Climate Change and Urban Resilience: A Study on the City of Dhaka

A Dissertation/thesis

by

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Declaration

I hereby declare that the content of this thesis has never been submitted for fulfilment of another academic degree or certification to other academic institutions or universities-except this degree in Master in Development Studies (MDS) at BRAC University, Bangladesh.

I also confirm that this dissertation work is an illustration of my own research work. Any research works of other writers in this paper have been distinctly recognized.

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CERTIFICATION

It is indeed a great pleasure to certify that the dissertation entitled “Climate Change and Urban Resilience: A Study on the City Of Dhaka”, completed under my guidance and supervision, is a unique work of Najia Sultana. So far I know, the dissertation is an individual achievement of the candidate’s own efforts and it is not a joint work. Also, I would like to acknowledge this dissertation acceptable for submission to BRAC Institute of Governance and Development (BIGD), BRAC University for partial fulfilment of the prerequisite for the degree of Masters in Development Studies (MDS).

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And, above all, heart-felt thanks to my mother and brother for their support to collect secondary data from the field. Despite their support I won't be able to complete this study.

Abstract

Among all Asian cities, Dhaka is the most vulnerable to climate change impacts having lower adaptive capacity, higher exposure and higher sensitivity. For its huge urban poor population a variable and unpredictable climate can critically restrict livelihood options, hamper daily life, causes damage to health condition and so on. Urban poor are continues to be neglected in research, policy and action for climate change adaptation in the country in comparison to rural or coastal area. The study builds on three propositions: i) To measure the contingent effects of climate change in Dhaka city ii) To explore coping mechanisms for climate change related vulnerabilities in Dhaka City iii) To propose some plans to mitigate these effects. The Climate Resilience Framework places a strong emphasis on how to build resilience for sustainability. It has three main parts; understanding the vulnerabilities, building resilience and sharing knowledge. Based on mixed method discussion of this study focuses on measuring climate change effects and planning to enhance resilience of Dhaka against climate change related vulnerabilities. Research findings show that people living in slum areas suffers most because of climate change. It causes damage in daily life and loss in livelihood. Poor people struggle economically, physically and socially because of the effects of climate change they face in their life. Urban dwellers specially who live in slum areas experience serious harm in health condition such as chikungunya, meningitis, food-borne gastroenteritis as the climate has changed a lot. It is also found that women of marginal group are the worst sufferers of climate change. Similarly it is also found that, there is serious lack in carefulness among the designated local government offices in taking and implementing measures to enhance resilience of the city. To build Dhaka as a resilient city this research suggests multi stake-holder engagement as the preeminent solution. In addition, proper urban planning can play an important role here. The increasing problem of water logging, sewerage and sanitation in Dhaka city can be improved by ensuring pre planed urbanization.

Chapter One

Introduction

1.1 Background of the Study

Various natural disasters are quiet frequent in Bangladesh due to its geographical location other physical and environmental conditions including low topography, land characteristics, multiplicity of rivers and the monsoon climate (World Bank, 2015, p.1). Though its contribution to global greenhouse gas emissions is one of the lowest these unfavorable conditions have made it extremely vulnerable to climate change. Though the factors responsible for climate change are global in nature but its impacts are carried locally and thus have become major concern for Bangladesh.

The capital of Bangladesh, Dhaka has been declared as the most vulnerable megacity to climate change by the World Wide Fund for Nature (WWF) in 2009 and ranked first among the eleven megacities of Asia vulnerable to climate change, especially to flooding (World Bank, 2015). This situation is likely to worsen further because of increased wetlands development by land-grabbers, which decreases the drainage capacity, a problem compounded by unpredictable heavy rainfall.

Dhaka, the rapidly urbanizing city with innumerable challenges is becoming more non livable day by day because of the problems of transportation, housing, water supply, sanitation, and waste disposal. However, its protection should get the highest priority because of its importance as the political, economic, social and cultural centre of the nation. So, high vulnerability of Dhaka to various natural and manmade hazards is a serious problem that needs urgent attention.

This research “Climate Change and Urban Resilience: A Study on the City Of Dhaka” has focused on all these problems and tried to come up with some solutions that can be applied.

1.2 Overall Goal of the Study

The overall goal of the study is to measure the vulnerability of Dhaka city in terms of climate change. Because of climate change big urban areas in Bangladesh are likely to face enormous challenges. This study tries to explore related challenges and shed light on coping mechanisms and resilience strategies for urban dwellers of Dhaka City.

1.3 Research Objectives:

The overall goal of the study can be achieved through the following research objectives.

i. To measure the contingent effects of climate change in Dhaka city.

ii. To explore coping mechanisms for climate change related vulnerabilities in Dhaka City

iii. To propose some plans to mitigate these effects.

1.4 Research Question

Following research questions have been formulated based on research objectives.

i. What are the major effects of climate change in Dhaka city?

ii. What coping mechanisms are the city dwellers and authorities adopting to enhance resilience of Dhaka city?

iii. What measures should be included in urban planning to enhance resilience of Dhaka against climate change related vulnerabilities?

The entire study is based on the research objectives and questions.

1.5 Reasons and significance of the study

Dhaka has long been experiencing devastating floods in regular basis among which floods in year 1988, 1998 and 2004 were the most devastating. The duration of the disaster and damage

was so high in 1998 flood with inundation of around 79 percent of the city and affecting around two-third of its total population (World Bank, 2015).

Not only flooding but also water-logging has become a perennial problem of the city. The overall condition of the roads, telecommunications, electricity supply and water supply becomes quite terrible during monsoon. Because of the continuous rainfall in September 2014 for about 48 hours swamped most parts of the city. It disrupted business and economic activities and affected schools and garment factories in addition to other working and educational places.

Dhaka is surrounded by several numbers of rivers that include Buriganga, Tongi, Turag, Balu and Sitlakhya. The city was criss-crossed by many drainage channels which carried away run-off to the surrounding rivers in the British period. There was a time when Dhaka had 43 natural canals among which many do not exist now a day. WASA has been successful to convey some of this canals and government has taken many other initiatives to control flooding of the city. However, many recent incidents show the vulnerability of the city dwellers has increased several folds over the years. And it will be increased further due to rapid urbanization, climate changes and related consequences. Under these circumstances it is worth to study climate change related vulnerabilities and resilience of the city. This study aims to examine the city's resilience of the frequent disasters triggered by climate change and provide policy recommendations in order to enhance the city's resilience. Thus this study hopes to contribute significantly for the country as well as to the city dwellers of Dhaka.

1.6 Structure of the Research

The study is organized in five chapters as follows-

- **Chapter One** includes the background of the study, objective and significance of the research and outline of the whole thesis.
- **Chapter Two** introduces the study area, covers literature review including the definitions of Climate change, urban poverty, vulnerability and resilience. In addition, this chapter covers discussing related concepts like causes of climate change, climate disaster

resilience index, SWOT Analysis of disaster management of Dhaka Metropolitan Region (DMR).

- **Chapter Three** includes conceptual framework and methodology of the research, design of research, instruments used for the survey, sample and data collection procedure, data analysis techniques and limitation of the research.
- **Chapter Four** illustrates the data analysis and discussion of study.
- **Chapter Five** includes summary, recommendations and conclusion.

Chapter Two

Introduction to the Study Area and Literature Review

This chapter, based on primarily relevant literature reviews, is divided into three parts. First part covers introduction to the study area. Second is defining the related concepts includes climate change, urban resilience, vulnerability. Third part includes analyzing related concepts.

2.1 Study area: Dhaka City

2.1.1 Introduction to the City of Dhaka

Dhaka the capital and largest city of Bangladesh is the chief economic, political and cultural center of Bangladesh (BBS, 2011). It is one of the major cities of South Asia, the largest city in Eastern South Asia and among the Bay of Bengal countries; and one of the largest cities among OIC countries. As part of the Bengal plain, the city is bounded by the Buriganga River, Turag River, Dhaleshwari River and Shitalakshya River. The city is located in an eponymous district and division.

2.1.2 Climate

Under the Köppen climate classification, Dhaka has a tropical savanna climate. The city has a distinct monsoonal season, with an annual average temperature of 26 °C (79 °F) and monthly means varying between 19 °C (66 °F) in January and 29 °C (84 °F) in May (Wikipedia, 2018). Approximately 87% of the annual average rainfall of 2,123 millimetres (83.6 inches) occurs between May and October (Weatherbase.com, 2018). Increasing air and water pollution emanating from traffic congestion and industrial waste are serious problems affecting public health and the quality of life in the city. Water bodies and wetlands around Dhaka are facing destruction as these are being filled up to construct multi-storied buildings and other real estate developments.

2.1.3 Administrative agencies

Unlike other mega cities around the world, Dhaka is serviced by over two dozen government organizations under different ministries. Lack of co-ordination among them and centralization of all powers by the Government of Bangladesh, keeps the development and maintenance of the city in a chaotic situation. Table 1 present the agencies, their responsibilities and reporting higher agencies.

