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Assessment of Climate Disaster Resilience Index of Dhaka City to Improve City Resilience Condition: A Case Study on Ward no. 29 of Dhaka South City Corporation

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Abstract

Dhaka city, the capital of Bangladesh is already facing the severity of climate related hazards due to a very complex dynamics of disasters and climate change risks of this city. It is predicted that among the mega-cities of the world, Dhaka would be one of the most vulnerable place to climate change. Old Dhaka, the historic center of Dhaka city has developed within a process of spontaneous growth. The characteristics of high population density, unplanned settlements, large number of poorly built buildings, contiguous building pattern, poor quality utility services, narrow lanes, loose soil and filled soil, shortage of evacuation space, lack of disaster management equipment and lack of open spaces not only make Old Dhakaa highly vulnerable place for earthquake, fire hazard, building collapse and water logging, but also create inaccessibility of movement, which will make any post disaster management even worse. Ward no. 29 of Dhaka South City Corporation (DSCC) is the third most densely populated ward in Dhaka City. Like other areas of the Old Dhaka, this area is also vulnerable for different disasters. In the context of city, resilience helps to bridge the gap between disaster risk reduction and climate change adaptation. The Climate Disaster Resilience Index (CDRI) measures the capacity of a city's infrastructure and services to withstand disasters and evaluates how the communities and institutions within a city are expected to deal with such an event. In these circumstances, this study attempts to measure the existing resilience condition of Ward no. 29 of DSCC by CDRI. From the study, it is observed that the study area has an overall CDRI score of 2.64, which indicates that the area is moderately resilient. As the study area is moderately resilient, any sudden disruption can causes great damage and makes the community more vulnerable. So, it is very urgent to adopt a balanced and systematic approach to address this issue. In this context, this research provides some important recommendations considering the guidelines of 'UNISDR 2013' and 'The Hyogo Framework for Action (HFA) 2005-2015', which can be helpful to improve the existing resilience condition of the study area as well as other urban areas of the country.

Introduction

Bangladesh is ranked as the world's fifth most disaster prone country. Its topographic and geo-physical location has made it vulnerable to various natural hazards, particularly to extreme climate-induced disasters (UNU-EHS, 2016). Besides natural disasters like cyclone, flood and tornado; man-made disasters like fire, drainage congestion, landslide and building collapse are increasing rapidly particularly in and around the major cities.

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In climate change and disaster terms, cities are arguably one of the most important battlefields. Already more than half of the world's population is living in cities and by 2050 this will increase to more than two-thirds of the global population. More than 90% of these new urbanites will be located in developing countries (Roy 2009). Explosive growth and high population density, low stages of economic growth and poor state of the environment in many developing countries are contributing to aggravate cities' vulnerabilities, enhance disaster risks and reduce climate disaster resilience (Razafindrabe et al. 2009; Roy 2009).The present context of the urban growth and development trend of Dhaka city is a reflection of this. In future, Dhaka will be affected through floods and drainage congestion, and heat stress (The Daily Star, July 15, 2011). The National Plan for Disaster Management 2010-15, identified 12 major hazards. Among these hazards, flood, fire, drainage congestion and infrastructure collapse are major dangers for Dhaka and Chittagong city (DMB, 2008). Earth quake is infrequent but Dhaka has been identified by Stanford University, as one of the 20 most earthquake vulnerable cities in the world based on "Urban Earthquake Disaster Risk Index". Besides earthquake, Dhaka has been identified as the second most flood prone metropolis, after Shanghai of China (Alam, 2017). At the same time Dhaka City is also vulnerable to water logging and fire hazard. Unplanned urbanization is consequently contributing to the threats for the city dwellers of this city.

Old Dhaka, the historic core of Dhaka City is an extreme example of dense and unplanned development, developed within a process of spontaneous growth. It represents vulnerabilities like high population density, informal or unplanned settlements, non-engineered buildings and shelters, large number of poorly built buildings, contiguous building pattern, poor quality utility services, narrow lanes, loose soil and filled soil, shortage of evacuation space, lack of disaster management equipment and lack of open spaces (Sultana, 2017). As a result, the Old Dhaka becomes a highly vulnerable place for earthquake, fire hazard and building collapse. Besides, due to lack of proper drainage network, the old part of Dhaka City is often facing water logging problem during rainy season.

Ward no. 29 of Dhaka South City Corporation (DSCC) is located in Old Dhaka. It was known as Ward 65 of former Dhaka City Corporation (DCC) and it is the third most densely populated ward in Dhaka City (BBS, 2011). The study area is located in zone 2 with earthquake intensity of IX. About 27% to 30% building will be destroyed completely if a 7.5 magnitude earthquake hits in the study area (Ansary and Rahman, 2013). So a small scale earthquake may cause massive damages in this ward. This ward is mainly comprised of manufacturing and processing industries of plastic, warehouses of chemical and unprocessed leather. As a result, fire incident is very common phenomenon in this area. Similarly, due to absence of proper drainage facilities, water logging in rainy season is also common here (Sultana, 2017). Unplanned and purely built buildings of this area are also vulnerable to building collapse.

