Impact of Climate Change on the Livelihood of the Urban Poor: a Case of Dhaka City

Abu Nayeem Md. Maruf Khan

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Master in Public Policy and Governance Program
Department of General and Continuing Education
North South University, Bangladesh

Dedicated to -

All the poor people of Bangladesh

who are affected by climate change

ABSTRACT

Bangladesh is widely recognised to be one of the most climate vulnerable countries in the world. It experiences frequent natural disasters, which cause loss of life, damage to infrastructure and economic assets, and adverse impacts on lives and livelihoods. Urban poor are extremely vulnerable to this climate change impact and the impact is even stronger in the case of Dhaka city. Global warming driven climate change affect Dhaka primarily in two ways: through floods and drainage congestion and through heat stress. Most of the poor urban dwellers in Dhaka live on the worst quality land: on the edges of ravines, on flood prone embankments, on slopes liable to mudslide or collapse or in densely packed areas which are the most vulnerable to climate change. The slum dwellers are very important for the Dhaka city since they are keeping the economy going through their hard toil and providing most of the necessary services to the city dwellers. Therefore, it is crucial to increase the understanding of the actual climate change dynamics on urban poor and on their livelihood especially in Dhaka as the capital city is carrying the highest number of urban poor people. This study uses four slums in Dhaka- Bhashantek and Baganbari at Mirpur, Karail at Mohakhali and Basila at Mohammadpur, for case study and examines Dhaka's climatic trends and its impacts on the livelihood of the poor. It also answers the questions how vulnerable they are and why, what are the local and institutional coping mechanisms, and what are the constraints that exacerbate vulnerability. The study identifies the vulnerability due to lack of accountability, capacity of urban institutions as well as lack of implementation of related policies, rules and regulations. The study uses semi-structured interview to garner data from local society, government officials and experts, and secondary data from published and unpublished sources, and systematically analyzes this material both using qualitative and quantitative data. The result shows that the poor's livelihood are usually vulnerable to flood, extreme temperature as well as waterlogging due to urban institutional inefficiencies. Climate change makes them more vulnerable. The study also shows the trend of gradual and extreme weather change is particularly negative for the livelihood of the urban poor in Dhaka. The major impacts are damaging of shelter and other household assets, unavailability and polluting of water, suffering from diseases like diarrhoea, dengue, scabies etc., problem of sanitation and loss of work or income. To cope up with the impacts the poor take shelter on the road or to school, take loan from relatives or neighbours, use saving and sometimes cut off their daily meal. They somehow sustain with the situation as the extreme events are unstoppable and cannot be altered. The livelihood assets of the poor are very limited and distressful. If the extreme events happen quite recurrently according to the projection of IPCC and to other scientific models and researches, it will be absolutely impossible for them to adapt or cope up with the impact with their narrow resources. The study suggests a relentless need to address these challenges both from short and long-term institutional and policy perspective.

Key Words: *Climate change, livelihood, urban poor, impact, urban institutions, coping mechanism*

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ACRONYMS

BBS	Bangladesh Bureau of Statistics
BSTI	Bangladesh Standard and Testing Institute
BCAS	Bangladesh Centre for Urban Studies
BMD	Bangladesh Meteorological Department
CUS	Centre for Urban Studies
DAP	Detailed Area Plan
DCC	Dhaka City Corporation
DFID	Department for International Development
DMA	Dhaka Metropolitan Area
DWASA	Dhaka Water Supply and Sewerage Authority
GCM	General Circulation Model
ICDDRB	International Centre for Diarrheal Disease and Research, Bangladesh
IFCDR	Integrated Flood Control and Disaster Research
IPCC	Intergovernmental Panel on Climate Change
NGO	Non Governmental Organisation
NAPA	National Action Plan for Adaptation
OECD	Organization for Economic Co-operation and Development
RAJUK	Rajdhani Unnayan Kartripakkha (Capital Development Authrity)
UN-HABITAT	The United Nations agency for Human Settlements Programme
UNFCC	United Nations Framework Convention on Climate Change
WB	World Bank
WHO	World Health Organisation
WMO	World Meteorological Organisation
WWF	World Wildlife Fund

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Chapter 1

Introduction

1.1 Background of the Research:

Climate change is already a reality and today it is widely agreed by the scientific community. The Intergovernmental Panel on Climate Change (IPCC) has concluded that human activities are altering our climate system and will continue to do so. Over the past century, surface temperatures have increased and associated impacts on physical and biological systems are increasingly being observed. Science tells us that climate change will bring about gradual changes, such as sea level rise, and shifts of climatic zones due to increased temperatures and changes in precipitation patterns. Also, climate change is very likely to increase the frequency and magnitude of extreme weather events such as, floods, storms, and droughts. While there is uncertainty in the projections with regard to the exact magnitude, rate, and regional patterns of climate change, its consequences will change the fate of many generations to come and particularly impact on the poor if no appropriate measures are taken.

Bangladesh is frequently cited as one of the most vulnerable countries to climate change because of its disadvantageous geographic location; flat and low-lying topography; high population density; high levels of poverty; reliance of many livelihoods on climate sensitive sectors, particularly agriculture and fisheries; and inefficient institutional aspects. Many of the anticipated adverse affects of climate change, such as sea level rise, higher temperatures, enhanced monsoon precipitation, and an increase in cyclone intensity, will aggravate the existing stresses that already impede development in urban and rural Bangladesh, particularly by reducing water and food security and damaging essential infrastructure. These impacts could be extremely detrimental to the economy, the environment, national development, and the people of Bangladesh (European Parliament, 2008).

Bangladesh, with a population of 147.4 million[1], is one of the poorest countries in the world. It has an urban population of about 35 million, or just about 23.1[2] percent of its total population and 50 percent of them are poor. The country will likely have an urban population

[1] CIA, Central, Intelligence, Agency. The World Factbook. *Accessed*
[2] Population Census 2001, July 2003, BBS

approaching 50 million by 2015. This rapid growth has been due primarily to migration by the rural poor, particularly to large metropolitan areas. On arrival, these poor migrants routinely turn to slums and squatter settlements for shelter. All major urban centers in Bangladesh have slums and squatter settlements, the largest concentrations being in Dhaka, followed by Chittagong, Khulna and Rajshahi. In a 1996 survey for the Asian Development Bank and the Government of Bangladesh, the Centre for Urban Studies (CUS) found 3,007 slums and squatter clusters with a minimum of 10 households and roughly 1.6 million slum dwellers (out of a population of 5 million) in the Dhaka Metropolitan area alone. In 2005, Dhaka had an estimated 3.4 million people lived in some 5000 slums[3] and in 2010, the population of the city of Dhaka has been projected at 17.6 million people, with up to 60% in the slums. Slums and squatters in Dhaka are characterized by poor housing structure, lack of safe water and unsanitary life. For living most of slum dwellers depend on informal and temporary job. Female adults and children are tended to work as housekeepers, laborers or in garment piecework, while male adults and children tended to work as rickshaw pullers, laborers, brick breakers, drivers or carpenters.

Dhaka, the capital of Bangladesh, is the fastest growing megacity in the world, with an annual growth rate of 4.4 per cent and population of 14 million, is one of the most unplanned urban centres in the world (UN-HABITAT, 2009). The expected impact of climate change to this city and its potential for disaster is frightening. Experts believe that the melting of glaciers and snow in the Himalayas, along with increasing rainfall attributable to climate change, will lead to more flooding in Bangladesh in general, especially in cities located near the coast and in the delta region, including Dhaka. Dhaka may also experience increased temperatures from rising levels of vehicle exhaust emissions, increased industrial activity and increased use of air conditioning. The urban poor are therefore especially vulnerable to the impacts of climate change, because of the fragility of the infrastructure of slums and squatter settlements, lack of sanitation, and lack of employment security.

1.2 Statement of the problem:

Far from being an issue that only has implications for energy supply or the environment, climate change touches all the resources that we depend on in life. In particular, the current

[3] Islam N. Slums of Bangladesh Mapping and Census, CUS, 2005

and future impacts of climate change will hurt the well-being of the poor and vulnerable. Climate change puts extra burdens on the social and economic challenges that the poorest people already face. Their vulnerabilities will be emphasized and increased due to the dependence of their livelihoods on climate sensitive natural resources and their weak social protection structures. By directly eroding the resources that poor people depend on for their livelihoods, climate change makes it easier for people to fall into poverty and harder for the poorest to escape from it.

Most of the poorest urban dwellers in Dhaka live on the worst quality land: on the edges of ravines, on flood prone embankments, on slopes liable to mudslide or collapse or in densely packed areas which are the most vulnerable to climate change. An estimated 7,600 households live in slums that are within 50 meters of the river and are in frequent risk of being flooded (WB, 2007). Floods in dense, poorly serviced settlements also lead to other hazards, which have a significant impact on the health of urban poor residents. During flood even poor people lose their jobs or become bound to change their occupations. The potential impacts of climate change on human health, haven and employment consequently increase vulnerability and reduce opportunities for their livelihood.

1.3 Illustration of the problem

Dhaka is most vulnerable of the 11 coastal and delta cities in Asia examined to climate change impacts. This large, relatively poor city sits just meters above current sea levels, is regularly impacted by tropical cyclones and flooding, and has very limited adaptive capacity (WWF, 2010). Severe flooding has already impeded the development of Dhaka significantly, but of the eight major floods that have occurred in the last 50 years, the three most recent (1988, 1998, and 2004) have been the most damaging (Reid and Sims, 2007). The key sectors affected by floods are infrastructure, industry, commerce and utility services. Productivity reduces in during and after major flooding increases the vulnerability of the urban poor. Further, as the adverse impacts of climate change on rural areas cause increased migration to urban areas in search of non-agricultural employment, they are putting greater pressure on scarce housing, water, sanitation, and energy services (Kelkar and Bhadwal, 2007) and increasing the number of vulnerable urban poor who are particularly at risk from climate related disasters.

Rainfall data of The Bangladesh Meteorological Department from the Dhaka station for 1971 to 2005 shows that the annual average rainfall in the city is about 2,120 millimetres, of which about 50 per cent falls during the months of June, July and August, generally referred to as the monsoon season. Average rainfall during the winter months (December, January and February) is negligible, less than 2 per cent of annual rainfall. Although there is no significant change in annual average rainfall, the number of "days without rainfall" is increasing. Second, seasonal rainfall data in both the monsoon (June, July, and August) and winter (December, January, February) seasons show a decreasing trend over time. The data on annual average rainfall and "days without rainfall" indicates that more rainfall is occurring in other months of the year and that rainfall intensity is increasing (Alam and Rabbani, 2007). The impacts can already be seen. Hospital admissions of people with diarrhoeal disease increase during both high and low extremes of rainfall in Dhaka (Dodman, 2008).

Climate change is associated with hotter summers and colder winters. Temperatures in Bangladesh have increased about 1°C in May and 0.5 °C in November between 1985 and 1998, and further temperature increases are expected. However, although the overall climate is warming, temperature extremes are increasing, and winter temperatures as low as 5°C have been recorded in January 2007, reportedly the lowest in 38 years (Reid and Sims, 2007).

Dhaka may also face 'heat island' problems, because temperatures in the city are a few degrees higher than in surrounding areas (UN-Habitat, 2009). Precipitation extremes will result in increased rainwater flooding, both because of the increase in monsoon rains, and also because of the increased incidences of flash floods associated with increased intensity of precipitation interrupted by sustained dry spells, increasing the surface runoff when the rains do come.

Floods hit nearly half of the total area of the city. Around 40 per cent of the population lives in "slums" and squatter settlements; they draw their livelihoods from industry (e.g. garments, textiles, leather etc.), the transport sector, shopping centres, hotels and restaurants, the construction sector and as domestic workers. These people are severely affected by floods, waterlogging and other relevant problems (Alam and Rabbani, 2007).

In the service sector, essential services are provided by the laundrymen, barbers, shopkeepers, newspaper boys, food vendors, rickshaw-pullers, bus and truck workers, sweepers,

carpenters, electricians and plumbers. In fact, almost any kind of service cannot be obtained without the participation of the poor. Even the houses of middle and upper classes would not run smoothly without the services of the domestic help but a survey conducted during the 1998 flood found that at least one in thirteen people had been forced to change their occupation, while the floods left 27.4 per cent of people unemployed (Reid and Sims, 2007). During that flood, some households were able to use emergency food and change their employment away from agriculture in order to cope. However, poorer households coped through reducing food consumption and through the sale of assets, reducing their resilience to future shocks (Moser and Satterthwaite, 2008).

All slums and squatters are made of bamboo, straw, low quality wood and tin sheets. Only half percent slum houses are of good quality and 46 percent are of very poor quality (weak and temporary structures or kutcha units) (CUS, 2005). These houses become more vulnerable during rainy season. Most of them hold a single room for the whole family that makes the slums of Dhaka very congested. According to a recent report, population density in slums and squatters ranges from 700 to 4,210 per acre, and a minimum of four and maximum of ten people share a room, which is highly congested and unhealthy (Akash and Singha, 2003).

Utility services are very inadequate in slums and squatters of Dhaka city. Water supply has improved a bit, but sanitation service is still very poor and does not meet the requirements of this huge population. Only 55% of the poor households currently receive tap water (Siddiqui and others, 2004). Another report states that less than 40% of the slum dwellers have access to safe drinking water (Sharmin and Rainer, 1999) but Water supplies become contaminated during floods, as pipes in slum areas are likely to be damaged or to leak.

Climate change affects health directly and indirectly. The most direct impacts of climate change on human health occur through extreme events, for example the floods in Bangladesh in 2004 caused 800 deaths, while the recent cyclone affected more than 8.5 million people, causing more than 3,500 deaths (Sayeed, 2007). Climate change will also affect the distribution of climate sensitive diseases. Malaria is a frequently cited example, because its prevalence increases in line with the warmer, wetter climates that are anticipated with climate change. Incidences of malaria have increased dramatically in Bangladesh over the last 30 years, and it is now a major public health problem, with 14.7 million people in Bangladesh

classified as high risk for catching the disease (Reid and Sims, 2007). Other diseases such as dysentery, diarrhoea, dengue, and hypertension associated with heat stress, asthma and skin diseases are also increasing in Bangladesh, particularly during the summer months. While a causative connection between climate change and these diseases is of course difficult to verify, the conditions associated with climate change (in terms of temperature, rainfall, and salinity) and the impacts on water supply, sanitation and food production, generate favourable environments for the incidence and spread of such diseases. For example, increased flooding as well as drought is resulting in a decline in the availability of clean water, for a country like Bangladesh where water-borne diseases are already responsible for 24 per cent of all deaths (European Parliament, 2008).

1.4 Review of literature:

According to DFID (2004), people develop coping strategies to deal with climate variability as with other shocks or stresses. These include building social networks as forms of insurance, traditional forecasting in order to be prepared for climatic changes and ingenious means of protecting assets. However, the poor's range of coping strategies is naturally more restricted by their lack of assets and by the other stresses on their livelihoods. These stresses are increasing following a number of trends such as increasing prevalence of conflict, globalisation and environmental degradation.

Sanderson (2000) opined that livelihood thinking emerges mostly from rural natural resources. Yet, a livelihoods perspective finds remarkable resonance in understanding the complexities of urban poverty and in linking poverty with disasters. As the World Bank's Disaster Management Facility states, disaster mitigation needs to be mainstreamed into development practice. Livelihoods approaches to urban poverty problems provide a way of seeing vulnerability to shocks and stresses as an integral part of the development picture. Whilst livelihoods programming is at a comparatively early stage of development, and has a rurally-focused origin, it appears that it has much to offer in understanding the dynamics of urban poverty and the role that disasters play. Such approaches place the vulnerable at the centre and, in so doing, aim to make city dwelling by the poor sustainable.

Hossain (2005) in 'Poverty, Household Strategies and Coping with Urban Life: Examining 'Livelihood Framework' in Dhaka City, Bangladesh' concluded that Slum people invariably

live below the poverty line and have little access to employment in formal sectors. They have failed to secure a sustainable livelihood in the city despite living for a long period of time. The poor communities are vulnerable in terms of their physical and social capital. They have little access to the city's social and political structure, which also shows their vulnerable situation. Urban government has little initiative to create opportunities for the poor sections of city's population. The poor communities cope with urban life through 'household strategies' such as: putting more family members into the work force, through petty trading, avoiding many basic goods, which represent luxuries to them, increasing their household size by inducting more relatives, withdrawing their children from education, constructing their own shelter, using kinship as social capital, and establishing patron-client relationships with local leaders.

Researchers studying the impact of climate change on Dhaka predict that the city will be affected in two major ways: flooding and drainage congestion, and heat stress. The elevation in Dhaka ranges between 2 and 13 metres above sea level means that even a slight rise in sea level is likely to engulf large parts of the city. Moreover, high urban growth rates and high urban densities have already made Dhaka more susceptible to human-induced environmental disasters. With an urban growth rate of more than 4 per cent annually, Dhaka, which already hosts more than 13 million people, is one of the fastest growing cities in Southern Asia, and is projected to accommodate more than 20 million by 2025. The sheer number of people living in the city means that the negative consequences of climate change are likely to be felt by a large number of people, especially the urban poor who live in flood-prone and water-logged areas.

Experts believe that the melting of glaciers and snow in the Himalayas, along with increasing rainfall attributable to climate change, will lead to more flooding in Bangladesh in general, especially in cities located near the coast and in the delta region, including Dhaka. Dhaka may also experience increased temperatures from rising levels of vehicle exhaust emissions, increased industrial activity and increased use of air conditioning. (Alam and Rabbani, 2007)

The findings of the Dhaka City State of Environment of 2005 were that none of the slums get proper sewerage services from WASA and only 9% of this population manages to get solid waste management services. As a result, both household waste and human generated wastes go directly or indirectly into the low-lying lands, open spaces or water bodies and causes a

number of problems. Temperature, precipitation and humidity significantly influence the incidence of water-borne (and air-borne) diseases. Bacteria, parasites, and their vectors may breed faster and live longer in warmer, wetter conditions in the slums.

According to the report of UN-Habitat, 2009, floods in dense, poorly serviced settlements can lead to other hazards, which have a significant impact on the health of urban poor residents. Floodwaters in slums can mix with raw sewage and breed water-borne diseases, such as diarrhoea, typhoid and scabies. Water supplies also become contaminated during floods, as pipes in slum areas are likely to be damaged or to leak.

Changes in temperature and rainfall may change the geographic range of vector-borne diseases such as malaria and dengue fever, exposing new populations to these diseases. Young children as well as pregnant women and their unborn children are especially vulnerable to malaria. Malaria contributes to prenatal mortality, low birth weight, and maternal anemia (WHO, 2002).

In a set of participatory poverty assessments from over 24 countries, the rural and urban poor identified natural hazards, changing climate conditions and unpredictable seasons as contributing to an increasingly fragile environment and increasing the vulnerability of their livelihoods (Moser and Satterthwaite, 2008).

1.5 Scope and objectives of the research

The study covers only slums and squatter settlements of Dhaka city. The term ‘Urban poor’ and ‘Slum dwellers’ is considered synonymous for this research. Coverage actually is extended beyond city corporation limits to include the urban fringe, administratively known as the Dhaka Metropolitan area (DMA).The major criteria for slums is considered here - predominantly very poor housing; very high population density and room crowding; low income; and very poor environmental services, especially water and sanitation. In respect of climate change of Dhaka effects of flood, heavy rainfall and extreme temperature are considered. The reason for choosing urban dwellers of Dhaka are that they are keeping the economy going through their hard toil and providing most of the necessary services to the city dwellers. The economy runs smoothly because the poor are producing the necessary

goods and services. A major export-earning sector of Bangladesh-garments-most of those are in Dhaka- is run by poor young women.

There are number of parameters involved in the urban livelihood. Among those only shelter or housing, water, sanitation, health and income are considered. The impact on social dimensions like network trust etc. is not analysed in details. For this research, men, women and children have been equally treated. The negative impacts of climate change are only considered here.

1.5.1 Research Questions:

1. Whether climate change affects the livelihood of the urban poor of Dhaka?
2. To what extent climate change affects the livelihood of the urban poor?

1.5.2 The objective:

General Objective-

To assess the impact of climate change on the livelihood of the urban poor.

Specific Objectives

1. To know the impact of climate change on shelter of the urban poor.
2. To identify the impact of climate change on the health of the urban poor.
3. To delineate the impact of climate change on water supply and sanitation of the urban poor.
4. To recognize the impact of climate change on the income of the urban poor.

1.6 Significance of the research:

Too little attention has been given to the vulnerability of urban livelihood to climate change – and especially to the vulnerability of their low-income populations. The growing literature on adaptation gives far more attention to agriculture and to rural livelihoods than to urban economies and livelihoods. It is also inappropriate to consider rural and urban areas

separately, given the dependence of urban centres on rural ecological services, the importance for many urban economies of rural demand for goods and services, and the reliance of much of the rural populations on urban centres for access to markets, goods and services.

Climate change is now the most burning and important issue for Bangladesh. Though several researches already have been done regarding urban and rural coastal areas and their population, the urban poor of Dhaka remain unexplored. Simultaneously, with a high concentration of economic activity and population the city is more vulnerable to the impacts of climate change. The economic and social costs of climate change will be therefore be much higher in Dhaka, where most high-valued infrastructure is located than elsewhere. Climate change has no boundary and therefore the urban poor have to be part of the equation to solve the climate change crisis.

The research is aimed to give a better perception of urban poor's vulnerable livelihood due to climate change. It is also that the findings will give us a conclusion about the relationship between the urban poor of Dhaka and climate change. The result can be useful for policy options for the urban poor of Dhaka. Another important role of this research also can be to increase the understanding of how investments in critical infrastructure and pro-poor investments can be smart choices in the long term. Given resource limitations, it is likely that Dhaka may create more low-cost, efficient solutions for adaptation strategies that could be shared with developed countries.

