



# **VULNERABILITY OF WOMEN, ADOLESCENT GIRLS AND CHILDREN TO CLIMATE CHANGE IN URBAN AREAS OF BANGLADESH**





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February 2018

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**ISBN 978-984-34-4577-3**

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**Citation** Ahmed, A.U. and Neelormi, S., 2018. Vulnerability of Women, Adolescent Girls and Children To Climate Change in Urban Areas of Bangladesh, Dhaka, CARE Bangladesh, pp. 61.

# FOREWORD

How can Bangladeshi cities be resilient to the impact of climate change, especially in the social context of marginalized poor, women and girls?

Despite having a wealth of information on climate change issues in rural Bangladesh, very little is known on the vulnerability of urban populations.

Extreme climatic shocks and climate change induced vulnerabilities in urban areas of Bangladesh often have a differential impact on marginalized and vulnerable groups. Among these marginalized groups, we know that women, girls, children, elderly and persons with disability remain at the center of impacts. These marginalized groups have a significantly lower capacity to adapt or even to cope with these shocks.

CARE Bangladesh has made an attempt to investigate the impact of climate change on urban marginalized communities, with a focus

on growing, actionable knowledge on emerging challenges and opportunities, in particular for women and girls. To analyze the perception of urban populations regarding known hazards, data was collected from four cities, representing different sizes and hydro-geophysical realities across the country.

We think that actors promoting urban resilience on the ground will find the analyses and recommendations useful for designing urban initiatives.

We sincerely thank Dr. Ahsan Uddin Ahmed, Dr. Sharmin Neelormi and Dr. Neelpol Adri for helping us to conduct this evidence-based study. We must, first and foremost, thank Mamunur Rashid, Palash Mondal and Mehrul Islam, as this publication could not have made the journey from concept to publication without their energy, knowledge and talent. We are also thankful to the NGOs, communities and CARE colleagues of different locations who actively contributed to this study.

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# ACRONYMS

BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
BDRCS	Bangladesh Red Crescent Society
BRAC	Bangladesh Rural Advancement Committee
BWDB	Bangladesh Water Development Board
CARE	CARE Bangladesh (an NGO)
CBA	Community Based Adaptation
CEGIS	Centre for Environmental Geographic Information Services
CGC	Centre for Global Change
CI	Corrugated Iron
CPP	Cyclone Preparedness Programme
FFWC	Flood Forecasting and Warning Centre
FGD	Focus Group Discussion
GED	General Economics Division (under Ministry of Planning)
GOB	Government of Bangladesh
HH	Household
HSC	Higher Secondary School Certificate
IWM	Institute for Water Modeling
KII	Key Informants' Interview
LGED	Local Government Engineering Department
MOEF	Ministry of Environment and Forest
MOLGRDC	Ministry of Local Government, Rural Development and Cooperatives
NE	North-east (region)
NGO	Non-government Organization
NW	North-west (region)
PWD	People With Disability
RA	Resource Analysis
RRI	River Research Institute
RVCC	Reducing Vulnerability to Climate Change
SW	South-west (region)
SWR	South-western Region
UNDP	United Nations Development Programme
WASA	Water and Sewerage Authority
WB	World Bank

## GLOSSARIES

Boro	A variety of paddy grown generally during December-May time frame
Climdix	A software to analyze climatological extremes using daily time-series data
Kaitani	A lengthy episode of rainfall in annual cycle, generally occurs in October, which indicates the general cessation of the monsoon season
Pourasava	A council of elected members who manages governance in the smallest tier of urban areas
Pucca	Something made of brick/concrete (in Bengali, it stands for a quality – strong)
Sajna	Moringa Oleifera, a fast-growing drought-resistant plant. The seed pod is used as vegetable.





## EXECUTIVE SUMMARY

Bangladesh, being an aspiring Middle Income Country, has been experiencing rapid urbanization since decades; the need for mainstreaming the urban agenda into the policy discussions becomes paramount. However, one-fifth of urban dwellers currently live in poverty in Bangladesh. A persistently high rate of increase in urban population, the territorial extension of existing urban areas with conversion of rural centers in the urban fringes towards re-definition of urban areas and 'opportunistic migration' along with 'forced migration' attributed by failed livelihood in different climate hot spots are shaping up the urbanization process of Bangladesh.

There are globally acclaimed documentation on Bangladesh's high vulnerability to climate change. The 'Fifth Assessment Report' of the Inter-governmental Panel on Climate Change reveals long-term implications for Bangladesh and its people from probable catastrophic impacts of climate change. The vulnerability of different segments of population, especially women, children, adolescents, elderly, ethnic minority communities, persons with disabilities, poor people depending on natural

resources for livelihoods, etc. have been analyzed and documented in different literature. With exception of a few studies, most of the studies have largely been limited to rural areas, particularly involving farmers and related communities. Despite having a wealth of information on climate change issues in Bangladesh, very little is known on vulnerability of urban population. In recent years, the state of wellbeing of marginalized people including women and girls in urban spheres has added additional complexities in the wake of climate change. In Bangladesh, there is a dearth of analysis in this important area of research.

An attempt has been made to probe into how Bangladeshi urban population are vulnerable and to understand what institutional supports are made available to them against known climate change induced hazard types, especially in the social context of marginalized poor, women and adolescent girls.

The current study attempts to analyze the perceptions of urban population regarding known hazards in the four cities, representing different sizes and hydro-geophysical realities

across the country. A large majority of the population can easily identify that the number of cold days have been reduced and the number of seasons have been reduced in recent years, both the observations signifying high climate variability. There has been an overwhelming agreement among the respondents regarding general surface warming in the urban areas. Perhaps the manifestation is supported by a potential increase in urban heat island effect in the target cities, which must have been simultaneously causing an overall increase in temperature across seasons.

People from predominantly industrial cities (such as Gazipur and Khulna) have indicated reasons that are linked with industrial sources and/or pollution from vehicular and industrial emissions. On the contrary, lack of vegetation and lack of vegetation in city landscapes are often cited as the key reasons by the respondents representing lesser industrial cities such as Sunamgang and Rangpur.

About half the respondents also report that both children and adolescent girls are forced to remain absent in school as a response to heat stress, which is found to be more common in more industrialized cities such as Gazipur and Khulna (High confidence). Part of the issue for not attending school may be explained by difficulties to go to school by walking and/or by availing public transportation, which becomes particularly difficult for the children and adolescent girls during heat stress conditions. Children suffer the most as a consequence of dehydration and fatigue during heat stress conditions.

The most frequently occurring urban hazards which are induced by climate variability and change include water logging, excessive rainfall, tornado/norwester and flood, etc. However, certain hazards are localized, therefore these are not cited in other cities as a common hazard. For example, flash flood is a

climate-induced hazard, which has no relevance outside Sunamganj. Similarly, storm surge and cyclone has no relevance in cities outside Khulna. Women, girls and children suffer through various health disorders due to deterioration of water quality when their neighbourhood is affected by water logging and/or flood.

An overwhelming majority of the respondents agrees that the frequency of excessive rainfall episodes is on the rise. It is indicated that, the usual prolonged rainfall episodes of October (known as Kaitani) is hardly experienced these days in urban areas. Rather, short-lived excessive rainfall episodes are observed, for which the available drainage system fails frequently, resulting into severe forms of water logging in urban areas. The reported failure of drainage system is found to be a common feature, irrespective of the size and location of a city.

Water logging is found to be more pronounced in Gazipur and Khulna cities, compared to Sunamganj and Rangpur cities. Since women suffer more under rainfall induced water logging, a greater proportion of women is found to report water logging in both Gazipur and Khulna compared to their male counterparts. This explains gender-differentiated sensitivity to water logging, for which males are not found to be as sensitive as their female counterparts.

In the key informants' interviews and focus group discussions, the major management related concern is drainage impairment in city landscapes. People ask for immediate institutional actions to improve drainage capacity – irrespective of location and size of the city. There is a general understanding that the concerned national institutional mechanisms have largely failed in dealing with operations regarding drainage capacity.

There is an insignificant male bias in

recognizing climate change as a concern: a significant proportion of female respondents recognizes the phenomenon as a concern. However, education is found to interplay in developing the information base and enhancing awareness on climate change, as a greater proportion of the respondents with relatively higher educational status (HSC and above) admits to have heard about climate change.

It is found that women are particularly vulnerable to high intensity rainfall events, which are induced by climate variability and change. Due to gender-based inequities, women's responses are generally contingent upon the assistance they receive from their male partners. Young and adolescent girls face the similar high intensity rainfall events differently: they suffer from water-borne diseases and their mobility is severely restricted due to deteriorated physical conditions and also due to escalation of transportation costs. It has direct impact on their schooling.

Climate change is perceived to cause deterioration of urban services, perhaps due to sheer population pressure. Since climate change will trigger an influx of displaced people in urban areas, the unplanned densification is likely to put insurmountable pressure on available urban services. The current institutional management is struggling to offer urban services, as relevant institutions are lagging behind in terms of capacities (financial, human resources, planning and efficient management). They do not have gender-specific services, with the exception of a few health related services. The management is perceived to falter if they do not adequately plan well ahead of time.

Under climate change, Bangladeshi urban areas are highly sensitive to water logging and heat stress. Since migration into a city is not at all guided by law enforcing agencies,

sprawls of poor squatters generally propagate in the urban fringes, particularly through the encroachment into low lying areas. Often it is found that these low lying areas lie within the natural drainage system. As a result of urban densification, Bangladeshi cities are rapidly losing natural water drainage pathways, aggravating the prevailing drainage congestion. With increased in-country forced migration of poor people, there is a greater likelihood of continued encroachment into remainder of the drainage system, thereby exacerbating the prevailing drainage related problems in the wake of climate change induced excessive rainfall, water logging and floods.

It is found that the poor respondents are more concerned about the possibility of losing out in terms of lowering of daily wage due to influx of migrants in the city environment. However, the highly educated group exhibits greater sensitivities around potential encroachment of public facilities such as the walkways by the migrant people. People also believe that overall management of function of the respective city/urban management bureau will be deteriorated if large-scale displacement takes place as a result of climate-induced loss of livelihoods.

Heat island effect effectively causes health related problems to urban inhabitants. However, most of the health-related institutions in urban areas – irrespective to their size and locations – do not have any specific institutional plan to reduce adverse effects on urban inhabitants.

Despite increasing urbanization, health and nutrition policies in Bangladesh have continued to focus on rural delivery of health services and improvements in health and nutrition outcomes. The unique urban health governance structure in Bangladesh—which divides roles and responsibilities among the Ministry of Local Government, Rural

Development and Co-operatives, the Ministry of Health and Family Welfare, and urban governments— has further constrained the effective delivery of urban health services. Lack of coordination among these major institutional actors is identified as a major cause for inadequate urban health delivery system.

The urban health landscape is evolving in Bangladesh without a concurrent vision of how the health system should work in city corporations and municipalities. The curative services seem to have hardly any arrangement for climate change/variability induced health hazards. Because of climate induced failed livelihoods in rural areas coupled with pull factors, migration to different cities are common. However, health services are not growing quickly enough compared to the growth in urban population. Often infants migrated with their mothers are missed out from the Expanded Program on Immunization. There is a pressing need for policy makers to develop a comprehensive urban health policy in consultation with relevant stakeholders.

The current institutional actors involving urban service delivery are least bothered about climate change and induced effects. They are struggling to offer basic level of services. Their efforts are often outpaced by the growth in demand for various services. The plans are often inadequate and ad-hoc in nature, therefore are criticized being inadequately forward looking. There is hardly any dialogue with national experts on climate change regarding the additional service requirements. The evolution process of the Bangladesh Climate Change Strategy and Action Plan must be integrated with future planning of these urban institutions across the country, which should be complemented by making financial resources available and emphasizing on the development of human resources to ensure service delivery.

The study finds that poor urban inhabitants, especially women, girls and children have limited means and capacities to build resilience against climate change induced hazards. They lack in terms of technical know-how and financial resources. However, women and adolescent girls can offer limited but significant resistance against hazard-related vulnerabilities, mostly through organizing themselves and engaging in collective works. They do have certain capacities, which can become handy. These capacities can be greatly enhanced and can also be organized towards reducing vulnerabilities, which may turn the apparent victims of climate change into 'potential champions of climate change'.

Adolescent girls express their desire to receive trainings, equipments and supports from relevant Government institutions to take up the challenge in an organized fashion. It is believed that socially constructed taboos and hindrances often do not allow Bangladeshi women and adolescent girls to take part in collective works for reducing vulnerabilities. Women should be encouraged by NGOs and local voluntary organizations to form self-help groups to learn a few skills towards reducing climate related risks and allowing them to utilize such skills during a hazard. The best practices developed by a few NGOs working in urban areas need to be disseminated so that these are integrated in future NGO programming related to climate change in urban areas. However, such programming should facilitate coordinated activities involving various service providers on behalf of the Government.



# 1

## INTRODUCTION

### 1.1 Introduction and background of the study

Bangladesh is a low lying deltaic country located in South Asia. The hydro geo-physical context of the country is largely sketched by the regional flow regime, with over 92% of the water flowing in Bangladesh's river systems originating from outside the country. Regional flows are dictated by the monsoon driven rainfall and runoff (Rahman et al., 1990; Ahmad et al., 1994), which brings too much water beyond drainage capacity during June-September time frame to cause drainage congestion and frequent flooding. In sharp contrast to monsoon season, there is hardly any rainfall

during the prolonged dry season (November to April) which gives rise to moisture stress and phonological drought (Karim et al., 1990). The lack of rainfall also induces low flow in rivers, which in turn gives rise to salinity ingress along the coastal river systems (Ahmed, 2006). The coastal areas are prone to cyclonic activities (Ali, 1999). A large population confined within a small landmass and proneness to natural hazards such as flood, drought, river erosion, salinity ingress and cyclonic storm surge make Bangladesh one of the worst affected countries under climate variability and change (World Bank, 2000; BCAS-RA-Approtech, 1994; Warrick and Ahmad, 1996; Huq et al., 1996; Huq et al., 1998; Ali, 1999; Agrawala et al., 2003; MOEF-UNDP, 2005). The Intergovernmental Panel on Climate Change's 'Fifth Assessment Report' reveals long-term implications for Bangladesh and its people from probable catastrophic impacts of climate change. A number of publications portray a very dismal scenario of the future for Bangladesh as climate change continues to take its toll

(IPCC, 2014; Schellnhuber et al, 2013).

Despite having a wealth of information on climate change issues, very little is known on vulnerability of urban sector in Bangladesh. Bangladesh is on track to become a middle-income country by 2021 (GED, Planning Commission, 7th Five Year Plan, 2015). As a stylized fashion, between 1961 and 2011, the country's total population increased from 55 million to 150 million (about 273 per cent) while the urban population, within the same time frame increased about 1600% (accounting about 43.43 million from 2.6 million) (BBS, Statistical Year Book, different years). About 60% of the urban population lives in City Corporations with remainder in Puroshavas and small towns. According to an estimate, by 2020, nearly every other man, woman and child will live in an urban area (World Bank ed., Bangladesh 2020). A persistently high natural increase of native urban population, the territorial extension of existing urban areas with conversion of rural centers towards re-definition of urban areas and "Opportunistic migration" along with "Forced Migration" attributed by failed livelihood in different climate hot spots are shaping up the urbanization process of Bangladesh.

Impacts of climate change induced urban flooding, cyclone and temperature rise (and heat island effect) are multifaceted and these problems will be further exacerbated with the increasing trend of urbanization and population growth (MoEF, 2012). The effects of flooding and cyclone are enormous and manifold such as damage to infrastructure and facilities like roads, houses, water supply, effect on health and hygiene, water quality and the environment among others. Poor urban populations are

likely to be amongst the worst sufferers of climate change (MoEF, 2012).

As for vulnerability to the impacts of climate change, poverty plays a major role. Due to the living conditions of the poor, they are often more exposed to hazards, and have fewer options to avoid such exposure, or cope with, the adverse impacts. Moreover, there are additional factors indicating that vulnerability involves heavy gender differentials that need to be taken into consideration. Since vulnerability is related to adaptive capacities and the poor and marginalized people including urban women and girls lack severely in adaptive capacity, the resultant vulnerability to climate change of these groups generally appear high, particularly in least developed countries.

The gender dimensions of human settlements and livelihoods as issues of research, advocacy and urban policy have a long history. The Habitat Agenda includes various provisions on gender, and the gender dimensions of the main issues related to human settlements have been addressed, such as urban poverty and gender, housing, land and property rights of women, water and sanitation, gender mainstreaming and the involvement of women in local government. In recent years, the state of wellbeing of marginalized people including women and girls in urban set ups have added additional complexities in the wake of climate change. In Bangladesh, there is a dearth of analysis in this important area of research. Adaptation to urban areas due to climate change is somewhat similar to though not entirely elsewhere within the economy and the country.

CARE Bangladesh is the pioneer to implement one of the very first community level adaptation projects anywhere in the

world in the early part of this century (Ahmed, A.U.; 2010). CARE Bangladesh implemented a project (Building Resilience of Urban Poor, BRUP) aiming to increase the resilience of Urban communities and institutions so that they can prepare for, mitigate, respond to, and recover from shocks and stresses. CARE Bangladesh has intended further exploration to understand the multi-dimensional impacts of climate change on the urban populations, particularly the ones who live in poor condition and exposed to various hazards and also to identify the critical gaps/emerging challenges and opportunities for women and girls to be involved as a force for urban resilience.

## 1.2 Key Research Questions of the Study

The main research question for the study is: How can Bangladeshi cities be resilient to the impacts of climate change, especially in the social context of marginalized poor, women and girls? More specifically, the following research questions appear important:

1. How the urban systems currently being impacted by changing climate? What are the sensitivities of Bangladeshi cities for climate change considering future projections? How can we characterize the vulnerability of cities to climate change?
2. How does the marginalized poor living in the urban slums/squatters/ pavements impacted by climate change? Are there any gender differentiated vulnerabilities? What are those differential vulnerabilities that climate change is adding for marginalized women & girls and Person with Disabilities (PWDs)?
3. What innovative approaches are needed to be addressed in order to enhance adaptive capacities of the above vulnerable

groups? What potentials the women & girls have that can add value to building urban resilience?

4. How migration would accelerate the problems under changing climatic scenarios? How climate induced migrants are putting extra pressure on service delivery systems?

5. What are the main approaches, strategies and interventions being used by the actors in different contexts to enhance urban resilience?

6. What are appropriate adaptation/resilience strategies in each scenario? What would be needed to implement these measures and strategies?

## 1.3 Composition of the Report

*Chapter One* Provides an idea of the background and rational of the research;

*Chapter Two* States the methodology carried out through the research;

*Chapter Three* presents the background of respondents and realities regarding climate-induced hazards in urban settings;

*Chapter Four* presents the impacts and response related findings of the research;

*Chapter Five* shades lights on the discourse of institutional management aspects in urban areas;

*Chapter Six* forwards the conclusions and a few recommendations.





# 2

## METHODOLOGY APPLIED

The generic approach to the task involves collection of both secondary/published information as well as primary information from major stakeholders regarding perceptions about climate change, related adverse impacts, adopted response mechanisms and ways to address future vulnerabilities through an institutional mechanism, with particular reference to urban poor women, adolescent girls and children of the country.

As a general method of identification of target urban areas, certain limitations had to be imposed based on available resources: time and budget (i.e. financial). It is decided in consultation with CARE

Bangladesh Officials that four geographic locations will be brought under the scoping, each representing different predominant vulnerabilities that are caused by various hydro-geophysical realities, however each might be offering distinctly different institutional response mechanisms to such hazards, based on their respective urban status. The four cities selected for probing into the research questions are Sunamganj (a District municipality), Rangpur (a Divisional municipality, which has been promoted to City Corporation only recently), Khulna (an old Divisional municipality, has been functioning as a city corporation since long), and Gazipur (a District headquarter based City Corporation, which have similar characteristics that of the megacity Dhaka, the capital). Their hazard-related features are briefly highlighted in Table-1.



**Table-1: Features of target urban areas**

Features	Target urban areas			
	<i>Sunamganj</i>	<i>Rangpur</i>	<i>Khulna</i>	<i>Gazipur</i>
Geographical position	Northeastern region (NE)	Northwestern region (NW)	Southwestern region (SW)	Central region
Climate-induced primary hazard(s)	Flash flood	Riverine Flood	Cyclonic storm surge (also salinity ingress)	Drainage congestion due to excessive rainfall
Urban status	A District municipality	a Divisional municipality, promoted to City Corporation only recently	An old Divisional city, has been functioning as a City Corporation	a District headquarter based City Corporation, adjacent to Dhaka megacity

*For data collection, the following methodology was applied:*

### 2.1 Collection and review of secondary information

An effort was made to collect secondary information on vulnerability and response mechanism of urban people, with particular reference to women and poor people in four target cities.

