J. Patuakhali Sci. and Tech. Uni. 2018, 9 (1&2): 97-110 ISSN 1996-4501

DYNAMIC PROGRESSION OF DISASTER INDUCED VULNERABILITY: A STUDY ON DHAKA CITY

Md. Ashiqur Rahman[1], Md. Moniruzzaman[2], Sahanaj Akter[2]

Abstract

Dhaka is one of most vulnerable city considering growing impact of disasters. This study assesses disaster induced vulnerability of Dhaka city using Pressure and Release (PAR) model. Secondary, qualitative content analysis and descriptive method are used to conduct the study. It has been revealed that limited access to power and role in decision-making structure of mass people and lack of good governance as the root causes for progressing vulnerabilities in the city. On the other hand, lack of institution, training and awareness, demographic changes, rapid urbanization, price hike, traffic congestion and waste disposal have been identified as the agents of creating dynamic pressure. Moreover, inadequate protection from social crime and threats, lack of hazard protection services and institutional facilities may create unsafe conditions. The study found flood, earthquake, fire and building collapse has been striking in the city in line with the root causes, dynamic pressures and unsafe conditions that makes the city more vulnerable to living and may result in massive loss of lives and properties. This study suggests implementing the Detailed Area Plan (DAP) and Dhaka Structure Plan (DSP), promoting awareness campaign, ensuring national training programs, incorporating seismic hazard information into land-use plan, updating the national building code and developing a control authority for monitoring the law enforcement.

Key Words: Pressure and release; Root causes; Dynamic pressures; Unsafe conditions; Vulnerability.

Introduction

Bangladesh is probably the most disaster prone countries in the world (Hossain, 2011a). The geographical location, high population density particularly in the urban areas, land characteristics, the multiplicity of rivers and monsoon climate renders Bangladesh profoundly vulnerable to natural hazards (Choudhury, 2001; Islam, 2012). In the other hand, the country has been facing gigantic challenges of rapid urbanization since last few decades. The proportion of urban areas would possibly cross the 50 percent mark by the year of 2040 and the 60 percent by 2050 when the total urban population would rise above 100 million (Islam, 2012). It began with a manageable population of 2.2 million in 1975 which reached 12.3 million in 2000 (Hossain, 2011b).

Dhaka, the capital of Bangladesh, is the fastest growing megacity, with an annual growth rate of 4.2 percent and a population of 19.84 million, is one of the most unplanned urban centers in the world (Populationof2018.com, 2018). United Nations' City Development Index (CDI) ranked it 7th worst; Economist Intelligence Unit (EIU) ranked it 3rd worst tied with Lagos; and Asia week (2000) placed it 39 out of 40 ranked cities (Ahmed *et al*., 2005). It was found 3,399 slums and clusters having 175,076 households and 643,735 dwellers in the

[1]Department of Geomatics, Patuakhali Science and Technology University, [2]Department of Geography and Environment, Jagannath University, Bangladesh.

city in 2014 (BBS, 2015). In addition to that, air pollution from transportation systems in Dhaka occurs due to the use of low led gasoline without proper catalytic converters, high sulphur in diesel, impure fuel, inefficient land use, and overall poor traffic management (Karim *et al.*, 1997). It may also experience on increased temperatures from rising vehicle exhaust emissions, industrial activity and use of air conditioning (United Nations-Habitat, 2009). These situations make the city more vulnerable to the upcoming disasters.

Several organizations and researchers e.g., Alam and Baroi (2004); Islam and Adri (2008); Government of Bangladesh (GoB) (2009); Islam *et al.* (2010); Sharin and Hossain (2011); Rahman *et al.* (2011); Dewan (2013); Dewan and Corner (2014); Masuya (2014); Momtaz and Kabir (2014); Rahman *et al.* (2015) and others conducted their research focusing the risk, vulnerability and damages of specific hazards and disasters in the context of Dhaka city, but they didn't assess the exposure of overall environment. The Pressure and Release (PAR) model focuses the increasing pressure on people arising from both sides e.g., their vulnerability and the impact as well as severity of the hazards. Their vulnerability is rooted in social processes and underlying causes which may ultimately be quite remote from the disaster event itself (Wisner *et al.*, 2004). This study has articulated the progression of the vulnerability to previously occurred disasters in the city by dynamic pressures and unsafe conditions based on root causes in the society.