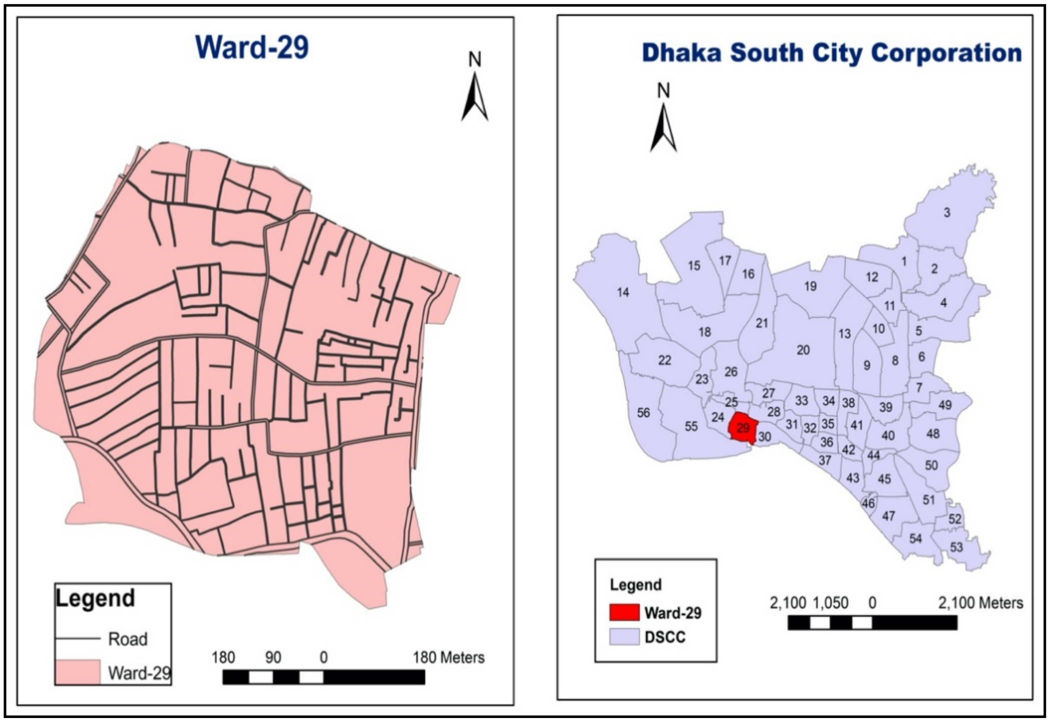
In the context of city planning, resilience has helped to bridge the gap between disaster risk reduction and climate change adaptation. Resilience is a term that emerged from the field of ecology in the 1970s, to describe the capacity of a system to maintain or recover functionality in the event of disruption or disturbance (Gunderson, 2000). It moves away from traditional disaster risk management, which is founded on risk assessments that relate to specific hazards. Resilience focuses on enhancing the performance of a system in the face of multiple hazards, rather than preventing or mitigating the loss of assets due to specific events. Recognizing the diversity within a city and its impact on patterns of vulnerabilities and resilience, it is critical to assess the strengths, weaknesses, opportunities, and threats of micro-zones within a city. The Climate Disaster Resilience Index (CDRI) identifies an area's strengths and weaknesses in facing and managing any climate-related disasters. In the urban context, it measures the capacity of a city's infrastructure and services to withstand disasters and evaluates how the communities and institutions within a city are expected to deal with such an event. In order to reduce risk and increase the efficiency and effectiveness of preparedness, it is necessary to have a better understanding of the level of climate disaster resilience of a specific area (Shaw et al, 2010). Thus, Climate Disaster Resilience Index (CDRI) is an attempt to identify the existing shortfalls and vulnerability in a broad based manner and support the city authorities and stakeholders to build a resilient city.

Study Area

Ward no. 29 of Dhaka South City Corporation (DSCC) was selected as the study area. The reasons behind the selection of this area are as follows:

- Due to unplanned urbanization and development, this area is in high risk zones for different disasters, which make the community vulnerable.
- The densely concentrated old and non-reinforced masonry buildings along with narrow local streets make the locality more vulnerable. At the same time, close proximities and mixed use of the buildings put residents at high risk.
- High density of population poses various threats in disaster risk reduction and makes the situation worse.

Dhaka South City Corporation (DSCC) was established by the "Local Government (City Corporation) Amendment Bill 2011" on 29 November 2011. Its function was started on 1 December 2011. Prior to the establishment of the corporation, this urban area was governed by the former Dhaka City Corporation. Dhaka South City Corporation is the largest city corporation of Bangladesh (http://en.m.wikipedia.erg).Ward no. 29 of DSCC is the third most densely populated ward in Dhaka City with 127,425 people per square kilometer in an area of 0.478 square kilometer(BBS, 2011). Its population size is 58,233 (BBS, 2011). Ward no. 29 is under Zone 3 of DSCC. It is located on the northern bank of the river Buriganga at Old Dhaka. The ward is under the jurisdiction of Chawkbazar Thana of DSCC. Ward no. 25 and Ward no. 28 are situated at the north, Ward no. 30 is situated at the east and Ward no. 24 is situated at the west of the study area. Lalbagh Fort is situated at north boundary of the Ward (http://www.dscc.gov.bd). Figure 1 shows the location of the study area.



Source: Developed by the author, 2020

Fig. 1: Location Map of the Study Area

In the study area, the proportion of one story buildings has been decreased from 71.74% to 22.3% in the recent time, whereas 4 to 7 storey buildings have been increased in a significant number (Sultana, 2017). From the field survey 2018, about 62.6% buildings are found to be used as mixed use purposes such as shops, other commercial activities and small scale manufacturing industries at ground floor and residence at upper floors.As the land is very limited and population as well as economic activities are increasing rapidly, the study area is expanding vertically. Around 50% buildings are not in good condition and susceptible to earthquake. Building code has been grossly violated during construction of these buildings. An overview of existing building condition of this area is shown in Table 1.

Table 1: Building Age and Visible Physical Condition of Buildings in Ward 29 of DSCC

Building Age(in %)	**<10 Year**	**10-30 Year**	**>30 Year**
	24.35	32.61	43.04
Visible Physical Condition(in %)	**Poor**	**Moderate**	**Good**
	51.11	38.08	10.81

Source: Sultana, 2017

Objectives and Methodology of the Research

The main objective of this research is to assess the existing climate disaster resilience condition of the study area using Climate Disaster Resilience Index (CDRI). This research also attempts to recommend some strategies to improve the existing resilience condition of the study area. These recommended strategies can be also applicable for improvement of existing city resilience condition of Dhaka city.