A scoping is done in consultation with CARE Bangladesh personnel, followed by the collection of secondary literature (published as well as grey literature, documents and reports). Gathering of secondary literature is arranged, which formed the base for the secondary source of information. With the help of the field-level enumerators, necessary steps were taken for the collection of secondary information and data. Check lists were developed for the collection of information (institution-based) on perceptions regarding urban level vulnerabilities of women, poor destitute/floating people, adolescent girls and children. Moreover, checklists were also

prepared for conducting Key Informants' Interviews (KII), which were conducted by the senior members of the Team. In order for the field enumerators to understand the tasks, a day-long training was arranged for the enumerators following the Initial consultative workshop.

The representatives of a number of institutions/organizations, including CARE Bangladesh and its partners working in the various urban areas, are contacted for key informants' interviews (KII). A formal set of questions have been asked to each of them for the KII. Such questions segregated key research questions as mentioned above. A few national experts, having adequate understanding regarding CBA in the SWR, were also contacted for conducting KII. The outcomes of the KIIs formed the basis to double check the evidence base for the analysis of vulnerabilities and adaptations to climate change in urban areas.

### a. Questionnaire survey

As part of methodology, a questionnaire survey involving a total of 350 respondents has been conducted in four target cities. The distribution of questionnaires is given below in Table-2.

**Table-2: Questionnaire survey plan involving four target urban areas**

All 4 cities	Sunamganj (NE)	Rangpur (NW)	Khulna (SW)	Gazipur (Central)
	87	88	87	88
350	Flash flood	Riverine Flood	Cyclonic storm surge (also salinity ingress)	Drainage congestion due to excessive rainfall

*Notes: NE stands for northeastern region, NW stands for northwestern region, and SW stands for southwestern region.*

The survey covered approximately 90 respondents per city, of which about 50 per cent are randomly chosen as representative households for the poor and ultra-poor class, identified by the respondents themselves and also categorized based on average monthly expenditure per member of the targeted household. Moreover, newly migrated households are not selected, where the minimum duration of staying in the target city is considered to be 5 years. The latter criteria allowed the urban dwellers to reflect somewhat deeper understanding regarding trends of hazards, which are generally considered in the literature as being induced by climate variability and change (Asaduzzaman et al., 1996; BCAS-Approtech-RA, 1994; MOEF, 2012 and MOEF, 2009).

In the process of conducting questionnaire survey, a questionnaire is developed and field tested in one target cities (Gazipur) and one randomly selected control city (i.e. Narsingdi). The adequacy of the questions is tested against research questions and based on field observations and results of adequacy testing, the questionnaire is

finalized. The questionnaire survey is conducted by a group of five Enumerators under the direct supervision of the Lead Researcher. The context of the study and climate change related issues have been presented to the Enumerators prior to conducting the survey. In Sunamganj, the Lead Researcher and other Team Members took part in the survey, giving first hand exposure for the Enumerators to learn methods of collecting non-biased answers. While applying the methodology, the Enumerators are asked not to select adjacent households as targets, rather following a criterion of two target households in the same locality being separated by at least ten households in a bid to avoid biasness in the answers.

### 2.3 Primary Stakeholders' Interview

In order to triangulate the information base and the subsequent analysis of perceptions on climate induced hazards and resulting vulnerability in urban areas, an effort was made to visit target cities. Such field-level consultations, again facilitated by indicative check-lists, were supplemented



by conducting field visits to a few key/representative field areas within the four cities to further consult with local people and service providers (including Mayors, GOB Officials and elected public figures). This step helped triangulate the information collected and provided a firm basis towards understanding impacts of climate change and adaptation needs in urban areas of the country.

#### **2.4 Data compilation and final analysis**

In the last step, the impacts, responses and adaptation needs are further reviewed. The data collected through the questionnaire survey are collated on a SPSS interface and analyzed. A Logit model exercise has enabled an analysis of sensitivities in order to avoid biases towards drawing inferences. The results of triangulation and KII have resulted in probing into institutional needs for providing supports to vulnerable poor communities across urban areas. All these data and understanding are finally utilized as a basis for this report.



# 3

## SOCIO-ECONOMIC REALITIES REGARDING SURVEY RESPONDENTS

The context of the analysis relates to urban areas of the country. There are several types of urban areas in the country, categorized on the basis of extent of development: (a) city corporations, (b) *pourasavas* (formerly known as municipalities) having three sub-categories: (b-1) Class-I, (b-2) Class-2 and (b-3) Class-3. Although these categories are defined by urban governance processes and these are listed by the Ministry of Local Government, Rural Development and

Cooperatives (MOLGRDC), there are many other tiny urban centres spread across the country, which have been going through a dynamic urban development process – with or without the support (and formal recognition) of the Government of Bangladesh.

In such a backdrop, there exists a significant inequality among inhabitants in urban areas throughout the country. Service quality in smaller and informal urban centres (and growth centres) is generally much inferior than that for larger urban areas including city corporations. Such inequalities have contributed to prevailing socio-economic realities of the urban inhabitants in Bangladesh.

Among the 350 households covered under the questionnaire survey, 46 per cent of the responses have come from males, while the rest involved female respondents. The mean age of respondents is 37.3 years, while only 5.2 per cent of the respondents are aged 18 years or less. Only 4 per cent of the respondents, alternatively, are aged above

60 years. Figure-1 provides a graphical representation of age distribution involving the respondents.

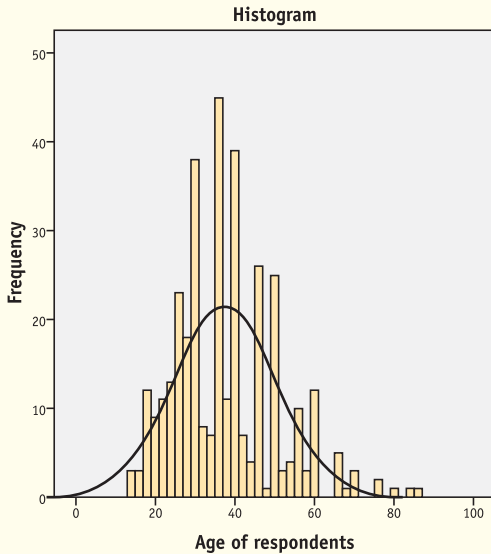


Figure-1: Age distribution of survey respondents

The average household size is found to be 5.9, which is much higher than that for urban areas (i.e., 3.93 per household in 2016, as suggested by BBS, 2016). The population distribution within the respondent households (involving the four target cities) suggests that an average household is composed of 3.749 adults (population above 15 years), 1.27 adolescents (between 5 and 15 years old) and 0.78 children (population below 5 years of age).

Among the 350 survey respondents, 83.7 per cent is found to be married at the time of the survey. It is found from the survey that 25.7 per cent of the respondents are illiterate. In addition, another 18.3 per cent of the respondents are found to have only little education, below level V (i.e. representing primary level). However, when

only female respondents are considered, the corresponding groups consist of 29.1 and 19.6 per cent, which are higher than the corresponding groups involving all 350 respondents. This is typical in the context of Bangladesh, where female education rates are found to be lower than that for the male education rates. Figure-2 presents sex disaggregated educational status of the survey respondents.

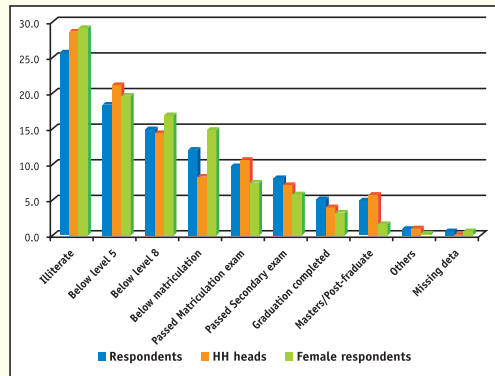


Figure-2: Educational status of the survey respondents

The survey also finds that only 10.0 per cent of the respondents (4.8 per cent for female respondents) are highly educated (graduate or above). Household heads are found more educated than the female respondents of the survey, which is typical in Bangladesh.

The respondents are randomly picked from a variety of employment backgrounds so that the survey itself becomes representative. This is reflected in the employment status of the respondents (Figure-3). Clearly, majority of the respondents are employed in petty businesses and trading (27.8 per cent), daily labours (14.0 per cent) and petty jobs (as peon, steno-typist, gate keeper, house maids and shop assistant, etc.) (11.8 per cent). Incidentally, a closer look into the dataset reveals that, majority of the rich or

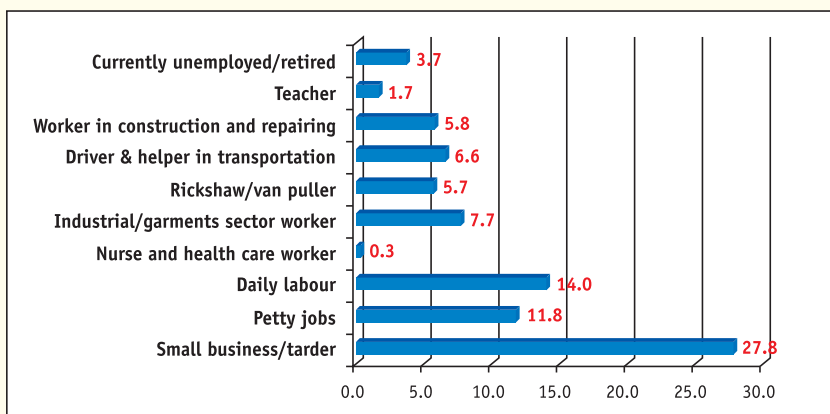


Figure-3: Distribution of respondent groups in various employment types

upper middle class households (top 20 percentile<sup>1</sup>) belongs to either employment groups involving traders or retired, while most of the poor households belong to groups such as daily labours, employed in petty jobs, rickshaw and van pulling, etc.

About 31.1 per cent of the respondents are found to reside in own houses, while majority is found to reside in rented properties. This is perhaps typical among urban inhabitants across the country. There exists a major regional difference in residential ownership pattern, as explained

graphically in Figure-4. While over 70 per cent of the respondents are found in Sunamganj who are living in self-owned houses, the majority of the respondents of Gazipur (some 85.2 per cent) claims that they have been living in rented properties.

The respondents living in their respective self-owned houses have provided information regarding the process of ownership. Majority of the respondents have owned the property through ancestral inheritance, while a quarter of them purchased the property from own-savings.

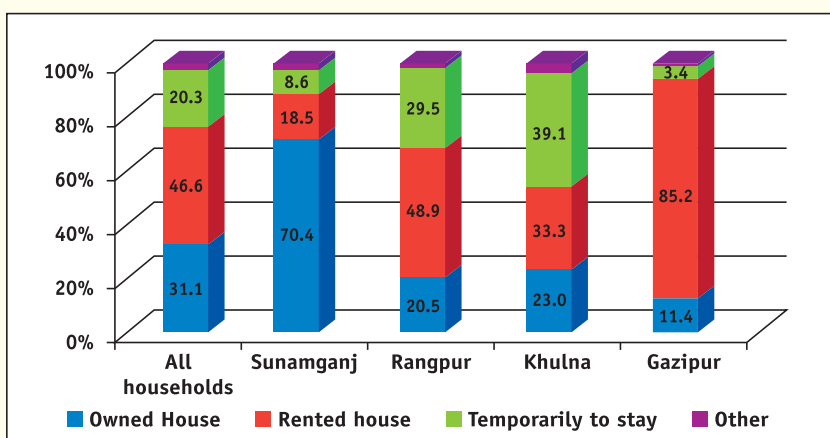


Figure-4: House ownership patterns in four urban centres under the survey

<sup>1</sup> Having average monthly expenditure on food per member of the household being Bdtk 6,000.

Figure-5 presents the ownership mechanisms of dwellings of respondents. Those who have reportedly owned their respective houses from own-savings, an overwhelming majority of them are found to belong to top 20 percentile of the economic status of the respondents, irrespective of the city under the survey.

It is heartening to find that, irrespective of the economic condition of the respondent

households, an overwhelming majority of the households have basic urban services, which involves electricity connectivity, water supply, and sanitation service. However, having a toilet within the household or inside it is still not a reality in almost two-thirds (61.9 per cent) of the respondent households. Table-3 provides for availability of urban services in self-owned and non-owned houses belonging to respective respondents.

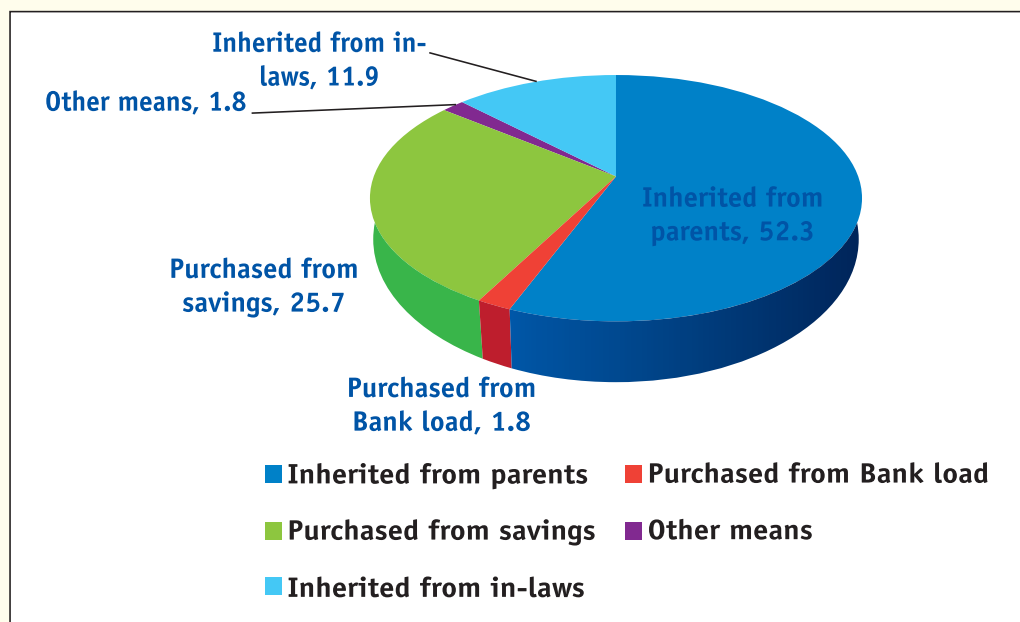


Figure-5: Reflection of house ownership mechanisms

Table-3: Availability of urban services in households participating in the questionnaire survey

Urban services	All surveyed HHs	HHs owned by the respondents	HHs not owned by the respondents
	% of respondents reporting so		
Water supply	73.7	73.4	74.1
Sewerage supply	74.0	77.1	72.4
Toilets inside the premise	37.4	60.6	26.8

From the above table, it is rather obvious that the rented households enjoy inferior sanitation services as only 26.8 per cent of such households have toilets inside the household and the rest generally depends on community and/or common toilets, often in a complex housing sprawl. This has been placed in a sensitivity test involving the economic status of the respondent households. A very strong correlation is found where the most-poor households reporting not to have a toilet inside their respective premises (95 per cent confidence level). The proportion of households having toilets inside the premises (60.6 per cent as against 26.8 per cent) is much higher for respondents living in their self-owned houses.

The regional difference in availability of urban services reveals that, service availability is the lowest in Gazipur, in comparison with other survey areas. Water supply is relatively low in Sunamganj as well. In terms of service availability, a larger proportion of households in Rangpur are getting the services compared to that for other areas. Figure-6 graphically presents the results.

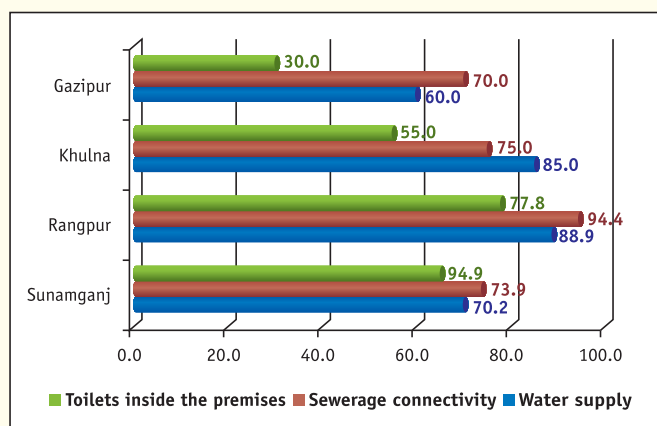


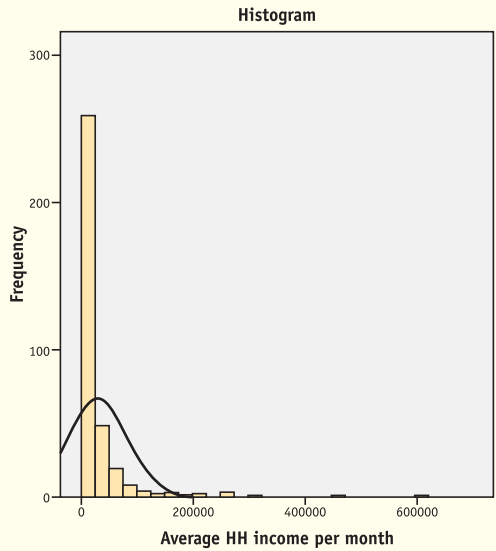
Figure-6: Regional difference in availability of urban services

Average income of the responding households is found to be BDTk 28,027, having a very high range: BDTk 3,000 to 600,000. A distribution curve (presented in the histogram in Figure-7) reveals that, over two-thirds of the households earns below BDTk 25,000, while the skewness is 6.478. The bottom 20 percentile households earn BDTk 8,000 per month, while the upper 5 percentile households earn BDTk 96,150.

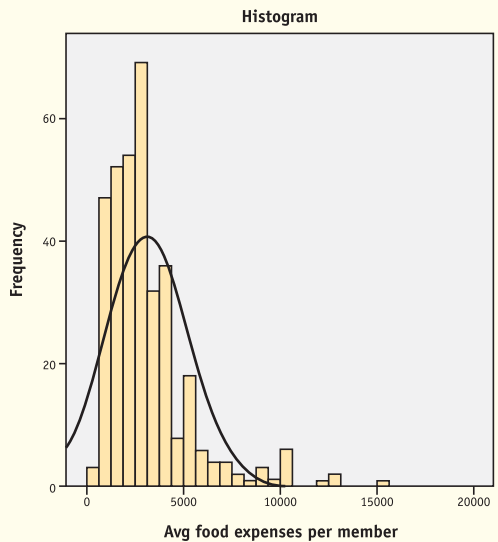
A regional analysis suggests that, the average monthly income in Khulna is significantly lower than elsewhere, while that for Sunamganj and Gazipur are generally higher than the other two target areas. The top 20 percentile earners generally make more money in Sunamganj than elsewhere for the same economic class. The income from fish trading generally contributes to the higher income level for the top 20 percentile households in Sunamganj.

It is found that, average household expenditure does not generally correspond to average household monthly income. Rather, the former depends on many aspects including the type of members (demographic structure), saving potential, household size and so on. The values obtained from the survey are normalized through dividing total monthly expenditure by the total number of household members, which gives figures on per capita average monthly expenditure on food. The distribution of the latter suggests that, the average per capita expenditure on food is about BDTk 3,069. The histogram is presented in Figure-8.





**Figure-7: Income distribution of survey household**



**Figure-8: Average per capita monthly expenditure on food**

The percentile distribution of per capita expenditure on food for various economic classes corresponds well with relevant figures obtained from Household Income and Expenditure Survey (HIES) of the Bangladesh Bureau of Statistics (BBS, 2016).



# 4

## PERCEPTIONS REGARDING CLIMATE-INDUCED HAZARDS IN URBAN SETTINGS

### 4.1 Perceptions regarding climate variability and changing climate

In the past, there have been a number of efforts to understand perception of Bangladeshi population regarding climate change. However, there is a general sense of neglect in understanding implications of climate change involving urban poor (Banks et al., 2011). With the exception of a few studies, most of the perceptual studies have largely been limited to rural areas (Haque et al., 2012; Ahmed et al., 2007), particularly involving farmers and related

communities (Habiba et al., 2012; Mahmood, 2010; Huda, 2013). Very little is available in published form regarding perception of vulnerability to climate variability and change among urban population (Jabeen and Johnson, 2013; Adri, 2013). The current study attempts to analyze perceptions of urban population regarding known hazards in the four target cities.