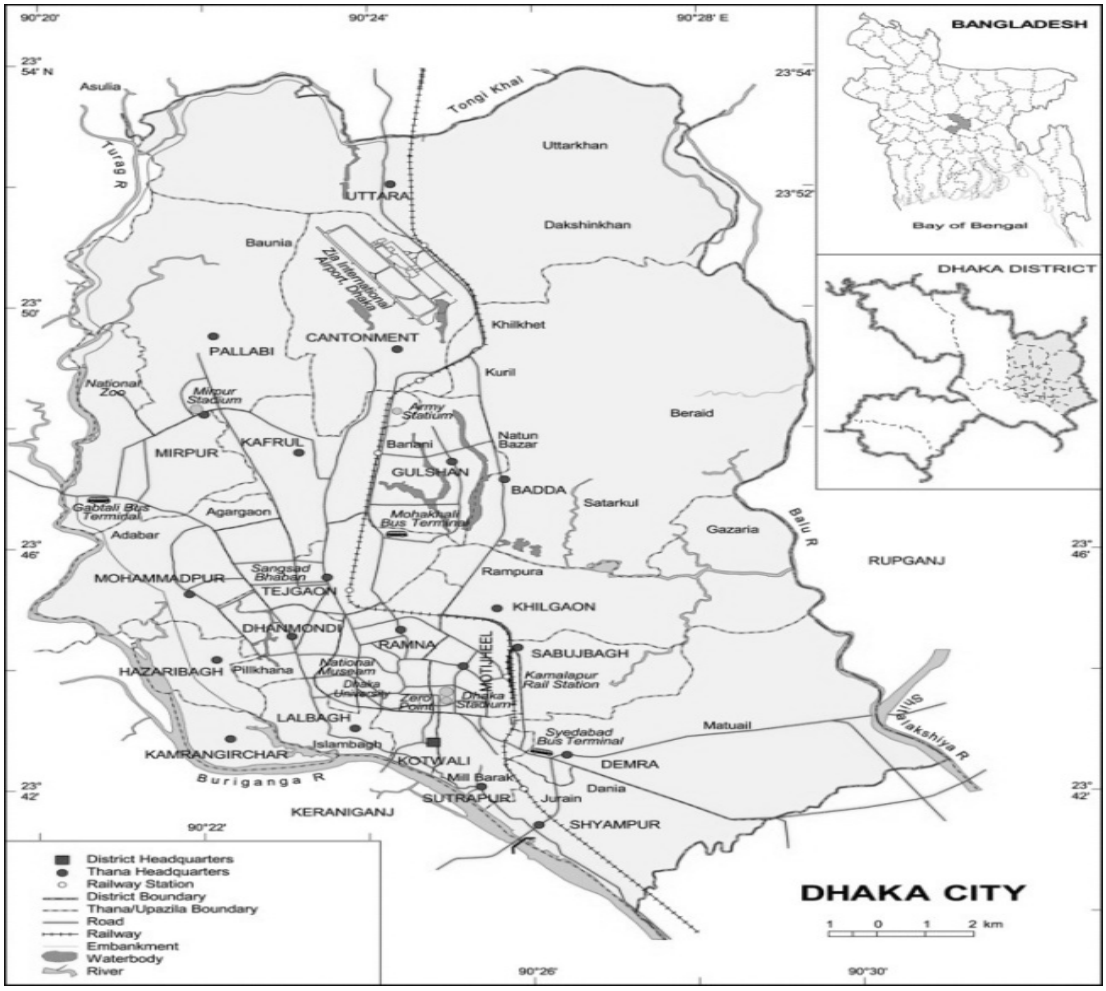
The aim of the study is to assess disaster induced vulnerability of Dhaka city using Pressure and Release (PAR) model. The specific objectives are to investigate the root causes of vulnerability of Dhaka city; and to analyze different hazards in line with the dynamic pressures and the nature of unsafe conditions that renders Dhaka city more vulnerable to upcoming disasters.

Materials and Methods

Dhaka city has been purposively selected for this study. The city having an area of 316 sq. km is located between the latitude 23^0 35' N - 23^0 54´ N and the longitudes $90^0$19´ E- 90^0 30´E. The expansion of the city is restricted (Figure 1) by the Buriganga river in the south, the Turag river in the west and the Balu river in the east (Karim and Rahman, 2002; BBS, 2014).

In the national population and housing census 2011, the total population of the city was 8,906,039 (54.4 percent male and 44.6 percent female) having 2,034,146 households (BBS, 2014). The city corporation has been divided into two corporations in 2011, named Dhaka North City Corporation and Dhaka South City Corporation.

This study has assessed the disaster induced vulnerability of inadvertent Dhaka city on the basis of PAR model. Wisner *et al.* (2004) developed this model and explained disaster risks from a macro perspective. The United Nations Disaster Management Training Program (UNDMTP) defines the elements of the progression of vulnerability as follows:



Source: Banglapedia, 2014

Figure 1. Location of the study area

Underlying causes: a deep-rooted set of factors within a society that together forms and maintains vulnerability.

Dynamic pressures: a translating process that channels the result of the negative causes into unsafe conditions;

Unsafe conditions: the vulnerable context where people and property are exposed to the risk of hazards.

The disaster induced vulnerability has been determined by dynamic pressures (e.g., rapid demographic changes and urbanization; lack of local institution, awareness training, etc.) and unsafe conditions (e.g., settlements in hazardous location, pollutions, poor social protection, risk of livelihood, lack of insurance against hazard etc.). In the presence of deep rooted causes such as limited access to political power and decision making structure, challenges of good governance in each sector have been analyzed to the progression of vulnerability for future disaster. This is basically

a review study, based on secondary data e.g., books, journals, research papers, online documents, newspapers etc. The description of different hazards which occurred in this city has been examined by observing the incidents and magnitude over the years. The most frequently occurring and predicted upcoming hazards e.g. flood, earthquake, fire and building collapse have been considered in this study.

Results and Discussion

The vulnerability to the disaster of Dhaka city has been analyzed based on the multidimensional factors of root causes and dynamic pressure, embodying the combined effects of unsafe conditions supported by assigned PAR model. The conceptual view of the progression of vulnerability is shown in the Figure 2. A set of activities that forms and preserves vulnerability within a specific community are considered as the root causes in PAR model. Limited access to political power and decision making structure makes the dwellers more vulnerable during the critical period of disaster. Good policy environment and strong governance system strengthen the policy makers' ability to facilitate and execute standardized policies (WHO, 2007). In this city, marginal and poor dwellers have limited access in decision making process in different sectors (economic, political, social, etc.) that may cause of creating vulnerability. Moreover, the political environment of the country was passing a crucial period with opposition campaigns and government's mass arrest program, businessmen suffered most etc. during the early of twenty first century (CPD, 2004).

