FLOOD WARNING AND EVACUATION SYSTEM: AN INTEGRATED APPROACH TO DISASTER MITIGATION IN BANGLADESH

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ABSTRACT

Mitigation is the cornerstone of emergency management. It's the ongoing effort to minimize the impact disasters have on people and property. Warning is the significant "hinge factor" in disaster management, which provides the vital link between preparedness measures and response action. It gives information on a hazard, identifies at a distant threatening of a particular area and allows the authority to take precautionary measures effectively. The consequences of flood event in Bangladesh are hazardous in terms of loss of lives and property. Comprehensive large-scale flood protection is neither economical nor environmentally friendly. Among non-structural methods, modern flood forecasting and the association with real-time data collection systems have increasingly found favor with countries prone to flood hazards. Flood risk mapping is required to provide information concerning flood risk areas to residents in flood prone areas and to establish flood protection and evacuation system. In determination of Decision Support System for flood risk assessment, it is important to apply the most efficient methods in flood forecasting and warning system associated with real-time data collection system.

An integrated approach was developed using hydrodynamic Model MIKE 11 and GIS to release warning of flood in advance of 72hrs, 48hrs and 24hrs. It can change the existing scenario substantially and render informed decision making in adopting proper measures towards disaster preparedness, mitigation, control, planning and management.

1 INTRODUCTION

Floods are the major disaster affecting many countries in the world year after year. It is an inevitable natural phenomenon occurring from time to time in all rivers and natural drainage systems. It causes damage to lives, natural resources and environment as well as the loss of economy and health. The impact of floods has been increased due to a number of factors, with rising sea levels and increased development on flood plain.

2 FLOOD PREPAREDNESS AND MITIGATION

Mitigation is the cornerstone of emergency management. It's the ongoing effort to lessen the impact; disasters have on people and property. The non-structural methods of mitigation of flood hazards are less expensive as compared to structural ones (dams and dikes). Among non-structural methods, modern flood forecasting and real-time data collection systems have grown favor in countries prone to flood hazards. Development of Decision Support System for flood risk assessment is vital in flood forecasting and warning for administrative machinery involved in rescue and evacuation work. The importance of the flood forecasting and warning is widely recognized as a vital non-structural measures to aid the mitigating- the loss of life, crops and property caused by the annual flood occurrence.

Preparedness provides leadership, training, readiness and exercise support, and technical and financial assistance to strengthen citizens, communities, State, local and Tribal governments, and professional emergency workers as they prepare for disasters, mitigate the effects of disasters, respond to community needs after a disaster, and launch effective recovery efforts.

3 STUDY AREA

Sundarganj Thana of Gaibandha district in Bangladesh has been selected as the case study (Figure 1). It is located in the northern part of the country bounded by two major rivers Brahmaputra (Jamuna) in the eastern and Teesta in the northern part of Bangladesh. Due to topographical condition the area is subjected to floods almost every year because of low gradient of the terrain. The terrain is basically alluvium flood plain and is not much stable as the river courses changes continuously. The region is characterized by shallow depressions and valleys of moribund river channels created by a long morphological history of changes in the river courses. Flash flood is caused by the river Teesta and the river flooding by the river Jamuna. Excessive precipitation, localized drainage congestions and insufficient capacity of hydraulic structures are the causes of flooding in this area.