This research is based on both primary and secondary data and information. The primary data and information of this research was collected through "Household Questionnaire Survey" and "Key Informant Interview". To be familiar with the community of the study area, primarily "Reconnaissance Survey" was conducted. The information regarding electricity, water, sanitation, accessibility and status of supply interruption, access to education, house ownership status and number of earning members etc. were collected by "Household Questionnaire Survey" to fulfill some indicators of the physical, social, economic and natural dimensions of CDRI to reveal the current scenario of the study area in terms of resilience index. A total number of 140 households were surveyed under "Household Questionnaire Survey" (20 households from each of the 7 mahallas of the ward). "Purposive Sampling" method was adopted here. In order to fulfill the requirements of institutional dimensions of CDRI, "Key Informant Interview" was conducted to understand about the professional opinions, policies, emergency plan and recommendations of the experts about the study area. To carry out "Key Informant Interview", 11 professionals were interviewed. 5 personnel from DSCC (1 personnel from urban planning section, waste management section, engineering section, budget section and chief inspector of ward 29), 1 personnel from Climate Change Cell of Department of Environment (DoE), 1 personnel from Disaster Management Bureau (DMB), 1 personnel from RajdhaniUnnayanKortipakkha (RAJUK), 2 personnel from Bangladesh Fire Service and Civil Defense (1 personnel from training section and 1 personnel from media cell) and 1 personnel from Network for Information, Response and Preparedness Activities on Disaster (NIRAPAD) were interviewed. "Purposive Sampling" method was used to conduct "Key Informant Interview".

Secondary data and information was collected through relevant literatures, i.e. statistical reports, newspapers, journal articles, seminar papers, published and unpublished thesis, books and official documents and records of the concerned authorities, such as DSCC, RAJUK, DoE, DMB, BBS, Bangladesh Fire Service and Civil Defense, NIRAPAD etc. But it is important to mention here that due to unavailability of exact employment related data, it was not possible to collect data related to the 5 indicators of employment variables under economic dimension.

The resilience score of the study area was calculated by using the collected data. Here the Weighted Mean Index (WMI) was used to calculate the resilience score. This resilience score has been categorized into 5 classes ranging from poor to the best.

Conceptual Issues

Resilience: Resilience moves away from traditional disaster risk management, which is founded on risk assessments that relate to specific hazards. Instead, it accepts the possibility that a wide range of disruptive events – both stresses and shocks – may occur but are not necessarily predictable. Resilience focuses on enhancing the performance of a system in the face of multiple hazards, rather than preventing or mitigating the loss of assets due to specific events (Shaw et al, 2010). There are some approaches or models for assessing the city resilience, such as "The City Resilience Framework (CRF)", "Oxfam GB's Conceptual Framework for Measuring Resilience", "USAID Community Resilience Framework", "FAO's Resilience Index Measurement and Analysis (RIMA) Model", "Climate Disaster Resilience Index (CDRI)" etc.

Climate Disaster Resilience Index (CDRI): Among different city resilience assessment models, the "Climate Disaster Resilience Index (CDRI)" is one of the most accepted and well used models. CDRI is a planning tool developed by the Climate and Disaster Resilience Initiative of the Kyoto University to measure climate disaster resilience. According to World Bank (2015), CDRI measures climate disaster resilience by considering five dimensions- (i) Physical, (ii) Social, (iii) Economic, (iv)Institutional and (v) Natural. Each dimension has five parameters and each parameter in turn has five variables. Table 2shows different parameters under the five dimension of CDRI.

Table 2: Dimension Wise Parameters of CDRI

Dimension	**Parameters**
Physical Dimension	1. Electricity,2. Water, 3. Sanitation and Solid Waste Disposal, 4. Accessibility of Roads and 5. Housing and Land Use.
Social Dimension	1. Population,2. Health, 3. Education and Awareness, 4. Social Capital and 5. Community Preparedness during a Disaster.
Economic Dimension	1. Income,2. Employment, 3. Household Asset, 4. Finance and Savings and 5. Budget and Subsidy.
Institutional Dimension	1. Mainstreaming of DRR and CCA, 2. Effectiveness of Cities Crisis Management Framework, 3. Knowledge Dissemination and Management, 4. Institutional Collaboration with Other Organizations and Stakeholders During a Disaster and 5. Good Governance.
Natural Dimension	1. Severity of Natural Hazards,2. Frequency of Natural Hazards,3. Ecosystem Services, 4. Land Use in Natural Terms and5. Environmental Policies.

Source: World Bank, 2015

Computation of CDRI:The CDRI questionnaire has 125 variables.

- Each variable (x1, x2, x3, x4, and x5) provides five choices answers starting from not available/very poor (1) to best (5).
- After rating each variable of a parameter, they should be ranked against each other. Status according to Rating is: 1 - 1.5 = Worst, 1.51 – 2.5 = Poor, 2.51 – 3.5 = Moderate, 3.51 – 4.5 = Good, More than 4.5 = Best
- The variables should be weighted according to their importance within the city's context between 1 (not important) and 5 (very important). Thus all the five variables representing a parameter are ranked on the basis of weights (w1, w2, w3, w4, w5) that range from not important (1) to very important (5). Importance according to Weight: 1 - 1.5 = Least, 1.51 – 2.5 = Low, 2.51 – 3.5 = Moderate, 3.51 – 4.5 = High, More than 4.5 = Highest.
- Using data collected from the questionnaire surveys, Weighted Mean Index (WMI) method is used to compute the scores for different variables under a specific parameter. The formula is shown below:

$$\mathrm{WMI} = \frac{\sum_{i=1}^{n} w_I x_I}{\sum_{i=1}^{n} w_i} = \frac{w_i x_i + w_i x_i + w_i x_i + w_i x_i + w_i x_i}{w_i + w_i + w_i + w_i + w_i}$$

- Then by calculating the average value of the CDRI scores of all variables under a dimension, the overall CDRI score of that specific dimension was computed.
- At the end, by calculating the mean value of the calculated scores of five parameters, the final CDRI score of a city or an urban area is determined.

