RISK ASSESSMENT DUE TO STORM SURGE IN POLDER 70 OF BANGLADESH

Md. Sajidul Hossain¹, Dr. K. M. Ahtesham Hossain Raju²

ABSTRACT

Bangladesh is one of the most cyclone prone areas in the world which is bounded on the south by the Bay of Bengal. The coastal area in Bangladesh is 710 km long which is highly susceptible to cyclone. Storm surge associated with the cyclone cause a huge damage to life, property and infrastructure. To protect the vulnerable area from damage, 139 polders are constructed in the coastal zone. This study focused on polder 70 located in Maheshkhali upazila of Cox’s Bazar district. The generation of risk map is necessary for the future planning of development works as well as to identify vulnerable areas where protection is necessary. Commonly, the risk map is generated with co-ordination of inundation map and vulnerability map. In the present study, inundation map is generated considering flooding depth of 6 m. The inundation depth is considered as hazard index. The study area has been divided into 5 zones based on fishnet grid size of 4.5 km x 4.5 km using ArcGIS. The zones are assigned vulnerability index based on very high, high, medium, low and very low density of different features like social institutions, roads, cyclone shelters, etc. The risk index is calculated by multiplying hazard index with vulnerability index. Finally, the risk map for Polder 70 is generated showing different intensity of risk. The risk map provides information on area of respective zones exposed to different risk level.

Introduction

Bangladesh is a land of rivers, canals, coast and islands. Because of its repeated cycle of floods, cyclones, and storm surges; Bangladesh is one of the most disaster prone areas of the world. It meets Bay of Bengal at the southern end of the country. During the time of 19th and 20th century, Bangladesh has been hit by about 60 severe cyclones mostly accompanied by storm surges (Hossain 2018). The coastal zone of Bangladesh is vulnerable to cyclonic storm surge floods because of its location in the path of tropical cyclones, wide and shallow continental shelf and the funneling shape of the coast (Flierl and Robinson, 1972). Storm surges are oscillations of the water level in a coastal or inland water body in periods ranging from a few minutes to a few days, resulting from atmospheric forces in the weather system. A storm surge is partly caused by pressure differences within a cyclonic storm and partly by high winds acting directly on the water. This results in a mass of water, a huge wave, moving at the same speed as the cyclone. Polder 70 is situated in the Maheshkhali Upazilla of Cox’s Bazar district. A number of cyclone tracks passed around the polder no.70 (Ahmed 2018). This is why polder No.70 is chosen for risk assessment study. The objectives of the present study area selected with a view to determine the extent of damages caused by storm surges and cyclones in the island and to recommend further actions to safeguard people and assets.

Methodology

The digital elevation map of the study area is collected from USGS (https://earthexplorer.usgs.gov/). The study area has been divided into 5 zones namely, A, B, C, D and E (Figure 1) based on fishnet grid size of 4.5 km x 4.5 km using ArcGIS (Hossain 2018). It is assumed that the polder is breached after the storm surge. The maximum inundation is found to be 6 m in Maheshkhali Upazilla (IWM, 2009). Here inundation map for a depth of 6m has been generated by creating 6m of constant raster from Mean Sea Level (Figure 3). In this study the inundation depth is considered as Hazard Index which is followed in Dinh et al. (2012) and Tingsanchali and Karim (2005). The Hazard Index is assigned a full number starting from 0 to 6 based on maximum inundation depth of 6m. In this study the selected features are: social institutions, roads, cyclone shelters, agricultural land and water bodies (Figure 2). Based on these features, vulnerability is assessed. Each of the zones is given a value named as Vulnerability Index which is assumed to be 1 for very high density, 0.8 for high density,

¹Undergraduate Student, Department of Water Resources Engineering, Bangladesh University of Engineering and Technology, Dhaka-1000, Bangladesh.
²Assistant Professor, Department of Water Resources Engineering, Bangladesh University of Engineering and Technology, Dhaka-1000, Bangladesh.
Email of Corresponding Author - sajidulhossain15@gmail.com
0.6 for medium density, 0.4 for low density and 0.2 for very low density (Dinh et al., 2012). Respective zone is assigned Vulnerability Index based on the density of selected five features as shown in Table 1. Therefore, the Risk Index may be calculated as follows:

\[ \text{Risk Index} = \text{Hazard Index} \times \text{Vulnerability Index} \]  