Table 1: Administrative agencies of the City of Dhaka

Agency	**Service**	**Parent agency**
Dhaka North City Corporation Dhaka South City Corporation	Public service	Ministry of Local Government, Rural Development and Co-operatives ∟ Local Government Division
Dhaka Metropolitan Police	Law enforcement	Ministry of Home Affairs ∟ Bangladesh Police
RAJUK	Urban planning	Ministry of Housing and Public Works
Dhaka Electric Supply Company Limited Dhaka Power Distribution Company Limited	Power distribution	Ministry of Power, Energy and Mineral Resources ∟ Power Division
Dhaka WASA	Water supply	Ministry of Local Government, Rural Development and Co-operatives ∟ Local Government Division
Dhaka Transport Coordination Authority	Transport	Ministry of Road Transport and Bridges ∟Road Transport and Highways Division

Source: Wikipedia, 2018

The area of the city of Dhaka divided into seven zones (Figure 1) (World Bank, 2015):

Figure 1: Subdivisions of Study Area for Local Analysis

Source: World Bank, 2015

1. Western Dhaka (Kallyanpur): Situated in the south-western part covering approximately 28 square kilometers, including four thanas: Mahammadpur, Mirpur, Kafrul, and Hazaribagh.
2. Eastern Dhaka: covers whole area of eastern Dhaka from Tongi Khal to Demra with total area of about 118 square kilometers including Badda, Khilgao and parts of two thanas; sabujbagh and Rupganj.
3. Central Dhaka: The area has 44 wards of Dhaka North and South city corporations and covers area of 39 square kilometers (World Bank, 2015).
4. Old Dhaka: A highly densely populated area in the south along the Buriganga river covering approximately twelve square kilometers with nineteen wards of Lalbagh, Kotwali, Sutrapur and shyampur thanas.
5. DND Area: This is the southern part of the city covering approximately 57 square kilometers.
6. Narayanganj: This zone covers approximately 33 square kilometers.

CDRI has been computed these seven zones/ zone so as to obtain information about local level climate resilience against flood and water logging in Dhaka.

2.2 Defining related concepts

There are some related concepts regarding this research those need to be defined.

2.2.1 Climate Change

Climate change is a change in the pattern of weather, and related changes in oceans, land surfaces and ice sheets, occurring over time scales of decades or longer (Australian Academy of Science, 2018). It is a change in the statistical numbers of the climate system that lasts for several decades or longer usually at least 30 to 40 years.

On the other hand, weather is the state of the temperature, humidity, wind, rainfall and so on of an area over hours to weeks. It is influenced by the oceans, land surfaces and ice sheets, which are blended with the atmosphere, form what is called the ‘climate system’. It can be forecast with

considerable skill up to about a week in advance through modern tools and techniques. Short term fluctuations in climate, such as droughts, temperature, and rainfall can be predicted with limited skill from season to season. In contrast, changes in the long-term statistics of the climate system (climate change) can be predicted if caused by long-term influences that are visible, known or predictable (Australian Academy of Science, 2018).

2.2.2 Resilience

"Resilience" comes from the Latin verb resilire, meaning to rebound or spring back. It is originated in the fields of ecology and natural sciences came to be used in various other disciplines, such as psychology and the study of psychiatric illnesses, the social sciences and community development, and engineering design (Kim & Lim, 2016, p. 1).

It has been an important concept in the contemporary debate on climate change and adaptation. The fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC) defines resilience as "the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning and transformation" (Kim & Lim, 2016, p. 1).

The report recommends creating a climate-resilient pathway as a measure to respond to climate change risks that may be concentrated in urban areas. This recommendation implies that, in terms of sustainable development, we must change our decision-making and behavior pertaining to the economy, society, technology and politics.

2.2.3 Urban poverty

There are two distinct approaches to understanding poverty, focusing on whether poverty is defined in absolute or relative terms. Urban poverty appears to be best understood through the relative perspective, but the absolute measure of poverty dominates the official and formal practices of poverty assessment and monitoring. The absolute measure of poverty uses levels of

consumption as a basis for classifying people (or households) as being poor or non-poor (a headcount measure). There are various methods of defining the consumption levels – in Bangladesh, for example, the Cost of Basic Needs approach is used to define poverty lines. This utilises a fixed food bundle, consisting of 11 key items based on a concept of 'minimum nutritional intake'. Food poverty lines are computed by pricing this bundle using the average price of each item for each of Bangladesh's 15 geographic areas. A number of critics have argued that the absolute measure produces underestimations of poverty in urban areas. The main criticisms are: The national poverty lines do not reflect the costs of basic necessities in urban areas (Roy. Manoj, 2011, p. 4). Low-income urban households must meet all of their food costs, high monthly rent and transport costs, as well as the high costs of water and electricity, and health and education costs. Poverty lines do not capture the (lack of) assets that households have, which reduces their vulnerability in the long run. If consumption is steady, but assets are being depleted, then a household's vulnerability to future poverty is increasing. The health situation of family members can be an asset or a liability (when labour is directed to the care economy and ill family members cannot work). Spatial segregation and social exclusion among poor households are not covered in such approaches, despite the fact that they reduce household access to important state- and/or community-provided resources. The relative approach, in contrast, assesses poverty in relational terms. It recognizes that access to a variety of assets makes a household capable of producing wellbeing for its members, or a lack of assets prevents them from doing so.

2.2.4 Vulnerability

Vulnerability is the degree to which a system or unit is likely to experience harm due to exposure to perturbations or stresses. It relates to the central concern in this research – how weather events and climate variability and change impact on poor urban people and communities in Bangladesh. Following, vulnerability is identified in terms of three elements (Roy. Manoj, 2011, p.4): (i) system exposure to crises, stresses and shocks; (ii) system capacity (or lack of capacity) to cope; and (iii) consequences and attendant risks of slow (or poor) system recovery. This perspective suggests that the most vulnerable individuals, groups, classes and regions or places are those

that: (a) are most exposed to perturbations or stresses; (b) are most sensitive to perturbations and stresses and (c) have the weakest capacity to respond and ability to recover. This conceptualization of vulnerability helps us to identify two main reasons for increased vulnerability of poor urban communities to weather events and climate variability and change in Bangladesh. This suggests that both poverty reduction and vulnerability reduction measures should go side-by-side. But these two objectives are not the same, although there are some common areas between them.

2.3 Discussing related concepts

Related concepts such as causes of climate change and why it is a matter to worry is discussed in this part. Policy approaches for building resilience has been described as well.

2.3.1 Causes of Climate Change

On the broadest scale, the rate at which energy is received from the Sun and the rate at which it is lost to space determine the equilibrium temperature and climate of Earth. This energy is distributed around the globe by winds, ocean currents, and other mechanisms to affect the climates of different regions.

Factors that can shape climate are called climate forcings or "forcing mechanisms". (Smith, Ralph C., 2013, p. 23). These include processes such as variations in solar radiation, variations in the Earth's orbit, variations in the albedo or reflectivity of the continents, atmosphere, and oceans, mountain-building and continental drift and changes in greenhouse gas concentrations. There are a variety of climate change feedbacks that can either amplify or diminish the initial forcing. Some parts of the climate system, such as the oceans and ice caps, respond more slowly in reaction to climate forgings, while others respond more quickly. There are also key threshold factors which when exceeded can produce rapid change.

Forcing mechanisms can be either "internal" or "external". Internal forcing mechanisms are natural processes within the climate system itself (e.g., the thermohaline circulation). External

forcing mechanisms can be either anthropogenic (e.g. increased emissions of greenhouse gases and dust) or natural (e.g., changes in solar output, the earth's orbit, volcano eruptions).

Whether the initial forcing mechanism is internal or external, the response of the climate system might be fast (e.g., a sudden cooling due to airborne volcanic ash reflecting sunlight), slow (e.g. thermal expansion of warming ocean water), or a combination (e.g., sudden loss of albedo in the Arctic Ocean as sea ice melts, followed by more gradual thermal expansion of the water). Therefore, the climate system can respond abruptly, but the full response to forcing mechanisms might not be fully developed for centuries or even longer. (Wikipedia, 2018)

2.3.2 Why climate change is a concern now?

Climate is always changing. All major climate changes, including natural ones, are disruptive. Past climate changes led to extinction of many species, population migrations, and pronounced changes in the land surface and ocean circulation. The speed of the current climate change is faster than most of the past events, making it more difficult for human societies and the natural world to adapt (National Academy of Sciences. 2014. p. 9).

Recent estimates of the increase in global average temperature since the end of the last ice age are 4 to 5 °C (7 to 9 °F). That change occurred over a period of about 7,000 years, starting 18,000 years ago. CO2 has risen by 40% in just the past 200 years, contributing to human alteration of the planet’s energy budget that has so far warmed Earth by about 0.8 °C (1.4 °F). If the rise in CO2 continues unchecked, warming of the same magnitude as the increase out of the ice age can be expected by the end of this century or soon after. This speed of warming is more than ten times that at the end of an ice age, the fastest known natural sustained change on a global scale (National Academy of Sciences. 2014.).

2.3.3 Urban Climate Change Resilience

The concept of resilience has been useful in addressing climate risk and unexpected events, and in enhancing efforts to survive and thrive in the context of climate change.

Urban resilience to climate change describes a city that is resilient on three levels (ADB, 2016): i) the systems of the city survives shocks and stresses; ii) the people and organizations are able to accommodate these stresses into their day-to-day decisions; and iii) that the city's institutional structures continue to support the capacity of people and organizations to fulfill their goals.

The process of building urban climate resilience requires an increased awareness of climate change impacts in urban environments and initiates processes that enable cities to adapt by reducing risk. In the context of natural disasters, urban climate resilience is a way to build the systematic capacity of an urban centre, so that infrastructural development and land-use management reduces the impact of particular hazards.

There is no single action that will make a city resilient to climate change. Resilience is instead achieved through a number of actions, building upon each other over time. These actions would be enhanced and progressed as peoples and institutions learn from past experiences and apply it to future decisions (ADB, 2016).