CDRI Scale:Depending on the CDRI score, the city is given a status about its level of resilience. Table 3 shows CDRI scale based on which the resilience status of a city is determined.

Table 3: CDRI Scale

CDRI Score	1-2	2.1-3	3.1-4	4.1-5
Resilience Status	Poor	Moderate	Good	Best

Source: World Bank, 2015

UNISDR Disaster Resilience Strategies: In order to overcome the increasing challenges of disaster risk and mainstreaming disaster resilience, UNISDR Disaster Resilience Strategies identifies following essentials for making cities resilient (UNISDR, 2013):

- Put in place organization and coordination to understand and reduce disaster risk, based on participation of citizen groups as well as civil society and build local alliances. Ensure that all departments understand their role in disaster risk reduction and preparedness.

- Assign a budget for disaster risk reduction and provide incentives for homeowners, low income families, communities, businesses and the public sector to invest in reducing the risks, they usually face.
- Maintain up-to-date data on hazards and vulnerabilities. Prepare risk assessments and use these as the basis for urban development plans and decisions, ensure that this information and the plans for your city's resilience are readily available to the public and fully discussed with them.
- Invest in and maintain critical infrastructure such as drainage, road, dam, bridge that reduces risk to cope with climate change.
- Assess the safety of all schools and health facilities and upgrade these as necessary.
- Apply and enforce realistic, risk compliant building regulations and land use planning principles. Identify safe land for low income citizens and upgrade informal settlements, wherever feasible.
- Ensure that education programs and training on disaster risk reduction are in place in schools and local communities.
- Protect ecosystems and natural buffers to mitigate floods, storm surges and other hazards to which your city may be vulnerable. Adapt to climate change by building on good risk reduction practices.
- Install early warning systems and emergency management capacities in your city and hold regular public preparedness drills. After any disaster, ensure that the needs of the affected population are placed at the centre of reconstruction, with support for them and their community organizations to design and help implement responses, including rebuilding homes and livelihoods.

TheHyogo Framework for Action (HFA) 2005-2015: The expected outcome of the Hyogo Framework is to substantively reduce disaster losses in terms of lives and the social, economic and environmental assets of communities and countries. The five HFA priorities for action are (https://www.unisdr.org/files/1217_HFAbrochureEnglish.pdf):

- **Build institutional capacity:** Ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation.
- **Know your risks:** Identify, assess and monitor disaster risks and enhance early warning.
- **Build understanding and awareness:** Use knowledge, innovation and education to build a culture of safety and resilience at all levels.
- **Reduce risk:** Reduce the underlying risk factors through land-use planning, environmental, social and economic measures.
- **Be prepared and ready to act:** Strengthen disaster preparedness for effective response at all levels.

Climate Change and Disaster Vulnerability of Dhaka City: A Brief Overview

Dhaka, the capital of Bangladesh, is the hub of administrative, political, economic, industrial, cultural, educational, and research activities in the country. Unfortunately, among the megacities in the world, it is considered the most vulnerable to climate change (WWF 2009). Climate change will affect Dhaka in two main ways through floods and drainage congestion and through heat stress. Melting glaciers and snow in the Himalayas and increasing rainfall will lead to more frequent flooding in Bangladesh (water-logging, drainage congestion from river floods and excessive rainfall during the monsoon already cause very serious damage). Furthermore, Dhaka may also face 'heat island' problems, because temperatures in the city are a few degrees higher than in surrounding areas. Besides, Dhaka City is also vulnerable for different natural and manmade disasters for its natural settings, unplanned urbanization and climate change impacts.This section of the study makes a brief description of different types of climate change and disaster induced vulnerability of Dhaka City.

Flood and Water Logging Vulnerability: By virtue of its geography along with rapid urbanization, Dhaka is considered to be one of the cities most susceptible to climate-related disasters, especially floods (Parvin and Shaw, 2011). Floods and water logging in Dhaka regularly disrupt the lives and livelihoods of the city dwellers and most adversely affect the old Dhaka, fringe areas and slums. With more frequent and intense rainfall, climate change is likely to further aggravate flooding and water logging in the coming decades. Potential damages from water logging between 2014 and 2050 will be Taka 110 billion in Dhaka, if climate change is not considered and in a changing climate with more intense rainfalls, the loss will be Taka 139 billion between 2014 and 2050 (World Bank, 2015). The study estimates Dhaka will need Taka 2.7 billion investments in storm water drainage pumps, drainage pipe clearing and other measures to reduce water logging in every ward within 12 hours.

Earthquake Vulnerability: Dhaka is highly vulnerable to tremor under Madhupur Fault as expressed by local experts, as the phenomenal urbanization, density of population and high-rise structures are growing fast here (SAARC, 2010). According to a report published by United Nations IDNDR-RADIUS Initiatives, Dhaka and Tehran are the cities with the highest relative earthquake disaster risk (Rahman, 2004).The plate motions shows that Dhaka is moving 30.6 mm/year in the direction North-East. Micro-seismicity data supports the existence of at least four earthquake source points in and around Dhaka (Ali and Choudhury, 2001). The densely constructed old and non-reinforced masonry buildings along with narrow local streets in Old Dhaka make the locality more earthquake disaster prone.

Fire Vulnerability: Apart from human death and injury, the damage of property in Dhaka city was estimated to be more than 6 crore taka on an average due to fire accidents in every year. A total of 158 people were killed and the property worth about Tk. 3832.69 million was burned in 6,454 fire incidences within Dhaka City during the period of 2001 to 2007 (BFSCD, 2007).In 2013, 34 people are killed and the property worth about TK 1753 million was burned in 2334 fire incidences within Dhaka city, and 41 people are killed and the property worth about TK 955 million was burned in 2374 fire incidences within Dhaka city in 2014(BFSCD, 2016). Surprisingly, in Old Dhaka, there is not a single building available with firefighting equipments. Almost 60% of the buildings have no planning permission from RAJUK as well aslack fire safetymeasures and 92% of the buildings located beside the minor roads have no fire license (Sultana, 2017).

