Flood Risk Mapping Using GIS and Flood Management Analysis: A Case Study of Bihar State

Author:- Suraj kumar soni and Prabhakar Mall

Guide:-Mr. Alok Sharma

Alok.21666@lpu.co.in

School of Civil Engineering Lovely Professional University, Phagwara-144411, Punjab, India.

Abstract

Floods are most recurring and frequent natural hazard in India causing enormous loss to life and livelihood, and damage to infrastructure. In India, Bihar is one among the worst affected states thanks to floods. As per one estimate, in Bihar flood affects about6.880 million hectares of land out of about 9.416 million hectare, which is about 73.06%. It not only affects the infrastructure but also the socio-economic life within the state. So, there's a requirement to attenuate negative consequences and ill effects off looding by means of flood management. In Bihar, most of the days , the choice makers choose structural measures like construction of embankments, flood retention walls, flood levees and channel improvements, etc. However, it's felt that structural measures itself isn't sufficient to scale back the adverse impacts of floods within the state. Hence non-structural measures like flood plain management policy, building bye-laws, flow and silt management policy also are required. It contemplates the utilization of flood plains judiciously, simultaneously permitting vacating of an equivalent to be used by the river whenever things demands. the aim of this paper is to spotlight the severity of flood impacts on development of state and to debate the possible flood management measures in context of Bihar.

KEYWORDS: Flood Risk Mapping (FRM), Flood Management Analysis, GIS Modeling, Catchment, Area, Flood, Susceptibility

Introduction:- Floods are a recurrent phenomenon in India causing huge losses to lives, properties, livelihood systems, infrastructure and public utilities affecting the event of the region. Bihar is one among the States of the India bounded by Nepal within the north. Main system of the state, the River Ganga flow eastward direction during a stretch of 432 km across Bihar and divides the state in two unequal halves. The plains in north of the River Ganga are drained by two major rivers, the River Kosi and therefore the Gandak additionally to the present there are several smaller systems like the Adhwara group of rivers, the Bagmati, the Bhutahi Balan, the Burhi Gandak, the Ghaghara, the Kamala, and therefore the Mahananda. of these rivers mainly originate in Nepal from the Himalayas whereas the River Kosi also includes its catchment in Tibet. Thus, the rivers of North Bihar mostly share basins outside the country in Nepal and Tibet. The water carried from the a part of catchment lying in Tibet also passes through Nepal. To fulfil the need of fuel for domestic purposes and reclamation of area for occupational needs, there's an increasing deforestation in Nepal which further causes degradation in vegetative cover within the catchment areas. thanks to this practice,soil has been increasingly getting eroded from these areas. therefore the rivers carries significant sediment load from the upper a part of catchments. These sediments additionally to inadequate carrying capability of the rivers cause congestion in natural drainage resulting in inundation and floods. So, flood may be a state of hydrological extreme of high. water level during a stream channel or on bank that leads to inundation of land that may not ordinarily submerged. Generally it occurs in event of heavy rainfall and becomes a hazard once it causes loss to the lives, livestock and livelihood. “The trend shows that the intensity and frequency of floods in Bihar Plains

have increased over the years causing human suffering and destruction of agriculture, habitation and infrastructure" (NIDM, 2007).

The National Flood Commission, set by Government in 1976 put the country's flood prone area at about 40 MHa out of total area of 329 MHa. This report, thus, revealed a rapid increase flooding proneness in only over a decade. Most of those area falls under Ganga and Brahmaputra basins. the foremost flood prone basins are those of the Ganga and Brahmaputra in Uttar Pradesh , Bihar, West Bengal and Assam. These five states are the foremost flood prone. But the commission analyzed the share of injury went up from25 to 50 percent of the entire and chronically flood prone area just in case of Bihar.

