

Climate Change, Gender and Vulnerable Groups in Bangladesh

June 2009

Printing supported by:

Comprehensive Disaster Management Programme
Ministry of Disaster Management and Relief





Climate Change, Gender and Vulnerable Groups in Bangladesh

June 2009

**Climate Change Cell
Department of Environment**

Climate Change, Gender and Vulnerable Groups in Bangladesh

Climate Change, Gender and Vulnerable Groups in Bangladesh

Published by

Climate Change Cell
Department of Environment, Ministry of Environment and Forests
Component 4b
Comprehensive Disaster Management Programme, Ministry of Food and Disaster Management
Bangladesh

Date of Publication

June 2009

The study has been conducted by **BASTOB-Initiative for Peoples' Self-Development**, commissioned by the Climate Change Cell.

Members of the study team are:

Ahsan Uddin Ahmed, Sharmind Neelormi, Neelopal Adri, Md. Shaiful Alam and Kazi Nuruzzaman

Citation

CCC, 2009. *Climate Change, Gender and Vulnerable Groups in Bangladesh.* Climate Change Cell, DoE, MoEF; Component 4b, CDMP, MoFDM. June 2009, Dhaka.

Contact

Climate Change Cell
Room 514, Paribesh Bhabhan
E-16, Sher-E-Bangla Nagar, Agargaon, Dhaka-1207, Bangladesh
Phone: (880-2) 9111379 Extension 147; 0666 2301 021
E-mail: info@climatechange-cell-bd.com
Website: <http://www.climatechange-cell-bd.org>

ISBN: 984-300-003316-3

Acknowledgement

Climate Change Cell of the Department of Environment expresses gratitude to the collective wisdom of all stakeholders including experts, professionals and practitioners dedicated to the service of climate change risk management particularly in climate change adaptation and modeling.

Mention of the research team, BASTOB-Initiative for Peoples' Self-Development and their associate Centre for Global Change (CGC), Bangladesh is obvious.

Cell also likes to mention Ian Rector, CTA, CDMP, Khondaker Rashedul Haque, PhD, former DG, DoE, Mohammad Reazuddin, former Director, DoE and Component Manager of the Cell, and Ralf Ernst, former Technical Adviser, Climate Change Cell for their support and inspiration provided during initial stages of the research programme.

Acknowledgement is due to Technical Advisory Group (TAG) and Adaptation Research Advisory Committee (ARAC) of the Cell for their valuable contribution in identification of concepts, evaluation of concept proposals, development of methodology and finalizing the research reports.

Views of government officials, civil society members and development partners in several stakeholders' consultation workshops enriched the research outcome.

Special gratitude to the distinguished expert, Mr. Mohiuddin Ahmad, Chairman, Community Development Library (CDL), who as peer-reviewer provided valuable insight on research methodology, analysis and findings.

Cell is grateful to the Department of Environment, Ministry of Environment and Forests for the initiative for publication of the research paper. In this respect, Md. Nojibur Rahman, former Director General, DoE supported the Cell throughout the initiative and provided much needed directives for the publication.

Contribution of Dr. Fazle Rabbi Sadeque Ahmed, Director, DoE in finalizing the research document is invaluable.

Mirza Shawkat Ali and Md. Ziaul Haque, Deputy Director, DoE extended their allout support during whole period of the research programme.

Acknowledgement is due to the Department for International Development (DFID) and United Nations Development Programme (UNDP) for their continued support to the Climate Change Cell in its effort to facilitate the climate change research programme.

Finally, Cell gratefully acknowledges the contribution of Abu M. Kamal Uddin, Programme Manager and Mohammad Showkat Osman, Research Officer, Climate Change Cell who were involved in the over all management of the research program; Md. Nasimul Haque, Information and Communication Expert who provided valuable insight in development of the research program and Md. Mezbanur Rahman, Research Officer who provided valuable assistance in preparing the report for publication.

Foreword

The impacts of global warming and climate change are worldwide. For Bangladesh they are most critical because of its geographical location, high population density, high levels of poverty, and the reliance of many livelihoods on climate-sensitive sectors, such as agriculture, fisheries.

To address current impacts and manage future risks of climate change and variability towards development of a climate resilient Bangladesh, the government has established the Climate Change Cell (CCC) in the Department of Environment (DoE) under the Comprehensive Disaster Management Programme (CDMP). Climate change research, covering modeling and adaptation is one of the major activities of the Cell.

CCC in association with its Technical Advisory Group (TAG) and other stakeholders identified a set of research activities related to climate change in Bangladesh through a number of consultations. The activities have been prioritized and a number of projects have been commissioned in last few years.

Cell is facilitating adaptation research in order to, fill knowledge gaps in the arena of adaptation to climate change and its impacts on the life and livelihoods; explore options to adapt with the climate change; and contribute in better understanding of adaptation options. In this regard, a number of projects have been commissioned in the field of Crop agriculture, Crop insurance, Health, Gender and disadvantaged groups.

It is generally recognized that vulnerability to climate-related hazards and climate variability is contextual, where poverty as well as gender discrimination and prevailing inequity are major determinants which add complexity to perceived vulnerabilities to climate events. It is well understood that the women and disadvantaged people of Bangladesh will experience the worst adversities due to climate change. However, little information exists that could help identify vulnerable groups, particularly women and people with disability and special needs.

The research attempted to build an information source on specific aspects of vulnerability of women and disadvantaged groups to climate change which would reduce vulnerability of women and disadvantaged groups under climate change.

This pilot study, with limited time and some representative locations, is not at all a comprehensive one to address all the issues and contexts of vulnerability in relation to climate change and gender. However it is expected that the research, as a stepping stone, will encourage researchers, practitioners, professionals to build on these findings and to devise proper adaptation tools to help the cause of vulnerable groups in the volatile future dictated and complicated by climate change in Bangladesh. Such drive will also support policy makers and planners to formulate viable adaptation policies, strategies and action plan.

Zafar Ahmed Khan, PhD
Director General
Department of Environment

Acronyms and Abbreviations

AAI	Action Aid International
ADB	Asian Development Bank
BARC	Bangladesh Agriculture Research Council
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
BFRI	Bangladesh Forest Research Institute
BIRD	Bangladesh Institute for Rural Development
BRM	Bangladesh Resident Mission
BRRRI	Bangladesh Rice Research Institute
BWDB	Bangladesh Water Development Board
CC	Climate Change
CCC	Climate Change Cell
CEGIS	Centre for Environmental Geographic Information Services
CEP	Coastal Embankment Project
CGC	Centre for Global Change
CPP	Cyclone Preparedness Programme
DAE	Department of Agricultural Extension
DAW	Division of the Advancement of Women
DC	District Commissioner
DFID	Department for International Development
DND	Dhaka-Narayanganj-Demra
DOE	Department of Environment
DPHE	Department of Public Health Engineering
DTW	Deep Tube Well
DWASA	Dhaka Water and Sewage Authority
EGIS	Environmental Geographic Information Services
EPIP	Environmental Policy and Implementation Program
FAO	United Nations Food and Agricultural Organization
FAP	Flood Action Plan
FFWC	Flood Forecasting and Warning Centre
FFWP	Food for Works Programme
FGD	Focus Group Discussion
GBM	The Ganges, the Brahmaputra, and the Meghna
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
GW	Ground water
HQ	Head Quarter

HYV	High Yielding Variety
IEC	Important Environmental Concerns
IPCC	Inter-Governmental Panel on Climate Change
KII	Key Informants' Interviews
KJDRP	Khulna-Jessore Drainage Rehabilitation Project
LDC	Least Developed Countries
LFA	Livelihood Framework Analysis
LGED	Local Government Engineering Department
MDG	Millennium Development Goals
MOEF	Ministry of Environment and Forest
MOWR	Ministry of Water Resources
NAPA	National Adaptation Programme on Action
NC	North Central
NGO	Non-Government Organizations
NIPA	National Institute for Public Administration
NWMP	National Water Management Plan
OB	Old Brahmaputra
PC	Planning Commission
PRSP	Poverty Reduction Strategy Paper
PVA	Participatory Vulnerability Analysis
RA	Resource Analysis
RAJUK	Rajdhani Unnayan Kotripakkha
RMG	Ready Made Garment
RVCC	Reducing Vulnerability to Climate Change
SD	Sustainable Development
SSP	Single Super Phosphate
SST	Sea Surface Temperature
SW	Southwest
TRM	Tidal River Management
TSP	Triple Super Phosphate
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNDP	United Nation Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
UNO	Upazila Nirbahi Officer
VGf	Vulnerable Group Feeding
WARPO	Water Resources Planning Organization
WB	World Bank

Table of Contents

Acronyms and Abbreviations	v
Table of Contents	vii
List of Figures	ix
Executive summary	xi
1. INTRODUCTION	1-6
1.1 Background of the study	1
1.2 Linkages among climate change, livelihoods, poverty, and women	2
1.3 Objective of the Study	6
2. APPROACH AND METHODOLOGY	7-12
2.1 The Generic Analytical Approach: LFA and PVA	7
2.2 Actual methodology applied for the Study	7
2.3 Selection of study sites	10
2.4 Activities Undertaken	11
3. HYDRO-GEOPHYSICAL CONTEXTS OF THE STUDY SITES	13-29
3.1 Cyclonic Storm Surge in Dholghata, Maheshkhali	13
3.2 Waterlogging in Keshabpur, Jessore	14
3.3 Waterlogging in Noakhali	15
3.4 Salinity in Satkhira	17
3.5 Drought in Manda, Naogaon	18
3.6 Riverine Flood and Riverbank Erosion in Kurigram	19
3.7 Riverine Flood in Char Harirampur, Faridpur	21
3.8 Flash Flood in Deerai, Sunamganj	23
3.9 Flash Flood in Garo Hills, Mymensingh	24
3.10 Coastal Tidal Flood in Chakoria, Cox's Bazar	26
3.11 Urban Flood in Dhaka City	26
3.12 Coastal Erosion in Char Fasson, Bhola Island	28
4. IMPACTS ON WOMEN AND SPECIAL VULNERABLE GROUPS	30-55
4.1 Women's Context of Vulnerability with Reference to Physical and Social Setting	30
4.1.1 Women Are Affected Differently and More Severely	30
4.1.2 Women are Under-represented in Decision Making	32
4.2 Perceived Impacts of Climate Change in Bangladesh: Views From the Field	32
4.2.1 Cyclonic Storm Surge in Coastal Islands	32
4.2.2 Waterlogging in Jessore and Noakhali	35
4.2.3 Salinity in Tala and Shaymnagar Upazilas of Satkhira District	37
4.2.4 Drought in manda Upazila of naogaon District	39
4.2.5 Riverine Flood in Kurigram and faridpur Districts	40
4.2.6 Flash Flood in Sunamganj and Mymensingh Districts	42
4.2.7 Coastal Tidal Flood in Chakoria Upazila of Cox's Bazar District	44
4.2.8 Urban Flood/Drainage Congestion in Dhaka City	44
4.2.9 Coastal Erosion in Bhola District	45
4.2.10 River Erosion in Kurigram and Faridpur	46
	vii

4.2.11	The Special Vulnerability of Minority Women	46
4.3	Special Vulnerability of Poor and Marginal Farmers to Climate Change	48
4.3.1	Cyclonic Storm Surge	48
4.3.2	Waterlogging	50
4.3.3	Salinity Ingress	52
4.3.4	Drought	52
4.3.5	Flood	53
4.3.6	Flash Flood	54
4.3.7	Coastal Tidal Flood	54
4.3.8	Urban Flood	54
4.3.9	Coastal and Riverbank Erosion	55
5.	COPING PRACTICES AGAINST CLIMATE-INDUCED HAZARDS	56-64
5.1	Coping Practices Among Women	56
5.1.1	Coping with Cyclone and Storm Surge	56
5.1.2	Coping with Waterlogging	57
5.1.3	Coping with Salinity	57
5.1.4	Coping with Drought	58
5.1.5	Coping with Riverine Flood	58
5.1.6	Coping with Flash Flood	59
5.1.7	Coping with Urban Flooding	59
5.1.8	Coping with Coastal and Riverbank Erosion	60
5.2	Coping Practices Among Poor Farmers	60
5.2.1	Coping with Cyclone	60
5.2.2	Coping with Waterlogging	61
5.2.3	Coping with Salinity	61
5.2.4	Coping with Drought	61
5.2.5	Coping with Riverine Flood	62
5.2.6	Coping with Flash Flood	62
5.2.7	Coping with Tidal Flood	63
6.	WITHER ADAPTATION TO CLIMATE CHANGE	65-80
6.1	Cyclone and Storm Surge Related Adaptation	66
6.2	Waterlogging Related Adaptation	68
6.3	Drought Related Adaptation	71
6.4	Salinity Related Adaptation	72
6.5	Flood Related Adaptation	74
6.6	Flash Flood Related Adaptation	78
6.7	Erosion Related Adaptation	79
7.	CONCLUDING REMARKS	81-82
	References	83-88

List of Figures

Figure 1: Graphical Representation of Methodological Approach of the Research	9
Figure 2: Selected Study Sites	11
Figure 3: Map of Maheshkhali Thana	13
Figure 4: Map of Keshabpur Upazila	14
Figure 5: Maps showing Noakhali Sadar and Subarna Char Upazilas	16
Figure 6: Map showing Tala Upazila	17
Figure 7: Map showing Manda Upazila	19
Figure 8: Map showing Kurigram Sadar Upazila	20
Figure 9: Map showing Char Bhadrasan Upazila	21
Figure 10: Map showing Deerai Upazila	23
Figure 11: Maps showing Dhobaura and Haluaghat Upazilas	25
Figure 12: Map showing Chakaria Upazila	26
Figure 13: Map of Dhanmondi Thana	28
Figure 14: Map of Char Fassion Upazila	29
Figure 15: Climate Driven Problem Prioritization	33
Figure 16: Response of Women in Keshabpur	35
Figure 17: Extent of Water Logging in Different Time Frame	36
Figure 18: FGD in Tala	37
Figure 19: Change in Rainfall Pattern	42
Figure 20: Prioritization of Vulnerability Context in Deerai	43
Figure 21: FGD in Dhaka	44
Figure 22: House built on stilts – an example of coping practices	56
Figure 23: Coping with Water Logging	63
Figure 24: A Multi-purpose Cyclone Shelter, where the only Toilet is located outside	67
Figure 25: ORS has been widely used for treating diarrhea affected patients	74
Figure 26: Safe relocation during high flood or water logging becomes a major concern	76

Executive Summary

An increasing number of evidences in recent years have clearly established the fact that anthropogenic climate change is a reality. According to latest findings of the International Panel on Climate Change (IPCC) and other concerned organizations/agencies, developing countries are expected to suffer the most from the negative impacts of climate change. This is because climate sensitive sectors such as agriculture and fisheries are particularly important in economic terms and because these countries have limited human, institutional, and financial capacity to anticipate and respond to the direct and indirect effects of climate change. Many sectors providing basic livelihood services to the poor are not able to cope even with today's climate variability and stresses. This is particularly true for Bangladesh. The frequent occurrence of extreme weather events such as the floods and tropical cyclones in Bangladesh can set back development in the country for decades.

To many across the globe, Bangladesh is known as one of the most vulnerable countries under climate change. A number of major studies in the past investigated the causes of vulnerability of Bangladesh due to Climate Change. In general, warming would increase both the summer as well as winter mean temperatures, while there would be an increase in monsoon rainfall with a likelihood of withdrawal of dry season rainfall over the country. The water resources sector of the country would most likely be affected significantly due to anticipated changes. Most of the adverse effects of climate change will be in the form of extreme weather events, while water-related hazards such as flood, drought, salinity ingress, bank erosion, and tidal bore are likely to exacerbate, leading to large scale damages to crop, employment, livelihoods, and national economy. Vulnerability and adaptation to the adverse impacts of climate change are the most crucial concerns for Bangladesh.

Initial attempts to link gender and climate change may seem rather far-fetched. There have been only a few publications to establish this linkage. Most of the approaches towards tackling the threats of climate change focus on scientific and technological aspects of the problem, ignoring the social issues. In at-risk resource-dependent communities, men and women have distinct roles and responsibilities, which give rise to differences in vulnerability and ability to cope with climate change. Both the Kyoto Protocol and the UN Framework Convention on Climate Change ignored to even mention gender concerns.

Gender, or the distinct social roles assigned to men and women, is a critical part of all development initiatives. A gender analysis is not a special focus on women, but rather, an understanding on how discrimination against women and gender roles interact to shape men and women's enjoyment of human dignity, rights, as well as quality of living. In the context of climate change, a 'gender analysis' promotes an understanding of the ways that men and women are differently impacted by climate-related hazards and by adopting adaptation and mitigation strategies.

Gender disaggregated research is required in order to shed more light on levels of vulnerability and coping mechanisms of different social groups. The findings should feed into the climate negotiating process to enable decision makers to have a better understanding of how different segments of people are affected and what capacity and support is needed. Given this premise and the paucity of information on women's particular vulnerability to climate change, it is only rationale to carry out a gender analysis of climate change for

Bangladesh. In responding to the needs the Climate Change Cell (CCC), working under the Ministry of Environment and Forests (MoEF) and the Department of Environment (DoE), has come forward to facilitate a research on this important issue. BASTOB and Centre for Global Change (CGC) have jointly conducted the study.

The overarching goal of the research is to build an information source on specific aspects of vulnerability of women to climate change and to analyze how these specific vulnerability contexts can be addressed with planned adaptation measures, given the sustainable development framework of the country. The study also covered, though to a much lesser extent, various other disadvantaged groups such as ethnic minority groups, physically and/or mentally challenged groups, etc.

Initially an attempt is made to collate relevant information from available literature. 12 study sites from all over Bangladesh were carefully chosen to meet the criteria of representing diverse geo-physical realities and their interactions with the climate system anticipated for the future. Participatory Vulnerability Analysis techniques, facilitated by tools such as Focus Group Discussions and Key Informants' interview (KII), have been used for the study. Through this technique an attempt is made to analyze vulnerability in the eyes of the vulnerable people. Two regional sharing workshops (at Jessore and Cox's Bazar) and a National Sharing Workshop (in Dhaka) are held in order to share the findings with local stakeholders and to have their feedbacks.

In both developed and developing countries women are primary caregivers, combining the care for the children and elderly along with their domestic and income earning activities. These additional responsibilities place additional burdens on women impacting their ability to work outside the home and to deal with the effects generated by environmental changes. In a traditional society like Bangladesh women are even more vulnerable to the impacts of climate variability and change because they are often not allowed to participate in the public sphere, and are therefore less likely to receive critical information for emergency preparedness. They are also less mobile due to strict gender codes of social behavior, and have lesser chances to escape from affected areas. Most climate change issues, policies and programs are not gender neutral. In view of the above, several areas deserve attention, specifically: gender specific resource-use patterns; gender-specific effects of climate change; gender related pattern of vulnerability; women's capacity to cope with climate change; gender and decision-making on climate change; and gender aspects of adaptation and mitigation.

Differential and Disproportionate Vulnerability of Women

The hydro-geophysical situation specific vulnerability contexts for the women, as reported by the vulnerable themselves in field discussions, are summarized below.

- Cyclonic storm surge is a natural hazard in coastal Bangladesh for which strong warning system has already been in place. Women in the coastal areas are aware of the issuance of warnings but the design and the insecure environment of the cyclone shelters in Bangladesh is not found gender-friendly. The capacity of these shelters is found to be inadequate and gradually decreasing with increasing population. The inadequacy of shelter capacity is translated into self-denial to save lives for those who decide against taking shelter, it also has caused occasional abortion and/or miscarriages while advanced stage would be mother is cramped into a crowded shelter. Women report that there are

cases of sexual harassment on the way to shelters. The very design of the shelter does not often provide minimum gender-friendly sanitation facility. During post cyclone period, intra-household food insecurity and sanitation become the major concerns for the women.