2.3.4 Maintaining essential urban functions

Actions to build resilience should respond to three key questions (Figure 2):

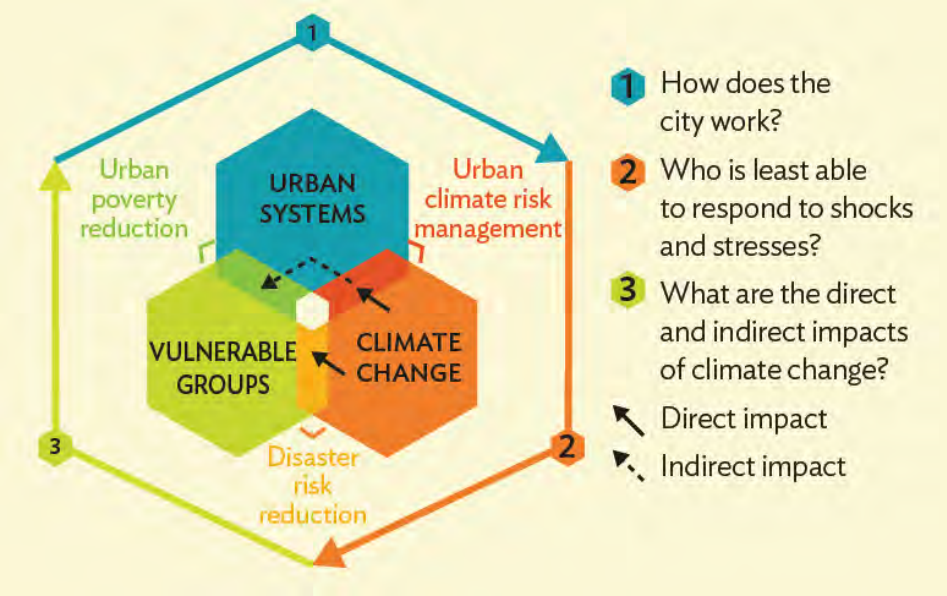
1. How does the city work (the urban systems)?

2. What are the direct and indirect impacts of climate change (climate change)?

3. Who is least able to respond to shocks and stresses (vulnerable groups)?

Figure 2 highlights that the action focusing on disaster risk reduction and/or urban poverty reduction is necessary but insufficient to maintain urban functions in the face of direct and indirect climate change impacts.

Figure 2: Actions focusing on disaster risk reduction



Source: Asian Development Bank [ADB], 2016

2.3.5 Policy approaches to build resilience

Cities are taking diverse policy approaches to enhance resilience in collaboration with other players, such as the national government, surrounding municipalities, NGOs, local citizens and the private sector (Figure 3) (OECD, 2016, p. 9).

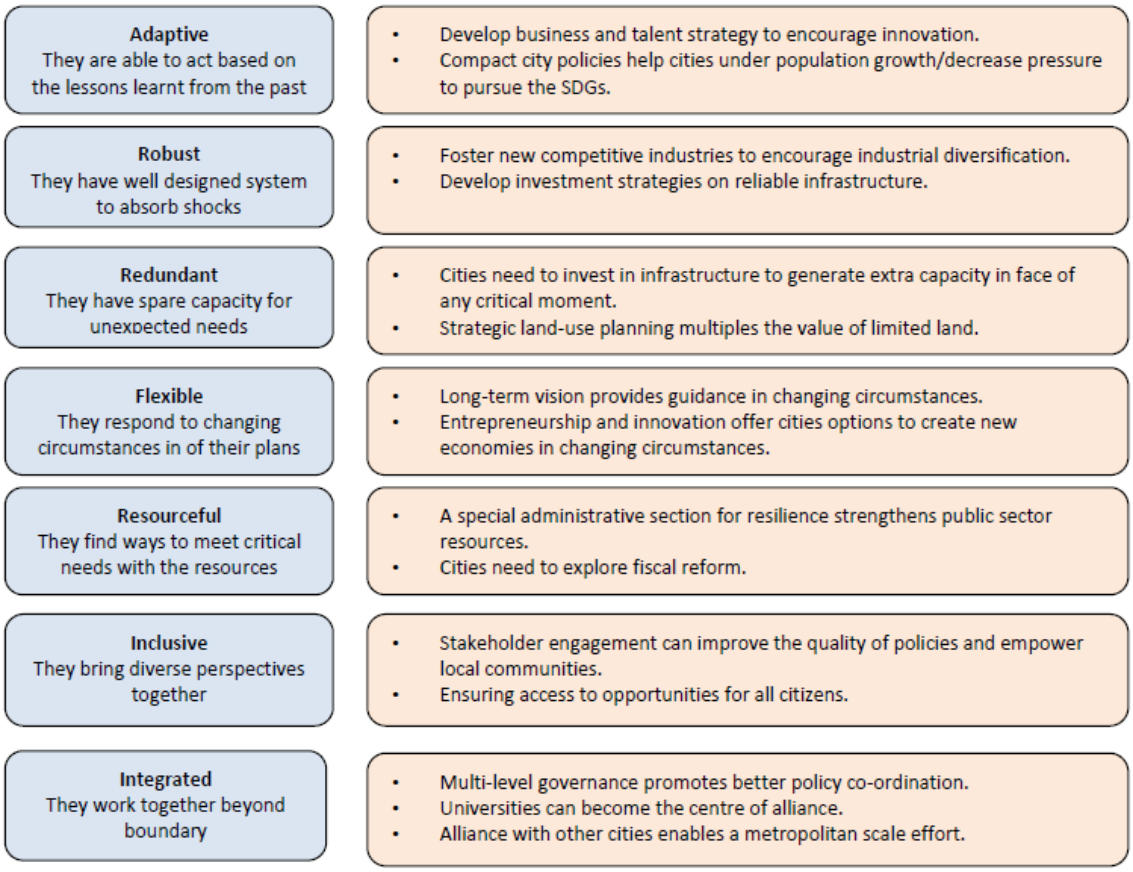
Adaptive: Resilient cities act based on the lessons learned from the past experiences

Cities increasingly seek to promote their economic development and strengthen adaptive capacity by supporting innovation. Tampere, Kobe and Lisbon are good examples of cities redefining their business strategies on innovation and shifting their course, using their local resources, including people and universities. Similarly, compact city policies can help cities adjust their urban form to accommodate needs both for expanding and shrinking sustainably, improving the cities' adaptive capacity such as in Toyama and Cardiff.

Robust: Resilient cities have well-designed systems to absorb shocks

Diversifying the industrial mix and striking a balance between existing industries and new ones will favor the robustness of their economy, and provide a space to mitigate an industrial structural change. Industrial diversification can be achieved by attracting more firms to the city

Figure 3: Suggested approaches



Source: OECD, 2016

Redundant: Resilient cities have spare capacity for unexpected needs

Developing extra capacity for infrastructure in case of emergencies, and strategic land use, for example, can provide cities redundancy and a way to prepare for unexpected circumstances, as

seen in the case of Kobe. It will enhance resilience to prepare for the future shocks and stresses by developing an alternative source of action, service or service provider when necessary.

Flexible: Resilient cities respond to changing circumstances in the scope of their plans

A well-designed long-term vision, such as those in Cardiff, Ottawa and Kyoto, gives cities a solid basis for governing their operations and helps them develop a flexible system that allows individuals, households, businesses, communities and government to adjust their behavior in order to respond to rapid change. Encouraging entrepreneurship and innovation, such as in Oslo, also makes a city's economic base more diverse and flexible, to respond to any changes (OECD, 2016, p.10).

Resourceful: Resilient cities find ways to meet critical needs with the resources available

Establishing a designated unit responsible for resilience within the city administration, such as in New York and fiscal decentralization and granting cities autonomy to introduce a new local tax scheme, such as in Yokohama, can make cities more resourceful and able to restore the functionality of essential services and systems. Kobe reduced the fixed number of city employees and generated financial resource as part of its administrative and fiscal reform after the earthquake in 1995. Imposing tariffs and fees for access to city centres by car, as Oslo or London have done, can also provide revenue sources for cities (OECD, 2016, p.10).

2.3.6 Climate Disaster Resilience index

Climate Disaster Resilience Index (CDRI) is a planning tool developed by the Climate and Disaster Resilience Initiative of the Kyoto University. CDRI measures climate disaster resilience by considering five dimensions (World Bank, 2015):

- physical
- social
- Economic
- institutional, and

- natural

Each dimension has five parameters and each parameter in turn has five variables.

Physical Dimension and Related Parameters and Variables

- **Electricity:** It includes access, availability, supply capacity, dependence on external supply and alternative capacity
- **Water**: It includes access, availability, supply capacity, dependence on external supply and alternative capacity
- **Sanitation and solid waste disposal**: It includes access to sanitation, toilets, collection of wastes, waste treatment and recycling.
- **Accessibility of roads**: It includes percentage of land transportation network, paved roads, accessibility during flooding, status of interruption after intense rainfall and roadside covered drain.
- **Housing and land use**: It includes building code, buildings with nonpermanent structure, buildings above water logging, ownership and population living in proximity to polluted industries.

Social Dimension and Related Parameters and Variables

- **Population:** It includes population growth, population under 14 and above 64, population of informal settlers and population density.
- **Health**: It includes population suffering from waterborne/vector-borne diseases, population suffering from waterborne diseases after a disaster, access to primary health facilities, capacity of health facilities during a disaster and preparedness for disaster.
- **Education and awareness**: It includes literacy rate, population's awareness about disasters, availability of public awareness programs/disaster drills, access to Internet and functionality of schools after disaster.

- **Social Capital:** It includes population participating in community activities/clubs, acceptance level of community leader (in ward), ability of communities to build consensus and to participate in city's decision-making process (level of democracy), mixing and interlinking of social class.
- **Community preparedness during a disaster:** It includes preparedness (logistics, materials, and management), provision of shelter for affected people, support from NGOs/CBOs, population evacuating voluntarily and population participating in relief works.

Economic Dimension and Related Parameters and Variables

- **Income:** It includes population below poverty line, number of income sources per household, income derived in informal sector, income disparity and percentage of households have reduced income due to a disaster.
- **Employment:** It includes formal sector: percentage of labor unemployed, youth unemployed, and women employed, employees who come from outside the city and child labor in city.
- **Household assets:** It includes households have television, mobile phone, motorized vehicle, non-motorized vehicle and basic furniture.
- **Finance and savings:** It includes availability of credit facility to prevent disaster, accessibility to credits, and accessibility to credits for urban poor, saving practice of households and household's properties insured.
- **Budget and subsidy:** It includes city's annual budget for DRR and CCA, availability of subsidies/ incentives for residents to rebuild houses, alternative livelihood, and health care after a disaster and budget for that emergency period.