1.7 Limitations of the study:

Some limitations were encountered during the study period to complete research work according to the selected objectives. These limitations are described below:

Climate change is a matter of several years. All the changes due to climate are determined from trend analysis. The impact or change usually has taken place for a long period of time. The respondents in the study were asked to recall those impacts from their back up mind. As a result, there might me some deviation from the actual incident. It is also that the findings have been verified through secondary data. The study only covers 4 slum areas due to lack of resources, though there are almost 5,000 slums in Dhaka. This might bring some variation of data like coverage of .water, sanitation etc. Though tropical cyclone is also a part of climate of Dhaka, it has not been considered here for time constraints.

1.8 Outline of the study

The thesis is composed of six chapters, references and appendix. **The first chapter** deals with the background of the research, its objectives and significance. It also deals with the limitations to carry out the study.

The second chapter explicates the theories on which the study is based on and the analytical framework on which the dependent and independent variables have identifies. It also has discussed explicitly the methodology of the research with the brief description of the study area.

The third chapter describes some basic concept of climate change and gives the idea about specific impact of climate change on cities.

The fourth chapter depicts the findings in respect of impacts of climate change on the urban poor's livelihood in quantitative and qualitative format using the designated questionnaire.

The fifth chapter is the nucleus of the report, which analyses the findings corresponding to the secondary findings. It also gives the author's own explanation about findings and analysis.

The sixth chapter gives the summary and conclusions of the research. It also makes some specific recommendations and gives direction about future research.

The reference chapter presents the various references used within this thesis and the appendix chapter provides the questionnaire used for primary data in this study.

Chapter 2

Analytical Framework and Methodology

2.1 Introduction

The study of the impact of climate change on the livelihood of urban poor is increasingly forwarded as an urgent research need (Morton 2007). A multitude of approaches and methodologies are used for this purpose. There are three concepts that are continuously reoccurring in the methodological literature and also used in the analytical framework developed for the purpose of this study. Therefore the first section defines three of these concepts.

There are different terms and definitions for the term 'impact' depending on the discipline literatures use. Some of the terms include hazard, risk, biophysical vulnerability or generally vulnerability (Brooks 2003). To limit the scope of the study to climate change impact on livelihood, the definition of biophysical vulnerability by Deressa et al., (2008), which refers to *the extent of damage inflicted by climate change on livelihood and social systems,* is used in this study. The impact on livelihood assets (human, physical, natural, financial, social), and consequently on the poor is analyzed based on local climatic data, impacts, vulnerability and coping strategies by employing quantitative and qualitative study or using appropriate themes or indicators selected from previous literatures.

An impact study is most helpful when focusing on a single stressor (Nkem et al. 2007), in this case climate change. Thus, impact alone is subtle and may not be sufficient to show the consequences of climate impact on different members of the same or different community (McCarthy 2001). Thus, to evaluate climate change impact in the context of multiple stressors that reduce adaptive capacity, many of which are not related to climate or climate change; vulnerability assessment is most helpful (Desanker & Justice 2001). Vulnerability assessment also helps to informs decision makers to facilitate decision-making process of specific stakeholders of a sector about their options for adapting to the effects of climate change within the scope of their resources (Nkem et al. 2007).

Vulnerability in this study is, thus, defined as the likelihood of urban poor households and communities in Dhaka city, to suffer from climatic adverse impacts on their livelihood assets

and their inability to respond to stresses resulting from the impact. This definition is also in agreement with the definition of IPCC (2001), where vulnerability refers to *'the degree to which a system is susceptible to, and unable to cope with adverse effects of climate change, including climate variability and extremes'* (IPCC 2001). To assess impact of urban livelihood strategy in context of climate vulnerability the Livelihood approach of DFID and CARE are used here.

Societies are dynamic and they use all possible strategies to reduce the vulnerability to climatic impacts. There are two kinds of responses to crisis that overlaps across the temporal scale, coping mechanisms and adaptive capacity. Coping mechanisms are the actual responses to crisis on livelihood systems in the face of unwelcome situations, and are considered as short-term responses (Berkes & Jolly 2001). Adaptive strategies are the strategies in which a region or a sector responds to changes in their livelihood through either autonomous or planned adaptation (ibid; Campbell 2008). Coping mechanisms may develop into adaptive strategies through times (Berkes & Jolly 2001). However, it is difficult to make a clear distinction between coping mechanisms and adaptations this study considers both schemes as coping strategies. In this study, both local and institutional coping strategies are also assessed partially from the collected information.

2.2 Livelihood Approach

Sustainable livelihoods methodologies provide a valuable opportunity for combining disaster reduction and development interventions in one unifying approach. Several agencies and donors are currently developing livelihoods-based approaches as bases for policy and practice formulation. These include DFID, the United Nations Development Program (UNDP), non-governmental organizations (NGOs) including Oxfam and CARE, and research institutes including the Institute of Development Studies. A common understanding of livelihoods is given by Chambers and Conway: "A livelihood comprises the capabilities, assets (both natural and social) and activities required for a means of living; a livelihood is sustainable which can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, both now and in the future, while not undermining the natural resource base."(Chambers and Conway, 1992) DFID and CARE's approaches are widely recognized among all the approaches in the urban context and explicitly described here -

2.2.1 CARE's Livelihood Approach

CARE's Household Livelihood Security (HLS) approach presents a tool for understanding how urban households live. Yet it is not prescriptive in advocating interventions. Rather it is a route-map on which the main elements that concern living are marked, from micro level household activities to macro level controls of resources. A key aspect of HLS and other livelihoods approaches is the role that assets play in strengthening households. Descriptions of assets vary. Common to several interpretations however are the following:

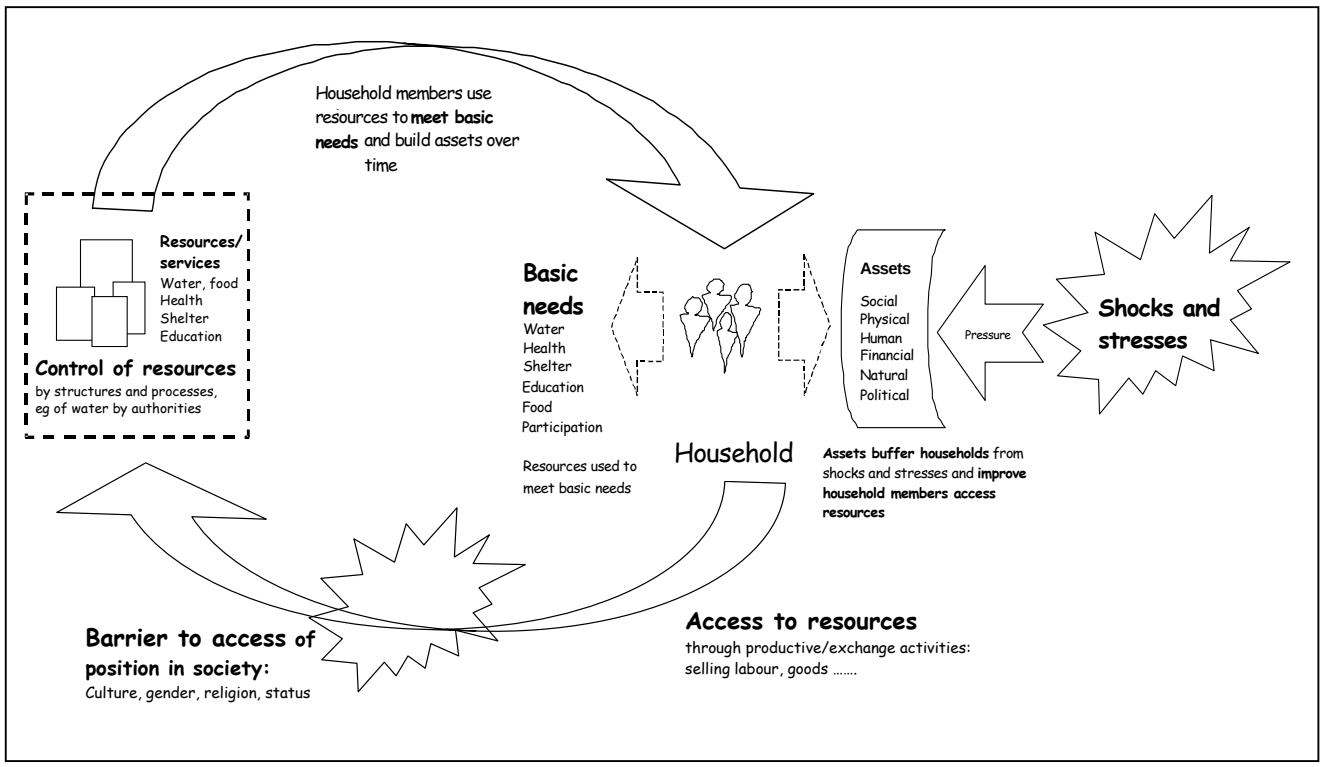


Figure 2.1 CARE's livelihood approach

HLS is described as 'sustainable and adequate access to income and other resources to meet basic needs, and to build up assets to withstand shocks and stresses'. This can be represented diagrammatically as follows:

The sequence followed by the diagram in the Figure 2.1, beginning at the HH and following the arrows, is:

1. Household members have basic needs: food, water, shelter, education, etc

2. To meet needs household members access resources or services, e.g. water, food, shelter, healthcare, electricity. Most access is gained through payment. Payment is secured by undertaking productive activities, e.g. selling labour to gain income to pay for resources needed

3. There are barriers to accessing resources/services which for the poor usually prevent or reduce the quality and quantity of resources accessible. Two barriers (of which there may be many) are:
    - Position in society, e.g. culture, gender, religion, status, being poor
    - Control of resources by *structures*, e.g. government, private sector employers, and *processes*, e.g. laws, regulations. Regulations may discriminate in particular against the poor

4. Depending on the degree of success of overcoming barriers, resources/services secured by household members are used:
    - To meet immediate basic needs
    - To build up assets (social, physical, financial and human) over time

5. Assets are used:
    - To buffer households against stresses and shocks, e.g. sickness, fires, sudden unemployment
    - To increase the ability to improve access, e.g. improved education (human assets) may lead to better jobs.

2.2.2 DFID's Livelihood Framework:

The DFID Livelihood approach is one of a number of conceptual frameworks which take an asset/vulnerability approach to analysis of the livelihoods of poor people. It organization understanding the vulnerability context and the organizational and institutional environment within which poor people draw upon assets of different types in order to implement a livelihood strategy. It defines five types of asset: human capital, social capital (the ability to draw on support through membership of social groups), natural capital, physical capital, and financial capital.

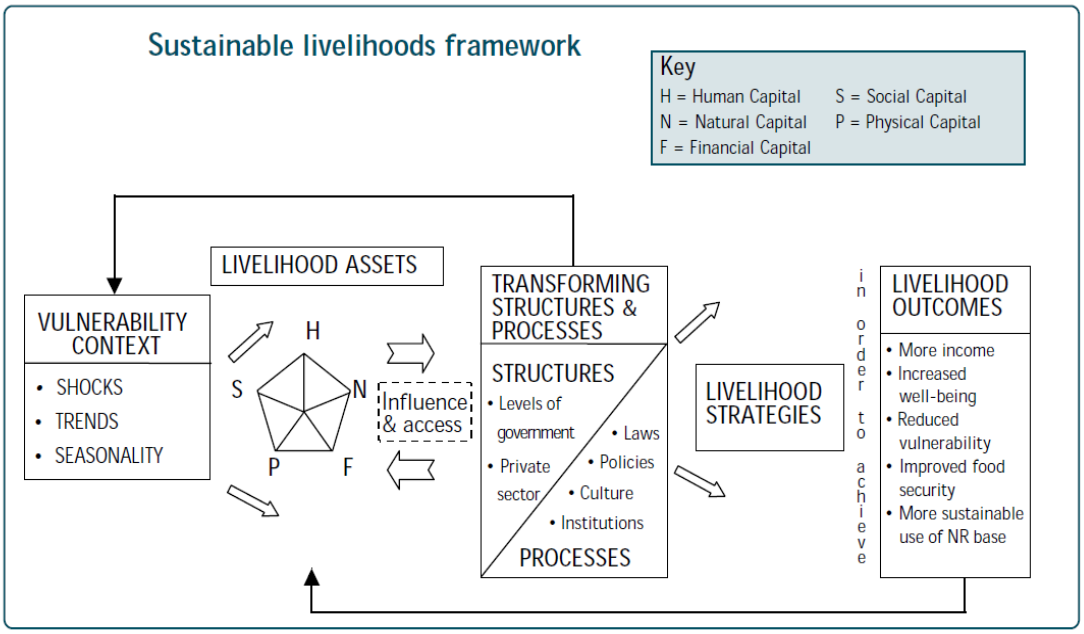


Figure 2.2 Sustainable livelihood framework of DFID

The framework in Figure 2.2 is centred on people. It does not work in a linear manner and does not try to present a model of reality. Its aim is to help stakeholders with different perspectives to engage in structured and coherent debate about the many factors that affect livelihoods, their relative importance and the way in which they interact.

1. **Vulnerability context** frames the external environment in which people exist. People's livelihoods and the wider availability of assets are fundamentally affected by critical trends as well as by shocks and seasonality – over which they have limited or no control.

   • ***Shocks*** can destroy assets directly (in the case of floods, storms, civil conflict, disease etc.). They can also force people to abandon their home areas and dispose of assets (such as land) prematurely as part of coping strategies. Recent events have highlighted the impact that international economic shocks, including rapid changes in exchange rates and terms of trade, can have on the very poor.

• ***Trends*** may (or may not) be more benign, though they are more predictable. They have a particularly important influence on rates of return (economic or otherwise) to chosen livelihood strategies.

• ***Seasonal shifts*** in prices, employment opportunities and food availability are one of the greatest and most enduring sources of hardship for poor people in developing countries.

2. Livelihood Assets

The approach is founded on a belief that people require a range of assets to achieve positive livelihood outcomes; no single category of assets on its own is sufficient to yield all the many and varied livelihood outcomes that people seek. This is particularly true for poor people whose access to any given category of assets tends to be very limited. As a result they have to seek ways of nurturing and combining what assets they do have in innovative ways to ensure survival. The asset pentagon (Figure 2.3) lies at the core of the livelihoods framework, 'within' the vulnerability context. The pentagon was developed to enable information about people's assets to be presented visually, thereby bringing to life important inter-relationships between the various assets.

a) Human capital represents the skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives. At a household level human capital is a factor of the amount and quality of labour available; this varies according to household size, skill levels, leadership potential, health status, etc. Human capital appears in the generic framework as a livelihood asset, that is, as a building block or means of achieving livelihood outcomes. Its accumulation can also be an end in itself. Many people regard ill-health or lack of education as core dimensions of poverty and thus overcoming these conditions may be one of their primary livelihood objectives.

b) Social capital - In the context of the sustainable livelihoods framework it is taken to mean the social resources upon which people draw in pursuit of their livelihood objectives. These are developed through:

- Networks and connectedness,
- Membership of more formalized groups
- Relationships of trust, reciprocity and exchanges

c) **Natural capital** is the term used for the natural resource stocks from which resource flows and services (e.g. nutrient cycling, erosion protection) useful for livelihoods are derived. Within the sustainable livelihoods framework, the relationship between natural capital and the *Vulnerability Context* is particularly close. Many of the shocks that devastate the livelihoods of the poor are themselves natural processes that destroy natural capital (e.g. fires that destroy forests, floods and earthquakes that destroy agricultural land). None of us would survive without the help of key environmental services and food produced from natural capital. Health (human capital) will tend to suffer in areas where water quality is poor as a result of industrial activities or natural disasters (e.g. flooding).

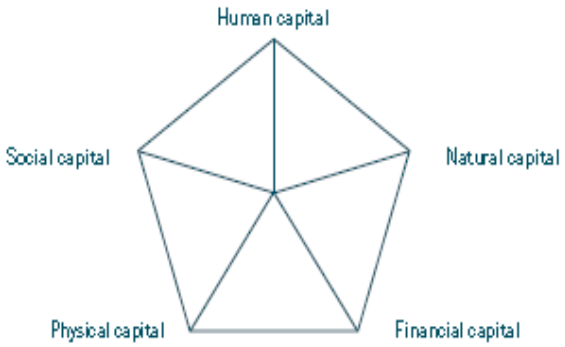


Figure 2.3 Asset pentagon

d) **Physical capital** comprises the basic infrastructure and producer goods needed to support livelihoods:

- Infrastructure consists of changes to the physical environment that help people to meet their basic needs and to be more productive.
- Producer goods are the tools and equipment that people use to function more productively.

The following components of infrastructure are usually essential for sustainable livelihoods:

- secure shelter and buildings;
- adequate water supply and sanitation;

- clean, affordable energy; and
- affordable transport;

Many participatory poverty assessments have found that a lack of particular types of infrastructure is considered to be a core dimension of poverty. Without adequate access to services such as water and energy, human health deteriorates and long periods are spent in non-productive activities such as the collection of water and fuel wood. The opportunity costs associated with poor infrastructure can preclude education, access to health services and income generation.

e) Financial capital denotes the financial resources that people use to achieve their livelihood objectives. It can contribute to consumption as well as production. However, it has been adopted to try to capture an important livelihood building block, namely the availability of cash or equivalent that enables people to adopt different livelihood strategies. There are two main sources of financial capital.

• **Available stocks:** They can be held in several forms: cash, bank deposits or liquid assets such as livestock and jewellery. Financial resources can also be obtained through credit-providing institutions.

• **Regular inflows of money**: Excluding earned income, the most common types of inflows are pensions, or other transfers from the state, and remittances.

Financial capital is probably the most versatile of the five categories of assets as-
• It can be converted – with varying degrees of ease, depending upon *Transforming Structures and Processes* – into other types of capital.
• It can be used for direct achievement of livelihood outcomes – for example when food is purchased to reduce food insecurity.

However, it is also the asset that tends to be the least available to the poor. Indeed, it is because the poor lack financial capital that other types of capital are so important to them.

Relationships with other framework components

• ***Assets and the Vulnerability Context*:** assets are both destroyed and created as a result of the trends, shocks and seasonality of the *Vulnerability Context*.

• ***Assets and Transforming Structures and Processes:*** The institutions and policies of the *Transforming Structures and Processes* have a profound influence on access to assets. They:

(a) Create assets – e.g. government policy to invest in basic infrastructure (physical capital) or technology generation (yielding human capital) or the existence of local institutions that reinforce social capital.

(b) Determine access – e.g. ownership rights, institutions regulating access to common resources.

(c) Influence rates of asset accumulation – e.g. policies that affect returns to different livelihood strategies, taxation, etc.

However, this is not a simple one way relationship. Individuals and groups themselves influence *Transforming Structures and Processes*. Generally speaking the greater people's asset endowment, the more influence they can exert. Hence one way to achieve empowerment may be to support people to build up their assets.

• ***Assets and Livelihood Strategies:*** Those with more assets tend to have a greater range of options and an ability to switch between multiple strategies to secure their livelihoods.

• ***Assets and Livelihood Outcomes*****:** Poverty analyses have shown that people's ability to escape from poverty is critically dependent upon their access to assets. Different assets are required to achieve different livelihood outcomes. For example, some people may consider a minimum level of social capital to be essential if they are to achieve a sense of well-being. Or in a remote rural area, people may feel they require a certain level of access to natural capital to provide security.

3. Transforming Structures and Processes

Transforming Structures and Processes within the livelihoods framework are the institutions, organisations, policies and legislation that shape livelihoods. Their importance cannot be overemphasised. They effectively determine:

- **access** (to various types of capital, to livelihood strategies and to decision-making bodies and sources of influence);

- the **terms of exchange** between different types of capital; and
- **returns** (economic and otherwise) to any given livelihood strategy.

4. Structures

Structures in the framework are the hardware – the organisations, both private and public – that set and implement policy and legislation, deliver services, purchase, trade and perform all manner of other functions that affect livelihoods. They draw their legitimacy from the basic governance framework. Private commercial organisations also operate at different levels from the multi-national to the very local.

5. Livelihood Strategies:

The livelihoods approach seeks to promote choice, opportunity and diversity. This is nowhere more apparent than in its treatment of livelihood strategies – the overarching term used to denote the range and combination of activities and choices that people make/undertake in order to achieve their livelihood goals (including productive activities, investment strategies, reproductive choices, etc.). Livelihood strategies vary at every level –within geographic areas, across sectors, within households and over time. This is not a question of people moving from one form of employment or 'own-account' activity (farming, fishing) to another. Rather, it is a dynamic process in which they combine activities to meet their various needs at different times. A common manifestation of this at the household level is 'straddling' whereby different members of the household live and work in different places, temporarily (e.g. seasonal migration) or permanently.

6. **Livelihood Outcomes** are the achievements or outputs of Livelihood Strategies and are:
    - More income
    - Increased well-being
    - Reduced vulnerability
    - Improved food security
    - More sustainable use of the natural resource base

2.3 Analytical Framework:

In urban areas livelihood strategies are complex. Contexts are changing and uncertain, with rapid urban growth, increasing disaster, an ill-equipped utility service, and intense competition for limited resources. Household members employ varied living strategies, often living on credit, surviving and competing in markets, undertaking seasonal work and earning incomes in the informal economy. Most resource access in urban areas results from cash exchanges. A large proportion of the urban poor are forced to work in the informal sector, earning low incomes for long hours of work. Competition for work is intense, usually making financial capital i.e. income very low.

Tenure is a key physical asset to acquire. Squatters and slum dwellers endure dangerous conditions to be close to sources of income whilst in the rental sector many families share crowded, poor quality illegally divided tenements. Most of those are with poor materials and in the flood-prone and vulnerable area.

Within a livelihood adapted to a particular climatic stress, an increase in intensity of the stress, climate extremes, or unseasonal changes can cause severe shocks that set back households. Coping with such events can result in a loss of assets, negative impacts on health and can require high expenditure in order to recover. This capacity to cope with climate variability and extreme weather events in it is highly dependent on the level of income. In general, livelihood sources of the poor are usually narrower and more climate-sensitive than those of the non-poor. Extreme weather events, which would cause limited damage and few casualties in a developed country, often cause extensive damage and substantial loss of life in a developing country like Bangladesh. Poor people are particularly vulnerable to deviations from average climatic conditions such as prolonged heat and to natural disasters such as floods. In periods of stress they may be forced to stay even without food, shelter and employment and, thereby undermining the sustainability of their livelihoods over the longer term. In impact assessments after disasters, assets are shown to be both a significant factor in self-recovery and to be influenced by the response and reconstruction process.