- Water logging disrupts land based productive system, which in turn aggravates women's malnutrition in affected areas due largely to gender-biased intra-household food distribution. Water logging compels women to stay in marooned conditions for several months a year. Prolonged exposure to filthy water causes severe skin diseases and gynecological problems to women. Collection of fuel and potable water become extremely hazardous. However, because of patriarchal nature of gender-specific roles as care givers, women cannot avoid being exposed to hazardous living conditions. Women can not send their children to schools during prolonged water logging. Males often leave their families back home in search of employment, leaving the responsibility to 'take care' of the family members on the shoulder of women, thereby adding to their vulnerability. Female headed households are common in water logging affected areas. In absence of land based productive system and incidence of acute poverty, women often are forced to go for anti-social works just to feed their child and their family as a desperate effort.
- Under the present climate change variability, salinity ingress becomes a major hydro-geophysical as well as social problem in the south western region of Bangladesh. During the dry season, salinity is more intense and lack of suitable drinking water becomes an acute problem for affected communities. Women and adolescent girls are usually required to fetch drinking water from distant sources, even 5-6 kilometers each day in some southern areas. Young girls often sacrifice their academic activities in a bid to fetch non-saline water. Even during their pregnancy women are forced to fetch water irrespective of the distance between the source and their dwellings. Women and girls suffer from various gynecological problems in the long run for taking over extra hurdle of work in their daily life and by using saline water during menstruation. Premature birth, abortion and still birth (blue-baby syndrome) are reported in alarmingly high numbers in these areas. Women in these areas plant few select species those are grown well in saline condition. Due to proximity of gher fisheries, women raise ducks.
- As a floodplain, part of the country becomes inundated in every peak monsoon. For the same hydro-geophysical hazard, however, women face flood differently than males. Among those affected by flood and related problems, women and children are usually the most helpless and disadvantaged. Flood related deaths are often caused by drowning and snake bites, which, tend to occur in increasing numbers for children, following by adult women. Destitute women, without any employment, and compelled to migrate elsewhere, face the most acute conditions of physical and social insecurity. Poor women find it extremely difficult to ensure food and drinking water security when they struggle to live in flooded condition. In deeply flooded areas young girls are reportedly scrounging for edible reeds and roots, while women of all ages travel long distances by boat or raft to fetch drinking water. In most cases, water sources become contaminated with pathogens. Moreover, due to lack of fuel water can not be boiled to make pathogen free, which in turn triggers wide-scale spread of water borne diseases.

During flood women's privacy seems to be completely challenged. Sanitation becomes worse especially in case of pregnant women. In absence of freshwater, adolescent girls cannot maintain hygienic reproductive health care and often report perinea rashes and urinary tract infections. Moving on the embankments or road side high lands often put the adult and young women in constant dangers of sexual harassment and assault. Women headed household in flood affected areas are increasing in numbers as the male counterparts leave the flooded area to a higher land for employment opportunities, and often they never come back to the family. In case of flash floods, food insecurity and sanitation are considered to be major issues for the affected women.

- Urban flood coupled with drainage congestion has been emerging as one of the major concerns these days. The slum dwellers are the worst victims of urban drainage congestion. Collecting safe drinking water appears as the biggest challenge for women as they are the responsible actors for this. Slum dwelling women make their living mostly by finding self employment as temporary housemaids (Thika Jhee). If the shanty dwelling is inundated, it becomes difficult to join in daily activities in employers' household while trying to safeguard her belongings. Creating an alternate temporary safe haven for the kids also becomes a necessity. Delay or absence in the job often is translated into loss of employment, with counterproductive results on food security. Many slum dwelling women are self employed as food producers and /or food vendors, especially targeting rickshaw pullers as their customers. They face enormous hardship during periods of torrential rainfall followed by temporary water logging, when their prime customers do not ply on city roads.
- River bank erosion, charland erosion, and coastal bank erosion are quite common in Bangladesh. Erosion leaves nothing for the affected people. In erosion prone areas, women are concerned regarding loss of homesteads, loss of housing for months and years, physical insecurity, loss of self as well as family esteem, lack of production opportunities, and lack of food security in the aftermath of the event. Since men tend to leave the area in search of employment, the onus of household well being falls on to rather weak shoulders of women. Often males never come back, causing enormously extra burden and vulnerability to the women with little kids. It is the women in the family who can not leave her family unfed and unguarded. In the dire poverty situation, trafficking is very common. Out migration is the only coping in erosion, if this desperation is titled as 'coping'.
- Bangladesh regularly faces agricultural drought. The entire western part of the country is drought prone, though the problem is acute in central-western and north-western regions. In the drought prone areas the major concerns of local women include food insecurity, problem in collecting drinking water, and outbreaks of diseases. However, none of these problems appears to be as acute as in case of water logged and saline affected areas. Women's lives are adversely affected due to difficulties towards maintaining homestead vegetable garden and managing water and fodder for the livestock. Although drought is well managed by means of groundwater irrigation, women have little or no option to cope with drought-induced adverse conditions around them. The most observed survival mechanism against drought-induced food insecurity is to sell whatever assets that women own, such as jewelry, poultry, livestock, etc. Sometimes women take part in pre-harvest

and post-harvest activities as day labours, in addition to taking full responsibility of household activities, in a bid to increase monetary flow. They also try to grow various types of vegetables in their courtyard which are moderately drought tolerant.

- Food insecurity, hurdle to collect safe drinking water, sanitation problem as well as health hazards, mental and physical trauma during and post disaster period, etc. are the cross cutting problems in almost all the hydro-geophysical contexts covered under this study. Bangladeshi people have been familiar with climate induced hazards since ages. As a result they have developed various coping practices against such hazards. Since agriculture has a profound impact on the economy of the country, farmers always practice their self innovative coping mechanism for survival. Millennia old traditional knowledge plays a significant role towards modifying and adjusting coping practices. As women are differently vulnerable than men under climate variability, they also have developed their own ‘survival coping’ mechanisms. Many of their practices are need-based, appear to be so obvious. However, these apparently ‘obvious’ practices have all passed the true test of time and have contributed immensely to reduce their immediate vulnerabilities against vagaries of nature. Women possess a strong body of traditional knowledge, which is used in disaster mitigation and coping. Proper acknowledgement of the contribution of women, provision of protection and financial support should be made available to them sustain and develop this knowledge base. Women-friendly technologies should be properly adapted where suited.
- Apart from gender analysis of climate change, the study has explored the vulnerability context, coping strategies and adaptation needs of hard core poor, persons with special needs, some minority and ethnic communities in selected areas. It is generally found that the absence of ownership on prime resources such as land and lack of access either to common properties or to governance processes increase vulnerability of these disadvantaged groups in any given hydro-geophysical context. The changed hydro-geophysical contexts under climate change will push them in distress by further alienating from governance processes and/or resource endowment. An all out effort to dent poverty is a must in a bid to reduce vulnerability of these disadvantaged people.
- In the nexus between poverty and climate change, sustenance of decent living under invigorated extreme weather events must be severely questioned, especially in countries such as Bangladesh where pervasive poverty is prevailing. Frequently occurring natural hazards and occasional disasters are perceived to be the major causes of the perpetuation of poverty in Bangladesh. Despite utmost efforts to bring the net fraction of population below poverty line by achieving MDGs and so on, there is a strong likelihood that the overall poverty level will remain at the same level, if not deteriorate further, due to adverse impacts of climate change on poor and marginally better off people.

Few Key Observations and Recommendations

Women’s vulnerability is context specific. The overall vulnerability of marginal people (such as poor, physically/mentally challenged, ethnic minority etc.) in any given hazardous geophysical context is high. However, among any such group of marginal people, vulnerability of women is of the highest order.

Women try to 'cope' with the altered hydro-geophysical condition the most. Their utmost attempt to survive through the bad times takes a lot of personal sacrifice and compassion as well as accepting psycho-physical burden. However, the anticipated intensity of changes in geophysical contexts under climate change appears to be so overwhelming in the backdrop of women's current vulnerability context that mere 'coping' will not be sufficient even to ensure survival coping.

Women's coping efforts are severely challenged by gender relationships and handicapped by power structure both within the household as well as within the community. Despite having provisions for inclusion of women representatives in (local) governance processes, gender relationship having a bias towards males does not allow women to meaningfully participate in any decision making fora, while lapses in good governance practices alienate women's voices further, leaving virtually no room to meaningfully contribute towards the reduction of their vulnerability.

The patriarchal elements of vulnerability of women will further eliminate women's opportunity to overcome their vulnerability.

Women, entrapped in water world due to prolonged water logging appears to be the most vulnerable group compared to other vulnerability contexts of women in various known geophysical set ups. Salinity affected women are also extremely vulnerable.

Women's resilience building demands women's empowerment in all aspects of life: physical and mental, social, economical, political, and cultural. The State must assume responsibility to remove common and known barriers towards empowering women.

Special attention is also required to ensure that similar barriers for other disadvantaged groups are removed with need-based targeted programmes and practices.

Though it appears obvious that simple coping would not help women much to reduce their vulnerability, raising awareness regarding the anticipated elements of risks and early warning could facilitate them to strengthen their approaches to coping. However, such programmes must be tailor-made to cater the needs of the target audience – the women and the disadvantaged.

The role of social safety net (SSN) towards helping communities in any geophysical contexts of vulnerability is becoming increasingly important. Efforts must be made to enhance allocation to maintain a healthy social safety net. However, new modalities will have to be sought and developed so that vulnerable women can directly receive the benefits from SSN practices. The current barriers in relation to rather illusionary access to SSN for women, especially for women headed households, should be eliminated with proper planning and implementation of programmes.

To complement State-run programmes, the donor and NGO communities must devise matching plan and programmes, taking special care to the above-mentioned issues. To facilitate inter-agency coordination and monitoring, a gender caucus may be developed and nurtured.

In cyclone prone areas, adequate number of new cyclone shelters need to be built on the basis of population density. Despite the recognition that the existing cyclone shelters have saved millions of lives already, new structures should be built on modified design having provisions

for women: at least one separate toilet designated for women, preferably a separate floor for women, at least one room designated for pregnant and elderly women, a ramp to accommodate the needs of physically challenged and women with advanced stage of pregnancy, etc.

The hydro-morphological causes of water logging must be addressed with adequate participatory planning and financing. Maintaining a sustainable drainage system is a must in order to address the issue of water logging. Emergency floating medical service is of utmost need in the waterlogged areas. Separate community latrines for women can be built, connected through a raised road network, and maintained under the supervision of female members of local government institutions. Roads connecting to schools must be raised. In absence of a land based production system, alternative sustainable livelihoods must be sought for.

Carefully planned efforts must be made to push saline front towards the estuary – a long-term solution is provided in National Water Management Plan, which requires immediate attention and financing. Meanwhile, sustainable solutions to address salinity in drinking water must be sought and implemented. The State must facilitate to increase coverage of safe and non-saline water supply in the saline affected areas. The relevant national institutions must pay attention towards surveillance and monitoring of salinity and of women's health. Public health care system needs to be strengthened in saline affected areas.

Since extent and duration of floods will only increase under climate change, a good coverage of multipurpose flood shelters in flood vulnerable areas needs to be established. Each of these structures must cater to the particular needs of women, as in the case of cyclone shelters. Instead of curative measures towards fighting against water borne diseases including diarrhea, efforts must be made to popularize alternative 'preventive measures' to reduce the health cost of women and children – the major victims of such diseases.

Credit flow needs to be strengthened in drought prone regions to facilitate supplementary irrigation. Safety net program for poor women and children needs to be strengthened.

This study has been the pioneering one to reveal gender specific vulnerability to climate change in Bangladesh. However, given the urgency of the issue and the dimension of the problems(s) this modest study is deemed extremely limited to address all the issues and contexts of vulnerability in relation to climate change and gender. Taking it as a stepping stone, new impetus is necessary with adequate support to build on these findings and to devise proper adaptation tools to help the cause of women in the volatile future dictated and complicated by climate change in Bangladesh.

1. INTRODUCTION

1.1 Background of the Study

The imminent multi-faceted dangers associated with climate change have been perhaps the most talked about issues across the world during the post-UNCED era. Due to anthropogenic activities the atmosphere has been loaded with various greenhouse gases which eventually are collectively causing a net increase in global surface temperature (Houghton *et al.*; 1996). There have been increasing number of evidences in recent years that earth's climate is changing, which is attributed to fossil fuel burning, land use & land use change, livestock and waste management, and agriculture (IPCC, 2001a). Only recently, the global community endorsed the latest findings of the Inter-Governmental Panel on Climate Change (IPCC) through its Fourth Assessment Report (AR4) that the average temperature might increase up to 7 degrees Celsius with respect to 1990 values by 2100. This rise is associated with increasing rates of melting of permafrost (i.e., icebergs, ice sheets, glaciers, etc.), increasing drought in some parts of the globe and increasing flood and cyclone vulnerability in many other parts of the globe (IPCC, 2007). It is feared that the poorest of the vulnerable countries will be the worst hit and the overall burden of adverse impacts of climate change will be disproportionate on the poor communities (DFID, 2004a, DFID, 2004b).

Global discourse on avoiding dangerous climate change revolves around two modalities:

- (a) *mitigation*, through which emission of greenhouse gases can be reduced and the root cause of global warming can be checked to a great extent (Schnellhuber *et al.*, 2006; O'Neill and Oppenheimer, 2002; Moss, 1995); and
- (b) *adaptation*, by means of which anticipated adverse impacts of climate variability and change can be reduced (Smit *et al.*, 2000; Smithers and Smit, 1997).

The most recent IPCC Assessment warns that, even if stabilization is possible at current levels of atmospheric concentration of CO₂, the prime driver of climate forcing, the world is destined to face a net change of 0.1°C per decade over the next five decades (IPCC, 2007). While such a reality provides ample impetus to commit to the limit to arrest GHG emissions from all possible sources, it also provides justification why the global community must prepare themselves through appropriate adaptation options. If mitigation is considered to be a 'must' and to be approached 'first', adaptation should also be taken seriously – especially amongst the poorest countries and communities.

To many across the globe, Bangladesh is known as one of the most vulnerable countries under climate change. A number of major studies in the past investigated the causes of vulnerability of Bangladesh due to climate change (Huq *et al.*, 1998; Warrick and Ahmad, 1996; ADB, 1994). In general, warming would increase both the summer as well as winter mean temperatures, while there would be an increase in monsoon rainfall with a likelihood of withdrawal of dry season rainfall over the country (Ahmed and Alam, 1998; Mirza, 1997; Agrawala *et al.*, 2003). According to a number of research initiatives, the water resources sector of the country would most likely be affected significantly due to anticipated changes (Ahmed *et al.*, 1998; Ahmed, 2005). Most of the adverse effects of climate change will be in the form of extreme weather events, while water-related hazards such as flood, drought, salinity ingress, bank erosion, and tidal bore are likely to be exacerbated, leading to large

scale damages to crop, employment, livelihoods, and national economy (Huq *et al.*, 1996; Asaduzzaman *et al.*, 1997; Choudhury *et al.*, 2005).

Although the geo-physical aspects of vulnerability to climate change for Bangladesh is better understood, there have been only a few literatures that describe vulnerability of social and economic sectors to climate change (Erickson *et al.*, 1996; Asaduzzaman *et al.*, 2005). It is claimed that the perceived outfall of anticipated geo-physical implications of climate change would be disproportionate for the women and disadvantaged groups. However, little information exists that could help identify vulnerable groups, particularly women, minority, marginalized, and people with disability and special needs.

1.2 Linkages among Climate Change, Livelihoods, Poverty, and Women

Bangladesh is a low-lying deltaic country that experiences high climate variability, both spatially and temporally. The hydrologic regime of the country is predominantly influenced by the monsoon from early June to early October, which brings about 80% of the total annual rainfall. The post-monsoon months become drier and there is hardly any appreciable rainfall during the winter months (December to February). The western parts generally receive significantly lower amounts of rainfall compared to the eastern parts of the country, which is a manifestation of high spatial distribution of rainfall. The in-country variability in rainfall over time and space is further complicated by regional aspects of rainfall-runoff. Bangladesh constitutes only about 7% of the area of the combined catchments of three major eastern Himalayan rivers: the Ganges, the Brahmaputra, and the Meghna (GBM) and the country drains over 92% of the total annual flow of this GBM system. As the lowest riparian with almost a flat terrain, when monsoon-driven excessive runoff in these rivers combined with local rainfall, the country is frequently faced with over-bank spillages and floods, particularly along the major rivers.

In contrast, river discharges become minimal during the winter months. This leads to water shortages all over the country and the intrusion of saline waters into the surface and groundwater systems along the coast¹. In combination with the fact that the net winter evapotranspiration becomes higher than the available topsoil moisture during the winter months, this often leads to serious moisture stress and severe drought conditions in the floodplains and in the coastal zone in particular. The temporal variability of availability of water becomes more acute due to either early arrival or late departure of the monsoon when agricultural goes through critical periods of harvesting and transplanting, respectively.

Climate change related risks are associated with *long-term changes* in trends, variability and extreme events of climate and related impacts. In Bangladesh such changes are relatively small compared with the natural climate variability and may be also with respect to other anthropogenic impacts such as: empoldering of the flood plains; deforestation of watersheds; over-extraction from groundwater aquifers (and their consequent salinization in coastal areas); and extractions upstream.

According to published literature, the most critical impacts associated with climate change in Bangladesh are: (i) drainage congestion (flooding); (ii) reduced fresh water availability; (iii)

¹ In addition to natural causes of salinity ingress, diversion and utilization of water from the Ganges River by the upper riparian state, India, has also contributed to the increase in surface water salinity along the coastal zones of Bangladesh (Mirza, 2004).

disturbance of morphological processes (erosion); and (iv) an increased intensity of disasters (extreme events: cyclone/storm surges, floods and droughts) (World Bank, 2000; Huq *et al.*, 1998; Ahmed, 2005). Sometimes, these hazards assume disastrous proportions causing great damages to lives and livelihoods and the incidence of large-scale poverty may be attributed primarily to their frequent occurrence (PC, 2005). The endemic nature of poverty in the primarily agrarian society is believed to be mainly due to poor resource to man ratio as well as frequently occurring disasters.

From literature the following specific impacts of climate change on geo-physical systems of Bangladesh can easily be identified².

- The *stronger monsoon rainfall* will aggravate flood conditions (higher flood coverage) while catastrophic flood events may occur with higher frequency (Huq *et al.*, 1996). Overall, the research findings suggest that under climate change scenario about 18 per cent of current lowly flooded areas will be susceptible to higher levels of flooding while about 12 to 16 per cent of new areas will be at risk of varied degrees of flooding (Alam *et al.*, 1998). On an average hydrological year, flood prone areas will increase from about 25 per cent to 39 per cent.
- Increased monsoon flows will result in an *increased sediment transport capacity and morphologic dynamics of the rivers*. Additional sediments to transport are most likely to be “picked up” mainly from river banks, thus leading to increased riverbank erosion (particularly along the GBM rivers).
- The coastal zone, particularly the southern areas of the country would face *increased water-logging* due to increased flood volumes to drain and increased sea levels downstream. In addition the increased transport of sediments might also lead to sedimentation of riverbeds in the mouth of the estuaries, further hampering the drainage of the upstream rivers and estuary branches.
- Southwestern embankments might face *occasional tidal overtopping*, leading to saline water-logging within embanked areas (CEGIS, 2006).
- Dry season low flow of rivers would further decrease, leading to *increased water shortages* all over the country and increased salinization in the coastal areas (Huq *et al.*, 1996; Halcrow *et al.*, 2001; Ahmed, 2005; CEGIS, 2006). The drier areas (particularly in the western parts) will face acute moisture stress (Karim, 1996; Karim *et al.*, 1998). The expected rise in sea level and corresponding backwater effect will aggravate the expected inland shift of brackish water zones.
- Reduced winter fresh water flows might aggravate the *draw-down of shallow aquifer systems*, reducing its potential for drinking and irrigation water (particularly in the western part of the country) (Halcrow *et al.*, 2001).
- *Cyclones will be stronger and more frequent* due to increase in sea surface temperature due to warming.

As consequence of these changes, one anticipates the following socio-economic impacts.

² This section (dealing with geo-physical and socio-economic impacts of climate change) heavily draws from a few key references such as Warrick and Ahmad, 1996; Huq *et al.*, 1998; and Ahmed, 2006a.

- *A higher incidence of socio-economic disasters* due to increased extreme weather events such as: severe and prolonged flooding; cyclonic storm surges; tornadoes; and riverbank erosion. These events will result in increases in: loss of lives and livelihoods and hardship for the poor, in particular women and children; devastation of human settlements and national infrastructure; and bottlenecks for national development due to frequent diversion of development budget to facilitate post-disaster rehabilitations.
- Higher risks for crop agriculture and the fisheries and livestock sector (floods, droughts, and salinity intrusion) will pose *risks to both livelihoods and national food security* (World Bank, 2000; Asaduzzaman *et al.*, 2005).
- Loss of livelihoods and productive activities in the rural areas might lead to *out-migration from rural areas (climate change refugees)* (Ahmed *et al.*, 1998; Ahmad and Ahmed, 2000).
- Fast growing urban areas in Bangladesh (PC, 2005 and MOWR, 2005b) will face growing problems with environmental conditions, in particular in the slum areas and mostly affecting the *urban poor*. This is associated with the supply of clean water and sanitation facilities (PC, 2005) while slum areas often suffer from poor drainage. All these water related issues are adversely affected by impacts of CC. Urban poor require special attention as the nature of their poverty is more severe than rural poverty (PC, 2005, p121)³. Urban poor are “at the end of the line” both in terms of access to resources and access by support programmes and safety nets. It might be feared that the difficult-to-reach hardcore poor in urban areas will grow in the near future.
- *The Sundarbans ecosystem will be at risk due to increased salinity*, which in turn will affect forest biodiversity and population depending on its resources (Ahmed *et al.*, 1998; CEGIS, 2006).
- General warming and increased heat waves will pose severe *health related risks* (particularly in April and August) especially for the children and old people (World Bank, 2000).