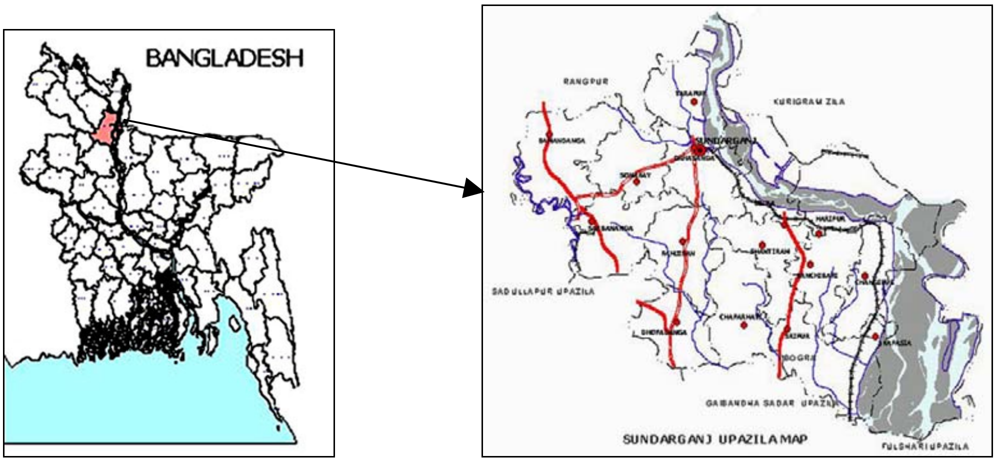


Figure 1. Sunderganj Thana of Gaibandha district, Bangladesh

4 INFORMATION REQUIREMENT FOR THE DEVELOPMENT OF WARNING SYSTEM

With the increase of population, industrial growth, more and more settlements and development in flood plains, flood hazards in Bangladesh have become ever-increasing natural disasters resulting in causing the highest economic damage among all kinds of natural disasters around the world. In order to formulate flood management and control policies, a thorough understanding of flood problems and how it can be solved is required. This can be done through data collection and analysis along with flood impact assessment. This study attempted to develop an integrated approach of a new model for warning of floods rather than flood mapping for flood risk assessment in flood prone countries for regular monitoring of damages.

Hydrodynamic model MIKE 11-FF (NAM, HD and FF) was successfully integrated with GIS in the Arc view GIS environment. MIKE 11 FF has been designed to predict the variation in discharges and water levels in a river system as a result of catchment rainfall and inflow/outflow through boundaries in the river system. GIS has been used intensively to create watershed models from digital elevation (DEM) data to trace flow-paths to get a complete surface for identifying the actual flood flow.

5 FLOOD AFFECTED PROPERTY

Flood inundation maps were being created by overlaying land use features and infrastructures to delineate flooded areas using dynamic spatial modeling. GIS was used for the analysis to determine hazard zones in the maps, which serve as risk zone identifiers for the general population. This information leads to locate safer location to evacuate the affected population utilizing the optimum route. Complete statistics will also be released for the predicted time stamps in advance by 72hrs, 48hrs and 24hrs. Finally, the information of population, land use and infrastructure are likely to be affected will be available in a user-friendly interface for timely decision for flood preparedness.

Mostly the Northern part of the Study area is always in the flood affected region. Flood inundation maps were prepared using simulation results. As the simulation results at every hour for the next 72 hours are available, so flood inundation maps can be prepared at any of those time stamps using the forecasting water levels. Water levels in the Flood Phase Maps (F0-F4) were classified into five classes- dark blue showing higher water depth (Figure 2).

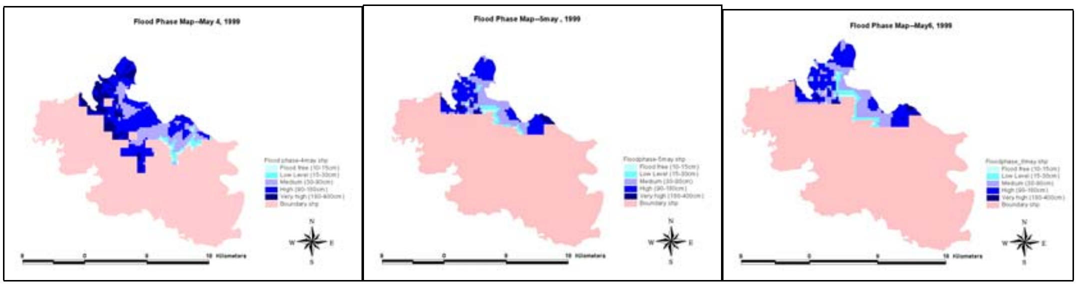
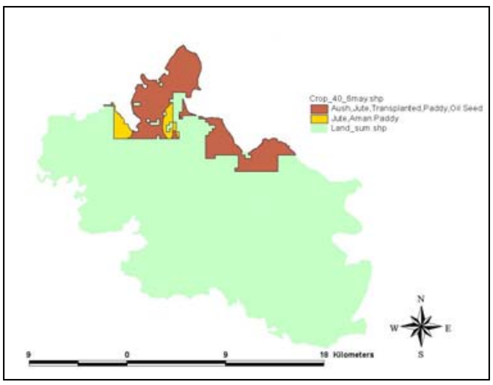


