ANALYZING VULNERABILITY OF A COMMUNITY TO FIRE HAZARD: A CASE STUDY OF CHANDGAON RESIDENTIAL AREA

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ABSTRACT

A fire hazard is any situation where is a greater than normal risk of harm to people or property due to fire. Greatest loss of life and property in urban areas is caused by fire hazards. Urban fires have most devastating & dangerous impact on communities & residential areas. Unplanned urbanization is mainly behind of intensifying the problem further. To increase the resiliency of a community to natural and man-made hazards, before they become disasters, must first begin with a comprehensive risk and vulnerability assessment. Community vulnerability assessment tool (CVAT) is a useful method to assess vulnerability of a community to any hazard. In this study, the traditional community of Chandgaon Residential Area has been selected to conduct a Community vulnerability assessment. CVAT method has been applied here in several steps. Firstly, a hazard map was created by using six attributes such as transformer and power line, floor area ratio, building material type, accessibility, firefighting scenario and location of risky fire sources in the study area. Every one of them was assigned a value using Analytic Hierarchy Process based on experts' opinions. Then by using Arc GIS, all of the data were processed and maps were prepared. After preparing the hazard map, it was overlaid with each of the maps like, maps of critical facilities, economic activities, etc. Then it was evaluated that how much vulnerable the community was to fire in various aspects from every intersected map. Finally, the overall vulnerability of the community was assessed. After completing the assessment, it was found that vulnerability of the community to fire hazard is low.

Introduction

"A fire hazard is any situation in which there is a greater than normal risk of harm to people or property due to fire" (Raja, 2007, p. 1). Fire, as a calamitous event, will have its origin either in natural or in human activities. It can occur anyplace wherever ignitable materials are present and can cause vast loss of human lives and properties if it's not controlled in due time (Haque, 2001).

The trend of urban fire is closely associated with the amount of urbanization of a section (Wang et al., 2011) and globally this urbanization is happening quickly. In 2007, for the first time in history over 1/2 the world's population, 3.3 billion folks were living in urban areas (FIG, 2010). Urban areas become at risk of differing kinds of natural and artificial hazards (FIG, 2010).

Bangladesh is a developing country in South-east Asia. Because of the geological features, it is affected by numerous types of hazards & disasters every year such as natural hazards that are flood, cyclone, earthquake, landslide, drought etc. It is also affected by several types of manmade hazards such as fire & many more. In Bangladesh around 1142.3 people lives in per square kilometer and nearly about 35.1% people lives in urban areas (World Bank, 2010). Fire is the most common hazard in Bangladesh especially is urban areas. The number of fire incidents in Dhaka was 1,861 in 2003, 2,053 in 2004, and 2,279 in 2005 (Fire Incidence at Rise, February 10, 2007).

Chittagong is a major coastal city and financial center in southeastern Bangladesh. The city has a population of more than 2.5 million, while the metropolitan area had a population of 4,009,423 in 2011, (Bangladesh Bureau of Statistics, 2012) making it the second-largest city in the country. Because of the port & the railway & other transportation facilities, industrialization & urbanization rapidly dictates the city. For the allocation of all these people, several residential areas along with unplanned areas got developed here. Chittagong is not also free from the grasp of the disaster caused by fire. In February 2006, a fire at a textile factory in the port city of Chittagong kills 65 workers and injures dozens (Reuters, July 4, 2017). Fires broke out at Rahattarpul and Badurtala in Chittagong on 10th March, 2006. The fire, which originated from an electric short circuit,