Given the complexity of inter-relationships among geo-physical variables observed currently, many of the above mentioned changes are likely to have dramatic adverse effects. However, these macro-level understanding about the imminent risks does not provide adequate insight regarding identification of who would be amongst the worst affected in the country. It is expected that people in the grassroots would continue to cope with the risks being posed and thereby reduce the adverse impacts of climate change. Unfortunately, the magnitude of changes will not be linear with respect to time and people with limited capacity to adapt will most likely to be the worst hit.

Bangladesh often experiences natural hazards, most of the water related hazards will be exacerbated due to climate induced effects (Ahmed, 2005). Floods, cyclones, tornadoes, and droughts strike the country and its population regularly and intensively. None of these hazards is new, but in recent years there have been some significant changes in their

³ Though head count poverty indices improved between 1992 and 2000 in both urban and rural areas, this was associated with a rise in inequality which grew faster in urban than in rural areas. Consumption expenditure inequality in this period increased from 30.7 to 36.8% in urban areas against 24.3 to 27.1% in rural areas (PC, 2005, p15).

occurrence. Unfortunately the damage due to such hazards has been increasing, especially due to the fact that increasing number of people are forced to occupy more marginal and hazard-prone lands. In such environments women bears the brunt of sufferings.

Climate change induced natural hazards create crisis situations that disrupt the fabric of everyday life at micro levels. Climate change induced risks are disproportionately carried by those who are already socio economically and physically disadvantaged. Knowledge, skills, power relations, gender roles, health, wealth, race/ethnicity, age, physical and (dis)ability also help to shape differential risk and vulnerability levels and determine individuals' ability to 'bounce back'. Those most vulnerable to disasters include the infants and very old, the poor, women⁴, ethnic minorities, physically and mentally disabled, and elderly.

Social vulnerability is an important concept, underscoring the ways in which, and reasons why, people's differential access to and control over resources (such as land, money, credit, good health and personal mobility, to name but a few) are closely interwoven with their ability to survive and recover from disasters (Enarson, 2002). The risk-scapes of hazards/disasters are also affected by poverty, population growth, land settlement into fragile areas, over exploitation of natural resources, inadequate communication structures and weak institutional bodies, global climate change (that is partially caused by human actions), as well as differential access to the kinds of information that could help people to protect themselves (GTZ, 2004).

Women are the ones who are supposed to ensure well being of the family, even if it is at the cost of their self well being. The woman (perhaps including the girl child) receives the least amount of food in a food impoverished household, even though she has to lactate an infant and nurture another child in her womb. In a common household in rural Bangladesh she has to maintain hygiene, ensure water supply, cook for the family, take the burden of post-processing of all agricultural produce, raise a few poultry, maintain a courtyard garden to ensure supply of nutritious food (vegetables) – all happening simultaneously. Yet, when a hazard strikes she has to safeguard all the belongings and any hint of an asset, send everybody to safer refuge, and stay back to ensure that the household is not ransacked while in absence. In this process, she accepts whatever the consequence of the imminent hazardous event. In a quickly on-setting hazard event, such an apparent 'passive' response may lead to death and such a risk is deliberately undertaken by women.

Following a hazardous event, the same woman (if poor or destitute) has to queue on lines for hours to receive relief for the family, provide physical labour to reconstruct dilapidated dwelling, and again do the usual stuff as always. If one wants to sell labour to earn money, she is given a lower wage than any man in the neighbourhood. A working woman in a rural set up is often harassed sexually, since it is 'perceived' that a woman accepts laborious job only when she does not have a male relation to feed her and therefore others possibly can take advantage of her condition. Sometimes, woman's lesser physical strength is challenged and sexual advantage is taken, especially when all the other people have virtually abandoned her to safeguard their belongings.

⁴ Among women, those who are pregnant and lactating face the maximum challenge, while the adolescent girls also face variety of risks in addition to natural hazard related risks.

In a disaster-related crisis condition women respond on the basis of what little they have or are left with following the event. Women has to respond as both the household manager as well as the disaster manager, guide through the reconstruction processes, and provide psychological support for members of their surviving families.

Under the prevailing social and economic circumstances, Bangladeshi women are lagging far behind than their male counterparts. Women's and men's responses to these crisis situation, as well as their abilities to cope with them to a very large extent reflect their status, roles and positions in society: because of gender based inequalities, girls and women are typically at higher risk than boys and men (UN, 2004; Enarson, 2002; Chew and Ramdas, 2004; SEEDS, 2005). A gender approach is therefore important to identify men's and women's differing vulnerabilities to crisis as well as their different capacities and coping strategies in order to design effective disaster management program.

In a hazardous/disastrous condition, the plight of the poor also needs to be recognized. Poor people have the least economic means to cope with, the least social and political empowerment with which one can 'bounce back', and the least technical and other skills to avoid the aftermath of such an event. Considering that a woman belonging to a poor household is the worst affected, as a distinct group the poor and marginal farmers constitute the largest vulnerable group in Bangladesh.

Given the above discussions and the paucity of information on women's particular vulnerability to climate change, it is only rationale to carry out a study on this issue. In view of scanty information on impacts of climate change on women and vulnerable groups, the Climate Change Cell (CCC), working under the Ministry of Environment and Forest (MOEF) and the Department of Environment (DOE), has decided to facilitate a research on the important issue⁵.

1.3 Objective of the Study

The overarching goal of the research is to build an information source on specific aspects of vulnerability of women and disadvantaged groups to climate change which would reduce vulnerability of women and disadvantaged groups under climate change. Towards meeting the goal, the following appears to be the specific objectives of the proposed study.

- To find out who would be the most vulnerable group (including women) under climate change (in each geo-physical environmental condition) and what would be their specific adaptation needs at micro-scale;
- To analyze whether women's adaptation needs are also satisfied by the known adaptation measures;
- To identify barriers of implementing perceived adaptation measures and to recommend ways and means to overcome the barriers;
- To analyze how specific vulnerability contexts of identified groups could be addressed with planned adaptation measures, given the sustainable development framework of the country.

⁵ The research has been recommended by a National Workshop, organized by the [MoEF](#), which assessed the prevailing gaps in understanding on climate related issues following the preparation of the National Adaptation Programme on Action (NAPA) and prioritized such a topic amongst the top three research needed for the country.

2. APPROACH AND METHODOLOGY

2.1 The Generic Analytical Approach: LFA and PVA

Assessing vulnerability of people in general has been attempted by many research groups, from all different perspectives (Dercon, 2001; Kenward, 1999). Kelly and Adger (2000) extended the framework to cover climate change related vulnerability, which has been further extended for more generic global scale environmental issues by Clark et al., (2000). It is often argued that country and regional scale vulnerability assessments often tend to miss the real vulnerable people, which are primarily due to the context of their vulnerability which exclude the vulnerable groups from being heard and from decision making processes, both before and after an assessment. The needs for incorporating perceptions and views of the vulnerable groups in the assessment mechanisms are highlighted repeatedly (Kelly and Adger, 2000; Heijmans, 2001; Ahmed, 2004; Smit and Wandel, 2006).

One of the means to incorporate concerns of the vulnerable people and analyze their context(s) of vulnerability is to employ the Livelihood Framework Analysis (LFA) technique, which not only allows integrate geophysical risks of the vulnerable people in question, it also considers all forms of assets, the absence of which can potentially increase vulnerability and/or the availability of which influences their empowerment and contributes to their resilience (Cannon *et al.*, 2003). In the recent past, Action Aid International adopted LFA and introduced its Participatory Vulnerability Analysis (PVA) technique to justify their approach to assess ‘socially inclusive’ vulnerability for a group of people, instead of a generic vulnerability assessment framework (AAI, 2002). The latter has been further adopted in Bangladesh to successfully assess vulnerability of local people in the southwestern region of the country under the RVCC project (RVCC, 2003; Schaerer and Ahmed, 2004). This methodology has again been adopted with a slight modification in Bangladesh and a few more countries to analyze vulnerability of groups of people in a given context of climate related hazard (Alam, 2006).

2.2 Actual Methodology Applied for the Study

In order to achieve the specific objectives mentioned above, the BASTOB-led Study Team carried out the study with a view to answering the following pertinent questions:

- Do men and women perceive and experience climate change impacts in different ways due to their different roles in society?
- How do contexts of vulnerability for women in relation to climate variability and change differ from those of men? How will they be impacted by climate change in different ecological and socio-cultural backgrounds?
- Do adaptation measures impact differently on men and women?
- Is there a need to develop gender specific measures and mechanisms to facilitate adaptation to climate change impacts?
- Are there specific micro-level adaptation measures that suit to women within a vulnerable community?

- What barriers are conceivable in order to implement gender-sensitive micro-scale coping/adaptation measures? What needs to be done in order to remove and/or modify these barriers and promote gender-sensitive micro-scale adaptation?
- Are there parts of the population (e.g. minority groups, people with special needs and disability) that are particularly vulnerable to climate change impacts?
- Is there a need to develop specific measures and mechanisms to assist these groups with adapting to climate change?
- Do minority groups and people with special needs and disability develop different coping mechanisms to react to climate change impacts?
- How do contexts of vulnerability for minority groups and people with special needs and disability differ from those of other vulnerable groups/people? How will they be impacted by climate change in different ecological and socio-cultural backgrounds?
- Do general adaptation measures impact on particularly vulnerable groups or are there specific micro-level adaptation measures that suit to particularly disadvantaged people including minority groups and people with special needs and disability within a vulnerable community?
- How would each of the perceived adaptation options advance sustainable development?

Initially, an attempt is made to collate relevant information on any and/or all of the above research questions, to the extent possible, from available literature (as provided in Section 1.4). It is envisaged that the study would require far more in-depth investigation on the major research questions, answers to all these questions weren't available in secondary sources. Therefore, as a generic approach of the research, a close interaction between the vulnerable ones (women & other disadvantaged group members) and the Study Team Members has been established. A number of such close interactions, by applying Participatory Vulnerability Assessment (PVA) technique, have been arranged. This technique has previously been applied under the RVCC project, which has drawn international attention as a very useful tool to define vulnerability in the eyes of the vulnerable (RVCC, 2003; Ahmed and Schaerer, 2004).

It is envisaged that the research would cover all major geo-physically vulnerable region in order to identify a wide range of vulnerable groups, and women therein. The study sites, as identified in the next section, are carefully chosen to meet the criteria of representing diverse geo-physical realities and their interactions with the climate system anticipated for the future.

In each of these study sites, efforts are made to have PVA sessions with economically challenged groups as well as with women. These efforts have been supplemented by organizing Key Informants' Interviews (KII), to ensure representation of other groups such as minority groups, people with disability and special needs. In addition to these areas, a few other groups are interviewed separately to understand their perception regarding vulnerability and their special needs for adaptation.

Each of the PVAs begins with general observation of the area, approached by a transect walk. These physical observations form the basis of analyzing people's vulnerability contexts. 'Close interactions' with women and separate interactions with ethnic minority groups

(where applicable) and special vulnerable groups (from here on referred to poor and marginal farmers) provide information on types of vulnerability, perception regarding physical aspects of vulnerability, ranking of vulnerability, seasonality mapping of livelihood aspects, cropping system, employment, food security, etc. Drawing a collective ‘resource map’ for any given study site gathers information on the basis of livelihoods in a location. Similarly, Vann Diagrammes are drawn to understand and record the status of social integration and empowerment of the vulnerable people. Simple perceptual analysis of various institutions allows institutional barriers and support services made available by those institutions in the study area. The entire analysis in each of the study sites has been informal⁶, without any written (prescribed) format to guide the processes and the study team members have been involved as mere facilitators of the discussions, not as resource persons. The entire methodology is graphically presented in Figure-1, in the form of a Methodological Flow-chart.

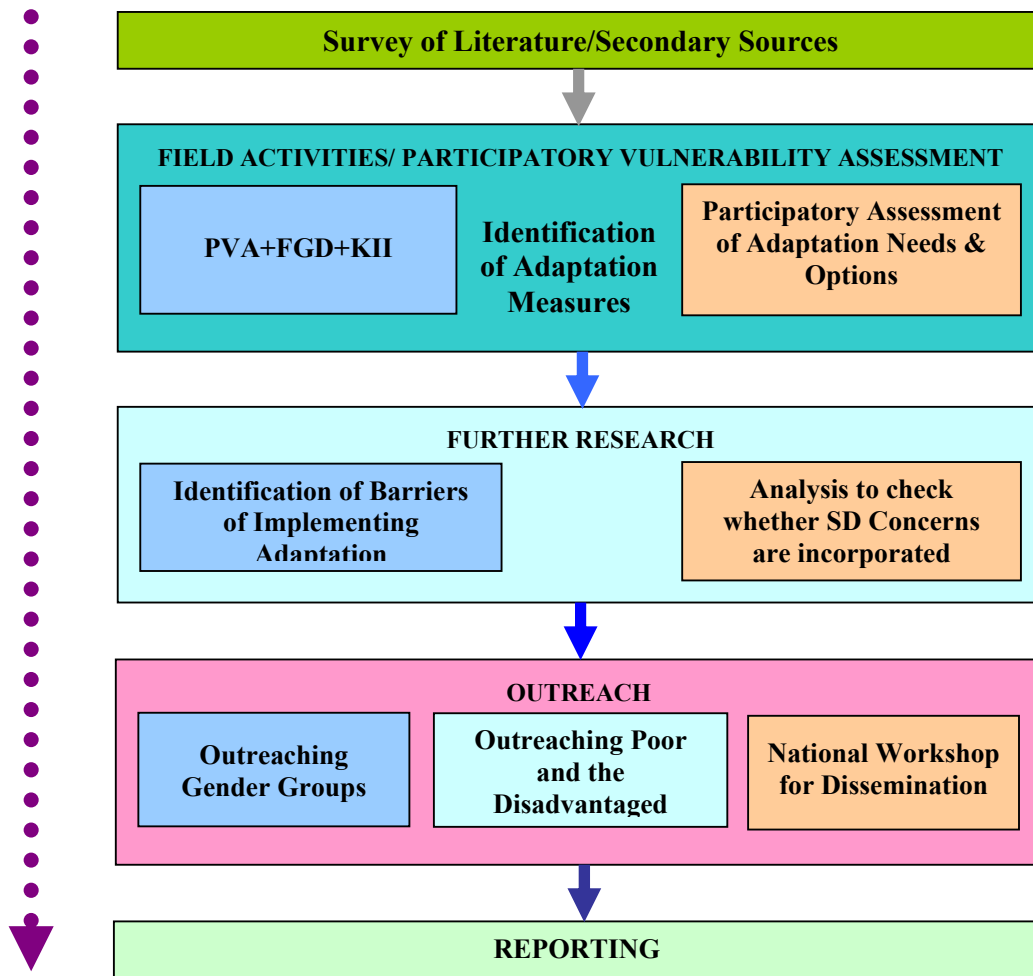


Figure-1: Graphical Representation of Methodological Approach of the Research

⁶ Representatives of the Climate Change Cell as well as one Senior Official of the Department of Environment (Mr. Mirza Shawkat Ali, Deputy Director, DOE) were present in one such informal FGD.

2.3 Selection of Study Sites

As a group, women are subject to a wide range of vulnerabilities, most of which are contextual. The contexts of vulnerability in relation to physical and socio-economic condition do not seem to fit directly into the climate-related contexts of vulnerability. However, a careful look into both the aspects and by superimposing all the elements of vulnerability emanated from both climatic and socio-economic origins reveals an intensification of the contexts of vulnerability for the women.

An analogous condition also seems to be present in the cases of economically disadvantaged people (poor and marginal farmers) and ethnic minority groups. Prevailing economic, social, religious, and cultural context put these people in an insurmountable hardship, which would make their lives even more vulnerable under the adverse implications of climate change. Selecting a few representative study sites is therefore, both easy as well as difficult. Women and poor are found almost everywhere; any given site is 'acceptable' for undertaking the study. Of course, minority groups are not yet adequately mainstreamed and they are confounded in a few selected locations (mostly in hills, foot-hills and coastal zones).

In order to avoid clumsy selection processes, a few simple considerations are given: (a) special zones which are physically threatened by different major climate-induced hazards should be selected, and (b) a few ethnic minority and socially secluded groups with different livelihood background will be selected. Given the diversity of vulnerability contexts in relation to climate variability and change, the following areas have been chosen for conducting the PVAs (overview is provided in Figure-2).

- A. **Coastal Islands** (which are vulnerable to cyclonic storm surges): Cox's Bazar (Dhalghata island under Maheshkhali) and Bhola (Charfassion)
- B. **Water-logging affected region** (vulnerability context: water logging): Jessore (Keshabpur thana) and Noakhali (Noakhali Sadar and SubarnaChar)
- C. **Saline affected region** (vulnerability to salinity ingress): Satkhira (Tala and Shaymnagar)
- D. **Drought prone region** (vulnerability to agricultural drought, livelihoods of the poor, and water scarcity): Naogaon (Manda)
- E. **Flood Prone areas**
 - E-1. Riverine Flood vulnerability: Faridpur (Char Harirumpur) and Kurigram (Kurigram Sadar)
 - E-2. Flash flood vulnerability: Sunamganj (Deerai) and Mymensingh (Haluaghat)
 - E-3. Coastal tidal flood vulnerability: Cox's Bazar (Chakaria)
 - E-4. Urban flood due to extreme rainfall event: Dhaka City (Dhanmondi and Mohammedpur Thanas)
- F. **Erosion prone areas**
 - F-1. Coastal erosion vulnerability: Bhola (Char Fassion)
 - F-2. River erosion vulnerability: Kurigram (Kurigram Sadar)
- F. **Minority Groups' Vulnerability**
 - G-1. Rakhain Ethnic Group in Cox's Bazar (Chakaria Thana)
 - G-2. Jaldas (Fisherfolk) Group in Cox's Bazar District (Chakaria/Malumghat) and
 - G-3. Garo Ethnic Group in Garo Hills (Haluaghat Thana, Mymensingh)

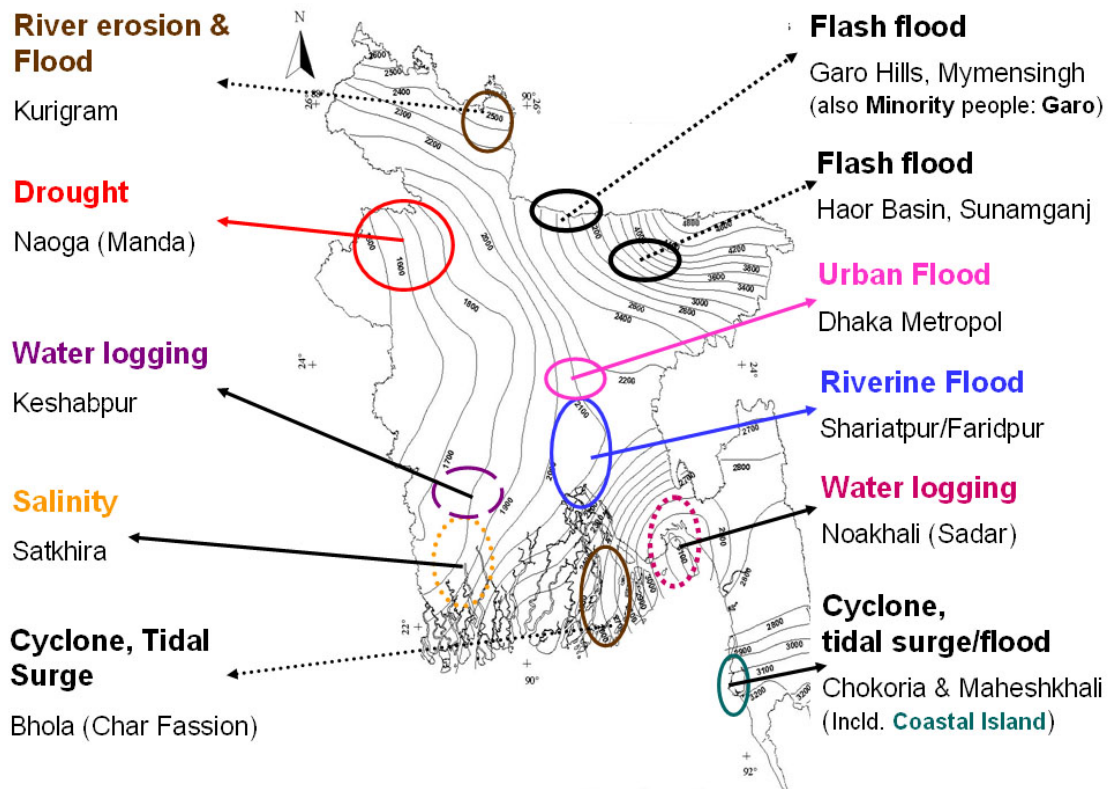


Figure-2: Selected Study Sites

The methodology and site selection processes have been provided with ‘Expert Input’ by holding a half-day-long Inception Workshop, where the relevant national Experts on Climate Change issues were present and took active part towards finalizing the study sites. Moreover, the Study Advisory Panel, proposed and formed by the Climate Change Cell, gave its recommendations in relation to finalizing the methodology as well as selection of the study sites. Although, in the mid-term project review meeting⁷ in presence of representatives of the Climate Change Cell (CCC) and the Department of Environment (DOE), concerns were raised regarding ‘too large’ study sites and ‘too many FGDs’ to cover within the stipulated time frame, efforts have been made to fulfill the target by covering all the intended study sites.