(1)

Table 1. Vulnerability Index of different zones

<table>
<thead>
<tr>
<th>Zone</th>
<th>Social Institutions</th>
<th>Roads</th>
<th>Cyclone Shelters</th>
<th>Agricultural Fields</th>
<th>Water bodies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone A</td>
<td>0.8</td>
<td>1.0</td>
<td>0.6</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Zone B</td>
<td>0.6</td>
<td>0.6</td>
<td>0.2</td>
<td>0.6</td>
<td>0.2</td>
</tr>
<tr>
<td>Zone C</td>
<td>0.4</td>
<td>0.4</td>
<td>0.8</td>
<td>1.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Zone D</td>
<td>0.2</td>
<td>0.2</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Zone E</td>
<td>1.0</td>
<td>0.8</td>
<td>1.0</td>
<td>0.8</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Results and Discussions

Figure 3 depicts the inundation scenario indicating the southern part of polder 70 to be mostly affected by the flood due to storm surge. However, it is decided that the flood inundation depth will represent the hazard index. In order to determine risk index, the hazard index (inundation depth) for each cell in a zone is multiplied by the average of vulnerability index for respective zone as mentioned in Table 1. In this way the risk map for each zone is produced as shown in Figure 4.
Table 2. Percentage of inundated area of respective zone exposed to different risk level

<table>
<thead>
<tr>
<th></th>
<th>Very Low Risk</th>
<th>Low Risk</th>
<th>Medium Risk</th>
<th>High Risk</th>
<th>Very High Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone A</td>
<td>23.30%</td>
<td>41.30%</td>
<td>26%</td>
<td>9.10%</td>
<td>0.30%</td>
</tr>
<tr>
<td>Zone B</td>
<td>25.70%</td>
<td>45.70%</td>
<td>24.10%</td>
<td>4.30%</td>
<td>0.20%</td>
</tr>
<tr>
<td>Zone C</td>
<td>20%</td>
<td>37.80%</td>
<td>28.90%</td>
<td>12.60%</td>
<td>0.70%</td>
</tr>
<tr>
<td>Zone D</td>
<td>22.80%</td>
<td>36.30%</td>
<td>17%</td>
<td>8%</td>
<td>15.90%</td>
</tr>
<tr>
<td>Zone E</td>
<td>14%</td>
<td>31%</td>
<td>28%</td>
<td>12%</td>
<td>15%</td>
</tr>
</tbody>
</table>

From the risk map developed, it can be seen that zone A, B and C is in low to medium risk. Zone D has some medium to very high risk portion. On the other hand, most of the areas of zone E is located at very high risk zones. The white portions of the map have larger elevation than 6 m and this indicates those areas are located at very low risk zones because those areas are not inundated during flood with 6 m depth. Table 2 shows variation of risk intensity over a particular zone. It gives the impression that each of Zone D and Zone E has 15% area that lies within very high risk level. It is observed that Zone A and Zone B has very close similarity in the risk level.
Conclusion

On the basis of the foregoing results and discussions, few findings and conclusions can be drawn. South-Eastern part of Polder no.70 is located in a high risk coastal zone and special care should be taken during the threat of flooding. The central part (zone C) is relatively of higher elevation and most of its area are exposed to low risk level. Within the total inundated area of polder it is found that around 38% area lies within low risk level, 25% area lies within medium risk level, 21% area lies within very low risk level and 16% area lies within high to very high risk level. It is hoped that this information may be of use for planning future development of infrastructures, to take measures/precautions to mitigate adverse effects at vulnerable areas. However, there are few scopes of improvement for future study, e.g. use of higher resolution DEM, better inundation maps, considering more features, etc. for the generation of comprehensive vulnerability maps and risk maps.

References