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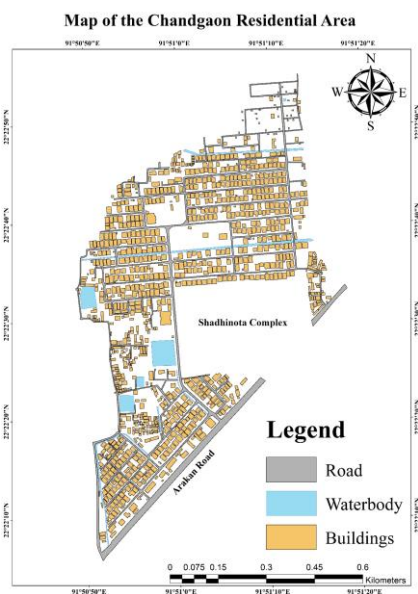
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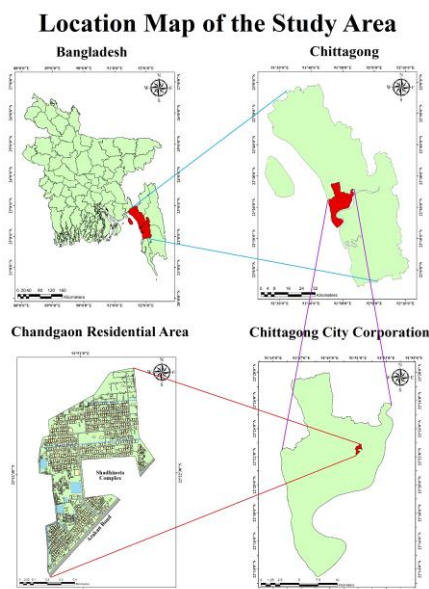*Email of Corresponding Author – ahnehal11@gmail.com*

burnt assets worth about Tk.7 lakh, the fire officials said (Fire Incidence at Rise, February 10, 2007). Because of this, the fire vulnerability assessment is very necessary in Chittagong.

Study Area Profile

The study area is Chandgaon R/A at ward no.4 of Chittagong City Corporation situated on the bank of Karnaphuli River. Ward no. 4 is the most densely populated (131,212) ward of Chittagong city and have a residential building value of 129 million US dollar (CDMP. 2009). Chandgaon have a population near 30,000 (Bangladesh Bureau of Statistics, 2012). The global positioning of Chandgaon is around the 91° 52' 10" N and 22° 21' 40" S. It is developed by Chittagong Development Authority (CDA) in 1978, it has 663 multi-storied residential buildings on 741 plots in two blocks. (Alamgir, 2007).

Map 1: Base map of the study area

Map 2: Location map of the study area

Methodology

Fire Vulnerability Map

It was prepared by combining five layers of info using Arc GIS software. Every layer was prepared on the basis of a single attribute which was selected while the data were collected. Those fire hazard attributes are:

Electric pole & line

The electrical poles and electricity wire were located by field survey. A buffer area of six meter around each pole and four meters along the line was demarcated and the buildings within this buffer area were located.

Existence of fire sources

In the study area, there are sources that can ignite or amplify a fire. Buildings with those were distinguished.

Accessibility

If the road giving access building is too narrow (assumed width less than 10 ft.) for fire engines to enter, the buildings cannot be served effectively by it and the structure became vulnerable to fire.

Building material type

All the buildings were categorized as kutcha, pucca and semi-pucca categorized on the basis of materials.

Floor area ratio (FAR)

For preparing this map, this equation was followed: [Floor area = (Build area × Building height in stories) / Plot area]. Then every building was categorized as very low floor area ratio & moderately low floor area ratio. The data for attributes were collected from the GIS map produced by Chittagong City Corporation of 2007 and field level survey of 2018. But before, the attributes were ranked using the Analytic Hierarchy Process (AHP). AHP requires a pre-defined weight to input which has been taken from 15 famous fire experts of Bangladesh.

Fire vulnerability analysis

Critical Facilities Analysis

This analysis focuses on finding out the vulnerabilities of key facilities or resources within the community. Firstly the critical facilities are to be identified, then a vulnerability assessment would be conducted on those facilities.