#### 4.1.1 Seasonal variability

The survey reveals that, to 78 per cent of the respondents the seasonal variations occurring in their respective cities are no longer the same, while only 14.9 per cent reporting that it has remained as usual over the past decades. A large majority of the population can easily identify that the number of cold days have been reduced and the number of seasons have been reduced in recent years (81.2 and 75.7 per cent of the respondents, respectively). Table-4 provides a summary of perceived changes with respect to 5 to 10 years ago in the respondents' respective cities. Clearly, the

**Table-4: Observed changes in climate-driven phenomena**

Changes observed		Proportion of population responding (%)
<b>Seasonal changes</b>		
1	No more six seasons	75.7
2	Autumn is lost	23.9
<b>Winter phenomena</b>		
1	Number of cold days reduced	81.2
2	Coldness in winter is milder now	65.5
3	Fogginess is increased	38.0
<b>Summer phenomenon</b>		
1	It is hotter in summer	63.9
<b>Rainfall related phenomena</b>		
1	Rainfall decreased	35.7
2	Rainfall increased over the season	58.4
3	Heavy rainfall episodes increased	54.9

Data source: Questionnaire survey for the study

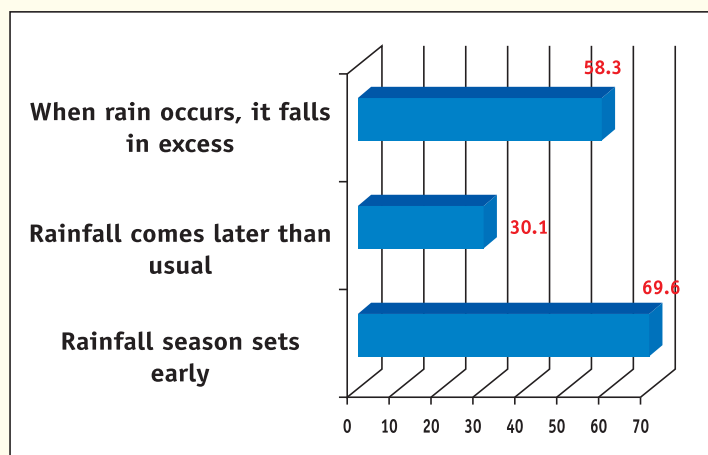
reduction of coldness, number of winter days and hotter summer indicate that there has been a general surface warming in the urban areas. Perhaps the manifestation is supported by a potential increase in urban heat island effect in the target cities, which must have been simultaneously causing an overall increase in temperature across seasons.

#### 4.1.2 Rainfall variability

Regarding rainfall, perceived responses on both increase and decrease in rainfall have been revealed through the survey. However, more people (some 58.4 per cent) tend to believe that rainfall has been exhibiting an

increasing trend, as opposed to 35.7 per cent believing that rainfall has actually been decreasing. The logit model analysis of sensitivity of results indicates that, there is a significant male bias in the results concerning a decrease in rainfall, particularly involving respondents who rely on physical labour for employment (i.e. daily labours, rickshaw and van pullers, etc.). On the contrary, women respondents and males with lesser reliance on physical labour (small shop owners, typist, gatekeepers, etc.) tend to believe that rainfall in the rainy season has been increasing. Since climate model-based projections have provided an inference that

the monsoon rainfall is likely to increase in medium to long time horizons (Ahmed and Alam, 1998), the perceived increase in rainfall supports the modeling results. A majority of the respondents (54.9 per cent) also have opined that heavy rainfall episodes have increased over the past 5 to 10 years. The summary of observations regarding rainfall variability is presented in Figure-9. Interestingly, the respondents clarify their observation further by indicating changes in micro-level rainfall patterns with reference to monsoon, the main rainfall season.



**Figure-9: Perception of respondents identifying change in micro-structure of monsoon**

projections have provided an inference that the monsoon rainfall is likely to increase in medium to long time horizons (Ahmed and Alam, 1998), the perceived increase in rainfall supports the modeling results. A majority of the respondents (54.9 per cent) also have opined that heavy rainfall episodes have increased over the past 5 to 10 years. The summary of observations regarding rainfall variability is presented in Figure-9. Interestingly, the respondents clarify their observation further by

indicating changes in micro-level rainfall patterns with reference to monsoon, the main rainfall season.

It appears important to note that, while 69.6 per cent of the respondents find an early setting monsoon, some 30.1 per cent also finds a late arriving monsoon – the two results oppose each other. Such results are better explained by regional analysis. The respondents in Rangpur find that monsoon generally arrives late, while an overwhelming majority of the respondents (93.3 per cent) of Sunamganj finds that monsoon generally arrives earlier than

expected. Therefore, the results also indicate a strong spatial and temporal variability in terms of occurrence of monsoon over Bangladesh, which is also scientifically valid. The early occurrence of monsoon in Sunamganj is perhaps due to the experience of 2017, when heavy downpour of late March and April ruined a significant proportion of Boro paddy in the Haor areas, which must have

interplayed in providing such information. However, this result also echoes with the scientific observation that the usual single-peak hydrological curve for monsoon has gradually been changing to a bi-polar distribution (Chowdhury, 2007).

The timing of occurrence of rainfall has changed as well, as observed by the survey respondents. Some 69.6 per cent of the survey respondents observe that seasonal rainfall generally comes before the usual timing for rainy season. Such observation

supports scientific analysis of past data which confirms (a) a bi-modal distribution of rainfall peak, and (b) an early occurrence of monsoon (Chowdhury, 2007). However, 30.1 per cent of the respondents observe prolonged monsoon and a very late occurrence of rainfall, referring to widening of the monsoon season. Both the above observations not only indicate high level of awareness among urban respondents regarding observed climate variability, it also confirms the scientific findings using long-time datasets of the country (Chowdhury, 2007).

Some 58.3 per cent of the respondents opine that, when rainfall occurs, it rains hard. Indeed, the analysis of datasets involving daily rainfall data for 1961-2000 suggests that, the one-day and three-days consecutive rainfall have been found to increase over Khulna, Dhaka and Sylhet data collection points (CGC, 2010). If the Sylhet station is assumed to be a station for Sunamganj (where there is no long-term rainfall/temperature observation by the Bangladesh Meteorological Department), the observation confirms the scientific proof of occurrence of heavy rainfall episodes during monsoon.

#### *4.1.3 Temperature variability*

The survey respondents also observe temperature variability in recent times. Some 93.4 per cent observes changes in temperature variability. Only a small minority (some 4.3 per cent) does not observe any change in temperature. The respondents also observe effects of changes in temperature regime. Some 98.8 per cent observes warmer days in summer, while some 72.2 per cent experience warmer weather in all seasons – referring to a

general warming. The latter echoes with the scientific data analysis result, which suggests that the overall temperature in the country has increased by 0.74°C over the past four decades (Islam and Neelim, 2010).

There exists a considerable gender bias in reporting an increase in temperature across all seasons and also in summer in particular. In Khulna city, only 52.8 per cent of the female respondents experience a general warming across seasons, as against 72.5 per cent of the male reporting the same. While 90.2 per cent of the males are reporting warmer summer days, the corresponding figure for females of Khulna city is only 72.2 per cent. In general, the proportion of respondents experiencing summer warming in all the four cities is higher than those experiencing general warming. It is difficult to single out the scientific cause and effect regarding experience of warmer weather in recent years. Perhaps the heat island effect is exerting greater influence in the observation of general warming among the respondents.

Of those who have noticed temperature variability, 98.8 per cent relates to warmer days in summer. Similar responses are found in all four cities. Some 72.2 per cent opine that they experience warmer feeling in all seasons, which may be taken as a testimony of the effect of general rise in temperature. However, there are strong regional differences in recognizing warm feeling across seasons: higher percentage of respondents (both male and female) in Gazipur city have expressed warm feeling in all seasons than that for Sunamganj city. Perhaps the heat island effect is much pronounced in Gazipur than elsewhere. There is also a sex-based difference in perception regarding the increase in warm

feeling across seasons: about 56.4 and 40.5 per cent of the male and female respondents in Sunamganj city recognize the warmer feeling across seasons as against 84.2 and 80.0 per cent in Gazipur city, respectively.

People are asked to reflect on their perception regarding causes of rising temperature. Despite the fact that about 60 per cent of the respondents belong to poor or extreme poor category, they tend to highlight the same major causes as the national level experts often cite. The results are summarized in Figure-10. The respondents have identified lack of vegetation cover (24.6 per cent), dense habitat (21.5 per cent), pollution (16.1 per cent) with particular reference to industrial and vehicular exhausts, etc as the main causes. About 3.5 per cent of the respondents have identified global warming as the main cause, however that is cited only by the highly educated respondents. About 8.2 per cent respondents have identified factory exhausts as the main reason for rising temperature.

People from predominantly industrial cities (such as Gazipur and Khulna) have indicated reasons that are linked with industrial sources and/or pollution from vehicular and industrial emissions. On the contrary, lack of vegetation and lack of vegetation in city landscapes are often cited as the key reasons by the respondents representing lesser industrial cities such as Sunamganj and Rangpur (high confidence due to high correlation from Logit model).

As a paradox to the earlier results regarding warmer feeling, a small fraction of the respondents also experience colder feeling, however only in winter season. Such reporting of colder winter appears more in Sunamganj than elsewhere. The Climdex analytical results at  $3\sigma$  level do not verify such claims. KIIs conducted in Sunamganj indicate that, perhaps the extreme poor people do not have adequate blankets to cover them up during cold winter nights which might have played a role in the perception of colder winter temperatures.

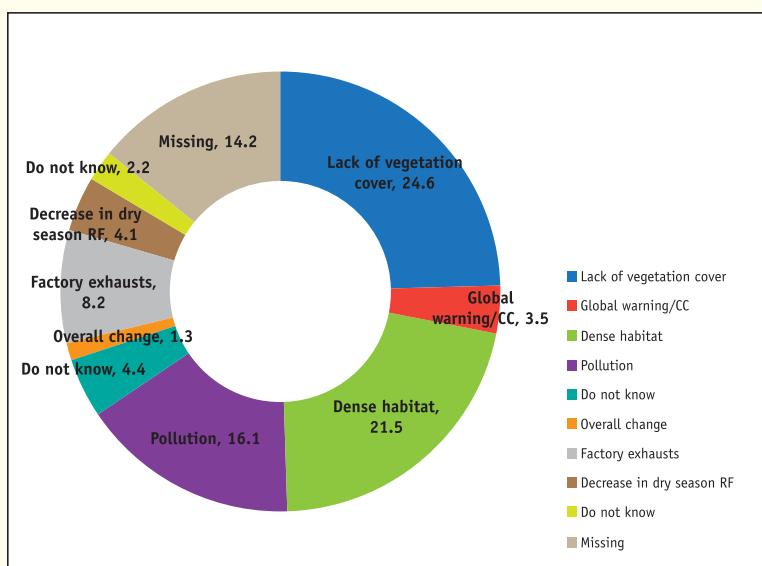


Figure-10: Perceived causes of rising trends in temperature

#### 4.1.4 Other relevant observations

Two other observations demand further elaboration. Some 38.0 per cent of the respondents have reported an increase in fogginess. It is found from the KIIs that an early morning fogginess induces accident-hazard in the urban set ups, causing disability and death of accident victims. The result appears more significant for Rangpur and Sunamganj cities than the two other target cities. Almost a quarter of the respondents have a common observation that autumn is no longer found in the seasonal cycle (please see Table-4 above). Although the urban population finds it difficult to cite an example or an urban-based indicator in favour of their observations (KII triangulation), such observations still tally well with perceptions of rural population on the same.

As indicated in Chapter-2, specific climate-induced hazards do have greater relevance to particular geographic locations. For example, cyclonic storm surge is more common in the coastal areas, therefore the phenomenon might not resonate well with the respondents in other target cities. However, heat stress due to accumulation of heat, excessive rainfall and resulting water logging (or, in technical terms, drainage congestion) are somewhat common in the four cities. Despite the fact that the same questionnaire is applied for the survey in all four cities, such regional biases are revealed.

## 4.2 Awareness and understanding on climate change

Upon inquiry, 49.4 per cent of the respondents admitted that they have heard about climate change. There is insignificant male bias in recognizing climate change as a

concern: 43.9 per cent female respondents have recognized the phenomenon as a concern. The observed male bias regarding awareness on climate change may be attributed to higher educational status of male respondents compared to that for female respondents. The logit model outputs confirm the fact that education is interplays in developing the information base on climate change. While a large proportion of the respondents (some 71.4 per cent) with relative higher educational status (HSC and above) admit to have heard about climate change, it is true for only 32.5 per cent of the group with lesser education (below primary level).

There is also a regional bias. While 67.0 per cent of the respondents in Gazipur admitted to have heard of it, similar recognition among the respondents of Rangpur and Khulna cities is about 36.4 and 36.8 per cent, respectively. The proximity to the capital city probably has increased access to information for the people of Gazipur, irrespective of their education and sex-based differences.

About 93.4 and 89.1 per cent of respondents across the four cities have indicated that they have experienced variations in temperature and rainfall, respectively. The recognition of climate variability by such overwhelming majority of the respondents exhibit great level of awareness about the issue. While on temperature the answer is somewhat similar in all four cities, a moderate sensitivity is observed in case of response to rainfall, with a moderate bias in Khulna and Sunamganj. Hindcast analysis of 60 years of daily rainfall data using Climdix software finds higher rainfall indices (say, decadal one day maximum and 3 days consecutive rainfall episodes using 3 $\sigma$

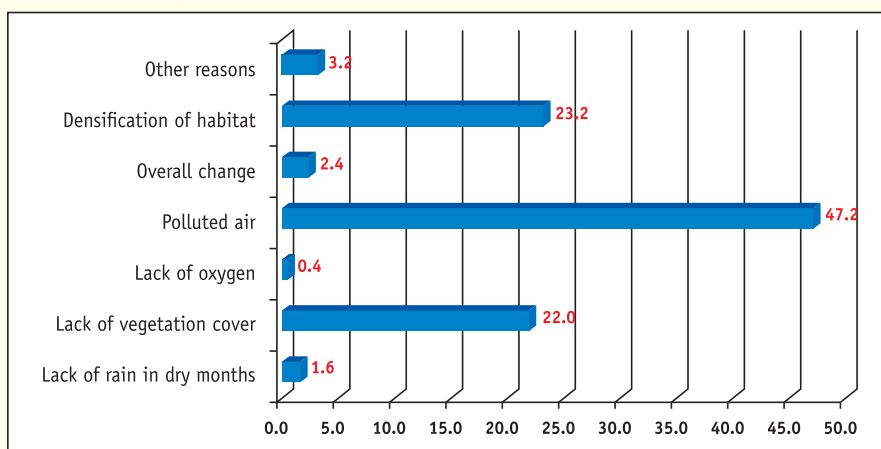
analytical screening threshold) for the stations Satkhira, Khulna, Sylhet and Srimangal, providing support to the perceived responses.

The level of awareness among the respondents is found high when they are asked to comment on future potential changes in temperature. Some 71.4 per cent of the respondent opine that the rising trend in temperature will continue in future, while only 2.3 per cent opine that no such increase is anticipated. Slightly over a quarter (i.e., 26.3 per cent) have expressed their inability to ascertain whether temperature will change in future due to climate change.

The high level of awareness is also exhibited when the respondents are asked to identify the cause(s) of rising temperature. Among the most cited causes for such changes, the respondents identify (a) pollution in air (some 47.2 per cent), (b) densification of habitat (some 23.2 per cent), (c) lack of vegetation cover (some 22.0 per cent), etc. as the main causes. The results of the query are presented in Figure-11. Such results, again, clearly demonstrate the level of awareness involving the respondents

representing the four target cities. The scientific literature have been providing research-based inferences on exactly the same aspects in relation to climate change in the country (Huq et al., 1998; Alam and Rabbani, 2012; MOEF, 2012).

The respondents also present their opinion regarding possibility of changing rainfall in their respective cities in future. However, most of the respondents are not as certain about changing urban rainfall as in the case for increasing temperature. Some 65.1 per cent of the respondents say they do not know whether such changes will occur or not. Only 18.6 per cent believe that rainfall will increase, while some 16.0 per cent thinks rainfall in their respective cities will decrease in future. Those of whom indicate that rainfall will increase, 21.5 per cent of them find an increase in evaporation as the main cause for increase in rainfall. Such a perception is validated by physical science (IPCC, 2014). Other causes which are frequently cited include observed trend in increasing rainfall, reflection of the past rainfall trends, increased deforestation in the cities, etc. The results are summarized in Figure-12.



**Figure-11: The causes of increasing temperature as cited by the respondents**



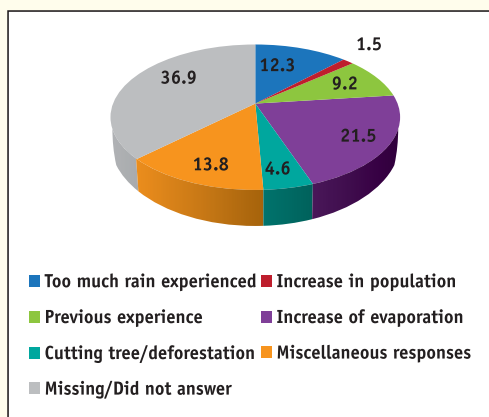


Figure-12: Reasons cited for increase in rainfall in future

### 4.3 Hazards induced by climate variability and change

According to the survey respondents, the most frequently occurring urban hazards induced by climate variability and change include water logging (71.4 per cent), excessive rainfall (65.1 per cent), tornado/norwester (60.9 per cent) and flood (31.7 per cent), etc. The corresponding figures are representative across the four target cities. However, certain hazards are localized, therefore these are not cited in other cities as a common hazard. For example, flash flood is a climate-induced hazard to 14.3 per cent of the respondents, which has no relevance outside Sunamganj. Similarly, storm surge and cyclone has no relevance in cities outside Khulna.

The apparent omission of heat stress as a prominent climate change induced hazard suggests low level awareness regarding the hazard. A further analysis of logit model outputs indicates that, people across the four cities relate higher temperatures and induced stresses with processes such as industrialization and lack of vegetation, not

so much on general warming (high confidence). May be the wider experiences regarding environmental degradation around them preoccupy their minds compared to distant global atmospheric processes that lead to climate change.

Efforts have been made to understand the perception of the respondents in the four target cities on the dynamics of known climate-induced hazards. The results are provided below.

#### 4.3.1 Excessive rainfall

In recent decades, there has been a general increase in occurrence of excessive rainfall episodes with devastating effects on urban lives and livelihoods. The excessive rainfall episode of July 28 in 2009 in Dhaka<sup>2</sup> amounted to 448 mm, 65 per cent of which fell within a period of 6 hours, between 01:00 to 7:00AM. It has broken the previous recorded highest rainfall of 333mm in 24 hours, which occurred during September 13, 2004. In both the cases of extreme rainfall event, over 75 per cent of the urban areas of the capital remained inundated, causing severe water logging for hours. The entire city came to stand still, the poorest people could not earn their daily living. The devastation was so severe that the Prime Minister's Office declared a public holiday on the 14th of September 2004, partly because the office was found to be non-accessible for continuing routine activities.

On similar notes, over the past fifteen years the second largest city Chittagong suffered through three most extreme rainfall episodes, where 24 hour rainfall exceeded 250mm in each of the cases. As a result of such high rainfall, not only severe water

<sup>2</sup> BMD database, checked with BMD through personal communication.

logging took place and it inundated the food storages of Khatunganj, the episodes also triggered landslides in hilly parts of the city, thereby causing deaths and destructions when sliding muds buried a number of houses and their inhabitants alive<sup>3</sup>. Although such extreme rainfall episodes are results of outburst of clouds, many tend to believe that the surface warming and an increase in frequency of occurrence of depression in the Bay of Bengal may be partially responsible for creating the condition for rainfall outburst. Despite the debate, it is certain that high intensity rainfall frequency is on the rise, which has specific adverse impacts on city lives and functioning.

In such a backdrop, it is only obvious that 98.8 per cent of the respondents agree that the frequency of excessive rainfall episodes is on the rise. Only a minority of respondents (1.2 per cent) think otherwise. About 59 per cent of the respondents opine that the current frequency of occurrence of extreme rainfall is at least four times a year or more. The frequency of occurrence of excessive rainfall thrice, twice and once a year is believed by 20.1, 16.0 and 5.0 per cent of the respondents, respectively.

There exists a considerable regional difference in identifying frequency of occurrence of extreme rainfall. Frequency of occurrence of 4 and above is reported by a much higher proportion of respondents in cases of Rangpur and Khulna, compared to that for Sunamganj and Gazipur. Since the term 'excessive rainfall' is used without a proper definition, the perceptions regarding such non-specific aspects of weather event appear inconclusive. However, in the FGDs the respondents indicated that, the usual

prolonged rainfall episodes of October (known as *Kaitani*) is hardly experienced these days in urban areas. Rather, short-lived excessive rainfall episodes have been observed, for which the available drainage system fails frequently, resulting into severe forms of water logging in urban areas.