2.4 Activities Undertaken

The study considered a number of enabling activities. A brief account of each of these activities is presented below.

Literature Survey

The background information on climate change issues and peoples’ vulnerability (individual /household/community levels) have been collated and synthesized, as a primer of the

⁷ Mr. AM Kamal Uddin, Mr. Mohammad Showkat Osman on behalf of the Climate Change Cell and Mr. Mirza Shawkat Ali of DOE were present in the meeting.

research. Special focus was being placed on identifying the vulnerable groups under climate variability, in view of scanty research outputs on climate change.

Conducting PVA

In each identified study area, PVAs were conducted for assessing vulnerability contexts of specific groups, suitability of adaptation measures and adaptation capabilities of vulnerable groups. PVAs had been supplemented by carrying out courtyard sessions and a few Key Informant's Interviews. Close interactions were facilitated by local actors/facilitators, while PVA among women groups were conducted by a female Team Member. Not only specific vulnerability contexts have thus been analyzed, efforts were made to discuss potential adaptation options at individual, household and community levels. Social criteria for selecting adaptation options/measures were properly registered.

Analysis of barriers of adaptation measures

Following public consultations, barriers of implementing adaptation measures were analyzed. Institutional barriers were analyzed by interviewing a few selected Government Officials working at different tiers of governance system in Bangladesh. Perception of vulnerable people was reflected towards identifying implementation barriers.

Sharing among primary stakeholders

The results obtained through the research efforts were shared amongst the primary stakeholders, the vulnerable themselves. Two such sharing workshops were held, one in Jessore and the other in Cox's Bazar District. A national level workshop has been organized to share the results of the research with national level stakeholders. Over 120 participants were present in the national sharing workshop, who responded to the study findings.

Reporting

Based on feedbacks received at the regional and national sharing workshops this Final Report has been produced and submitted to the Climate Change Cell.

3.0 HYDRO-GEO-PHYSICAL CONTEXTS OF THE STUDY SITES

Vulnerability of any human system is context-specific, which largely depends on the hydro-geophysical realities of the area where the subject population is living. These hydro-geophysical aspects sometimes are greatly influenced by climate system, bringing significant changes in the prevailing contexts of vulnerability, and resulting in profound impacts on social and economic aspects of subject population. A brief account of current hydro-geophysical and socio-economic aspects of the study sites are presented below.

3.1 Cyclonic Storm Surge in Dholghata, Moheshkhali

Dholghata is an island in the Bay of Bengal in Maheshkhali Upazila. It is in the western part of Maheshkhali islands. Dholghata is demarcated by a channel (Maheshkhali channel) from Cox's Bazar main land. This island is extremely vulnerable to cyclone. It is reported that

there is hardly any family who did not lose any of its family members in 1991 cyclone.

Technically a cyclone is an area of low pressure where strong winds blow around a centre in anticlockwise direction in the northern hemisphere and clockwise direction in the southern hemisphere. Cyclones occurring in tropical regions are called tropical cyclones. Tropical cyclones are usually destructive and these are the ones which affect Bangladesh and as such Maheshkhali islands in almost regularly.

Bangladesh is a part of humid tropics, with the Himalayas in the north and the funnel shaped coast touching the Bay of Bengal in the south. This particular geography of Bengal brings not only the life giving monsoons but also catastrophic ravages of cyclones, tornados and storm surges. As a part of Maheshkhali islands bounded by the Bay of Bengal, Dholghata is an ideal



Figure-3: Map of Maheshkhali Thana

breeding ground for tropical cyclones. The Bay of Bengal cyclones often move towards the eastern coast of India, towards Burma and occasionally into Sri Lanka. But they cause the maximum damage when they come across the coastal islands of Bangladesh. This is because of the low flat terrain, high density of population and poorly built houses.

In addition to the waves associated cyclonic winds, abrupt surge of water known as storm surge are associated with cyclones. They strike the coast nearly at the same time the centre of the storm crosses the coast. As the cyclone is a low pressure area, the ocean water rises like an inverted barometer due to low pressure. This is most profound at the centre of the storm where pressure is the lowest. The surge is further amplified if this coincides with the normal diurnal high tides.

Both cyclone and associated tidal surge have made the people of Dholghata Island extremely vulnerable to extreme impoverishment. Damage to livestock and other assets (trees, houses etc.) have always been much greater in a cyclone. Salt cultivation in the dry season is the major economic activity in this island. Almost all the laborers get engaged in salt cultivation during dry season. They also get employed with forestry, fishing, sericulture, commerce for the rest of the year. Official statistics reveal that the number of population in Dholghata is 219520; among them male are 53.13 percent and female are 46.8 percent; Among the profession agriculture accounts for about 22.9 percent while forestry 1.25 percent, fishing 6.08 percent, sericulture 6.08 percent, agricultural laborer 25.19 percent, wage laborer 7.17 percent, commerce 13.78 percent, service 2.57percent, others 19.94 percent. Cultivable land is about 5275.36 hectares, the land used for salt production is about 2073.4 hectares, shrimp cultivation 2105.69 hectares, fallow land 1715.21 hectares. Main crops in this island are Betel, paddy, betel nut. Most of the houses are built with straws and mud which are naturally susceptible to destruction in any regular cyclone. Because of poverty, they can not afford to have strong building to get protected from cyclone. Education, sanitary, medical facilities are the most ignorant sectors here. Lack of connectivity to mainland and very limited employment opportunity within the island coupled with devastating cyclones lead to extreme misery to the lives of the inhabitants of this island. As inhabitants of such an island, many of them never have gone to the mainland, they have their different culture altogether. There is very limited scope for women education; superstition and social taboos force women to be grounded to home based activities only. Lack of adequate trained midwives and almost absence of any modern medical facility trigger the vulnerability of women in this island.

3.2 Waterlogging in Keshabpur, Jessore

Jessore is located in the south west region of Bangladesh. India is on its western part, Shatkhira and Khulna to the south, Jhenaidoh and Magura to the north and Narail to the east. Bhairab, Kabodak, Chitra are the major rivers in this district. This region has a typical tropical monsoon climate regime. River flow varies greatly by season, with water flow in the peak monsoon season between 10 to 15 times greater than in the lean season.



Figure-4: Map of Keshabpur Upazila

The total area of Keshabpur Upazila (Jessore district) is about 258.53 sq km. Main rivers are Harthar and Chengral; Keshabpur Thana was turned into an Upazila in 1983. It consists of 9 Union Parishads, 142 *mouzas* and 143 villages. Population is 200229; among them male are 51.16% and female 48.84%; Main occupation is Agriculture (47.84%). Total cultivable land is 20404.28 hectares; fallow land 297.86 hectares; single crop 28%, double crop 61% and treble crop 21% and Cultivable land under irrigation is 63%. Among the peasants 12% are landless, 64% small, 22% intermediate and 2% are rich; cultivable land per head is 0.12 hectare.

Main crops are Paddy, wheat, jute, potato, betel leaf, sugarcane, oil seed, chilli, turmeric, vegetables. Local varieties of paddy, *arahar*, *khesari* are Extinct or nearly extinct crops. Main exports are Paddy, jute, jackfruit, wheat and date molasses. Apart from agriculture, fishing is a major livelihood activity here. Many families diversify their income with various services and commercial activities such as small scale trading, shop keeping, handicraft production, rickshaw and van pulling, and a range of skilled and unskilled labor occupations.

Water logging is the most pressing problem in Keshabpur. Almost 8 months in a year most of the area is inundated. Gradual siltation on the riverbed of Kabodak , triggered by inadequate runoffs in the south reach caused by Coastal Embankment Project (CEP), is the main source of the problem. A series of embankments and polders were constructed as a part of the CEP during the height of green revolution in the early 1960s. The goal of the project was to protect the cropland and homes of the coastal people from saline intrusion, tidal surges and cyclones. The project has had some positive effects, with rice production increasing initially 2 to 3 times. However, the project has caused a number of problems including: the siltation of river beds, increased saline intrusion (due to poorly located and/or maintained sluice gates), the narrowing of river estuaries and changes in the normal morphological process of river. Biodiversity is threatened and cultivable land has shrunk. The result is a congested drainage system and a large area of southwest districts (especially, Keshabpur and Manirampur in Jessore) is water logged.

3.3 Waterlogging in Noakhali

Noakhali coastal region is an accreted area having almost flat land, depending on locations, just 2.2 to 5.0m above the mean sea level. Although the northern parts of the country are higher than the southern areas allowing easy drainage of the main rivers, many of the southeastern areas of the country closer to the coast have serious problem of water congestion. This is mainly due to the impeded drainage as a result of siltation of the canals (Noakhali *khal*, in particular), particularly of the secondary and tertiary ones. All these processes have resulted in an elevated foreshore and the effect of the general slope of the country becomes almost obsolete in the immediate vicinity of the coast. Although flat lands dominate the region, localized depressed areas are common. Because of these depressed areas there are variations in the microenvironment of the specific sites which is important for agricultural diversities. Noakhali district is bounded by Chandpur and Comilla districts to the north, Feni to the east, Laxmipur to the west and the Bay of Bengal to the south. Noakhali *khal* is a major waterbed in Noakhali. There were a number of charlands to the south of the district which gradually joined to the mainland some 50 to 60 years ago.

Subarna Char Upazila and Noakhali Sadar Upazila had been selected for the Focus Group Discussion (FGD). These two areas are almost protected naturally from saline flooding in one hand, and has a slower drainage during monsoon on the other, due to its elevated foreshore close to Hatiya river to which it drains. In some areas of Subarna Char water remains stagnated up to a height (0.4 to 0.9 m) that makes introduction of improved crops very difficult. Two types of flood occur here-a) the normal flooding caused by accumulation of monsoon rain which can not drain into the rivers or takes longer time to drain due to impeded drainage canals, and b) the damaging flood during tidal and or storm surges associated with cyclones. However, normal floods are also damaging when it prolongs or comes untimely.

Seasonal flood occurs after heavy downpour during the monsoon. The depth of flooding varies with location even within a particular area. During monsoon the canals in the areas usually remain filled up with rain water that can not recede because of raised water level in the nearby larger water bodies together with very low seepage and percolation rate. In some areas ground water level reaches the ground surface while the water level in the nearby canal remains above that during the monsoon. This, together with elevated foreshore of some of the areas, impedes rapid drainage and prolongs the duration of water stagnation until late December. Drainage congestion often occurs in most of the areas due to wanton mechanical obstructions by the influential local people and other vested interest groups in the internal drainage canals behind the sluices. All these contribute to the poor drainage conditions of the areas thereby practicing of high yielding varieties of *aman* rice is difficult.



Figure-5: Maps showing Noakhali Sadar and Subarna Char Upazilas

South part of Subarna Char, being coastal areas, experiences a daily cycle of low and high tide and the medium to lowlands of the unprotected areas is occasionally flooded with tidal water. Although this flooding occurs twice a day, the frequency of devastating tidal flooding of the crop fields varies considerably with the land type and proximity of the areas of the coast. Crops in areas close to the coast are affected by tidal flooding almost every year.

The storm surge or the raising of the sea level during the passage of the cyclone is another source of damaging flood and is a characteristic of coastal areas of Noakhali. However, not all cyclones are accompanied by storm surges. Storm surge damages infrastructure and crops by strong forces of water flow, flooding, salt and burial of land by sediments.

Agriculture is the predominant occupation in both the areas. A significant portion of people in Subarna Char are engaged in either fishing or fishing business. There are specific communities in Subarna Char whose only occupation is fishing (*Jaladash* community). Culture fisheries are common in Sadar Upazila.

3.4 Salinity in Satkhira

Satkhira district is located in the south west region of Bangladesh which is bounded by Jessore to its north east, Khulna to its south east, Bay of Bengal to the south, and India to its Western part. The entire landmass in Satkhira is deltaic, low lying and fluviially dominated, with a complex and varied landscape of forest, rice fields, ponds, lakes and river systems, subject to major seasonal changes with successive periods of monsoon flooding and winter drying.

Tala Upazila and Shyamnagar Upazila of Satkhira were selected as the study areas for Focus Group Discussion (FGD). The area of Tala Upazila is 344.15 sq km. Main rivers are Kobadak and Betna. Salinity problem is acute in this Upazila. Though water logging is one of the problems, but its extent is not near to that in Keshabpur (Jessore).



Figure-6: Map showing Tala Upazila

Number of population in Tala Upazila is 251388; among them 51.31 per cent are male, and 48.69 per cent are female; Average literacy is 29.7 per cent; where male are in advance compared to female, 38.1 per cent male are literate while it is only 20.8 per cent among the female. Main occupation is agriculture (45.95 per cent), with fishing 1.72 per cent, agricultural labourer 25.43 per cent, wage labourer 2.18 per cent, commerce 11.88 per cent, service 3.36 per cent, transport 2.51 per cent, others 6.97 per cent. Total cultivable land in Tala

Upazila is 26709.83 hectares, *khas* land is 1641.43 hectares; about 34.85 per cent land is single cropped, while almost 60.60 per cent land is double cropped and about 4.55 per cent land is triple cropped. Among the peasants, landless and marginal farmers constitute the largest portion (18.4% and 20.7% respectively); among the rest 39.4% small, 17.6% intermediate and 3.9% rich; cultivable land per head is 0.13 hectare. *Main crops* are Paddy, jute, wheat, potato, mustard seed, brinjal, tomato, chilli, onion, turmeric and varieties of pulse. *Extinct or nearly extinct crops* are Tobacco, linseed, *kaun* and coriander. (Source: Banglapedia, 2005).

Syamnagar Upazila is located to the south of the district and just bounded by the Sundarbans and Bay of Bengal to its south. River Raimongal, River Malancha, River Jamuna (locally called) and River Chunar are the major rivers. Salinity is the major environmental concern which severely affects agricultural production. Most of the soils are non-saline during the rainy season. Salinity of topsoil begins to increase when the monsoon rains end. In dry weather, moisture is drawn to the surface by capillary action and evaporates, leaving salt behind. Salinity level reaches its maximum in April before the monsoon rains begin. In

Shaymnagar a substantial landmass is affected by salinity in the dry season, with the yields of many crops restricted. Farmers grow jute, betel leaves, fruits and vegetables, mustard seed and oil seed, coconut, sugarcane and *goalpata* palm from which a molases product is produced. Many people earn their livelihoods from extractive activities in the Sundarbans. Fishing is an occupation of a significant number of families, either as a part time or full time activity. The major economic trend in Shaymnagar has been the emergence of aquaculture, particularly prawn and tiger shrimp farming.

Availability of sweet drinking water is the most pressing daily life concern that affects the entire living of the population here. The quality of the upper aquifer in areas south of Satkhira is poor because of salinity, which precludes its use as a source of irrigation water. The lower aquifers exploited by deep tube wells (DTWs) are of good quality. Irrigation abstractions cause drawdown of the water table over the dry season, with the lowest levels in Satkhira, especially in Shaymnagar. Arsenic is a particularly acute problem in this area.

3.5 Drought in Manda, Naogaon

Naogaon District is again located along the border between Bangladesh and India along the central western part of Bangladesh. Atrai River, a trans-boundary river, is the major perennial river which flows through the middle parts of the District. The Punarbhaba River flows along the western reaches while Nagar-Little Jamuna river system flows along the eastern parts of the District. Both the trans-boundary rivers (i.e., Atrai and Punarbhaba) carry very little flow during the long dry season (November-April). Simultaneously, the District receives scanty quantum of rainfall, especially during the dry season there is hardly any appreciable rainfall. The average annual rainfall is also low in this region, which is about 1350~1400 mm, compared to national average of around 2350 mm per annum.

A combination of very low rainfall availability and scanty flow regime in rivers give rise to moisture stress throughout the District, making it one of the drought vulnerable Districts of the country. Agriculture, especially the dry season (Rabi) cultivation is mostly dependent on groundwater resources, as surface flows are inadequate in regional rivers during the dry season. The groundwater aquifers are believed to be in healthy state, however there is a growing concerns that any intensification of groundwater based dry season cropping might lead to net mining of the resource from groundwater aquifers.

A part of Naogaon falls under the Barind Tract, an upland area which has been naturally uplifted just above the Ganges flood plains during the Pliocene period. Due to its upland nature, the soils have slightly different characteristics than those for floodplain soils. Consequently, the soils can hold lesser quantum of moisture and drain quickly, which add to vulnerability in terms of moisture stress and drought.

Agricultural drought is generally tackled by the farmers by drawing GW resource from underneath and mostly by employing a pump. Since there has been a gradual lowering of piezometric surface of the GW aquifer system in the region, GW-based irrigation has already become a constraint to dry-season agricultural activities, especially for the poor subsistent farmers. Any further stress on the available GW resource will therefore be detrimental to the poor farming communities of the District.



Figure-7: Map showing Manda Upazila. The area of Manda Upazila of Naogaon is about 376 sq km. Total number of population is 330,995, of which male is 50.56 per cent and female is 49.44 per cent; Main occupations constitute agriculture 52.67 per cent, livestock 1.19 per cent, fishing 2.57 per cent, agricultural labourer 25.88 per cent, wage labourer 2.18 per cent, commerce 7.19 per cent, service 1.91 per cent, and others 6.41 per cent. Cultivable land is 28,725 hectares where single crop is on 23.42 per cent, double crop 47.4 per cent and triple crop 29.18 per cent land area. About 71 per cent of cultivated land requires irrigation. Among the peasants 26 per cent are landless, 16 per cent

3.6 Riverine Flood and Riverbank Erosion in Kurigram

Kurigram District has been selected as an area which is frequently experiencing riverine floods and riverbank erosion. Kurigram is located in the north-western region of the country. It has common borders both in the north-east as well as in the north-west with India, while the eastern reaches are located in the flood plains of the Brahmaputra river (though, after entering into Bangladesh at Noonkhawa point, the Brahmaputra River is known locally as Jamuna River). The Brahmaputra River virtually bisects the District and greatly influences the hydrology of the region. The River Teesta flows along the western reaches of the District, while the Dharala River flows north-west to south-east direction and bisects the District. All the three rivers of the District overtop during peak monsoon and flood large parts of the District. Flooding is a major phenomenon, which occurs almost every year along the river banks. Even in an average hydrological year such as 2002 and 2003, moderate flooding has been observed throughout the District. However, the char (riverine sand bars) lands suffer from annual flooding, while the banks along the three major rivers are also vulnerable to floods.

Riverbank erosion is another major hazard in the District. The Brahmaputra River being a braided river, it is highly erosion-prone. Large parts of Kurigram Sadar, Roumari, Chilmari, and Ulipur Upazilas are vulnerable to riverbank erosion. In terms of riverbank erosion, the Brahmaputra River causes the most damage. During 1973-2007 a total of 18,210 ha of land of the District have been eroded by the River as against a mere 210 ha of net accretion (CEGIS, 2007). Between 2002 and 2006 the rate of erosion has shown slight increase; 1,847 ha land has eroded from the District. In 2006 alone, 200 ha land has been eroded with 13 ha

settlement areas, where 175 km rural road, 280 km active embankment and 335 km inactive embankments have also been eroded by the Brahmaputra River. Dharala river also causes erosion, though the extent of erosion is much less compared to that of the Brahmaputra River.

There is no available data on rainfall for the District. However, a GIS analysis suggests that, on an average Kurigram receives about 1900 mm rainfall per annum, which is somewhat higher than the average annual rainfall for the SW region of the country. The distribution of available rainfall is season-specific: over 80 per cent of which occurs only during the four months of peak monsoon.

Unlike rest of the Southwest region, Kurigram possesses abundant groundwater resources. No literature has been found which suggests that groundwater mining has been occurring in Kurigram district. However, the seasonal fluctuation of water table has been moderate. The lowered groundwater table reduces the already precarious dry season flow of the rivers in the region, putting their ecology at risk. Surface water quality is poor and characterized by pollution due to low prevalence of sanitary latrines in the rural areas, lack of sewage collection and treatment in the urban areas, industrial pollution, agro-chemical residues etc.