Economic vulnerability analysis

The aim of this analysis was to find out economic vulnerability to fire hazard. Firstly, the economic features are to be identified, then a vulnerability assessment would be conducted on those features.
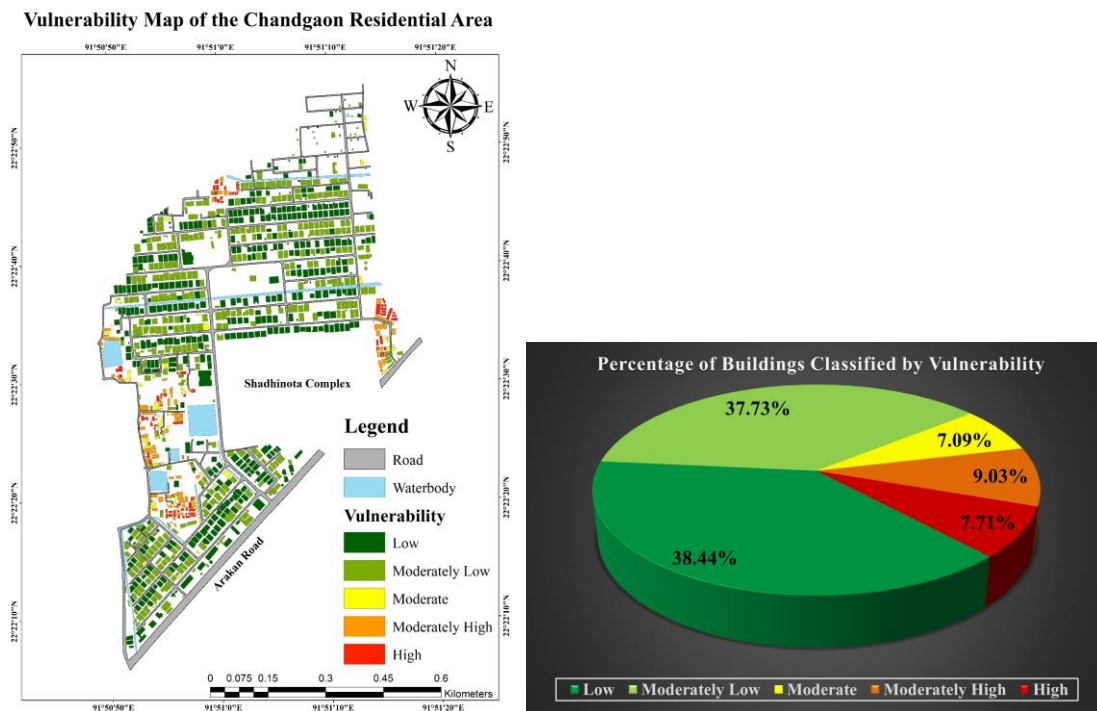
Environmental vulnerability analysis

To find out environmental vulnerability, sorting out secondary hazard risk consideration sites are necessary. Secondary impacts occur when hazard events create new hazards such as toxic releases.

Social vulnerability analysis

In this analysis, vulnerability to fire hazard is cross checked with some social aspects.

The Fire Vulnerability Map

| Map 3: The fire vulnerability map | Figure 1: Comparison of vulnerability of buildings |

The weight determined the AHP with the basis of the famous expert opinion are: Electric pole and line=
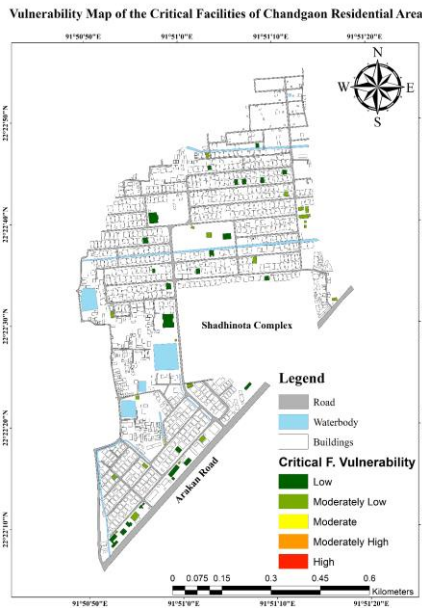
0.122; Availability of fire source= 0.354; Accessibility= 0.247; Material type= 0.135 & FAR= 0.141.
Vulnerability score= Weight for electric pole and line× (0 for Not Vulnerable or 1 for Vulnerable) + weight for availability of fire source × (1 for Available and 0 for Not available) + weight for accessibility × (1 for No access or 0 for Access) + weight for building material type × (1 for Pucca; 2 for Semi-kutcha or 3 for Kutcha) + weight for floor area ratio× (0 for Very Low or 1 for Moderately Low FAR). The buildings of the map were classified according to the score into five classes: low, moderately low, moderate, moderately high and high.

