Research Paper Geography

# Flood Hazard And Risk Assessment of the Haora River Basin: A Case Study On Khayerpur Mouza, Tripura, North-East India

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**ABSTRACT**

*Worldwide, flooding is probably the number one cause of losses from natural events. No region in the world is safe from being flooded. As, the flood risk is a function of the flood hazard, the exposal values and their vulnerability, the increase in flood losses must be attributed to changes in each of these aspects. While flood protection measures may reduce the frequency of inundation losses, appropriate preparedness measures lessen the residual financial risk considerably (Korn, 2002). Khayerpur Mouza also faces problem of huge flood water of the Haora River. It is observed from the land use map of this Mouza that in different years, the population is increasing along the river side, thus exposure to losses from flood hazard is also increasing. Some people are settling in the bank of the river due the lower cost of the area knowing that this is a risky area. But some people do no have any idea about extent of damage of flood. So in this study an attempt has been made to assess the risk of Khayerpur Mouza (Risk = Hazad * Vulnerability), so that the people can prepare themselves for such kind of hazards. Therefore, the flood management programme should be implemented in these limited areas to save the people from their suffering during flood hazard. This work will help the govt. to prepare plans for disaster management at those areas under flood risk.*

**Keywords : Flood Hazard Index, Vulnerability Index, Risk Index, Haora River.**

**Introduction**

Khayerpur Mouza is located along the right bank of the River Haora. Dapda Gang, a tributary to Haora River is also flowing along the northern side of this Mouza. Haora River originates from Baramura Hill Range and meets the Titas River in Bangladesh and therefore considered as a sub-basin. Almost every year the residents of the river side suffer from flood problem. Khayerpur Mouza is one of those affected areas. Geologically the study area is characterized by Quaternary deposition, physiographically this area falls under flood plain. The area is agriculturally rich due to the dominance of fertile alluvial soil developed by River Haora and Dapda Gang during flood. About 52% of the total area is occupied by paddy land, 35% is settled area and rest of the area is covered by river, roads and fallow land. According to 2001 Census, total population of the Mouza was 9,731 and the total area is 947.32 acre i.e. population density was 10.27 persons / acre and field study shows a significant increase in population density during 2012 along the river course (2011 Census data not yet published). During flood this densely populated area suffers from many problems. Flood Hazard Map or Flood Risk Map for this area has not yet been prepared and therefore an attempt has been made to prepare Flood Hazard Map, Flood Vulnerability Map and Flood Risk Map for the Khoyerpur Mouza of the Haora River Basin.

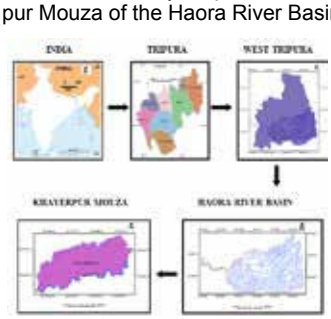


Fig.1: Location map of the Khayerpur Mouza.Flood risk is a result of the combination of the flood hazard and the consequences of the flooding. Thus, a vulnerability analysis enables to identify the population and infrastructures at greatest risk from flooding. Once information about the flood hazard and the communities at risk has been gathered, the challenges are to present that information in useful and coherent ways and to overlay the physical flood areas with the vulnerable areas. Therefore, flood hazard and vulnerability maps are often required to produce flood risk maps (Onana et al, 2008). According to James Lancaster et al (2003), flood risk can be described as a measure of the potential for flooding to cause damage, which is a combination of the likelihood of flooding occurring and the consequences of flooding.

The term risk is understood in different ways by different people. In the scientific community it is widely agreed that risk is a product of a hazard and its consequences. Where there are no people or values that can be affected by a natural phenomenon, there is no risk. In a similar way a disaster can only happen when people are harmed and / or their belonging damaged (Kron, 2002). He also mentioned that three components determine risk viz. hazard, exposure and vulnerability.