The study area is the Char Araji Palashbari Village of Holokhana Union, located in Kurigram Sadar Upazila. Population of Kurigram Sadar is 217311; of which 51.01 per cent are male and 48.99 per cent are female (BBS, 2003). Main occupation of the population is agriculture. Some 34.81 per cent are farmers; other occupational groups constitute agricultural laborer

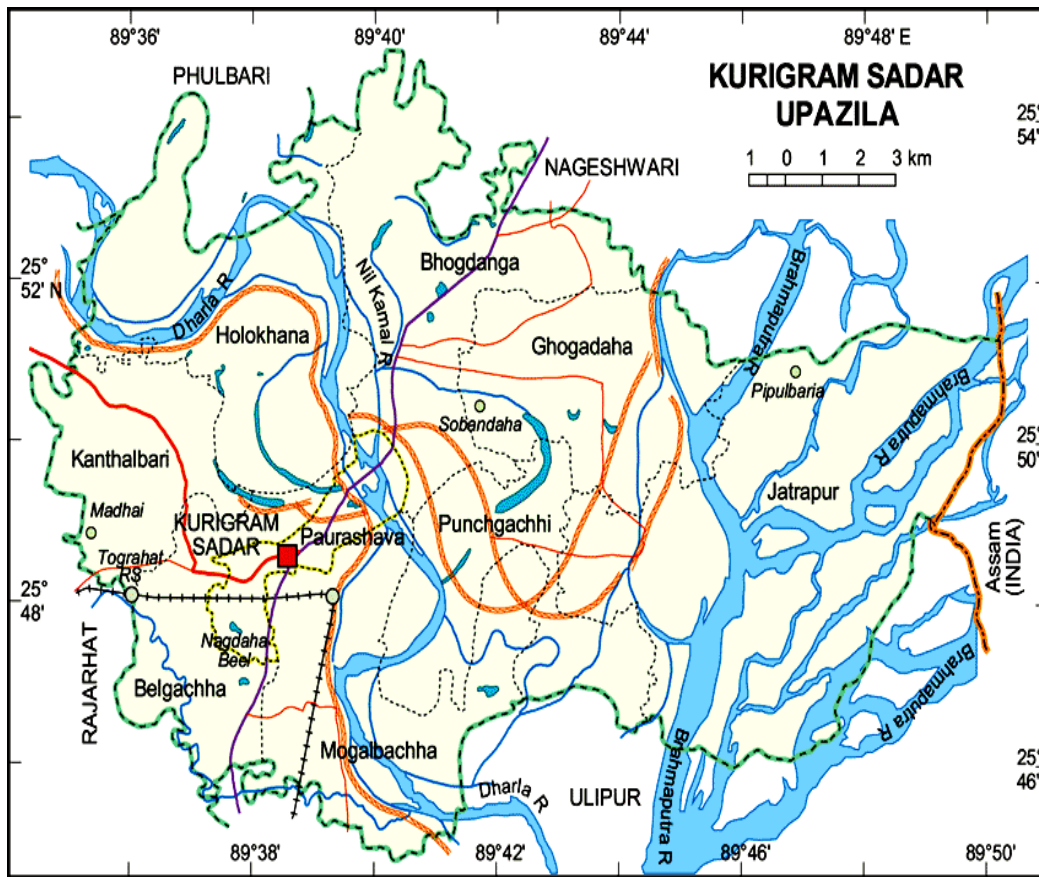


Figure-8: Map showing Kurigram Sadar Upazila

(25.63 per cent), traders (10.91 per cent), wage labourer (4.56 per cent), service (8.24 per cent), transport (3.21 per cent) and others (12.64 per cent). Total cultivable land is 18,300 hectares, fallow land 553 hectares; single crop land 22.93 per cent, double crop 62.93 per cent and triple crop land 14.14 per cent. Cultivable land under irrigation is 31.72 per cent. Main crops are Paddy, jute, wheat, kaun, potato, corn, peanut, bamboo, vegetables etc. Among the peasants 30 per cent are landless, 28 per cent small, 35 per cent intermediate and 7 per cent rich; cultivable land per head 0.08 hectare¹⁶.

3.7 Riverine Flood in Char Harirampur, Faridpur

Faridpur is a riverine District located in the central region of the country. The River Ganges, locally named Padma, flows perennially between Faridpur and Dhaka Districts. The north-eastern reaches demarcate the border between Rajbari District and Faridpur District. The River Madhumati, one of the major tributary of Ganges, flows between Magura and Faridpur Districts. Madaripur District is located on the eastern reaches while Gopalganj and Narail Districts are located in the south of the Faridpur District.

As a part of the central region of the country, Faridpur District receives about 2400mm of rainfall on an average hydrological year (June till mid-October). However, local rainfall and consequent runoff are not the determining factors that bring in hydro-geophysical vulnerability to the population of the District. The regional flow pattern of the Ganges and the rainfall distribution along the Ganges Basin are the major drivers of hydro-geophysical vulnerability of the District.

The hydrology of the Faridpur District is greatly influenced by the hydrology of the Ganges River. Being a wide river, there are a number of char lands (sand bars) in the river. These char lands are part of the District and are subject to both annual flooding as well as occasional bank erosion. Both flood and riverbank erosion therefore provide the major hydrological context of vulnerability of the District.

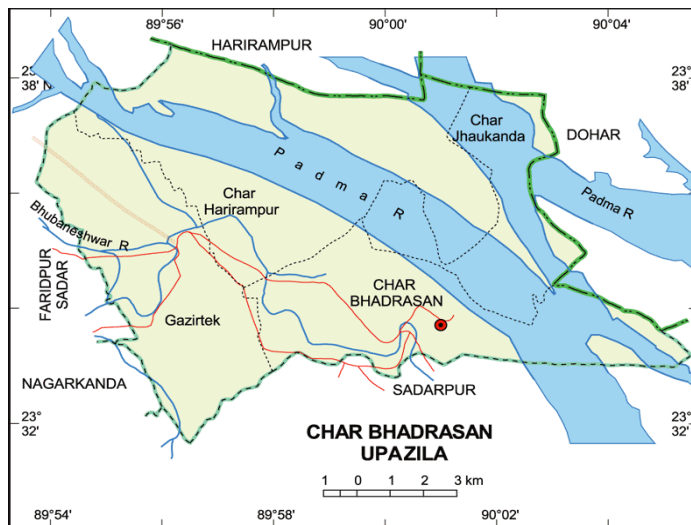


Figure-9: Map showing Char Bhadrasan Upazila

Flooding occurs either when water pool effect takes place at any of the two major confluences: (a) one between the Ganges and the Brahmaputra Rivers, and (b) the other between the Meghna and the Padma Rivers. Drainage congestion often contributes to such floods, which has become almost an annual event in the recent past. However, major flooding occurs when the River Ganges swells and overtops its banks. Usually the occurrence of the two events takes place with a

time lag of about two weeks. Ganges flooding generally takes place in mid to late August,

¹⁶ District level data are collected from District Information Office of respective Districts.

while drainage congestion induced flooding takes place in mid-July to mid-August. Sometimes, the timing of the two events merge, which results into the occurrence of Mega Flood events, as it occurred during 1998. Such floods not only inundate Faridpur District, but the entire central and south central regions of the country.

When flood water recedes, erosion takes place along the Ganges River. However, pre-monsoon erosions are also common, though the intensity varies quite considerably. Of course, the char lands are the most severely affected due to frequent erosion. It has been reported that both the banks of the Ganges River are subject to riverbank erosion (CEGIS, 2007b).

Char Bhadrasan is an Upazila of the District, which is located just on the right bank of the River Ganges. The Upazila has a number of chars, one of which is called Char Harirampur. The latter is exposed to and repeatedly affected by a particular type of hazard - flood, with concomitant river bank erosion due to shifting of river channels.

Char Bhadrasan Upazila consists of one mouza with an area of about 28 sq km. It has a population of 69,876, of which 51.35 per cent is male and 48.65 per cent is female. Main occupational group consists of agriculture 46.95 per cent, fishing 1.63 per cent, agricultural labourer 20.97 per cent, wage labourer 2.82 per cent, commerce 7.38 per cent, transport 2.92 per cent, service 5.06 per cent, and others 12.27 per cent. Land use consists of 9,804 hectares of cultivable land and 134 hectares of fallow land. Interestingly, in Char Bhadrasan about 51.19 per cent land is doubly cropped and 39.22 per cent land is singly cropped. In contrast, almost all the lands in Char Harirampur are not cultivable during the monsoon season and are classified as singly cropped. In Char Bhadrasan, the main crops are paddy, sugarcane, jute, wheat, onion, peanut, garlic and pulse. Extinct or nearly extinct crops are sesame, linseed, *kaun* and *kusumphul*. Main fruits are papaya, coconut and betel nut. There are 17 Fisheries, 6 dairy, 21 poultry, and 3 hatchery in the Upazila, offering very limited opportunity for non-agricultural employment. Main exports from the Upazila are jute, onion, garlic, sugarcane molasses and pulse.

Unlike Char Bhadrasan, the riverine Char Harirampur has just one cropping season – the Rabi season. Since the lands are silty in nature, crops of lesser economic value are generally grown in early rabi season, especially just following a flood season. However, most of the farmers make out a living by growing Boro rice, though the productivity of Boro is found to be much lower than the average national yield. Other than Boro, people grow peanuts and even potatoes, often with the help of limited scale surface water irrigation by means of local irrigation techniques. Since farming opportunity in the Char is reduced to just one crop season, the poor farmers find it extremely difficult to maintain their livelihoods. Moreover, the opportunities for year-round livestock rearing and homestead afforestation are not considered seriously as the lands undergo frequent seasonal inundation. Interestingly, in char Harirampur dry seasonal livestock rearing is a common occupation for the char dwellers.

The hydro-geophysical and economic contexts of vulnerability are exacerbated by prevailing social elements of vulnerability. Char dwellers often do not enjoy the same social status as the mainland people. Charland people frequently are forced to relocate, especially during peak flood periods and following severe erosion spells. That is why, char dwellers often do not have a permanent address, a necessity to be accepted socially with due respect. In one hand, their abject poverty also put them in socially derogatory position. On the other hand, it is the poverty which force them to stay in the chars and struggle to maintain livelihoods with

the given opportunity of only one cropping season. A combination of these factors creates a nexus between char dwelling and being poor.

3.8 Flash Flood in Deerai, Sunamganj

Sunamganj District is located in the North-Central (NC) Region of the country, which is bound to the east by Sylhet District, to the south by Habiganj and Keshoreganj Districts, and to the west by Netrokona district. The northern part of the District demarcates the border between Bangladesh and India. Sunamganj, along with Sylhet, Keshoreganj and Netrokona constitute the bowl-shaped depression basin of the country, locally called haor. A number of ecologically important haors are located in Sunamganj. A haor generally acts as a natural water storage area during April to November. Haors act as natural fish habitats while inundated. However, following the peak monsoon period, haor lands are deliberately made water-free (by pumping out water) in a bid to cultivate Boro paddy.

Sunamganj is criss-crossed by a number of perennial and seasonal rivers. Both the tributaries of Meghna River, the Surma and Kushiya Rivers flow across the District. The Sunamganj District township is located on the banks of Surma River, which is a perennial river. The other important rivers are all flashy in nature, swell high during early showers of April and May and only recede during October-November. Such flashy rivers include Jadubata River, Balui River, Rakti River, Sabdevpur River and Someswari River. These rivers receive runoff from the wettest parts of the world, Cherapunjee and its adjacent areas in India, and carry all the water within hours of an intense shower. Due to extremely short lead time, it becomes impossible to forecast a flash flood event. As a result, people are generally caught unprepared and the onrush of water sweeps everything from its course.

Generally, with the first showers in early April these haors got inundated within a very short time. Early inundation did not allow farmers to harvest almost-matured boro paddy, since traditional Boro reached its maturity in the second week of May. With the help of structural interventions, dwarf embankments had been erected along each of these haors by the Bangladesh Water Development Board (BWDB) with a notion that the structures would hold water and delay complete inundation of paddy fields inside a haor for a few days allowing farmers to harvest matured paddy. Following the harvest, with further rise in water levels, it was expected

that the embankments themselves would be inundated along with the haor land. Such ‘submergeable embankments’ have transformed haor wetlands into seasonal paddy fields and have been contributing to a significant proportion of national food grain production in recent



Figure-10: Map showing Deirai Upazila

decades. Unfortunately, in some hydrological years water overtops the dwarf embankments early due to excessive rains and destroy matured paddy within the haor basin.

Deerai is an Upazila which is located to the southern part of the District and it is very close to the Haor basin. The total area of Deerai Upazila (Sunamganj district) is about 421 sq km, Main rivers are Surma, Piyain, Kushiya, and Dahuka. Deerai upazila consists of 9 union parishads, 165 mouzas, and 233 villages. Population is 185,284; among them male are 51.38 per cent and female are 48.62 per cent. As evident from the statistics, the population density of the Upazila is rather low compared to other parts of the country, which can be considered as a manifestation of the degree of difficulty for the poor people to eke out a living inside the Haor basin. Since flash flood occur frequently and maul standing crops, people do not feel like accepting the damage and stay back. Livelihoods vulnerability of people living there is perhaps among the highest compared to other parts of the country.

Main occupation in Deerai is agriculture (45.24 per cent). Arable land is 32,061 hectares, among them cultivated is 26,061 hectares, uncultivated arable land 2,913 hectares, barren land 3,087 hectares; and *khas* land 184 hectares. Single cropped land is about 87.58 per cent, which also tells that most of the land is inaccessible for cropping for their other seasons. Double cropped land is 12.42 per cent. Land under irrigation is 14,490 hectares. Among the peasants, 9.07 per cent are landless, 20.95 per cent belonging to marginal farmers class, 38.03 per cent are small farmers, 23.30 per cent are medium size farmers and 8.65 per cent are rich. The main crop is Boro, however, among the double cropped land people grow mainly Aman paddy. Jute is nearly an extinct crop.

Within the haor basin, the villages are generally located in high lands. During monsoon, the clusters of dwellings look like created safe havens in the middle of water. All other human infrastructures are located in those highlands so that those do not become inundated and get ruined. The roads are often become inaccessible during peak monsoon. Providing and maintaining basic services in the haor villages during peak monsoon becomes a management nightmare. While winters come with lots of activities and possibilities, life becomes stand and still during each monsoon.

3.9 Flash Flood in Garo Hills, Mymensingh

Mymensingh District is located in the North Central (NC) region of the country. The northern boundary has a common border with India, separated by Garo hills. The eastern side is demarcated by Netrokona and Kishoreganj Districts, while Jamalpur and Tangail Districts demarcate the western side. Gazipur District bounds the southern reaches of the District. The major hydrological feature of the District is the Old-Brahmaputra river and its distributaries (Mahari, Sutija and Banar Rivers/rivulets), which is a perennial system. However, during the dry season the OB system carries scanty amount of flow and the flow volumes of its distributaries are found to be decreasing with time in recent years. Old-Brahmaputra brings in huge quantum of water during each monsoon, which generally inundates large low-lying areas along the Brahmaputra flood plains. Floods therefore are quite common in the region.

The other feature of the District is the Garo Hills, a natural abode to the hill tribe named after the Hill (i.e., Garo ethnic group) who has been living in the region since ages with distinct cultural and social identity. The foot hills are located in Bangladesh, while the larger hills are located in India. The region receives good amount of annual rainfall (about 2200 mm/year). However, the pre-monsoon local convection induced rainfall (during early to mid-April)

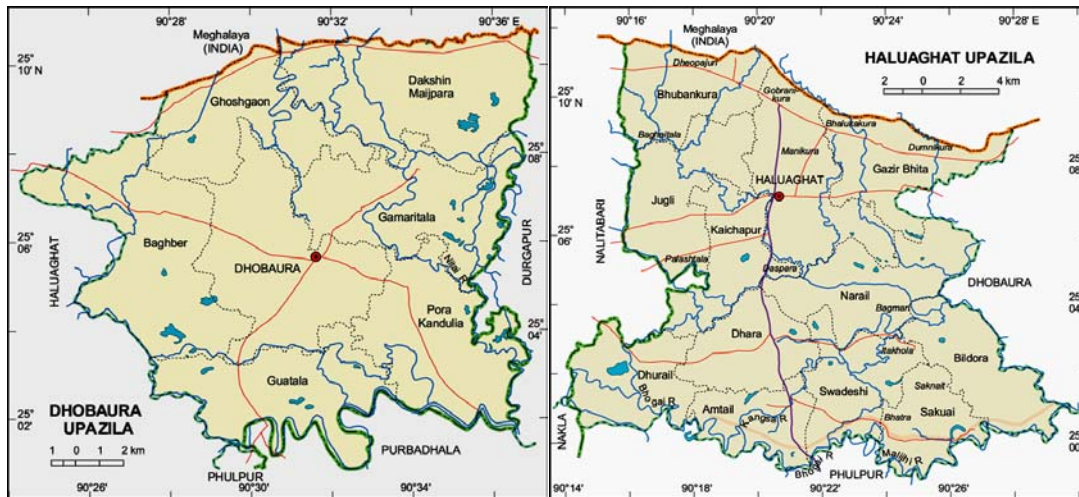


Figure-11: Maps showing Dhobaura and Haluaghat Upazilas

often transforms local rivulets into flashy rivers and the runoff often swells the north-south bound Kangsha River System. The District, therefore, becomes flash flood prone during April and early-May and becomes flood prone during peak monsoon. Flood generally occurs along the OB system and also along the Kangsha system, while flash flood generally occurs along the smaller rivulets adjacent to the Garo Hills.

Since Garo ethnic community lives along the foot hills of the region, they are easy victim of flash floods. Flash floods are short lived phenomenon (only a few hours of intense rainfall can effectively make the area inaccessible for over a day or two). However, the quickly on-setting nature of the hazard washes away almost everything on the way of rushing runoff. Not only standing crops are devastated, physical infrastructure (especially roads and poorly constructed culverts) are often washed away. Dhobaura and Haluaghat upazilas are perhaps the worst victims of flash flood in the District.

Since Mymensingh District receives a good amount of annual rainfall, its cropping practices depend on both rainfed agriculture as well as irrigated agriculture. In the dry season, most of the lands are generally irrigated, owing to availability of adequate amount of groundwater from shallow aquifers. The southern parts of the District, especially in Bhaluka Upazila, the lands are hardly inundated, which offers a unique opportunity for aquaculture. Indeed, in recent years, crop lands are deliberately transformed into excavated ponds to facilitate year-round aquaculture. Fulpur Upazila, however, has also been enjoying low vulnerability to flooding. As a consequence, the farmers have been opting for horticulture (pot/decorative flower production) in lieu of traditional crops (rice etc.), which has been providing them with great dividends. Interestingly, not all the Upazila could take advantage of such suitable ecological conditions and are subject to certain levels of hydro-geological vulnerability.

The study area is Dhobaura Upazila, which occupies a landmass of about 251 sq km. The size of population is 157,027, of which males are 50.52 per cent and females are 49.48 per cent. Average literacy rate is 18.7 per cent (male 23.6% and female 13.6%), much lower than national averages. Among the major occupational groups, agriculture constitutes 52.6 per cent, agricultural labourer 27.84 per cent, commerce 6.14 per cent, service 1.65 per cent, wage labourer 2.29 per cent, livestock, forestry and fishery 1.84 per cent, and others 7.64 per cent. Main crop is paddy. Extinct and nearly extinct crops are jute, mustard seed, sugarcane,

tobacco, sesame, aus paddy and asheena paddy¹⁷. Main fruits are jackfruit, mango, banana, papaya. There are 8 Fisheries, 3 dairies, 23 poultries and 1 hatchery in the Dhobaura Upazila.

3.10 Coastal Tidal Flood in Chakaria, Cox's Bazar

The area of Chakaria Upazila is 643.46 sq. km. The devastating cyclone and tidal bore of 29



Figure-12: Map showing Chakaria Upazila

April 1991 caused serious damage to the upazila with a death toll of 16,705 persons.

Number of Population is 409346; among them male are 51.48% and female are 48.52%. The major occupations of the population is agriculture 29.55%, fishing 2.03%, forestry 1.56%, agricultural labour 24.5%, non-agricultural labour 6.74%, commerce 14.02%, service 4.96%, transport 1.98% and others 14.66%. Cultivable land is 27142 hectares, fallow land is 180 hectares; single crop 27.6%, double crop 61.66%, triple crop 10.74%. Cultivable land under irrigation is 79.18%. Among the peasants, 20% are landless, 24.28% are marginal

peasants, 28.57% are small peasants, 20% intermediate and 7.15% rich; cultivable land per head is 0.7 hectare. Main crops are paddy, potato, mustard, pepper, maize, sugarcane, wheat, ground nut, betel, tobacco, watermelon, vegetables etc. Extinct and nearly extinct crops are Lentil, vetch, *kaun*, linseed, onion, garlic, turmeric and ginger.

3.11 Urban Flood in Dhaka City

Dhaka – the Capital City is located at the central region of the country, along the banks of a number of rivers: the Tongi Khal (rivulet) in the north, the Balu River in the east, the Turag River in the west, and the Buriganga River in the south. Although the city-scape is surrounded by all these rivers, the newest mega city does not often get flooded – thanks to the western embankment along the Buriganga and the Turag Rivers and the major national highway connecting the northern Districts and acting as a virtual embankment. These structures are high enough to protect the urban landscape from being flooded in any moderate flooding event. However, in an ultra high flood event such as the case of the 1998 deluge and 2004 flood, Dhaka too gets inundated.