The map shows that most of the buildings are low & moderately low vulnerable for fire. Number of highly vulnerable buildings is significantly low & normally found in the unplanned clusters in the area. Number of moderate & moderately highly vulnerable buildings is also significantly low.

Fire Vulnerability Analysis

Critical facilities vulnerability analysis

At first all the critical facilities in Chandgaon Residential Area were identified such as: Educational institutions, Religious centers, Government organizations, Healthcare facilities, Bank, Community facilities, NGO offices. Finally, the following vulnerability map was prepared that represents which critical facilities.

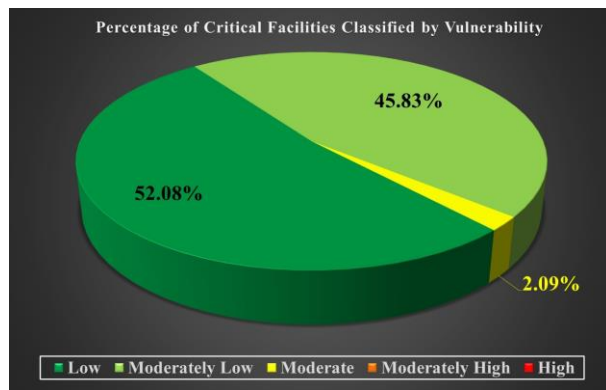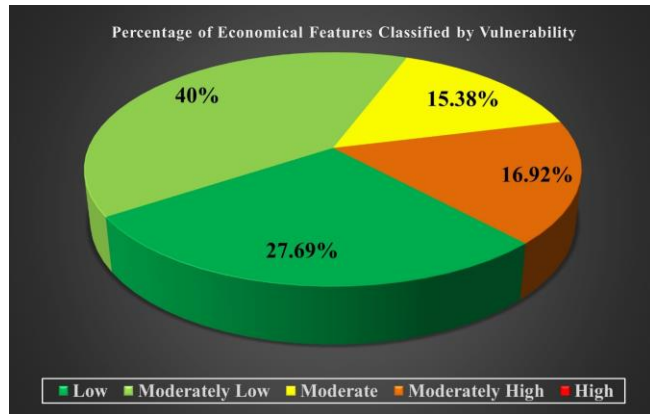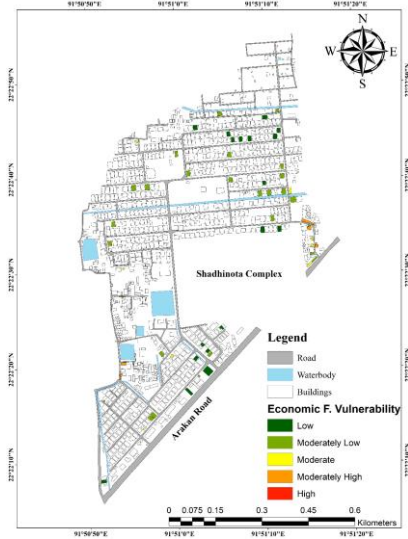*Map 4: Vulnerability map of critical f.*   *Figure 2: Comparison of vulnerability of critical f.*

We can see that, most of the critical facilities has low & moderately low vulnerability. Only 2.09% has moderate vulnerability. No economic features have high & moderately high vulnerability.

