Abstract

Chapter 1: General introduction

The present study takes an integrated approach for studying riverine hazards in Upper Brahmaputra River plain. To achieve this, first the riverine processes and their dynamics which translates themselves into hazards in the neighbouring floodplains were assessed. Then a study to assess the socio-economic aspects, susceptibilities and adaptations of the floodplain dwellers was carried out. And finally, flood hazard, vulnerability and the resultant risk for the study region was assessed and mapped by integrating the physical and the social components.

Research worldwide shows that riverine hazards, especially flood, is not merely a hydro-meteorological phenomenon but is a complex interaction of man and its environment. The riverine processes and the floodplain communities are mutually inclusive and influence each-other. It is more so in case of South-East Asia where people, culture, economy, environment and the rivers are inseparable and therefore, riverine hazards are natural and indispensible.

This investigation is centred in the Upper Brahmaputra River plain specifically in chronically flood-affected district of Dhemaji. Major investments in structural measures like earthen embankments by government agencies throughout Brahmaputra valley have proved insufficient. Breaches in embankments, in recent decades, have become synonymous with flooding in this region. This shows the mismatch between the policies, implementation and outcome.

The specific objectives of the study are:

i. Quantify and assess the river dynamics and explore the controls that drive these processes.
ii. Assess the land-use changes driven by river dynamics as a measure for socio-economic damage assessment due to fluvial hazards.
iii. Understand and document stakeholders' perceptions, susceptibilities and adaptations towards floods.
iv. Analyse and map the hazard, vulnerability and risk of the region towards flood.

Chapter 2: Review of literature

In this chapter a review of the literature is provided to give an over view of the riverine dynamics and genesis of hazard, human-environment interaction and the social component of riverine hazards, and finally techniques of assessing and mapping flood hazard, vulnerability and risk. These earlier works have been helpful to find out the knowledge gap, formulate the framework of the study and to identify the methodologies to be utilised in the present study.

Chapter 3: River dynamics and facets of riverine hazard in Upper Brahmaputra River plain: processes, controls and effects

Study of historical planform changes is an important part of understanding fluvial systems and is critical to many geomorphological and river management problems. This part of the work quantifies channel processes in two partially-confined rivers of the study, namely, Gai and Simen and explores their controls. This is followed by assessment of implications of the dynamic processes on the neighbouring floodplains using land-use land-cover changes as a tool. Topographical map and Landsat data for a period of 40 years (1970-2010) were utilised to quantify river dynamics. Hybrid classification scheme was employed to classify the land-use pattern in the floodplains. The hybrid classification yielded a good accuracy of the classified landscapes. Overall accuracy for land-use classification for both the rivers ranged between 88.5 - 96.25%.

The planforms of Gai and Simen in different periods depicted changes which are rapid, deviation from experiences in some other subsystems of Brahmaputra valley (especially in terms of erosional and depositional processes) and at times chaotic. Repetitive avulsions played a major role in changing the morphology of the rivers. Role of human interventions, especially the road intersection, in the avulsion process, is evident. Confluence migration in Simen River has been the most dominant process during the study period.

Rainfall regime, seismicity and anthropogenic intervention were examined as indicators of controlling factors of observed changes. Rainfall regime which is a major control of surface runoff did not show any significant change in the total and seasonal amount. Seismicity, another influential stimulus of geomorphic changes shows an overall

increase. Complete evaluation of seismicity as a control of sediment dynamics requires detailed measurements across a range of timescales for which the technology and data is missing in this region making it difficult to specify the role of seismicity. Further, increase in seismicity is a global trend which is generally attributed to enhanced capacity of detection. The nature and spatial distribution of the observed geomorphic changes clearly indicates dominance of anthropogenic control in the observed process dynamics of these partially-confined rivers.

Land-use change shows that there is an increase in settlement and agriculture class and a decrease in the grassland highlighting increased population pressure on floodplains. Erosion and deposition along with river bank migration affected the adjacent floodplains. The area affected by these processes comprises primarily of agriculture land. Effect of river dynamics on settlements is also evident. Loss of agricultural land and homestead leads to loss of livelihood and internal migration in floodplains. The active nature of the rivers and consequent land-use change frequently throws newer environmental challenges, at times way beyond the coping capabilities of the dwellers.

Chapter 4: Assessing stakeholders' perception, susceptibility and adaptations to flood in Upper Brahmaputra River plain

This chapter attempts to present the complex human-flood interaction from the district of Dhemaji in the Upper Brahmaputra River plain. The objectives were to analyse perception, susceptibilities, indigenous knowledge and adaptations that enables coexistence with floods directly from floodplain dwellers from chronically flood-affected area. In addition, data on flood damages, breach and cuts, and embankment collected from government departments are analysed. The study takes an ethnographic route for data collection. Descriptive statistical analyses of variables are performed using SPSS. Results revealed realistic perceptions of stakeholders and scientific understanding of the riverine hazards. The result of indicator based analysis reflected higher susceptibilities of floodplain communities in the study area. The results also underscore the paradoxical situation where flood control measures themselves have become woes of the floodplain dwellers. This creates situations where environmental challenges outstrip indigenous adaptation strategies. This work is a contribution towards the long standing debate on choices of human response to riverine hazards.

Chapter 5: Assessing and mapping flood hazard, vulnerability and risk using stakeholders' knowledge and multi-criteria evaluation (MCE)

Assessing flood hazard, vulnerability and integrated risk has long been recognised as an important input for formulation of policies aiming at flood risk management. This investigation is an endeavour to assess hazard, vulnerability and risk due to flooding, using an indicator based methodology incorporating stakeholders' knowledge and multi-criteria evaluation in GIS to achieve community based assessment. Rapid Rural appraisal (RRA) among different stakeholders and secondary data from various government organizations were utilized to identify and rank the components of hazards and vulnerability and thereby the risk. The outcomes along with remotely sensed data were incorporated in GIS to perform Multi-Criteria Evaluation in the form of map algebra to produce hazard, vulnerability and risk maps. The framework which was developed in this work is illustrated for the district of Dhemaji, a chronically flood affected area in the Upper Brahmaputra River plain. Results provide spatial distribution of hotspots of flood hazard and vulnerability, and locations at risk at regional and sub-regional level. The emerged risk pattern indicates that vulnerability indicators are more significant contributors than hazard indicators while calculating risk. The methodology provides a dynamic platform where the flexibility in uses of hazard and vulnerability indicators, depending on variation in physical and socio-economic setup, is possible.

Chapter 6: Conclusions and future scope

This chapter summarises the present work and also puts forward the scope for future research in the area.