Industrial Science
Vol.1,Issue.5/June. 2014 **ISSN** : 2347-5420

Research Papers

FLOOD INUNDATION MAPPING USING SPATIAL TECHNIQUES

S G Sarkar[1] **and D R Vaidya** [2]

[1]M.E Hydraulics 2nd Year,Sinhgad College of Engineering, Department of Civil Engineering, Pune.
[2]Asst Professor , Sinhgad College of Engineering, Department of Civil Engineering, Pune.

Abstract

This paper discusses the role of various spatial techniques available for extracting the flood inundation map for river basins. Flood inundation mapping is a vital component for appropriate land use planning in flood-prone areas. In this paper examples of some previous case studies are included to illustrate how spatial techniques are being used now days for preparing flood hazard mapping. Flood inundation mapping is a basic tool for flood preparedness, mitigation activities and also flood insurance programs. For flood management it is always necessary to monitor continuously as floods are among the most recurring and devastating natural hazards, impacting human and causing severe economic damages around the globe. The current trend and future scenarios demand accurate spatial and temporal information on the potential hazard and risks of floods. Today, spatial techniques especially remote sensing, geographic information system (GIS), digital elevation model (DEM) have become practical tools for development of cost effective methods for flood inundation mapping in gauged and ungauged river basins.

KEYWORDS:

Flood, Flood Inundation Mapping, Spatial Techniques, Remote Sensing, Geographic Information System, Digital Elevation Model Gauged Basins, Ungauged Basins.

INTRODUCTION

Floods are among the most recurring and devastating natural hazards, impacting human lives and causing severe economic damage throughout the world. It is understood that flood risks will not subside in the future, and with the onset of climate change, flood intensity and frequency will threaten many regions of the India. Flood disrupts people's live, damage infrastructures and road networks in urban areas. In rural areas it damages crops, causes death to livestock and people become isolated due to the unavailability of communication mode. So therefore identifying flood prone areas can be one of the key solutions in flood mitigation that can reduce the impact of flood significantly.

Flood Inundation is defined as rising of body of water mainly due to flood water and overflowing the dry lands with flood water. In other words Flooding is the inundation of an area by unexpected rise of water body by both dam failure and extreme rainfall in which life and properties in the affected area are under thread. Flood inundation map shows the extent of flooding expected spatially over a given area. As the frequency and risk associated with flood has increased considerably there is a growing global concern about the need to decrease flood related fatalities and associated economic losses. Predicting susceptible floodplains and high potential flash flood prone areas can help emergency managers and decision-makers to make decision on flood mitigation strategies such as designing water control structures, decision making for flood insurances and providing emergency preparedness to cope with flooding.

Remote Sensing technologies have proved to be valuable tools to support effective early warning for disasters. The ability of remote sensing technologies to identify surface water has been utilized for many years. Mapping surface water has allowed the potential to monitor the dynamics of hydrological events through space and time at a consistent level of accuracy. To select suitable sensors for flood inundation mapping which is both cost effective and efficient is a major challenge. The major problem of the optical sensors is its inability to penetrate clouds. But during monsoon period when flooding occurs, most of the days sky is covered by clouds. In this context, Synthetic Aperture Radar (SAR) is considered as the most efficient sensor for detecting flood inundation area. Although RADARSAT and other synthetic aperture radars are also capable of monitoring land surface but it is not feasible to use them for monitoring a large areas for a long time due to its high data cost. Keeping in mind the cost of production, we are going to discuss some cost-effective and efficient methods for developing inundation maps in the area of interest.

Previous Case Studies:

The study area was taken as Bangladesh nation which lies between Latitude 20–27 °N and Longitude 88–93 °E (Figure 1). This country is located at floodplain delta of a three major rivers Padma, Jamuna and Meghna rivers. Almost 80% of the total rainfall of Bangladesh occurs during monsoon period between June to September. The major reason of the monsoon flood in Bangladesh depends on the duration, intensity and magnitude of the rainfall in the three main basins. Every year one fourth to one third of the country gets inundated during monsoon period by overflowing flood water. However, the intensity of this inundation sometimes become very severe and cause damage to infrastructures, crops, communication system, and human being. Floods in 2007 and 20004 were one such severe floods in recent years in Bangladesh nation.