Unlike its western side, the eastern side of Dhaka City is not yet protected from flooding. The absence of the part of the Dhaka embankment system in the eastern side, vast low lying areas of Shabujbagh, Demra and Uttara Thanas (i.e., Police Stations) become inundated

¹⁷ A recently lost variety of paddy which used to be harvested in Ashwin month of Bengali calendar (mid-September to mid-October), much earlier than usual harvest time for Aman (December). This variety has been traditionally grown in a bid to avoid mid-Kharif season hunger (locally known as Monga).

occasionally. Rise in water level during peak monsoon in the adjoining rivers can be attributed to such inundation.

Other than riverine causes, parts of Dhaka city are often inundated due to drainage congestion, especially after a moderate shower spell. Intense rainfall of over 35mm can easily trigger drainage congestion and short-duration inundation of city areas. The area within the Dhaka-Narayanganj-Demra (DND) embankment becomes inundated due to very poor drainage system. Shantinagar area under Ramna Thana is a place which is known for its unusual vulnerability to drainage congestion for the past three decades. The low lying areas of Mohammedpur and Dhanmondi Thanas often become temporarily water logged due to inadequate and/or faulty drainage system.

The hydrological realities are compounded by poor water management and lack of good governance. Dhaka Water and Sewerage Authority (DWASA) have so far largely failed to cope up with increasing population and sewerage demand. Moreover, the DWASA drainage system predominantly consists of underground pipes, which are easily clogged with polythene sheets, construction debris, and indiscriminately thrown objects such as green coconuts etc. Due to these obstructions, the pipes do not often perform optimally, resulting in delayed discharge of water into the adjoining rivers.

To add to the misery, the natural water retention ponds/depression areas around the city have already been filled up in a bid to accommodate increasing population. Such a deliberate but illegal act on the part of 'urban developers' has resulted in drastic reduction of water storage capacity of the urban landscape, which have certainly aggravated water congestion. Sometimes, land grabbers fill up discharge canals within the city and further reduce discharge capacity. Despite clear legal provisions, City Development Authority (i.e., RAJUK) often allows construction on encroached lands and contributes to the deterioration of the water logging condition.

Dhaka is inhabited by a large population, some 130 million people live in about 430 sq. km area. The population density of Dhaka is the highest in the world. Although the capital city does not look like as the capital of an LDC, there are areas within the city where a large number of poor people find themselves in unacceptable living conditions. Over 10 million people are practically floating people, while another million people are living in either squatters or in slum areas. Rikshaw (non-mechanized three wheeler) pulling offers a great source of informal employment to over 1.6 to 1.8 million people. Many people find self-employment by serving these rikshaw pullers. Moreover, construction sector employs a large number of poor people, while another large population is engaged in formal transportation system. Over 1.6 million people, most of them being women, are engaged in Ready Made Garment (RMG) industries – the largest industrial activity in the country. There is no specific updated data on occupational diversity in the ever changing mega city. However, the concentration of the poorest of the Dhakaites can easily be located in the most low lying areas such as Shabujbagh, Uttara, Mirpur and Mohammedpur Thanas. It is ironical to note that all these Thanas represent the most vulnerable areas to drainage congestion and occasional inundation.

During high flood events, Dhakaites rise to the occasion and offer various services to flood victims. As has been observed during the high intensity rainfall event on 13th September 2004, over two million people had been forced to live outside their inundated shanty homes and were provided with temporary shelters even in the garages of high rise buildings. During

the deluge of 1998, large quantum of food and safe drinking water had been distributed by Dhaka dwellers to flood victims within and just outside Dhaka city. However, no such extraordinary effort has been observed during frequent drainage congestions caused by occasional intense rainfall. It is intriguing to note that the vulnerability to such frequent drainage congestion in Dhaka has been on the rise.

Kathalbagan is an area under the Dhanmondi Thana of Dhaka District. The total area of Dhanmondi Thana (DHAKA district) is about 7.74 sq km. Dhanmondi thana was established in 1976. It consists of three wards, 20 mouzas. Population is about 162088; among them male are 54.87%, female are 45.13%; Main occupations are

Industry	2.32%
commerce	27.6%
service	41.68%
construction	2.71%
transport	6.33%
house renting out	4.61%
others	14.75%

100% area is urbanized; residential is 70%, commercial 8%, office 2%, public use 10% and low lying land is 10%. Extinct or nearly extinct crops are paddy, jute, sugarcane, pulses.

Main exports are ready made garments, handicrafts, leather goods, etc.

3.12 Coastal Erosion in Char Fassion, Bhola Island

The South Central Region covers approximately 22,730 km² or 15% of the country. The area is bounded by the Ganges-Padma to the North, by the Bay of Bengal to the South, the lower Meghna River to the East and the SW region to the West. The major rivers and the drainage of the southern part of the area are tidally influenced and saline intrusion up the river is a feature for many kilometres inland. Hence, salinity and tidal surge is very common in some parts of the region. Hotspots for industrial pollution are Barisal, Faridpur and Kamarkhali. River bank erosion and flood are the two major problems of the area.

Agriculturally, the region is moderately developed, with a current net cropped area estimated at 2098 km². Rice occupies 72% of the net cropped area, the remaining crops being jute, wheat, potatoes, oil seeds and pulses.



Figure-13: Map of Dhanmondi Thana

The landform consists of a complex of inter-linked and overlapping alluvial deposits, in the delta of the Ganges-Brahmaputra-Meghna River system. Also with its fresh and brackish water habitats, the region supports many fish species, with the Tetulia River west of Bhola Island an important migration route for Hilsa species.

The area of Charfasson Upazila of Bhola district is about 1106.3 sq km. Population is 342038; male 51.49% and female 48.51%; Average literacy is 25.4%.



Figure-14: Map of Char Fasson Upazila

Main occupations are agriculture 41.51%, fishing 5.28%, agricultural laborers are 25.85%, wage laborer 5.1%, commerce 7.12%, service 3.11%, others 12.03%. Land use Total land 56997.16 hectares, cultivable land is 47221.77 hectares, fallow land is 9775.39 hectares; single crop is 27%, double crop is 57%, triple crop 16%, Main crops in Bhola are Paddy, wheat, chilli, pulses, peanut, betel nut. Extinct and nearly extinct crops are local varieties of paddy, jute, sesame and linseed. Main fruits are mango, jackfruit, papaya, and banana. Cottage industries are weaving, mat work, tailoring, goldsmith, blacksmith, and welding, wood work. Hats and bazars are 45, most noted of which are Charfasson, Dular Hat, Goldar Hat, Letra Bazar, and Chairman Hat. Main exports are Paddy, chilli, pulses, peanut, betel-nut, hilsa fish and shrimp.

4.0 IMPACTS ON WOMEN AND SPECIAL VULNERABLE GROUPS

Climate change is often perceived as a multi-dimensional environmental problem with a strong political and development component. The impacts of global climate change are not only physical and economic (for instance, in the form of natural disasters), but also social and cultural, threatening to jeopardize environmentally based livelihoods in many areas of the world.

As predicted by the IPCC, “... *climate change impacts will be differently distributed among different regions, generations, age classes, income group, occupations and genders*” (IPCC, 2001b). The IPCC also notes: “... *the impacts of climate change will fall disproportionately upon developing countries and the poor persons within all countries, and thereby exacerbate inequities in health status and access to adequate food, clean water, and other resources.*” People living in poverty are more vulnerable to environmental changes.

4.1 Women’s Context of Vulnerability with Reference to Physical and Social Setting

The gender-poverty links show that 70 per cent of the poor in the world are women and their vulnerability is accentuated by race, ethnicity, and age (Enarson and Morrow, 1998). When natural disasters and environmental change occur, women and men are affected differently because of traditional, socially-based roles and responsibilities (GTZ, 2005).

The contexts of vulnerability to climate change are somewhat different for women, since they have lesser financial means and decision-making power than their male counterparts to respond to climate-driven stresses. Moreover, as being the household manager women have to bear the burden of meeting the needs of the family, even when fighting against adversities. Most climate change issues, policies and programs are not gender neutral. In light of this, several areas deserve attention, specifically: gender specific resource-use patterns; gender-specific effects of climate change; gender related patterns of vulnerability; women’s capacity to cope with climate change; gender and decision-making on climate change; and gender aspects of mitigation and adaptation.

4.1.1 Women are affected differently and more severely

The effects of climate change manifested in the increase of extreme weather conditions such as hot summers, droughts, storms or floods, impact women more severely than men, both in developing and in developed countries. For example, the 20,000 people who died in France during the extreme heat wave in Europe in 2003 included significantly more elderly women than men.

In natural disasters that have occurred in recent years, both in developing and in developed countries, it is primarily the poor who have suffered — and all over the world, the majority of the poor are women, who at all levels earn less than men. In developing countries, women living in poverty bear a disproportionate burden of consequences of climate change. Because of women’s marginalized status and dependence on local natural resources, their domestic burdens increased, including additional work to fetch water, or to collect fuel and fodder. In some areas, climate change generates resource shortages and unreliable job markets, which lead to increased male-out migration and more women are left behind with additional agricultural and household duties. Poor women’s lack of access to and control over natural resources, technologies and credit mean that they have fewer resources to cope with seasonal

and episodic weather and natural disasters. Consequently traditional roles are reinforced, girls' education suffers, and women's ability to diversify their livelihoods (and therefore their capacity to excess income-generating jobs) is diminished (Masika, 2002; Denton and Parish, 2003).

Following the cyclone and flood of 1991 in Bangladesh the death rate was almost five times as high for women as for men. Warning information was transmitted by men to men in public spaces, but rarely communicated to the rest of the family and as many women were not allowed to leave the house without a male relative; they therefore were perished waiting for their relatives to return home and take them to a safe place. Moreover, as in many other Asian countries, most Bengali women have never learned to swim which significantly reduces their survival chances in case of flooding

An Oxfam Report on the impacts of the 2004 Asia Tsunami on women raised alarms about gender imbalances since the majority of those killed and among those least able to recover were women. In Aceh, for example, more than 75 percent of those who died were women, resulting in a male-female ratio of 3:1 among the survivors. As so many mothers died, there have been major consequences with respect to infant mortality, early marriage of girls, neglect of girls' education, sexual assault, trafficking of women and prostitution. These woes, however, are largely neglected in the media coverage (Deepa Kandaswamy, 2005).

Climate change, which reduces crop yields and food production particularly in developing countries, affects women's livelihood strategies and food security, and therefore their right to food. Women are responsible for 70-80 per cent of household food production in Sub Saharan Africa, 65 per cent in Asia, and 45 per cent in Latin America and the Caribbean. Traditional food sources may become more unpredictable and scarce as the climate changes. Droughts and flooding can be detrimental to women who keep livestock as a source of income and for security. Women's knowledge and experience of maintaining bio-diversity through the conservation and domestication of wild edible plant seeds and food crop breeding is the key to adapting to climate change more effectively.

Both in developing and in developed countries women are primary caregivers, combining the care for children and the elderly with their domestic and income-earning activities. These additional responsibilities place additional burdens on women impacting their ability to work outside the home and to deal with the effects generated by environmental changes caused by global warming.

In a study executed on behalf of ACTIONAID in 1993-1994 in the Himalayan region of Nepal, it became clear that environmental degradation has compounded stress within households and pressure on scarce resources. This meant that the pressure on children, particularly girl children, to do more work and at an earlier age was increasing. Girls do the hardest work; have the least say and the fewest education options. Programs that concentrate only on sending more girls to school were failing as the environmental and social conditions of the families deteriorated (Johnson *et al.*, 1995).

In traditional societies women are even more vulnerable to the impacts of climate change because they are often not allowed to participate in the public sphere, and are therefore less

likely to receive critical information for emergency preparedness. They are also less mobile due to strict and gendered codes of social behavior, and have lesser chances to escape from affected areas.

As reported by the gender disaster workshop in Ankara (DAW-UNISDR, 2001), “Women’s human rights are not comprehensively enjoyed throughout the disaster process. Economic and social rights are violated in disaster processes if mitigation, relief, and reconstruction policies do not benefit women and men equally. The right to adequate health care is violated when relief efforts do not meet the needs of specific physical and mental health needs throughout their life cycle, in particular when trauma has occurred. The right to security of persons is violated when women and girls are victims of sexual and other forms of violence while in relief camps or temporary housing. Civil and political rights are denied if women cannot act autonomously and participate fully at all decision-making levels in matters regarding mitigation and recovery” (DAW-UNISDR, 2001).

4.1.2 Women are under-represented in decision-making

Women’s role in communities is not formally recognized or accounted for in mitigation, adaptation and relief efforts. Women’s knowledge about ecosystems and their strategies, experiences and skills for coping with natural disasters and water shortages, are often ignored (Dankelman, 2002). Strategies and policies to cope with climate change often neglect the gender dimensions of climate change and the current gender-climate change agenda. Women are poorly represented in planning and decision-making processes in climate change policies, limiting their capacity to engage in political decisions that can impact their specific needs and vulnerabilities (Enarson, 2002, Climate Alliance, 2005). Vulnerability and mitigation are part of the 1988 IPCC Agenda, but gender perspectives have still not been incorporated in its work. The level of women’s participation in planning and decision-making on climate protection is very low even in industrialized countries, and this is linked above all to the heavily technical nature and male dominance in key areas of work; energy, transport, town planning. Consequently, it is generally men who profit more from the newly emerging jobs in these areas, be it renewable energies or emissions trading.

4.2 Perceived Impacts of Climate Change in Bangladesh: Views from the Field

4.2.1 Cyclonic Storm Surge in Coastal Islands

Cyclone is a natural disaster for which strong warning system has already been developed. In spite of that, many people become victims of cyclone and associated storm surge every year. Among them women are differently vulnerable than men in the society for various physical and social reasons.

Two separate FGDs, one each in Dholghata Island (of Cox’s Bazar District) and the other in Bhola Island (of Bhola District), have been conducted with women to understand their perceptions regarding climate change related vulnerability. A number of climatic hazards²⁰ have been identified by the FGD participants, which include the following: (a) cyclone, (b) tidal flood, (c) iron in drinking water, (d) salinity intrusion, (e) fog, (f) hail storm, (g) tornado, (h) water logging, and (i) thunder storm.

²⁰ Women in Chakaria misunderstood by identifying earth quake as a climate induced hazard.

When asked to prioritize their major context of hydro-geo-physical vulnerability, women in Dholghata clearly mentioned tidal surge, associated with high speed wind due to cyclone as being the most destructive of all hazards. The hazards are prioritized by the women, which are summarized in Figure-15. Salinity intrusion, especially contamination of drinking water sources by saline water following a high intensity cyclone event appeared to be second most important vulnerability concern for the women in Dholghata. However, women in Char Fassion of Bhola island) identified cyclone as the most damaging vulnerability concern, which was followed by saline water logging due to high neap tide. Death and destruction of dwellings and food insecurity have been identified as common results associated with such vulnerability concerns.

Women in the coastal areas are aware about issuance of warnings. However, they have informed that their male counterparts receive the warning first and sometimes do not pass on the information to their respective family members. Consequently, women generally fall victim to delayed response to such warnings. Even if the warnings are conveyed quickly enough, the male members often rapidly quit after giving the warning, but the women cannot act as promptly as their respective counterparts. They manage the whole household and take

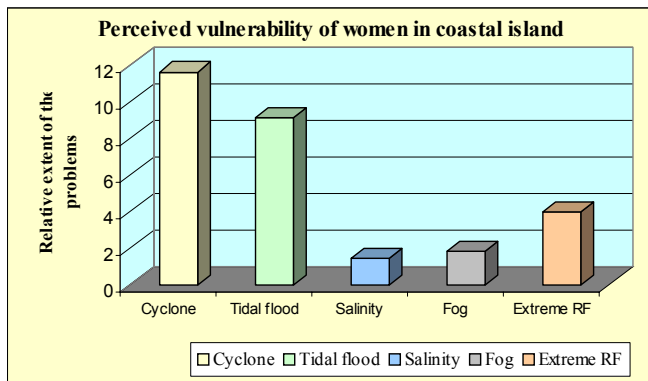


Figure-15: Climate Driven Problem Prioritization

precautionary measures to safeguard all the assets including livestock before taking temporary refuge to cyclone shelters.

Often, in cases, women do not go to the cyclone shelters due to 'insecure' environment over there and instead, they prefer to stay back during the cyclone. Such deliberate actions are results of social insecurity; they do not necessarily demonstrate their fatalistic attitude towards an

imminent disaster as has been portrayed by various researchers. Many women send their children with their counterparts but do not feel comfortable going to the cyclone shelters. A large fraction of the FGD participants find the condition of such shelters being unhygienic and they complain that the only toilet in the entire shelter complex is generally being kept under lock and key by the members of local management of the shelter. Even, in cases, when the women are willing to take refuge in such shelters, their husbands are often found to be reluctant to accompany them due to anticipated adverse social and religious responses.

If the shelter is inaccessible or too far away, families take shelter in a neighboring embankment (if available) under open sky, where the women spend days in insecure condition. Those who dare to cross long distance to reach out a shelter on foot, often they fall prey to local miscreants (i.e., *mastans*). Young and adolescent girls are harassed sexually if not accompanied by a number of adult women. The women in the coastal zone find it physically risky to take refuge if not accompanied by males. Elderly women and pregnant women find it even more difficult to walk along muddy rural roads under stormy conditions. After issuance of a warning, they do not often find a rural vehicle to go to a shelter.

The design of cyclone shelters in Bangladesh is not found to be gender-friendly, as reported by coastal cyclone vulnerable women. Multi-purpose cyclone shelters are generally built on high stilts, deliberately so in a bid to avoid tidal surge. However, the stairs are reportedly steep and unfriendly for the elderly women, children, disabled women and pregnant women. Almost no cyclone shelter has a ramp to safely carry the disabled persons and pregnant women. During Cyclone, it is a common scene that people are taking their pregnant members on their laps and moving upwards by the sharp stairs with heavy risk. There is hardly any designated space for lactating mothers and pregnant women to either serve the infant or have a breather. Adequacy of privacy for women, though for a few hours of staying at the cyclone shelter, seems to be socially important criteria which appear to be missing in current practices.

The capacity of cyclone shelters is found to be very low and decreasing further with increasing population. The cyclone shelters become full and even beyond capacity during cyclones. People have to defecate right at the places where they find a place to stand up. In such circumstances, women suffer a lot. Due to inadequate capacity of existing shelters, women find it overcrowded during the course of a cyclone. Young males often take advantage of physical proximity of a young girl while all the temporary refugees are cramped in a small room. A young unmarried girl complains “... *we certainly save our lives, but we lose self dignity*”. One aged women in Bhola raised her concerns by saying “... *nobody seems to care about these nitty-gritty details of coping facilities. As if, saving lives solves the entire problem. We need to go back to normal life and for that, we need to maintain our dignity as well. One must not forget this*”. Sexual abuse is one important reason for which women are mostly forced not to go to cyclone shelters during cyclones. Women report that there are cases of abortion and miscarriages in the cyclone shelter only because of the crowded condition.

The after effect of cyclone is even more serious. Destruction of houses leads to economic and social insecurity. Credit facility for strengthening housing is also very limited especially for the marginal poor. Here poverty, as a whole, works as the major factor to intensify the severity of the effects of disasters.

Nevertheless, the storm surge and/or tidal flood are common after cyclones in Bangladesh. People suffer through saline floods along with the extra pressure of cyclonic destruction. Such pressure is severe because they face tidal flood from dilapidated dwellings and destructed livelihoods.

Capacity to face the disasters becomes low because they lose their economic capability due to destruction of livelihood. As a result, food insecurity occurs and most of the time women have to face the harsh effect of intra-household food insecurity. Women become socially insecure as they lose their houses. Young girls and women become more vulnerable when they are forced to live under open sky. Sanitation becomes a major problem and also tube wells are often damaged in cyclones. As a result, fetching water from a long distance and defecating in the nearby forest etc. lead women towards a vulnerable living condition in the post phases of cyclone hazard. At a poor household, surviving through a cyclone turns a nightmare for the woman/women in the aftermath of the event. The hazard easily becomes a disaster to a poor women living in cyclone prone areas.

4.2.2 Water Logging in Jessore and Noakhali

The field based information on water logging related vulnerability of women has been collected through three FGDs, a few Case Studies and a few KIIs. These were conducted in Keshabpur Upazila of Jessore District and Subarna Char and Sadar Upazilas of Noakhali District. There exist high levels of awareness regarding changes in climate system, as have been reported in all the three consultations. Women can fairly easily associate themselves with changes in seasonal behavior and rainfall patterns. Women representatives of those areas are of the general opinion that drought-inducing dry spells and intense rainfall episodes are on the rise.