Based on the DFID and CARE's livelihood framework I have developed a model that assesses impact of climate change on the urban poor's livelihood and is shown in Figure 2.4-

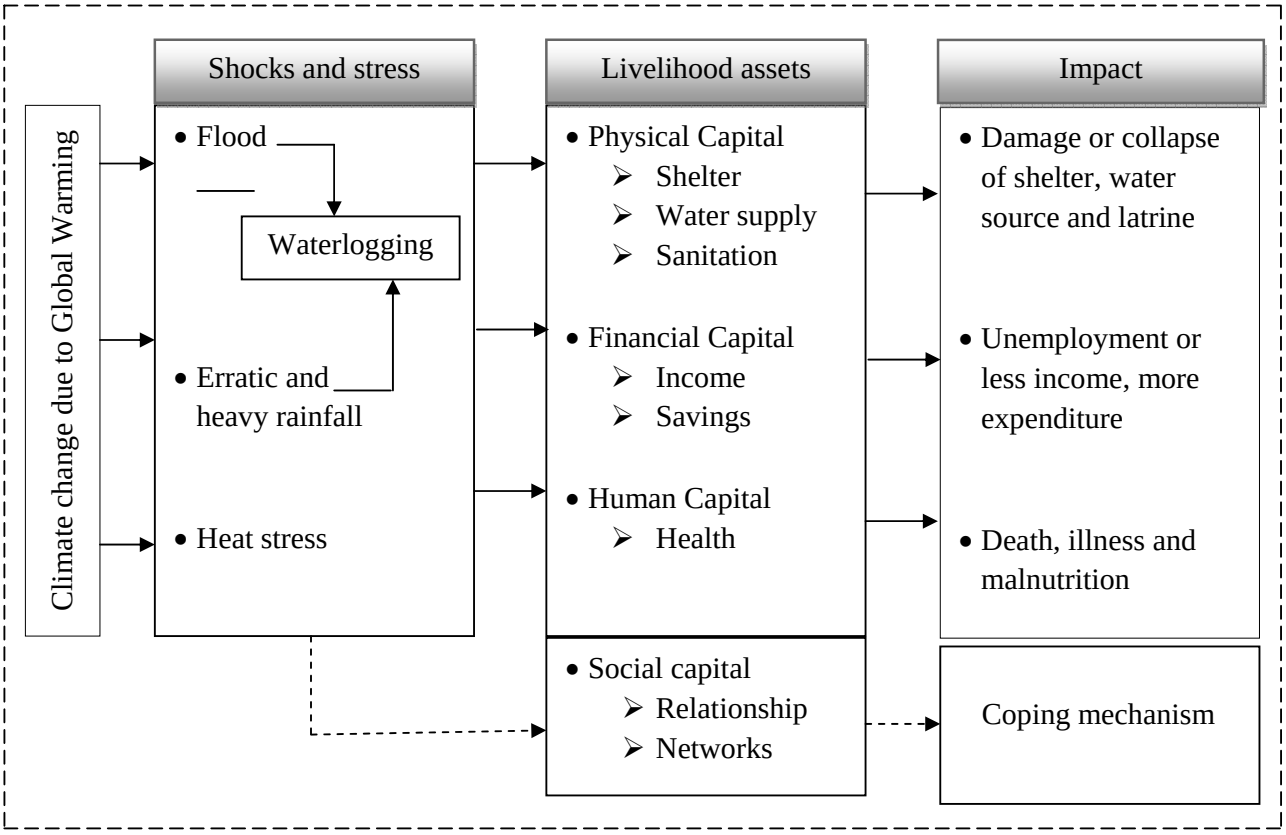


Figure 2.4 Analytical framework for climate change impact on livelihood of the urban poor

As figure 2.4 shows the climate change (gradual changes and extreme weathers) causes an impact on livelihood assets. However, the societies across the world have a long record of adapting to and reducing their vulnerability to the impacts of weather and climate related events (Pachauri & Reisinger 2007) and thus, the coping strategies used to reduce the impact, and the presence of other internal and external stressors determine the societal vulnerability to climate change. Identification of the current climate change, its impacts on livelihood, current coping strategies and identification of vulnerabilities and stressors help to assess the future likely changes, impacts, coping strategies and social vulnerability.

The trend of climate change due to global warming is collected from the secondary source. The impact of these climatic events on livelihood asset is collected from the slum dwellers. In the framework social capital is used as a positive impact as friends, relatives and neighbours are found first for immediate coping mechanism.

2.4 Study area

Dhaka, the capital and the largest city of Bangladesh is located in the central region of the flat deltaic plain of the three major international rivers, the Ganges, the Brahmaputra and the Meghna which enjoys a distinct primacy in the national and regional hierarchy. The city is surrounded by the distributaries of these three major rivers. Geographically, Dhaka is situated on the northern bank of the river Buriganga. The Balu River in the east and Turag bound it in the west and north. In spite of its water confinement on all sides Dhaka is considerably high above the water of surrounding rivers in ordinary seasons of inundation. The elevation of Greater Dhaka lies between 2 to 13 m above mean sea level (msl). Most of the urbanised area lies at the elevation of 6 to 8 m above msl. Dhaka's increasing growth and primacy is partly explained by its geographic location. Being centrally located enjoys good accessibility with rail, road, water and air connections with all major towns and cities of Bangladesh (CUS, 2005).

With a population of over 13 million, Dhaka is one of the largest cities in Southeast Asia. In fact, Dhaka is reportedly the 9th largest urban center in the world, by far the most densely populated, and growing at one of the fastest rates in Asia. Dhaka's population is estimated to be 25 million by the year 2025. Dhaka is situated on the Buriganga River or "Old Ganges" within the Ganges- Brahmaputra megadelta. The city proper covers an area of 154 km2, however the Dhaka district has an area of nearly 1500 km (WWF, 2010). Metropolitan Dhaka has two connotations, first is that of central city i.e. Dhaka City Corporation covers an area of 200 sq. mile and the population is about 8 million, or Dhaka city as it is popularly known and the other one is the Dhaka Statistical Metropolitan Area (DSMA) covers an area of 550 sq. mile (CUS, 2005).

2.4.1 Climate of Dhaka

The tropical climate of Dhaka is marked by the fairly different six seasonal variations. Rainfall in Dhaka occurs from three main sources: i) the western depression of winter, ii) the early summer thunderstorms know as Nor'westers, and iii) the summer monsoon. It is hot and humid during May to October while cool and dries during November to February. The rainy season generally prevails from May to October. Approximately 90 per cent of the annual rainfall occurs during this time and the average annual rainfall is about 2000mm. Heavy

rainfalls, sometimes extending up to several days, are common during the monsoon. The total annual rainy days vary from 95 to 131 days.

Rainfall is rather scarce during the months from November to February. The lowest temperature during this period may drop down to about 5^0C. On the other hand, temperature as high as 40^0C may occurs during the warm months of March and April. Monthly evaporation varies from 80 to 130 mm. The normal climatic condition of Dhaka city are summarised in the table 2.1.

Table 2.1 Climatic condition of Dhaka

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Minimum Temp (°C)	12.7	15.5	20.4	23.6	24.5	26.1	26.2	26.3	25.9	23.8	19.2	14.1
Normal Maximum Temp (°C)	25.4	28.1	32.5	33.7	32.9	32.1	31.4	31.6	31.6	31.6	29.6	26.4
Average rainfall (mm)	7.7	28.9	65.8	156.3	339.4	340.4	373.1	316.5	300.4	172.3	34.4	12.8
Rainy day	2	3	5	10	15	14	17	16	13	7	2	1

Source: BMD, 2010

2.4.2 Slums of Dhaka:

The 2005 survey identified some 4,966 slum clusters in DMA with a total population of 3.4 million, a 65% increase in the number of clusters and more than doubling of the slum population over the 1996 levels. Of the 4,966 slum clusters of the present survey, 4,342 were within DCC limits. The slum population in the DCC was 2.5 million with an additional 0.9 million in the DMA areas outside of the DCC (CUS, 2005). The slums in Dhaka have been shown in Figure 2.5.

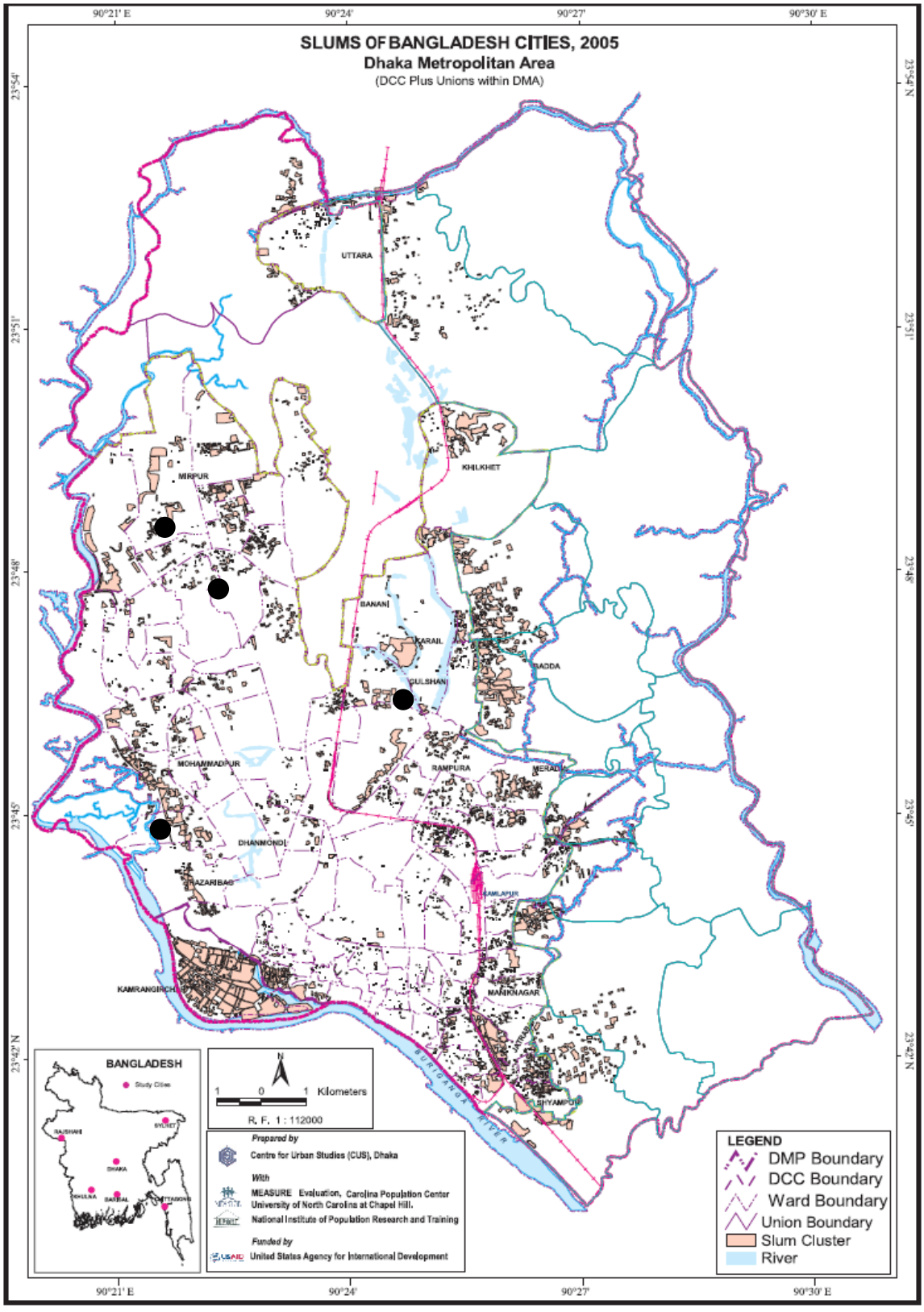


Figure 2.5 Study area and slums in Dhaka city Source: CUS, 2005

2.4.3 Urban poor of Dhaka:

In Dhaka, the urban poor are those residents who are mainly rural migrants living in the slum and squatter settlements. It has been estimated that nearly 50 per cent of the city's poor population live in slum and squatter areas (CUS, 2005). Slums are high-density areas (over 300 people per acre), characterised by overcrowding (three or more adults per room), and poor-quality housing such as *kutcha* (mud homes), semi-*pucca* (semi-concrete) or other dilapidated buildings, either rented or owner occupied. The slum areas have inadequate water supplies, poor sewerage and drainage facilities, and hardly any paved streets or lanes. The squatter settlement areas are where the urban poor have illegally occupied land belonging to government or non-governmental organisations by constructing makeshift structures with various materials (jute sacks, newspapers, polythene) for sleeping. The poor and hardcore poor people who live here are mostly engaged in various informal sector jobs.

2.5 Methodology

2.5.1. Research strategy

Since the emphasis of this research is to undergo an intensive examination of impacts of climate change in association with urban poor in Dhaka, a case study research strategy is used. In case study research, an exploratory questions, ''what'' and ''how'', and inductive research are most appropriate and helps to harness detailed and valuable insights and understanding of the topic which could not be achieved by a survey. The case study strategy is both qualitative and quantitative. Methodological triangulation; obtaining data from different sources, such as observations, documentations and interviews, has helped to harnesses diverse ideas about the same issue and assist in cross-checking the results, and consequently has helped to increase the validity, reliability of the findings and has eased data analysis. This study uses data from primary sources (interviews with households, urban institutions' officials and experts) and secondary data sources (published and unpublished documents, meteorological data, and newspaper report).

2.5.2 Selection of study area

Four slums were selected in Dhaka city regarding location, type of structure, density and size. According to above criteria the selected slums are –

- Bhashantek, Mirpur – Largest concentration of slums on public land
- Baganbari, Mirpur 14 – On the flood prone area
- Karail at Mohakhali - The largest single slum in Dhaka
- Basila, West Mohammadpur – along the western embankment

2.5.3 Description of the study area

Karail, Mohakhali

The informal settlements at Korail, considered being the biggest slum in Dhaka, started to develop during late 80's on the vacant higher grounds. Eventually the settlement expanded by encroaching the highly vulnerable water edges. At present Karail covers an area of approximate 90 acres with an estimated population of over 100,000 (CUS, 2005). The eastern and southern edge of the area is defined by the Gulshan-lake, a main water reservoir for the adjoining areas.

Figure 2.6 Study area – Karail, Mohakhali

Because of its location near the high-end residential and commercial (Gulshan, Banani and Mohakhali) areas of Dhaka it attractes low income people engaged mostly in service jobs like cleaners, household helpers, rickshaw pullers as well as worker of ready made garments industries.

Bhashantek, Mirpur

The Bhasantek slum is one of the biggest and reputed informal settlements in Dhaka on the Govt. land. It is 2 km away from Mirpur 14 bus stand. At least 2200 to 2500 households live

Figure 2.7 A view of Bhashantek slum

in the area. The area is very high in respect of other slums of Dhaka city. Even during the floods in 2004 and 2007 the slums were free from water. The houses in the slum are arranged almost in a planned way.

Baganbari slum, Mirpur 14

Baganbari, the large slum and linear in shape, is located beside the Dhaka Dental College at Mirpur 14. A narrow ditch has just passed by the slum. The land on which the settlement has

Figure 2.8 A view of Baganbari slum at Mirpur 14

established is very low. At present almost 1200 households living in the slum with a lot of problems and constraints. This slum is very vulnerable to flood and heavy rainfall.

Basila, Mohammadpur

The slum stands beside the flood embankment. Some are within and some are outside of the embankment, which is now used as major road connecting Gabtoli and Sadarghat. The slums

Figure 2.9 Poor settlements of Basila slum

outside the embankment are vulnerable as those stands on the bamboo sticks. Most of the land is private. The slum dwellers pay rent for the land, not for the rooms. All the rooms are constructed by the households themselves. The water under the settlement is polluted and black in colour.

2.5.4 Collection of Primary data

a. Interview with local households

Primary data on impact were collected by using household interviews from March to April 2010. The interview was conducted on 40 households, 30 households from mid and lowlands, and 10 from highlands. Since the objective of the study is to get a more comprehensive overview about the study, households were randomly selected. To enhance the chance of meeting the households in their slums, early morning and

afternoon time was found to be an appropriate time. In cases where the households happened to be away from home a new household was randomly found in the same slum. Semi-structured interview was found to be an appropriate strategy for the study because questions that were not included in the questionnaire were asked and new questions were raised as ideas emerge through the process. The interview questions focus on a more comprehensive range of issues including socioeconomic status (HH size, sex, age, occupation), climate change trends, climate change impact on the livelihood assets (see Appendix A).

The households represented in the study encompass age groups 18 and above; which also encapsulates the idea of all age households. The total number of female respondents interviewed is 14; 3 widows, 8 married and 3 unmarried females respectively. The lower female number is mainly attributed to society's tradition and male dominance; it is the male who is responsible to identify the stranger and give family details. Therefore, it is not a surprise to see a woman refusing an interview in the presence of the men, arguing the appropriate person for interview is the husband.

Based on the language know-how of the respondent Bengali were used for interview and later translated into English. The interview was taken place face-to-face. In cases of lack of consent from interviewee or distractions 'interview protocol', a form with questions and ample space between the questions to write the responses was used. To get as much information as possible the respondents were treated as a 'carriers of information' while I acted as an 'ignorant knower', but I was curious enough while the information flows from the interviewee. The interview took an average of 25 to 40 minutes each.

b. Interviews with Government officials

Interview was also held with the acting Director of BMD, Executive Engineer of Drainage Division of Dhaka WASA, environment expert of BCAS and flood expert of IFCDR. It was kind of informal discussion (without any questionnaire or format) to know the facts and figures of concerned issues. The detailed interview with the respective officials was particularly very crucial to harness and comprehend the climatic change trends, impacts, vulnerabilities and the existing stressors.

2.5.5 Secondary data

Secondary data is based on existing literature and reports .The climatic data related to rainfall, flood, and temperature are collected from the secondary sources of Bangladesh Meteorological Department, Dhaka WASA and IFCDR.

2.5.6 Analysis Plan

The data obtained from the survey method is processed with the use of simple mathematical tools as well as MS Excel for graphs and charts. At first the findings from the primary source are presented. Then those findings are compared and explained with results from secondary source as well as findings from the interview with different department officials. Finally, I have given my own explanation and infer on the basis of the findings and analysis.

Chapter 3

Climate Change

3.1 Climate:

Climate is simply the weather that is dominant or normal in a particular region; the term climate includes temperature, rainfall and wind patterns. Geography, global air and sea currents, tree cover, global temperatures and other factors influence the climate of an area, which causes the local weather. Figure 3.1 below is a schematic diagram of the climate system.

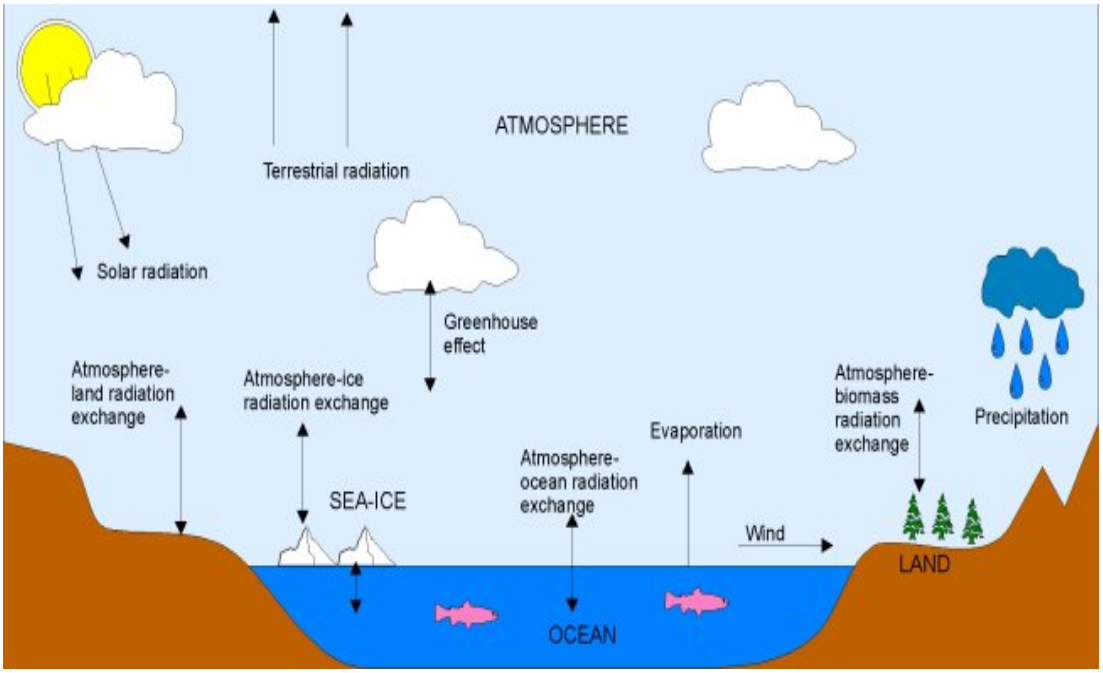


Figure 3.1 A schematic illustration of the climate system Source: IPCC 2001.

The earth's climate has always varied naturally, in the past cooler cycles due to variations in the earths orbit round the sun, sunspot activity or volcanic eruptions, have altered the climate. However, large changes have been very gradual over huge time periods; nevertheless they are still blamed for the extinction of the dinosaurs.

What is new is that humans are now, due to pollution from industrial processes and wasteful lifestyles directly influencing the climate of the earth. Human influence is now believed to be changing the climate much faster than occurring in the past under natural processes.