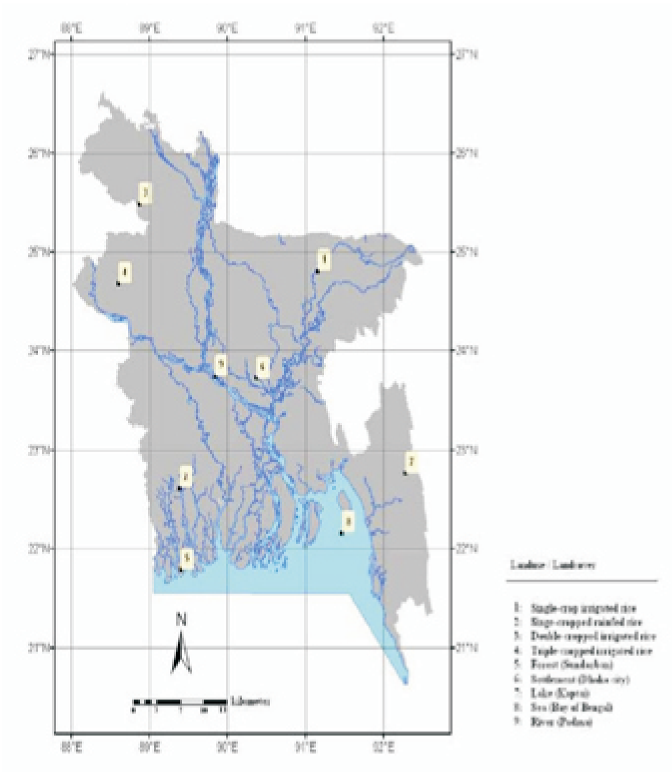

Figure1: Location Map of Study Area.

They have selected total nine categories of land use land type to analyze inundation areas (Figure 1). They are 1) single-crop rain fed rice in the Haor area of north-eastern region , 2) single-crop irrigate rice in the south-west region, 3) double-cropped irrigated rice in north region, 4) triple-cropped irrigated rice in the Brand area of north-west region, 5) forest area in the Sundarbans, 6) settlement area of Dhaka city 7) Kaptai lake, 8) Bay of Bengal ocean, and 9) Padma river.

Data Used:

The study was carried out using moderate resolution imaging spectroradiometer (MODIS) which started acquiring data in February 2000. The instruments capture data in 36 spectral bands ranging in wavelength from 0.4 µm to 14.4 µm and at varying spatial resolutions (2 bands at 250 m, 5 bands at 500 m and 29 bands at 1 km). Together the instruments image the entire Earth every 1 to 2 days. They are designed to provide measurements in large-scale global dynamics including changes in Earth's cloud cover, radiation budget and processes occurring in the oceans, on land, and in the lower atmosphere. The MODIS images can be freely downloaded through the Earth Observing System Data Gateway. The presented the study involves an analysis of 8-day composite data of MODIS during 2007 and 2004. The label of this product was "MODIS/TERRA SURFACE REFLECTANCE 8-DAY L3 GLOBAL 500 M SIN GRID V005". The spatial resolution of this product was approximately 500 meter.

Methodology Used:

In this study first step they have detected cloud cover pixel from the images. If blue reflectance (Band 3 of MODIS) is equal to or greater than 0.2 (Thenkabail et al., 2005; Xiao et al., 2006), it is considered as cloudy pixel. Using this formula they have removed cloudy pixel from the image. In next step they have estimated EVI (Enhanced Vegetation Index), LSWI (Land Surface Water Index) and their difference as DVEL for each of the land class cover types. In this study, discrimination of Water-related pixel and Non-Flood pixel was conducted in accordance with the pioneering method developed by Xiao et al. (2006; 2005). In this study EVI, LSWI and DVEL are exclusively used to discriminate Flood, Mixed, Non-Flood and Water-related pixels. A flow-chart of the method used in this study has been shown in Figure 2. The proposed technique used to identify the water surface from MODIS time series data has been validated by using subsequent RADARSAT images and they have also showed that most of the area in both images quite a good match between images from these two types of satellite and sensors.