Three fourths area and population of Bihar dwell the natural flood plains of the Ganga and its Himalayan tributaries. About6.880 out of 9.416 million hectare comprising 73.06 percent of the state is flood affected which accounts for about one-sixth of the flood prone area in India. Geographically, northern Bihar is susceptible to flood as major rivers flowing through North Bihar originates from Nepal and therefore the Tibetan region of China. About 65% of the catchment basin of Bihar's rivers fall in Nepal and Tibet and only 35% of the catchment areas dwell Bihar.

The upper a part of catchment is responsible for the morphological activities within the downstream reaches. It carries huge sediment load with its flow per annum which is liable for change in morphological behaviour of the stream. The matter of the flooding is implicitly guided by sedimentation in river. This sedimentation has gradually reduced the potential of the river to empty extreme flows resulting in flooding within the plains.

The variation of minimum and therefore the maximum flows within the Himalayan Rivers is significantly high. This causes huge seasonal variation in river discharge. additionally to the present terrain of North Bihar is nearly flat having elevation at Indo-Nepal border starting from 90-95 m whereas elevation at confluence of those rivers in Ganga is of the order of 40-45m.

HISTORY OF FLOOD IN BIHAR

A review by Kale (1997) indicated that the plains of north Bihar have recorded the very best number of floods during the last 30years. within the years 1978, 1987, 1998, 2004 and 2007 Bihar witnessed high magnitudes of flood. the entire area suffering from floods has also increased during these years. Flood of 2004 demonstrates the severity of flood problem when a huge area of 23490 Sq Km was badly suffering from the floods of Bagmati, Kamla & Adhwara groups of rivers causing loss of about 800 human lives, even when Ganga, the master drain was flowing low.

During year 2002 North Bihar experienced serious flood and overtopping reported in Kamla Balan left embankment and Khiroi right embankment. Four hundred and eighty nine persons died. Crop damage of rupees 51149.61 lacs and property damage of rupees 40892.19 lacs were reported.

2008 :- an appreciable amount of rainfall was received on very first day of monsoon season i.e. 15th June (160mm at Chanpatia, 141 mm at Sikanderpur and 92.2 mm at Khagaria). July was the wettest month having maximum rainy days followed by August-08.

There was an unprecedented flood thanks to breach near 12.9km of Eastern Kosi Afflux Embankment near Kussha village in Nepal on 18th August 2008 that took a shape of a catastrophe resulting in miseries to lakhs of individuals in Sunsari and Saptari districts of Nepal and Supaul, Madhepura, Araria, Saharsa, Katihar and purnea districts of Bihar. River Kosi entirely changed its course from earlier one which was again tamed to its original course by Water Resources Department after an incredible effort keeping in line with the recommendation of Kosi Breach Closure Advisory Committee (KBCAT).

FLOOD HAZARD AND RISK MAPPING – METHODOLODY, DATA

Flood hazard maps were created using risk matrix. This semi quantitative method expresses the most frequently used risk expression method at present in which a colour scale is used to segment the hazard-prone flood plain into individual hazard categories and subsequently risk categories. When creating risk maps, present land use is taken under consideration as well as future projects in area use based on local plans. The expression of risk by means of this method enables to acquire results on the basis of relatively accessible data. The method itself consists in doing three steps: quantification of flood hazard on the basis of acquired input data (flood intensity), quantification on the basis of risk matrix (flood hazard map), risk assessment (flood risk map) .

In order to process the individual steps, the hydraulic modelling of the state enterprise was used to acquire the maps of water depths of flood plain of Bihar and flow velocity grids (in grid resolution 10 x 10 m). The layer of depths was obtained as a difference between flooding level and digital model of the terrain. Then the geographical database was used to create the risk map. Materials of geodetic and cadastral were also used, mainly as source materials (Base map of the India 1:10 000, Photo – pixel size 0,25 m x 0,25 m). The field research served mainly for a more detailed acquaintance with the area and for the determination of sensitive objects on the risk map. And the cooperation with local administration and citizens made it possible to correctly determine the area categories for risk maps (in disputable cases), vulnerable objects and to evaluate the resulting maps in terms of clear arrangement and comprehensibility.