In Keshabpur Upazila, the participants have found the following five general climatic hazards in their locality: (a) excessive rainfall episodes, (b) water logging, (c) salinity intrusion, (d) tornado, and (e) hail storms. Women are of the opinion that often water logging is aggravated due to excessive rainfall episodes in the peak monsoon. The Figure-16 explains the priority of hydro-geophysical vulnerability found from the perception of the women in Keshabpur Upazila. It appears clear that water logging is judged as the key concerns of vulnerability in Keshabpur.

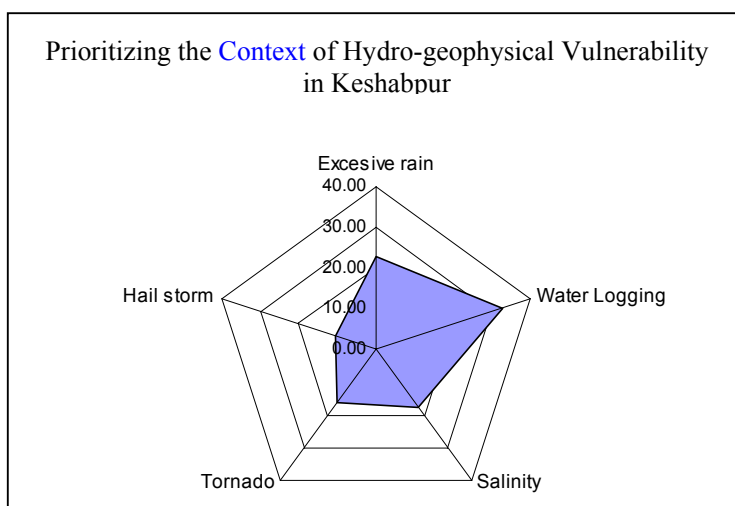


Figure-16: Response of Women in Keshabpur

In Noakhali Sadar Upazila, women have identified the following five climate-induced concerns according to ascending order of priority: (a) water logging, (b) drought, (c) Cyclone, (d) changes in temperature regime, and (e) salinity intrusion. In Subarna Char Upazila, women are of the opinion that saline water logging is the major climate induced concern, which practically gives rise to increased soil salinity and affects food security in the long run. The five top priority concerns are the following: (a) water logging, (b) salinity, (c) drought, (d) cyclone, and (e) tidal surge.

In both the regions (Jessore and Noakhali Districts) under water logging condition, the problem appears to be seasonal in nature. However, in Keshabpur water logged condition prevails during the entire course of monsoon, while people report that the duration has been increasing gradually. On the other hand, water logging condition in Noakhali has been triggered by intense rainfall events coupled with lack of adequate drainage, which finds its

route to the implementation of coastal embankment project. In the latter case, therefore, it is predominantly a man made hazard, only aggravated by climate induced effects. Figure-17 represents women’s perception regarding intensification of water logging problem in Noakhali with an approximate time lag of about 15~20 years.

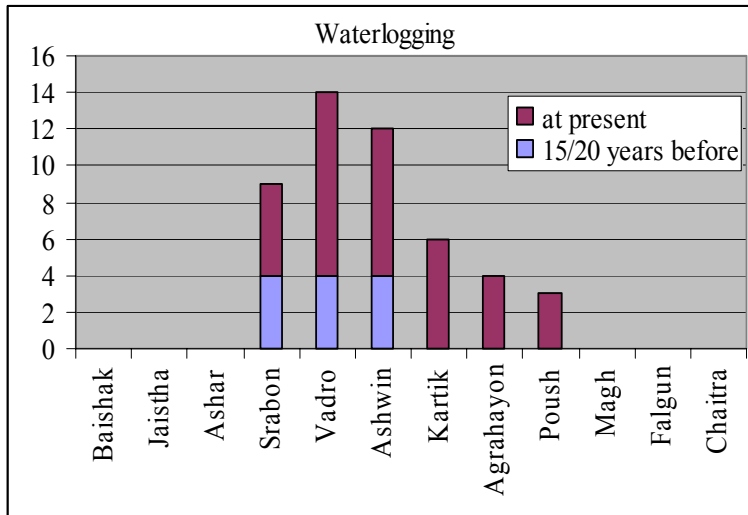


Figure-17: Extent of Water Logging in Different Time Frame

Water logging compels women to stay in marooned conditions for several months in a year. Women of the waterlogged households face different problems than other women of the society. In rural areas in Bangladesh, most of the mud-built houses are destroyed in water logged condition. This leads to social vulnerability of women who have to take shelters on embankments.

Often families take shelter on the roof top of the house. In a bid to avoid sudden slipping of young children into chest high stagnant water, women take every precautionary measure and often curtail the slightest opportunity to rest during the day. Collection of fuel and potable water become extremely hazardous. Preservation of cooking fuel, food, and safeguarding educational material for the children become difficult. Also the women cannot send their children to school for education during prolonged water logging.

Loss of livelihood due to submergence of land often forces males to go far away for weeks at a time. In their absence, females are easy victims of social vices. They are teased and sexually abused by other males in the neighborhood. While women are forced to go out in search of fuel, they often keep their children unattended or tie them inside the dwelling with ropes etc. Such behavior, according to these women, is believed to be inhuman. However, they find little alternative other than requesting other women to accept the responsibility to look after the children in their absence.

In the rural Bangladesh, most of the kitchens as well as latrines are situated outside the main dwelling unit and in waterlogged condition it becomes difficult to reach to the kitchens and in cases even to the latrines. All family members especially women cross the waterlogged courtyard several times a day in chest high water for cooking purposes. If one wants to avoid such hopeless cooking condition, she accepts cooking inside the house and shares unhygienic smoky exhaust with the children.

Waterlogged situation often increases diarrhea, dysentery and skin diseases. Pregnant women cannot stroll in marooned condition, they are forced to stay back inside the house and ultimately fall victim to unhygienic reproductive health conditions. In many cases, it has been observed that people are not keen to establish a marital relationship with the women from water logging affected areas because those women generally suffer from skin diseases.

Water logging has a far reaching effect on the social and economic status of women. Inadequacy of fodder, livestock rearing cannot be sustained which is often the means of livelihood of many women at rural areas. Homestead vegetable production also becomes difficult in waterlogged condition and therefore, women cannot plan quickly to upgrade their economic situation.

Economic activities and agricultural activities are greatly hampered in a water logged situation. As a result poverty is intensified which leads to food insecurity among the entire community; here women are the most affected segment of the population. If one tries to catch fish in a bid to avoid hunger, she can only do it after dusk to avoid social harassment. Women's work outside their homestead has been perceived derogatory for the family and such families pay the price when no respected bride groom wants to get involved in a marital relationship with a bride of that family.

In areas which have been waterlogged most frequently, such as Keshabpur and Manirampur in Jessore, children are reported to be growing up without even the opportunity of going to school. Such instances are illustrative of the 'dissipation', rather than the formation of human capital. While the rich can afford to send their children to school elsewhere (e.g., urban centres, safe from flooding), the poor do not have such options. It is in this varied sense that women and children, particularly from the poorest social groups, constitute the most vulnerable segment of the population.

Water logging halts all forms of social activities: marriages, ceremonies, social interactions – everything seem to be postponed during water logging condition. Nobody wants to engage herself in such activities especially when one has to negotiate standing water. There is hardly any scope for recreation. *“Who wants to accept such a life? Do you think we like it? We are simply forced to accept this unacceptable living conditions”*, reminds one woman in Keshabpur.

4.2.3 Salinity in Tala and Shaymnaagar Upazilas of Satkhira District

Under the present climate change variability, salinity ingress becomes a major problem for the people of Southwestern region of Bangladesh such as Satkhira, Khulna, and Bagerhat Districts, and to a lesser extent in the coastal reaches of Borguna, Pirojpur, Barisal, Bhola, Laxmipur, Noakhali, Chittagong and Cox's Bazar Districts. During the dry season, the problem is more intense and lack of suitable drinking water becomes an acute problem for the households. This is especially true in Satkhira and Khulna Districts. Two FGDs have been



Figure-18: FGD in Tala

organized in Tala and Shaymnaagar Upazilas of Satkhira District to understand women's perception regarding salinity-related vulnerability to climate change. Women participants have identified a large number of vulnerability contexts in relation to climate variability and change, which include the following: (a) increased salinity, (b) untimely occurrence of rainfall, (c) inadequate rainfall, (d) increased heat /temperature, (e) increased drought stress, (f)

delayed occurrence of winter, (g) reduced intensity and duration of cold spell, (h) reduced availability of sweet water, (i) excessive silting of canals and riverbeds with high tides, (j) increased water logging situation, and (k) change in the seasonality of occurrence in monsoon wind.

Women are also asked to prioritize a few problems that require immediate attention. The following appear to be the three most important climate induced vulnerability concerns: (i) increased salinity, (ii) increased water logged situation and (iii) increased drought stress.

As women are generally the homemaker, they feel it necessary to provide saline-free drinking water. Since at some areas water sources in the neighborhood are all affected by high salinity, the women need to travel long distance on foot every day in search of drinking water. This is almost the compulsory duty of women in the southwestern Bangladesh irrespective of their physical condition. Recent observation and field study reveals that a significant proportion of women, who travel long distance to fetch drinking water, are pregnant or mothers of new born. People who can afford to buy filtered sweet water are not a significantly large part of the population. Most of the people, especially the poor faces acute salinity problem of drinking water (RVCC, 2003).

Women and adolescent girls are usually required to collect drinking water from distant sources. This may take three to four hours a day. As a result, they do not have enough time or energy to carry out other household duties like cooking, bathing, washing clothes, taking care of elders, etc. In saline prone region, therefore, women have to curtail extra hours from their household works to combat with salinity problem. The consequent effects are difficulty in time management in their other household duties. For example, women become tired after the daily ordeal and cannot concentrate to the fullest towards their mental and physical health. Also, in cases respective husbands use to complain for not serving food on time and women are also physically assaulted for this reason.

When they go out to collect water, women and adolescent girls are sometimes harassed by boys and men. The women and girls therefore feel uneasy and threatened while collecting water from distant sources. The skin of adolescent girls becomes rough and unattractive due to the use of saline water. Men from outside the area do not show their interest in marrying these young girls. Even within the area, girls from poor families are neglected by the rich families.

Nevertheless, such women suffer from various diseases in the long run for taking extra hurdle of work in their day life. Women and adolescent girls are affected by gynecological problems by using saline water during menstruation. Women, explaining their bitter experiences about menstrual hygiene management, reported that saline water creates pain during menstruation. The used clothes become hard after drying (due to the water salinity), which creates discomfort when next used. Further use of the same hard clothes can create genital injury, including bleeding, infection and other complications. Some women, who do not feel safe to keep their children alone at home, bring their children with them while traveling for drinking water. Obviously, it affects the health of the accompanying children as well. When a poor family cannot afford to collect water due to sickness or because it does not have any member in the family to do the job, they have to buy water from water vendors at Taka 10 per pitcher. It is very difficult for them to spend Taka 300 per month for drinking purposes as their monthly income is typically Taka 500 - Taka 1500. Therefore, sometimes they have no choice but to use saline water for drinking purposes. Furthermore, females are the prime consumers of saline water within their family. There are examples of families where old

parents can not afford to spare their daughter to get married as the daughter is the key person to collect water for the family.

4.2.4 Drought in Manda Upazila of Naogaon District

Moisture stress leading to drought is a major climate related hazard in the Barind track. Since moisture stress is detrimental to crop production, it affects household food security to a large extent. To appreciate the women's concerns for climate induced vulnerability in Manda Upazila, one FGD was organized, followed by KIIS and a few courtyard sessions. Women have identified a large number of climate related concerns, which include the following: (a) drought (Inadequate rainfall during the dry season. Drought occurs every year in a routine manner), (b) crisis of drinking water, (c) flood (periodic inundation almost every year caused by Shiv and Attrai rivers in rainy season), (d) excess rainfall in a few consecutive days, especially in the month of Ashwin causing water logging, (e) vegetable production irregular due to inadequate rainfall in the dry season, (f) health ailments (mainly during drought/flood), (g) winters are colder and summer warmer, (h) storms and tornado have increased in intensity but less in frequency, and (i) excess fog /mist during winter. However, when people are asked to prioritize, they come up with two acute problems: (i) moisture stress leading to drought, and (ii) lack of drinking water during the long dry months.

In the FGD conducted in Naogaon, women express their perception and experience of vulnerability and risks associated with climate variability and change. Lack of food security appears to be the major concern, which is perhaps the same as for their male counterparts. However, the degree of vulnerability for women is much higher as they receive the least amount of food and there is strong deprivation for the women when it comes to intra-household food allocation. No wonder, women are generally mal-nourished. When such a malnourished girl is forced to have kids within her teen years, her reproductive health suffers severely.

Problem of drinking water become evident during this drought condition. In many areas tube wells can not support as the layer goes down. In drought condition, due to water stress women have to take burden on their shoulder to collect safe drinking water from a long distance. Pregnant women also have to fetch water from a greater distance in the drought condition. Sanitary hygiene is hampered due to unavailability of water and the inevitable consequence is outbreaks of diseases like diarrhea, cholera and dysentery. In business as usual scenario, women eventually face food insecurity because of economic hardship; these extra elements only add to this endless list their vulnerability context.

When there is a paucity of drinking water, it becomes extremely difficult to maintain livestock. If a household is desperate to keep the livestock, the woman is again forced to 'manage' water for the animal, no matter how long a distance she need to cover and how frequently. It is often a family decision (i.e., the decision of the male within the family) which the woman can only obey.

The other difficulty is to maintain the homestead (courtyard) vegetable garden. With diminishing moisture on the top soils, it becomes a nightmare on the part of the woman to irrigate the plants frequently. Ironically, the physical effort does not pay off when she finally cooks her produce and the family members get priority to have their fare share, totally depriving the actual producer in the process. The poor woman has to contend with the leftovers in most of the cases.

Flood too is a frequent problem in the area. However, the extent of flooding is quite low compared to proper flood-vulnerable areas of the country. During the flood season, houses and homestead are severely damaged as they are often earthen structures. Affected people often take shelter on the roads and embankments. Robbery becomes a common practice during that time but fortunately, women are not harassed. Ailments due to water borne diseases cause extreme misery to their life. Very poor access to modern treatment facilities, especially for pregnant women, children and elderly people, become a major concern at that time.

A specific concern for women is when an embankment is deliberately breached by local people creating potential for conflict and armed confrontation. In such cases, if a woman happens to be a bride of a contending group, the in-laws create pressure on taking sides. Often a woman finds herself in a position where members of her parental family as well as members of her in-laws are injured and needs to be attended to.

4.2.5 Riverine Flood in Kurigram and Faridpur Districts

Among those affected by floods and related problems, women and children are usually the most helpless and disadvantaged (Nasreen, 1995). Flood related deaths are often caused by drowning and snake bites, which tend to occur in increasing numbers for children, following by adult women. Destitute women, without any employment, and compelled to migrate elsewhere, also face the most acute conditions of physical and social insecurity.

Two separate FGDs have been organized, one each in Kurigram and Char Harirampur of Faridpur District, in a bid to gather information on women's perception regarding their particular vulnerability to riverine floods. In Kurigram, women identify a host of climate related issues which provides the contexts of their vulnerability. They are also asked to prioritize five most important contexts of vulnerability, which include the following: (a) flood, (b) riverbank erosion, (c) drought, (d) cold wave and (e) excessive rainfall. In Faridpur FGD, women identify five contexts of vulnerability according to the following priority: (a) flood, (b) riverbank/charland erosion, (c) lack of drinking water, (d) spread of diarrhoeal diseases, and (e) poor sanitary conditions. Of course, in both the cases they find poverty and womanhood as cross cutting contexts of vulnerability, irrespective of climatic perturbation, however being severely aggravated under climate variability and change.

With rising water levels in the adjacent river(s), women tend to prepare for relocation. Preparation prior to relocation means an extra load of activities on the part of the woman in the household, where her male counterpart hardly assumes any responsibility. Fulfillment of women's traditional gender-based roles on the customary "sexual division of labor" becomes increasingly difficult under flooding condition. Preparing dry food for emergency, collecting banana stems and preparing a raft, collecting and safeguarding biomass for cooking, safeguarding poultry and livestock, improving storage condition of seeds for the post-flood season, making an extra portable earthen cooking stove – all these are additional to daily household activities. Usual activities such as cooking, cleaning, fetching of drinking water, homestead production, etc. cannot be easily performed in flood affected areas. Yet a woman must not give up, she must prepare herself to face the worse!

Women know that abandoning her homestead might mean losing valuables to burglars. Therefore, she refrains herself as long as possible to relocate in safer places. Sometimes women are found to take shelter at the roof top along with their children. By doing so, she

can perhaps avoid flood water, however fall victim to snake bites and occasional drowning of her kid.

Poor women find it extremely difficult to ensure food and drinking water security when they struggle to live in flooded condition. During flood people confront acute shortages of potable water and edible food stuff. And all these are mainly faced by women. In deeply flooded areas young girls are reportedly scrounging for edible reeds and roots, while women of all ages travel long distances by boat or raft to fetch drinking water. Sometimes water sources become contaminated with pathogens, which trigger large scale spread of water borne diseases such as diarrhoea, cholera, and hepatitis. Not only women take care of themselves, they also help other ailing patients of the family and provide comfort to the younger ones by counseling them.

Poor women often tend to collect relief, if anything is in offer in the neighborhood. However, they pay huge personal prices by standing in queue for hours in waist to chest high flood waters. Moreover, such an act on the part of a woman is not considered to be 'respectable' in social norms and those queuing for relief generally face hardships in post-flood normal life. Just to avoid such 'derogatory treatment' by others in the society, the middle class sometimes accept whatever consequences of flood and do not take refuge along with destitute people.

Women constantly try to improvise and feed their families, whatever little food they can collect or manage to cook. To ensure food security for other family members they usually eat as the last person and the least amount. Even sometimes they pass their days without having food. As a result, they become more vulnerable to malnutrition. Flood destroys the homestead vegetable gardens and livestock/poultry which are the main sources of income for rural women.

During flood women's privacy seems to be completely challenged which ultimately renders to enormous social sufferings for them. There are thousands of instances that women could not timely respond to the call of nature because of lack of privacy. Consequently, they wait till night for excretion. In a flooded condition women often go outside by rafts for excretion in open water, often in the middle of night. The situation becomes worse in case of pregnant women, children, disabled and elderly persons. Besides these there are other biological conditions such as pregnancy and menstruation etc. with which women cope with extreme difficulties. Social taboos around menstruation and norms about appropriate behavior for women and girls are reported to contribute to health problems in young women in disaster situations. During floods, adolescent girls report perineal rashes and urinary tract infections because they are not able to wash out menstrual rags to dry, or access to clean water. They have reported wearing the still damp cloths, as they do not have a place to dry them.

Outbreak of diseases is common during floods. Flood often submerges the latrines and leads to sufferings especially for women. Women of the household mostly take bath in flood water, often at night just to avoid the sight of on looking males around them. Not only they become victims of snake bites, they also frequently suffer from skin diseases.

In some Char areas (Char Harirampur in Faridpur) livestock rearing is one of the major income generating activities where women take a key role to manage most of the herds. During flood it seems to be very difficult either to keep these livestock safe or to feed them with proper fodder. Collecting fodder during high flood appears to be another major hurdle.

When women are completely helpless without any source of income and shelter, they usually move out to non-affected areas. However, this migration does not necessarily make their lives easier. In their new shelters as migrants, they lose the physical and social security they once enjoyed at their native villages. This, in turn put them in other kinds of adverse social circumstances. Young girls taking shelters on embankments are also in constant dangers of sexual harassment and assault. Often young women are lured into prostitution by professional gangs, with promise of jobs elsewhere. Their mothers are always alert to protect them from any kind of insecurity.

The schooling of the children is particularly affected during floods because it becomes impossible to hold and attend classes during submerged conditions. Furthermore, wherever the school building is not submerged, these tend to become the ‘front-line’ flood shelters for uprooted families. The loss of academic year for an adolescent girl student is often translated into an early arranged marriage, without having to get consent from the girl child. During post-flood rehabilitation phase, especially amongst the poorest of the society, such early forced marriages are very common, as reported in the FGDs.

4.2.6 Flash Flood in Sunamganj and Mymensingh Districts

One FGD is conducted in Haluaghat Upazila with Garo (tribal) women. Women are of the opinion that rainfall pattern has changed over the past two decades, especially during the period April till September, as represented in Figure-19. In the FGD the following issues have been raised in relation to identifying climate induced vulnerability: (a) flash flood, (b) flood, (c) drought, (d) hail storm, (e) high intensity short-duration rainfall episodes (despite the fact that overall rainfall in the area has been declining), and (f) stormy weather in mid-April (*Kalbaishakhee*). The other FGD was conducted in Deerai Upazila of Sunamganj District where the local women identified the following key elements of vulnerability: (a) flash flood, (b) hail storm, (c) tidal action during monsoon, (d) drought, and (e) flood. The participants have been asked to prioritize their climate related concerns and it is revealed that flash flood is the top most priority concern that adds to their vulnerability (Figure-20).