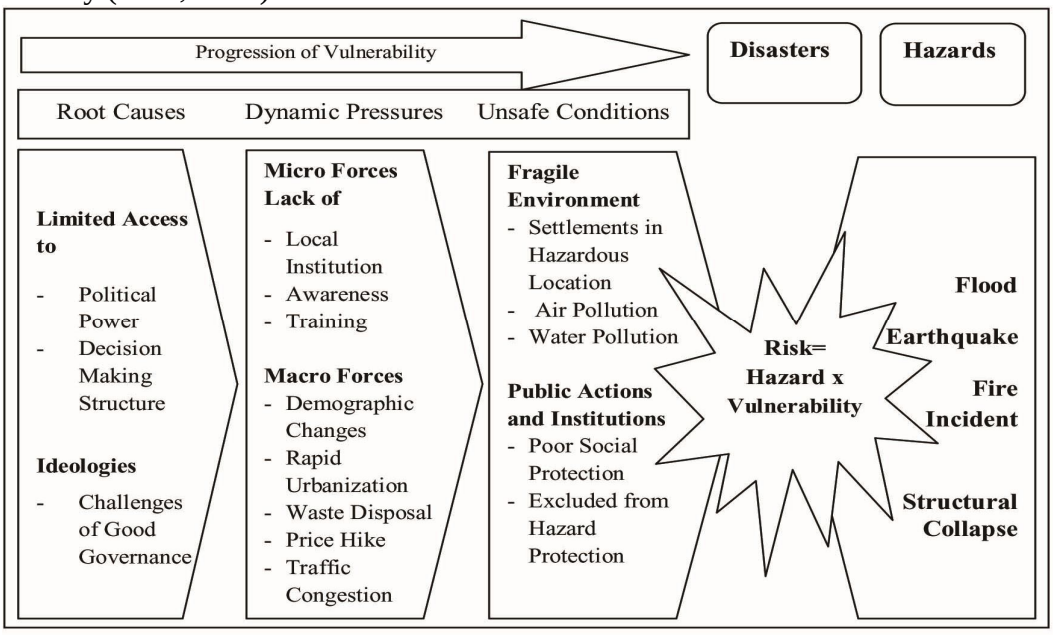


Figure 2. Conceptual development of 'Progression of Vulnerability' adopted from Wisner *et al.* (2004)

Root Causes in Progressing the Vulnerability

Challenges of good governance create an inappropriate and insecure condition within society and make it susceptible to disaster. Top-bottom approaches are failed in most

development processes addressing the local specific needs of the marginal communities (Bhatt, 2002). Some people using their power for their own benefit that make barrier in establishing good governance. Thus, good governance constitutes a significant challenge for Bangladesh now-a-days. Though, the current government of Bangladesh has taken several initiatives in order to ensure good governance in all the sectors in the country such as zero tolerance policy against corruption (The Daily Star, 2019).

Dynamic pressures in progressing the vulnerability

Dynamic pressure is a transforming process that the root causes trigger to form unsafe conditions. There are many contemporary and up to date forms of underlying economic, social and political processes that accelerate the progression of vulnerability.

Micro-forces of dynamic pressure

Ministry of Disaster Management and Relief division requires a close cooperation among the different sectors of various organizations for effective disaster management at all levels over the country (GoBa, 2010). Institutional capacity building including various short and long term training and awareness raising programs have been developed to ensure the efficiency of the disaster management committees of all levels (GoBb, 2010; GoB, 2014). Moreover, urban community volunteers are being trained by Bangladesh Fire Services and Civil Defense (BFSCD) department (Arambepola *et al.*, 2014). But, these training programs are still not available for all levels. City Corporation Disaster Management Committee (CCDMC) is responsible to carry out all activities of disaster management in this city. But, there have limited effectiveness of local level emergency management system (GoB, 2014). Mahjabeen (2002) identified that less public response is the main cause of failing awareness programs in Bangladesh. Training is considered as an important tool that can reduce the loss of lives and damages of properties from various incidences e.g. fire, building collapse, etc.

Macro-forces of dynamic pressure

Dhaka has grown from a small settlement to the present mega city. Already the city has been ranked as the eleventh largest city and an estimated 300,000 to 400,000 new migrants, mostly poor, arriving every year (World Bank, 2007). The intervening ditches, swamps and marshes were filled up in unplanned manner. However, the demand arose and private initiatives played a dominant role in the process (Huq & Alam, 2003). Rapid growth of industries, lack of financial ability, untrained manpower and lack of awareness of the community are the major limitations of solid waste management in this city (Islam, 2016).

The waste generation rate was 0.56 kg/capita/day and the total generated waste was 4,634.52 tons per day in the year 2005, when the total population was below 7.0 million (Bahauddin & Uddin, 2012). Two important ingenuities, one was undertaken by Japan International Cooperation Agency (JICA) in 2005 and another was 3R (Reducing, Reusing and Recycling) Strategy was undertaken in 2010 by Department of Environment (DoE), Ministry of Environment and Forestry of the Government (Yasmin & Rahman, 2017). A study of Waste Concern found that about 4,500 tons of household wastes are produced daily in Dhaka but officially DNCC and DSCC

claimed the amount was 4,000 tons. It has seen no major improvement in the past few years despite various initiatives taken by the city authorities (Dhaka Tribune, 2018).