Now a day though rainfall is less from the previous years but hazard is increasing due to population explosion. People are liking to settle in the flood plain because life style is more easy here but water holding capacity of the river is decreasing, thus due to narrower passage, velocity is increasing and consequences of hazard is also increasing. Moreover, due to huge population, exposure is also increasing thus vulnerability is also increasing ultimately risk from flood is greater now a day compared to the earlier days.

It appears that excess and haphazard development and rapid population growth in the valleys and flood plains have primarily resulted in increased vulnerability of population to flood hazard. As more and more people populate flood prone areas, the potential of damage from flood increases (Kron, 2002). Khayerpur Mouza is located on the flood plain, of

which, 35% area is occupied by various settlements, which are located on the banks of the river Haora and Dapda Gang. As per survey, due to their nearness to the river and being located on the flood affected zone, the settlements suffer from huge losses almost every year due to inundation. So it is necessary to have proper flood hazard zoning, risk assessment and vulnerability analysis of the study area.

**Aims and Objectives:**
The main aim of this work is to study the nature of flood hazard within the Khayerpur Mouza under Haora River Basin.

**Therefore the objectives of the study are:**
(1) to prepare flood hazard map;
(2) to assess the vulnerability of flood within the study area; and
(3) to assess the risk of flood in the Khayerpur Mouza.

**Methodology:**
The methodology has been divided into three parts - pre field, field and post field. In pre field study land use data has been collected from Office of the Settlement and Land Records, Govt. of Tripura. During field study inundation depth has been measured. In Post field study flood hazard map has been prepared using the inundation status. Then vulnerability index has been prepared using formula, finally risk map has been prepared. Details methodology has been discussed in concerned portions of result and discussion part.

**RESULT AND DISCUSSION**
Flood inundation map has been superimposed on the Digital Elevation Model (DEM) of Khayerpur Mouza to verify the elevation-wise inundation depth. An elevation profile has been drawn from north-east to south-west direction to show the elevation variation. Northeastern part is comparatively higher than the southwestern part and therefore the depth of inundation is also higher in the southwestern part and population density is also high. The areas with more than 20 m elevation does not experience flood, but the areas are very less in respect to the total flood affected area. Therefore those areas have been considered under less than 1 m inundation depth.

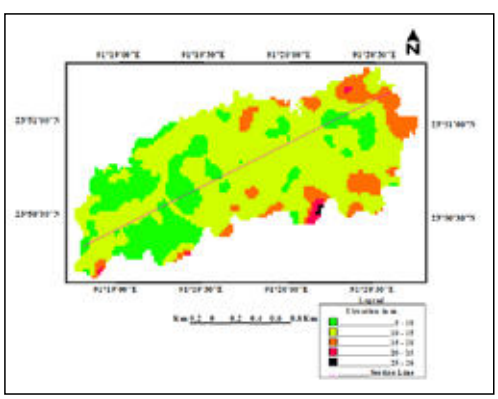

**Fig.2: Digital Elevation Model (DEM) of the Khayerpur Mouza)**

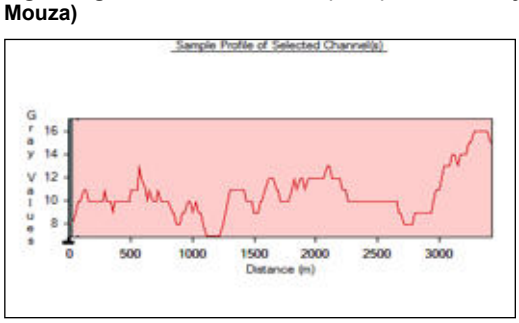


**Fig: 3 Cross-sectional view of elevation of the Khayerpur Mouza from northeast to southwest direction.**

**Flood Hazard Map:**
A flood hazard map of the Khayerpur Mouza has been prepared using the inundation status which was measured during field survey. According to the inundation depth the whole area has been divided into 3 categories (Fig.4).