Institutional Dimension and Related Parameters and Variables

- **Mainstreaming of DRR and CCA:** It includes mainstreaming of CCA and DRR in cities development plans, in housing and transport policies, ability (manpower) and capacity

(technical) to produce development plans, extent of community participation in development plan preparation process and implementation of disaster management plan.

- **Effectiveness of cities crisis management framework:** It includes existence of disaster management plan, existence and effectiveness of an emergency team during a disaster: leadership, availability of evacuation centers, efficiency of trained emergency workers during a disaster and existence of alternative decision-making personnel.

- **Knowledge dissemination and management:** It includes effectiveness to learn from previous disasters, availability of disaster training programs for emergency workers, existence of disaster awareness programs for communities, capacity (books, leaflets, etc.) to disseminate disaster awareness programs (disaster education), extent of community satisfaction from disaster awareness programs.

- **Institutional collaboration with other organizations and stakeholders, during a disaster** It includes cities dependency on external institutions/support, collaboration and interconnectedness with neighboring cities, city's cooperation (support) with central municipal department for emergency management, cooperation of city's ward officials for emergency management, city's institutional collaboration with NGOs and private organizations.

- **Good governance:** It includes effectiveness of early warning systems, accountability and transparency of city government, implementation of building codes, existence of disaster drills, promptness of city body to disseminate emergency information during a disaster to communities and capability of city body to lead recovery process.

Natural Dimension and Related Parameters and Variables

- **Intensity/severity of natural hazards:** It includes floods, cyclones, heat waves, droughts (water scarcity) and tornados.

- **Frequency of natural hazards:** It includes floods, cyclones, heat waves, droughts and tornados.

- **Ecosystem services:** It includes quality of city's biodiversity, soils, air, water bodies and urban salinity.
- **Land use in natural terms:** It includes area vulnerable to climate-related hazards, urban morphology, settlements on hazardous ground, amount of Urban Green Space (UGS) and loss of UGS.
- **Environmental policies:** It includes use of city-level hazard maps in development activities, extent of environmental conservation regulations reflected in development plans, extent of implementation of environmental conservation policies, implementation of efficient waste management system (RRR) and implementation of mitigation policies to reduce air pollution.

Chapter Three

Conceptual Framework and Research Methodology

This chapter has two sections. First one includes climate resilience framework, characteristics of resilience, shared learnings. Second part includes methodology used in this study.

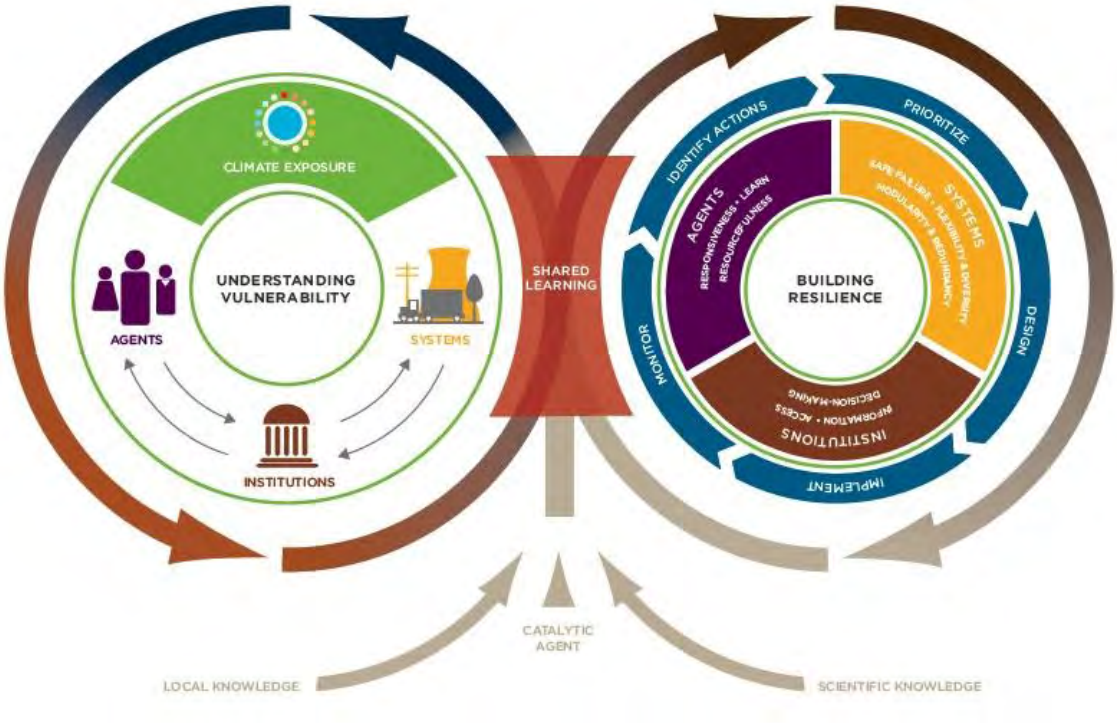
3.1 Climate Resilience Framework

The Climate Resilience Framework (CRF) is considered as a conceptual planning approach that helps in building resilience to climate change. It has been developed from field situations. It is designed for practical application and has been tested in field as well. CRF identifies complex sources of vulnerability and addresses the complexities of climate adaptation. It is simple enough for local practitioners to apply in their own context.

The CRF is designed to build a broad understanding of urban resilience through unfolding the characteristics of urban systems, the agents (people and organizations) and institutions (laws, policies and cultural norms). Agents are depends on institutions to manage those systems. In order to develop practical strategies for local action, it operationalizes these concepts through structured and iterative shared learning approaches that allow local planners to define these factors in their local context (MacClune. & Optiz-Stapleton. 2012. p. 1).

The CRF has 4 major elements, as shown in figure 4: inputs to the process at the bottom of the figure; a detailed assessment of vulnerability; and, a resilience building component - all of these are facilitated through a shared learning process. Working alone, most local NGOs (not necessarily in North America or Western Europe) will not have the resources to deliver this program. Because the Framework reframes the adaptation challenge as one of building resilience. One of the greatest benefits of this approach is that it avoids over-focusing on the climate science and helps cities to identify systematic factors causing vulnerability.

Figure 4: Climate Resilience Framework, Graphical Representation of the Climate Resilience Framework, Showing the Process of Resilience Planning.



Source: Tyler & Marcus, 2012

The left-hand loop of the CRF in Figure 4 guides users through an assessment of who are vulnerable, why they are vulnerable, and what factors leading vulnerability in place.

This assessment has of four key elements—**systems** (both infrastructure and ecosystems), **social agents**, and **institutions** (laws, policies and social norms), and, for each, the degree to which they are **exposed** to climate change hazards. Within the framework, building resilience defined as (MacClune. & Optiz-Stapleton. 2012.):

- Identifying the disclosure of systems and agents that are relevant to climate hazards;
- Identifying and strengthening fragile systems that reduce their vulnerability to climate hazards;

- Strengthening the capacities of agents to access systems and develop adaptive responses at the same time; and
- Addressing all those institutions that constrain effective responses to system fragility and undermine the ability to build agent capacity.

The right-hand loop of the Framework in Figure 4 guides users through developing possible adaptation or resilience building actions, this framework aims to address the vulnerabilities identified in the left-hand loop. Development of resilience indicators and follow-up monitoring is used to learn from the implementation. The CRF is taken by the planning element from an academic exercise to application.

The CRF cannot be implemented without Shared Learning Dialogues (the center element, in red, in Figure 4). Participatory engagement and research techniques lead drawing Shared Learning Dialogues. Local knowledge is solicited in these dialogues and relevant global/international knowledge is introduced as well. The dialogues are structured to assure that learning is bi-directional, and dialogues are held iteratively to inform engagement and allow for increasingly detailed and informed engagement (as shown in Figure 4).

The focus of CRF is on capacity building and on utilizing pre-existing skills and knowledge throughout the planning process. As a result, the Framework can be implemented within existing development or disaster risk reduction (DRR) mandates. Throughout the CRF planning process, the focus is on capacity building and on utilizing pre-existing skills and knowledge. Consequently, the Framework can be implemented within existing development or disaster risk reduction mandates. The entire process and the individual components within the process are repetitive. To successfully engage in this work the process allowing time to build the understanding and relationships required to successful engagement.

3.1.1 Characteristics of Resilience

We can find great deal of discussion about “building resilience” and “resilient systems”, but limited exploration of what this looks like at the city level. Even there are not sufficient discussion or concrete guidance on how to achieve it. What is the standard of a “resilient city”?

Referring back to the characteristics in a regular basis, is a critical element in ensuring that assessment of and actions taken to build resilience actually increase city resilience. For this purpose, the resilience characteristics of systems, agents and institutions are explicitly included in the right-hand loop of the CRF graphic shown in Figure 1. These resilience characteristics are described below (MacClune. & Optiz-Stapleton. 2012.).

i) Systems

Urban systems consist of infrastructure and ecosystems that support the high density of human occupation and economic activity in cities. Urban systems are essential to create the productive opportunities central to urban life. Specially, main or "critical" systems are essential to urban function. These systems include water supply, food supply and the ecosystems that support these systems, as well as energy, transport, shelter and communications. Resilient systems possess is given below (MacClune. & Optiz-Stapleton. 2012.):

Flexibility and diversity: is the ability to perform various essential tasks under a wide range of conditions. Key assets and functions are physically distributed and there are multiple ways of meeting a given need (functional diversity).

Redundancy and/or modularity: There are multiple pathways and a variety of options for service delivery; and/or interacting components are composed of similar parts that can replace each other if one, or even many, fail. Redundancy is also supported by the presence of barrier stocks within systems that can compensate if flows of systems are disturbed (e.g., local water or food supplies to buffer imports).