Price hike is a great problem that spread without any limit and make more complex the livelihood of the poor dwellers of the city as well as over the country. As a result, the low income people suffer a lot because an average household spends close to two–third of their income for food (Rahman, 2015).

The major parts of this city are badly affected by severe traffic jam (Ahamed *et al*., 2016). Defective traffic signaling systems, lack of sufficient personnel, rough and narrow road space, improper action of traffics rules make the system more difficult (BIGD, 2016). An estimation of 2013, the cost of traffic jam was approximately USD 3.8 billion per year (Khan & Islam, 2013) while, Revised Strategic Transport Plan (RSTP) (2015) estimated USD 11.4 billion per year in 2014. RSTP (2015) has already been proposed some initiatives to be completed by 2015-2035 including five mass rapid transits, two bus rapid transits, three ring roads, eight radial roads, six expressways, twenty-one transportation hubs and so on for reducing the traffic jam in the city area.

Unsafe conditions in Dhaka city

Unsafe condition defines as the vulnerable context where people and property are exposed to the risk of hazards. The dimensions of unsafe conditions are people having to live in hazardous places and they have poor institutional facility.

The fragile physical environment

Settlements in hazardous location, air and water pollution makes the city's physical environment more fragile. The shelters are located near the hazardous location, results a high risk when a hazard like flood, earthquake, fire, building collapse etc. occurs. Reid and Simms (2007) found that most of the poorest dwellers live on the worst quality of land, on flood prone embankments or in densely crammed areas that works as dynamic pressure for creating the progression of vulnerability. Paul and Bhuiyan (2010) explored that any collapse of the existing structures having not any open space will block, further hindering rescue operations during earthquake. Due to absence of earthquake resistant features, high population density and poor emergency response and recovery capability, Dhaka has got the highest values of earthquake disaster risk index (EDRI) among the 20 cities of the world (Islam *et al*., 2006; Khan and Hossain, 2005). A foremost earthquake of 7.5 on the Richter scale might kill about 88,000 people and thrash 72,000 buildings and damage 86,000 others in the city (Babu, 2010). Some 78,323 buildings will be demolished completely if an earthquake of 6.0 Richter scale shakes it, originating from beneath (The Daily Star, 2010). BFSCD officials echoed that as there was no accurate data on the fire risk structures and about 95 percent of city buildings were in such state (Ahmed, 2016). World Bank (2014) stated that it ranks highly amongst the world's major cities in terms of poor urban air quality. It has been estimated that about 13 percent of water supply of the Dhaka Water and Sewerage Authority comes from the encircled rivers and being polluted by the discharge of unprocessed industrial waste, urban wastewater, agrochemicals, sewage water, solid waste dumping, oil spillage etc. (Kamal *et al*., 1999; Subramanian, 2004;

The Daily Star, 2011). Meeting these challenges, the greater plan namely Dhaka Structure Plan (DSP) of the city for 2015-2035 has been imposed. The DSP has been undertaken for updating and shifting the philosophies of spatial planning including to make the city liveable functional and resistant in respecting socio-cultural fabric and environment sustainability (DSP, 2015).

Poor institutional actions

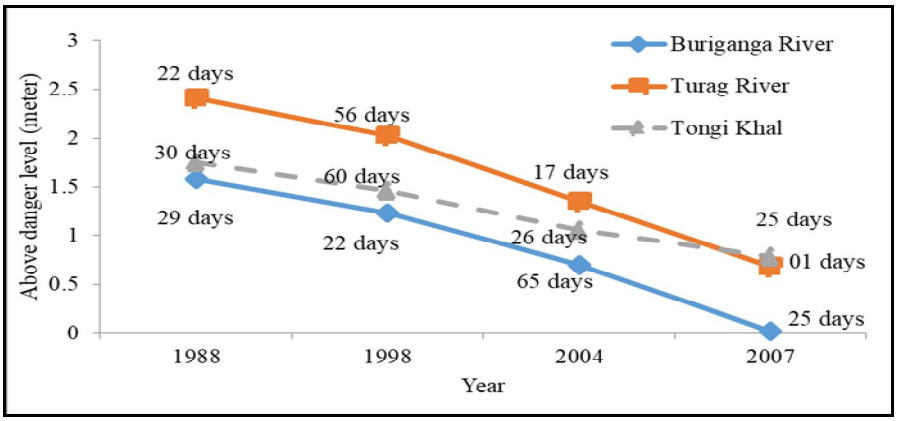
Social protection means to take some initiatives related to poverty alleviation and make capable to reduce the hazard risks. Especially the dwellers of slums or scatters are the main target group of such programs. Most of all social security benefits (85 percent) go to the rural poor while urban poor receive only 15 percent. As a food subsidy getting the rice and other goods from open market is an only benefit of the urban poor (GoB, 2015). The political economy of the country is the major lacking to support the urban poor for the access to service, land and employment those keep the dwellers more prepare to concurrent hazard (Shaw, 2014). The Disaster Management Bureau (DMB) introduced the Standing Order on Disaster (SOD) in 2010 and the National Disaster Management Act in 2012. The National Plan for Disaster Management (NPDM) 2010-2015 try to mainstream disaster management into every segment of development process in order to ensure disaster resilience environment. Moreover, the city is unprotected where life is vulnerable because of crime, political instability, etc. Overseas Security Advisory Council (OASC) (2011) of United States reported that urban crime can be conducted by individuals or groups, and commonly including fraud, theft, robbery, rape, assault, etc. Therefore, in one hand poor people are unprotected or poorly protected from social crime as well as threats and on the other hand they are excluded from hazard protection services.