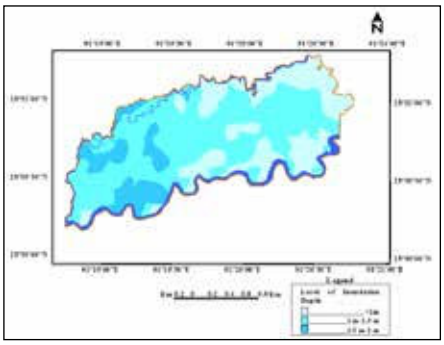

**Fig.4: Flood hazard map of the Khayerpur Mouza**

**Table 1: Inundation Depth-wise area and its percentage to total inundated area at Khayerpur**

| Inundation Depth (m) | Inundated Area (acre) | % with respect to total inundated area |
|---|---|---|
| 1.5 to 2 | 247.85 | 28.09072 |
| 1-1.5 | 524.52 | 59.44782 |
| Less than 1 | 109.95 | 12.46147 |

**Risk Assessment:**
Risk faced by the people must be seen as a cross cutting combination of vulnerability and hazard. Disasters are a result of the interaction of both; there can not be a disaster if there are hazards but vulnerability is (theoretically) not or if there is a vulnerable population but no hazard event (Wisner B.; Blaikie P.; Cannon T, and Davis I., 2004). These three elements: Risk (R), Hazard (H) and Vulnerability (V) can be written in a simple form:

R= H*V

For preparation of flood risk map two elements are important. One is hazard index and another is vulnerability index.

- Firstly the whole area has been divided into 500m X 500 m grid. Here total number of grid is 27.
- For each grid an integer value ranging from 0 to 3 has been assigned as a Hazard Index according to inundation depth (Table 2).

**Table 2: Hazard Index values according to inundation depth**

| Inundation Depth (m) | Hazard Index |
|---|---|
| 1.5 to 2 | 3 |
| 1-1.5 | 2 |
| Less than 1 | 1 |

- A plot by plot land use map has been prepared for the Khayerpur Mouza for in depth study.
- Land use map has been superimposed on the grid map. For vulnerability index, a value ranges from 0 to 10 has been calculated for each grid. Weightage of 10, 4 and 2 have been used for area covered by houses, agriculture and road respectively.

From the land use map it has been observed that the population concentration is more along the river (Fig.5). The increase in losses from natural events is a direct function of the number of people who must or wish to settle in flood prone areas and a function of the increasing values they possess and their greater susceptibility (Kron, 2002). The materials used by the people living in the flood plain are difficult to move

in a higher level when flood water rises. In the study area there are agricultural lands which also fall under hazard zone, standing crops are also affected by flood, but as population is considered, the weightage 10 is assigned to the areas under settlement.

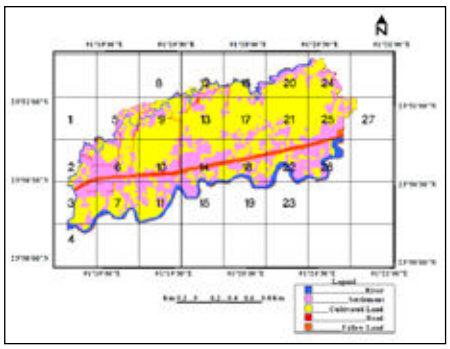

**Fig. 5: Land Use Map of the Khayerpur Mouza**

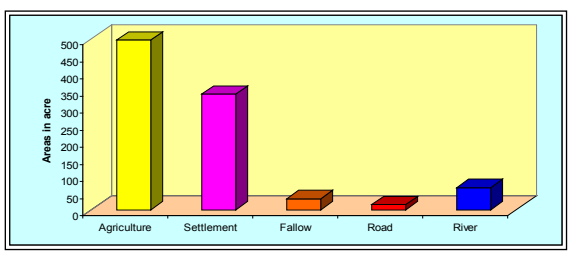


**Fig.6: Area-wise land use of Khayerpur Mouza**

Vulnerability is the exposure and susceptibility to losses. The Vulnerability Index is calculated using the following formula:

V.I. = 10 * A house + 6 * A agriculture + 4 * A road +2* A plantation + 0 * A no use

A total
V.I. = Vulnerability Index,
A house = Area covered by house/living place
A agriculture = Area covered by agricultural land,
A road = Area covered by road,
A plantation = Area covered by plantation,
A no use = Area under no use,
A total = Total area.