Safe failure: is the ability to absorb sudden shocks (including those that exceed design thresholds) or the cumulative effects of slow-onset stress of natural hazards in ways that avoid catastrophic failure. Safe failure refers to the interdependence of various systems internally and externally that support each other. Failures in one structure or linkage that are unlikely to result in tumbling impacts across other systems.

ii) Agents

Agents are one of the main actors in the urban environment. They include individuals (e.g., farmers, consumers); households (as units for consumption, social reproduction, capital

accumulation); and private and public sector organizations (government departments, private firms, multinational organizations, civil society organizations). Key capacities that contribute to agent resilience include following topics (MacClune. & Optiz-Stapleton. 2012. p. 7)-

Responsiveness: Responsiveness is the capacity to organize and re-organize to establish function, structure and basic order in a timely manner in response to a disruptive event or organizational failure.

Resourcefulness: Resourcefulness is the capacity to identify and anticipate problems, establish priorities, and mobilize resources for action.

Capacity to learn: Capacity to learn is the ability to learn new skills, internalize past experiences, avoid repeated failures and innovate to improve performance.

iii) Institutions

Institutions are defined as the rules or conventions that constrain human behavior and exchange in social and economic transactions. Both formal and informal institutions are created to reduce uncertainty, to maintain continuity of social patterns and social order, and to stabilize forms of human interaction in more predictable ways. Institutional characteristics that support resilience include are following (MacClune. & Optiz-Stapleton. 2012. p. 7):

Access: Access is the clear rights and entitlements to use key resources or access urban systems.

Decision-making: Decision-making is the transparent, accountable and responsive decision-making, particularly in relation to urban development and urban systems management.

Information: Information is the facilitation of the generation, exchange and application of new knowledge. Private households, businesses and other decision-making agents should have ready access to accurate and meaningful information that is needed for functioning institutions.

3.1.2 Shared Learning

Shared Learning Dialogues are one of the most important components that are used to connect and deliver the various components of the CRF. Shared Learning Dialogues are the processes of

structured interaction designed to bring together often widely divergent communities, sources of knowledge and perspectives in a manner. It builds common understanding and enables diverse responses to different interests. SLD processes can be focused on the urban area instead of periphery as a whole or on specific systems or groups of agents that have particular vulnerabilities or relevance to climate change urban resilience (MacClune. & Optiz-Stapleton. 2012. p. 8).

The Shared Learning Dialogue process is used to combine top down and bottom up information. It is applicable in such an environment that equally values both types of knowledge and experience. This requires the removal of artificial hierarchies, barriers and building consciousness for collaborative communication. Initial dialogues focus on engaging agents and external technical or scientific experts to share knowledge from different perspectives. Later dialogues provide the space for more targeted interactions, for the active inclusion of marginal groups. Moreover, for building greater understanding among all those engaged regarding how the four main elements of the framework (systems, agents, institutions and exposure) interact in the local context.

3.2 Research Methodology

Research methodology is the specific procedures or techniques used to identify, select, process, and analyze information about a topic. In a research paper, the methodology section allows the reader to critically evaluate a study's overall validity and reliability. The methodology section answers two main questions: How was the data collected or generated? How was it analyzed?

Types of research methods can be broadly divided into two quantitative and qualitative categories.

Quantitative research "describes, infers, and resolves problems using numbers. Emphasis is placed on the collection of numerical data, the summary of those data and the drawing of inferences from the data" (Herbst, F. & Coldwell, D. 2004; Juta and Co Ltd, p.15).

Qualitative research, on the other hand, is based on words, feelings, emotions, sounds and other non-numerical and unquantifiable elements. It has been noted that "information is considered

qualitative in nature if it cannot be analysed by means of mathematical techniques. This characteristic may also mean that an incident does not take place often enough to allow reliable data to be collected" (Herbst, F. & Coldwell, D. 2004; Juta and Co Ltd, p.13).

Another type of method used in research now days is mixed method. It combines both qualitative and quantitative method.

Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the purpose of breadth and depth of understanding and corroboration (Johnson, Onwuegbuzie, & Turner, 2007. p. 112-133).

This research preferred mixed method to conduct this study. This study is basically based on qualitative method. But it needed some sort of quantitative data to explain the research question. So, it was not possible to cover the entire research with one particular research method.

However, as this study requires deep conceptual analysis to explore the research questions. Related data was collected from both primary and secondary sources.

3.2.1 Data Collection

Data has been collected from both primary and secondary sources.

Primary Source: Primary data related to climate change vulnerabilities was collected from city dwellers of different segments such as: people living in formal and informal settlements, slums etc. Also data is collected from different service providing authorities and organizations to understand challenges and preparedness of these organizations against climate change related vulnerabilities. Data is collected by using various methods including:

- Interview
- Questionnaire (given in Annex 1)
- Focus group discussion (FGD)

Secondary Source: Secondary data means the data that are already available. They refer to the data which have already been collected and analyzed by someone else. Secondary data may either be published or unpublished data. Secondary sources are-

- Working papers
- Article
- Journal
- Book

3.2.2 Sampling

Sampling is the act, process, or technique of selecting a suitable sample, or a representative part of a population for the purpose of determining parameters or characteristics of the whole population. In this research, sample size is 45 people. Of them, 5 middle class people and 40 urban dwellers of marginal classes, who were the residents of two slums; Kuril and Bosila were interviewed.

Chapter Four

Data Analysis and Results

This chapter analyzes data collected from interviews, FGD, questionnaire survey and reviews of secondary materials to answers the research questions. Analysis and findings are divided in six main parts to answer three research questions. First part discussed hazards and effects of climate change in Dhaka City. In second part other effects of climate change on urban dwellers have been discussed. In third part a SWOT analysis of disaster management of Dhaka Metropolitan Region (DMR) has been presented. Fourth section focused on the coping mechanisms by city dwellers and city authorities adapted to enhance their resilience. In fifth and sixth parts existing government policies and policy gaps are analyzed.

4.1 Hazards and Effects of Climate Change in Dhaka City

Analysis from secondary and primary data shows multidimensional hazards and effects faced by city dwellers of Dhaka due to climate change and related vulnerabilities. Some of these are discussed below:

4.1.1 Climate Induced Hazards: Sensitivity and Vulnerability in Dhaka

(i) Temperature variations

In Bangladesh, the temperature during monsoon season is projected to increase by 0.7°C and by 1.3°C in winter (World Bank (2000). These recent estimates are reflected in temperature trends within Dhaka. While the city has experienced a slight increase in temperature (March–November) over the last 30 years this average has sharply increased during the last 5 years, at a rate of 0.11°C, denoting higher rate of statistical strength.

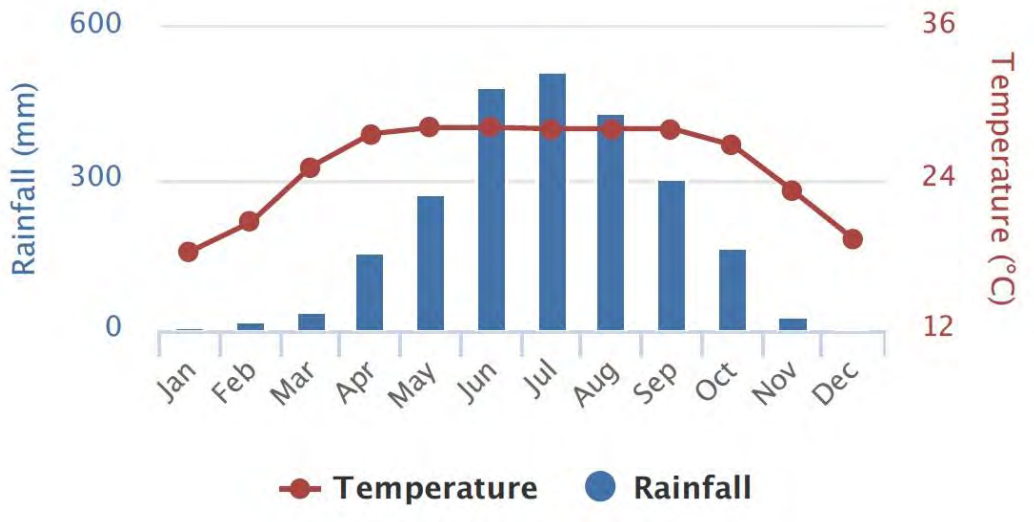
Climate induced heat and cold waves pose additional challenges for city dwellers in Dhaka. Children and the elderly are particularly vulnerable to these temperature fluctuations. These

events have been observed frequently in recent years. Towards the end of April 2009, Bangladesh faced a severe heat wave. Throughout the end of December 2009 and the first weeks of 2010, it was also hit by a cold wave. Heat waves and cold waves have damaging effects on the human body. Heat stroke, for example, affects not only health, but economic productivity at the individual level, particularly in poor income groups who are day labourers. The burden of costly health treatment in city area and the loss of productivity due to illnesses would push these poorer groups into greater poverty and vulnerability.

(ii) Variations to rainfall

A World Bank study (2000) shows an increase of annual precipitation in Bangladesh. An estimation of yearly rainfall from 1978 to 2008 reflects an average rise of about 4 mm per annum in the city (ibid.).

Figure 5: Average Monthly Temperature and Rainfall for Bangladesh from 1901-2015



Source: The World Bank, n.d

The recent estimate demonstrates that over a long-term trajectory overall rainfall does not change drastically, the trend in seasonal rainfall does. While there is no significant change in the annual average rainfall, the number of days without rainfall is increasing.

Observations also suggest that seasonal rainfall during the monsoon (June–August) and winter (December–February) in Dhaka is decreasing during these periods, while sporadic heavy rainfall is becoming more frequent. With respect to flooding and water logging in the last half of the twentieth century, Dhaka has faced flooding at least once every 5 years due to the overflow of its surrounding rivers. Of these, the 1988, 1998 and 2004 floods have been the most devastating. Figure 5 shows average monthly temperature and rainfall in Bangladesh during 1901-2015.