3.2 Greenhouse Effect and Global warming:

The Greenhouse Effect is a natural process through which various gasses and water vapour in the atmosphere affects the earth's climate. The earth's climate is driven by this continuous flow of energy from the sun, mainly in the form of visible light. About 30% is immediately scattered back into space, but most of the remaining 70% passes down through the atmosphere to warm the earth's surface. Being much cooler than the sun, the earth does not give out energy as visible light. Instead, it emits heat in the form of infrared or thermal radiation. Greenhouse gases in the atmosphere block this infrared radiation from escaping directly from the surface to space (Williams 2002). This is illustrated in figure 3.2 -

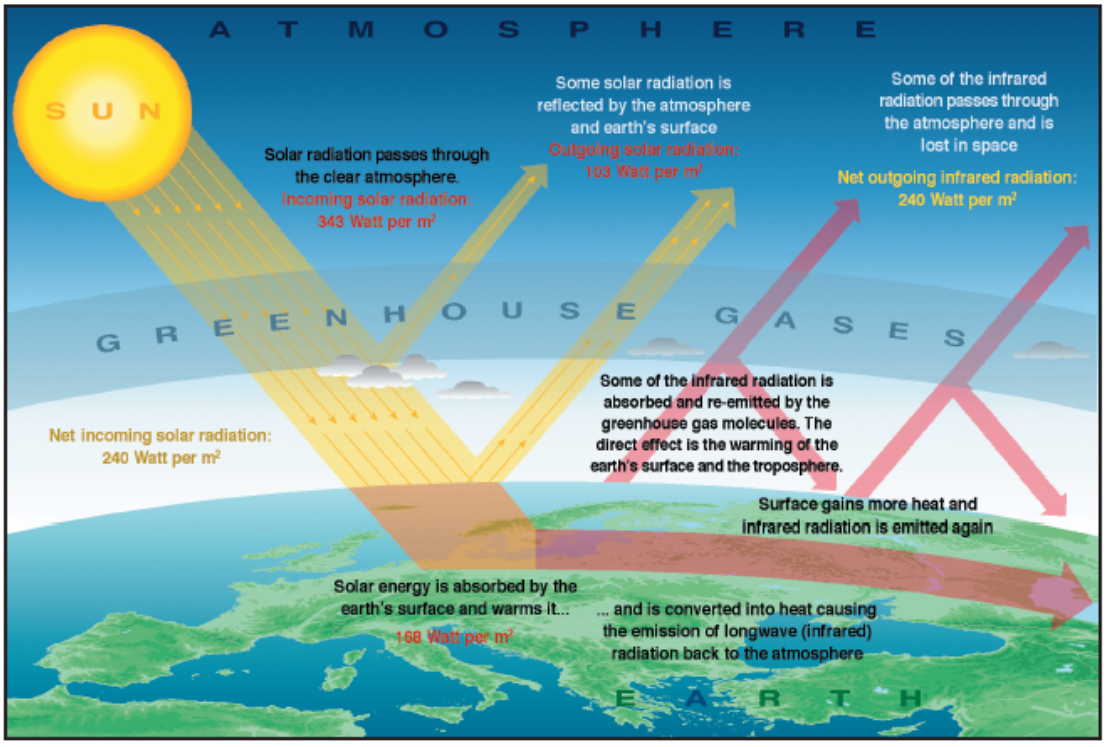


Figure 3.2 Greenhouse effect

However, since the beginning of the industrial revolution around 1750, one of these greenhouse gases, carbon dioxide, has increased by over 30% and is now at a higher concentration in the atmosphere than it has been for many thousands of years. Chemical analysis of the carbon demonstrates that this increase is due largely to the burning of fossil

fuels - coal, oil and gas (Houghton, 2005). These are consumed mainly through industry and transportation and along with other greenhouse gases such as nitrous oxide and methane that are also produced by human activity are thickening the natural greenhouse layer. This therefore leads to a warming of the earth, commonly known as „Global Warming" that may also cause more evaporation and a further increase in the greenhouse layer due to increased water vapour (Williams, 2002).

There is a worldwide consensus among climate scientists that global average temperature has risen about 1°F (0.4°C-0.8°C) in the past 140 years. The Assessments is done by the U.S. National Academy of Sciences and the United Nations' Intergovernmental Panel on Climate Change (IPCC) find that most of the warming of the past 50 years is likely due to the accumulation of greenhouse gases. The Fig 3.3 shows the increase in the Earth's surface temperature from 1860.

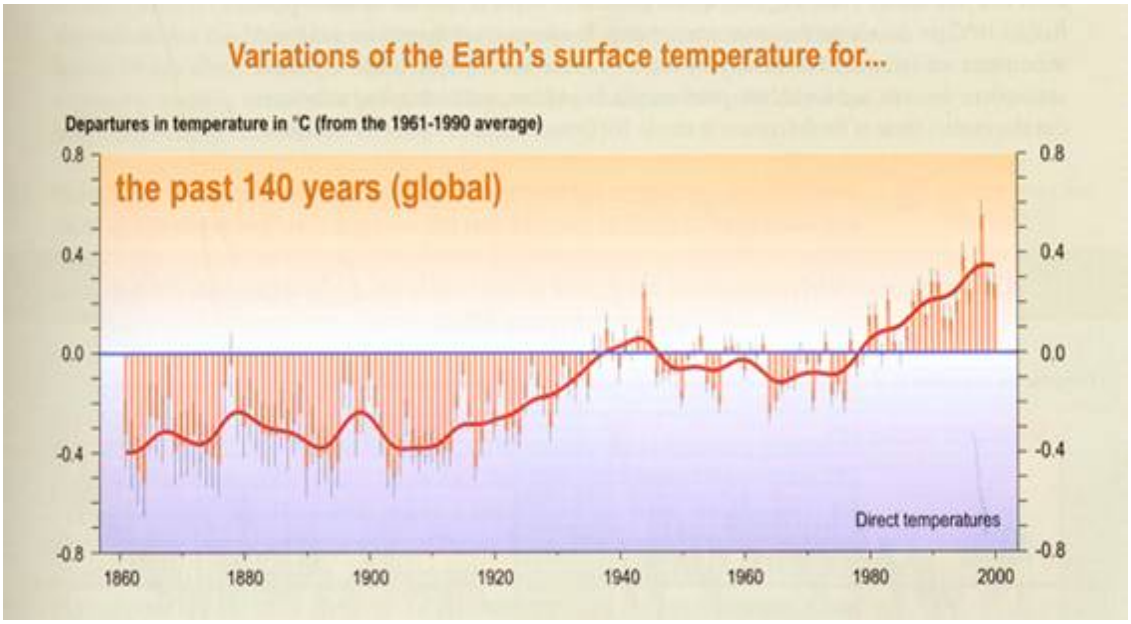


Fig 3.3 Variations in the Earth´s Surface Temperature, 1860-2000 *Source: IPCC, 2001 a*

The foremost evidence for worldwide climate change has been global warming. For the Northern Hemisphere temperatures during the second half of the 20th century were higher than during any other 50-year period in the last 500 years and probably in the last 1,300 years. In addition eleven of the last twelve years (1995–2006) rank among the 12 warmest years in the instrumental record of global surface temperature began in 1850 (Alley *et al*, 2007).

3.3 What is climate change?

Climate change is the variation in global or regional climates over time. It reflects changes in the variability or average state of the atmosphere over time scales ranging from decades to millions of years. These changes can be caused by processes internal to the Earth, external forces (e.g. variations in sunlight intensity) or, more recently, human activities (Arctic Climatology and Meteorology).

In recent usage, especially in the context of environmental policy, the term "climate change" often refers only to changes in modern climate, including the rise in average surface temperature known as global warming. In some cases, the term is also used with a presumption of human causation, as in the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC uses "climate variability" for non-human caused variations. (IPCC, 2001)

3.4 Vulnerability and Symptoms of climate change:

The magnitude of vulnerability varies in terms of geographical location, seasonality and exposure of population and infrastructure. People who live on arid or semi-arid lands, in low-lying coastal areas, in water limited or flood prone areas, or on small islands are particularly vulnerable to climatic variability and change. Other factors include economic and social conditions, natural resource capital, political and institutional mechanisms, equity in terms of resource distribution and gender, and coping and adaptive capacity. In the future, a warming climate (Fig. 3.4) will influence the normal range of weather patterns for major regions of the globe (IPCC, 2001a).

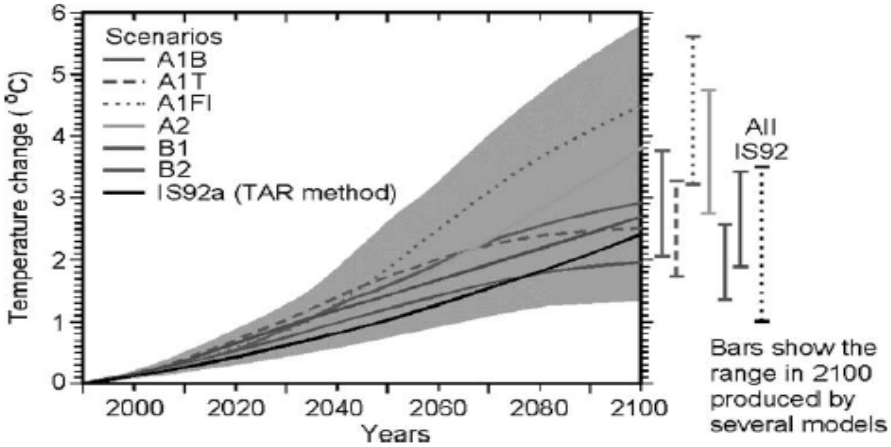


Figure 3.4 Temperature increase as projected by the IPCC Working Group I for scenarios from the *Special Report on Emissions Scenarios (SRES).* Source: IPCC, 2001a

The fourth assessment of the Intergovernmental Panel on Climate Change (IPCC) states that the impacts of human-induced climate change are likely to be felt in poor countries and poor communities first. The IPCC highlights the following as being particularly vulnerable:

- Small Island Developing States (SIDS)
- Africa
- Mega-deltas (particularly in Asia)
- The Polar Regions.

The UN Framework Convention on Climate Change (UNFCCC) also recognises SIDS and Africa as being particularly vulnerable, and adds to this the Least Developed Countries (LDCs). The countries making up these three groups are shown in the figure 3.5.

The normal range of weather patterns will be influenced in two ways. *First*, there will be gradual changes in average weather patterns. Incremental changes in precipitation patterns will result in either floods or droughts. *Second*, the increased variability of extreme weather events associated with changes in surface temperature and precipitation.

Table 3.1 Estimates of confidence in observed and projected changes in extreme weather and climate events

Confidence in observed changes (latter half of the 20th century)	**Changes in phenomenon**	**Confidence in projected changes** (during the 21st century)
Likely Higher maximum temperatures and	More hot days over nearly all land areas	Very likely
Very likely Higher minimum temperatures, fewer	Cold days and frost days over nearly all	land areas
Very likely	Reduced diurnal temperature range over most land areas	Very likely
Likely, over many areas	Increase of heat index over land areas	Very likely over most areas
Likely, over many northern hemisphere mid-to high latitude land areas	More intense precipitation events	Very likely, over many areas

Likely, in a few areas	Increased summer continental drying and associated risk of drought	Likely, over most mid-latitude
Not observed in the few analyses available	Increase in tropical cyclone peak wind intensities	Likely, over some areas
Insufficient data for assessment	Increase in tropical cyclone mean and peak precipitation intensities	Likely, over some areas

Source: IPCC, 2001a

The Intergovernmental Panel on Climate Change (IPCC, 2001b) has summarised the estimates of confidence of extreme events, as shown in Table 3.1 Increases in mean temperature and precipitation, rise in sea level and extreme weather events due to climate change would make developing countries more exposed to disasters. Table 3.2 summarises selected impacts of climate-related extreme events in developing regions.

Table 3.2 Selected impacts of climate-related extreme events in Asia

Region	**Region Expected regional impact of extreme events**
Asia	• Extreme events have increases in temperate Asia, including floods, droughts, forest fires, and tropical cyclones (*high confidence*) • Thermal and water stress, flood and drought, sea-level rise, and tropical cyclones would diminish food security in countries of arid, tropical, and temperate Asia; agriculture would expand and increase in productivity in northern areas (*medium confidence*) • Sea-level rise and increase in intensity of tropical cyclones would displace tens of millions of people in low-lying coastal areas of temperate and tropical Asia; increased intensity of rainfall would increase flood risks in temperate and tropical Asia (*high confidence*) • Climate change increase energy demand, decrease tourism, and influence transportation in some regions of Asia (*medium confidence*)

Source: IPCC (2001a). *Note*: The IPCC uses the following words to indicate judgmental estimates of confidence: *very high* (95% or higher), *high* (67–95%), *medium* (33–67%), *low* (5–33%), and *very low* (5% or less).

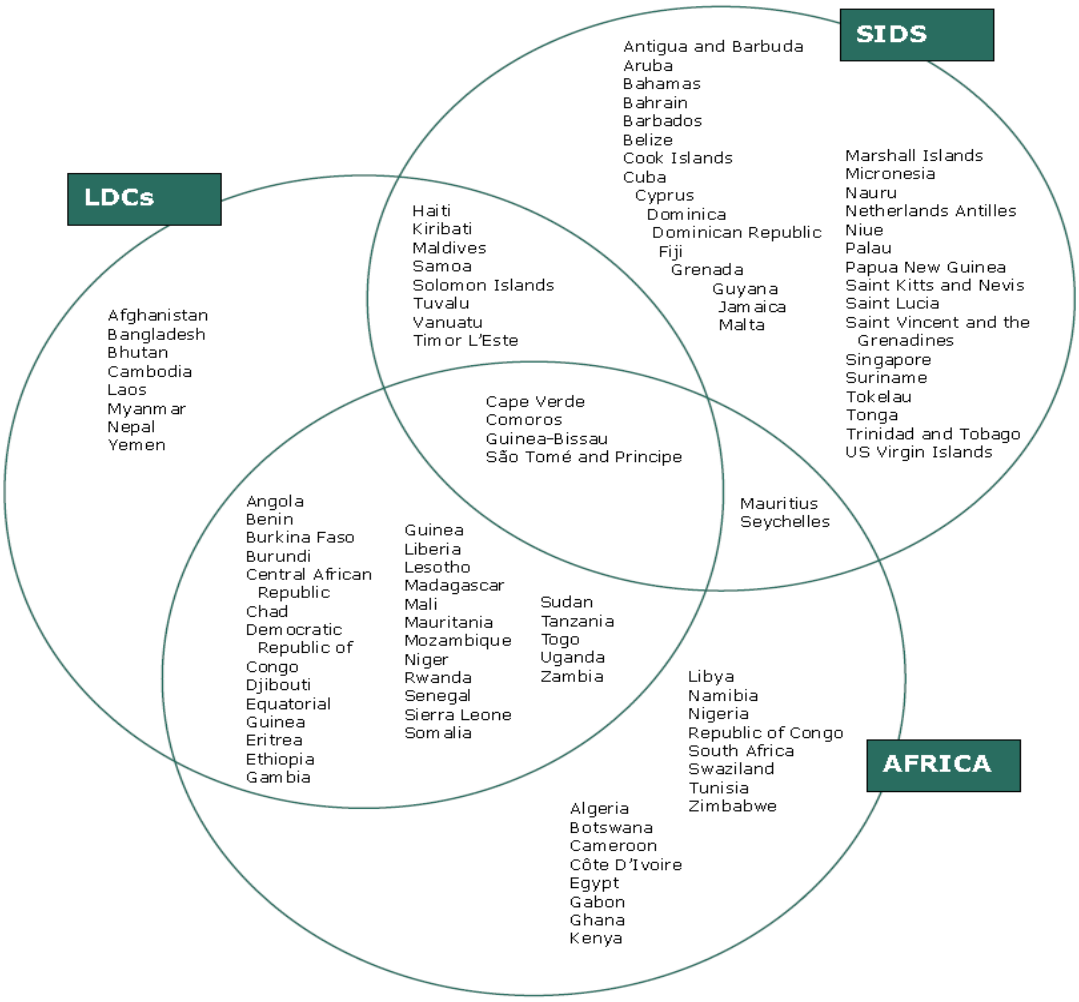


Figure 3.5 Most vulnerable 100 nations to climate change Source: IPCC, 2007

3.5 The impacts of climate change on cities

There are a variety of potential impacts of climate change on cities. A number of reviews have investigated these effects, including the IPCC Third Assessment Report (TAR), 2001; Bigio, 2003; McEvoy, 2007; Wilby, 2007, IPCC Fourth Assessment Report (AR4) 2007b; and Huq et al, 2007, andgenerally identify the most important effects of climate change on cities as:

- Effects of sea level rise on coastal cities (including the effects of storm surges);
- Infrastructure damage from extremes (wind storms and including storm surges, floods from heavy precipitation events, heat extremes, droughts);

- Effects on health (heat and cold related mortality, food and water borne disease, vector borne disease) arising from higher average temperatures and/or extreme events;
- Effects on energy use (heating and cooling, energy for water);
- Effects on water availability and resources;
- Effects on tourism, and cultural heritage;
- Effects on urban biodiversity;
- Ancillary effects on air pollution.

The TAR also concluded that vulnerability for settlements was mainly due to three factors:

1. Location (with coastal and riverine areas at most risk);
2. Economy (with those areas that are dependent on weather-related sectors at most risk),
3. Size (larger settlements have a greater aggregate risk, but also have greater adaptive capacity (resources) to mitigate impact risks.

The information from the TAR was summarised in Table 3.3 of the Impacts Report (chapter 7).The relevant urban scale parts of the table are reproduced below, with the degree of importance highlighted in colour.

Table 3.3 Impacts of climate change on human settlements by impact type and settlement type

Type of Settlement and Importance Rating									
Impact	**Dependent (Effects on Resources)**		**Coastal-Riverine - Steeplands (Effects on Buildings & Infrastructure)**		**Urban area with population more than 1million (Effects on Populations)**		**Urban area with population less than 1million (Effects on Populations)**		**Confidence**
	Urban high capacity	Urban low capacity	Urban high capacity	Urban low capacity	High capacity	Low capacity	High capacity	Low capacity	
Flooding, landslides	L-M	M-H	L-M	M-H	M	M-H	M	M-H	H
Tropical cyclone	L-M	M-H	L-M	M-H	L-M	M	L	L-M	M
Water quality	L-M	M	L-M	M-H	L-M	M-H	L-M	M-H	M
Sea-level rise	L-M	M-H	M	M-H	L	L-M	L	L-M	H

Heat/cold waves	L-M	M-H	L-M	L-M	L-M	M-H	L-M	M-H	M (H for urban)
Water shortage	L	L-M	L	L-M	L	M	L-M	M	M
Agriculture /forestry /fisheries	L-M	L-M	L	L	L	L-M	L-M	M	L
Air pollution	L-M	L-M	-	-	L-M	M-H	L-M	M-H	M
Heat islands	L	L	L	L	M	L-M	L-M	L-M	M

Source: IPCC TAR (2001)

Table note Impacts generally are based on 2xCO2 scenarios or studies describing the impact of current weather events (analogues) but have been placed in context of the IPCC transient scenarios for the mid- to late 21st century. The horizontal axis differentiates vulnerability according to type of settlement, capacity to adapt, and the mechanism through which the settlement is affected by climate change. The vertical axis identifies 9 different types of climate change impact in descending order of global importance. Vulnerabilities are rated as low (L), medium (M), or high (H) magnitude.

Chapter 4
Findings

4.1 Introduction:

The findings part describes the impacts of flooding, extreme temperature, excessive rainfall and waterlogging on the livelihood of the urban poor corresponding to the developed analytical framework. To narrow down the stress the climate change is deciphered into extreme weather events based on the trends of climate in Dhaka. It combines both quantitative and qualitative data of the housing, water, sanitation, health and income scenario of the slum dwellers induced by climate change.

4.2 Trend of climate change in Dhaka

Though the frequency and extent of feeling the impact varies, the frequently experienced climatic shocks are flood, erratic and heavy rainfall, and temperature rise. The relative recent floods that hit Dhaka and marked in the minds of respondents interviewed are 2004 and 2007. The floods of 1988 and 1998 are also identified as the most notorious in their lifetime. The respondents consider the erratic and unusual heavy rainfall like almost shock because it is occurring quite frequently. The heavy and dramatic rainfall in July 29 of last year was a terrible incident to everybody. Six persons died including two children in Dhaka. That was the heaviest rain in last 53 years in Dhaka. On that day 333mm rain fell in just twelve hours. The previous record was 326 mm on July 13 in 1956. Water logging due to heavy rainfall is recognized as stress by the respondents. At the end of July of 2009 (on 26th) Dhaka also faced the highest temperatures in last 14 years with a blistering 38.7 Celsius.

4.3 Impact on shelter:

Entrance of water during rain:

Though the slums are located in the flood-prone areas, water does not enter into room in normal average rain. According to the respondents 75% rooms are not affected by normal rain whereas 25% room's floor get wet during normal rain. Baganbari and Karail slums, those relatively are on the low land and very near to ditch normally become affected in normal rain. At least 34 households reported that they become severely affected due to heavy rainfall (Table 4.1) and they are mostly from Karail and Baganbari. Bhashantek slum is less affected

in normal or even heavy rainfall. During heavy rainfall the poor people suffers a lot with their kids and their necessary stuff. The major problems they identified can be listed as below-

- Difficult to stay in the room and compelling to leave
- Problem of cooking
- Economic loss due to damage and loss of necessary things
- Drowning of children in extreme case

Table 4.1 Affected by rain (no. of respondents)

Slum Area	Affected in normal rain (%)	Affected in heavy rain (%)
Karail	20	100
Baganbari	60	100
Bhashantek	0	60
Basila	20	80
Total	25	85

Source: Field survey, 2010 *N = 40*

Opinion about recent change

The respondents also identified that the sufferings had been increased since last 2-3 or 5 years. They are not well aware of the capacity or performance of DWASA or DCC regarding drainage system and so they think recent heavy rain is the only reason for entering water into their room. Significant number of respondents (68%) feels that intensity and frequency of heavy rainfall has been raised in the recent past. The change started since last 2 or 3 years and 45% respondents go with this. Rest of the households (23%) believe that it is since at least 5 years before. The detail opinions are as follows-

Table 4.2 Opinion about change in rainfall

Area	Change since last2/3 years	Change since last 5/6 years
Karail	50%	30%
Baganbari	70%	20%
Bhashantek	20%	20%
Basila	40%	20%
Total	45%	23%

Source: Field survey, 2010 *N = 40*

Affected by flood:

A number of severe floods have struck Dhaka since its early days and some of those devastated the city and the dwellers. In recent history, Greater Dhaka city experienced major floods in 1954, 1955, 1970, 1974, 1980, 1987, 1988, 1998, 2004 and 2007 due to the overflow of surrounding rivers. Among these, the 1988, 1998 and 2004 floods were catastrophic. Flooding due to rainfall is also a severe problem for certain city areas that may be inundated for several days, mainly due to drainage congestion. For the study the immediate three floods of 1998, 2004 and 2007 are considered.