#### 4.3.2 Water logging

In recent years, water logging is perhaps the most talked about urban hazard which is induced by climate variability and change. Since the well-being of the inhabitants of the capital depends largely on frequency of occurrence of water logging, and the unplanned rapid urbanization has been identified as one of the major reasons for the frequent occurrence of such hazard, the issue is widely discussed in media and in political arena throughout the monsoon season, every year. Available literature suggest that urban water logging will be quite common under a warmer world in Bangladesh, with the possibility of inflicting upon severe damage and destructions in economic terms (Rabbani et al., 2011; MOEF, 2012).

An overwhelming majority of 91.4 per cent respondents identify water logging as a major hazard in their respective cities. In contrast, only 6.9 per cent of the respondents opine that water logging is not a major hazard. About 61 per cent of the respondents believe that they suffer four times or more in an average year as a result of rainfall induced water logging. In contrast, only about 18 per cent of them observe that the frequency of occurrence of water logging can be twice a year or less.

<sup>3</sup> Summarized from daily newspaper articles, published in regional and national dailies.

Water logging is found to be more pronounced in Gazipur and Khulna cities, compared to Sunamganj and Rangpur cities. Since women suffer more under rainfall induced water logging, a greater proportion of women is found to report water logging in both Gazipur and Khulna compared to their male counterparts. The KII suggests that water logging in Sunamganj hardly occurs due to incessant rainfall, however there is greater probability of occurrence of water logging in certain parts of the city (i.e., municipal area) due to runoff from the northern areas of the locality. Since the city Sunamganj is located at the south of the Meghalaya Hills, the heavy rainfall in the latter must be responsible for causing water logging in certain parts of the city.

The KII on water logging in Khulna reveals that, the rapid filling up of wetlands and low-lying lands around Khulna Metropolitan area (under Khulna City Corporation) has shrunk drainage capacity of the city significantly over the past two decades. As a consequence, frequent water logging takes place in Khulna city in every monsoon season. Similarly, the gradual filling up of low-lying lands and conversion of wetlands into urban lands in Gazipur has resulted in much reduced drainage capacity of the city, eventually giving rise to the occurrence of frequent water logging. The national experts are of general agreement that, if monsoon rainfall increases under climate change and the reduction of drainage capacity continues, the threshold for the occurrence of water logging will reduce alarmingly in cities such as Gazipur, Khulna, Dhaka and Chittagong.

#### 4.3.3 Riverine flood

About 88 per cent of the landmass in

Bangladesh is floodplain. The land is crisscrossed by many rivers, the most known of these rivers are the Ganges, the Meghna and the Brahmaputra rivers. Riverine flood, therefore, is a common phenomenon in Bangladesh. Historically, many urban centres have been established along the rivers, owing to easy and inexpensive transportation facilities. The proximity of an urban area along a river makes a city naturally susceptible to suffer from occasional flooding. Since monsoon influences regional rainfall and runoff significantly, flooding has become an annual phenomenon for many urban areas in the country. The four cities are of no exception.

Over 53 per cent of the survey respondents indicate that they experience flood. Since flooding is a localized phenomenon, not all the respondents are found to be flood vulnerable. About 42.6 per cent of the respondents are not found to be flood vulnerable. The survey clearly indicates that the respondents of Sunamganj and Gazipur experience more floods than the respondents of Rangpur and Khulna. Apparently, a significantly less proportion of respondents of Khulna (i.e., only 11.5 per cent) indicate flood as a common hazard.

Although both water logging and flooding are induced by rainfall, the frequencies of occurrence are quite different for the two distinctly different types of hazards. Unlike water logging, in most cases (over 59.7 per cent) flooding occurs only once across the four target cities. There exists a strong regional signal: while the frequency of occurrence of flood in Rangpur is just 1, majority of the respondents from Sunamganj indicate the frequency of occurrence to be twice.

The KIIs report that in much smaller

townships of Jamalpur, Gaibandha and Kurigram districts (in the north-central region), sometimes three flood peaks are observed in a single monsoon season. Such a phenomenon is more pronounced in charlands of these districts. However, a good number of bigger cities such as Dhaka, Sirajganj, and Rajshahi is at least partially protected against floods. It is to be noted that these protections are provided with the establishment of embankments, having designs to protect the hinterland against a design flood of once in a 20 years. If floods with greater magnitude occur, then the embankments are usually found to fail (as it was the case during the floods of 1998, 2004 and 2007).

Since flooding is the most common form of climate induced hazards, there has been a large number of research-based literature to understand the extent of flooding and their frequencies in a warmer world, with particular reference to Bangladesh (Mirza, 2002; Agrawala et al., 2003). Indeed, literature suggest that both the frequency and extent of riverine flooding will be exacerbated in Bangladesh, which is likely to affect built environment and urban centres (Alam and Rabbani, 2007; MOEF, 2012).

#### 4.3.4 Flash flood

Flash flood refers to a particular type of riverine flood which has a lifetime of few hours to at the most few days, however the rise and fall of water level occurs within a shorter time than regular riverine floods. Flash flood is more pronounced in Sylhet basin. Such floods are hardly ever experienced in cities such as Gazipur and Khulna. Therefore, only a small proportion of the respondents (23 per cent) indicate that

they are familiar with such a climate induced hazard.

About 38.8 per cent of the respondents of Sunamganj city report that flash floods occur at least thrice or more per annum. A little over one third of the respondents there finds the frequency to be twice a year. The hydrographs of Surma and Kushiya rivers at various northeastern points clearly show occasional two to three peaks, referring to ideal conditions for the occurrence of flash floods along the river banks.

In recent years, however, a different kind of flash flood is occurring in smaller coastal towns. During full moon periods, the water stage appears much higher over the monsoon period. If these phases are coincided with a depression, the waves become much stronger and inundate coastal urban areas – even if there is some protection against flooding. The embankments are overtopped and flood takes place. However, these are not necessarily riverine flash floods, which are observed in the north-eastern region.

#### 4.3.5 Tornado

Tornadoes are common weather events during mid-April. Unlike cyclones, tornadoes (also called norwesters and *Kaalboishakhee*) are formed in land, however the genesis generally follows similar principle with respect to cyclone/depression. The onrush of air following a land-based low formation gives rise to rapidly developed high wind speed, accompanied by a circular motion. Tornadoes are accompanied by hail storms and/or incessant but short duration rainfall. In Bangladesh, tornadoes are quite common phenomena, however each event covers only a small geographic area. In many occasions, tornadoes are found to hit urban areas.

An overwhelming majority of the survey respondents (95.0 per cent) recalls that they have experienced tornadoes in their respective cities. However, they do not tend to report frequency of occurrence of such events on an annual basis. The KII reveals that, tornado occurs once in about every four to five years. However, the KII respondents also explain that they observe *kaalboishakhee* storms of much lower intensity than tornadoes in every summer, even occasionally more than once in every April.

#### 4.3.6 Cyclonic storm surge

Cyclones occur along the coastal zone. Therefore, its relevance is only found in the coastal city Khulna, not in the other three cities. Consequently, only 19.7 per cent of the respondents have identified that the city is subject to occurrence of cyclonic storm surge. However, in response to the same question, 62.2 per cent of the respondents of Khulna city have identified cyclonic storm surge as a known hazard in the city. Despite the fact that cyclonic storm surges are common in the Southwestern region of the country, due to the presence of the Sundarbans forest in the sea-facing southern reaches of the Khulna city, not all the city dwellers have identified the phenomenon as a hazard for the city. As a result, 35.4 per cent of the Khulna city inhabitants opine that no cyclone has been experienced in Khulna.

Among those who identified cyclonic storm surge as a hazard in Khulna city, about 36 per cent of the respondents inform that the phenomenon occurs just once in a year, while 35.2 per cent of them believe that it occurs twice a year. About 22.2 per cent of the respondents believe that cyclonic storm

surge occurs in Khulna thrice or more times in a year. Women respondents have indicated higher frequencies of occurrence of cyclonic storm surge, perhaps based on their experiences of hazard intensity during and after each incident. The KIIs conducted in Khulna city reveals that, the incessant rainfall prior to and following an episode of cyclonic storm and associated surge brings additional hazards to women with respect to men, mostly due to lack of information, preparation and also due to differences in attire that are worn by women. Women often do not get early warnings regarding an imminent cyclone. Even if a warning is received, the language appears complex and are 'subject to technical interpretations'. "We do not understand what a signal number 5 or 7 means, what exactly we should be doing in which specific case. I only know that the higher the number, the more severe it (the event) will be. But if the reference point is Mongla port, how do I know what to do in Khulna city?" said Mrs Rukhsana Begum (40) representing Ward number 24 of Khulna City Corporation.





# 5

## IMPACTS OF CLIMATE-INDUCED HAZARDS ON URBAN POOR AND MARGINALIZED GROUPS

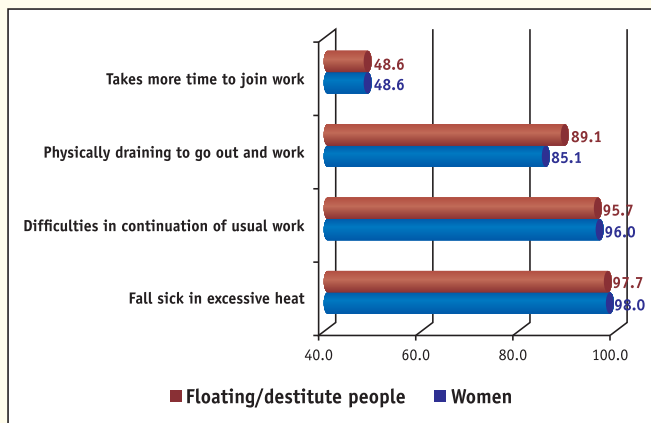
### 5.1 Adverse effects on livelihoods of the respondents

The respondents are asked to reflect on types of adverse impacts likely to face by different vulnerable groups with increasing temperature and rainfall, assuming that these two are the most cited hazards which will be accentuated under climate change. Since the primary focus of the study is to

concentrate on impacts on women, floating people, children and adolescent girls, the answers are clustered accordingly.

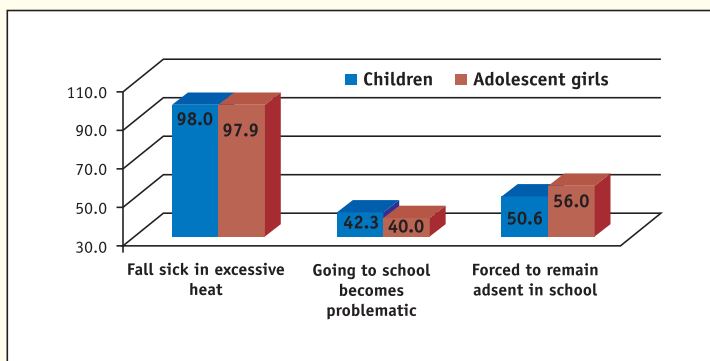
#### 5.1.1 Effects of warming and heat stress

An overwhelming majority of the respondents opines that both women and the floating (destitute) people generally fall sick, face difficulties in continuation of physical labour-based works, and get physically drained to go out and work if (surface) temperature rises above normal levels. The normal high temperature during summer months is perceived to be around 36 to 37°C. During high or excessive heat stress condition, it is reported that it takes more time to join work for these two groups. Since they go to work on foot, walking in high temperature causes physical exhaustion. The results are summarized in Figure-13 (the fraction of population responding to each type of adverse impact is given along the bars for the two groups).



**Figure-13: Heat stress-induced adverse impacts faced by women and floating/destitute people**

Similarly, an overwhelming majority of the respondents (over 97 per cent) tends to believe that both children and adolescent girls fall sick due to excessive heat stress conditions. About 40 per cent of the respondents have opined that both the groups find it problematic to go to school. About half the respondents also reports that both children and adolescent girls are forced to remain absent in school as a response to heat stress, which is found to be more common in more industrialized cities such as Gazipur and Khulna (High confidence). Part of the issue for not attending school may be explained by difficulties to go to school by walking and/or by using public transportation, which becomes difficult particularly for the children and adolescent girls during heat stress conditions. The results for children and adolescent girls are graphically presented in Figure-14.



**Figure-14: Heat stress-induced adverse impacts faced by children and adolescent girls**

### 5.1.2 Effects of excessive rainfall

The respondents also are asked to share their perception regarding adverse effects of increased rainfall episodes on the four groups, as above. According to an overwhelming majority of respondents, both the women and floating/destitute and poor people face issues such as (a) falling sick if drenched in excessive rainfall, (b) they lose income opportunities, (c) they cannot freely move around (and thereby

cannot join work with adverse economic consequences), and (d) they incur higher travel cost to workplace. To a lesser number of respondents, both the groups also require increased travel time to workplace, if they are adamant to join work within hours of a torrential rainfall event. The results are similar across regions, however slightly more pronounced in more urbanized cities such as Gazipur and Khulna than the two other cities. There is hardly any difference if one compares results of perception of poor and rich (high confidence). The summary of results is graphically presented in Figure-15.

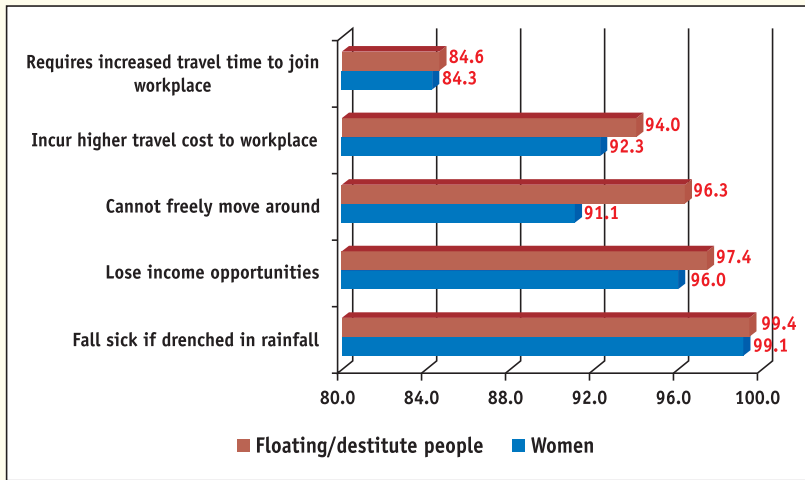


Figure-15: Excessive rainfall-induced adverse impacts faced by women and floating/destitute people

The results for children and adolescent girls are summarized in Figure-16. It is clear from the study that the respondents do not consider that children and adolescent girls losing income opportunities, as it is the case for women and poor destitute people. It is perhaps obvious that if children and adolescent girls are drenched in excessive rainfall, they fall sick – as indicated by the overwhelming majority of the respondents (similar responses across geographic areas and sex). However, a large majority of the respondents opine that both children and adolescent girls incur higher travel costs to school (which appears to be deterrent for the parents to send them to attend school), spend increased travel time to school, and accept forced absence in attending schools. The triangulation process involving KII with adolescent reveals that, there are examples of occurrence of eve teasing if a group of

adolescent girls are seen to take a stroll when fully drenched, which eventually triggers the process of cessation of schooling for some adolescent girls and culmination into early arrangement of marriage. “When such social vices appear common on our way to school, our parents do not have courage to take a risk. They get afraid and arrange a marriage, even if it is not desired by us” informed Ms Soheli (15) in Sunamganj.

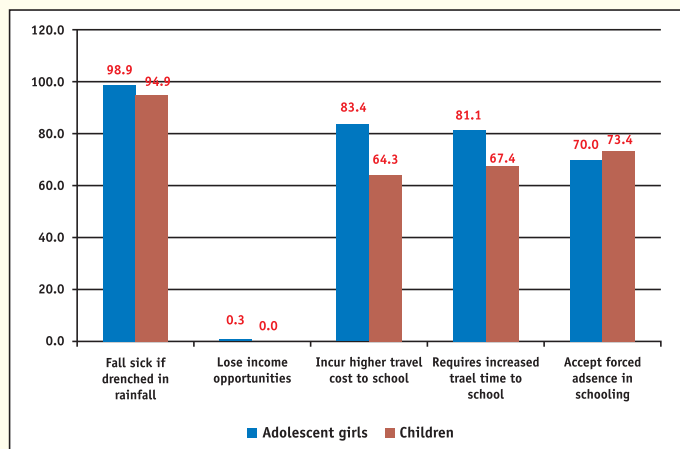


Figure-16: Excessive rainfall-induced adverse impacts faced by children and adolescent girls



### 5.1.3 Adverse effects of water logging

In a city environment, single waterlogging event is already hazardous, especially for poor city dwellers. It brings a host of adverse impacts. If such events occur frequently, the hazard becomes a severe cause of climate-induced ‘loss and damage’, particularly for women (Neelormi and Ahmed, 2012).

The survey respondents are asked to reflect on the usual hazards and discomforts associated with water logging conditions in city environment. The major impacts include: (a) restriction of movement (where women and adolescent girls suffer the most, and the persons with disabilities find no way to maintain livelihoods), (b) loss of income opportunities, particularly for the poor urban dwellers who depend on activities along the roads or the roadsides (for example, those who sell fruits and other commodities, and those who process low-cost snacks and food on footpath, etc),

(c) damages to dwelling units, (d) family members falling sick, and (e ) going to work/school becomes problematic. The spectrum of various impacts and their relative citation frequencies are summarized in Figure-17.

On certain adverse effects frequently cited by the respondents, there exists a significant regional difference. Figure-18 presents summary of the results from the survey. Clearly, more respondents of Khulna city face various adverse effects compared to other cities under the survey, while the adverse effects are relatively less acute for Rangpur city. Falling sick in water logged condition is more prevalent in Sunamganj (some 89.2 per cent), while damage to dwelling units is not a major issue there. In sharp contrast, the latter is a major concern in both Gazipur and Khulna cities. High frequency of occurrence of water logging in Sunamganj also plays a big role in causing its inhabitants to fall sick.

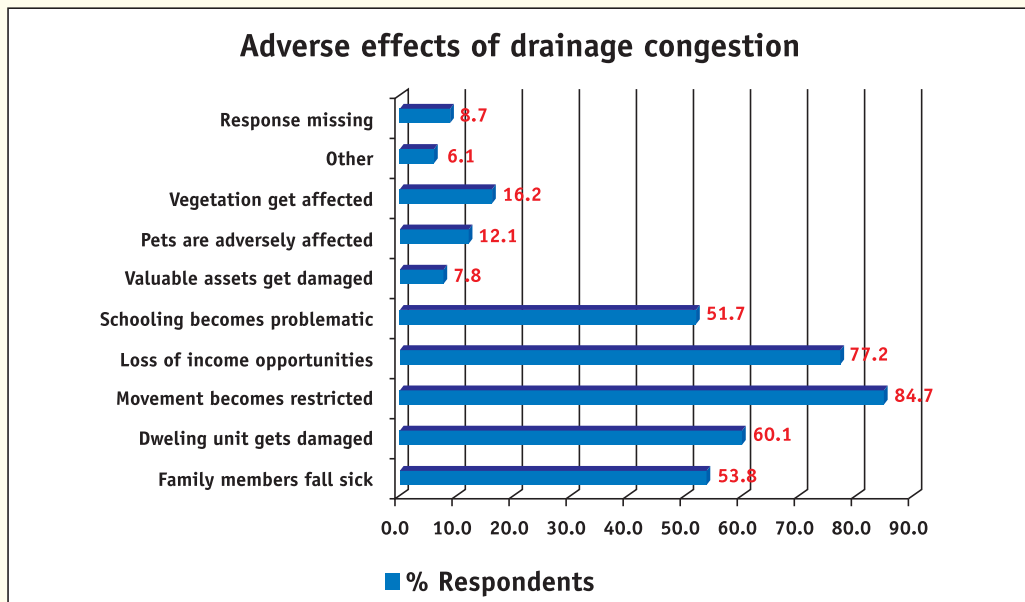
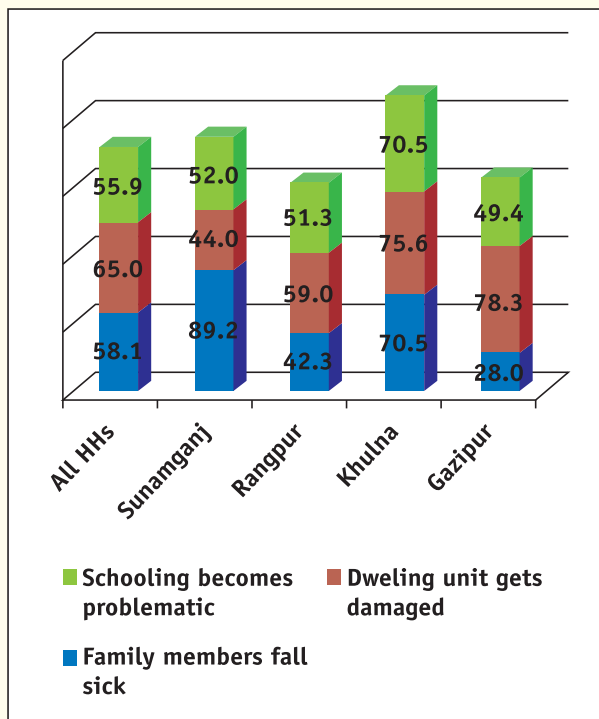


Figure-17: Respondents indicating adverse effects of water logging/drainage congestion

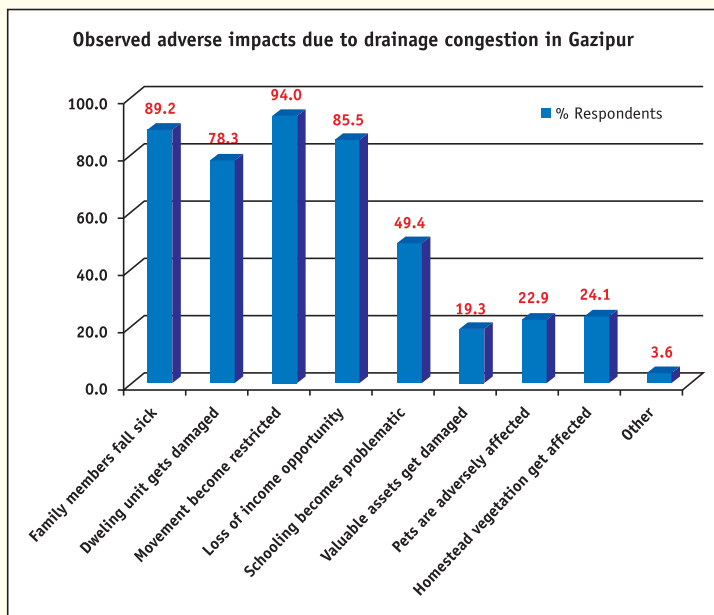


**Figure-18: Regional difference in experiencing adverse effects of water logging**

the megacity Dhaka, the land price is very high – the latter has enticed land grabbers to fill in almost all the wetlands and naturally occurring drains around the city. Moreover, the city is within 3 meters from peak water level of the river Turag, which flows towards the southern reaches of the city. As a consequence of these two major factors (there may be other factors as well), experts believe that water logging has become a serious issue for the sustenance and performance of the city.