Economic vulnerability Analysis

Different types of economic activities were found on the study area. Most of them are resident oriented such as grocery stores, pharmacy, restaurants, filling stations, cyber cafes, mobile shops, super shops etc. Only one shopping mall was found in the area.

For preparing the inventory location of these has been collected from the GIS map and field survey regarding the economic features. Finally, the following map was prepared that represents which economic features are vulnerable to fire and which are not.
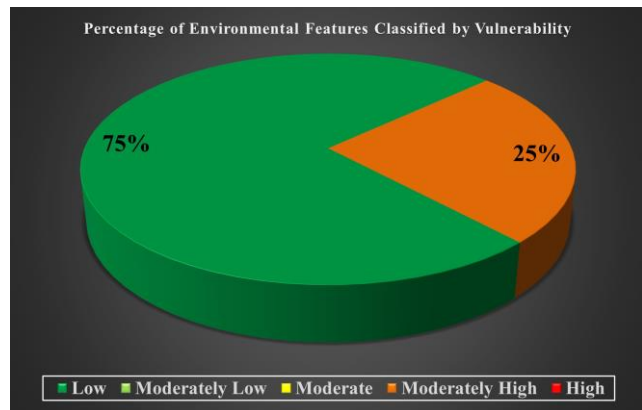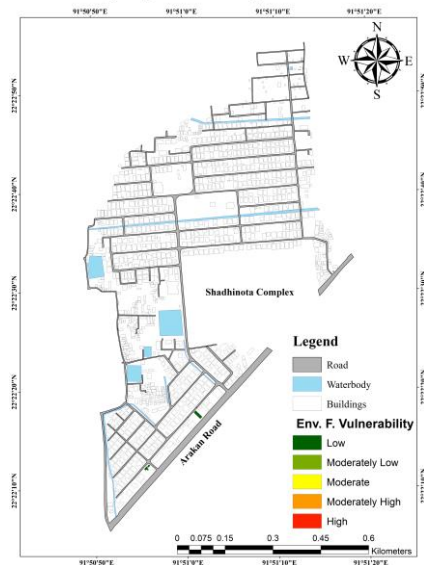
Map 5: Vulnerability map of economic f.   Figure 3: Quantitative comparison of vulnerability of economic f.

As we can see, most of the economic features have moderately low and low vulnerability. Only 15.38% & 16.92% buildings has moderate & moderately high vulnerability. No economic features have high vulnerability.

Environmental vulnerability analysis

Secondary impacts occur when hazard events create new hazards such as toxic releases. Only features that can cause secondary risk found in the study area are filling stations. For preparing the inventory location of these has been collected from the GIS map and field survey regarding the secondary risky features. Finally, the following map was prepared that represents which secondary risky features are vulnerable to fire and which are not.

Map 6: Vulnerability map of environmental f. Figure 4: Comparison of vulnerability of environmental f.

As we can see, most of the environmental features, specifically 75% has low vulnerability. The rest 25% has

moderately high vulnerability.

Social vulnerability analysis

As the Chandgaon Residential area provides housing for middle- & high-income groups, the literacy rate in high here. Various age group can also be found here & the male female ratio is nearly equal. So, the social vulnerability can be defined as the vulnerability of the community as a whole and it is moderately low.

Conclusion

Table 1: Result of the study

Parameter	Status
Critical facilities vulnerability	Low
Economic features vulnerability	Moderately low
Environmental features vulnerability	Moderately low
Social vulnerability	Moderately low
Number of vulnerable buildings	Moderately low
Large fire incidents	No

Taking in account the above status of different factors it can be concluded that the community of Chandgaon Residential Area is not so much vulnerable to fire. But this is an aggregate result, not an absolute decision. Because findings from this study can change if more attributes are considered & also if the method.

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