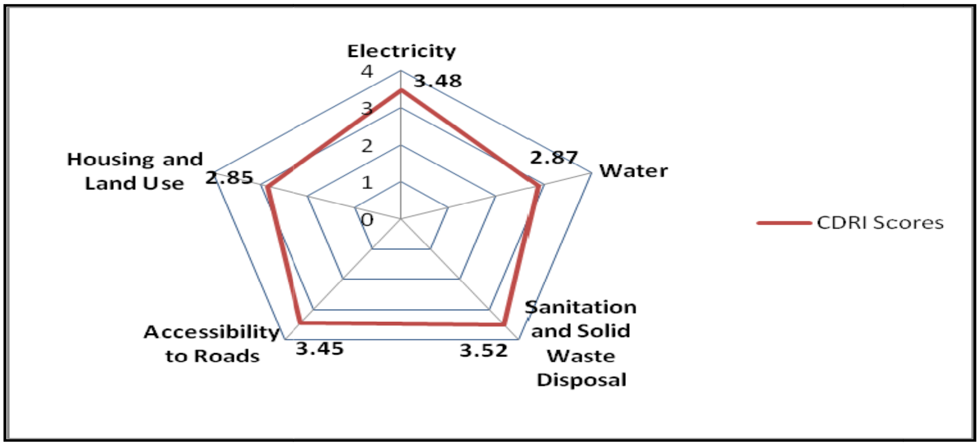
Building Collapse Vulnerability: Buildings collapse mostly due to faulty structure and noncompliance of existing building rules of the country; many of the high-rise buildings are built higher than the approval limit and with more than approved number of floors. In newly filled low lying areas, building are being constructed without any protective engineering measures and, thus many of these buildings faces sudden structural failure with loss of life and properties. 78,000 out of 326,000 buildings in Dhaka were detected as risky according to Comprehensive Disaster Management Programme (CDMP). The recent history of building collapse in Dhaka city suggests that old and dilapidated, newly built but faultily designed and overloaded weak buildings are highly at risk of being collapsed. RAJUK has classified around 1,000 buildings in Dhaka as "visibly vulnerable and risky" (Alam, 2017).

Calculation of CDRI Scoreof Ward no. 29 of DSCC

The CDRI score of Ward no. 29 of DSCC was calculated with help of Weighted Mean Index (WMI) method by analyzing all data collected by household questionnaire survey, key informant interview and secondary sources to measure the resilience level of this area.

CDRI Score of Five Dimensions: This section of the paper makes an interpretation on the calculated result of five dimensions of CDRI.

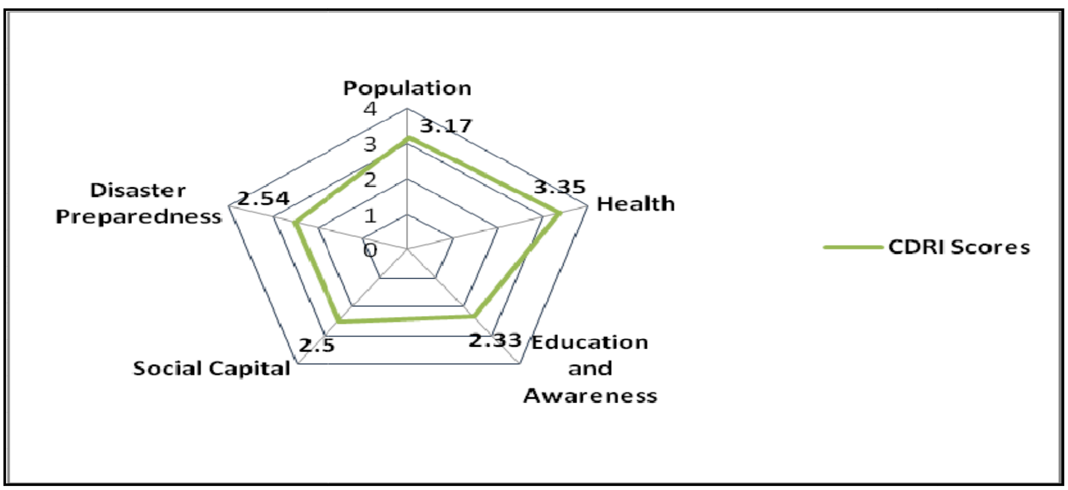
i)Physical Dimension: Fig. 2 shows the variable wise CDRI scores of physical dimension in the study area. From the following figure it is seen that CDRI score for "Sanitation and Solid Waste Disposal" is 3.52, which is the highest score followed by "Electricity" (3.48), "Accessibility to Roads" (3.45), "Water" (2.85) and "Housing and Land Use" (2.85). As compared with the CDRI scale, it is observed that CDRI scores of 3 variables fall in "Good" category in terms of resilience. These variables are "Electricity", "Sanitation and Solid Waste Disposal" and "Accessibility to Roads". Other two variables, i.e. "water" and "Housing and Land Use" fall in "Moderate" category. The overall CDRI score for "Physical Dimension" is **3.23**, which indicates "**Good**" category. That means the resilience status of the study area is good in terms of physical dimension.