Although the respondents of the survey, the common people, often do not analyze the way the national experts had done and they express their opinion regarding the adverse effects they face due to water logging. The results are summarized in Figure-19.

The landform (i.e. elevation of the built up areas with respect to water level of river during peak monsoon) and drainage capacity of the river (partly natural and partly regulated through the application of governance processes) also play significant roles in shaping up perception of loss and damage regarding water logging. One may take a deeper look at responses from Gazipur city. Due to its proximity in relation to



**Figure-19: Observed adverse effects of water logging in Gazipur city**

#### 5.1.4 Adverse effect of floods

As indicated in section 4.3.3, floods do not occur in all the cities with equal intensity and frequency. The realities based on the context of floods in each city largely determine the responses of survey respondents regarding adverse effects of floods. In city landscapes, flood waters impose restrictions on free movement of inhabitants. As in the case of water logging, restriction on movement is the most cited adverse effect of floods (to some 84.5 per cent respondents). Damage to dwelling units and loss of income opportunities come as the second and third most cited adverse effects (with 75.4 and 73.3 per cent responses, respectively). Figure-20 presents the result involving all four target cities.

There are significant regional differences in adverse effects which are observed in the four cities. For example, damage to dwelling unit is far bigger a problem in Gazipur (to 83.6 per cent respondents) than in Sunamganj (to 50.8 per cent respondents).

On the other hand, sensitivity towards restricted movement during flood is almost equally high in the three districts where flood is a major concern.

It is interesting to note that, urban drinking water availability is not as vulnerable as in the case for rural areas. In all four cities, non-availability of safe drinking water is highlighted as an adverse effect of flood by only 42.8 per cent of the respondents. The relatively low response may be attributed to somewhat increased investments in drinking water by relevant Municipalities/City Corporations. Experts believe that, the gradual lowering of cost for sinking a tube well in a city has resulted in increased NGO-led investments in drinking water sector in cities, especially where a large number of poor lives. However, experts also express their concerns that, most of the water coming from shallow aquifers through the tube wells may have active microbial activity or other persisting pollutants, and the sources of water may not be considered as 'safe'. However, to most of the

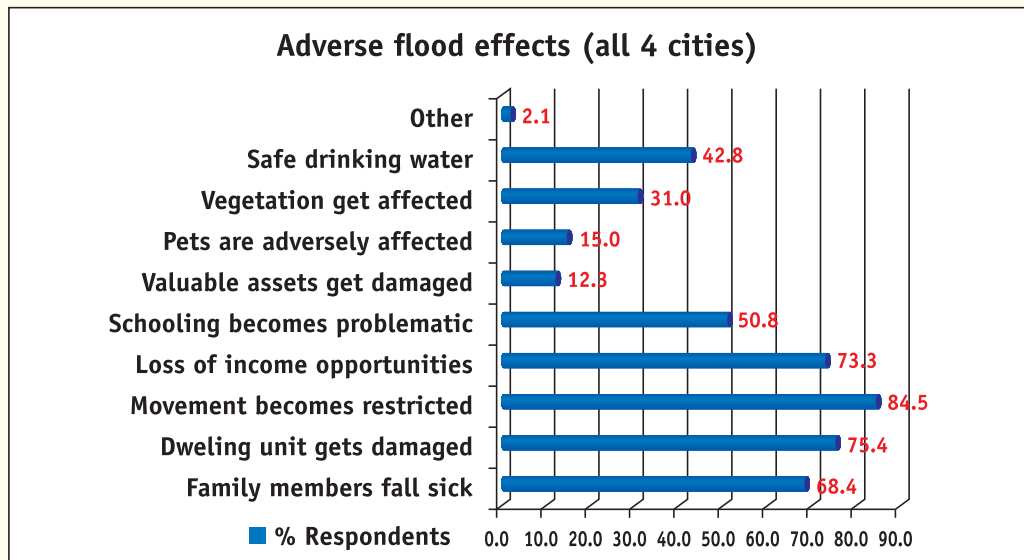


Figure-20: Adverse effects due to floods

respondents in KIIs and FGDs, water coming out of a tube well is largely considered as safe anyway. Even during floods, city dwellers do not treat water before drinking, irrespective of the sources of water. Lack of time to collect water from relatively safer but far away sources appears to be a major barrier, especially during flood when collection time increases as a result of restricted movement.

There are a few minor but significant issues concerning adverse effects of floods in urban environment. There is no denying the fact that vegetation cover in city landscapes is declining alarmingly over the past three decades. Every flood inundates such vegetation. Only the deep rooted household vegetations tend to survive in a prolonged flood. Unlike rural areas, urban dwellers highlight the loss of homestead vegetation as an adverse effect of flooding (to some 31.0 per cent respondents). With change in rainfall patterns in urban areas, it is feared

that urban vegetation will be next to none under climate change affected future. On the other hand, the additional warming and heat stress caused by climate change could have been ameliorated if adequate green vegetation could be restored in urban areas. The ecosystem service(s) most needed in urban environment under climate change may not be accrued with diminishing vegetation as a consequence of increased flooding.

#### 5.1.5 Adverse effect of flash floods

Riverine flash floods do not occur in cities other than in Sunamganj. As in the case of floods, flash flood also restricts movement of city dwellers (to some 82.0 per cent respondents). The poor and marginalized groups often face difficulties to maintain livelihoods due to loss of income opportunities (to 74.0 per cent respondents). The summary of results for Sunamganj city is presented in Table-5.

**Table-5: Summary of adverse effects of flash floods identified by respondents of Sunamganj**

Adverse effects	Response intensity (%)	Rank of adverse effects
Movement restricted	82.0	1 <sup>st</sup>
Loss of income opportunities	74.0	2 <sup>nd</sup>
Damage of dwelling units	52.0	3 <sup>rd</sup>
Schooling becomes problematic	44.0	4 <sup>th</sup>
Household members fall sick	34.0	Joint 5 <sup>th</sup>
Homestead vegetation destroyed	34.0	
Non-availability of safe drinking water	26.0	7 <sup>th</sup>
Difficult to keep household pets	16.0	8 <sup>th</sup>
Valuable assets get damaged	8.0	9 <sup>th</sup>

Data source: Survey results

### 5.1.6 Adverse effects of tornadoes

The circular and extreme whirl wind runs through any given path, it wreaks havoc underneath its path. There have been experiences of severe events and destructions in rural areas of Saturaia, Demra and Narayanganj in the past, with large scale devastation on crop fields, dwelling units and homestead vegetation. In the rural areas, most of the dwelling units are made of corrugated iron sheets, which are easily dislodged by the whirl wind. These freely moving rajor-sharp metal sheets act like rotor blades and cause physical injury, even death, to human beings. However, the quality of buildings is generally better in urban areas, which is why the extent of destruction can be significantly lower in urban areas.

The majority of the respondents (some 80.3 per cent) identify damage to dwelling units as the most significant adverse effect of tornadoes. The other important adverse effects include loss of income opportunities, damage of valuable assets, destruction to homestead vegetation, etc. The extent of use of corrugated iron sheets as a common material for building walls and roofs is much less in urban areas compared to rural areas. Therefore, tornadoes cause lesser number of deaths in urban areas.

### 5.1.7 Adverse effects of cyclonic storm surge

Cyclones are associated with high whirling winds, followed by surge of water. As indicated earlier, this is a phenomenon which is common only along the coastal

areas. Other than Khulna city, the respondents of the other three cities have not shared their experience regarding cyclonic storm surge.

In Khulna city, surge of water is not found to be too damaging, which is not the case in urban centres that are closer to the sea, especially the ones devoid of any vegetative protection<sup>4</sup>. The questionnaire survey reveals that 68.6 per cent of the respondents identify damage to dwelling units as the most observed adverse effect of a cyclonic storm surge. Other notable adverse effects of cyclonic storm surge include (a) damage to valuable assets (29.4 per cent), damage to homestead vegetation (29.4 per cent), and injury of family members (23.5 per cent). Figure-21 presents the most cited adverse effects of cyclonic storm surge among respondents of Khulna city.

## 5.2 Adopted response mechanisms to address adverse effects

People in Bangladesh, irrespective of locality, socio-economic and cultural background, have been experiencing climate-induced events since millennia. Based on their grassroots experiences, they have developed their own and localized responses strategies. Many of such response strategies are primitive in nature and offers only little remedial services to adverse impacts. However, people try their utmost to find a low-cost solution to an imminent climate-driven issue, with or without proper institutional facilitation.

<sup>4</sup> Where the Sundarbans mangrove forest is not present, the southern urban centres are subject to high tides even during a full moon (Ahmed, 2008) and high surge of water during a cyclone/deep depression. This has been observed during the super cyclone Sidr (occurred in November 2007) and the category-1 cyclone Aila (landfall on 25th May 2009) (Mallick et al., 2011).

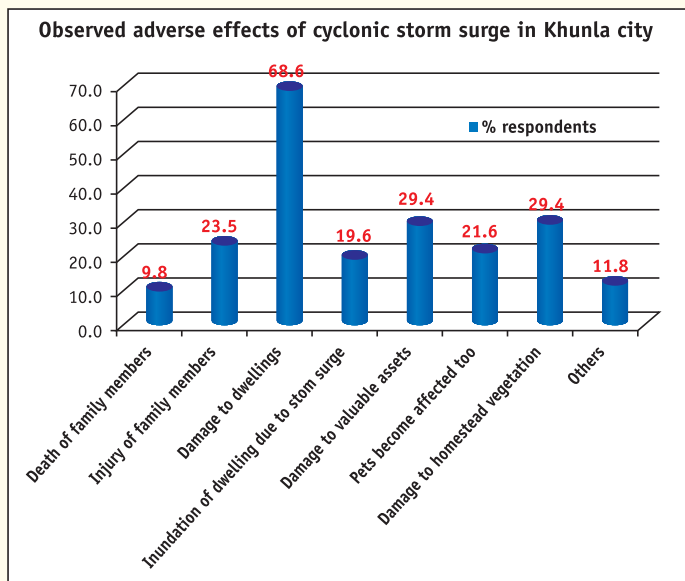


Figure-21: The extent of observed adverse effects of cyclonic storm surge in Khulna city

### 5.2.1 Responses considered for addressing heat stress

People are generally conscious about heat stress. During extreme hot days, people generally take simple measures such as (a) taking additional amount of fluid than usual, (b) taking rest frequently (each time for a brief period). Reducing food consumption is also a common practice, especially people do not prefer to take food prepared with too much oil/fat. Those who have access to electricity and can afford to have an electric fan, they arrange it even in their workplace. Even if they fall sick, they contact health care centres and accept

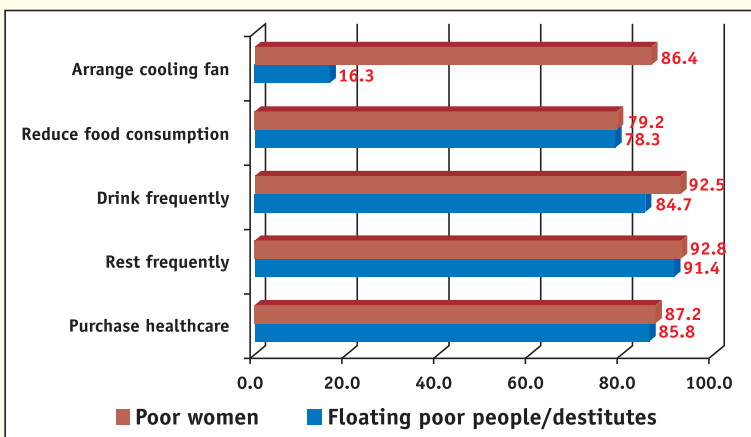


Figure-22: Perceived responses for women and floating people to heat stress

remedial measures.

For most of the people, leaving her/his job is not an option during a heat stress condition. The day labours suffer during hot days, however they soak a towel and wrap it around their forehead/neck to keep the body cool. The same is used for just wiping the body in a bid to take extra heat out of the body. These are relatively inexpensive modalities to keep the conditional tolerable.

The respondents perceive similar responses for both women and

floating/destitute people. The tendency towards choosing an option for the two groups is more or less the same. However, the floating ultra-poor people often do not have the luxury of accessing electricity and a cooling equipment (a fan). Therefore, having a fan is not always an option for floating/destitute people. The summary results are presented in Figure-22.

In general, the respondents perceive the same responses for adolescent girls and children. However, there are subtle differences in perceived coping strategies against heat stress. While the survey respondents do not indicate why they have chosen an option, the respondents of KII explain that, children are restless by nature and they often do not listen to their parents. Consequently, even on an extreme hot day, they tend to ignore an advice to drink fluid frequently.

Many respondents of KII suggest indigenous techniques to deal with heat stress. For example, they choose bitter gourd and *sajna* as summer vegetables, which are believed to have elements that ‘keep the body cool’. It is widely believed that a soup made of any of the two vegetables cited help restore body fluids and act against dehydration in extreme hot summer days. Figure-23 presents a summary of responses for children and adolescent girls.

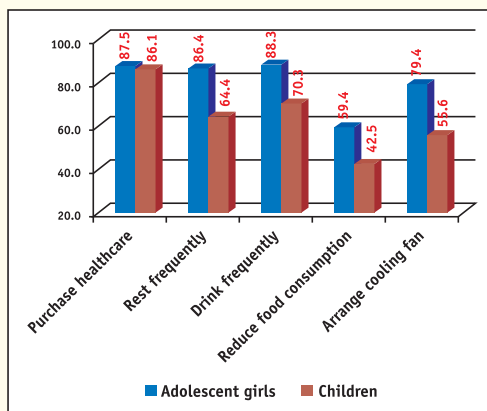


Figure-23: Household level responses to heat stress applicable for children and adolescent girls

### 5.2.2 People’s responses to excessive rainfall

The study attempts to reveal how people responds to climate variability and change

driven effects. The survey finds that, a significant proportion of women and floating poor people (or destitute people) take precautionary as well as remedial measures in an effort to ameliorate adverse effects of heavy rainfall, which include (a) the use of a protective gear such as an umbrella (or a raincoat), (b) taking leave of absence at work, (c) purchase medical services, (d) reduce food intake when income is significantly reduced, and (e) work harder (may be extra hours in the following few days after the heavy rainfall event) to compensate for any loss of income as a consequence of heavy rainfall event. The degree to which each group adopts such measures varies significantly. However, these results are found to be similar irrespective of educational and economic status of the respondents. Figure-24 presents the cases pictorially.

The women taking leave of absence during a heavy rainfall event appears more prevalent among women working in more formal sector, rather than those representing households having daily labours. The KII reveals that, even if they show up an hour or two late, the daily labours often cannot continue working and they often lose daily wage for that missing working day. In a bid to compensate the loss of income for the heavy rainfall day, women generally work harder to ensure that they earn an extra amount, which often takes toll on their physical conditions. The responses regarding receiving medical treatment in cases of sickness, women inform that such responses are more prevalent for the women representing the ultra-poor and the rich households (high confidence).

As per the responses, households often arrange for similar responses for the children

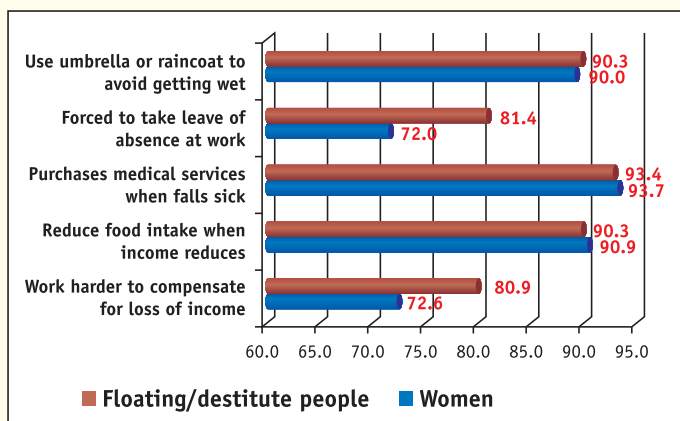


Figure-24: The various coping modalities to deal with heavy rainfall events (for women and floating/destitute people)

and adolescent girls in an event of heavy rainfall. The results are summarized in Figure-25 for children and adolescent girls. It is often quoted in the context of poverty stricken households in rural Bangladesh, people adopt negative coping modalities to address food insecurity (Ahmed et al., 2012). Such negative coping modalities include missing a number of meals on an average day, reduction in both quality and quantity of food, depriving women and elderly people to have a fair share of food, etc. However, such adverse coping strategies have not been followed by the respondent households.

labours and van/rickshaw pullers opine that, in case of a sudden rise in food price, they are forced to raise their wage or fare in order to compensate for increased food costs. National experts are of the opinion that, urban poor has better bargaining capacities than that for the rural poor, which restricts the ability of the rural poor to maintain the intra-household supply of food items when a seasonal food insecurity affects them. The survey reveals that the reduction in food intake is much less prevalent response mechanism involving urban households. However, it is still observed primarily in cases of poor and ultra-poor households (high confidence).

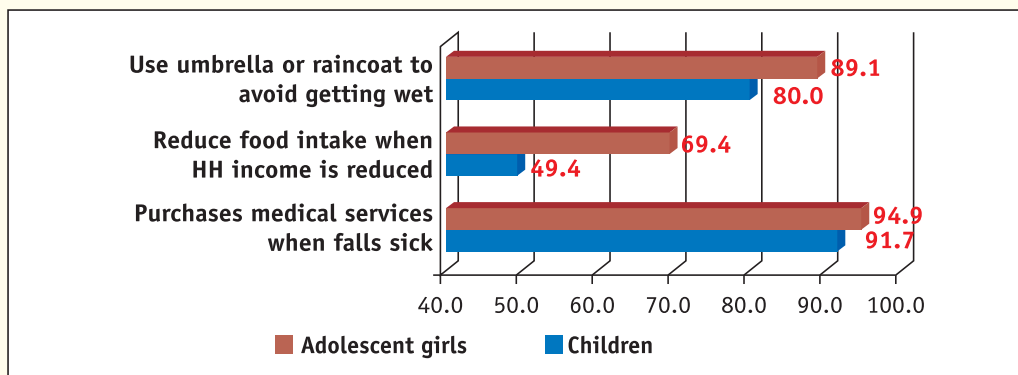


Figure-25: The various coping modalities to deal with heavy rainfall events (for children and adolescent girls)



The KII reveals that an increasing number of children and adolescent girls are given raincoats to cover them up in case of heavy showers, which enable them to go to school/educational institutions. However, they still fall sick (perhaps, they deliberately get drenched), where the parents are required to take medical services for their children.