Most of the respondents in Karail and Baganbari were affected by the flood of either in 1998, 2004 or 2007 or both. As the severity of the flood in 2004 was high, they were affected more. In Basila who resided almost on the embankment, were not so affected. Karail is adjacent to Gulshan lake and over-flooding of the lake affected its adjacent area. Being on the high land Bhashantek are in the safe zone regarding flood and waterlogging. As a whole, 67% respondents were somehow affected in the last two floods of Dhaka. 50% of the respondents had to leave their slums and took shelter on the road or in different schools or flood centers.

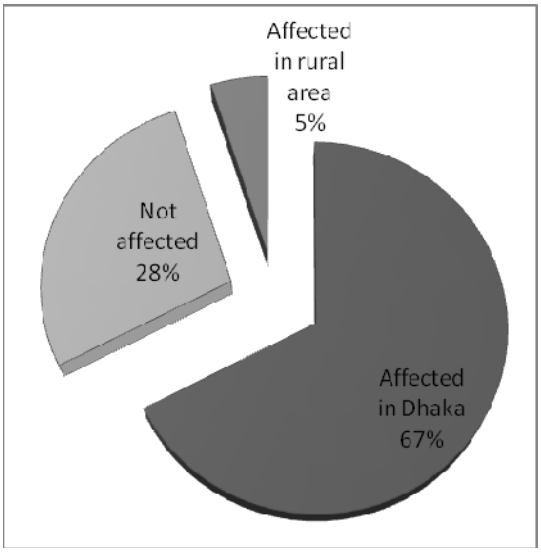


Chart 4.1 People affected in flood

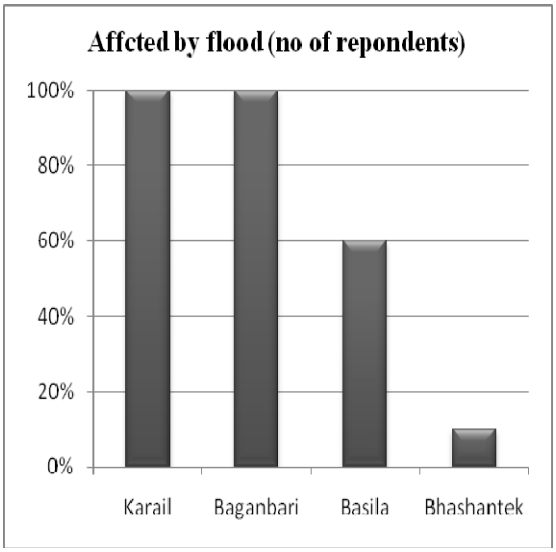


Chart 4.2 Flood affected people in different areas

Very few people took shelter in their relative's houses. The respondents, who suffered in rural area, migrated to Dhaka loosing everything. They became landless, homeless and workless. They came to Dhaka to survive but are now afraid of flood listening their neighbours' experiences. Apart from other losses, the damage of their shelters compelled them to live in distress. Among the affected HHs in heavy rain 56 percent (23 respondents)

households repaired their shelter by themselves or by their landlords. It should be noted that the construction materials and techniques are not so durable to resist flood or heavy rain flow. The construction material used by 55% HH is CI sheet (*tin*) for fencing and roof.

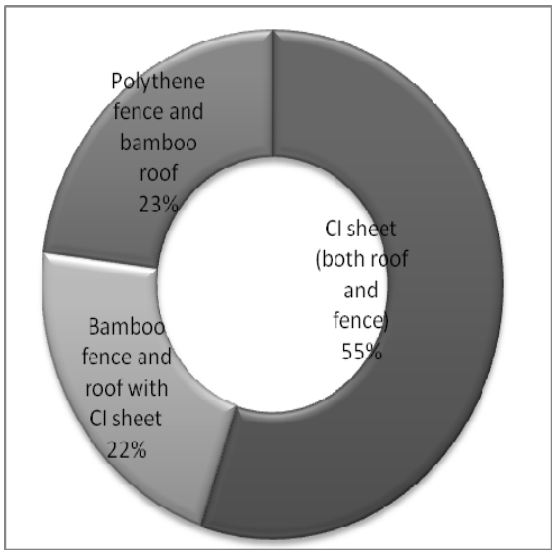


Chart 4.3 Construction materials of shelter

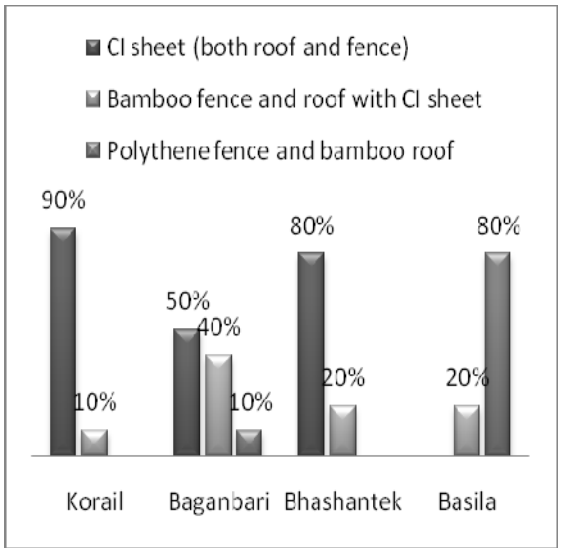


Chart 4.4 Materials of structure in different areas

Incomes of the slum dwellers are very limited and they find it very difficult to manage the money for repairing. The repairing cost ranges minimum Tk. 400 to maximum Tk.25000. Parents who borrow money from their relatives or friends, sometimes restrain themselves from taking their lunch or dinner for some days. Though neither govt. nor NGO provides any help for housing in the study area, Bhashantek and Baganbari slums are on govt. land.

4.4 Impact on water and Sanitation:

Water supply is a serious problem for the slum dwellers as they often find it very difficult to manage. Since there is no other alternative for water, the slum dwellers somehow manage

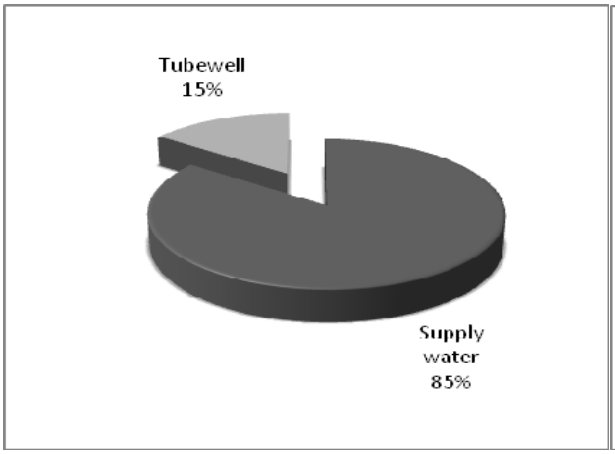


Chart 4.5 Water source of slum dwellers

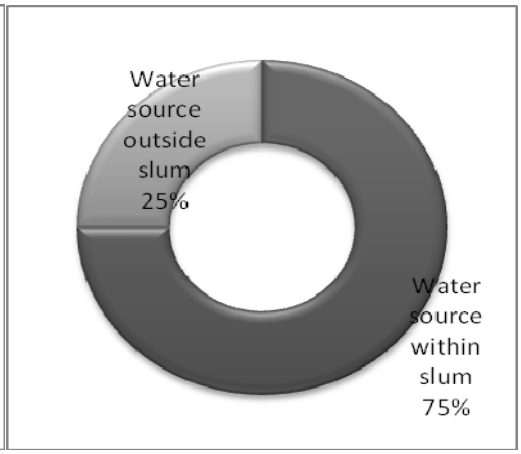


Chart 4.6 Location of water source

that. Most of the people use WASA's supply pipe water for drinking. At least 85% of the respondents use supply water for drinking and other purposes and a few uses tubewell water. The supply water is not available within all slums. Consequently, some households (25%) collect it from outside the slum with a monthly payment of Tk. 100 to Tk. 150. The sources of water in the slums are as follows –

Table 4.3 Sources of water

Area	Supply water within slum	Supply water bought from outside	Tubewell
Korail	60%	40%	0%
Baganbari	80%	0%	20%
Bhashantek	70%	0%	30%
Basila	40%	60%	0%

Source: Field survey, 2010 *N = 40*

A very few people use artificial well water for other purposes, though the water quality is not satisfactory. Some respondents also try to collect rain water for drinking and other purposes on a rarely basis.

Problem due to flood or excessive rain:

Slum dwellers face more difficulties to collect water during or after flood and heavy rain. Different kinds of problems are faced by 90% respondents to collect their water during flood and or during heavy rainfall. Among them 52% respondents faced problem during flood and 38% during heavy rain like the occasion of 29th July of 2009.

Table 4.4 HH faced difficulties for collecting water during flood and heavy rain

Area	Problem faced during heavy rain	Problem faced during flood
Karail	30%	50%
Baganbari	70%	80%
Bhashantek	10%	20%
Basila	40%	60%
Total	38%	52%

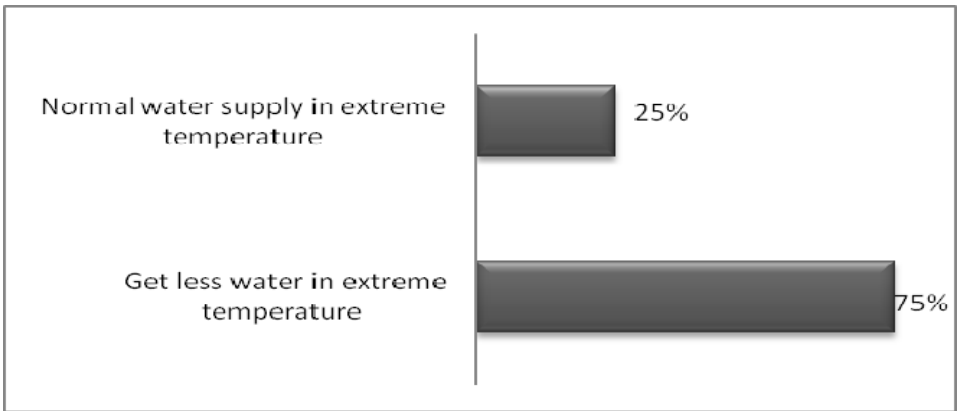
Source: Field survey, 2010 *N = 40*

Problem due to extreme temperature:

Water become inadequate in the summer as the ground water level goes down. If the temperature becomes extreme, the load shedding of electricity reaches its peak. As the water

supply is related to electricity run pump, restoration of water in reservation is interrupted frequently. In summer, 75% respondents noticed that they get less water and face problems in respect of collecting water.

Chart 4.7 Slum dwellers' opinion about water supply in extreme hot temperature



Source: Field survey, 2010 *N = 40*

Regarding raising temperature major respondents believe that temperature has been increased or summer is hotter than before. Eighty five percent (85%) of the respondents feel that the sufferings in the summer have increased during last 1 or 2 years and load shedding is more frequent now.

Place of defecation:

As the respondents live in the informal settlements, their place of defecation is very poor with unhygienic condition. Major respondents (40%) use pucca latrine, 35% use *kutcha* or pit latrine and rest use hanging latrine. Those who live on the elevated dwellings over water have

Table 4.5 Place of defecation in slums

Area	Pucca latrine	Kutcha latrine	Hanging latrine
Karail	20%	50%	30%
Baganbari	40%	60%	0%
Bhashantek	80%	20%	0%
Basila	20%	10%	70%
Total	40%	35%	25%

Source: Field survey, 2010 N = 40

no option except hanging latrine. Some NGO has constructed community latrine with the collaboration of Dhaka City Corporation. Most of the HH expected from government to help them for building latrines.

Problem during flood and excessive rain:

Heavy rain like of 29th July in 2009 or during last three floods 78% (31 HHs) respondents face problem regarding defecation. At that time some did the task beside rivers and some went to the adjacent dry latrine. People stayed in flood shelter have to wait in queue for defecation. Among the affected respondents 35% (14 HHs) suffered in both the occasion.

Table 4.6 Opinion about defecation problem during flood/heavy rain fall

Area	Problem faced during heavy rain	Problem faced during flood	Problem faced during both occasion
Karail	50%	70%	30%
Baganbari	70%	90%	60%
Bhashantek	10%	20%	0%
Basila	60%	70%	50%
Total	50%	63%	35%

Source: Field survey, 2010 N = 40

Waste disposal and Sewerage system:

There is almost no sewerage system in the slums. All the kutcha latrines are connected to the nearest ditches and rivers. According to the households in study area, there is no fixed place for waste disposal. Generally wastes are disposed wherever they live like on the ground or above the water body. Therefore, scattered wastes are found visible in open place. It indicates that adequate facilities of waste disposal as well as collection are almost non-existent in slum area. River or ditches are used for waste disposal by 40% of the respondents whereas only 15% respondents use dustbin. The rest 45% throw their waste here and there. These haphazard wastes block the very few drains where available. Exposure to such dirty

environment is very risky for children as they spend most of their time playing outside. The overall scenario is as follows-

Table 4.7 Place for waste disposal in the slums

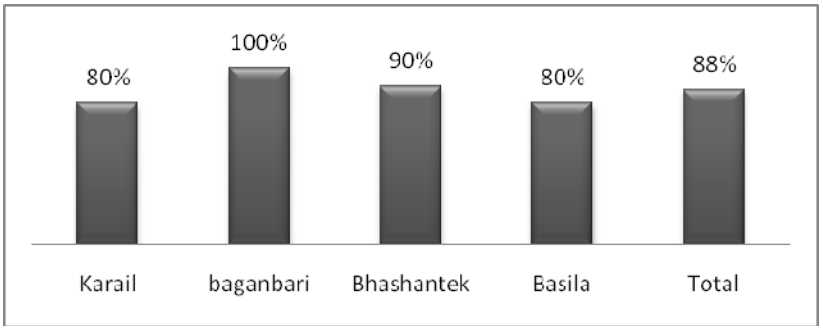
Area	Beside room	Into ditch/river	Dustbin
Karail	10%	90%	0%
Baganbari	70%	30%	0%
Bhashantek	40%	0%	60%
Basila	40%	60%	0%
Total	40%	45%	15%

Source: Field survey *N = 40*

Water logging

The drainage system is very poor in the slums and consequently rain caused water logging is a common problem for the slum as well all urban dwellers. This problem is faced by most of the respondents (88%). The area-wise opinion is shown in the chart 4.8. Walking becomes very difficult for them by crossing water and clay. Children are affected more as they suffer from diarrhea playing in the dirty water of waterlogged areas. Some suffer from skin disease in their foot. The alarming scenario is- the waterlogged water mix with the raw sewage and the solid waste which ultimately produce mosquitoes, flies and bad odour.

Chart 4.8 Households affected by waterlogging



Source: Field survey, 2010 N = 40

4.5 Impact on Health:

Natural disaster and the adjacent environment of slums play a significant role in the dwellers health. Flooding has been shown to cause epidemics of waterborne and vector-borne disease. Water-borne outbreaks of diarrheal illness after floods are thought to result primarily from contamination of water caused by disruption of water purification and sewage disposal systems. The study areas are characterized with the adjacent heap of wastes, poor sanitation and polluted ditch which are the breeding ground for mosquitoes. Consequently, major respondents (50%) suffered from diarrhea and very few respondents suffered from malaria and dengue. The scenario of water-borne and vector-borne diseases people suffered once or more in recent five years in the study areas in the table as follows-

Table 4.8 Respondents suffered from water and vector-borne diseases

Disease / Area	Diarrhoea	Malaria	Dengue
Karail	**80%**	**0%**	**0%**
Baganbari	**50%**	**10%**	**10%**
Bhashantek	**30%**	**0%**	**10%**
Basila	**40%**	**0%**	**10%**
Total	**50%**	**3%**	**8%**

Source: Field survey, 2010 N = 40

Medical Expenditure:

Though most of the people in slums are poor, they had to expend on treatment sometimes even if they went to the govt. hospital. 11 respondents (28%) reported that they spent from Tk. 20 to Tk. 20000. Among the respondents who himself or his/her children suffered from diarrhoea, 40% respondents went to the ICDDRB and 15% respondents went to other hospitals for treatment. In the ICDDRB, the treatment is almost free and all the respondents who went there comment positively about their service. The average expenditure for diarrhoea treatment is 200 or 300 taka. On the contrary, those who suffered from dengue expended 12000 taka on average.

Effect on health and social problem:

Because of the abovementioned diseases, some respondents faced health problem like weaker than before. Some children did not attend school and some people even lost their job. 11

respondents found that he or she himself/herself or their children become weaker than before, 4 respondents noticed that their children could not attend school and 2 respondents lost their job.

Causes of diarrhea

Diarrhoea is very much related with the sanitation, water and cleanliness and vector-borne diseases are related with cleanliness. Flood makes water sources contaminated and scarce. Extreme temperature is another reason identified by the respondents. 23% of the respondents identified flood as responsible for diarrhoea who personally or family members suffered. The

Table 4.9 Opinion about cause of diarrhea

Area	Flood	Heat	Decaying food
Karail	50%	10%	20%
Baganbari	20%	20%	10%
Bhashantek	10%	20%	10%
Basila	10%	20%	10%
Total	23%	17%	12%

Source: Field survey, 2010 N = 40

other reason they identified are extreme temperature and decayed food. Except diarrhoea and dengue, the respondents also found flood as the source of other health problems like scabies and fever. The scenario of diseases the respondents suffered in the flood of 2004 and 2007 is as below-

Table 4.10 Diseases observed during flood

Disease / Area	Diarrhoea	Scabies	Fever
Karail	**50%**	**10%**	**-**
Baganbari	**40%**	**10%**	**-**
Bhashantek	**10%**	**10%**	**-**
Basila	**20%**	**10%**	**20%**

Source: Field survey, 2010 N = 40

The respondents also identified some health problems due to extreme hot or cold weather. Fever, tiredness, diarrhoea, skin diseases, vomiting, headache and prickle are observed in

very hot weather. On the contrary, cough and respiratory problem are significantly identified by the respondents in very low temperature. It is also that during very hot weather people take rest intermittently due to tiredness as they have no option to work less.

4.6 Impact on work and income:

Female adults and children tended to work as housekeepers, laborers or in garment piecework, while male adults and children tended to work as rickshaw pullers, laborers, brick breakers, drivers or carpenters. Male adults worked an average of 9 hours and female works almost dawn to dusk everyday.

Income and expenditure

According to survey data, 68% of households have income less than Tk. 5000 and 32% have income Tk. 5000 to less than Tk.10,000. A major portion of households' income is spent on food items following expenditure on nonfood items and house rent. Survey data reveals that a major share of their income is spent on food (average monthly expenditure Tk. 3416) followed by house rent (Tk 1242 on average) and non-food items (Tk 879 on average) respectively.

Significant number of households (88%) reported their expenses equal to income or greater than income and as a consequence they often depend on loans for survival. In case of medical treatment and repairing of damaged house they take loan from their relatives or friends. To repay the loan they sometimes sacrifice even their meal. Only 12% HHs reported that they can save some money after all expenditure at the end of the month.

Situation during flood/heavy rainfall/extreme high temperature

Extreme weather disrupts the slum dwellers work and income. Some occupations are very much influenced by weather like rickshaw pulling, daily labour, brick breaking etc. In heavy rain or flood the informal sectors are affected significantly. All respondents feel tiredness during their work in extreme high temperature. They take a pause for by taking rest for a while and then start again. As a consequence, in profession like rickshaw pulling or vendor the respondents earn less. According to the respondents of the study during flood 38% of them were absent from work for 8 days on average. This absence put tremendous pressure to manage food for their families/. Two respondents (5%) lost their job due to long absence

from work. Excessive rainfall with waterlogging also hampers 48% respondents' work in many ways. The detail scenario is as follows –

Table 4.11 Impact on work due to excessive rainfall

Impact	**No. of respondents**
Absence from work	1
Faced difficulties or became late in their work	8
Tough to move around for vendor through water in walkways	1
Need more strength and time for rickshaw pulling	2
Social problem as a woman to draw cloths above knee to cross water	1
Less income as a result of less customer for shopkeeper	3
No/less work as day labour/carpenter	3

Source: Field survey, 2010 N = 40

4.7 Conclusion:

The households' responses regarding impact of different extreme events on their livelihood have shown some serious matters of concern. However, these findings need to be compared with the similar researches or data for justification because the relation between climate change and urban poor's livelihood is not understood by the respondents. The following chapter analyses the above primary findings with number of secondary references as well as opinions of concerned experts.

Chapter 5

Analysis

5.1 Introduction:

In general, slum dwellers are vulnerable in respect of accessing to urban basic services. Natural calamities or disaster make urban poor's life more vulnerable and have its strong impacts on livelihood assets. The respondents in this study think that recently these impacts are increasing frequently with more intensity. Their inferences are analysed here with secondary results corresponding to climate change.