We can see in the above figure 5 that from 1901 to 2015 the average temperature and rainfall both have increased. In 1988, nearly 85% of the city was inundated. In 1998 and 2004, the eastern part of the city was severely affected while the western half was protected by an embankment along the Buriganga river from Gabtoli to Sadarghat. Excessive rainfall is also a serious problem in many parts of the city, which can become inundated for several days due to drainage congestion and inadequate pumping facilities.

iii) Cyclone and storm surges

Cyclones and storm surges are another climate induced threat for Dhaka. Although the city is located at the centre of the country, it remains vulnerable to cyclone events. Cyclonic wind, coupled with continuous rainfall, is particularly problematic in low-lying parts of the city, where water logging occurs due to inadequate infrastructure. Risks and vulnerabilities associated with storm surges will increase in the face of the rises in sea level predicted by various institutions.

While the World Bank has predicted a 30–50 cm rise in sea levels between 2030 and 2050 (2000) the Intergovernmental Panel on Climate Change (IPCC) places the range between 18 and 59 cm within the twenty-first century (IPCC 2007). Another recent report predicts sea level rise as much as 7 m in case of total melting of the Greenland Ice sheet. With an elevation of 2–13 m above sea level, each projection places Dhaka high on the list of cities threatened by sea level rise.

4.1.2 Non-climatic Factors: What Makes Dhaka City More Vulnerable to Climate Change?

Population: Bangladesh is the most densely populated country in the world and the rapid growth of its population, combined with strong trends of rural-urban migration, places additional pressure on Dhaka City management authorities to meet the challenging demand of providing adequate utility and other services to city dwellers, especially those in slum areas. According to the Bangladesh Bureau of Statistics (BBS), the population of Dhaka metropolitan region and the DCC are approximately 9.9 million and 5.3 million respectively. The population density of the DCC area is 19, 286/km2, which is more than double the mega city average of 7,918/km2 (Rabbani, etal. 2011).

Poverty and poor living standards: Dhaka's densely population is largely poor, with approximately 50% of Dhaka City earning less than US$2 per day (ibid.). Most of the poor population lives in slums and squatter dwellings frequently exposed to flooding and water logging and without access to safe water and sanitation services. Sea level rise and higher intensity of cyclone events may cause increases in both internal and external migration, placing further stress on poverty-inflicted areas within Dhaka's urban slums.

Access to services and utilities: Many city dwellers lack access to safe water supply and sanitation, electricity, gas and solid waste management. Existing services are insufficient for city residents, and the capacity to deliver services to city residents, particularly electricity and water supplies, is affected by climate-related impacts. For example, while DWASA can usually meet around 70% of water demand in the city, the supply is stretched in the face of increased demand in pre-monsoon periods.

4.2 Other Effects

Besides these effects there are many types of effects of climate change on the city dwellers. Specially people who lives in slums in a vulnerable condition they face it more than others. The effects are presented in Table 2.

We can see that highest number people have said that their major encounter with problems occurs in terms of livelihood. The total number of respondent was 45. Among them, 40 people responded yes in answering the question regarding living. Next to livelihood major affected area is daily life. 38 respondents shared their daily life struggles because of climate change affects. It is also found from the primary data that health is a foremost in climate change. 35 respondents

Table 2- Types of Problems

Problems	Yes	Percentage	No	Percentage
Daily life	38	84.44 %	7	15.56 %
Livelihood	40	88.89 %	5	11.11 %
Health	35	77.78 %	10	22.22 %
Women	25	55.56 %	20	44.44 %

Source: Field Survey

reported that their physical resilience is getting more vulnerable because of newly emerged seasonal diseases. However, almost every female respondent claimed that they experienced all of these problems two times more than a male member of their family.

Responses are also presented illustratively in Figure 6. Types of problems have been categorized in three aspects: livelihood, daily life and health.

It is revealed that 35% of the surveyed people struggle with challenges in livelihood because of climate change. People who belong to lower class and who earn from hand to mouth face immense challenge. Many respondents stated that during bad weather they cannot go outside for earning. Since they steps their foot outside, they fail to manage any job for that day.

Daily life crises are also to be mentioned here by 34% people. Respondents from middle class have admitted this as well. People face challenges in going to their destination specially who moves towards office and educational institution.

Chart 1- Problem faced in the aspects of life

And health issues are a matter of concern as well. The patterns of diseases are changing and number of people getting affected from these are increasing as well. 31% people said that they suffer from diseases during monsoon and this rate is getting higher than before.

4.2.1 Effects on Daily Life

Hazards and effects of climate change affect the daily life of city dwellers, said 84.44 % of the respondents. It hampers their mobility. The amount of rainfall is increasing day by day. Even an hour of heavy rainfall causes water logging in busy areas like Mirpur, Malibag and Dhanmondi. School going children and office going people suffer a lot because of this situation. It becomes a challenge to manage a public transport to reach to the targeted destination on time.

Some respondents living in the slum shared that their children cannot go to school during this type of situation. It became a very common situation that roads in front of their home get drawn and cannot go out. They have to cross that watered road which is mixed with drain water to go to the school.

But the problem not ends here. If they reach school anyhow they found the same situation in school. The school playground or field gets drawn because of monsoon. Many times water enters the class room which is a very disappointing scenario in a capital city.

A student of Dhaka University said that water logging in monsoon in the campus area is very common. It becomes very difficult to move from one academic building to another because of it. Female students face more challenges during this situation. Thus, climate change effects interrupt the social mobility of people of every age and class.

4.2.2 Effects on Livelihood

Climate change has a very crucial impact on livelihood. We found in many cases that people's lives in a very poor condition are highly vulnerable to climate change effects especially in terms of livelihood. During the days of bad weather daily laborers have to remain inside home. Even if they could manage to got outside, the chance of getting work is very low. It is a gloomy reality that they lead to starvation for those days. 89 % respondents have said that climate change is hampering their livelihood.

A 35 years old female respondent, living in the Bosila Metro Housing in Dhaka said that during rainy days their life become more miserable. It becomes almost impossible for her to go out for work as she is a house maid. Once due to heavy rain and storm roof of her home blown off and it took three days for her to repair it. At the same time, she lost her job because she couldn't go to her work for three days.

Another 30 years old male respondent who is a mason has said that he hardly gets any job in heavy monsoon. In maximum cases he uses to stay at home because there is no work available outside during those days. It leads to starvation for him as well as for his family.

4.2.3 Effects on health

Climate change has been an issue for health. Balancing with climate change the pattern of diseases has changed as well. People experience new and re-emerging infectious diseases such as severe acute respiratory syndrome, pneumonia, influenza, swine flu (H1N1), tuberculosis (TB), hepatitis, malaria, cholera, chikungunya, meningitis, food-borne gastroenteritis, salmonellosis, and campylobacteriosis continue to threaten global public health as well as Bangladesh.

Most of the respondent said that the waste management system is not satisfactory at all. During the monsoon waste from dustbin float around and spread bad smell. It is further revealed that City Corporations do not take necessary steps to remove those garbage or take any step to unblock water lodging. This causes diseases to their children but also to themselves as well. Visiting doctors for diseases is a luxury for them. 78 % of the respondents complained that in every monsoon the incidence of disease increased.

A 30 years old female respondent at Korail said that it became an untold rule that in every time of seasonal change especially in monsoon, at least a child got severely sick and have to get admit to the hospital. It proves that though the public health conditions have improved a lot, it's still a matter of concern.

4.2.4 Effects on women

It is said that women are the poorest among the poor and the most vulnerable among the class of vulnerable people. This study found that climate change hazards at first affects the social mobility of a woman.

Around 56 % of the surveyed women said that due to disaster prone weather they could not go outside for work in most cases. When it comes to a situation where between husband and wife only one can go outside for work and another has to stay at home to look after the children, it always has to be the woman. Due to this they lose their job sometimes.

A 15 years old girl said that during the days of heavy rain she use to miss school. To go to the school she has to cross the drawn road which makes her dress wet. Even if she goes to school

somehow she cannot use the washroom of school. It became unusable and dirtier in rough days. Thus, analysis in above paragraphs shows city dwellers faces a lot of challenges because of climate change.

4.3 SWOT Analysis of Disaster Management of Dhaka Metropolitan Region (DMR)

Strength (RAJUK, 2016):

- Adequate number of legal backup in place to control and monitor the activities of development
- Presence of water channels around the city
- Increasing recognition of the need to reduce the adverse effects of natural hazards on urban and peri-urban areas
- Access to water supply for fire extinguishing

Weakness (RAJUK, 2016):

- Lack of coordination at implementation stage could hinder progressive development
- Poor drainage systems in many municipalities lead to flooding
- Weak enforcement of protection policies for flood plains, hazard prone and low lying areas
- Failure to execute building control regulations
- Weak enforcement of protection policies for flood plains, hazard prone and low lying areas

Opportunity (RAJUK, 2016):

- Incorporating Disaster and Risk Management at planning stage will greatly reduce the risks and vulnerability of the people and community
- Risk reduction as a strategy for development will have long- term advantages for communities and for the institutions involved in disaster management and mitigation

- Availability of sufficient water bodies

Threat (RAJUK, 2016):

- Vulnerability to flooding due to indiscriminate filling of water retention and flood flow areas
- Over dependency on ground water
- Presence of vulnerable building
- Fire hazards of the interlocked construction is high and the problem is multiplied by poor access
- Lack of proactive initiative of the responsible organizations could thwart any form of development being proposed in the area
- Presence of a number of informal settlements in highly hazard exposed and vulnerable locations
- Filling and encroachment of flood plains and water bodies; Presence of vulnerable and dilapidated buildings (RAJUK, 2016).