Figure 2. Flood phase maps of Sunderganj Thana before forecasting of 24 hours 48 hours and 72 hours

There is considerable crop damage almost every year of moderate flood. Overlaying land use map over the flood map, the area of affected crops was found out (Figure 3a).



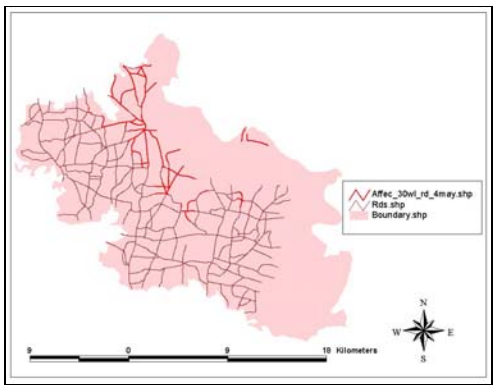


Figure 3(a). Flood affected crops in Sunderganj

Figure 3(b). Flood affected road infrastructure in Sunderganj

The area was then reclassified according to the types of crops. The table 1 shows the possible percentage of affected crops in the next 72 hours.

Information of predicted populations and infrastructures affected (Figure 3b) were also established using overlay operation. Those maps indicated the accessible route to evacuate people during emergency.

Table 1: Estimation of Affected Crops under 40cm Water Level in Sunderganj Thana

Description	Affected Crop in Area (ha)	Percentage (%) of Crop Affected
4-May	10631.12	25.39
5-May	4932.26	11.78
6-May	4900.90	11.70

It is important for the Warning System, to develop/ find out the efficient route to provide direction to the vulnerable people to move out during emergency. Before doing this, we need to come up with a plan that will enable us to choose the best possible way to minimize travel time to reach to the destination in an effective manner. Arc view Network Analyst helps us to use networks more efficiently. It helps to find out the quickest way to get the safest location (Figure 4), to determine the best route to reach. Overlaying this information with population data, it is easy to understand the situation, from where most of the people getting service and where to provide more additional set up of facilities.