2 PROCESSING

Maps of flooding depths and flow velocity grids in model area were further processed in ArcGIS program. Flood intensity maps were produced this way. The flood intensity is defined as a product of the above mentioned flooding depth and flow velocity and it is further used for the calculation of flood hazard. The flow velocity in Northern Bihar reached the flow velocity outside the river channel less than 1 ms-1.

METHOD DISCUSSION – SELECTED PROCESSING PROBLEMS

The risk assessment by means of semi quantitative analysis is the most widely used method in these days. The output of this method is maps. This is perhaps the most understandable possibility of presenting the results to public. Unlike tables and charts, maps use colours which enable quick evaluation, even for a layman. In spite of that there appeared several problems in creating the maps in Northern Bihar which might complicate the presentation and limit the use of maps. Some of them will be presented within the following discussion. Most of the problems were defined with the help of local authorities and lay public. The main problem is colour projection in the hazard maps and loss of simple legibility in the risk map. In order to enable comparison of flood maps on the territory of the Bihar , the methodology defines exact colour scales. However, adherence to the scales lowers the content quality of the created maps. Extremely low transparency of individual colours results in the illegibility of the map. This fact was pointed out by the public when evaluation map outputs for the municipality of major affected districts of Bihar. Therefore, the maps were modified to enable legibility of the data and simplify the orientation in the area, thus performing its primary function. Another problem, probably more significant, that in opinion should have been solved in the stage of methodology approval, is the color scale for hazard categories. Concerning visual aspects, flood hazard maps should meet the expectations and therefore be elaborated in blue colours which can be associated with water, e.g. water depths. The colours implemented in the hazard maps 3(red, blue, yellow for hazard zones) do not meet these expectations and are therefore inappropriate for risk communication with the public.

Conclusion

Flood disaster susceptible zone mapping is one among the foremost constructive methods that permits a discount offlood hazard damages and assist planners, stakeholders, and decision-makers to possess proper supervision over the flood-prone areas, ensuring proper and sustainable socio-economic development. The remote sensing GEE-based multi-parametric AHP-GIS technique may be a sound alternative approach to spot the flood susceptibility zones within the state of Bihar, India. For total flood susceptibility evaluation, 21 criteria were grouped into 5 primary criteria supported their proximity and relative level of influence in causing flood. Each and each flood affecting the raster layer was processed within the code editor GEE API platform then reclassified within the GIS environment for flood susceptibility map development. Using Saaty's AHP technique, the hydrologic criterion was given the very best rank for locating areas vulnerable to flooding, followed by morphometric criterion, permeability, land cover dynamics, and anthropogenic interference. a neighborhood of ~3000 sq km (40.36%) was concentrated in high to very high flood susceptibility zones that were within the vicinity of rivers, whereas a neighborhood of ~1000 sq km (12%) had very low flood susceptibility. The GIS-AHP technique provided useful insights for flood zone mapping when a better number of parameters were utilized in GEE. the bulk of the detected flood-susceptible areas flooded during the 2019 floods and was mostly located within 500 m of the rivers' paths.

REFERENCES

1. The Bihar Flood Story; Dinesh Kumar Mishra, Economic and Political Weekly, August 30, 1997 pp: 2206-2217
2. Marta Paani: floods in Bihar, Editor: Hemant and Raj Valabh, Aggarwal Press, Jharkhand, 2005
3. "Bihar Ki Nadiyaan", part-1, Hawaldar Tripathi, Bihar hindi Granth Academy, Patna, January 2003
4. Dakshin Bihar Ki Nadiyaan: Dhaar aur Kachaar; Hawaldar Tripathi, Bihar Hindi Granth Academy, Patna, October 1998
5. Report on Flood affected/ heavy rainfall affected area/ population in Patna District; Dr. B. Rajendrer, IAS, District Magistrate, Patna, 2007