Disaster Profile of Dhaka City

Dhaka is one of the foremost populous city. The substantial hazards i.e., flood, earthquake, fire, building collapse etc., are stuck most frequently in this city (Quattri and Watkins, 2016; Ahmed and Ahmed, 2010).

Flood

This large and comparatively poor city sits simply a few meters above the current sea levels, is often impacted by flooding, and has terribly restricted adaptive capability (World Wide Fund, 2010). Severe **flooding** has already impeded the development of Dhaka significantly. Out of the ten major floods in terms of most damaging nature in the last 50 years, four (1988, 1998, 2004 and 2007) occurred in most recent (Reid and Simms, 2007). Figure 3 presents station- wise magnitude of recent four floods in this city.



Source: Islam *et al.*, 2008

Figure 3. Year wise magnitude of floods of different stations in Dhaka city

The whole of the eastern part was affected by flood in both years of 1988 and 1998. On the other hand, approximately 75 and 23 percent of the western part was affected in the flood of 1988 and 1998 respectively (Nishat *et al.*, 2000).

Earthquake

Bangladesh is located close to the plate margins of the Indian and Eurasian plates, is susceptible to earthquakes (Rashid, 2008). United Nations pointed out that Dhaka and Tehran are the two most probable cities to have earthquake disaster risks (Rana, 2010). Moreover, micro-seismicity data also support the existence of at least four earthquake source points in and around Dhaka (Ansary, 2005). Table 1 presents the place and incident date of earthquakes and its magnitudes.

Table 1. Earthquakes in Dhaka city

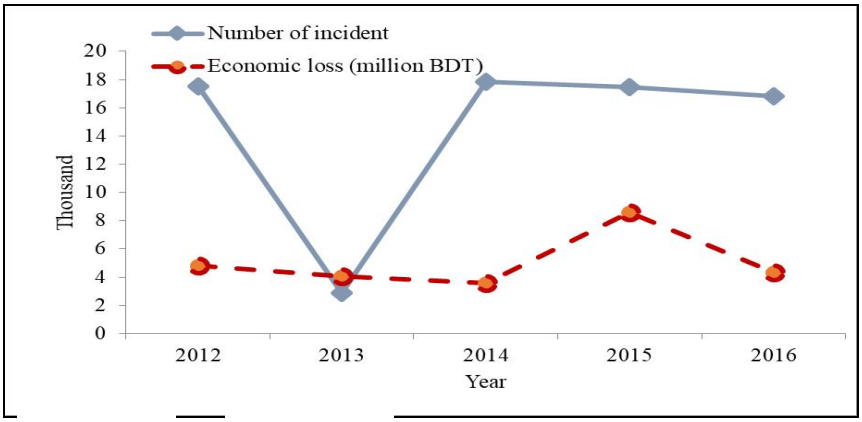
Incident	Place	Magnitude
18 Jul, 1918	The Epicentre at Srimangal, Maulvi Bazar	7.6
3 Jul, 1930	The Epicentre at Dhubri, Assam	7.1
15 Jan, 1934	The Epicentre at Darbhanga Of Bihar, India	8.3
15 Aug, 1950	The Epicentre in Assam, India	8.4
22 Nov, 1997	Chittagong	6.0
22 Jul, 1999	Maheshkhali Island with the Epicentre in the Same Place	5.2
27 Jul, 2003	Kolabunia Union of Barkal Upazila, Rangamati	5.1
5 Aug, 2006	Epicentre Located 110 km Southwest of Dhaka Near Narail	4.2
20 Mar, 2008	Manikgonj	3.8
27 Jul, 2008	The Epicentre Was Located 12 km Northeast of Mymensingh City	5.1
20 Sept, 2008	The Epicentre Was 50 km Southeast of Dhaka near Kachua of Chandpur	4.5

Source: Akhter, 2010

Fire incident

Fire incident is a common phenomenon in Dhaka city, especially in the dry season.

Fire breakout in slums, garment factories, and small manufacturing industries are regular news throughout this season that causes the loss of numerous lives and valuable assets. Figure 4 shows the number of fire incidents and associated economic loss in recent years. Amongst them, Nimtali fire incidence broke out on 3 June, 2010 in densely settled older part of the city that claimed 124 lives and injured hundreds (Mahmud, 2010). Tazreen Fashion factory fire incidence in Ashulia (a sub-district in the greater Dhaka area) on 24 November, 2012 claimed at least 117 lives and injured 200 (Ahmed, 2012). In another incident, 11 people were burned alive to death on 18 November, 2012 at Hazaribagh slum (Mollah and Shaon, 2012). On 13 March, 2009 at least seven people died and 20 people were injured in the Bashundhara city complex (The Daily Star, 2009).



