FLOOD RISK ASSESSMENT OF THE NORTH-EASTERN PART (SURMA RIVER BASIN) OF BANGLADESH USING RAINFALL-RUNOFF-INUNDATION (RRI) MODEL

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1. INTRODUCTION

This paper aims to find and assess flood problems in the north-eastern region of Bangladesh. Bangladesh is mostly a flat country. There are some low lands in this north-eastern region. The selected study area covers two districts of the country. They are Sunamganj and Sylhet. The area is the basin of the Surma River. The rivers in this region enter Bangladesh from India. Almost half of the selected basin is within India. The rainfall intensity is higher in the Indian region. In Bangladesh region, the rainfall intensity is lower than in the Indian region but still higher compared to other parts of the country. Heavy rainfall occurs in this area in the monsoon season. In this season, the Surma River often inundates the surrounding areas. The low lands of this region are flooded almost every year. Sometimes flash floods occur early in the season just before the rice harvesting and prevent the people of the haor basin from harvesting their crops. In many cases, people in this part of Bangladesh lose all crops when such floods occur (Rahman et al., 2009). The main agricultural product is rice in this region. Rice is grown here only once a year. The rice production is often damaged due to flood in this area. The initial objectives of this study are simulation of rainfall runoff, deriving discharge hydrograph and inundation depth by using the Rainfall-Runoff-Inundation (RRI) model (Sayama et al., 2012). Then an inundation map is to be prepared by using data from RRI, and frequency analysis is also to be performed. Damage assessment will be performed in this study after the collection of damage-related information. A flood hazard map will also be prepared at the end of the study after completing the initial tasks.

Figure 1: Selected area of Bangladesh

2.STUDY AREA

Total area of the selected catchment is 6819 square kilometers (Fig. 1). This region of Bangladesh is a low land area consisting of several haors. Haors are large saucer-shaped flood plain depressions located mostly in north-eastern region of the country. The haor basin is surrounded by the hill ranges of Meghalaya (India) on the north, the hills of Tripura and Mizoram (India) on the south, and the highlands of Manipur (India) on the east. Most of the rivers in these areas originate from the nearby hilly area of India. These rivers are extremely flashy and characterized by sudden and wide variation in flow as a result of excessive rainfall. When heavy rainfall occurs in the hilly region of India, rain water quickly moves towards the Haor area of Bangladesh through a number of rivers and canals. Sometimes flood water comes very early in the monsoon season and causes severe damage. Most parts of the Haor area continue to be flooded for 3-6 months a year (Yoshitani, et al., 2007).

3. METHODOLOGY

Topographic (DEM, Flow Accumulation and Flow Direction data) and hydro-meteorological (discharge, rainfall etc) data were collected for this study. The Rainfall-Runoff-Inundation (RRI) model was used for the simulation. The RRI model is a two-dimensional model capable of simulating rainfall-runoff and flood inundation simultaneously. Using the collected data, the RRI model performed simulation for a six-month period. Then the model was calibrated and validated. The collected rainfall data was used for frequency analysis in Gumbel Distrubution Method and Generalized Extreme Value (GEV) distribution method. Twenty seven-year rainfall was used for frequency analysis. Rainfall data used in this study was of two-month duration. The results of this analysis were used to determine design hyetograph. Damage assessment of the region due to flood will also be performed. From the design hyetograph data, the RRI model will be simulated again, and inundation will be attained for design rainfall. This inundation information will be used for preparing inundation map and flood hazard map.

Keywords: Rainfall-Runoff-Inundation (RRI), Flood Hazard Map, Gumbel, GEV, Inundation Map
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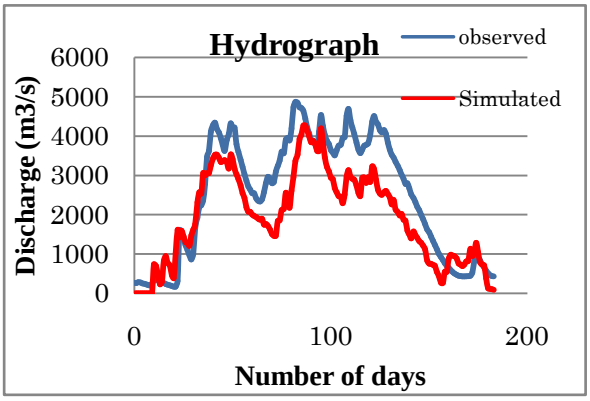