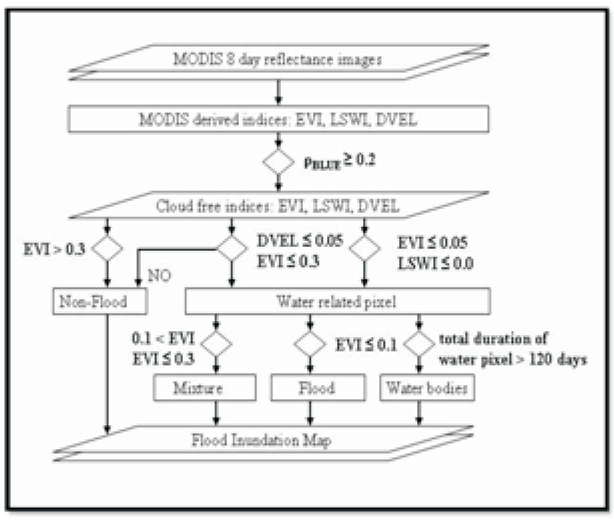

Figure 2: Flood chart for developing Flood inundation map using MODIS data.

GIS in Flood Inundation Mapping

Accurate floodplain mapping is one of the most valuable tools for avoiding severe social and economic losses from floods. A Geographic Information System (GIS) is a computer system designed to capture, store, manipulate, analyze, manage, and present all types of geographic data. GIS is ideally suited for various floodplain management activities such as base mapping, topographic mapping, and post-disaster verification of mapped floodplain extents and depths. Currently Geographic Information System (GIS) is being used as a major tool for preparing flood hazard map in many river basins.

Case Study:

This study presented an efficient methodology to accurately delineate the flood-hazard areas in the Kosi River Basin, North Bihar using GIS. The Kosi is one of the major tributaries of the Ganga River, and rises in the Nepal Himalayas. After traversing through the Nepal Himalayas, it enters India near Bhimnagar. Thereafter, it flows through the plains of north Bihar and joins the Ganga River near Kursela, after traversing for 320 km from Chatra. The river has been causing a lot of destruction by lateral movement and extensive flooding. As its waters carry heavy silt load and the river has a steep gradient, the river has a tendency to move sideways.

Data and Software Used:

They have obtained the data from three sources. The first set of data includes topographic maps, district level maps, and census data of 1991 for the regional divisions of Bihar. The second set of data includes the digital elevation data, global digital elevation model (DEM) and the DEM derived from the toposheets of the study area. The third set of data is the digital remote sensing images for the study area (IRS-1D, LISS III) have obtained from the National Remote Sensing Agency, Hyderabad.

They have used ArcVIEW GIS 3.2 and ERDAS IMAGINE 8.5 for extracting the flood inundation map in the proposed study.

Methodology Used:

In this method first they have generated DEM of the study area by using the spot height data collected from the topomaps in ILWIS (Integrated Land and Water Information System), Image Processing software. Then they converted it into point map and exported it into ArcVIEW GIS, where they have converted vector elevation model into raster grid format. Then they have georefrenced the satellite images and on this georeferenced image, image classification algorithms NDVI (Normalized Difference Vegetation Index) were applied to extract the land cover and vegetation information. Then they have exported all classified and processed images to ArcVIEW GIS. They also added demographic data, population density. Finally they have integrated all the data in GIS environment using a multi criteria decision making technique Analytical Hierarchical Process. The flow chart of the proposed methodology is shown in figure 3.