Urban households also consider various responses to specific climate-induced extreme weather events such as cyclonic storm surge, waterlogging, flood (seasonal, riverine) and/or flash flood, tornado/ norwesters, etc. However, there is a strong regional bias towards considering such response modalities. It is only obvious that, households of Khulna appear more sensitive to consider response measures against effects of cyclonic storm surge, while such sensitivity cannot be observed in Sunamganj. Alternately, the households of Sunamganj city consider responses against adverse effects of flash flood. Therefore, hazard specific responses with a very strong regional bias are obtained through the questionnaire survey.

### 5.2.3 Household responses to urban waterlogging

Urban waterlogging has been a common phenomenon in all the four target cities. The respondents indicate that, almost three-fourth of the respondents (75.9 per cent) incur higher than usual travel costs

either for going to job or for other activities. About two-thirds of the respondents (63.9 per cent) consider not to send their children to educational centres (mostly schools). Again, two-thirds of the respondents (63.9 per cent) also keep the locally elected leader (i.e., the commissioner of the ward in question) informed that there are areas within the ward which are prone to waterlogging. The rest of the responses are graphically presented in Figure-26.

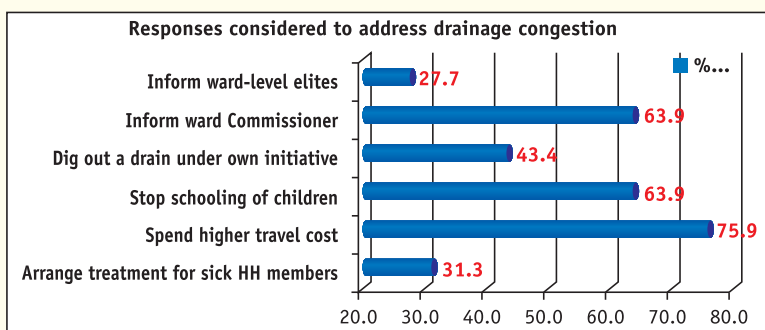


Figure-26: Responses considered by households to address water logging/drainage congestion

There exists a significant regional difference in variety of responses considered by the households affected by waterlogging. For example, more than 50 per cent of the respondents in Sunamganj (some 54.3 per cent) and Rangpur cities (50.0 per cent) are required to take measures to treat an ailing member of the household, whereas the same response comes down to 26.3 and 29.5 per cent in Khulna and Gazipur cities, respectively. Similarly, while 82.8 per cent of the respondents in Khulna city are willing to accept higher travel costs, it is prevalent to only about 50.6 per cent of respondents of Sunamganj city. The diversity of income levels, the level of desperation to commit to higher level of travel costs – all interplay in the decision-making for committing to higher levels of travel costs among victims of urban waterlogging.

#### 5.2.4 Household responses to urban flooding

Flooding is a common climate variability induced hazard across the country and respondents from all four target cities have admitted that they generally face flooding. Flooding increases probability of spreading of water borne diseases in the urban areas, mostly because of widespread contamination of drinking water sources. However, the poor households suffer the most, perhaps because they rely mostly on available sources coupled with their inability to pay for bottled (safe?) drinking water. On the contrary, the rich households often do not get affected due to water borne diseases (such as diarrhea). About 50.8 per cent of the respondents across all the four cities indicate that they treat their ailing household members. About 21 per cent of the poor and ultra-poor households do not take direct measures to treat their sick members, mostly because of lack of financial resources. They collect medications from local pharmaceutical outlets and/or from quack doctors - both are low-cost responses, which also indicate their relatively higher levels of vulnerability. There is hardly any regional difference in the responses regarding seeking medical treatment for ailing patients (high correlation).

The most common response appears to be incurring higher levels of travel costs (65.2 per cent of the respondents) during floods in urban areas. Since mobility becomes severely restricted during a flood, people are required to

pay more to hire a rickshaw or a mechanized tricycle (i.e. baby-taxi). The summary of the responses during floods is graphically presented in Figure-27.

During a high intensity flood, income opportunity for the poor households reduces drastically. In such cases, the poor households significantly reduce expenditure on food, accepting risks on nutritional conditions. Such adverse coping strategies are prevalent in all four cities, although it is found predominantly in Rangpur and Sunamganj cities (over 85 per cent of poor and ultra-poor households, respectively). One may, therefore, take an inference that poor urban households often consider adverse coping measures at the cost of their nutritional well-being during severe floods.

#### 5.2.5 Household responses to flash flood

Flash flood is generally observed in Sunamganj city out of the four target cities. Sylhet Metropolitan city, Moulavibazar township, etc are all susceptible to flash flood. Many other Category-III Pourasavas in the north-eastern region are also highly prone to flash floods. Since this is a seasonal

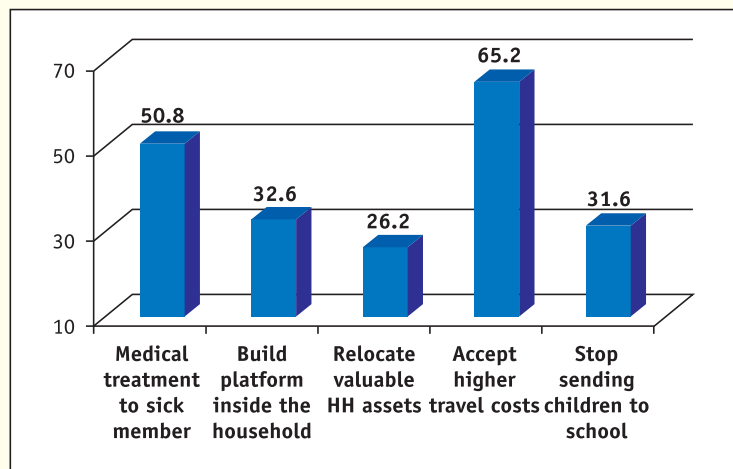


Figure-27: Major responses of households during flooding

phenomenon, one generally expects it starting late-March till end of Monsoon (in September). As in the case of flood, the impacts are similar for flash flood, especially in urban areas. However, the rural scene is completely different than in urban areas, due to the fact that an early flash flood can be devastating for the standing Boro crop, which is not expected in urban areas.

Table-6 presents the common responses against the adverse impacts of flash flood.

background (high correlation). The latter result is somewhat reinforced by the fact that, in general, the households with lesser income are also the households with lesser educational background. As anticipated, the higher income households tend to pay more as travel costs, yet they try to keep their children in school (high confidence). However, such data is limited only to Sunamganj, since flash flood is a regional phenomenon.

**Table-6: Summary of responses to flash flood In Sunamganj**

Sl	Common responses cited	Percentage of household
1	Arrange medical treatment for sick member	52.0
2	Arrange higher travel cost	46.0
3	Relocate valuable assets	6.0
4	Reduce expenditure on food	36.0
5	Refrain from frequent food intake	26.0
6	Stop sending children to school	36.0
7	Build platform inside the homestead	22.0
8	Inform ward Commissioner for institutional measures	10.0
9	Inform elites of the ward to begin community actions	8.0
10	Other measures as appropriate	2.0

Data source: The questionnaire survey

There exists a bias regarding the fact that an increased proportion of poorer households are forced to accept adverse coping measures compared to the rich households (high correlation). These results regarding adverse coping are also sensitive to households having lesser educational

#### 5.2.6 Household responses to tornadoes

The seasonal phenomenon is found to take place in all the four regional cities. However, people often do not find appropriate responses to reduce their vulnerability to such storms. About 69.4 per cent of the

respondents indicate that they have invested additional money to build their dwellings somewhat resilient to tornadoes. The KII reveals that, the houses with roofs made of corrugated iron (CI) sheets (some middle class and most of the poor live in such houses) are attached tightly by metallic wires with the corner pillar. People opine that it does not cost more than 1 to 2 per cent costs additional to the usual construction costs of the house.

KII reveals that people used to plant deep rooted trees (often known fruit bearing trees) in the homestead in earlier days, so that the wind speed could be somewhat dampened. The popular belief was that, the tree top would resist the whirl wind to dismantle the CI sheets from the dwelling unit, and thereby people sharing the homestead would be spared from physical injury. However, such indigenous method of avoiding a potential disaster is no longer pursued because of the little landmass available for planting a tree in an urban homestead. Since land prices have increased significantly with increasing population density, nobody now affords open spaces for planting trees in the homestead and thereby reducing the devastation power of a tornado. In sharp contrast, people in rural areas still plant trees and avoid being completely devastated by a tornado.



Tornadoes are short lived, by definition. Therefore, there is no effort in most of the households to keep a packet of dry food and a container of drinking water in a bid to provide emergency nutritional support in the aftermath of an event.

### *5.2.7 Household responses to cyclonic storm surge*

In case of cyclonic storm surge, 74.5 per cent of the urban households (predominantly in Khulna city) safeguard dry food and water, especially after receipt of early warning. From experience, it is also found out that, as soon as the bulletins in media announce 'signal number 7 or above', people in the potential impact zone starts collecting dry food and drinking water in plastic containers and wrap such containers in plastic sheets only to be buried in a newly dug earthen hole. Such methods of safeguarding food and water to be used during emergency are promoted through television clippings following an issuance of warning for an imminent cyclonic storm. The KII reveals that the proximity to shops for collecting such items enables them to spend some time in doing so, instead of rushing immediately after the receipt of a warning. The national level experts tend to believe that, people in general have realized that, if they store adequate amount of dry food and drinking water to last for about two to three days, they can easily survive through the uncertainty phase before normalcy is restored in an aftermath of a cyclone. Experts believe that such realization and ability to pay for arranging such items have already become part of the learning process of coastal people.

Urban households also take a few preparatory measures (35.3 per cent of

responses). Taking shelter under a pucca (concrete) shed appears to be quite a common response (to 54.9 per cent of the people). Many people take such shelters in proper cyclone shelters, if available in the vicinity, or tend to find an alternative shelter such as a concrete-roof school building or an administrative building. If they have acquaintances having a single or a multi-storied building, they also take shelter in such buildings. The KII reveals that, the strong social capital always interplay when poor people seek refuge in such buildings and the owners often allow them to come. National experts have reflected upon such a healthy social interaction and opine that, the short duration of a cyclonic hazard play a major role in allowing poor people to take refuge inside a residential building. They believe, in cases of flood victims, the willingness of the receiving households will not be as strong as in the case of a cyclonic storm.

Urban people, likewise rural population, tend to safeguard their assets upon receipt of cyclone warnings. The results are summarized in Figure-28. Indeed, relocation of valuable assets (27.5 per cent HHs) and relocation of livestock (35.3 per cent HHs) are common responses. About 33.3 per cent of the households make investments to build their house stronger to avoid being damaged. However, such a response appears to be more prevalent in case of upper middle income and rich households (i.e., top 40 percentile

on income level, high confidence).

### 5.3 Self-help measures to reduce climate-induced hazards

Poor urban inhabitants do not often wait for any external assistance when they face climate change induced hazards. Waiting for assistance is often result into wastage of time and loss of opportunity. The poor women and adolescent girls rather look for self-help opportunities to address the immediate problems they face. Such self-help actions are often reactive and do not provide long-term solutions.

For example, when women face excessive heat, over 98.9 per cent drink water frequently. Pouring water on forehead is a common practice, some 91.4 per cent women resort to such no-cost practices during heat stress. In a bid to fight dehydration under heat stress, 85.4 per cent urban women make oral saline and drink it as an antidote. In the workplace, they do not often get cool air from an electric fan. However, about 64.3 per cent of the respondents believe that women enjoy cool

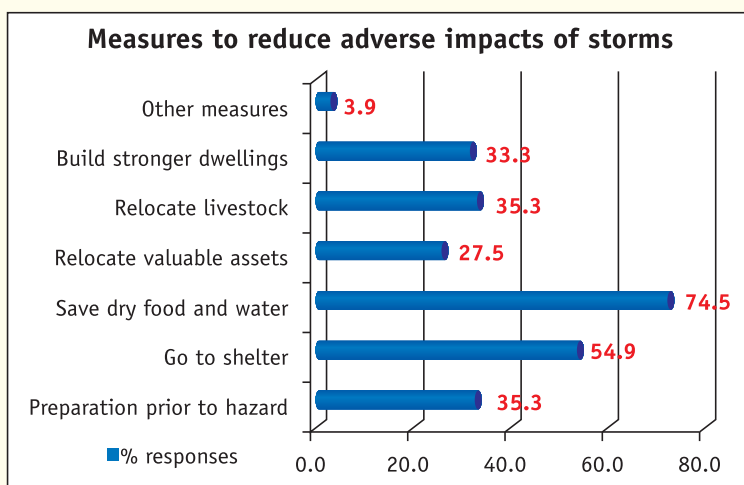


Figure-28: Measures to reduce adverse impacts of cyclonic storms

air at home during their sleeping time under heat stress conditions. A greater proportion of the respondents representing the richer section of the society, some 90.2 per cent, indicate that they enjoy cool air by running an electric fan at home.

During drainage congestion, poor women often initiate cleaning up of drains in their locality (to some 34.3 per cent). Other than such a measure, poor women do not find any other viable means to reduce the impact of drainage congestion. During high rainfall events, urban women use umbrellas (86.6 per cent). There is hardly any difference in considering this measure involving poor and richer households (High confidence). About 40.3 per cent of the respondents opine that poor women raise plinth height of respective dwellings to avoid inundation during floods. Among the richer households, only 9.8 per cent of the respondents consider the same self-help measure. Relocation of valuable assets to non-flooded areas is also a common self-help measure during floods. The survey reveals that 95.1 per cent of the respondents representing richer households relocate their valuables, while the proportion of poor households doing the same is only 37.1 per cent. In reality, poor households have little valuable assets which may be relocated, which is why their participation for the same is rather low.

Adolescent girls generally offer assistance to elderly people in the household to reduce their vulnerability (about 87.7 per cent). This include providing assistance to ailing member of the household, raising plinth height if necessary, cleaning up a clogged drain to facilitate drainage and taking personal care as and when needed (for example, drinking water and oral saline during heat stress, etc.). About 50.3 per

cent of the respondents indicate that adolescent girls organize themselves to form a volunteer team and offer somewhat organized assistance to others in the neighbourhood. However, such initiatives are confined in Gazipur and Khulna cities. It is found that NGOs have inspired adolescent girls to form such groups in the two cities. In Gazipur, it is found that the girls initially have faced resistance, which turned into general acceptance when they had started to offer assistance collectively to their neighbours.

About 30.9 per cent of the respondents indicate that organized girls exchange hazard related information, which come handy in the neighbourhood. Again, such initiatives are found in Gazipur and Khulna cities, where there had been NGO programmes involving the adolescent girls. The self-help initiatives could have been more effective if similar initiatives were considered in other cities involving the adolescent and youth.

#### **5.4 Perception of respondents regarding institutional support and management**

The primary responses at household level, as identified by the people, offer modalities to reduce the adverse impacts of climate induced hazards to some extent. However, such responses appear too little compared to the overall need for responses to address impacts in urban areas. In order to cater the need for such overarching responses, the involvement of organized efforts at institutional levels appears vitally important.

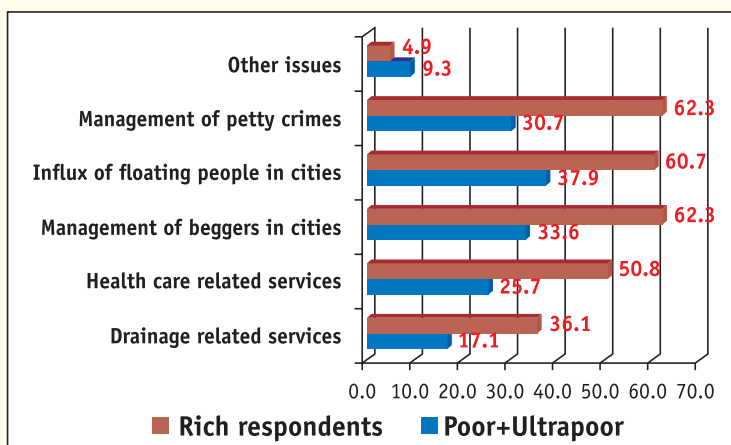
Poor people, especially women and adolescent girls generally exhibit lack of knowledge regarding the possibility of receiving institutionally managed supports

in case of climate induced hazards. They know the existence of certain service-oriented infrastructure (for example, a drain along the road). However, they do not often realize that (a) there are national institutions having specific mandates to serve urban inhabitants and (b) the inhabitants have rights to seek support services from such institutions. Since the poor are overwhelmingly preoccupied in eking out a living, they do not even bother if a designated service provider does not fulfill its mandate. In such a lack of knowledge and awareness, the questionnaire survey appears to be an ineffective tool regarding institutional support services for women, girls and children under climate induced hazards.

About 62.9 per cent of the respondents, irrespective of economic status (high confidence), indicate that the changes in the climate system in their respective towns will pose adverse effects on the management of urban affairs. Such opinions are expressed in increased numbers by the higher educated groups (some 71.7 per cent). The awareness regarding management issues are found to be more pronounced for the respondents of Gazipur and Khulna compared to Rangpur and Sunamganj.

Those who have the opinion that urban management will face difficulties as a consequence of climate-induced effects, almost 40 per cent of them identify three issues: (a) mismanagement in healthcare

services, (b) influx of floating people in the city, and (c) management of beggars in the city – the latter would most likely to be a function of increased displacement of people from rural set ups due to loss of livelihoods. Interestingly, literature have projected such consequences at least two decades earlier than the respondents of current study (Ahmad and Ahmed, 2000; Ahmed et al., 2009). The results show significant differences in understanding of the poor class and those representing rich households (i.e., top 20 percentile). The summary of such differences based on economic class-based analysis is presented in Figure-29.



**Figure-29: Differences in concerns regarding urban management issues by poor and rich respondents**

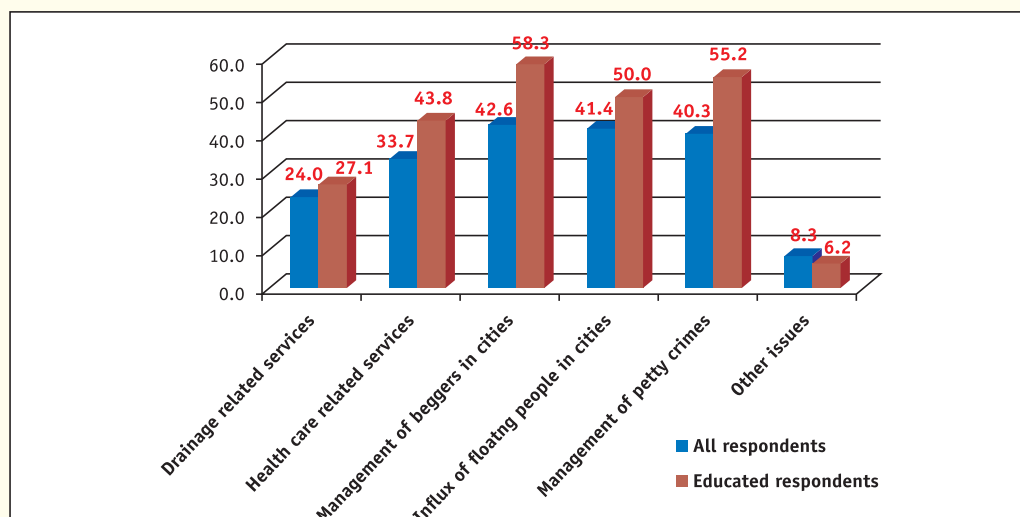
The same results are further analyzed to understand the sensitivities of highly educated (i.e. above HSC) and illiterate/less-literate (i.e. lesser than class V) groups. It is found that, the more the education, the more sensitive the educated respondents become regarding services that are not covered by utilities. For the educated group, management of street beggars and management of petty crimes appear more challenging than drainage and

water supply related urban services. Figure-30 gives a graphical presentation of the results regarding anticipated urban management issues as a consequence of climate-induced phenomena.