5.2 Impact of flood:

Damage of housing:

During flood the majority of families was unable to remain in their homes or even on the *chals* (roofs) of their homes, and moved with their basic belongings of utensils and bedding into the nearby shelters and relief camps. During floods 67% of the respondents were affected by flood and they were even compelled to leave the place without even their necessary stuffs. Despite the appalling conditions in the slums, there were some families who preferred to remain in their homes. They refused to move, as they did not want to leave their household belongings behind. Instead they coped by raising the level of their *chowkis* (beds) and stoves with bricks and bamboo in an attempt to remain. Most of them were frantic to keep their belongings from sinking, and used bricks, sandbags and makeshift wooden platforms. Similar findings in a report on the flood situation in Dhaka, indicated that many of the families managed by using sandbags and bricks to prevent water from flooding their homes; while some individuals set up wooden pillars and temporary platforms to live on, and a few even made makeshift arrangements to live in trees (Ahmed, I., 1999).

The respondents described - many families were reluctant to move from their homes, but felt compelled to because of the stench of stagnating dirty water and the nuisance of mosquitoes. The dirty water created a perfect breeding ground for mosquitoes, and people saw snakes, leeches and rats floating in it. Several flood reports found that families moved because they feared being bitten by snakes or rats; and many were scared that their babies could fall and

drown in the water, or someone might be electrocuted because of the loose electrical lines littering the area (Ahmed, S.M. et al., 1999; Ahmed, I., 1999; Rashid and Halder, 1998). The case study in the Box 5.1 gives same kind impression of the sufferings.

Box 5.1 Case study – relentless sufferings during flood

"*I had to stay on the road with my 6 days new born baby*" – the pathetic incident is described by Md. Munir of Basila slum of Mohammadpur. Being a transport worker of the Mohammadpur Beribadh area Munir lives in the Basila slum since 2000 with his six family members. Their sorrows know no bound in the poor shanty small room but somehow managed their life and livelihood. After two daughters Munir became the father of his expected son, though his joy was transient. After 6 days of his son's birth the demolishing flood hit their settlement in 2004. His wife was not fully well and just returned from maternity hospital. They had to leave their slums and took shelter on the western embankment of Dhaka. Munir was just crying while describing the incident. "It *was a horrible 8 days in my life and I will never forget this in my life*", said Munir. He could not attend to his work for those days and was deprived of earning 300/400 taka each day. He spent all his savings regarding his wife's delivery purpose and had nothing to buy food or water. "*So far I remember, I used to take only one piece bread and water at noon and night. I took loan to buy medicine for my wife. People who were with us also suffered a lot*", Munir also added. He was very angry with the government for not getting proper help.

When flood strikes on the poor structure situated on the flood-prone areas, the houses become demolished. In this study 72% households described that the most devastating loss for them was the irreparable damage to their houses and they were distressed at having their bamboo walls, tin and other house materials destroyed. Fifty five percent (55%) of those affected settlements were made of CI sheet. Reminders' qualities were comparatively inferior as those were with bamboo or polythene fence and roof. In Dhaka, 60.9% slums have experienced fully or partially flooding and 46% slum houses consist of very weak structure (CUS, 2005). When the flood was over most of them came back to their destroyed slums and tried to repair their house. Those who were tenant went to other slums. Slums in Bhashantek, Karail and Baganbari are on the govt. land and most of the dwellers built their own houses there. In Basila slum which is on private land, the dwellers pay monthly rent. Best part of the

respondents (85%) repaired their shelters once or more by themselves or by their slum owners. According to their opinion the maximum repairing cost ranged Tk. 20000 to Tk. 25000. Managing money for repairing became tougher for them since some of them became jobless due to flood and most managed the money by borrowing from relatives or friends. Two respondents lost their job as they could not attend work for shifting their families to the flood shelter. A survey conducted during the 1998 flood also found that at least one in thirteen people had been forced to change their occupation, while the floods left 27.4 per cent of people unemployed (Reid and Sims, 2007).However, repaying that extra money was great challenge for them and some did it even by sacrificing their meal.

The 1998 flood caused damage to more than 262,000 shelter units, or 30 percent of the 860,552 units in the Dhaka Metropolitan Area; the cost of damage was Tk. 2,311 million. Of these, 32 percent were permanent and semi-permanent structures belonging to wealthy or well-to-do households not dependent on assistance for repair and rehabilitation. About 36 percent of shelter units in the katcha-1 type, belonging to lower-middle and poorer classes, suffered damage of Tk. 283 million. Their owners had the ability to cope with repairs but would face hardship. Nearly 32 percent (of units of Katch-2 and Jupri types), belonging to the poor and hard-core poor, suffered severe damage and required Tk. 195 million in repairs. The owners were too poor to mobilize funds on their own (Islam and Ali, 1999).

Floods often cause extensive damage to its economy and could be in the range of US$ 3–4 billion, such as resulted from floods in 1998 (Ahmed and Mirza, 2000). Flood damage during

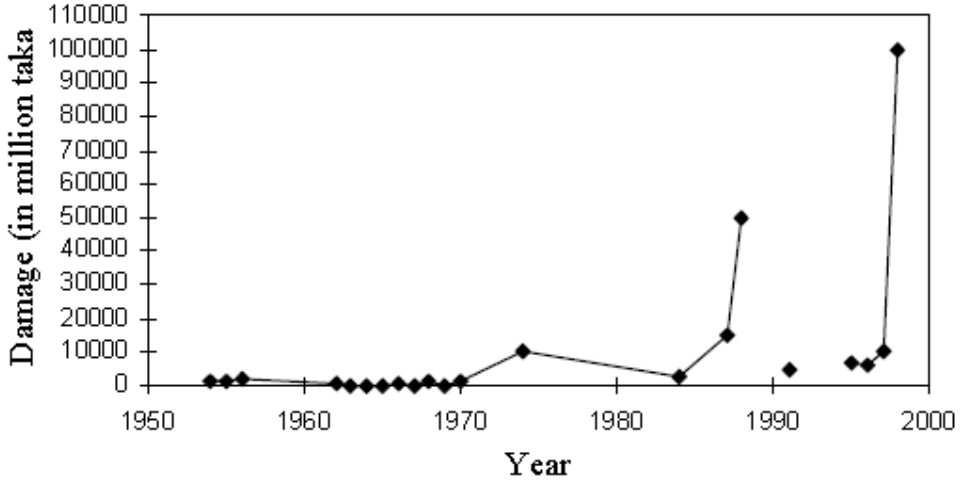


Figure 5.1 Flood damage in Bangladesh during 1955–1999. *Source*: Mirza, 2002.

the period 1955–1998 in Bangladesh is shown in Fig 5.1 and the sector wise damage in the last major floods is shown in Table 5.1 as below:

Table 5.1 Damages due to major flood in Bangladesh

Year		1987	1988	1998	2004	2007
District		50	52	52	39	46
People		24823376	35732336	30916351	36337944	13771380
Crops damaged (Acre)	Fully	2983362	364258	1423320	1605958	890898
	Partially	1873207	9902967	1808401	1038176	1353366
No. of House damaged	Fully	71572	1030659	980571	894954	84321
	Partially	1691104	2265776	2446395	3389101	1003799
No. of Dead People		1470	1517	918	747	1092
No. of Dead Livestock		370129	348042	26564	15143	1459
No. of Damaged Institution	Fully	1155	2593	1718	1295	563
	Partially	2583	6506	23272	24276	8190
Road Damaged	Fully	12624	45840	15927	14271	3705
	Partially	11534	14016	45896	45528	27828

Source: Sarker, 2009

***Water and sanitation**:*

The sources of water are damaged or inundated during flood and water becomes unavailable for the slum dwellers. The respondents suffered badly since they struggle in general to manage water for both drinking and other purposes. During flood 40% of the respondents found difficulties for managing water and traditional chores for women, such as cooking and fetching water became very difficult. Kitchen utensils and clothes were usually washed in the flood waters. 'Though GO and NGO provided limited amount of drinking water and purifying tablets, all did not get that', some respondents depicted. Many of the women stood in line for hours on end to gain access to free water. Some respondents also bought water from owner of deep tubewell or from where available. HHs of Karail slum bought water from T&T colony through out the flood period. In many cases, women filled up large pitchers and carefully rationed their use of water over the next days. Not everyone, however, could afford to buy water or otherwise obtain safe water easily and some resorted to drinking the dirty floodwaters. Many went to school, mosque and hotels for collecting water. During the 1998 flood, 44 deep tubewells of WASA were affected by floodwater and water production was suspended in 13 of them, with an estimated loss in production of 45 million litres per day

(Alam and Rabbani, 2007). Water becomes also contaminated as many pipes break or damage due to water pressure. A late July newspaper report during the 2004 flood noted that more than 2 million city residents faced an acute drinking water crisis as supplies had become contaminated. Thirty water pumps operated by the Dhaka Water and Sewerage Authority (WASA) were inundated by rising floodwater. Water pipelines stretching over a few hundred kilometres and many reservoirs were also under water, posing a serious threat to public health (*Star*, 2004).

Sanitation is a major problem for the slum dwellers in Dhaka city where flood makes it worse. Women are especially vulnerable in this regard. In this study 78% of the respondents suffered badly in gaining access to basic sanitation as most of the latrines were submerged by the floodwaters. Women faced more problems since they had no option to sit here and there for urination as well as for defecation. As a result they resorted to a number of desperate measures to cope with this predicament. At day women could not sit nearby the people but at night they had no option except sitting behind any tree or obstacles in extreme cases. Some of the women admitted walking long distances with female relatives, or planned trips together by boat to other less flood-affected areas to use the latrines. The difficulties faced by women during floods has also been reported in a number of studies, which found that women and young adolescents girls were unable to use a latrine until very late at night; while others out of desperation used their immediate surroundings as a toilet, and some stood in the floodwaters to urinate or defecate. Some of the adolescent girls threw their used menstrual cloths into the dirty floodwaters or in some cases, re-used menstrual cloths washed in dirty water (Anam, 1999; Rashid and Michaud, 1998).

Diseases:

Flooding has been shown to cause epidemics of waterborne disease by the 50 percent respondents. Diarrhoea became a serious problem during and after flood due to lack of safe drinking water. Children were mainly affected with diarrhoea as many of them swam in the dirty flood waters to fetch relief items, and some of the young children played in the dirty water out of boredom, even drinking and bathing in it. A study of ICDDRB (2006) also shows that there is a good relation between diarrhoea and flood. Figure 5.2 shows the relationship between river levels and diarrheal epidemics for the flood periods of 1988, 1998, and 2004. The study found that a median of 8.5 days (range, 3–13 days) from the time the

rivers reached flood stage until the beginning of epidemics, and a median of 17.5 days (range,

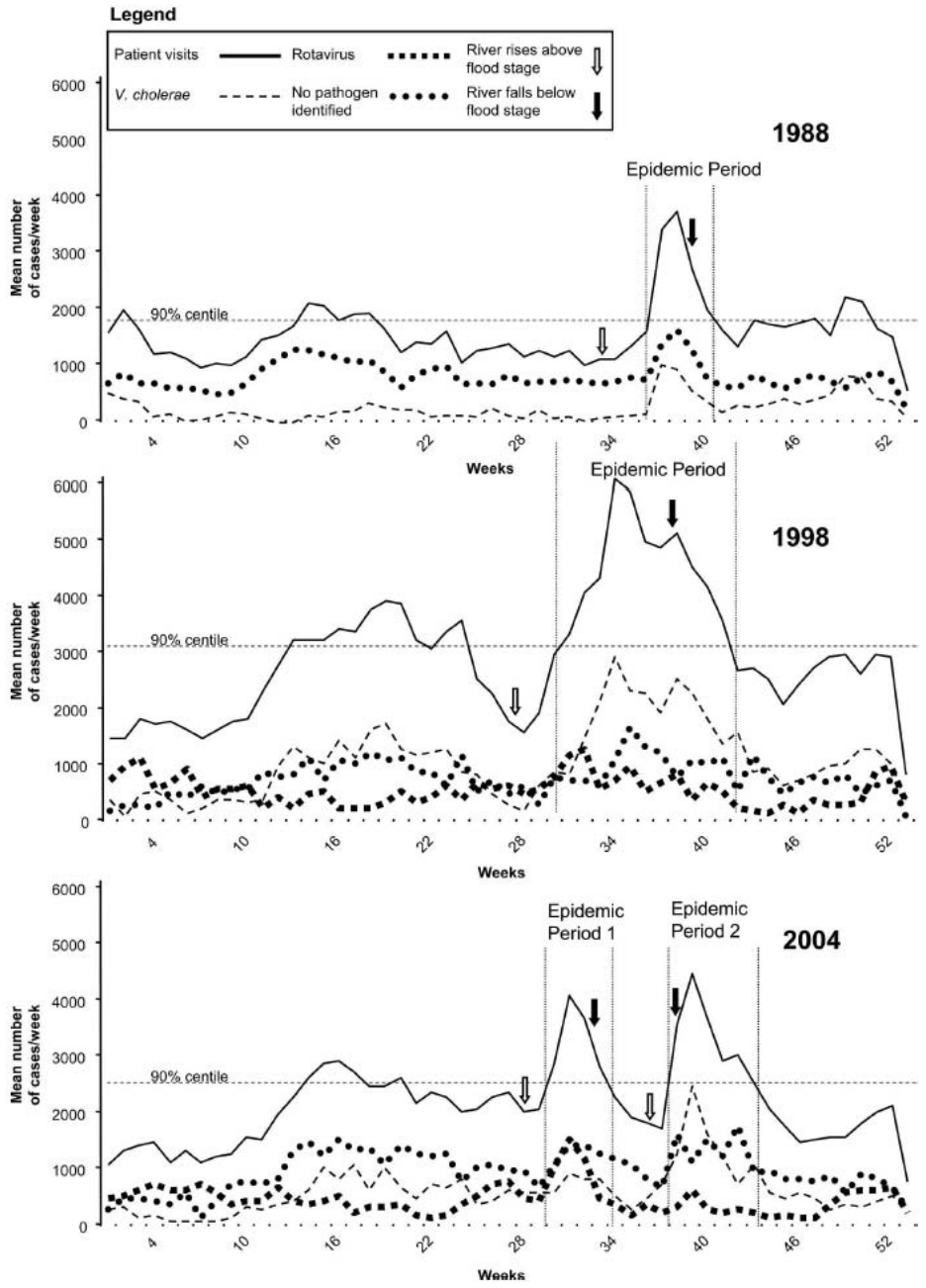


FIGURE 1. Mean cases per week of patient visits and selected enteric pathogens at the Dhaka Hospital of the ICDDR,B during 1988, 1998, and 2004. All values are estimated cases per week based on surveillance data representing 4% (1987–1989) and 2% (1997–2004) of total cases. River level data was only available from May 1 (week 18) through October 15 (week 42) for each year studied. These periods correspond to highest river stages. Horizontal dashed line represents 90th percentile of mean number cases/week for non-flood years for each flood year. Vertical dashed lines represent epidemic periods.

Figure 5.2 Relationship between flood and diarrhoea

8–36 days) for the epidemics to end after falling of the river levels below flood stage. In the 1998 and the second 2004 floods, there was a longer lag from the end of flooding until the

end of the diarrheal epidemic (22 and 36 days, respectively) compared with the 1988 and the first 2004 floods (13 and 8 days, respectively).

The study also showed that patient suffering from cholera and those without microbiologically identifiable cholera infection were both more likely to have severe dehydration during flood-related epidemics than during non-flood periods. It is also that the proportion of cholera infection increased during all of the flood-related epidemics compared with non-flood periods.

Slum dwellers also suffered from scabies and fever during flood and 15% respondents identified this. They thought staying in and walking on water continuously created such problems. In 2004, the prevalence of disease during extreme events such as floods increased greatly. These diseases included diarrhoea, dysentery, acute respiratory infection, fever, skin diseases and eye infections. (Alam and Rabbani, 2007)

Other than flood, the normal quality of water is not fully secured. Recently a test of 22 samples of water from different places of Dhaka city has been occurred by BSTI. Only 7 samples have been fulfilled the criteria of purity. Among the unsafe 15 samples, bacteria were discovered in 8 samples and TDS (total dissolved solids) is found in 4 samples. The water samples from Bhashantek, Mohammadpur and Gulshan have identified with bacteria. (Prothom Alo, 2010)

No work:

During any disaster situation, work and wages become scarce for the poor. Most of the urban poor are unskilled and involved in the informal sector. A majority tend to work casually as wage or daily labourers. According to this study, 38% of the respondents were absent from their work during flood and 5% lost their job. The prices of basic food items generally multiply, with severe stress imposed on the poor who were not only unemployed but suffered from severe financial constraints. Therefore, to save on costs, most family members reduced their food intake. In most of the cases parents sacrificed their meal for their children.

Causes and trends of flood:

Bangladesh acts a drainage outlet for the vast river basins of the Ganges, Brahmaputra and Meghna rivers (Figure 5.3). The cross-border and local runoff generated by intense monsoon

precipitation often causes floods in Bangladesh where more than 70% of the country is vulnerable to floods. Annually, floods inundate 20.5% or 31,000 km2 area. In an extreme case, this may go up to 70% of the area of the country. Four types of floods generally occur in Bangladesh. They are: flash, riverine, rainfall-induced and storm surge floods.

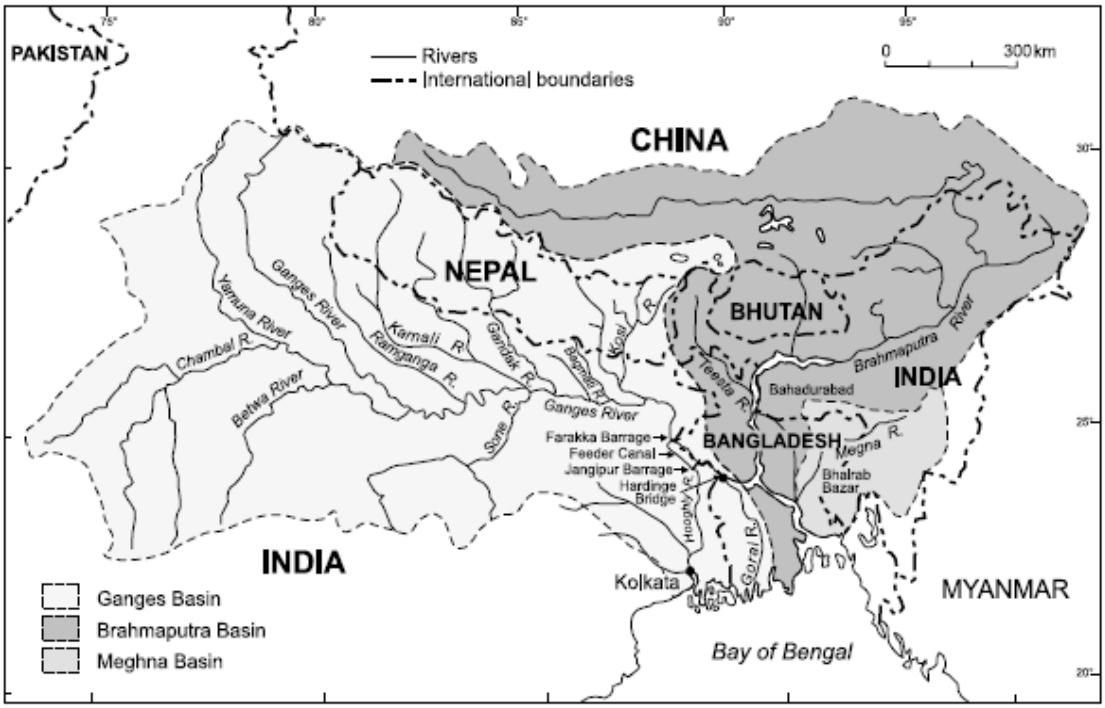


Figure 5.3 The Ganges, Brahmaputra and Meghna basins Source: Ahmed and Mirza, 2000

Bangladesh is facing floods almost every year due to heavier rainfall inside and outside the country. Further, the frequency of floods has become increasingly unpredictable and extreme. After citing major flood occurrences in Bangladesh from 1970 to 2009, it can be inferred that the frequency of major flood occurrences has increased since1990 (figure 5.4).

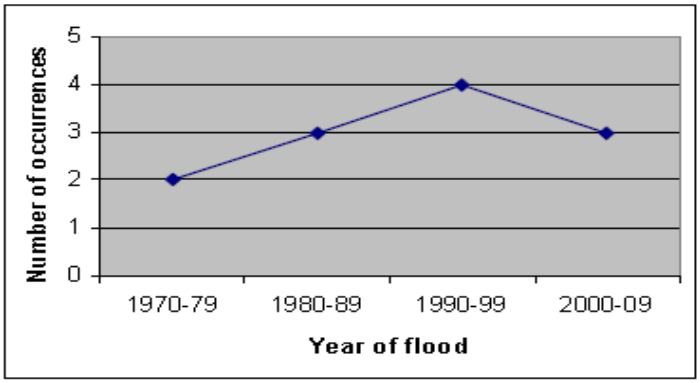


Figure 5.4 Number of occurrences of floods since 1970

Dhaka is prone to damaging and costly flooding, both from the rivers that bound it and from rainfall that generates runoff that is beyond the capacity of the drains. Dhaka's topography is a huge issue related to flooding as the elevation of the City varies from 0.5 m to 12 m, with 70% of the total area within 0.5 to 5 m. These low lands, act as temporary detention basin for flood water. In less than 20 years, the city has faced four major floods, each causing huge damage and economic loss. The 1988 flood that lasted for two to three weeks and affected close to 250 sq km; the 1998 with a duration of six to eight weeks and an affected area of 168 sq km; the 90 sq km flooded in 2004 during a time span of two to three weeks.

Recurrent floods are being widely mentioned as an impact of climate change, alongside frequent and severe cyclones. The country tends to have more devastating floods because of higher sea levels. This is due reduced gradient of rivers, higher rainfall in the Ganges-Meghna-Brahmaputra river basins and melting of glaciers in the Himalayas (Pender, 2007). In addition, the prolonged floods affecting Dhaka as well as Bangladesh indicate that the intensity and frequency of floods are on the rise.