Source: Alam and Hossain, 2017

Figure 4. Year wise fire incidents and associated economic loss in Dhaka city

Structural collapse

Building collapse in Bangladesh is a significant and traumatic experience. Recent buildings collapses in the capital city of Dhaka have taken place without the occurrence of earthquakes. Such structural failures beneath gravity loading suggest the likelihood of inherent weaknesses in several buildings, which can simply collapse in the event of further loading from an earthquake (Watanabe, 1995). A six storied (three stories were unauthorized) building made of bricks and lime mortar collapsed at Shankhari Bazar that resulted in 19 deaths and 11 serious injuries on June 11, 2004. After this event, an unsanctioned nine storied concrete frame building in the outskirts of Dhaka collapsed on April 11, 2005, claimed 61 lives and injured 86 (Al-Hussaini and Hossain, 2008). In another case, a three-decade old 5 storied building of Phoenix Group collapsed in Tejgaon industrial area on 25 February, 2006 and about 21 died with 50 severely injured (Bdnews24.com, 2013). In 2005, at least 85 workers were killed when the factory's building of Spectrum Garments in Savar (beyond the city's administrative boundary but being emerged with the main city, because of its commercial, structural and living standards) had collapsed. In recent, an eight-story commercial building, Rana Plaza, collapsed in Savar on 24 April 2013 with a death toll of 1,129 and an approximate injury of 2,500 people (The Guardian, 2013).

Conclusions and Recommendations

Based on the above mentioned results, the authors can conclude that the root causes e.g. social, economic and political issues are the inherent factors for creating vulnerable situations. The policy gap, challenges of good governance, development structures are responsible for making the root causes of vulnerability. The generating forces called dynamic pressures and their factors accelerate the sequence of vulnerability that can enhance to create unsafe environment. It is also found that the city has been experiencing several sorts of natural hazards. In addition, the intensity of these hazards is being increased in recent years. Urban growth and performance of urban institutions are considered as the important catalyst in this regard. Present study revealed that the city has been experiencing high rate of urbanization since the last few decades due to over population that makes the city vertically expanded. This rapid urbanization is putting pressure on its limited land, an already fragile environment, and weak urban services. Therefore, the vulnerable situation of the city is increasing day by day.

The study predicts that if a serious hazard strikes on Dhaka, a huge disaster will occur and the impact will not be limited within the city boundary. The whole country will be affected, because the city is the hub of all administration, trade and commerce as well as other activities of the country. For reducing vulnerability of this city, the study suggests that the awareness campaign targeting poor urban people should be run to prepare them for coping with the extreme events and rescue activities; Detailed Area Plan (DAP) and DSP should be efficiently executed; national training programs should be made available for the stakeholders of all level; seismic data should be integrated into land-use planning for vulnerability zoning by city development authority; proper monitoring should be done by the Dhaka City Corporations (both North and South) for implementing National Building Code as well as land use plan.

References

Ahamed, R., Hossain, M.S. and Hossain, E. (2016). Rugna Dhaka, sustho Dhaka (In Bengali) (Editorial: Fragile Dhaka and Healthy Dhaka). The Daily Samakal [online].

Ahmed, F. (2012). At least 117 killed in fire at Bangladeshi clothing factory. CNN [online].

Ahmed, M. U. (2016). 95% Dhaka buildings at fire risk. The Asian Age [Online].

Ahmed, S. and Ahmed, A. H. T. 2010. Disaster risks and risk mitigation in Dhaka/other cities [online].

Ahmed, S., Ahmad, J.K. and Mahmud, M. (2005). Making Dhaka liveable. Washington, D. C. : World Bank.

Akhter, S. H. (2010). Earthquakes of Dhaka. In M. A. Islam (Ed.), Environment of capital Dhaka - Plants, Wildlife, Gardens, Parks, Air, Water, Earthquake, 1st ed. Dhaka: Asiatic Society of Bangladesh, pp. 401-426.

Alam, M. J. B. and Baroi, G. N. (2004). Fire hazard categorization and risk assessment for Dhaka city in GIS framework. *Journal of Civil Engineering.* **32** (1): 35-45.

Alam, M. S. and Hossain, M. E. (2017). Personal communication with Bangladesh fire service and civil defence officials about fire incidents and economic loss induced by fire. Dhaka.

Al-Hussaini, T. M. and Hossain, M. N. A. (2008). Post-disaster management issues related to building collapse in Bangladesh. In: International Disaster and Risk Conference 2008. International Disaster and Risk Conference, Davos.

Ansary, M. A. (2005). Recent earthquake related activities in Bangladesh. In Paper Presented at Seminar on Tsunami and Seismic Risk Action for Bangladesh. Dhaka.

Arambepola, N. M. S. I., Rahman, M. A. and Tawhid, K. (2014). Planning needs assessment for responding to large disaster events in cities: Case study from Dhaka, Bangladesh. *Procedia Economics and Finance*. **18**: 684 - 692.

Babu, R. 2010. Bangladesh: major earthquake might kill 88000 people in capital. South-South Information Gateway.

Bahauddin, K. M. and Uddin, M. H. (2012). Prospect of solid waste situation and an approach of environmental management measure (EMM) model for sustainable solid waste management: Case study of Dhaka city. *Journal of Environmental Science and Natural Resource*. **5** (1): 99-111.

Banglapedia. (2014). Dhaka city corporation. The Asiatic Society of Bangladesh.

BBS. 2014. Population and housing census 2011. National volume 3: Urban area report. Bangladesh Bureau of Statistics, Ministry of Planning, Government of the people's Republic of Bangladesh.

BBS (2015). Preliminary report on census of slum areas and floating population 2014. Bangladesh Bureau of Statistics, Ministry of Planning. Government of the People's Republic of Bangladesh.