4.4 Coping Mechanisms by City Dwellers and City Authorities

In this part the effective coping mechanisms are discussed briefly. To understand the importance of multi stakeholder collaboration we have to explore the status of stakeholder collaboration, positive aspects of collaboration and multi stakeholder collaboration.

4.4.1 Multi-stakeholder collaboration and climate resilience

Status of stakeholder collaboration

The field work identified only project-based collaborations among stakeholders and communities. When an NGO initiates any project with other partners they collaboratively maintain some steps (Alam, Alam & Rahman, 2015, p. 31):

- Make an assessment of the area
- Prioritize needs, ensure citizen voices in action (raising awareness)
- Organize stakeholder meetings
- Divide activities on the basis of the component
- Develop an action plan
- Form WASH committees and
- Implement the project and follow up.

Collaborating with partners like this has made these projects successful and they have been completed on time. The national policy adviser for the Bangladesh Urban Forum (BUF) describes some key points of a successful collaboration from his experience which was implemented in the capital city after the flood in 2004.

To implement project activities, partners arranged at least monthly meetings involving community members, who submitted the status of their assigned tasks. Moreover, they also discussed and finalized work plans for the coming months. To implement projects in the water and sanitation sector it is necessary to have support from the government and especially DWASA and the city corporation.

This is why they also involved representatives from those organizations. During the monthly meetings, stakeholders shared their experiences in working with the partner organizations to smoothly run their activities to schedule. After successfully implementing the project they shared the results and their achievements with other organizations.

Positive aspects of collaboration

All the stakeholders who took part in this study expressed their positive experiences while working in collaboration with other organizations. However, this type of collaboration is mostly based on partnerships between similar organizations. One of the most important benefits of stakeholder collaboration is to reduce the chance of overlapping.

When multiple stakeholders work together, every party can share their ideas, thoughts, knowledge and working procedures which ensures the maximum use of resources enhance communication and networking and bring diversity to the work. Moreover, this collaboration also helped the NGOs in their mandate to approach government.

When different organizations collectively seek to modify or change any policy it is always beneficial if the government helps them. In addition, collaborations can bring about positive policy dialogues in areas that require policy or even legal reform. Representatives can also bring evidence-based experiences to promulgate for necessary policy change (Alam, Alam & Rahman, 2015).

Improvements to multi-stakeholder collaboration for urban climate resilience

To ensure climate resilience in the urban area, the following steps should be followed (Alam, Alam & Rahman, 2015):

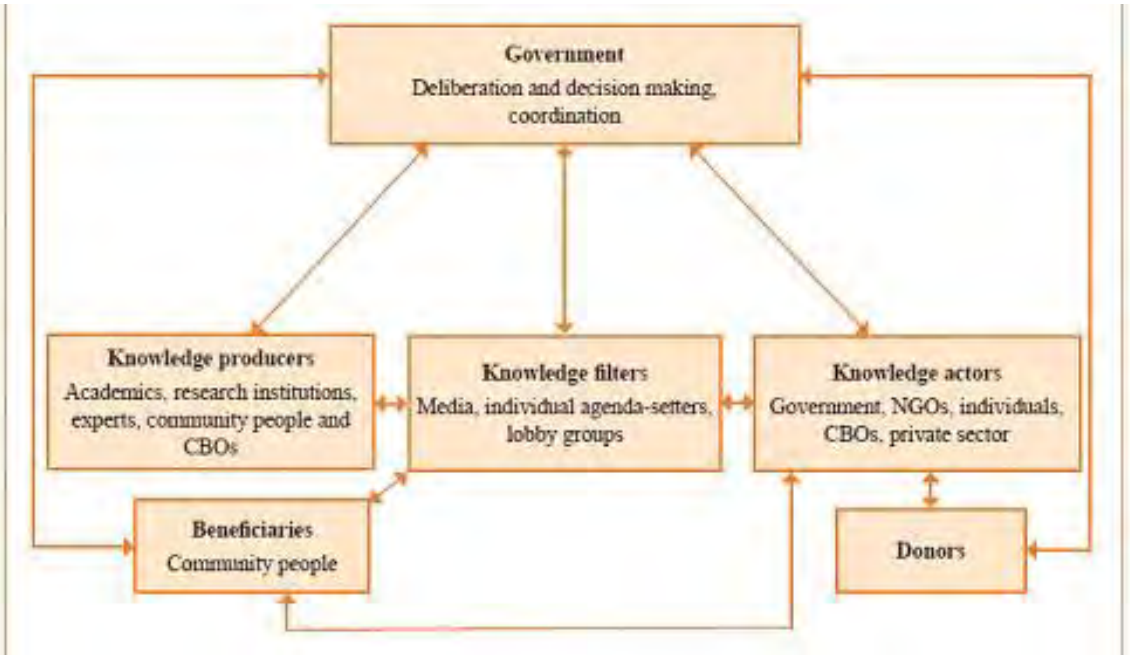
Firstly, national government must formulate a group to coordinate the work where the responsibilities of every actor should be outlined. This coordinating group should act as the backbone organization to determine the responsibility of all the stakeholders. By the actions of this group, coordination among the key government agencies (DWASA, Dhaka City Corporation, Ministry of Housing and Public Works etc.) will be increased.

Resilience also means retrospective maintenance of existing infrastructure and this group must ensure this point, too. Government policymakers and other stakeholders should develop a policy with long- and short-term strategic action plans by consulting with all relevant stakeholders, experts and advisors etc. This group should ensure inter linkages between different policies by revising them. Policymakers are also responsible for addressing the issue of climate change in all policies.

Secondly, research organizations and academics should conduct research, including understanding the potential future impact of climate change by considering historical and projected data and considering the present infrastructure and coping capacities of low-income

groups. Media and lobbying groups have a role to play in communicating scientific findings to local communities, policymakers and other stakeholders.

Figure 6: Diagram of stakeholder collaboration for bringing resilience to the urban sector



Source: Alam, Alam and Rahman, 2015

Thirdly, the private sector should play a key role in the development of Bangladesh. They should be included as stakeholders as industrial waste is disposed into rivers which cause water logging during flooding. Also, the private sector employs people living in informal settlements as labour, so it is important for those people to be healthy.

Furthermore, a good number of projects for the improvement of water and sanitation have been completed but development has not yet happened. Analysis of those implemented projects might

provide quality information which will provide guidance on how to plan successful project initiatives.

Fourthly, to play a key role in urban climate resilience NGOs must have a long-term strategic plan. By initiating a long term strategic plan they can form a platform in collaboration with other NGOs who are working in different sectors. This platform of NGOs should lobby government about different demands for improving plans to ensure the flexibility of resilience planning.

Representation in urban policy dialogues could ensure the process runs smoothly. Government can be supported by researchers and academics. NGOs also have the capacity to mobilize slum dwellers quickly and efficiently.

Urban climate resilience could be achieved within the short term if the capacity of CBOs was also developed quickly. Here, NGOs can play a vital role in building CBO capacity through proper mobilization and training until the CBOs are able to arrange their finance themselves. They can also act as a bridge between the communities and policymakers. Figure 6 explains the entire concept in brief.

Lastly, monitoring and evaluation is a very important part of project cycle management. The coordination group should be able to evaluate the limitations and successes of every activity. This could be done by NGOs or donors can monitor directly. This action will be helpful for developing the strategic action plan further.

After formulation of the guidelines and plans, NGOs can develop collaborations among themselves in the usual, way but they would have to report their every activity to the coordinator so that follow-up can be ensured. Moreover, this will also reduce the chance of duplicity.

4.5 Existing Government Policies

Dhaka City is administered through a number of plans and policies developed by ministries, departments and agencies. Some of the key policies and plans include: the Dhaka Land Management Project 1994 produced by DCC; the Dhaka Metropolitan Development Plan, 1997, produced by RAJUK; the Detailed Area Plan, 2004 produced by RAJUK; the Dhaka Urban

Transport Project (DUTP) produced by Dhaka Transport Coordinator Board (DTCB); and the Master Plan for Solid Waste Management in Dhaka City, 2005 produced by DCC (Rabbani, etal. 2011)

Bangladesh's regulative framework for disaster management provides for the relevant legislative, policy and best practice framework under which the activity of Disaster Risk Reduction and Emergency Management in Bangladesh is managed and implemented. The framework includes:

Disaster Management Act 2012 (GOB, 2014)

Disaster Management Act of Bangladesh was passed in the parliament on 24 September, 2012. This Act has established legal cover under which disaster risk and emergency management will be undertaken in Bangladesh, and the legal basis in which activities and actions will be managed. It will also create mandatory obligations and responsibilities on Ministries, committees and concerned authorities to comply. Before the Act, the country already had National Disaster Management policy which was good enough as expressed commitment but this was not legally enforceable.

Following passing of this Act, Government of Bangladesh established the Disaster Management Department for more effective management of all types of disaster in Bangladesh in a coordinated manner.

Under legal cover of this Act, Disaster Management Committees have been established from national level to Union level with defined roles of various authorities.

Disaster Management Policy 2008 (GOB, 2014)

The Overall Objective of the Disaster Management Policy is to strengthen the capacity of the Bangladesh disaster management system to reduce unacceptable risks and improve response and recovery management at all levels.

The strategic goals of the policy are drawn from the SAARC Disaster Management Framework are given below:

1. Professionalizing the disaster management system

2. Mainstreaming risk reduction

3. Strengthening institutional mechanisms

4. Empowering communities at risk

5. Expanding risk reduction programs

6. Strengthening emergency risk reduction systems

7. Developing and strengthening networks

Standing Orders on Disaster (GOB, 2014)

The Standing Orders on Disaster describes the detailed roles and responsibilities of committees. Ministries and other organizations in disaster risk reduction and emergency management, and establish the necessary actions required in implementing Bangladesh's Disaster Management Model. The Standing Orders have been prepared with the avowed objective of making the concerned persons understand their duties and responsibilities regarding disaster management at all levels, and accomplishing them. All Ministries, Divisions/Departments and Agencies shall prepare their own Action Plans in respect of their responsibilities under the Standing Orders for efficient implementation.