5.3 Impact of extreme temperature:

Extreme temperature or more heat has a significant impact on the health of the urban poor. In this study it had also been identified another reason for diarrhoea by 14% respondents, though the severity is high during flood. Fever is another disease faced by respondents due to high temperature. Almost all the respondents now feel that the summer is hotter and longer and winter is warmer and shorter than before. Their opinions comply with the two incidents of extreme temperature in 1995 and 2005. At the end of July of 2009 (on 26th) Bangladesh faced the highest temperatures in last 14 years with a blistering 42.2 degrees Celsius in its Jessore district and 38.7 Celsius in the Dhaka city. An unrelenting heat wave had swept the country for over that week. The highest temperature in 1995 was recorded as 43 degrees in Rajshahi, and 39 degrees in the capital. According to the BMD record, the average maximum temperature in Dhaka and Jessore are 31.4°c and 32.0°c respectively.

Diseases:

High temperature is positively associated with the number of non-cholera diarrhoea cases (Hashizume et al., 2007**).** The study showed that there is linear increase in the number of

cases with high temperature. For a one degree increase in average temperature over lags 0–4 weeks, the number of cases increased by 5.6% by using a model that assumes a log-linear increase in risk. The independent effects of temperature at different lags showed that the positive association was observed in the same week and decreased to null at lags 2 and afterwards (Figure 5.5).

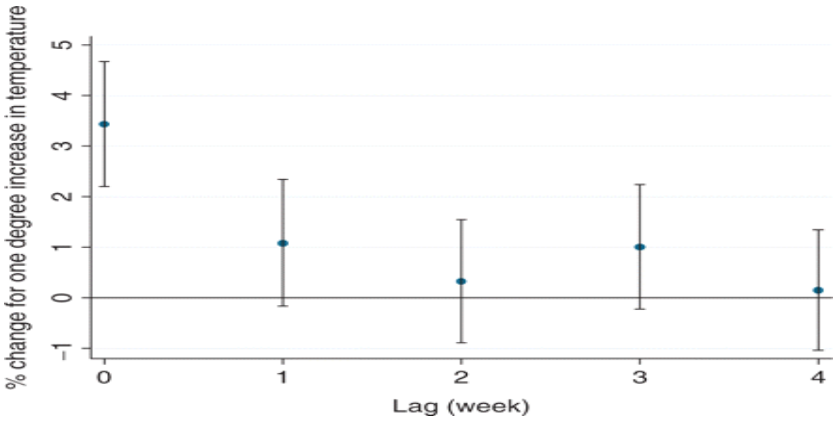


Figure 5.5 Percentage change in the number of non-cholera diarrhoea cases for a 1°C increase in temperature at each lag. Source: Hashizume et al., 2007

Disrupted water supply:

Extreme temperature also had been identified as the cause disrupted water supply by 75% of the respondents. They collect water from sources within slum and outside slum 4 or 5 times in a day. In summer or heat they get 2or 3 times after waiting in the queue for a long time. Those who (25% respondents) brings water from outside suffer most. According to CUS survey in 2005 about 95% slum dwellers collect their water within slums. The respondents identified that frequent distraction of electricity supply is the major cause for less water supply. Water is collected in the reservoir by using electric pump. As a result less water can be reserved if electricity is disrupted frequently. Moreover, people need more water in high temperature than normal.

Trends of extreme temperature:

Climatic variability for the period 1981-2003 over Bangladesh has shown that in all seasons the mean maximum temperature is increasing except in winter for the northwest and middle zone (-0.004 °C/year and –0.007°C/year). Overall the temperature is increasing over the whole country (the rate of max temp is +0.028°C/year) concurrent with the global temperature increase (Sarker, 2009). From the table 5.1 and 5.2 it is clear that the mean

maximum temperature is increasing in Dhaka which is located in the middle zone of Bangladesh.

Table 5.2 Trends of mean maximum temperature in Bangladesh (1981-2003)

Mean maximum temperature trend (°C/year)				
Regions	**Winter**	**Pre monsoon**	**Monsoon**	**Post monsoon**
Northwest	-0.0004	+0.0076	+0.024	+0.0248
Northeast	+0.0131	+0.0166	+0.0166	+0.0323
Middle zone	-0.0069	+0.0034	+0.0308	+0.0313
Coastal	+0.0361	+0.0375	+0.0433	+0.0436
Islands	+0.0076	+0.0488	+0.0255	+0.018
Hilly	+0.0754	+0.0635	+0.0554	+0.0679

Source: Sarker, 2009

Table 5.3 Trends of mean minimum temperature in Bangladesh (1981-2003)

Mean minimum temoerature trend (°C/year)				
Regions	**Winter**	**Pre monsoon**	**Monsoon**	**Post monsoon**
Northwest	+0.0281	+0.0481	+0.0352	+0.06
Northeast	-0.0129	+0.023	+0.014	+0.0645
Middle zone	+0.0019	+0.0102	+0.002	+0.0169
Coastal	+0.0014	+0.0093	+0.0105	+0.0315
Islands	-0.0368	-0.006	-0.004	+0.0006
Hilly	-0.0444	-0.045	-0.003	-0.0411

Source: Sarker, 2009

Since early 1990s a number of General Circulation Models (GCMs)[4] have been exercised for projecting possible future temperature and precipitation pattern in Bangladesh. The BUP-CEARS-CRU (1994) attempted first on GCM model in Bangladesh where it reported 0.5 to 2.0°C rise in temperature in Bangladesh by the year 2030 under 'business as usual' scenario.

[4] **General Circulation Model** (GCM) is a mathematical model of the general circulation of a planetary atmosphere or ocean and based on the Navier-Stokes equations on a rotating sphere with thermodynamic terms for various energy sources (radiation, latent heat). These equations are the basis for complex computer programs commonly used for simulating the atmosphere or ocean of the Earth. The **Navier–Stokes equations** describe the motion of fluid substances.

It also projected an increase of 10-15% in precipitation by the motioned projected year. The ADB (1994) study used 4 GCMs to project climate change: CSIRO9, CCC, GFDLH and UKMOH. There are many outputs in this study following the IPCC scenarios, however, a summary of the results of this study show an increase in monsoon rainfall and decrease in dry season rainfall for 2010 and 2070 projection years. The study indicated 0.3°C increase in temperature by the year 2010 and for 2070 the corresponding increase would be 1.5°C. Ahmed and Alam (1998) reported an increase in temperature by 1.3°C and 2.6°C by the projection years 2030 and 2075 respectively. They projected a negligible amount of rainfall in dry seasons in the projection years while monsoon rain were projected to increase about 12 and 27 percent for the two projection years, respectively. The WB (2007) used outputs of Mirza (1997) in their study which developed climate change scenarios using a number of GCMs. The results show similarities with Ahmed and Alam (1998). Mirza (2005) again exercised an ensemble of GCMs instead of any particular model and its validation analysis for Bangladesh Climate Change case. The study suggests that the mean rainfall over Bangladesh would be increasing with global warming.

Agrawala *et al.* (2003) used the MAGICC driven SCENGEN database to produce a best estimating ensemble of 11 GCMs for projecting Climate Change Scenario in Bangladesh. The results were obtained using IPCC B2 SRES scenario and suggests that annual temperature would increase up to 1.4°C and 2.4°C by the projection year 2050 and 2100. Dry season precipitation was projected as 1.7% and 3.0% reduced for the projected years, respectively. An increase in monsoon precipitation up to 6.8 and 11.8 percent by the year 2050 and 2100 was also found in the study. However, unlike other GCM out puts, Choudhury *et al*. (2005) obtained results using HadCM2 regional model suggesting an high increase in pre-monsoon and winter precipitation.

According to IPCC‟s Fourth Assessment Report (2007) all of Asia is likely to warm this century and warming in South Asia is likely to be above the global average at around 3.3ºC. In the last 10 years severe cold waves have become common in Bangladesh (Roach, 2005), temperatures as low as 5ºC were recorded in January 2007. A recent study also found that extreme climatic conditions enable the water living cholera bacteria *Vibrio cholerae* to rapidly multiply and spread more easily (Huq, 2006).

5.4 Impact of excessive rain and waterlogging:

In recent years Dhaka City is facing extensive water logging during the monsoon (May to October) as a common and regular problem of the city. Most of the respondents (90%) face water logging quite frequently. They think that heavy rainfall is the main reason for waterlogging. In Dhaka, 58.7% are poorly drained (CUS, 2005). Slum settlements are often found on land which is in most cases unsuitable in this sense for proper housing. For instance, low lying areas, marshes, sewage canals, riversides, railway tracts and embankments are frequently the site of slums. These sorts of places are prone to suffer from poor drainage and hence water logging (stagnation of water) particularly during the rainy season.

Both flooding and waterlogging due to excessive rainfall cause very serious damage in the trade and commercial sectors (Box 5.2). The waterlogging especially becomes a burden for the dwellers of Dhaka city as it poses challenges to social functioning, the environment and economic activity.

Box 5.2 Effect of waterlogging

In September 2004, business and economic activities came to a virtual standstill in Dhaka as a result of heavy rainfall. On the 12th and 13th of the month, constant rains inundated most of the business centres, including Motijheel commercial hub, and the Meteorological Department measured a record 315 millimetres rainfall in the city during those 48 hours. The overnight downpour forced the suspension of Dhaka's Stock Exchange and the weather also disrupted production in garment factories. Many workers could not reach the factories because the roads from their houses, mostly located in the city's low-lying areas, were inundated. A report by Dhaka's Water and Sewerage Authority (WASA) indicates that waterlogging during September affected 250 schools and 681 garment factories in Dhaka city,

Source: Tawhid, K G (2004), "Causes and effects of waterlogging in Dhaka city, Bangladesh". TRITA–LWR Master's Thesis, Department of Land and Water Resource Engineering, Royal Institute of Technology, Sweden.

Health:

Heavy rainfall leading to waterlogging causes health problem like diarrhea, fever, scabies etc. The relationship between the number of non-cholera diarrhoea and heavy rainfall is positive (Hashizume et al., 2007**)**. An increase in non-cholera diarrhoea can be seen with high rainfall at lag 0–8 weeksand at lag 0–16 weeks. For a 10 mm increase above the threshold, the number of non-cholera diarrhoea cases increased by 5.1%.

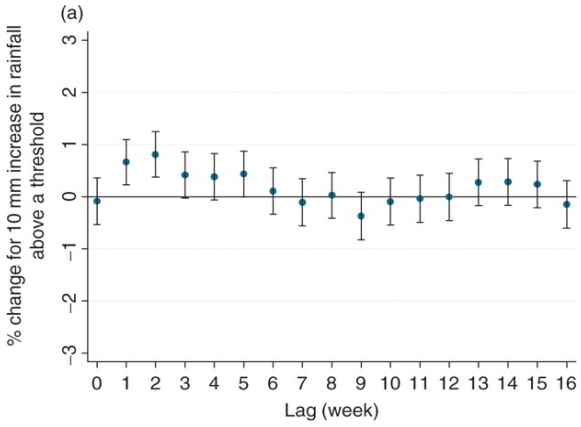


Figure 5.6 Change in non-cholera diarrhoea for increase in rainfall

Source: Hashizume et al., 2007

Sanitation:

Major portion of the slum dwellers (60%) use pit or hanging latrines and 85% respondents throw their daily waste haphazardly. Those pit and hangings latrine are connected to the ditches and canals. As a result, both household waste and human generated wastes go directly or indirectly into the low-lying lands, open spaces or water bodies of the city and causes a number of problems including health. In a seminar, the DCC chief waste management officer Bipon Kumar Saha told that 20 percent people are getting sanitation facilities whereas about 15 millions are living in the city (Prothom Alo, 01 april, 2010, p-7). During flood or excessive rain large number of respondents (78%) suffered for their defecation as most of the latrines were on the edge of rivers, canals, ditches and outside of their rooms.

In Dhaka, WASA drainage system only covers 37% of the total area through 265 km of pipelines. Among the lines 16 km are box culvert and 65 km are canals. With an interview of Drainage Division-2 of Dhaka Mr. Abdul Waset told that present drainage infrastructure is capable of taking the load of rainwater up to 15mm per hour whereas the record in July 29 of 2009 was 50 mm per hour. Any excessive rain comparing the capacity of WASA will often create water logging in the city. He also said that the uncovered 63% will suffer very badly. On the contrary, slums on the ditches, rivers, canal and on the embankment are creating problem by themselves as those illegally encroached areas previously worked as the retention pond for rainwater. Though there are 43 canals on record in Dhaka, 26 are now operating

with obstacles. For better performance of the existing drainage all 26 canals need to be free flow.

Empirical evidence of excessive rainfall

A study on climate change vulnerability based on certainty of impact, timing, severity of impacts and importance of the sector, ranked water resources as the greatest concern due to climate change in Bangladesh (OECD, 2003). It has been predicted that due to climate change, there will be a steady increase in temperature and rainfall of Bangladesh (Intergovernmental Panel on Climate Change, 2007). Small changes in the mean and standard deviation values can produce relatively large changes in the probability of occurrence of extreme events (Chiew, 2006; Su *et al*., 2006). Studies in different parts of the world indicate that global warming has altered the precipitation patterns and resulted in frequent extreme weather events, such as floods, droughts and rainstorms (WMO 2003; Schmidli and Frei, 2005; Briffa *et al*., 2009).The time series of average monsoon rainfall in Bangladesh for the time period 1958–2007 from BMD also shows (Figure 5.7) an increase in monsoon rainfall in most of the stations of Bangladesh.

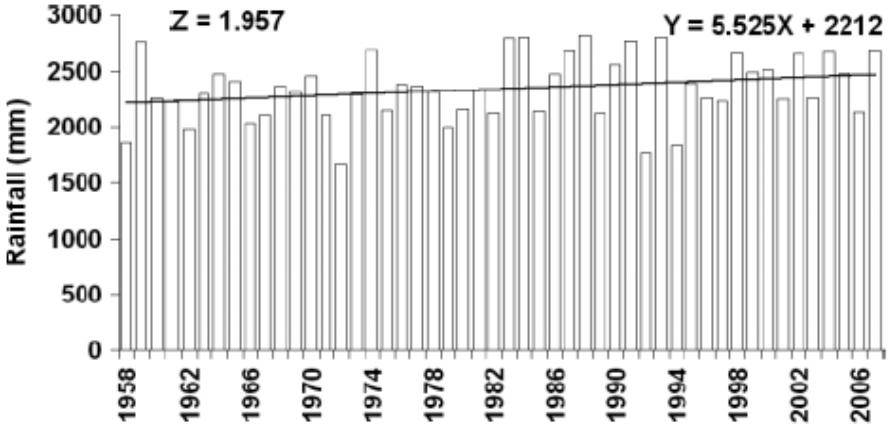


Figure 5.7 Trend of annual rainfall in Bangladesh (1958-2006)

Rainfall data from the Dhaka station for 1971 to 2005 show that the annual average rainfall in the city is about 2,120 millimeters, of which about 50 per cent falls during the months of June, July and August, generally referred to as the monsoon season. Average rainfall during the winter months (December, January and February) is negligible, less than 2 per cent of annual rainfall. While Dhaka's long-term trend in annual rainfall shows no significant

change, the trend in seasonal rainfall appears to be erratic. Two important facts support this finding-

- Trend analysis reveals that although there is no significant change in annual average rainfall, the number of "days without rainfall" is increasing.
- Seasonal rainfall data in both the monsoon (June, July, August) and winter (December, January, February) seasons show a decreasing trend over time.

However, these two facts together indicate that more rainfall is occurring in other months of the year and that rainfall intensity is increasing (Alam and Rabbani, 2007). The heaviest rainfall (373 mm in 12 hours) in 29th July in 2009 complies with the predictions. In September 11th to 16^{th,} of 2004 heavy rainfall (341 mm) also occurred in Dhaka City and its devastating impact paralyzed the city life.

5.5 Overall impact on Income and saving:

The negative effects of flood ultimately lead to damage of settlements including water source and sanitation, to weaken or injury to health through different diseases and sometimes to death. Except the later one, others are repairable or curable but money is needed to do that. The slum dwellers are usually ill-paid as most of them works in the informal sector. Both sound health and strength are important to do those kinds of jobs. Living in the very small, unhygienic rooms and eating less nutritious food they can not maintain good health. Whenever they or family members suffer from any disease they take loan from their relatives or friends. Sometimes they can not manage loan locally and go for NGOs. They try hard and soul to take the loan from known person instead of any NGO as NGO has high interest rates. During sickness jobs related to physical labour become nearly impossible. As a consequence the whole family suffers if the sick person is the only earning member. Most of the households (60%) are with single earning person and very few (5%) can save after all expenditure in a month. On an average they spend Tk. 3000 for food, Tk. 150 for electricity, Tk. 100 for water supply and Tk. 150 for fuel. If the extra burden comes they manage it by cutting off their meal. *'Today I and my wife have not taken our lunch as I've spent Tk. 200 for the diarrhoea treatment of my baby…..I went to ICDDRB….it is far away from my slum…I don't know whether I will take dinner or not...'* , Shamsul Alam of Basila slum told the hardship of his life. The impact of any extreme weather events thus brings some loan, some hunger and ultimately more distress.

5.6 Climate Refugee

Migration to urban areas is a regular phenomenon but climate induced displacement forced to migrate to cities especially to Dhaka over the recent years is a matter of concern. Increased frequency and severity of flood and cyclones by climate change over the past recent years are not only displacing people physically but also exposing to enhanced poverty by threatening their livelihoods temporarily and permanently. Growing number of people rushed to city's slums creates urban crisis. In this study 10% of the respondents also migrated to Dhaka due to flood or river erosion. Respondents from Sirajgonj, Chandpur and Barisal were compeled to leave their villages loosing everything by flood. These people living in urban slums are in search of better and secure life. Since their slums are located mostly in low lying environmentally hazardous area coupled with inadequate facilities like food, shelter, sanitation, health care make their life even worse. Those who migrated to Dhaka before 2004 already suffered again by the devastating flood of 2004 and 2007. The following story in Box 5.3 represents similar scenario-

Box 5.3 Case study- Migration from Chandpur to Bhashantek

"Everything I lost in the 1998 flood", says Salma Banu of Bhashantek slum. The 35 years old lady came to Dhaka in 1999 after critical struggles with her life. She used to live a happy life at Matlob upazilla of Chandpur district with her family before appearance of devastating flood in 1998. Salma banu had 40 decimal of agricultural land, two cows and small house with number of fruit trees. "The Meghna snatched and washed away all my assets and happines and I could not save anything", she added. She also said, "I have not seen such destructive river erosion in my life and some of aged people were saying so". Loosing everything her husband and she tried hard and soul to restart their life but they failed. Her husband could not manage any single work after flood and her son's study was stopped. They took shelter to a relative's house. They spent all their savings to sustain their livelihoods. After six months they finally migrated to Dhaka city with simply nothing and took place in Bhashantek slum at her husband's cousin's home. "At the initial stage we suffered a lot but the sufferings still continue. There are many problems in this slum. We were far better in our villages", she exclaimed. As my husband is illiterate, he couldn't manage anything but rickshaw pulling in Dhaka. She is frustrated about their honour in city whereas they used to get special attention in their village. She had a dream about her son that he would be a literate man. The devastating flood has washed away all her dreams.

From 1970 to 2009, the total number of major cyclones striking Bangladesh was 26, where the number of occurrences increased significantly since 1990. It should also be noted that the highest number of affected people has been recorded after 1990. In 2007, the country was ravaged by Cyclone *Sidr*, which displaced 650,000 people and killed 3,447 (official record). In the year 2009, two cyclones hit (cyclone *Bijli*, April 2009, and cyclone *Aila*, May 2009). About 200,000 people were displaced by cyclone *Bijli*. The intensity of the damage caused by the cyclones in 2009 might not be as high as cyclone *Sidr*, but though the country was hit twice in the same year.

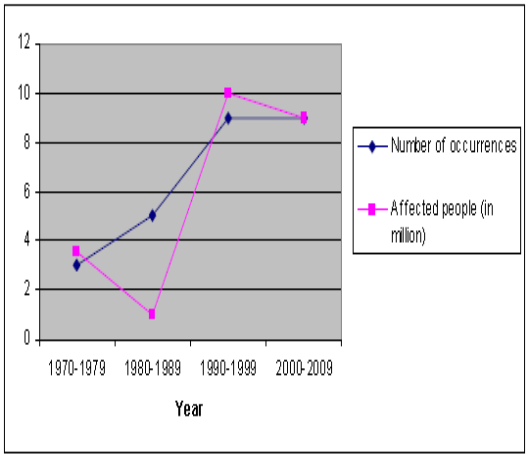


Figure 5.8 Frequency of major cyclone and number of affected people Source: BBS, 2007

5.7 Discussion:

The respondents' perception and meteorological data shows that the urban poor suffer most in Dhaka in respect of access to basic services. Climate change–induced flooding, excessive rainfall, waterlogging and extreme temperature increase the degree of sufferings. The meteorological data and prediction of IPCC depict that the extreme climate events are increasing as well. Flood record of last 12 years directs that the gap between major floods are decreasing at an alarming rate as starting from 1988 to 2007 the gaps are 10 years, 6 years and 3 years respectively for 1998, 2004 and 2007. Extreme floods like those in 1988 and 1998 are expected to occur as 50-100 year events (Ahmed, 2006) but environmental damage including climate change is thought to be making them occur more often, they are expected to become even more common in the future due to global warming. The next magnitude of flood down, the 20-50 year flood such as in 2004 are expected to increase by 2.5% with a 2ºC rise in average temperature (Mirza, 2002), so by 2050 instead of every 20-50 years they are expected to occur every 4-20 years.

