

Flood Hazards And Changing Pattern Of Settlement In Muzaffarpur District : A Geographical Analysis

Dr. Devendra Sharma Post- Doctoral Research Scholar
University Department of Geography, BRA Bihar University Muzaffarpur

ABSTRACT

Over the past few decades, natural disasters have increased in severity and occurrence, events that are compounded by the vulnerabilities of the contemporary world. In view of this, action is required not only from actors at the national level, but states and districts must also work towards resilience-building to disaster. Hazard awareness, potential impacts, and knowledge of how to cope are critical elements necessary for successfully reducing disaster risk. As one of the most hazard-prone areas in the globe, disaster management is a key issue in India. So much so that in 2005 the national government enacted the Disaster Management Act, providing general standards and guidelines to be followed by every district and state in the country. Since then, policy and awareness have evolved, and a new paradigm has emerged. This paradigm places greater focus on the pre-disaster phase in lieu of only prioritizing response needs. This means that smart risk management also requires investments in prevention and mitigation, once it is both financially and socially more effective than only running an emergency plan. The Disaster Management Act, 2005, requires every district to both prepare and regularly review a District Disaster Management Plan (DDMP). In this regard, in early February 2015 the Bihar State Disaster Management Authority (BSDMA) issued a call for proposals for the preparation of such plans in its districts. Located in the eastern region of India, Bihar is one of the most vulnerable states in the country. This may be explained by two different angles. First, Bihar is the most flood-prone state in India. While Bihar houses 16.5% of the total flood-affected area in the country, a higher proportion of the flood affected population lives in that territory: 22.1%. Other hazards include earthquake, drought, cyclonic storm, as well as heat and cold waves. Secondly, socio-economic indicators in Bihar stand among the worst in the country: while it is the third most populated state, over half live under the poverty line. The Human Development Index (HDI) in Bihar is low, as literacy rates fall below the national average with gender-related figures also poor. Additionally, climate change and the increased likelihood of weather-related disasters pose a serious threat to the districts in Bihar, primarily because their main economic activity relies so heavily on agriculture. All these mean that when a disaster strikes, it is likely to impact a large number of people, i.e. the poorest and vulnerable, and the impacts will be more pronounced in terms of gender.

Keywords: Muzaffarpur, Flood Hazards, Bihar, Population.

INTRODUCTION

According to the estimates prepared by the Rashtriya Barh Ayog (National Commission on Floods), the area prone to floods in the country is of the order of 40 million hectares out of which about 80% can be provided with reasonable degree of protection through various measures. During such floods, the losses suffered by the people include: the damage to crops, damage to houses and loss of human and cattle lives. Besides, public utilities also get damaged on a large scale. According to the data published by NDMA in National Disaster Management Guidelines-Management of Floods, from the year 1953 to 2005 inclusive, 6,45,49,660 houses

had been damaged by floods averaging about 12,18,000 houses lost per year, the maximum number of houses lost in one year (1978) was 35,07,540. The number of people who lost their lives during floods has been 84,207 with an average of 1588 persons per year, the maximum in any one year (1977) being 11,316. Most of the lives lost were due to drowning of people due to the collapse of their shelters which also results in the displacement of the people from their habitations for considerable length of time, putting a huge burden on the relief machinery of the States to take care of their temporary sheltering and feeding requirements.

HOUSE TYPES USUALLY DAMAGED UNDER FLOODS

A study of the Vulnerability Atlas of India 1997 and that revised in 2006 based on Census of Houses in India 1991 and 2010 respectively, gives the following house type figures which are prone to damage or destruction during floods:

Houses by Material of Wall in the Rural Areas of India

S.No	Wall Material	1991 Census of Housing		2010 Census of Housing	
		No. of Houses	% of Total Houses	No. of Houses	% of Total Houses
1.	Mud & Unburnt Bricks	67,218,236	34.47	65,087,212	26.13
2.	Burned Brick	36,646,602	18.79	62,715,919	25.18
3	Stone	17,284,400	8.86	20,347,899	8.17
4.	GI Sheets and other Metal Sheets	251,910	0.13	876,677	0.35
5.	Grass, Leaves, Reeds, Bamboo or Other Materials	18,432,665	9.45	22,162,932	8.90
	Total number of Census of Houses (Rural + Urban)	195,024,357		249,095,869	

From Table it is seen that first three wall materials are of heavy type and the last two materials are of the light weight type. Mud and Unburnt Brick walls when inundated under water become soft losing their dry strength by even as much as 85% of the dry value and therefore, start collapsing when inundated for longer duration of time. Burnt Brick and Stone houses are usually constructed using mud mortar in the rural areas. The mud mortar also becomes soft under continuous wetting under water by which the walls lose their bearing strength and tend to collapse under their own weight or the weight of the roof. Also, if the water is flowing, they collapse more easily under the dynamic pressure of water.

