazard zoning using analytical hierarchy process: A case study for pampa river basin, Kerala, India, Journal of Geomatics 2016; Vol-10 No. 1 April 2016.

State Statistical Handbook 2014; Bureau of Applied Economics and Statistics Department of Statistics and Programme Implementation Government of West Bengal.