Bdnews24.com (2013). Over 350 dead in 3 building collapses in 8 years [online].

Bhatt, M. R. (2002). Corporate social responsibility and natural disaster reduction: Local overview of Gujarat. London: The Department for International Development (DFID).

BIGD (2016). STATE of cities 2016: Traffic congestion in Dhaka city - governance perspectives. Dhaka: BRAC Institute of Governance and Development (BIGD). BRAC University.

Choudhury, A. M. (2001). Cyclones in Bangladesh, In K. Nizamuddin, (ed.), Disaster in Bangladesh: Selected Readings, Dhaka: Disaster Research Training and Management Centre (DRTMC), Dept. of Geography and Environment, University of Dhaka.

CPD. 2004. Bangladesh development forum 2004: Civil society's perspectives report: 71. Dhaka: Centre for Policy Dialogue.

Dewan, A. M. (2013). Vulnerability of a megacity to flood: A case study of Dhaka. In: A.M. Dewan, (ed.), Floods in Megacity: Geospatial Techniques in Assessing Hazards, Risk and Vulnerability, 1st ed. Netherlands: Springer. pp. 75-101.

Dewan, A. M. and Corner, R. 2014. Spatiotemporal analysis of urban growth, sprawl and structure. In A.M. Dewan and R. Corner, eds., Dhaka Megacity: Geospatial Perspectives on Urbanisation, Environment and Health, 1st ed. Netherlands: Springer. pp. 99-122.

Dhaka Tribune. 2018. Waste management projects gone to waste [online].

DSP. (2015). Dhaka Structure Plan (DSP), 2015-2015. Dhaka Rajdhani Unnayan Kartripakkha (RAJUK). Ministry of Housing and Public Works, Government of Bangladesh.

GoB. 92009). Earthquake risk assessment of Dhaka, Chittagong and Sylhet city corporation area. Dhaka: Ministry of Disaster and Relief, Government of People's Republic and Bangladesh.

GoB (2010a). Standing orders on disaster. Disaster Management Bureau, Ministry of Disaster Management and Relief, Government of People's Republic and Bangladesh.

GoB (2010b). National plan for disaster management 2010-2015. Disaster Management Bureau, Ministry of Disaster Management and Relief. Government of People's Republic and Bangladesh.

GoB (2014). Bangladesh - urban resilience project: Social management framework. Government of the People's Republic of Bangladesh.

GoB (2015). National social security strategy (NSSS) of Bangladesh. General Economics Division: Planning Commission, Government of the People's Republic of Bangladesh.

Hossain, M. F. (2011a). Disaster management in Bangladesh: Regulatory and social work perspectives. *Journal of Comparative Social Welfare*. **27** (1): 91-101.

Hossain, S. (2011b). Urban poverty in Bangladesh: Slum communities, migration and social integration. London: IB Tauris.

Huq, S. and Alam, M. (2003). Flood management and vulnerability of Dhaka. In: A. Kreimer, M. Arnold and A. Carlin, (eds.), Building Safer Cities: The Future of Disaster Risk, 1st ed., Washington: The World Bank.

Islam, A. K. M. S., Haque, A. and Bala, S. K. (2008). Hydrological aspects of flood 2007. Dhaka: Institute of Water and Flood Management. Bangladesh University of Engineering and Technology.

Islam, F. A. S. 2016. Solid waste management system in Dhaka city of Bangladesh. *Journal of Modern Science and Technology,* **4** (1): 192 – 209.

Islam, M. M. and Adri, N. (2008). Fire hazard management of Dhaka city: Addressing issues relating to institutional capacity and public perception. *Jahangirnagar Planning Review*, **6**: 57-67.

Islam, M. S., Hossain, M. T., Ameen, S.F., Hoque, E. and Ahamed, S. (2010). Earthquake induced liquefaction vulnerability of reclaimed areas of Dhaka. *Journal of Civil Engineering*, **38** (1): 65-80.

Islam, N. (2012). Urbanization and urban governance in Bangladesh. In: 13th Annual Global Development Conference on "Urbanization and development: Delving deeper into the Nexus". Budapest.

Islam, N., Mahbub, A. Q. M., Nazem, N. I., Angeles, G. and Lance, P. M. (2006). Slums of urban Bangladesh: Mapping and census, 2005. Dhaka: Centre for Urban Studies, National Institute of Population Research and Training, and Measure Evaluation.

Kamal, M. M., Malmgren-Hansen, A. and Badruzzaman, A. B. M.(1999). Assessment of pollution of the river Buriganga, Bangladesh: Using a water quality model. *Water Science and Technology*. **40** (2): 129–136.

Karim, M. F. and Rahman, M. Z. (2002). Possible effect of a moderate earthquake on existing infrastructures of Dhaka city: A geological-geotechnical overview. *Bangladesh Journal of Science and Technology,* **4** (2): 193-203.

Karim, M. M., Matsui, H., Ohno, T. and Hoque, M. S. (1997). Current state of traffic pollution in Bangladesh and metropolitan Dhaka. In: Proceedings of the 90th Annual Meeting of Air and Waste Management Association. Toronto, Canada.

Khan, A.A. and Hossain, M. S. (2005). Recurrence of 1885 Bengal earthquake and hazard vulnerability status of Dhaka metropolitan city, *Bangladesh. Oriental Geographer,* **49** (2): 205-216.