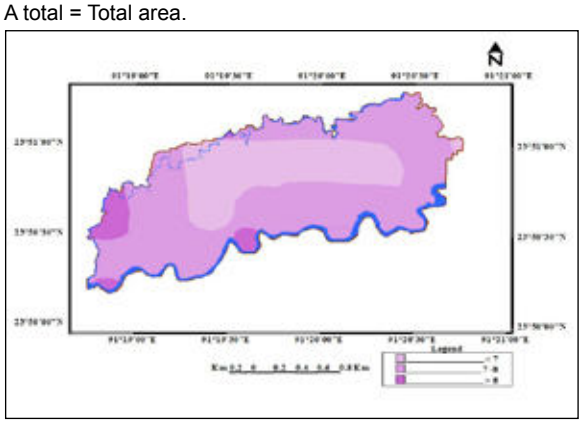

**Fig.7: Vulnerability Map of the Khayerpur Mouza**

The northern and middle portions of the Mouza are comparatively less vulnerable than the rest parts of the Mouza. The maximum vulnerability value is found in some portions of southeast, south and west of the Mouza. The vulnerability is high where the areas under settlement are more.

- Risk Index for each grid has been calculated by multiplying Hazard Index and Vulnerability Index

R = H * V

R = Risk Index
H = Hazard Index
V = Vulnerability Index

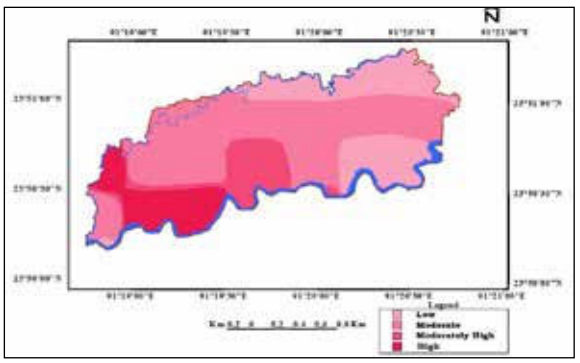

**Fig.8: Risk Map of the Khayerpur Mouza**

It is observed in the risk map that there is a similarity between vulnerability and risk values. As the whole area is under different flood hazard zones there is no flood risk free zone. The high risk zone covers 22.41 % of the total area and which is located near the river bank. Population density is also high in this high flood risk zone. High flood risk zone represents the area where people are more exposed to flood hazard. South and northwest portions of the mouza fall under high risk zone due to high population concentration and high inundation depth. Central part of the mouza is less vulnerable due to low population concentration but risk is moderate due to high inundation depth.