Source: Developed by the Author with help of Field Survey, 2018

Fig. 2: Variable Wise CDRI Scores of Physical Dimension

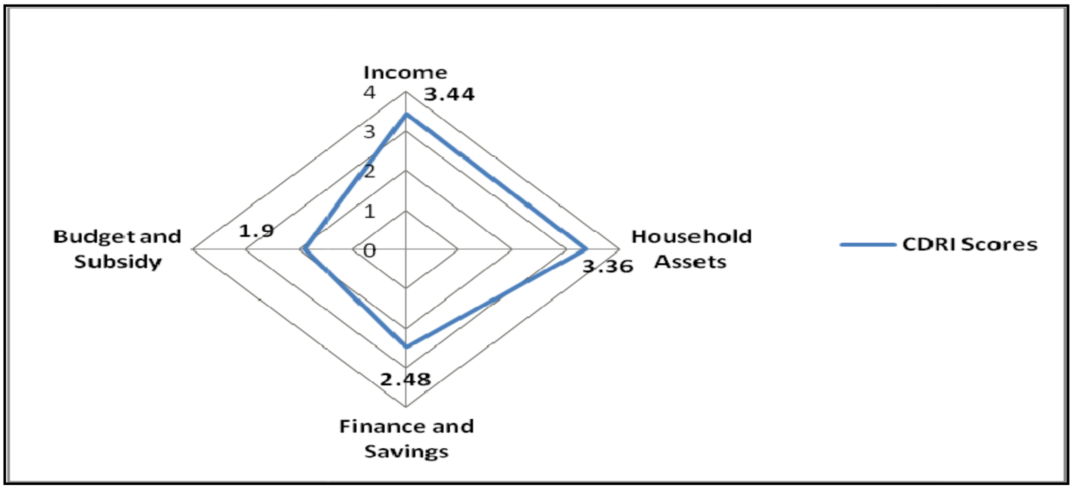
ii) Social Dimension: Fig. 3 shows the variable wise CDRI scores of social dimension in the study area. CDRI score for "Health" is 3.35, which is the highest score followed by "Population" (3.17), "Disaster Preparedness" (2.54), "Social Capital" (2.5) and "Education and Awareness" (2.33). As compared with the standard level of CDRI scale, it is observed that CDRI scores of 2 variables fall in "Good" resilience category. These variables are "Population" and "Health". Other three variables, i.e. "Disaster Preparedness", "Social Capital" and "Education and Awareness" fall in "Moderate" resilience category. The overall CDRI score for "Social Dimension" is **2.78**, which indicates that it is in "**Moderate**" category. That means the study area is moderately resilient in terms of social dimension.



Source: Developed by the Author with help of Field Survey, 2018

Fig. 3: Variable Wise CDRI Scores of Social Dimension

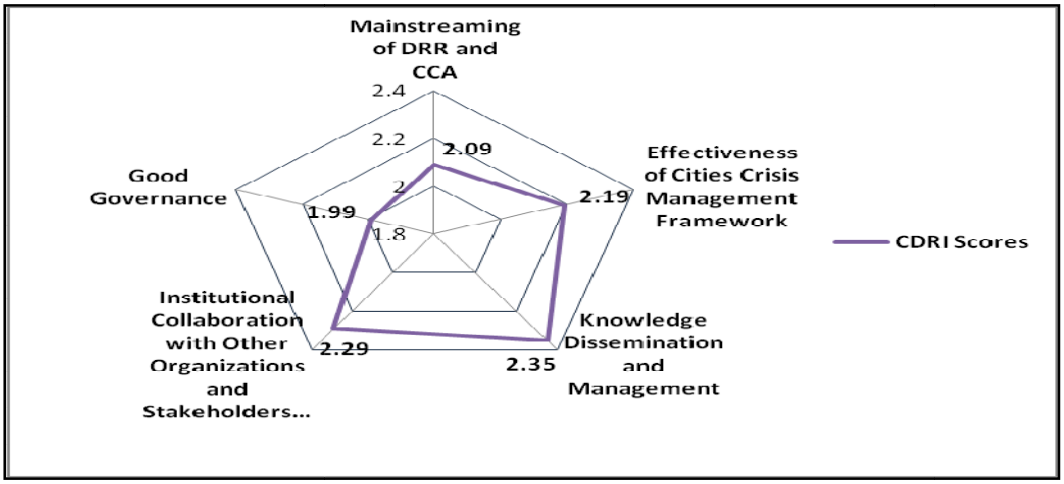
iii) Economic Dimension: Fig. 4 shows the variable wise CDRI scores of economic dimension in the study area. From the following figure it is seen that CDRI score for "Income" is 3.44, which is the highest score followed by "Household Assets" (3.36), "Finance and Savings" (2.48) and "Budget and Subsidy" (1.9). As per CDRI scale in the study area, CDRI scores of 2 variables fall in "Good" category in terms of resilience. These variables are "Income" and "Household Assets". On the other hand, "Finance and Savings" falls in "Moderate" resilience category and "Budget and Subsidy" falls in "Poor" resilience category. The overall CDRI score for "Economic Dimension" is **2.79**, which indicates that it is in "**Moderate**" category. That means the study area is moderately resilient in terms of economic dimension.