Khan, T. and Islam, M. (2013). Estimating costs of traffic congestion in Dhaka city. International *Journal of Engineering Science and Innovative Technology,* **2(**3): 281-288.

Mahjabeen, Z. (2002). Environmental movement in Bangladesh: Some case studies. In: M. F. Ahmed, S. A. Tanveer, A. B. M. Badruzzaman, eds., Bangladesh Environment 2002. Dhaka.: Bangladesh Poribesh Andolon.

Mahmud, F. (2010). Chemical fires: Old Dhaka still at risk. Dhaka Turbine [online].

Masuya, A. (2014). Flood vulnerability and risk assessment with spatial multi-criteria evaluation. In A. M. Dewan and R. Corner (eds.), Dhaka Megacity: Geospatial Perspectives on Urbanization, Environment and Health, 1st ed., Netherlands: Springer, pp. 177-202.

Mollah, S. and Shaon, A. S. (2012). Fire kills 11. The Daily Star [online].

Momtaz, S. and Kabir, S. M. Z. (2014). Environmental problems and governance. In: A. M. Dewan and R. Corner (eds.), Dhaka Megacity: Geospatial Perspectives on Urbanization, Environment and Health, 1st ed., Netherlands: Springer, pp. 282-300.

Nishat, N., Reazuddin, M., Amin, R. and Khan, A. R. (2000). An assessment of environmental impacts of the 1998 flood on Dhaka city. Dhaka: Department of Environment and International Union for Conservation of Nature.

OASC. 2011. Bangladesh 2011 crime and safety report. Washington D. C.: Overseas Security Advisory Council. United States Department of State. Bureau of Diplomatic Security.

Paul, B. K. and Bhuiyan, R. H. (2010). Urban earthquake hazard: Perceived seismic risk and preparedness in Dhaka city, Bangladesh. Disasters. **34** (2): 337-359.

Poputation of 2018.com (2018). Dhaka population 2018 [online].

Quattri, M. and Watkins, K. (2016). Child labour and education: A survey of slum settlements in Dhaka. London: Overseas Development Institute.

Rahman, M. M. (2015). Food price hike in Bangladesh: A supply side approach to its determinants and solutions. *Asian Journal of Humanities and Social Sciences.* **3**(1): 120-141.

Rahman, M. M., Paul, S. K. and Biswas, K. (2011). Earthquake and Dhaka city- An approach to manage the impact. *Journal of Science Foundation,* **9** (1&2): 65-75.

Rahman, N., Ansary, M.A. and Islam, I. (2015). GIS based mapping of vulnerability to earthquake and fire hazard in Dhaka city, Bangladesh. International *Journal of Disaster Risk Reduction*. **13**: 291-300.

Rana, M. M. P. (2010). Urbanization and sustainability: Challenges and strategies for sustainable urban development in Bangladesh. *Environment, Development and Sustainability.* **13** (1): 237-265.

Rashid, K. B. S. (2008). Bangladesh: Resource and environmental profile. Dhaka: A H Development Publishing House.

Reid, H. and Simms, A. (2007). Up in smoke? Asia and the pacific: The threat from climate change to human development and the environment. London: International Institute for Environment and Development, p. 18.

RSTP (2015). Revised strategic transport plan (RSTP), 2015-2035. Dhaka Transport Co-Ordination Board, Ministry of Communications, Government of the People's Republic of Bangladesh.

Sharin, R. and Hossain, T. R. (2011). Seismic performance evaluation of residential buildings in Dhaka city by using pushover analysis. In: Fourth Annual Paper Meet and 1st Civil Engineering Congress. [online] Dhaka: Civil Engineering Division Institution of Engineers, Bangladesh. pp. 279-286.

Shaw, R. (2014). Urban disaster risk reduction framework: Assessing urban resilience in world vision project sites in Bangladesh, Indonesia, and China - final report –2014. Chai Chee: World Vision International.

Subramanian, B. (2004). Water quality in south Asia. *Asian Journal of Water, Environment and Pollution,* **1**(1&2): 41–54.

The Daily Star (2009). Blaze at Basundhara city [online].

The Daily Star (2010). Dhaka city at risk of massive destruction [online].

The Daily Star (2011). Pollution of rivers around Dhaka [online].

The Daily Star (2019). Government's 'zero-tolerance policy' against corruption [online].

The Guardian (2013). Bangladeshi factory deaths spark action among high-street clothing chains [online].

United Nations-Habitat (2009). State of the world cities 2008/2009: Harmonious cities. London: Earthscan Publications.

Watanabe, T. (1995). Building collapses south Korea. The Los Angeles Times [online].

WHO (2007). Sound choices: Enhancing capacity for evidence-informed health policy. Geneva: World Health Organization.

Wisner, B., Blaikie, P., Cannon, T. and Davis, I. (2004). At risk: Natural hazards, people's vulnerability and disasters. 2nd ed., London: Routledge.

World Bank (2007). Dhaka: Improving living conditions for the urban poor - Bangladesh development series. Working Paper No. 17, Development of the World Bank, World Bank Office Dhaka.

World Bank (2014). Cleaning Dhaka and Bangladesh's air [online].

World Wide Fund (2010). Mega-stress for mega-cities: A climate vulnerability ranking of major coastal cities in Asia. Switzerland: World Wide Fund, p. 11.

Yasmin, S. and Rahman, M.I. (2017). A review of solid waste management practice in Dhaka city, Bangladesh. *International Journal of Environmental Protection and Policy*, **5** (2): 19-25.