The houses made from light weight materials like GI or other Metal sheets or Grass, Leaves, Reeds, Bamboo etc. easily float away as soon as their holding down ports are uprooted by the flowing water. The overall damage depends upon the intensity of flooding. Such an Intensity Scale was first defined by the Expert Group appointed by the Ministry of Urban Development for producing the Vulnerability Atlas of India as given in the Table below:

Table **Inundation Intensity Scale for Damage to Houses***

Depth of Inundation above plinth (mm)	Inundation Intensity scale		
	Period of Inundation in hours		
	≤ 24	>24 to 72	>72
< 0.9 m (3 ft)	I	II	III
900 ≤ 2000	II	III	IV
>2000	III	IV	V

* Intensity may be assumed to increase linearly between the hours of inundation or depth of inundation stated in the table. From Table it is inferred that if the inundation is less than 900 mm and if the water stays less than 24 hrs, it may be considered as very light intensity of Grade I. However, if the depth of the inundation is more than 2 m (6.56 ft) and water stays more than 72 hours, the inundation Intensity may be considered most severe, of Grade V. These inundation intensities will be most relevant to the safety of earthen walls or masonry walls using mud mortar. The intensity of flow will depend upon the velocity of flow along with the depth of water and will be much more severe for the earthen walls as well as walls of lighter materials which could flow away with the velocity of water.

SITE SOIL CONDITIONS

Floods occurring in the alluvial plains of the rivers or the costal deltas give rise to the following types of problems during floods:-

- (i) The bearing capacity of the soil gets reduced and buildings of heavy materials may sink and get damaged by differential settlements.
- (ii) The soil can be eroded under the action of flowing water and scouring can take place around and under the foundations resulting in the uprooting of the lighter posts or sinking and tilting of the heavier foundations.
- (iii) Siltation can take place around the buildings when the flood water recede away from the site.

(iv) The phenomena of *soil liquefaction* can take place during an earthquake of medium to high intensity if occurring during the flood seasons. It actually happened in large areas of north Bihar during August 1988 earthquake when the area was already under floods. All the site effects can lead to severe damage to the housing units unless constructed using appropriate types of foundations, materials and technologies.

MULTI HAZARD SITUATION

Most flood prone areas in the country are also affected by other natural hazards, namely Earthquakes (such as Assam, Bihar, U.P., Punjab and Haryana); Cyclones in the coastal states along with storm surges; and high winds occurring in the coastal areas as well as the flood plains in the northern states. Under the present construction types, namely lighter materials such as Metal sheets and bio-mass materials are not much affected during earthquakes, but can be blown away under the high winds. But those constructed using heavy materials will be totally destroyed under earthquake conditions endangering life and property. Therefore, in all new constructions the choice of materials and technology will need to be based on prevailing multi-hazard conditions in the construction areas so that whatever is constructed should remain safe not only under floods but also under the other natural hazards if and when they strike the area.

COST CONSIDERATION

If ample funds are available to the owner from his own sources or through bank loans etc. one can always choose from such materials and technology options which will save his house from all types of natural hazards, for example one can use deep piles for the foundations with an appropriate plinth beam above the high flood level, use reinforced concrete or reinforced brickwork super-structure with flat RCC slab-beam roof approachable by an appropriate staircase. This will result into a very safe house. However, where the funds are limited such as for IAY houses, the choice of the construction materials will be much limited and will therefore require very deep consideration of the available choices. It is understood that under IAY Scheme it is expected that the beneficiary will also supplement the grant provided by the Government through his own means, in terms of labour and material, to complete the comforts in the house, hence the funds of the Government may be utilised to achieve a stable structural system for safety of life and property under the given natural hazard scenario of the area.

DELIVERY MECHANISM

In a housing scheme of large magnitude such as planned in the State of Bihar, namely construction of 5,00,000 houses at a cost of Rs. 25,000/- each, a scheme of owner driven construction may best be employed with overall technical guidance and delivery mechanism of the chosen construction materials. The best example in India of the construction of more than

2,00,000 houses under ‘beneficiary driven’ scheme was adopted in Gujarat after the Bhuj earthquake wherein, the following mechanism was used:

- (i) The funding was given to the beneficiaries through bank accounts in the joint names of husband and wife in three stages, 40% advance, 40% when the construction was completed upto plinth /door lintel level and 20% when the construction was complete upto the eve level band.
- (ii) Technical guidelines were made available for various types of construction and technology options, also permitting variation in the house plan to suit the beneficiary’s requirement.
- (iii) Enough Junior Engineers were trained in the construction technology to guide, supervise and monitor the construction as it proceeds upwards and verify the level of construction and the technology adoption for releasing the next installment.
- (iv) Training of masons in the art of Disaster resistant construction through the trained Junior Engineers/Non-Governmental Organisations. Such Masons once trained will become an asset to the construction industry in the State.
- (v) Material banks were created by the Government where cement and steel bars were made available at cheaper rates through waivers of the duties on such materials for strict use in the rehabilitation/reconstruction work.
- (vi) Third party audit was adopted to check the quality of construction and proper use of technology by an independent organization appointed by the Government.

It may be mentioned that with all these measures, the constructions were assured of the required quality and safety of the houses under various natural hazards. It also had an added benefit that the knowledge base of ‘disaster resistance’ was expanded upto the village level.

CRITERIA TO BE ADOPTED IN THE DESIGN OF NEW HOUSES.

Based on the multi-hazard situation and prevailing alluvial soils with high water table conditions the following criteria may be adopted for designing the houses:-

Foundations

The foundations to be adopted should be resistant to erosion effect of flowing water, and also under the liquefaction effects which may be caused under earthquake intensities MSK VIII and higher likely to occur in Seismic Zone IV & V. Also it is know that rise of water table to the level of footings reduces the bearing capacity of the soil by 50%, hence, the bearing capacity to be considered in the design should be taken of a low value such as 5 – 6 ton/sq.m in the case of shallow foundations, otherwise deep foundations should be adopted.

Plinth

It will be appropriate to consider the plinth level of the house above the most common flood level in the area and naturally above the drain level in the village.

The plinth of the house must be made of non-erodeable material such as reinforced concrete,

plain concrete, masonry constructed in cement mortar and the like.

Superstructure

The superstructure walls can be constructed using different materials like brick work, concrete block work, stabilized compressed earth block work or lighter materials such as wattle and daub, bamboo matting covered with mud plaster etc.. The requirement will be that the superstructure walls must be made stable under earthquake as well as high wind conditions. Also if the inundation level rises, the wall material should not become soft and dissolve under water. For heavy materials earthquake safety will require use of special reinforcing details for stability as per IS:4326-1993 or IS:13828-1993. If a steel frame is adopted for superstructure framework with different kind of paneling, the steel work must be used with proper cross bracing to make it stable under earthquakes and wind conditions and pointing to make the construction corrosion-resistant.

At the top level of the walls there will have to be a horizontal framework or use of an eave level band beam or all around integrated with the superstructure walls/frame to provide integrity to all the enclosing wall system. In case, RC slab roofs such a *band* or beam may not be necessary.

Roof

As per the recommendations given by NDMA in the *National Disaster Management Guidelines – Management of Floods* it is required that the houses in the flood prone areas should be made with *flat horizontal roofs* which could be used as the shelter by the family. This will become necessary when the flood water will rise above the waist level in the house. Therefore, the design criterion should be that the roof must be designed with capability of supporting the occupants of the house during high floods. Also either a permanent stair system will have to be devised, or a ladder will have to be kept by the occupants of the house to use it for going to the roof at the time of the need. For the same reason the roof must be

provided with a parapet for providing security to the people when they are using the roof for temporary living.

10. ESTIMATED CONSTRUCTION COSTS

Using the drawings shown on sheet no. 01 & 02 and taking the current Schedule of Rates (24th March, 2008) for distt. Muzaffarpur, kindly supplied by Er. V.N.Sah, Subb. Engg. Services, Muzaffarpur, Bihar, detailed estimates of the various quantities and costs were worked out under the following variable conditions:-

- a) Seismic Zones IV & V
- b) Costs *including* ‘all taxes and contractors profit’ and costs *excluding* ‘all taxes and contractor’s profit’.
- c) Providing earthquake resisting features and *without* earthquake resisting features.

The abstract of costs are shown here in tables 5,6 & 7 for the three types of foundation alternatives.