Source: Developed by the Author with help of Field Survey, 2018

Fig. 4: Variable Wise CDRI Scores of Economic Dimension

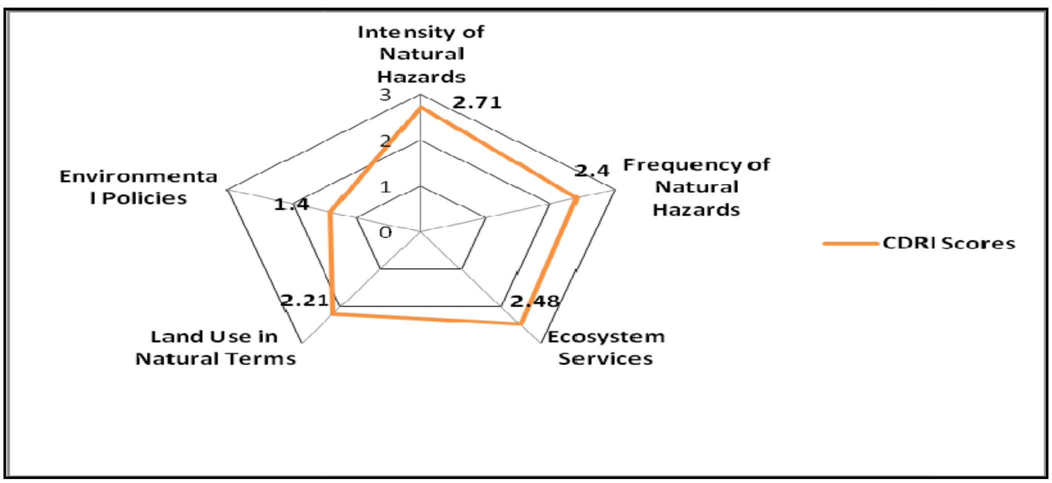
iv) Institutional Dimension: Fig. 5 shows the variable wise CDRI scores of institutional dimension in the study area. CDRI score for "Knowledge Dissemination and Management" is 2.35, which is the highest score followed by "Institutional Collaboration with Other Organizations and Stakeholders during a Disaster" (2.29), "Effectiveness of Cities Crisis Management Framework" (2.19), "Mainstreaming DRR and CCA" (2.09) and "Good Governance" (1.99). According to CDRI scale, it is observed that according to CDRI scores,"Mainstreaming DRR and CCA" and "Good Governance" fall in "Poor" resilience category and other3 variables fall in "Moderate" resilience category in terms of resilience.The overall CDRI score for "Economic Dimension" is **2.18**, which indicates that it is in "**Moderate**" category. That means the study area is moderately resilient in terms of institutional dimension.



Source: Developed by the Author with help of Field Survey, 2018

Fig. 5: Variable Wise CDRI Scores of Institutional Dimension

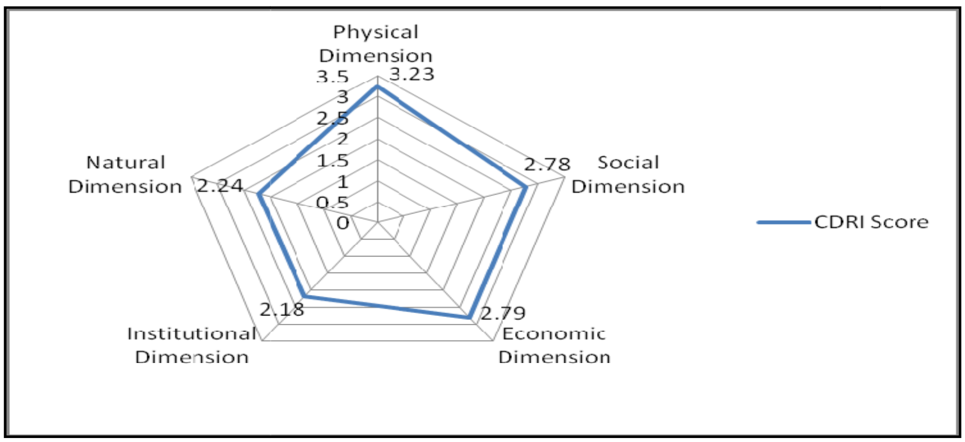
v) Natural Dimension: Fig. 6 shows the variable wise CDRI scores of natural dimensionin the study area. From the following figure, it is seen that CDRI score for "Intensity of Natural Hazards" is 2.71, which is the highest score followed by "Ecosystem Services" (2.48), "Frequency of Natural Hazards" (2.4), "Land Use in Natural Terms" (2.21) and "Environmental Policies"(1.4). According to CDRI scale, the obtained CDRI scores relating "Environmental Policies" falls in "Poor" resilience category and other 4 variables fall in "Moderate" resilience category in terms of resilience.The overall CDRI score for "Economic Dimension" is **2.24**, which indicates that it is in "**Moderate**" category. That means the study area is moderately resilient in terms of natural dimension.



Source: Developed by the Author with help of Field Survey, 2018

Fig. 6: Variable Wise CDRI Scores of Natural Dimension

Overall CDRI Scorein Ward no. 29 of DSCC: The overall CDRI score in Ward no. 29 of DSCC is **2.64**, which indicates that the area is in "**Moderate**" resilient category as per CDRI scale. Therefore the study area shows moderate level of resilience, that means at present the study area is in moderate condition to address climate disaster risk. But there are variations in the levels of resilience by major dimensions. The resilience value of "Institutional" dimension is the lowest, while this value is high for "Physical" dimension. CDRI scores for "Social", "Economic", "Institutional" and "Natural" dimensions are 2.78, 2.79, 2.18 and 2.24 respectively, which indicate moderate level of resilience while CDRI score for "Physical" dimension is 3.23 which indicates good level of resilience. "Physical Dimension" shows higher level of resilience, which means that the physical condition of the study area is in good and satisfactory condition to address climate disaster risk. On the other hand, other four dimensions show moderate level of resilience, which indicate that social, economic, institutional and natural condition of the study area are in moderate condition to address climate disaster risk.