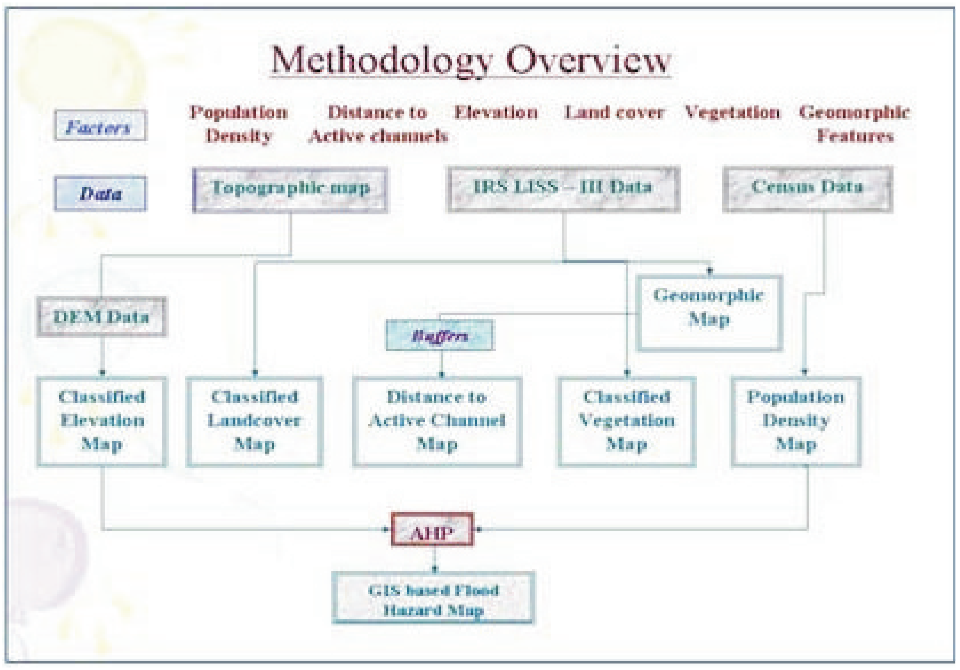

Figure 3: Methodology followed for flood hazard mapping

CONCLUSION:

After studying the papers we can say that for extracting the flood hazard or flood inundation map remote sensing and geographic information system are very efficient and effective tools. Therefore by using these spatial techniques we can get the flood inundation map accurately with minimum effort and also flood prone zones can be easily mapped which in turns minimise the losses that can occur due to flood. Predicting susceptible floodplains and flood prone areas also help authorities in planning management strategies for flood mitigation programs.

REFRENCES

1.Ali Sarhadi, Saeed Soltani and Reza Modarres "Probabilistic flood inundation mapping of ungauged rivers: Linking GIS techniques and frequency analysis" Journal of Hydrology, PP 68-86, 2012.
2.Tobias Landmann, Matthias Schramm, Ndafuda Shiponeni, Christian Huettich and Stefan Dech "The Utility of 250 Meter MODIS Metrics and AMSR-E Observations For Assessing Climate Induced Variability Within Southern African Wetlands" PP 3038-3041, 2012.
3.Youngjoo Kwak, Jonggeol Park and Kazuhiko Fukami "National-Wide Flood Risk Assessment Using Inundation Level Model and MODIS Time Series Imagery" International Centre for Water Hazard and Risk Management (ICHARM) under UNESCO, 2011.
4.Jung Hyun Choi, Nguyen Van trung and Joong-Sun Won, "Inundation Mapping Using Time Series Satellite Images", 2011.
5.Akm Saiful Islam, Sujit Kumar Bala and Anisul Haque "Flood Inundation Map of Bangladesh Using MODIS Surface Reflectance Data" International Conference on Water & Flood Management, 2009.
6.Chang Huang, Jianping wu, Yun Chan and Jia Yu "Detecting Floodplain Inundation Frequency Using MODIS Time-series Imagery".
7.Praveen Kumar Thakur and Accarapol Sumangala, "Flood Inundation Mapping And 1-D Hydrodynamic Modelling Using remote Sensing And GIS Techniques".
8.G.Venkata Bapalu and Rajiv Sinha GIS in Flood Hazard Mapping: a case study of Kosi River Basin, India.
9.Thenkabail, P. S., Schull, M., and Turral, H. (2005). Ganges and Indus river basin land use/land cover (LULC) and irrigated area mapping using continuous streams of MODIS data. Remote Sensing of Environment, 95, 317-341.
10.Xiao, X., Boles, S., Frolking, S., Li, C., Bau, J. Y., and Salas, W. (2006). Mapping paddy rice agriculture in South and Southeast Asia using multitemporal MODIS images. Remote Sensing of Environment, 100, 95-113.
11.R. Sinha . G.V. Bapalu . L.K. Singh . B. Rath " Flood Risk Analysis in the Kosi River Basin Using Multi-Parametric Approach of Analytical Hierarchy Process".

S G Sarkar
M.E Hydraulics 2nd Year,Sinhgad College of Engineering, Department of Civil Engineering, Pune.

D R Vaidya
Asst Professor , Sinhgad College of Engineering, Department of Civil Engineering, Pune.