TABLE :- COST OF THE PROPOSED BUILDING WITH 'STRIP' FOUNDATION

S.No.	Description	Cost in Zone IV		Cost in Zone V	
		Without Taxes & CP	With Taxes & CP	Without Taxes & CP	With Taxes & CP
1	Cost of super structure alone	20209.61	24145.41	20881.27	25640.52
2	Cost of foundation including plinth	13261.24	15829.73	13261.24	15829.73
3	Cost of Earthquake resisting elements	1338.17	1701.47	3314.49	4212.90
	TOTAL COST	34809.02	41676.61	37456.99	45683.16
	% COST OF EARTHQUAKE ELEMENTS TO THE TOTAL COST	3.84	4.08	8.85	9.22

TABLE 6:- COST OF THE PROPOSED BUILDING WITH 'PEDESTAL' FOUNDATION

S.No.	Description	Cost in Zone IV		Cost in Zone V	
		Without Taxes & CP	With Taxes & CP	Without Taxes & CP	With Taxes & CP
1	Cost of super structure alone	20209.61	24145.41	20881.27	25640.52
2	Cost of foundation including plinth	6534.39	8045.22	6534.39	8045.22
3	Cost of Earthquake resisting elements	1338.17	1701.47	3314.49	4212.90
	TOTAL COST	28082.17	33892.11	30730.14	37898.65
	% COST OF EARTHQUAKE ELEMENTS TO THE TOTAL COST	4.77	5.02	10.79	11.12

TABLE 6:- COST OF THE PROPOSED BUILDING WITH 'PILE PEDESTAL' FOUNDATION

S.No.	Description	Cost in Zone IV		Cost in Zone V	
		Without Taxes & CP	With Taxes & CP	Without Taxes & CP	With Taxes & CP
1	Cost of super structure alone	20209.61	24145.41	20881.27	25640.52
2	Cost of foundation including plinth	8469.58	10607.15	8469.58	10695.62
3	Cost fo Earthquake resisting elements	1338.17	1701.47	3314.49	4212.90
	TOTAL COST	30017.36	36454.03	32665.34	40549.04
	% COST OF EARTHQUAKE ELEMENTS TO THE TOTAL COST	4.46	4.67	10.15	10.39

CONCLUDING RECOMMENDATION

Considering the multi-hazard situation in the districts in North Bihar, it is strongly recommended that all houses under the proposed scheme of the Bihar Govt. should not only be of permanent nature capable of resisting the flood hazard but also should be made safe, in the first instance, against the earthquake hazard postulated in the seismic zoning map, of India. The houses should have a flat roof as recommended by NDMA, Flood Safety Guidelines, which could be used by the residents as temporary shelters. The designs proposed here satisfy all the safety requirements and have been so planned that it is feasible to construct such houses at very economical costs.

REFERENCES

1. "District-level flood maps for Bihar ready".
2. "FMIS". fmis.bih.nic.in.
3. India Water Portal - Bihar Floods 2008 Archived 1 February 2009 at the Wayback Machine
4. "Flood threat grows to 37 districts".
5. "Bihar's scary new flood".
6. "Bihar speeds up Flood Relief and Rescue Operations". Retrieved 5 September 2013.
7. "Floods in state not man-made, says minister".
8. "Flood Situation Improves In Bihar, Number Of Dead At 514".
9. "Bihar Floods: Number Of Deaths Rises To 341".
10. "Death toll in Bihar floods mounts to 304; situation grim in UP".
11. "Flood situation worsens in Bihar, death toll rises to 253".
12. "Bihar floods: 119 dead; bridge collapse caught on camera".
13. "Bihar floods: Death toll rises to 202 in 18 districts; thundershowers likely to continue today".
14. "Bihar Flood Deaths Rise To 440; Prime Minister Announces Rs. 500 Crore Relief".
15. "Bihar floods' death toll touches 440, 1.71 crore people still affected".
16. "Bihar floods cost 39 more lives, UP staggers".
17. "Bihar floods: Death toll rises to 304, 1.38 crore people still battling deluge in 18 districts".
18. "Alert sounded in north Bihar plains".
19. "Over 50 years ago, Bengal's chief engineer predicted that the Farakka dam would flood Bihar".
20. "Farakka not to blame for Bihar floods: CWC".
21. "BJP leader Sushil Modi questions Nitish demand for decommissioning Farakka barrage".
22. "Disaster Management". disastermgmt.bih.nic.in.
23. "Loss of Public Property". disastermgmt.bih.nic.in.
24. <http://tirhut-muzaffarpur.bih.nic.in/>
25. Law, Gwillim (25 September 2011). "Districts of India". Statoids.
26. "Muzaffarpur Geographical At a Glance". Retrieved 10 July 2015.
27. "Island Directory Tables: Islands by Land Area". United Nations Environment Program.
28. "7. LYCHEE PRODUCTION IN INDIA". *Fao.org*. 31 May 1992.
29. "Archived copy". Archived from the original on 28 August 2011.
30. US Directorate of Intelligence. "Country Comparison:Population". 4,740,737 July 2011 est.
31. "2010 Resident Population Data". U. S. Census Bureau.
32. "C-16 Population By Mother Tongue - Bihar". censusindia.gov.in.