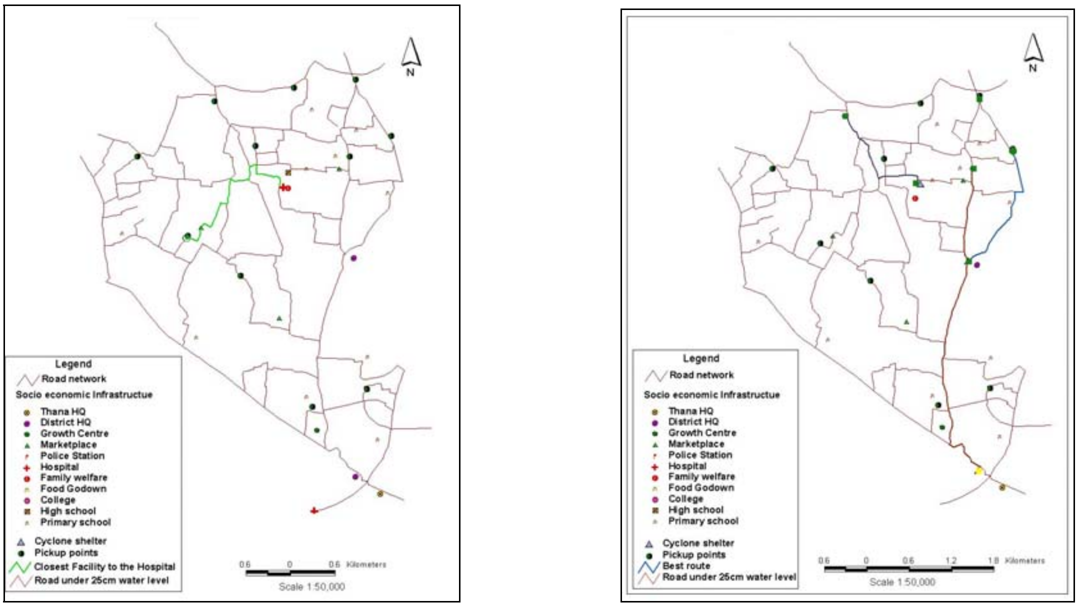


Figure 4. Closest route to the hospital and optimum route to the cyclone shelter

5.1 Warning is crucial in emergency management

Adequate flood warning is a crucial element in emergency management, and operations of all of the systems around flood forecasting that actually deals with. Being able to give information on what's going on, and provide an adequate warning time to all of the public and emergency responders. To be able to have them, get out of harms way. Be able to remove them without putting themselves in greater jeopardy. So, our aim is to develop a user friendly Flood Warning System (Figure 5) to support flood warning in advance at 72 hrs, 48hrs and 24hrs. Maps of the flood affected land use features, such as roads; agricultural lands, population and households can be released for above warning time stamps. In addition, complete statistics will also be available about the affected region. The information of population, land use, infrastructure etc to be affected will be available in term of user-friendly queries for timely decision for flood preparedness.

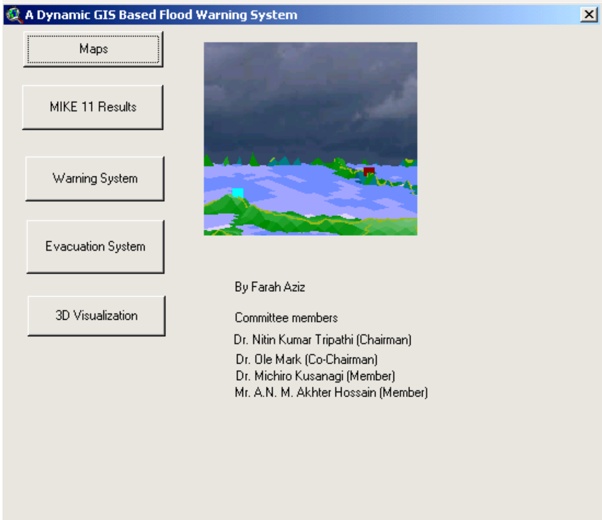


Figure 5: A Customized Flood Warning System

6 CONCLUSION

We cannot avoid flood, but by implementing effective flood prevention schemes, we can reduce damages from severity, if sufficient information for flood forecasting is given timely. Dynamic use of GIS integrated with hydrodynamic model provides useful measures towards disaster preparedness and planning. This dynamic model can be automated fully to be accomplished with the existing flood warning system to provide warning for the people without the knowledge of GIS to identify the possible inundated areas to take initiative to evacuate people to the safe places in time. It can help to promote public awareness in disaster management activities as a part of focusing the dissemination of forecast at the grass-root level.

Therefore, new flood control / management schemes based on dynamic model can be implemented for important disaster management aspects like prevention/ mitigation, preparedness, response and recovery and also planning for operational activities, immediately before, during and after flood.

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