The survey respondents perceive a number of ways through which an elected representative of local urban council (i.e., Municipality/Pourasava and City Corporation) can offer assistance in order to reduce sufferings caused by climate-induced hazards and phenomena. The most notable ones are the following: (a) measures to improve drainage congestion (some 74.0 per cent respondents), (b) by drawing attention of relevant GOB agency (for service delivery) (66.3 per cent), (c) by mobilizing GOB funds and by developing and subsequently implementing projects (30.3 per cent), and (d) offering food assistance for the ultra-poor (13.7 per cent). There is hardly any regional bias towards the general pattern of the perceived answers (high confidence). However, there is some bias on the basis of educational and economic

status of the respondents. For example, the highly educated group tends to prefer that their elected representative in the local urban council will mobilize funds and implement projects related to drainage improvement, establish water hydrants/tube wells and clean up walkways, etc. In sharp contrast, about half of the ultra-poor and the poor group prefer that an elected representative will help sanctioning of relief and/or arrange food items to be sold at a lower price.

In the KII and FGDs, the major management related concern has been drainage impairment in city landscapes. People ask for immediate institutional actions to improve drainage capacity – irrespective of location of the city. A school Teacher Mrs Tanjila Khatun of BRAC Pre-Primary School of Jalilpur in Sunamganj opines “flood water recedes earlier than rainfall-induced water logging. The leaders must find ways to improve the situation. We cannot even come to our school when water inundates the streets”.



**Figure-32: Difference in perception regarding deterioration of urban services involving average people and the educated group**



**Table-7: An overview of institutional responses to climate-induced hazards in urban areas and current state of performance**

<b>Hazard/Issue</b>	<b>Impact(s) to be addressed</b>	<b>Modality suggested</b>	<b>Institution(s) responsible</b>
Excessive Heat	Dehydration	Frequent water intake	Health clinics, hospitals, media
	Fatigue (during hard labour)	Frequent resting	Employing authority
		Aeration/cold air circulation	Employing authority, educational institutions
Excessive (winter) fogginess	Lack of visibility	Issuance of warning	City corporation/ pourasava, BMD, media
Excessive rainfall	Both water logging and flooding	Enhance drainage	City-based WASA, pourasava
		Cease/remove drainage impediments	City-based WASA, pourasava
		Keep drainage clean & functional	DOE, Environmental Court
		Resuscitation of natural canals	BWDB, City corporation, pourasva
		Reversal of encroachment of canals/ revival of choked canals	BWDB, City corporation, pourasva
Water logging	Water logging	Arrangement of designated transportation for women/ girls	BRTC, City corporation, pourasva
Flood/flash flood	Flood/flash flood	Flood warning with greater lead time	FFWC and DDM
		Schools turned into relocation centres	City corporation, pourasava, school management committees
		Physical relocation of affected people	School management committees, civil defense authority
		Create flood defense embankment	BWDB, City corporation, pourasva, UP
Excessive rainfall	Land slide in hills	Early warnings	BMD, media
		Relocation of houses/dwellings at the foothills	Civil defense authority, civil administration
Tornado	Destruction of dwellings	Recovery and rehabilitation	Civil defense authority, civil administration
		Health care support	MOH, hospitals/clinics, NGOs
Cyclonic storm surge	Loss of human lives and assets including infrastructure	Issuance of early warnings	BMD, BDRCS, MPSC management committees
		Recovery and rehabilitation	Civil defense authority, civil administration
		Damage to coastal polders	BWDB, local WMGs
Service requirement in an event of cyclone and/ or flood	Loss/deterioration of services	Emergency drinking water supply	City corporation, pourasva
		Health camps	MOH, hospitals/clinics, NGOs
		Awareness regarding available services	NGOs, media
		Relief operations during post-flood rehabilitation	Government agencies, NGOs

<b>State of institutional performance</b>	<b>Comment(s)</b>
Limited preparation	No seasonal contingency plan as such
Limited options provided	People themselves arrange (as much as possible)
Needs are only partially fulfilled	People purchase equipment for own use (only in workplaces)
No updated bulletin	No service is planned/intended as yet
Poor service quality	Most plans are outdated, lacks finance & human resources
Lack of service quality, inadequate service	General mass do not cooperate
Inadequate provision	Lack of mass awareness & integration of self-help initiatives
Lack legal enforcement, inadequate planning	Excessive political interference, lacks inter-agency coordination
Lacks political will and planning	Management system lacks accountability
Lacks political will and planning	Management systems in general are gender insensitive
DDM has mandate but limited technical capacity	Significant efforts needed to enhance human resource & technical capacities
Decision-making is not done timely	Poor coordination and inadequate financial allocation
No specific plan for flood susceptible areas/wards	No visible efforts during flood, no effort to integrate with local-level self-help initiatives
No specific plans developed by BWDB	Lacks finance and inter-agency coordination
Poor analytical capacity and dissemination coverage	Needs significant efforts to enhance capacity
Lack of mobilization prior to occurrence	Inter-agency coordination and frequent seasonal monitoring are needed
Limited capacity to offer various services	Needs significant efforts to enhance capacity
No contingency plan	Lacks leadership, medication, financing
Excellent capacity, massive mobilization and dissemination	Among best practices in the world
Limited capacity to offer various services	Needs significant efforts to enhance capacity
Poor monitoring, inadequate contingency finance mobilization capacity	Prevailing weaknesses need to be studied and steps considered for enhancement of capacity, monitoring & governance
Inadequate capacity	No visible institutional effort
No contingency plan	Lacks leadership, medication, financing
No organized effort	No realistic plan to raise awareness
More publicity than effective delivery of supports	Concerns regarding pilferage and corruption

According to the survey respondents, media also can play roles in reducing sufferings of the urban population caused by climate-induced hazards. The three most cited media actions are the following: (a) highlight the most nagging concerns in media (76.6 per cent of respondents), (b) run analytical news items to enhance accountability of service providers (44.6 per cent), and (c) raise mass awareness so that people understand the bottlenecks and exert pressure (39.1 per cent). Since the poor even do not properly recognize the role of media, their most preferred answer deals with only highlighting the most nagging concerns in media (high confidence). However, the higher educated class also looks for greater roles considered by the media.

The national experts are also of the opinion expressed by the higher educated respondents. They believe media can and should exert more pressure until a solution is reached. However, they also recognize the political economy of losing wetlands around the major cities – which has been continuously reducing water drainage pathways and causing water logging in almost all urban areas. They tend to believe that, if the leadership at the top do not care for implementation of legal provisions and establish a just governance system, all the other stakeholders would not be able to solve the issue of urban water logging.

The researchers and academicians, however, possess a revolutionary viewpoint. They think law enforcing agency will never try to establish good governance. Professor Md S. Islam of Dhaka University opines "... people collectively must destroy the establishments which have been built on historical water passages. The existing land use is

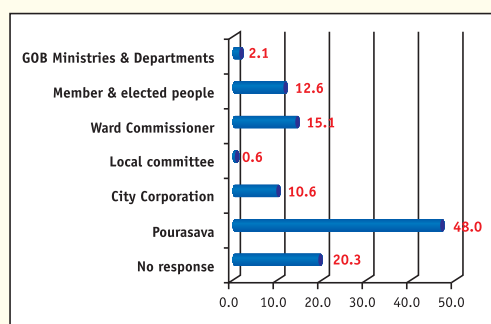
unsustainable and should not be tolerated. A people's movement is a must". He also believes that, if people can collectively do that, media will follow and help build mass movement across the country.

The respondents recognize the roles of non-government organizations (NGO) in providing certain limited services to urban poor. Some 61.1 per cent of the respondents believe that NGOs can run own initiatives to develop certain small-scale capacities. However, such responses are more pronounced in Gazipur and Khulna cities, compared to the other two cities (high confidence). National experts recognize that NGOs have indeed developed a few 'good practices' in various urban areas which have been helpful to reduce sufferings of urban population. The capacity building efforts to develop urban self-help and rescue groups are cited as great examples. In case of Gazipur city, such an effort has turned frustrated adolescent girls into trained social workers. However, experts are also of the opinion that such efforts need to be institutionalized so that larger clientele outside the beneficiary groups of NGOs can be reached and brought under certain services.

In addition to implement regulatory framework, the law enforcing agencies can also help reduce sufferings of urban inhabitants caused by climate-induced hazards. The two most cited assistances may be realized through (a) reduce mismanagement during and after a major hazards (49.1 per cent respondents) and (b) relocate people in safer places during prolonged flood and water logging (44.9 per cent respondents). The role of civil defense is most desired during and after a climate-induced hazard. FGD participants in

Gazipur have expressed that a few adolescent girls are trained by the Fire Service Group so that they become the front line actors to arrest spreading of fire in a slum. Such initiatives, although facilitated by an NGO, should be propagated in other city areas. Many other initiatives can also be considered by the law enforcing agencies.

The survey respondents have identified key organizations which may facilitate urban drainage. The results are presented in Figure-31.

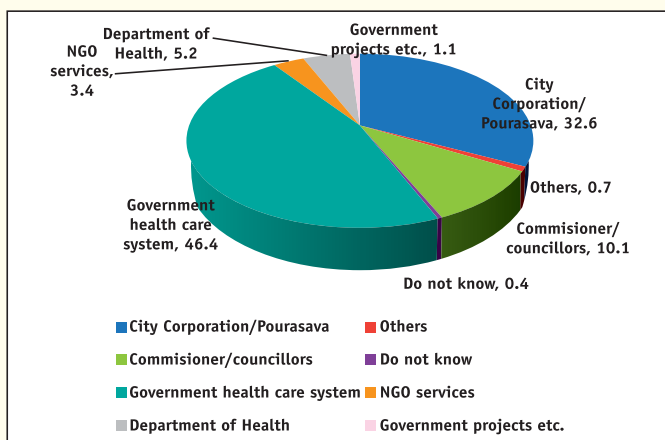


**Figure-31: Organizations which might offer services to reduce drainage congestion**

Clearly, local city council (i.e., pourasava) is identified as the most preferred agency to address the issue of water logging and drainage (48.0 per cent). While the rich and the higher educated groups identify a specific agency for doing the job, the large majority of the poor are found to be confused. They do not provide a clear answer and prefer to remain silent answering the question. This indicates the level of awareness among city dwellers regarding institutional mechanisms to solve one of the most nagging climate-induced hazards in their respective cities.

About 46.4 per cent believe that GOB health-care system should be the key service provider to address health-care issues in cities during climate-induced hazards. However, 32.6 per cent of the respondents express that the health-care services should also be provided by City Corporation/local urban council (i.e., Pourasava). The summary of the survey results is presented in Figure-32.

Experts believe that there is no national institution which can provide health-care service in smaller cities in case of climate-induced health debacle. However, they recognize that the larger cities do have at least one major public Medical College and Hospital (as in the case of Dhaka, Khulna and Rangpur), which can provide certain relevant services. They also recognize that such services are only meager compared to the total service demand during a major climate-induced hazard. National Experts have cited an example of flood 2004, where all the hospitals in Dhaka city including the specialized hospitals were engaged fully to support diarrheal patients and yet, an epidemic could not have been managed due to sheer number of patients.



**Figure-32: Major health-care service providing agency identified by the survey respondents**

## 5.5 Service provisioning for people with disability

With the exception involving less than 5 per cent of survey respondents, all the others have not responded to issues and needs concerning people with disability (PWD) in cases of climate induced hazards and impacts. This clearly suggests that there is a general lack of awareness, even neglect regarding issues dealing with the PWDs. In the KIIs, people have shared their views, based on their experiences on one or two aspects of disability considering the following diverse disabilities: (a) physical disability, (b) eye sight impairment, (c) hearing impairment, (d) speech disability, and (e) neurological/mental disability/disorder, etc.

It is generally understood that people with neurological disorder and/or mental disability require almost 24 hours of nursing and support, with or without climate change related impacts. During water logging/flood/flash flood, their physical movement is completely arrested, along with people having physical disability and sight impairment. They need relocation support during waterlogged/inundated conditions. Generally, no national institution assumes any responsibility for such groups. In extreme flood conditions in the past, local clubs mobilized young volunteers to relocate victims, in cooperation with the primary caregivers for each disabled persons. However, such efforts are sporadically organized and are completely inadequate compared to the overall demand for services.

The fate of people with physical disability and sight impairment, including aged people, is also similarly dismal. Their needs for contacting people and services outside their homesteads are significantly

undermined during water logging and flood. There are 'old age support groups' in major cities. However, they do not have specific plans to offer services for target groups during climate induced hazards. Other than the management of old-homes, their existing capacities are severely constrained in terms of finance, human resources, etc. It is recommended that NGOs having urban-specific programmes may organize and train local youth to form self-help groups, who could come handy during climatic hazards in their neighbourhood. Since the youth represent local households, they are familiar with the location of each PWD and needs for specific services. They can thus be effective towards rendering humanitarian services in densely populated urban centres.

The persons with sight, speech and hearing disabilities should be reached out physically and warned regarding an imminent danger/hazard by means of using sign language. Many such PWDs rely mostly on one or two caregivers within their household, who could be facilitated with information, know-how and support services so that the PWDs can have access to given set of support services. However, the pre-requisite is to enhance institutional services and their general quality so that people can reduce their vulnerabilities by accessing those services.

## 5.6 Perception of respondents regarding influx of migrants in urban areas

As indicated earlier, people do believe that changing climate will have impacts also in rural areas, which will trigger influx of people to urban areas. 91.7 per cent of the respondents indicate that displacement of people will take place under climate change,

as against only 3.7 per cent believing that this will not take place. Such a perception is found to be almost equally present among respondents, irrespective of economic class and gender (high confidence).

Among those who indicate that there will be displacement of people from rural to urban set up, some 79.7 per cent of the respondents also mention that such rural-to-urban displacement would increase difficulties for those already living in urban areas. While only 3.1 per cent of the respondents indicate that such influx of people will have beneficial effects for urban population, about 14.7 per cent think that the effect will be adverse as well as beneficial, simultaneously. Those of whom believe that urban migration will have adverse implications, the large majority of them believe that overall urban health condition will deteriorate (92.2 per cent) and labour wage will be decreased due to sudden influx of unskilled labour (85.5 per cent). Respondents also mention that poor people will face increased competition in search of unskilled jobs (79.9 per cent of the respondents).

It is found that the poor respondents are more concerned about the possibility of losing out in terms of lowering of daily wage due to influx of migrants in the city environment (high confidence). However, the highly educated group exhibit greater sensitivities around potential encroachment of walkways by the migrant people (64.8 per cent). People also believe that overall management of function of the respective city/urban management bureau will be deteriorated if large-scale displacement does take place as a result of climate-induced loss of livelihoods.





# 6

## CLIMATE CHANGE AND URBAN MANAGEMENT: TOWARDS BUILDING RESILIENCE

From literature, it is already known that climate change will trigger excessive rainfall episodes. The early signs are on the walls: two of the highest ever recorded rainfall episodes in Dhaka city (highest rainfall in 24 hours) have occurred in 2004 and 2009 since the systematic data management began in 1950 (BMD, 2018). Similarly, the three worst rainfall days in Chittagong city has been experienced in the past 15 years. Excessive rains generally are associated with water logging (and/or drainage congestion).

It is found in the literature that urban water logging events are associated with temporary inundation in low lying urban areas (and slums), putting restrictions in mobility of women, children and adolescent girls (Ahmed, 2013). Water logging also causes deterioration of health condition, especially among poor people (Alam and Rabbani, 2007). Water logging as a consequence of heavy rainfall in urban areas also trigger loss of productivity, particularly in industry, construction sector, education and trading. Poor women who eke out a living by selling processed food (particularly for urban poor-class consumers) along sidewalks, they face loss of income as a direct consequence of rainfall-induced water logging. These phenomena are observed during the past high rainfall events in Dhaka.

Managing water logging is primarily the responsibility of (a) the Water and Sewerage Authority (WASA) in each City Corporation (as in Dhaka, Chittagong, Khulna and Rangpur), (b) the Poursavas in smaller

towns (such as Sunamganj and Gazipur). However, none of these authorities are successful to manage the growing menace of water logging, irrespective of the size and location of the cities/towns with respect to major water bodies. The different WASAs build storm sewerage drainage, however the discharge is often blocked due to filling in of wetlands around the cities/towns. A few years after the establishment of new/refurbished drains, most of the drainage capacities are lost due to filling in by various materials, particularly sandy debris from construction sites. The removal of debris from construction sites is the responsibility of the respective City Corporation/Pourasava, however their cleaning operations are almost always lagging behind in terms of meeting demand for cleaning services.

Moreover, the political influences often arrest the capacity of the system to perform its duties. For smaller towns or Pourasavas, the Engineer deployed by the Local Government Engineering Department (LGED) is responsible for ensuring drainage within the town/Pourasava, however this appears only secondary to other engineering related responsibilities. There is hardly any allocation to continue to improve upon available drainage capacity – in all levels. The Respective mayors often do not have adequate vision, plan and/or finances to be able to enhance drainage capacity. Therefore, it would be extremely difficult to manage proper drainage under climate-induced hazards such as rainfall-related water logging, riverine floods, flash floods and cyclonic storm surge.

Urban heat island effect is a fairly new phenomenon in Bangladesh, which is

associated with general warming and also with increased levels of pollution in urban areas. In such cases, children and elderly people face difficulties, especially in terms of dehydration and exhaustion. During summer when such events are coincided with hottest days in the season, elderly people and neonatal children fall sick and need medical attention. It can lead to deaths. Such episodes even can contribute to reduction in productivity in summer, especially labours are required to work without any shed.

Heat island effect effectively causes health related problems to urban inhabitants. However, most of the health-related institutions in urban areas – irrespective to their size and locations – do not have any specific plan to reduce adverse effects on urban inhabitants. Rather the City Corporations sometimes get in touch with respective WASA and sends movable water dispensing vehicles to offer drinking water for roadside poor people. Even such humanitarian support appears much less than the actual demand in the large City Corporations. Due to lack of fund and the absence of institutions such as WASA in smaller towns, the Pourasava authorities cannot arrange similar services. The Government run hospitals only serve both indoor and outdoor patients, however the total demand for such services are left unattended. While wealthy people can find many ways to rehydrate themselves, the poor often do not find any service available to them for addressing heat stress.

Climate change is likely to enhance floods in Bangladesh (Mirza, 2002; Alam et al., 1998). Adverse effects of floods are better understood from the deluges in 2004, 2007, 1988 and 1998 in Dhaka city. Floods



severely restrict urban mobility and cause cessation of educational activities in schools (most schools are turned into flood shelters during high floods). Floods cause spreading of water-borne diseases, loss of stored food at both institutional and household levels and damage properties and vegetation alike. Many of such adverse impacts have been reported in various literature (Alam and Rabbani, 2007; Nishat, 2000; Ahmed, 2013).

Flood and flash flood management is the responsibility of Bangladesh Water Development Board (BWDB). The Research for riverine flood is the responsibility of River Research Institute (RRI), while two other GOB Trusty Organizations have been formed under the Ministry of Water Resources, namely (a) Institute for Water Modelling (IWM) and (b) Centre for Environmental Geographic Information Services (CEGIS) to conduct various research on behalf of the ministry. There are a few research institutes which are established in a number of public universities, where research on flood management is taken rather seriously. BWDB builds flood protection embankments to protect areas, including urban areas, from flood vulnerability. Only in Dhaka city, there are 16 water discharging stations where water is pumped out during peak flooding. Such hard-engineering based interventions are often requiring large capital investment as well as hefty operation and maintenance costs.

Unless a city offers significant employment at national levels and contributes to national economy, BWDB does not invest much to offer any flood protection for the city. Greater efforts are made on non-structural measures of flood

management. Bangladesh has made significant progress in understanding floods and offering flood forecasting services through a unit within the BWDB called the Flood Forecasting and Warning Centre (FFWC). While the warnings are useful for major rivers, an urban authority often cannot translate the web-based warnings into a local-level flood advisory. As a consequence, the current efforts of FFWC appear not so useful for the management of flood in urban areas.

The coast line of Bangladesh is prone to cyclonic storm surges (Ali, 1999). Such events are associated with high intensity wind and surge of water – the latter devastate both rural and urban areas along the coastal zones. There are reports of occurrence of large scale deaths and destructions (to properties), loss of stored food, disruption of critical infrastructure, urban water supply and sewerage systems, etc.

The nature's wrath in the form of cyclone cannot be completely eliminated. However, Bangladesh has made significant strides towards developing cyclone forecasts, which has four to five days of lead time and which are fairly accurate. The Bangladesh Red Crescent Society (BDRCS) runs a warning and evacuation programme throughout the coastal areas in cooperation with national administration services at various tiers, which is very effective through the involvement of about 62,000 trained volunteers. BDRCS arranges training and all mobilization of warning and relocation activities. The cyclone warning management under the Cyclone Preparedness Programme (CPP) is among the globally acknowledged best practices on cyclone management. The GOB has developed a policy titled "Standing

Orders on Disaster”, which is further supplemented by the enactment of legislation in 2012 (i.e., the Disaster Management Act). These mechanisms and instruments are working well to reduce cyclone related damages and losses, even for cyclone affected urban areas.