Source: Developed by the Author with help of Field Survey, 2018

Fig. 7: Dimension wise CDRI Score of the Study Area

Recommendationsto Improve Disaster Resilience Condition of the Study Area

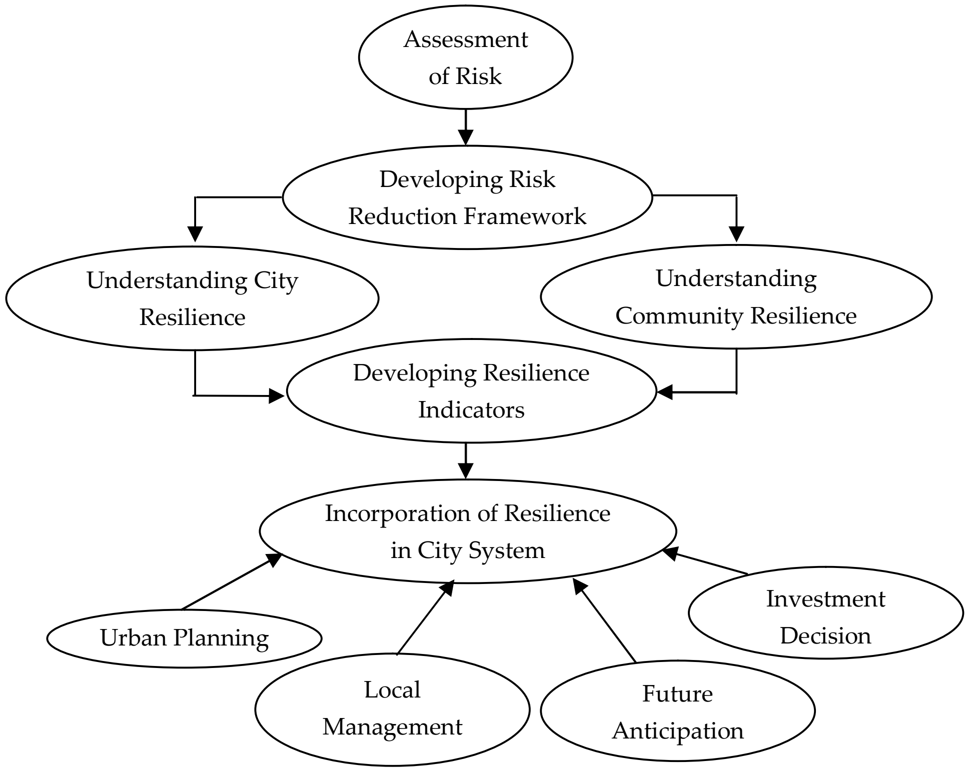
It is impossible to avoid disasters, however only risk reduction approach and pre planning can increase disaster coping capacity or functionality of any area. Mainly government organizations at the national and local level are responsible to take initiatives to manage disaster risks and assess urban risks due to different certain or uncertain disasters. Pro-active planning and action of preparedness and mitigation are the best approach to minimize the urban disaster risks and reduce the future losses.

The study area has been found moderately resilient and any sudden disruption can cause great damage and make the community more vulnerable.So, it is very urgent to adopt balanced approach to systematically address the physical, social, economic, institutional and natural dimensions of climate disaster resilience index of this area. Considering the guidelines of "UNISDR 2013" and "The Hyogo Framework for Action (HFA) 2005-2015", some recommendations are provided here, which can be helpful to improve the existing resilience condition of the study area as well as other urban areas of the country.Table 3 presents some recommendations to improve the present resilience condition of the study area and Fig. 7 shows the proposed framework for improving resilience of the study area, as well as other urban areas of the county.

Table 3: Proposals to Improve the Resilience Condition of the Study Area

Type of Resilience	Proposal for Improvement of Resilience
Physical Resilience	(1) Formulation of area specific detail land use planning to control development, regulate new and existing construction and taking disaster risk reduction into account in new urban planning regulations, plans and development activities. (2) Make an inventory of existing old and poorly constructed buildings which are vulnerable to earthquake and adopt reconstruction mechanism to ensure safety of the local people living in those buildings. (3) Formulation of innovative integrated approaches and strategies for ensuring water resource efficiency, and discuss institutional and technical challenges and solutions for improving water and solid waste management.
Social Resilience	(1) Development of multi-hazard disaster management plans and training for communities and health sector staffs to manage disasters. (2) Raise disaster awareness and use both scientific and local knowledge in disaster risk reduction practices; ensure that education programs and training on disaster risk reduction are in place in schools and local communities.
Economic Resilience	(1) Ensure direct access to funding especially for urban poor for crisis management. (2) Assign a budget for disaster risk reduction in order to maintain well-trained and equipped emergency response services, communications, early warning systems and risk assessment capacities as well as contingency fund to meet post-disaster needs.
Institutional Resilience	(1) Make strong and participatory local governance in collaboration with local stakeholders, relevant authorities, private sectors, professionals in planning and urban risk management. (2) Empowering technical and professional staff to build municipal capacity and ensure the continuity of risk reduction initiatives. (3) Installation of early warning systems and emergency management capacities and hold regular public preparedness drills.
Natural Resilience	(1) Maintain up to date data on hazards and vulnerabilities and prepare hazard map to guide development. (2) Adapting indigenous knowledge with scientific methods to protect, restore and enhance ecosystems, watersheds, unstable slopes and vulnerable areas. (3) Engage local community in ecosystem-based risk management and commit to reduce contamination, improve waste management and protect green space.

Source: Developed by the Author with help of UNISDR 2013, The Hyogo Framework for Action (HFA) 2005-2015 and Field Survey, 2018



Source: Developed by the Author, 2018

Figure 7: Proposed Framework for Improving Resilience

The purpose of this framework is to provide cities with a robust, holistic and accessible basis for assessment so that they are better placed to make investment decisions and engage in urban planning practices that ensure people living in cities – particularly the poor and vulnerable – survive and thrive no matter what shocks and stresses they encounter. State and local government has to take initiatives to incorporate resilience in planning process, development system and disaster management approach to minimize the disaster risk and to reduce human and economic losses. Successful incorporation of risk reduction tools with future anticipation and investment decision can help to create a resilient community.

Conclusion

Resilience seems a clear approach for addressing the problems of cities and reflects a city's ability to persevere in the face of emergency, to continue its core mission despite daunting challenges. Minimizing human vulnerabilities is the prime issue of resilience. A resilientcommunity or city is enable to achieve a standard of living which goes beyond simple survival and allows people to deal with unforeseen circumstances. Though the study area (ward no. 29 of DSCC) has good physical resilience but moderate score of other dimensions are the major threat and poses challenges to become the area resilient in future. So, it is the right time to properly address the emerging issue of city resilience and take necessary steps as recommended on an emergency basis to improve the present level of resilience in the study area along with other urban areas of the country.

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