**Table 3: Values of Hazard, Vulnerability and Risk Indices of the Khayerpur Mouza**

| Grid No | Hazard Index | Area (acre) | | | | | Total area | Vulnerability Index | Risk Index |
|---|---|---|---|---|---|---|---|---|---|
| | | agriculture | settlement | fallow | plantation | road | | | |
| 1 | 2 | 0 | 0 | 0.13 | 0 | 0 | 0.13 | 0 | 0 |
| 2 | 3 | 5.76 | 15.31 | 0.93 | 0 | 1 | 23 | 8.333043 | 24.99913 |
| 3 | 2 | 16.06 | 14.14 | 1.56 | 0 | 0.85 | 32.61 | 7.395278 | 14.79056 |
| 4 | 1 | 0.53 | 1.27 | 0 | 0 | 0 | 1.8 | 8.822222 | 8.822222 |
| 5 | 2 | 11.13 | 11.32 | 0.18 | 0 | 0.46 | 23.09 | 7.874405 | 15.74881 |
| 6 | 2 | 27.38 | 25.6 | 3.82 | 0 | 3.29 | 60.09 | 7.21318 | 14.42636 |
| 7 | 3 | 23.27 | 19.91 | 0 | 0 | 0.61 | 43.79 | 7.79082 | 23.37246 |
| 8 | 2 | 0.17 | 0.26 | 0 | 0 | 0 | 0.43 | 8.418605 | 16.83721 |
| 9 | 2 | 42.66 | 11.41 | 0 | 0 | 1.35 | 55.42 | 6.774811 | 13.54962 |
| 10 | 2 | 35.68 | 19.71 | 5.19 | 0 | 1.52 | 62.1 | 6.719163 | 13.43833 |
| 11 | 3 | 19.81 | 17.95 | 0 | 0 | 0 | 37.76 | 7.901483 | 23.70445 |
| 12 | 1 | 7.32 | 5.71 | 0 | 0 | 0.53 | 13.56 | 7.606195 | 7.606195 |
| 13 | 2 | 46.76 | 13.95 | 0.74 | 0 | 0.44 | 61.89 | 6.815641 | 13.63128 |
| 14 | 2 | 18.7 | 35.93 | 5.44 | 0 | 1.36 | 61.43 | 7.763959 | 15.52792 |
| 15 | 2 | 0.47 | 6.23 | 0 | 0 | 0 | 6.7 | 9.719403 | 19.43881 |
| 16 | 1 | 11.08 | 4.18 | 0 | 0 | 0.2 | 15.46 | 7.055627 | 7.055627 |
| 17 | 2 | 46.94 | 14.08 | 0 | 0 | 1.08 | 62.1 | 6.872142 | 13.74428 |
| 18 | 2 | 27.33 | 23.48 | 4.92 | 0 | 1.29 | 57.02 | 7.084181 | 14.16836 |
| 19 | 2 | 0.33 | 1.2 | 0 | 0 | 0 | 1.53 | 9.137255 | 18.27451 |
| 20 | 1 | 26.79 | 9.39 | 0 | 0 | 0 | 36.18 | 7.038143 | 7.038143 |
| 21 | 2 | 49.67 | 12.43 | 0 | 0 | 0 | 62.1 | 6.800644 | 13.60129 |
| 22 | 1 | 16.69 | 24.95 | 5.23 | 0 | 1.16 | 48.03 | 7.376223 | 7.376223 |
| 23 | 1 | 0 | 0.29 | 0 | 0 | 0 | 0.29 | 10 | 10 |
| 24 | 1 | 21.37 | 10.97 | 0 | 0 | 0 | 32.34 | 7.356834 | 7.356834 |
| 25 | 2 | 31.77 | 22.23 | 1.49 | 0 | 0.22 | 55.71 | 7.427751 | 14.8555 |
| 26 | 1 | 5.98 | 15.87 | 2.8 | 0 | 0.5 | 25.15 | 7.816302 | 7.816302 |
| 27 | 1 | 2.09 | 0.52 | 0 | 0 | 0 | 2.61 | 6.796935 | 6.796935 |

**CONCLUSION:**

The above study reveals that the flood inundated area is extended throughout the flood plain for 1 – 1.5m depth and 1.5 – 2m inundation depth is found in some limited areas. These areas are therefore high flood hazard prone areas. With increase in population density the vulnerability has also increased and ultimately risk to flood has increased in these areas. Therefore, the flood management programme should be implemented in these limited areas to save the people from their sufferings during flood hazard.

**Acknowledgement:**

The authors are grateful to The Department of Science and Technology (DST), SERC Division, Govt. of India for providing financial help to carry out the research project on fluvial hazards of the River Haora, Tripura.

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