In coastal urban centres, salinity ingress is likely to take place due to sea level rise and other effects. Available modeling data reveals that, the isohaline lines will move to northern reaches and salinization will take place to many coastal urban areas including three metropolitan cities: Chittagong (the second largest city of the country), the Khulna City (a divisional city) and the Barisal City (again, a Divisional city). Salinity ingress will slowly damage buildings where cost for repairing will become a major issue. Salinization has already taking a huge toll in deteriorating water supply condition in Khulna city, whereas it becomes extremely difficult in Satkhira city to provide non-saline drinking water. In urban centres, many households have fruit-bearing trees where productivity of such trees decline due to increase in salinity.

Although drought is a reality in Bangladesh, such agricultural droughts do not affect urban areas (where agricultural activities are almost non-existing). However, coastal and riverine cities/urban centres face high wave interactions – the latter causing damages to properties and have adverse impacts on specific employment groups (say, petty traders, van and rickshaw pullers, etc.).

Despite gradual improvements in the recent past on developing mechanisms and institutional capacities to deal with various climate-driven hazards, Bangladesh is lagging behind in terms of institutional strengthening and arrangements. As a

consequence, when a hazard turns into a disaster, the institutional managements are severely criticized for their underperformance. This has been common in almost all the past climate-related extreme events in recent years.

When institutional mechanisms tend to fail to contain a hazard and reduce adverse impacts, the poor people has no choice but to seek GOB support in terms of food relief and health-care services. No city and/or urban centre in the country has adequate capacities to deal with the sudden increment of demands for various services towards relief and rehabilitation, especially in the aftermath of a climate-induced disaster. In such cases, media come forward and highlight needs for various service demands in various places, where the GOB institutions involved try to meet the demand for services as much as possible. Sometimes the political masters call upon the Border Guard and/or the Bangladesh Armed Forces to set up medical teams and to offer specialized humanitarian services, including relief operation and rehabilitation. However, the overall efforts are still inadequate to meet the service demand. Sometimes, the political masters take too much time to decide for mobilizing such special services through special agencies and personnel.

While general people try to fight against such hazards and adverse impacts, most of the responses are reactive in nature and does not necessarily offer satisfactory results. This is why research communities and experts emphasize on institutional responses on top of individual- and household-led autonomous responses. Many of the adverse impacts as above can only be addressed significantly if proper

institutional responses are planned early and delivered judiciously. As indicated above, the respondents have highlighted a few issues, however there can be many other responses designed by the relevant institutions in a bid to address climate change adaptation.

### **6.1 Managing urban health and nutrition services**

The Government of Bangladesh is committed to put in place the strategies to address the issues of improving the health status of urban population. This is to be done through improved access to and utilization of efficient, effective and sustainable Primary Health Care Services. The provision of public health services in urban areas is the responsibility of Local Government Bodies as mandated by the Local Government (City Corporation) Ordinance 2008 and the Local Government (Pourasava) Ordinance 2008.

Despite increasing urbanization, health and nutrition policies in Bangladesh have continued to focus on rural delivery of health services and improvements in health and nutrition outcomes. The unique urban health governance structure in Bangladesh—which divides roles and responsibilities among the Ministry of Local Government, Rural Development and Co-operatives (MOLGRD&C), the Ministry of Health and Family Welfare (MOHFW), and urban governments—has further constrained the effective delivery of urban health services. Therefore, much remains to be accomplished in ensuring access to quality health services in urban areas, particularly for the poor. Significant knowledge gaps also persist regarding the financing, delivery, and regulation of urban health services. Even less well understood

are the non-health-sector-related issues that have an important bearing on health and nutrition outcomes in urban areas.

For primary health care services delivery, the public sector works in partnership with NGOs and the local government institutions such as the City Corporations and Pourasavas. The health service delivery mechanism in urban areas involves diverse roles of the government (MOLGRD&C and MOH&FW), NGOs and the private sector.

Both Municipalities/ City Corporations offer health services, primarily preventive. The Expanded Program on Immunization (EPI) is the most successful public health intervention in Bangladesh, and has contributed significantly to reducing mortality and morbidity from vaccine-preventable diseases. The service delivery mechanism of EPI throughout the country has been used as the role model and a platform to deliver other interventions. More than 95 per cent of infants receive BCG vaccine on first contact. However, the coverage gradually falls with subsequent doses. Nationally, 63 per cent of infants receive all antigens at the right time and at appropriate intervals (accessed on [https://www.unicef.org/bangladesh/health\\_nutrition\\_468.htm](https://www.unicef.org/bangladesh/health_nutrition_468.htm)).

Two important challenges pertaining to stewardship and planning are (a) a lack of meaningful coordination between MOHFW and MOLGRD&C on the provision of urban health services, and (b) the inability of the urban health system—particularly at the primary health service level, to adequately reach to urban population.

There are public urban health centres, mostly provide basic curative health care services. The district Civil Surgeon Office

also shoulders the responsibility of both preventive and curative interventions. The District/ Upazila hospitals/ health complexes are under the preview of District Civil Surgeon Office. The regular outbreak of different diseases in certain seasons is quite common in different parts of Bangladesh. The civil surgeon office are aware of such outbreak and usually try to accommodate such health issues with care, usually makes earlier arrangements for its management (for example: arranging adequate number of oral/intra vascular saline on the eve of diarrhea outbreak).

The City Corporation has its own health service division headed by one health official. It is quite common that this health official in the City Corporation is often deployed from the civil surgeon office. It has been reported that the EPI activities (preventive) are well managed by the civil surgeon office. In EPI, the health volunteers go door to door to identify infants and children of certain age to provide them vaccination and also list them so that the later stage vaccination can be continued. The City Corporation does not have enough manpower to do the list and they often miss their annual target for vaccination. Another challenge in EPI arises due to urban migration. People often move with families to other urban centres for greater job opportunity. In case of garments workers who are mostly young women move to urban areas, often with kids. Such migration can be seasonal or permanent. In both cases, the follow up EPI interventions in new area are often lacking. Poor families often do not have the awareness to continue with the steps needed to complete certain vaccination. In such cases, these children are left away and the achievement for EPI goes down.

Bangladesh's health system consists of different legal entities, with limited horizontal and vertical integration and no mechanism in place to facilitate patient referrals. The health system puts inadequate emphasis on aspects such as equitable access to quality care, continuity of care, patient-centeredness, and patient rights. The sector also lacks a culture of accountability. Because of the strong focus on maternal and child health, services are not widely available for treating certain conditions (such as noncommunicable diseases) or patient groups (such as men), particularly among public and NGO health providers. Patients cannot easily access credible, relevant information.

Urban governments do not have a separate budget allocation for health services or public health initiatives, and they have limited capacity to mobilize their own funds. Each urban local body may employ a small number of health staff, paying their salaries from its budget and through donorfunded projects. This is in line with the country's overall administrative structure, which is not fiscally decentralized and does not allow local participation in funding decisions. Urban governments also lack updated, standardized systems to determine who qualifies as poor and who should qualify for exemptions from user fees. Fees are not standardized across providers.

The urban health landscape has been evolving in Bangladesh without a concurrent vision of how the health system should work in city corporations and municipalities. As such, there is a pressing need for policy makers to develop a comprehensive urban health policy in consultation with relevant stakeholders. The policy needs to better



reflect changes in the operating environment, including increased rural-urban migration and shifts in the epidemiological and demographic profiles of urban areas. It should also consider the potential for multi-sectoral actions to influence health and nutrition outcomes, the country's unique urban governance structures, and the needs of a working population. Any urban health policy should also recognize the proliferation of urban slum settlements and the special needs of their residents. There is a lack of understanding regarding potential health issues in a given climate induced hazard among medical professionals and service providers.



# 7

## CONCLUSIONS AND RECOMMENDATIONS

Climate change is a reality in Bangladesh. There is only a handful of literature which highlight some of the impacts of climate change on urban areas. No effort has been observed to reveal particular vulnerabilities of women, poor people, children and adolescent girls. This study attempts to fill in the gap by conducting primarily a perceptual study on how these target groups are impacted, what response functions they consider, what institutional arrangements are being sought and how they think that their particular vulnerabilities will be addressed. The results

of questionnaire survey and the key informants' interviews are summarized in the report.

It is found that women are particularly vulnerable to high intensity rainfall events, which are induced by climate variability and change. Due to gender-based inequities, women's responses are generally contingent upon the assistance they receive from their male partners. Young and adolescent girls face the similar high intensity rainfall events differently: they suffer from diseases and their mobility is severely restricted due to deteriorated physical conditions and also due to escalation of transportation costs. It has direct impact on their schooling.

Climate change is perceived to cause deterioration of urban services, perhaps due to sheer population pressure. Since climate change will trigger an influx of displaced people in urban areas, the unplanned densification will put insurmountable pressure on available urban services. The management is perceived to falter if not adequately planned well ahead of time.



It is found that women and adolescent girls can offer a bit of resistance and collective works, enabling them to overcome difficulties arising out of climate-induced phenomena. They do have certain capacities. Moreover, their capacities and skill-sets may be greatly enhanced, which may be organized in a fashion to turn such skills into forces in a bid to reduce vulnerability, rather than accepting the fact that women are just vulnerable. However, there are socially constructed taboos and hindrances that do not often allow Bangladeshi women to take part in collective works for reducing vulnerability. Women should be encouraged by NGOs and local voluntary organizations to form self-help groups to learn a few DRR skills and allowing them to utilize such skills during a hazard, so that their vulnerability can be addressed almost immediately.

There are increasing national efforts to recognize women-related and urban-centric resilience needs. A number of projects are now being designed and implemented. However, these efforts need to engage proper stakeholders so that a comprehensive approach is developed and shared among various actors.

## REFERENCES

- A.U. Ahmed (Ed.), 2010, Reducing Vulnerability to Climate Change: The Pioneering Example of Community-based Adaptation, CARE Bangladesh and Centre for Global Change (CGC), Dhaka, pp. 154.
- Adri, N., 2013. Climate-induced Rural-Urban Migration in Bangladesh: Experience of Migrants in Dhaka City.
- Agrawala, S., Ota, T., Ahmed, A. U., Smith, J. and Aalst, M.V., 2003, 'Development and Climate Change in Bangladesh: Focus on Coastal Flooding and Sundarbans', Paris, OECD, pp 49.
- Ahmad, Q.K. and Ahmed, A.U., 2000. "Social Sustainability, Indicators and Climate Change", in M. Munasinghe and R. Swart (Eds.), Climate Change and Its linkages with Development, Equity, and Sustainability, Jointly published by LIFE, RIVM and World Bank for IPCC, Geneva, pp. 95-108.
- Ahmad, Q.K., N. Ahmad and K.B.S. Rasheed, 1994. Resources, environment and development in Bangladesh: With particular reference to the Ganges, Brahmaputra and Meghna basins, Dhaka, Academic Publishers.
- Ahmed, A. U. and Neelormi, S. 2008. Climate change, loss of livelihoods and forced displacements in Bangladesh: Whither facilitated international migration, Centre for Global Change, Dhaka, p. 8.
- Ahmed, A.U. and Alam, M., 1998. Development of Climate Change Scenarios with General Circulation Models, in Vulnerability and Adaptation to Climate Change for Bangladesh, S. Huq, Z. Karim, M. Asaduzzaman, and F. Mahtab (eds.), Kluwer Academic Publishers, Dordrecht, 13-20.
- Ahmed, A.U., 2006, Bangladesh Climate Change Impacts and Vulnerability: A Synthesis, Comprehensive Disaster Management Program, Department of Environment, Government of the People's Republic of Bangladesh.
- Ahmed, A.U., 2008. Assessment of Vulnerability to Climate Change and Adaptation Options for the Coastal People of Bangladesh, Practical Action, Bangladesh, Dhaka, 40 p.
- Ahmed, A.U., 2013. Climate Resilient Cities: Bangladesh Perspectives, paper presented at the National Launching of the programme titled "ELLA – Urban Climate Change in Bangladesh", 31 January 2013.
- Ahmed, A.U., Hassan, S.R., Etzold, B. and Neelormi, S., 2012. Rainfall, Food Security and Human Mobility – Case Study: Bangladesh, Bonn, United Nations University, Institute for Environment and Human Security, pp. 156.
- Ahmed, A.U., Neelormi, S., Adri, N., Alam, M.S. and Nuruzzaman, K., 2007. Climate change, gender and special vulnerable groups in Bangladesh. Draft Final Report. Dhaka: BASTOB-Initiative for People's Self-Development and Center for Global Change (CGC).
- Alam, M. and Rabbani, M.G., 2007, "Vulnerabilities and responses to climate change for Dhaka", Environment and Urbanization Vol 19(1):81–97.
- Alam, M., Nishat, A.U. and Siddiqui, S.M., 1998. Water resources vulnerability to climate change with special reference to inundation. In Vulnerability and adaptation to climate change for Bangladesh (pp. 21-38). Springer, Dordrecht.
- Ali, A., 1999, Climate Change Impacts and Adaption Assessment in Bangladesh, Climate Research, Vol. 12, pp. 109-116.
- BBS, 2016. Preliminary Report on Household Income and Expenditure Survey 2016, Dhaka, Bangladesh Bureau of Statistics (BBS).
- Banks, N., Roy, M. and Hulme, D., 2011. Neglecting the urban poor in Bangladesh: research, policy and action in the context of climate change. Environment and Urbanization, 23(2), pp.487-502.
- BCAS-RA-Approtech, 1994. Vulnerability of Bangladesh to Climate Change and Sea Level Rise: Concepts and Tools for Calculating Risk in Integrated Coastal Zone Management, Dhaka. Bangladesh Centre for Advanced Studies (BCAS).
- Chowdhury, M.R., 2007. Rainfall Variability: Impacts of Climate Change? An article published in the Daily Star, also available at the URL <http://www.southasianfloods.icimod.org/>
- Ciavola, P., Uddin, M.M., Duo, E., Lee, B. and Fakhruddin, S.H.M., 2015. Vulnerability of the Bangladesh Coastline to Inundation Under Cyclone Activity: Past Records and DRR Strategies at Sandwip Island, E-proceedings of the 36th IAHR World Congress, 28 June to 3 July, 2015, The Hague, The Netherlands.
- Faisal, I.M., Kabir, M.R. and Nishat, A., 1999. Non-structural flood mitigation measures for Dhaka city, Urban Water, Vol 1(2): 145-153.
- Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir and L.L. White (eds.), 2014. Climate Change 2014: Summary of Policymakers, Impacts, Adaptation and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, pp. 1-32, Cambridge, Cambridge University Press.
- GED, 2015. The Seventh Five Year Plan, General Economics Division (GED), Planning Commission, Government of the People's Republic of Bangladesh, Dhaka.
- Habiba, U., Shaw, R. and Takeuchi, Y., 2012. Farmer's perception and adaptation practices to cope with drought: Perspectives from Northwestern Bangladesh. International Journal of Disaster Risk Reduction, 1, pp.72-84.
- Haque, A N (2010), Climate Change Adaptation Assessment: A Case of the Eastern Fringe of Dhaka, Bangladesh, Masters thesis, Institute for Housing and Urban Development Studies, Erasmus University, the Netherlands.



- Haque, A.N., Grafakos, S. and Huijsman, M., 2012. Participatory integrated assessment of flood protection measures for climate adaptation in Dhaka, Environment and Urbanization, 24(1): 197-213. Available at <http://journals.sagepub.com/doi/full/10.1177/0956247811433538>.
- Haque, M.A., Yamamoto, S.S., Malik, A.A. and Sauerborn, R., 2012. Households' perception of climate change and human health risks: a community perspective. Environmental Health, 11(1), p.1.
- Huda, M.N., 2013. Understanding indigenous people's perception on climate change and climatic hazards: a case study of Chakma indigenous communities in Rangamati Sadar Upazila of Rangamati District, Bangladesh. Natural Hazards, 65(3), pp.2147-2159.
- Huq, S. and Alam, M., Undated?, Flood Management and Vulnerability of Dhaka City (Chapter 9) in A. Kreimer, M. Arnold, and A. Carlin (eds.), Building safer cities: the future of disaster risk, Washington D.C., World Bank, pp 129-136.
- Huq, S., Ahmed, A.U. and Koudstaal, R., 1996. Vulnerability of Bangladesh to Climate Change, in T.E. Downing, Climate Change and World Food Security, Berlin, Heidelberg, Springer-Verlag.
- Huq, S., Karim, Z., Asaduzzaman, M., & Mahtab, F. (1998). Vulnerability and adaptation to climate change for Bangladesh. The Netherlands: Kluwer Academic Publishers.
- Islam, S. and Rahman, M 2011, 'Climate Change: Pressure on Urbanisation', The Daily Star, (Bangladesh, 10 July 2011), online, consulted on 28 May 2012, available at <http://www.thedailystar.net/newdesign/news-details.php?nid=193545>
- Islam, T. and Neelim, A., 2010. Climate Change in Bangladesh: A closer look into temperature and rainfall data, Dhaka, University Press Limited, pp. 80.
- Jabeen, H. and Johnson, C., 2013. Perceptions of climate variability and coping strategies in informal settlements in Dhaka, Bangladesh. In: Joffe H., Rossetto T., Adams J. (eds) Cities at Risk. Advances in Natural and Technological Hazards Research, vol 33. Springer, Dordrecht, pp. 149-170.
- Karim, Z., Ibrahim, A, Iqbal, A. and Ahmed, M., 1990. Drought in Bangladesh in Bangladesh agriculture and irrigation schedules for major crops, Dhaka, Bangladesh Agricultural Research Council.
- Mahmood, S.S., Najneen, F., Hoque, K.S., Rahman, S. and Shamim, M., 2010. Climate change: A study on impact and people's perception (a case study on Mongla Upazila, Bagerhat District, Bangladesh). Bangladesh Research Publications Journal, 4(2), pp.153-164.
- Mallick, B., Rahaman, K.R. and Vogt, J., 2011. Coastal livelihood and physical infrastructure in Bangladesh after cyclone Aila. Mitigation and Adaptation Strategies for Global Change, 16(6), pp.629-648.
- Mirza, M.M.Q., 2002. Global warming and changes in the probability of occurrence of floods in Bangladesh and implications. Global environmental change, 12(2), pp.127-138.
- Mirza, M.M.Q., 2005. The Implications of Climate Change on River Discharge in Bangladesh, in M.M.Q. Mirza and Q.K. Ahmad (eds.) Climate Change and Water Resources in South Asia, Balkema Publishers, Leiden, The Netherlands, pp. 103-136.
- MOEF, 2012. Second National Communication: Adaptation, contribution to Second National Communication (SNC) of GOB, submitted to Ministry of Environment and Forest, GOB, November 2012.
- MOEF, 2009. Bangladesh Climate Change Strategy and Action Plan. September 2009. Ministry of Environment and Forests (MOEF), Government of the People's Republic of Bangladesh.
- MoEF-UNDP, 2005. National Adaptation Programme of Action (NAPA). November 2005. Ministry of Environment and Forests (MOEF), Government of the People's Republic of Bangladesh and United Nations Development Programme (UNDP), Dhaka.
- Neelormi, S. and Ahmed, A.U., 2012. Loss and Damage in A Warmer World: Whither Gender Matters? Gender Perspectives on the Loss and Damage Debate, Loss and Damage Series, German Watch, Berlin, 2012.
- Nishat, A, 2000. The 1998 flood: impact on environment of Dhaka city. Department of Environment, Ministry of Environment and Forest, 2000.
- Rabbani, G., Rahman, A.A. and Islam, N., 2011. Climate change implications for Dhaka City: A need for immediate measures to reduce vulnerability. In Resilient cities, Springer, Dordrecht, pp. 531-541..
- Rahman, A.A., S. Huq, and G.R. Conway, (eds.), 1990. Environmental Aspects of Surface Water Systems of Bangladesh, Dhaka, University Press Limited.
- Schellnhuber, H.J., Hare, B., Serdeczny, O., Schaeffer, M., Adams, S., Baarsch, F., Schwan, S., Coumou, D., Robinson, A., Vieweg, M., Piontek, F., Donner, R., Runge, J., Rehfeld, K., Rogelj, J., Perette, M., Menon, A., Schleussner, C.-F., Bondeau, A., Svirejeva-Hopkins, A., Schewe, J., Frieler, K., Warszawski, L. and Rocha, M., 2013, Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience – Full Report, Washington, DC, World Bank.
- Warrick, R. A., & Ahmad, Q. K. (Ed.). (1996). The implications of climate and sea-level change for Bangladesh. Dordrecht: Kluwer Academic Publishers.
- World Bank, 2000. Bangladesh: Climate Change and Sustainable Development. Report No. 21104-BD, Rural Development Unit, South Asia Region, The World Bank (WB), Dhaka, pp. 95..



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