Figure 2: Observed and Simulated hydrograph

4. RESULTS AND DISCUSSION

The RRI model was applied to the selected basin. The simulation ran for a six-month period and the results were compared with observed daily discharge. The river discharge hydrograph was plotted and compared with the observed one (Fig. 2). The simulated hydrograph matches well with the observed one during rising period, but they differ slightly during the recession period. Although half of the study area is in India, information on the intensity and pattern of Indian rainfall was not available. Therefore the intensity and pattern of the Bangladesh portion was used in simulation over the whole catchment. This is the reason for this slight difference. Frequency analysis was also performed by using Gumbel distribution method and GEV method. The Gumbel probability plot is shown in Fig. 3. The results of both types are very similar. The Gumbel method is chosen because the number of data is limited in this case. Using RRI model output, inundation map was produced for the flood of 2004 (Fig. 4). This map was compared with an inundation map for the flood of 2004 (Fig. 5), which was produced by Bangladesh Water Development Board (BWDB). The simulated inundation map shows good resemblance with this map. Inundation of 4m depth and above is encircled in Fig. 4 and Fig. 5. Using the result from Gumbel distribution, a design hyetograph was obtained for 100-year return period and used in RRI model simulation. From this simulation, an inundation map was obtained, as shown in Fig. 6.

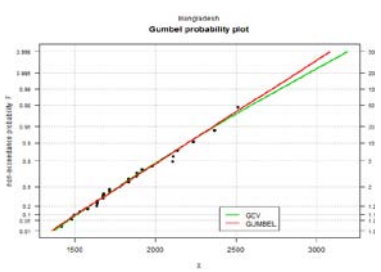

Figure 3: Frequency analysis

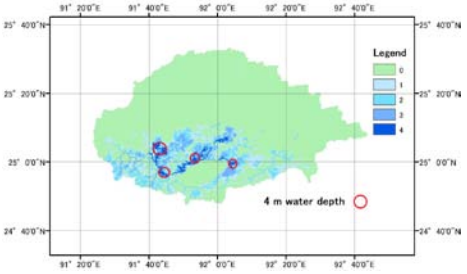

Figure 4: Inundation from RRI model for 2004 Flood

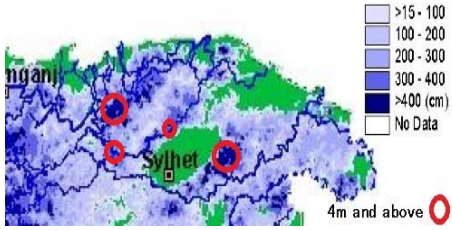

Figure 5: Flood Inundation Map 2004 by BWDB

5. CONCLUSION

Bangladesh is affected seriously by flood almost every year. The north-eastern region of Bangladesh is a flood prone region. Flash floods are a common phenomenon there. They destroy crops, houses, roads, etc. and cause severe damage to the area. The study aims to analyze risk and damage in the area. The simulation found that most of the catchment may be inundated to a great degree. So floods are a severe problem for that region. The model simulation may not be perfect but it produced good results for the study and fulfilled the study requirements. The flood hazard map which is the probable output of the study may help to make necessary decisions to reduce damage from flood hazard in this region. The results of this study may help in further study in this regard.

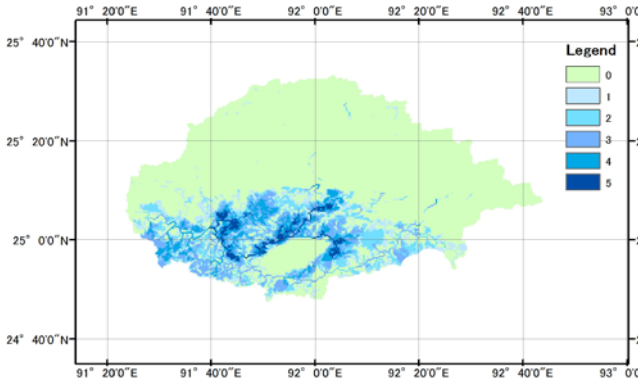

Figure 6: Inundation due to 100 year design rainfall

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