4.6 Major Policy Gaps

Though there are many laws and policies we didn't find its implications. Some major policy gaps that have been identified is described below-

- Number of authorities is a big problem. There are several authorities in local administration in our country. They can easily blame each other for not delivering the service properly. Dhaka city was split into two city corporations for delivering service properly. Respondents from two different city corporations said that they did not get service like waste disposal properly.
- There is duplicity of policies. So, it is not clear that which authority is employed to do what.
- Policies are backdated. All policies need to be updated.
- Most importantly while preparing any policy local knowledge should be included. Resident of a particular area knows better than any expert about the problems and potentials of his area. For this some local residents should be included in decision making committees.
- Government is aware of preparing policies but not aware of implementing policies. If existing act and policies are followed properly people would not suffer this much and the resilient system of Dhaka city would have improved a lot.

Chapter Five

Summary and Conclusion

5.1 Summary

This research is intended to measure the contingent effects and coping mechanisms for climate change. It discussed the climate change related vulnerabilities in Dhaka city as well. It also proposed some plans or recommendations to mitigate the effects of climate change to make Dhaka city resilient. Analysis shows, most of the slum dwellers of Dhaka are unfamiliar with the term climate change. They can mark the changes in current weather patterns or variations in temperature compared to the past, or a shift in rainfall occurrences in this decade. However, they think that rain and weather changes are the blessings of Almighty. So, there is nothing to do rather suffering. They have a fear and uncertainty that extreme events like the floods of 1998 and 2004 could reoccur, that would damage their households and other infrastructures like roads, schools, mosques etc. in the community.

Analysis of primary data also shows that affiliation of NGO is different in different areas. There is discrimination in providing assistance here. It is found that NGOs assistance is centered in some slums like Korail and in some areas like Bosila it is found opposite. In some cases people blamed that NGOs only work for rural poor and they hardly get any service from NGOs. Political representatives are not conscious about them. People only see them during election.

This research findings shows that the major effects of climate change in Dhaka city are both natural and manmade. Bangladesh is considered as the most vulnerable country in terms of climate change in the world according to some international reports. So the city of Dhaka has already started experiencing excessive flood, heat and other weather changes. This research categorized the effects on urban dwellers on three major categories. They are the effects on livelihood, daily life and health. It restrains people's daily income, mobility and causes diseases.

Many government organizations are working in Dhaka for providing citizen service. But lack of coordination among those organizations has hindered their activities. Not only that they are lack

in finance and manpower to perform their duties. Although NGOs are working to fill up the gaps as well, most of their work is projects based. And unfortunately, they terminate their interventions after the completion of the projects or after termination of the projects because of the crisis in funding. After a disaster situation like waterlogging or floods, poor infrastructures in slum areas become dysfunctional due to the absence of any proper maintenance.

However, we are living in the age of climate change. To cope with this situation we have to be more updated with laws, policies, strategies and tools. Consciousness building among multi-stakeholder is a long term process that enables open communication and greater clarity of roles and responsibilities. We badly need collaboration among all stakeholders. It can change the scenario in real. City dwellers, government agencies and NGOs all need to work together proactively to cope with it and make the city of Dhaka livable and resilient.

5.2 Recommendations and Guidelines

Some recommendations and policy guidelines are given bellow-

5.2.1 Prepare Comprehensive Risk Sensitive Land Use Plan

Land-use planning provides a set of useful planning tools for mainstreaming DRR (Disaster Risk Reduction) such as mapping, zoning and participatory planning. Risk-sensitive land-use planning requires an assessment of risks (including hazards, vulnerability and capacity). To display the zones risks are mapped throughout a city with various levels of risks. Sometimes development can turn into disaster. So, it is necessary to ensure safety of the development taking place in vulnerable areas that might become victim of disaster (RAJUK, 2016, p. 232).

Strategic Action:

- Insert the issue of risk sensitivity in the land use planning.

Implementation Tools:

- Include Disaster Risk Impact Assessment prepares urban land use planning taking account of the risk sensitivity of areas.
- Identifying shelter places during the hazards like earthquake, fire incidents etc. to use.

- Areas those are flood flow should avoid reclamation
- Should prepare zoning planning and try hard to maintain the zoning guidelines
- Respect local knowledge to deal with environmental issues connected with slums.

Implementing Agency:

- Implementing agencies are RAJUK, Local Government Agencies, and Directorate of Disaster Management.

5.2.2 Prepare Multi Hazard Risk Mapping for Dhaka Metropolitan Region

Multi Hazard Risk Mapping would enable to identify areas safe for habitation and other development (RAJUK, 2016).

Strategic Action:

- Firstly prepare a project to execute mapping.

Implementation Tools:

- To prepare Multi Hazard Risk Zoning Maps for the entire DMR (Dhaka Metropolitan Region), RAJUK and Directorate of Disaster Management shall immediately take up a project
- Prepare a map with risk information such as evacuation routes, and location of temporary shelters and critical facilities (hospitals, schools, etc.)
- To identify safer locations for development initiatives by building an urban risk profile
- Maintain an updated map with details and their level of vulnerability

Implementing Agency:

- RAJUK, Directorate of Disaster Management, Local Government Agencies.

5.2.3 Monitoring and Evaluation of Flood Protection Embankments around the City

To examine the strength and sustainability of embankments encircled around the city during a heavy flood or an earthquake with moderate to high intensity we need a detail monitoring and evaluation plan. (RAJUK, 2016, p. 235)

Strategic Action:

- Regular monitoring and reporting by BWDB can be helpful.

Implementation Tools:

- BWDB should make a regular routine program to visit and monitor the condition of embankments encircled around the city within a regular gap like six months and report to the higher authority for necessary action.

Implementing Agency:

- Water Development Board in association with other agencies

5.2.4 Building Urban Resilience to Floods

To an extend we need to allow water of folds to enter the city, so that we can learn from them. And thus it will help to become more resilient to extreme ones (RAJUK, 2016). It is seen that cities those are dependent on flood-control infrastructure tend to address only the river and not the built environment because flood-control infrastructure.

Strategic Action:

- Cities are becoming intolerant to wet conditions because Cities that are dependent on flood-control infrastructure are highly resistant but not resilient to floods as they have physically adapted to the artificially expanded dry-and-stable conditions

Implementation Tools:

- Flood water can be useful sometimes. To convey and store floodwater during wet seasons open spaced can be used effectively;

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- Infrastructure can be redesigned into such a way so that the diverse functional elements will be flexible in operation;
- Building planning can be renovated to have elevated, floatable, or wet-proofed buildings;
- Identify areas those are flood plains and water retention area.

Implementing Agency:

- RAJUK, BWDB, Local Government Agencies, HBRI

5.2.5 Others

Above all this recommendations building awareness among people is the most important thing to do. We have many policies regarding disaster management and acts but people hardly know about all this. NGOs can play a vital role to make people educate on their legal rights.

There are sufficient policies and laws regarding DRR in Bangladesh. But the problem is implementation. Law enforcement authorities don't give effort to implement these rules. So implementation of policies in service delivery is needed.

Policies need to be updated. On the other hand, duplicity of polices has to be ignored. Coordination among government offices is also needed to avoid red tapes in implanting policies.

And another important issue is proper urban planning. Dhaka is going through rapid urbanization with enormous challenges. In this situation increasing pressure on public services is increasing the threats related to climate change. We need adequate open urban space, modern wastage disposal system and more greenery to build Dhaka as a urban climate resilient city.

5.3 Conclusion

Climate change is the biggest threat and Bangladesh is one of the most vulnerable countries to climate change, impacts are already evident. Analysis shows Dhaka is currently lacking proper resilience mechanisms where combination of multiple climatic factors such as temperature variation and erratic rainfall is causing disturbance in the sound city life. On the other hand, non-

climatic factors such as population density and poverty are affecting city life as well. Socio-economic uncertainties of Dhaka's city dwellers, one-third of whom live in slums, paying a lot because of climate change effects, risks and hazards.

In responding climate change related risks and vulnerabilities the major responsibility goes to city authorities. However, in Dhaka in one hand city authorities has various types of limitations and on the other hand urban adaptation issues still receive limited or sometimes least attention in central government policies. In fighting with climate hazards and thus enhancing urban resilience government plans and policies should ensure the implementation of laws combined with the efforts from different stakeholders through a holistic approach.

The focus of this research was to explore the climate effects in Dhaka city and to explore to enhance resilience for such effects. This research importantly tried to find out the gaps in existing research and policy, this paper has presented an analytical climate resilience framework to present the understanding the concept of vulnerability, the process of building resilience and sharing existing knowledge. At the conceptual level the research is built on a livelihood-based understanding of urban poverty, vulnerably, urban climate resilience that recognizes multiple sources of deprivation that people in lower use to face. Poor people in the city of Dhaka are struggling to build resilience in response to environmental and climatic change.

The research methodology includes a number of features designed particularly to ensure public service and policy relevant findings. These include: FGD with slum dwellers, interview of different classes of people living in Dhaka with open ended questionnaire. From data analysis this research found that city corporation is not active in addressing this issue. There are sufficient numbers of existing policies but the rate of implementation is very low. People hardly know about these policies. Though a multi stakeholder engagement we can reduce these problems and can build resilient Dhaka city. Finally, by implementing the measures suggested in this study will help the city and its inhabitants to overcome problems induced by climate change.

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Annex A

Questionnaire for slum dwellers and urban resident

Name:

Age:

Occupation:

Q 1. Do you face any problem because of rainy season?

Q 2. What are they?

Q 3. Do you think seasonal changes are affecting your living?

Q 4. Does City Corporation take any step to reduce the problems?

Q 5. Do you get any service from NGOs?

Q 6. What do you do to solve these problems?

Q 7. Do you have any suggestion?