As changing rainfall patterns indicate, delays in rain, no rain or sudden heavy rainfall are remarkable symptoms of climate change. After a long delay in rainfall, about 290 mm continuous rainfall in 6 hours in July 2009 (a record in 60 years) might be a warning from climate change. Over South Asia, the summer is dominated by the southwest monsoon, which

occurs from June to September and influences the seasonal cycles. However, according to the IPCC‟s Fourth Assessment Report, climate change is likely to weaken the monsoonal flows and the large scale tropical circulation; this could affect rainfall patterns, such as the time it occurs each year. Furthermore a warmer, moister atmosphere is also likely to lead to heavier rainfall during the monsoon (IPCC, 2007). A variety of different studies all point to average rainfall increasing in Bangladesh during the summer monsoon by around 1-4% by the 2020s, and 2-7% by the 2050s (Tanner *et al*, 2007).

The increased frequency of climate extremes like flood or heavy rainfall is of particular concern since it reduces the time for poor households to recover from one climatic shock to another. There is also the risk of unprecedented shocks, such as the heavy rainfall experienced in July of last year. Within one night some slums got totally inundated and people had to leave slums before planning anything. Traditional coping strategies may not be sufficient in this context and will lead the poor to rely on ad-hoc and unsustainable responses. This not only reduces resilience to the next climatic shock but also to the full range of shocks and stresses that the poor are exposed to.

Extreme weather does not produce disasters if there are no vulnerable populations. In Dhaka slum dwellers make themselves vulnerable residing at the flood prone areas and in weak structure. The large differentials between locations within and around most cities in the scale and nature of climate related hazards and in the quality of housing, infrastructure and services means that where they live or work influences their level of risk. This means that households and concerned authorities can buy their way out of risk by choosing safer sites and sites with good quality buildings and infrastructure. In most of the cases the poor prefer flood-prone or low land in the out skirt of the city due to low rent or free of cost. They construct settlements on those risky zones defined by RAJUK (Dhaka City Development Authority) through the illegal contact with its staff. Though RAJUK is accountable to implement policies regarding urban planning and building construction, poor people and musclemen are illegally encroach those lands with the help of its stuff. As a result, the major city development authority is giving the impression of lack of accountability and lack of transparency in this matter. Good governance should be able to greatly diminish these spatial differences in risk, for instance by ensuring that low income groups can find accommodation in safe sites with good infrastructure. Increasing urbanization has also put tremendous pressure on land. Dhaka is the fastest growing mega-city in the world, with an estimated 300,000 to 400,000 new migrants,

mostly poor, arriving to the city annually (BBS, 2006). The population of Dhaka has grown from only 0.1 million in 1906 to 3,36,000 in 1951 and 10.71 million in 2001 (Census 2001). It is growing at an alarming rate (5.6% during 1991-2001 inter-casual periods). There are no vacant places and large number of public plots has become slum settlements. The government meets the pressure by evicting slum settlements. Pressure on roads and footpaths is increasing. Only 7% roads are available in the city whereas ideally it should be 25%.

Much of the physical growth and economic expansion in Dhaka has taken place outside any official plan and outside official rules and regulations. In part, this is because poor people could never afford a house that met building codes. In part, it is because of very large mismatch between the growth of Dhaka city's economic bases and populations, and the competence, capacity and accountability of urban institutions, especially DCC and RAJUK. As a result, due to the high demand of land the poor somehow try to possess a piece of govt. land in the fringe and flood prone areas. Those who can manage built shanty and weak structure with bamboo, *tin* (CI sheet) and wood. People fail to manage land rent room in slums. When flood sweeps away their weak shelter they can not even save their belongings and leave their slums. They face big problem with their damaged shelter after getting back to their slums since they cannot manage money for repairing. Managing any loan for repairing or new construction from formal institutions is absurd as access is denied there for them. Although the nationalized commercial banks and the House Building Finance Corporation provide loan for building of houses and apartments these loans are usually given to the middle and upper classes and influential people of the society.

Besides financial institutions, urban poor are also have limited access to their basic services – water, electricity, gas etc. However, the urban institutions are not capable to meet the demand of 14 million people of the mega city. Other than energy slum dwellers often suffer from water shortage. The present water supply system of Dhaka almost entirely depends on groundwater. But exploitation of groundwater has its limit and depends on how much water is replenished during the monsoon of every year. In Bangladesh, recharge occurs primarily through direct infiltration and percolation, mostly from huge amount of rainfall and floodwater during the period from June to September. The aquifer of Dhaka city is recharged by direct rainfall, river water, and floods (MPO, 1987). But due to rapid urbanization, the recharge area of the city is decreasing significantly with time. Within this situation the city water supply authority needs to install more tube wells to serve the ever increasing population

of the city. According to DWASA, it is estimated that about 450 deep tube wells are needed to be installed within the city to meet the present water demand. With this shortage of water DWASA cannot supply adequate water to the slum dwellers. Tenure security is serious problem for the slum dwellers to get the DWASA connection, though some NGOs are helping in this aspect with the collaboration of DWASA and DCC. During extreme temperature the demand of water in the slums become high and they suffer from dehydration or diarrhea.

The burden of climate bearing diarrhoea and malnutrition is already high in Dhaka's slums relative to elsewhere in Asia. According to ICDDRB, in April of this year diarrhea patients has increased many times than before and the hospital admitted 40 patients per hour on an average. The hospital authority also identified that those patients were mainly slum people and was not getting enough water. Future climate projections also suggest that this large relative risk is expected to increase, with flooding and sea level rise causing pollution in surface water and an increase in cholera and diarrheal diseases. Increasing temperatures are likely to yield a spread in insect borne diseases, whilst warmer sea-surface temperatures support phytoplankton blooms that are the breading ground for bacterial diseases such as cholera.

The potential impacts of climate change on human health increase vulnerability and reduce opportunities by interfering with the ability to work. The ill health of main earning person resulting from diarrhea, cholera, fever etc. has ultimate impact on income. As a result the whole family suffered severely. Flood makes informal sector collapsed and people working in formal even lose their job due to remaining busy with family shifting. Without income they cannot even go to doctors for his or his family members' treatment.

Impact of climate change is also severe in the coastal zones and those area already have watched the devastating storm namely *Sidr* and *Ila*. Thousands of people are now living in distress on the road. They have no food or work which ultimately follows migration to Dhaka. Migration from following extreme weather events is also to be expected. Temporary migration to sell labour is a response already employed by fisher communities suffering from reduced fish stocks.

Urban growth and large number of migrated poor also put tremendous pressure on services of water, sanitation, health, electricity, education etc. provided by the government. Government agencies responsible for delivery of these services can not meet up this huge demand and additionally they are extremely poor in their governance. These agencies, in general, lack accountability and transparency in their operation and never seek people's participation. There is always a lack of coordination among the urban institutions including local government. Co-ordination gap among service delivery agencies lead to duplication, overlapping, and fragmented social services. In order to survive, inter-organizational coordination, therefore, is a sin-qua-non for any organization (Jamil, 2010).

The loss of life, serious injury, damage to property, and negative effects on livelihoods caused by disasters ought not to be seen only as natural events, but rather as a failure of urban management – in which institutions have been unwilling or unable to meet their obligations to urban residents. For instance, absence of proper coordination between WASA, DCC and RAJUK is the prime reason for waterlogging. Individual accountability is another reason. Poor solid waste management is the main problem to maintain the storm water drainage. DCC is responsible for solid waste management lack sufficient resources and equipment for drain cleaning. "The existing manpower in not sufficient for the DCC to conduct the cleaning drive at a faster pace as four-day downpour in September, 2004 threatened prolong the misery of Dhaka," said Shah Alam, Deputy Chief Conservancy Officer of DCC, though the Corporation has 7156 cleaners for its 82 wards. Recently RAJUK has finalized the Detailed Area Plan (DAP) for Dhaka under Dhaka Metropolitan Development Plan (DMDP) where Dhaka is divided into 17 land use zones like residential, commercial, industrial, administrative, flood flow, water body etc. DAP has proposed 24.70% area for flood flow zone, 1.75% for water retention area, 5.73% for water body to protect Dhaka from waterlogging which is appreciable. However, the implementation of DAP will be a great challenge for any government because the implementation of the master plan of 1959 was almost unsuccessful.

There is not much point in discussing how city or municipal governments can adapt to protect the population within their jurisdiction from risks arising from climate change when they have shown so little inclination or ability to protect them from other environmental hazards. There are really two separate issues here, although they often act together. The first issue is the incapacity of the major urban institutions- RAJUK, DCC and DWASA in terms of their

power and the resources at their disposal and this in turn relates to the refusal of higher level of government to allow them the power and the resources they require to address local needs. The second issue is the antagonistic relationship urban governments and slum dwellers, this also relates to urban governments' lack of accountability to their poor people, but it goes beyond this. It is strongly reinforced by urban elites' visions of what they see as a modern city and by real state interests wanting access to land currently occupied by informal settlements. The poor are often seen as critical part of Dhaka city, though they are contributing significantly to the economy of Bangladesh.

Far from being an issue that only has implications for energy supply or the environment, climate change touches all the resources that urban poor depend on in life. In particular, the current and future impacts of climate change will hurt the well-being of the poor and vulnerable. Climate change puts extra burdens on the social and economic challenges that the poorest people already face. Their vulnerabilities will be emphasised and increased due to the dependence of their livelihoods on climate sensitive assets and their weak social protection structures. By directly eroding the resources that poor people depend on for their livelihoods, climate change makes it easer for people to fall into poverty and harder for the poorest to escape from it. Climate change adds urgency to understanding and addressing the poor's vulnerability to current and future climate variability and to reevaluating the role of policies and programmes in reducing this vulnerability.

We cannot consider the adaptation that cities must make with regard to climate change independent of the very large deficits or deficiencies in basic infrastructure (including storm and surface drains). It makes little sense to discuss the impact of the climate change on the urban poor and their responses to it separately from their current and often long-established vulnerability to climate variability, including extreme weather events There is long history of Dhaka being seriously affected by floods, storms etc. that has nothing to do with human-induced climate change. The key to understand the processes that shape urbanization create or exacerbate risk.

There is also not much point in discussing how to adapt urban planning and its regulatory framework to reduce people's vulnerability to climate change when planning and regulation enforcement will only serve those with power and will be used to evict and dispossess poorer groups whenever it serves those in power to do so. Slum dwellers are often forcibly evicted

from their homes- mostly without compensation and with inadequate or inappropriate compensation.

I argue that current climate, social and institutional shocks and stresses already have a devastating impact on the vulnerability of the poor. Moreover, most of the urban poor have lack access to resources as 55.2% are living in a 100 sq. ft single room of flimsy structure and with 5 members, 58.7% are living in poorly drained slums, 45.8% are sharing one tap for 10 persons, 27% share a tap with other 9, 48.6% are sharing latrine with other 4 persons (CUS, 2005). It is evident from the scenario that they can not manage their basic needs and amenities properly. How will they survive if shocks like flood or waterlogging come? From where will they manage extra money for treatment or repairing shelter? What will happen to their food and water? Thus, increasing frequency and intensity of weather-related extremes, and gradual changes in the average temperature due to climate change will exacerbate these impacts. As a consequence this has implications for the vulnerability of the poor to shocks of all kinds. Finally, for poor people climate change is a highly complex problem, which has the potential to impact negatively on every sphere of their life, if left unabated.

Chapter 6

Conclusion

Although climate change has happened throughout the earth's history, it has never before occurred at the current pace, nor has it ever occurred because of human interference. Dhaka has several experiences of natural disaster and incidence but in the recent past their intensity has increased. Urban poor was also vulnerable before in Dhaka but now they are more vulnerable due to climate change. Urban growth and performance of urban institutions are also two important catalysts in this regard. Extreme events are unstoppable and we cannot ignore it. The whole world is trying to minimize the carbon discharge through UNFCC and the Kyoto protocol[5]. The success of convention or protocol is uncertain as the leading carbon producing country USA has not yet signed the Kyoto protocol. As a result, country like Bangladesh should concentrate on minimizing risk and on strong adaptation policies. Bangladesh has already developed National Action Plan for Adaptation (NAPA) and Bangladesh Climate Change Strategy and Action Plan (BCCSAP), though urban poor has got less focus there. Thus, for minimizing risk of urban poor our main focus should be on urban institutions and their governance.

6.1 Recommendations:

Above all, three drivers of increased vulnerability to climate variability and change in urban areas need consideration: the drivers of urbanization and other aspects of urban change; the weakness and incapacities of governments (both local and national); and the development and expansion of Dhaka in high risk sites. The recommendations are-

- To address the challenges of climate change for low income urban dwellers, urban institutions need to develop a set of specific policies and strategic actions.

[5] The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions .These amount to an average of five per cent against 1990 levels over the five-year period 2008-2012. The major distinction between the Protocol and the Convention is that while the Convention encouraged industrialised countries to stabilize GHG emissions, the Protocol commits them to do so.

- RAJUK and DCC have a number of specific roles in reducing climate change vulnerability. Zoning and planning controls often contribute to the exclusion of much of the population from legal land markets, but they can be used to help provide appropriate and safe locations for low-income households while reducing exposure to the risks of flooding, slope failure and other disasters. The application of building standards that are appropriate to local contexts (including affordability) and applied in ways that support incremental improvements can make housing resistant to extreme weather while still enabling poor residents living in self- or artisan-built constructions to upgrade at an appropriate pace and cost.

- Land use planning mentioned in the DAP should be effectively implemented by the government.

- Coordination between DWASA and DCC should be ensured regarding operation and management of drainage system for minimizing waterlogging.

- Awareness program for the poor regarding diseases connected to flood and extreme events should be started immediately.

- For immediate adaptation govt. financial institutions especially for the poor should be set up for disbursing necessary loans regarding housing, treatment, small business, latrine etc.

- Effective adaptation strategies should build upon, and sustain, existing livelihoods and thus take into account existing knowledge and coping strategies of the poor. Traditional risk sharing mechanisms, such as asset pooling and kinship, could be complemented by micro-insurance approaches, and infrastructure design and investment, both for private and public use, should take into account the potential impacts of climate change.

6.2 Conclusion:

Major indicators show that urban poor of Dhaka with low income live in deplorable conditions, subject to receive inadequate and poor services from the government. Being the hub of major economic and administrative operations Dhaka's rapid urban growth due to incoming migration is putting extra pressure on the slum dwellers. However, there is a plethora of declarations and policies describing the rights of all citizens regarding basic services. In reality little respect is shown to these laws and is hardly practiced for the poor. Nevertheless, sometimes they also violate government policies and regulation and live in the flood prone areas. As a result, the poor of Dhaka always remains in the vulnerable position in respect of different natural events like flood, rainfall and summer.

According to this study, the frequency of flooding, extreme temperature and excessive rainfall due to climatic change is increasing, both in terms of extreme weather frequency and gradual changes, and consequently aggravating the impact to livelihood assets. Some impacts are direct, such as more frequent and more intense floods or waterlogging. Those that are less direct include reduced availability of freshwater supplies. Finally, others that are indirect for urban poor include constraints on health and thus impact on income and expenditure. The study also identifies the crucial roles and responsibilities that individuals, households and communities adopt in their own adaptation processes, independent of government such as saving, social interconnectedness and loans. There are also limited institutional coping strategies such as emergency aid, water distribution, and awareness rising on saving and diseases from government and NGOs. These coping mechanisms are not sufficient to address the challenges for the urban poor, since they even lose their earning source due to climate shocks. It also shows the lack of governance of urban institutions including local government authorities, utility companies regarding to face any climate or other stresses with lack of commitment for the urban poor. However, where this commitment is made, it should be seen as an opportunity to address three key issues affecting urban poor: climate change adaptation, effective local development and good local governance. Wedded with poor income, poor sanitation, water scarcity, lack of affordability of hygienic shelters, unavailability of skill and other stressors, climate change is more likely to continue to gamble the urban poor's socio-economic activities and exacerbate their vulnerability.

Considering all the national and international scientific reports it can be conferred that climate change is evident in Bangladesh as well as in Dhaka. There is no way of ignoring the impact of climate change on people and obviously on the poor people. Climatic incidence cannot be altered but its adverse impact can be minimized through formulating and implementing effective policies and regulations. To minimize the impact focus should be on reducing the hazard where this is possible (e.g. better drainage that stops a heavy rainstorm creating floods), or reducing people's exposure to it (e.g. working with those who live in areas at risk of flooding to improve their housing or move to safer locations). The policy intention should be to avoid the event causing a disaster. Finally, in the post-disaster response, it should not only help people to build their homes and livelihoods, but also encourage and support measures that reduce risk from likely future hazards. There are two difficulties in adapting to future risks. The first is that the scale and nature of the hazards climate change brings will change. The second is the uncertainty in any locality of exactly what changes will happen and when. In the past, without climate change, it was easier, for any location, to establish from historic records the likely range and frequency of extreme weather events for which provision had to be made. However, even in cities that have adapted well to extreme weather, a storm or rainfall just a little more intense than the historic record often becomes a disaster.

In all instances, people's capacity to avoid hazard or to cope with it and to adapt (to reduce future risk) is influenced by individual/household resources (e.g. income, asset bases) and community resources (e.g. for coping, the quality and inclusiveness of community organizations that provide or manage safety nets). In urban areas, it is also greatly influenced by the extent and quality of infrastructure and public services, especially for vulnerable populations.

6.3 Future scope of study:

Urban governments typically have a large and diverse range of roles and responsibilities with regard to the built environment, infrastructure and services that have relevance for adaptation as well as minimizing risks. Consequently, what role urban governments or institutions are playing and need to be played as risk reducer for climate change– can be a potential scope for future research.

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APPENDIX 'A'

Sample Questionnaire

Impact of Climate Change on the Livelihood of the Urban Poor:

A case of Dhaka city

A. General Information:

1. Name: ……..…… 2. Age:……

3. Occupation:
   a. Rickshapuller b. Day labourer
   c. Transport worker d. Garments worker
   e. Factory/industries worker f. Hawker
   g. Housewife h. Others

4. Household member: ……..

5. Tenure in the present slum: ……

6. Reason for migration to Dhaka: ……

B. Settlement

1. Location of the house/room
   a. On the river
   b. On the embankment
   c. Inside the embankment
   d. Others

2. Distance from the river (Approx)…….

3. Construction materials
   a. Wood and bamboo
   b. CI sheet
   c. Clay
   d. Plastic paper
   e. Brick
   f. Others

4. Does water enter into your house during normal rain?
   a. Yes b. No

If yes, what do you do then……..

5. What kind of problem did you face during excessive rain?

6. What problem did you face during flood in 2004 and 2007?

7. Do you face any difficulty to live in the room due to high temperature?

   a. Yes b. No

   If yes, then what kind of …….

8. Have your room ever repaired?

   a. Yes b. No

   If yes,

   a. when and what was the reason?.....

   b. What was the approximate expenditure of that repairing?.....

   c. What difficulties did you face for managing the money?.....

9. Any other problem you face to live in the room?

10. Have Govt./NGO ever helped regarding repairing or building your room?

    Yes b. No if yes, please describe in details……..

C. Water and Sanitation

1. What is the source of your drinking water?
   a. Tube well
   b. Well
   c. Pond
   d. Supply water by DCC/WASA
   e. Others……

2. Do you drink water after boiling or purifying?

   a. Yes b. No

3. What is the source of water used for other purposes?
   a. Tube well
   b. Well
   c. Pond
   d. Supply water by DCC/WASA
   e. Others……

4. What is the quality (taste, colour and odour) of drinking water in general?

5. Do you face any difficulty regarding collection of water during excessive rain?
   a. Yes b. No

   If yes, what kind of…….

6. Did you face any problem regarding managing water during any last flood (2004/2007)?

   a. Yes b. No
   If yes, what kind of…….

7. Do you face any difficulty regarding collection of water during excessive temperature?
   a. Yes b. No

   If yes, what kind of…….

8. Where do you normally go for defecation?
   a. Pucca latrine
   b. Katcha latrine
   c. Hanging latrine
   d. No specific place
   e. Others…….

9. Where do you go for defecation during excessive rain?

10. Did you face any problem regarding defecation during last flood (2004/2007)?

    a. Yes b. No

    If yes, then what kind of …….

11. Do you face water logging in your area after excessive rain?

a. Yes b. No

If yes, what problem do you face due to water logging?
.....

12. What about the sewerage system of your slum?
13. What problem do you face with the waste and sewerage?

14. What happen to the sewerage system during excessive rain/flood/waterlogging?

15. Have you any help from Govt./NGO regarding water and sanitation?

16. Who should come forward regarding the matter?

D. Health

1) Have you or your family member ever suffered from diarrhoea/malaria/cholera/dengue since 1998?

   a. Yes b. No
   If yes, when and what was the reason?.....

2) Have you or your family members ever been admitted into hospital to the above reason?

   a. Yes b. No

   If yes, why…….

3) Do you or your family member face any problem during high temperature in summer and low temperature in winter?

   a. Yes b. No
   If yes, what kind of…….

4) Did you or your family member become sick after flood in2004 and 2007?

   a. Yes b. No if yes, please in details……

5) Where do you go for treatment?
   a. Public hospital
   b. Private clinic/hospital
   c. NGO clinic

d. Quack
e. Homeopath
f. Others

6) What kind of facility do you get in Govt. hospital?

7) Do you/HH members know the reason of diarrhoea/malaria/dengue?

8) Have Govt./any NGO ever make award during the matter?

9) Are you capable enough to meet the expenditure regarding medical treatment?

a. Yes b. No
If no, how do you meet up?.....

10) Did you face any difficulty spending your money on treatment?

a. Yes b. No
If yes, what kind of…….

11) How many hours you can work in general?

12) How many hours you can work during extreme summer and in winter?

E. Income

1. No of your family members are engaged in any work…….
2. What is your monthly income and expenditure on average (optional)
   ……..
3. What are the major sources of your expenditure?.....
4. No. of children go for school…….
5. Is there any saving at the end of month……..
6. Have you taken any loan ……
   a. Yes b. No

If yes, how much……..

7. What happened to your work during last flood?.....

8. When you become sick how do you manage your family?

9. Have you ever become jobless?
   a. Yes b. No

   If yes, why and what problem did you face?

10. Have you ever changed your occupation?
    a. Yes b. No

    If yes, why?.....