Flash flood is the incidence which generally occurs without any sort of prior warning and as a result people terribly suffer from this hazard. Flash floods are severe flood events that occur with little or no warning. It generally occurs in the pre-monsoon months; however it can also occur any time between May and October. The frequent occurrence of flash floods poses a severe threat to lives, livelihoods, costly infrastructure. The hardest hit are the socially most vulnerable-the poor, women and children, who often can only find places to live in floodplains or other vulnerable areas. Lack of communication and transportation often means that a flash flood event is not known to outside community and the affected people do not have access to medical or relief facilities.

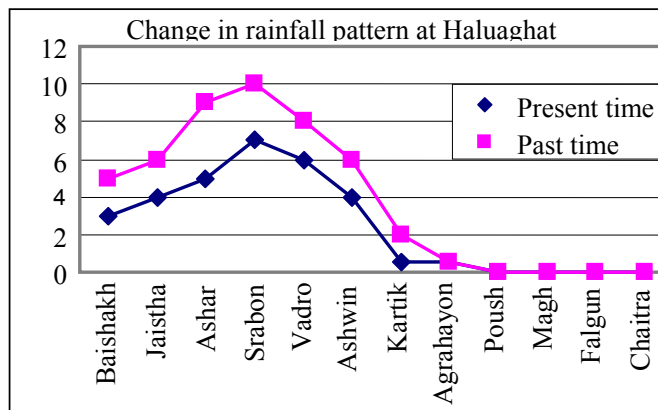


Figure-19: Change in Rainfall Pattern

BOX-1

General Findings on flash flood

- During *Chaitra* and *Baishakh*, the sudden flood occurs frequently.
- Due to flash flood, the flood condition deteriorates. It damages *Boro* crop severely.
- The water of flash flood often sustains for 5 months.
- The water level drops during *Aswin* and *Kartik*.
- As the rivers are not deep, the water submerges the crop field.
- The duration of summer has increased.
- The temperature is lesser than before and the intensity of winter has increased.
- The sudden flood damages *Boro* crops and also spreads variety of diseases. Unemployment increases during this time.
- The rivers, lakes and ponds of the area are encroached and as a result the navigation capacity has reduced in recent years.
- The quantity of fish been decreased in *Haors*. The Government has leased out maximum *beels* in the area and as a result people have less access to catch fishes over there. Now most of the people including poor have to buy fishes from market.

As the homesteads are flooded suddenly, women in the household have to face the sudden danger. People generally suffer more in flash flood than in the normal flood due to its unpredictability. Sudden occurrence appears to be the main reason for huge property loss in the flash flood prone areas. Houses are over flown, standing crops are mauled, stock biomass are either rotten or deteriorated, and often sanitary latrines and tube wells of the households are submerged by flooded water. Under such miserable condition, women find it difficult to ensure well being of the household.

Women are differently vulnerable than men in an event of flash flood in a number of different mechanisms. First of all, flash flood often washes away latrines of the family. In such cases it becomes difficult for women to go outside for defecation. They face sanitation problem also at the places where they take shelter, especially if it is an

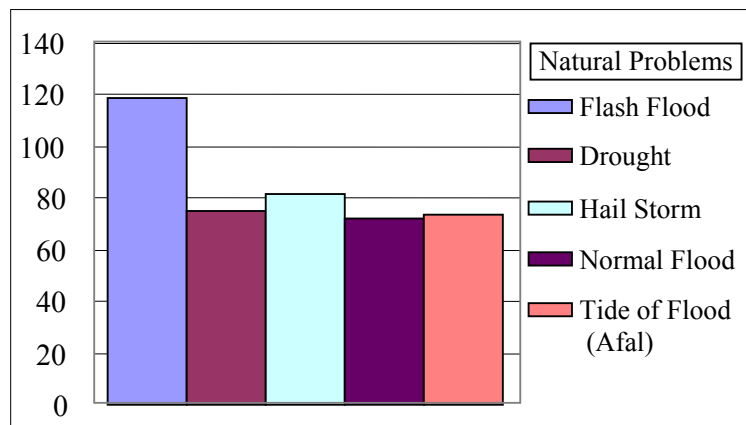


Figure-20: Prioritization of Vulnerability Context in Deerai

embankment. The responsibility of providing pure drinking water generally falls upon women and it becomes difficult for them to fetch water from a far distance in flooded condition. Outburst of epidemics is common as people hardly manage safe sanitation and pure drinking water during post-flash-flood conditions. Preservation of fuel is necessarily a significant responsibility of women which become difficult during the aftermath of an event. As a result, many households suffer from hunger during post-flash-flood if they cannot manage dry foods. Also, flash flood washes away means of livelihood like poultry, livestock etc. which are the main sources of income for many rural women in Bangladesh.

4.2.7 Coastal Tidal Flood in Chakaria Upazila of Cox's Bazar District

Vulnerability to coastal tidal floods in embanked areas can be viewed as a combination of flood and water logging condition, with perhaps another bad element – the saline laden tidal water. Such sudden saline inundation might cause several weeks of water logging with devastating effect on crop lands and low lying settlement areas. An account of coastal tidal surge in an island landscape is provided in section 4.2.1. The plight of the women due to tidal flooding is also described there. The food and employment security aspects in relation to saline coastal flooding are presented later.

4.2.8 Urban Flood/Drainage Congestion in Dhaka City

The slum dwellers are the worst victims of urban drainage congestion. Slum dwelling women make their living mostly by finding self employment as temporary housemaids (in Bangla, they are called *Thika Jhee*). If the shanty dwelling is inundated, it becomes difficult to join in daily activities in employers' households while trying to safeguard her belongings. Creating an alternate temporary safe haven for the kids also becomes a necessity. Delay or absence in the job often is translated into loss of employment, with counterproductive results on food security.

Many slum dwelling women are self employed as food producers and/or food vendors, especially targeting rickshaw pullers as their customers. Finding a suitable place for the micro-scale business is already a hazard, which often requires giving cash or in-kind bribes to local hoodlums (mastans). A long absence from the vending spot might result into losing it altogether to other women/vendors.

Perhaps the worst adversity is to find a suitable source of safe drinking water in the neighborhood. Women generally collect drinking water. Unfortunately, the public drinking water distribution system in the city has been abolished recently with the withdrawal of DWASA run hydrants. Women need to maintain a good social contact to be able to find a source, as most of the slums are barred from getting water supply connection from DWASA. Under flood/waterlogged condition, available sources often become contaminated with pathogens. Women often fall victim to water borne diseases. No wonder, a large number of



Figure-21: FGD in Dhaka

women had been admitted to various hospitals following the flood event of 2007.

The spread of diarrhoeal disease, cholera and dengue as an aftermath of a flood event often leads to loss of employment, which appears to be vital for survival of a poor woman.

Interestingly, the middle class women also find it difficult to cope with sudden water logging. In a large number of middle class households the woman has to take her kids to school, often by rickshaw. As the city roads are waterlogged, rickshaws

cannot operate and women are found to carry her child along with the loaded school bag on their weak shoulders. If one cannot offer her services by choice, it is translated into absence from the school and academic activities. Which is not welcomed by the school authority either.

In the aftermath of floods, the victims are immediately confronted with the outbreak of water-borne and intestinal diseases such as diarrhea and dysentery. In the face of this situation, the long run effects of flooding on morbidity and subsequent decline in productivity are potentially high.

4.2.9 Coastal Erosion in Bhola District

Coastal erosion appears to be the most prioritized climate related vulnerability concerns in Bhola District, as revealed in the FGD which has been conducted in Char Fassion. Of course, women in Char Fassion are almost equally concerned with cyclone storm surge. However, they are of the opinion that due to southern embankments created by the Bangladesh Water Development Board and the coastal green belt of vegetation created by the Bangladesh Forest Department their sense of physical vulnerability has reduced to a great extent. Among other climate driven risks and hazards, intensification of monsoon rainfall and tornado draw attention of the respondent women.

As it has been described by women in Char Fassion, from Bhadro till Ashwin is the time when the erosion reaches its peak. They have informed that a large part of north-eastern Bhola island has now been totally eroded and the island is gradually shifting to south-west direction. The strong current in the rivers during peak monsoon provides the energy to devour lands. Simultaneously, smaller southern islands such as Char Patila has been eroding toward the southeastern side and the local people informed that at least two (2) kilometers of land had been eroded over the past 15 years.

Erosion leaves profound physical marks on the landscape, which can rather easily be studied later by means of satellite imagery. A comparison of Rennell's Map and recent images reveals that Bhola has undergone tremendous morphological changes over the past two hundred years. When large areas are eroded, as frequently experienced by the local women, settlements, infrastructure, and community places, service centres – all are destroyed within days. People cannot withstand the fury of nature, neither can they slow down the eventual destruction.

When the dwelling unit is completely destroyed, the woman becomes totally helpless. It forces them to live in the open, without the slightest sense of privacy. The kids often go astray. It becomes a nightmare for the woman to maintain family well being. Fetching water becomes a major task, which takes an extra effort to ensure safe drinking water. Loss of sanitation becomes a major headache on the part of the woman as she cannot defecate along the river in open. She often has to wait till darkness falls and consequently she accepts unhygienic health condition.

Women find it socially derogatory to live in the open, since they face its consequence first hand. Unlike their male counterparts, a woman cannot escape social misconduct if one has to accept living of a destitute woman following erosion.

People find it difficult to arrange marriage for their adolescent daughters once they become homeless. One Pari Khatun comments “... *those who does not go through this, would never understand the true meaning of becoming erosion victim. It is perhaps better to die than become erosion victim*”.

4.2.10 River Erosion in Kurigram and Faridpur

River erosion and charland erosion are quite common in Bangladesh, especially so in Kurigram and Faridpur Districts (Elahi and Rogge, 1990, CEGIS, 2007a, CEGIS, 2007b). As indicated earlier in section 4.2.5, women identified erosion in the Kurigram FGD as the second most prioritized context of vulnerability in view of climate variability and change. The top five priority concerns are the following: (a) flood, (b) riverbank erosion, (c) drought, (d) cold wave and (e) excessive rainfall. In Char Harirampur, both flood and riverbank erosion are equally important to the local women. They identify lack of drinking water as another added vulnerability concern, especially when associated with flood condition.

As in the case of coastal erosion, women are concerned regarding loss of homesteads, loss of housing for months and years, physical insecurity for the woman, loss of self as well as family esteem, lack of production opportunities, and lack of food security in the aftermath of the event. Char dwellers somehow accept the fact that their living cannot be matched with those living in ‘mainland’ areas and their social acceptance is bound to be regarded as lower than those in the mainland. However, they do believe that when the ‘unacceptable’ event just occurs (due to mighty Allah’s will, for which they have little to do), they need to accept the fate.

The social cost for erosion affected women is extremely high. They lose their dignity and respect in the society, to many women which appear to be unbearable. One participant points out in Char Harirampur “... *you cannot force a mainland young woman to marry someone living in a char land. She would rather die but accept the marriage proposal. If she does accept it, she knows she would lose her dignity for ever. Living in a char land and frequently facing erosion are synonymous*”.

As argued earlier, loss of housing and living in the open allow miscreants to take undue advantage of the condition of the woman, which often culminate into sexual harassment and abuse. Accustomed with hygienic defecation and all on a sudden losing sanitary latrine can lead to health disorder. Having no homestead at all means the woman can no longer supplement the family diet with home grown vegetables, which the women rate as important food items.

4.2.11 The Special Vulnerability of Minority Women

Jaladash is a community where fishing both in sea and rivers is the only occupation they are involved in. They are secluded from the mainstream of the society. With the only exception of going into fishing grounds, their access to natural resources and social facilities are restricted by social taboos and practices.

They live in a congested, highly populated place, often next to the seashore. In the dry season when the sea is comparatively calm and cyclone does not seem to occur, the male members of Jaladash families go to sea for fishing. They get advance from their boat owners, give it to their families and go to sea for about 5 to 6 months. During that period, not a single adult

male member is available in the community unless someone is physically incapable of taking the trouble. In the absence of male members in the community, the women and children of Jaladash families often face economic hardship and social harassments. It is reported to the study team that there had been instances of physical harassments to the women. Outsiders know about the absence of the male members in the neighborhood and often tend to take advantage of the situation.

Jaladash community represents the most oppressed and extremely poor section of the society. Not a single brick-made house is found during the visit of the Study Team. Due to their sheer proximity to the sea, they often face cyclone storm surge. Although their traditional knowledge help them sense an imminent cyclonic event, the formal cyclone warning hardly reach them. When they tend to take refuge in nearby shelters along with other ‘mainstream’ people, they face misbehaviour and maltreatment. It is reported that in some instances they are forced to stay in a toilet of a nearby cyclone shelter since other people were reluctant to stay with them

The Jaladash community often find no traces of their shanty dwellings following a high intensity cyclonic event. If their male counterparts can safely negotiate to the shore, they do not receive any help from formal ‘rehabilitation services’. The women collectively help each other, often in the absence of the male members of the community, to rebuild their shanty houses – only to be destroyed again in the next cyclone. The extreme living condition of the Jaladash women is never heard or discussed!

Rakkhain community is another minority group who possesses distinct social and cultural values. The women in Rakkhain community are gifted craftsman, as they weave beautifully coloured clothes by using looms. Like many other minority groups, these women are poor and struggling to eke out a living. However, the remarkable feature is that they do not feel like exposing their particular vulnerability to climate related events.

They can read Bangla and follow closely the issuance of cyclone warnings. Unfortunately, they are reluctant to go to nearby cyclone shelters due to the fact that they are maltreated by Bengali people. Their presence in the shelter is regarded as ‘unholy’ by the mainstream people and they do not get equal treatment there. Coexistence with Bengali people often does not give them a sense of comfort.

In a bid to avoid from certain drowning, Rakkhain men climb up the hills, thereby leaving the family behind. It is the women who stay back in their dilapidated houses, stay close and pray until the storm surge is over. They take care of the elderly people and the kids, bear the risk of drowning and prepare food for their male counterparts who have gone in the wilderness to safeguard their lives. Even after all that when a Rakkhain woman says “... we just do our duties”, it really sounds surreal.

Garó is also a minority community, who are habituated to live in hilly environment. Garó women are extremely hard working. They never leave their toddlers unattended; rather tie her with her back, no matter how extraordinary physical labour she has to put on. Garó women find flash flood and flood are the two topmost priority issues in relation to climate induced vulnerability.

They are fearful for the simple fact that quickly on-setting flash floods often tend to drown livestock and human beings if they are on the natural ways of rushing waters. Unlike other

people Garo women are not differently vulnerable than their male counterparts, since males are willing to share the responsibility burden in their society. However, during the reconstruction processes, Garo women need to work equally hard, if not more, and that too after ensuring well being of the kids and the elderly people. In that respect, Garo women also have to accept an extra burden in view of facing flash flood.

4.3 Special Vulnerability of Poor and Marginal Farmers to Climate Change

There are many ways in which poverty and climate change are interconnected. Livelihoods of rural poor are predominantly based on natural resources. Poverty forces them to degrade their environment, which in turn reduces opportunity to enjoy services of these natural resources on a sustainable manner. Since climate change is likely to jeopardize the availability of natural resources base, poor people's livelihoods will face significant challenges in near future.

In the nexus between poverty and climate change, sustenance of decent living under invigorated extreme weather events would be severely questioned, especially in countries such as Bangladesh where pervasive poverty is prevailing. Frequently occurring natural hazards and occasional disasters are perceived to be the major causes of perpetuation of poverty in Bangladesh. Unfortunately, climate change will exacerbate both the frequency and extent of natural hazards, often in the forms of floods, droughts, riverbank erosion, salinity intrusion, water logging, and cyclonic storm surges. Despite utmost efforts to reduce the net fraction of population under poverty by achieving MDGs and so on, there is a strong likelihood that the overall poverty level will only remain at the same level, if not deteriorate further, due to adverse impacts of climate change on poor and marginally better off people. Despite every conceivable mechanism to fight against poverty, climate change will compound the prevailing contexts of vulnerability and tend to perpetuate poverty.

As revealed through the field FGD exercises involving poor and marginal farmers, the key vulnerability contexts in relation to climate variability and change against each hydro-geophysical case are discussed below.

4.3.1 Cyclonic storm surge

Areas which are covered for cyclone and storm surge include Dholghata and Bhola islands. In the Dholghata Island, most of the people are found to be poor. Employment opportunities are extremely limited, which is why they remain poor. Land based production system consists of Aman production during Kharif season and Salt production on the same land during the dry season. The close proximity to the sea allow them to produce salt during November to early May. Since the lands are under salty condition for about seven months a year, high salinity significantly reduces Aman yield from those lands. Although salt production requires labour and provides employment to a significant proportion of population in the island, employment opportunities drastically fall during the Aman season, since Aman production is not a very profitable venture. According to the poor people present in the FGD, 60 per cent of the employment is provided by salt industries, followed by farming (15 per cent), and development project-related activities including food for works programme (i.e., FFWP, some 15 per cent). About 10 per cent of the population finds self-employment in marine fishing.

Examining the nature of employment distribution in the Dholghata island, it appears evident that most of the poor people do not find employment opportunities during the monsoon

months. Winter period is the best period to find a suitable employment. Both salt production and FFWP activities take place in the dry months. Even the condition for fishing in the sea is much conducive during the dry period. Therefore, there exists a crisis in terms of finding an employment during wet monsoon months.

Inadequate employment opportunities mean lesser income opportunities, which are often translated into much reduced food security for the poor households. Poor people spend days without having rice (the staple food) and lentil soup during monsoon season.

Intriguingly, most of the resources within the island have been owned and managed by a handful of elites (locally called as *mahajans*) and their musclemen. They control the entire economic pursuit and determine prices against available employment opportunities. When poor people have no employment, they often borrow cash from these mahajans at extremely high interest rates (determined by the mahajans) and try to survive through the 'lean period'. When the monsoon is over, the mahajans ask for the return of the borrowings along with cumulative interests, which the poor people cannot immediately pay off. Consequently, they become 'forced bonded labours' to find employment in the salt pans of the same mahajans at nominal wages. This cycle goes on the next year and the years that follow. Poor people remain poor, often become poorer in every successive year.

If men become sick, they depend on the mercy and wish of their respective mahajan to take 'expensive health' care. Women do not even dare to think of afford health care, they just share it with someone trustworthy and accept any consequence. Those who consider them fortunate by finding an employment in salt pans, they often develop skin legions due to prolonged exposure to corrosive work environment. However, they do not receive any treatment. Of course, NGO driven health care services have reached to islands such as Dholghatam, which appears to be a great relief to these lackluster people.

When the people are struggling with abject poverty, there comes occasional cyclone and tidal surge. If they are lucky, they can save their lives by taking few hours of refuge in a nearby cyclone shelter. The fishermen often defy cyclone warnings, especially when successive warnings are issued and they apprehend loss of fishing season by spending time on shore. Sometimes rough weather on the open sea causes capsizing of their fishing boats and they drown.

Extreme poverty and the economic oppression by the local mahajans have already created the context of vulnerability for these poor people, which is compounded by cyclones and tidal surges. Under climate change, their extreme vulnerability will only increase to a great extent.

The case of Bhola island is quite different than that in Dholghata island. Bhola is a much bigger island than Dholghata and its population is perhaps bigger than that of all the Small Island States combined. Although a sizeable population there belongs to poor class, they find employment in crop agriculture, livestock rearing, even in a few small scale industries. Estuarine fishing is a major source of employment. The diversity of employment options provides much improved opportunities for the poor people in Bhola island.

Even though people in Bhola island enjoy better employment opportunities, poor's ability to cope with shocks remain inadequate. The southern parts of the island have been experiencing gradual increase in salinity, which has detrimental affect on crop agriculture. Therefore, the poor farmers find it difficult to maintain yield levels from the same land in successive years.

Salinity in the dry season appears to be a major concern for poor farmers. Since input-intensive high yielding Boro paddy is grown during the dry season, poor farmers need to borrow money from wealthy money lenders. With diminishing profitability, crop production does not facilitate economic emancipation. Economic hardship of the poor and marginal farmers therefore remains unabated.

Considering the possible dwindling nature of rainfall throughout the dry season, Boro cropping in future might face increased difficulties under climate change. This holds true not only for Bhola island, but the entire country.

The estuarine fishermen are poor too, however their economic hardship is most likely to be aggravated under climate change. Since global warming will cause a rise in sea surface temperature (SST), it is very likely that an increased number of depressions and low pressure systems will be developed in the Bay of Bengal. Increasing numbers of low pressure system means that for an increasing number of days per annum the sea will be rough along with high tides along the shore – a change in the coastal environment which will not allow fishermen to go for fishing. In simple terms, poor fishermen will have lesser number of active days, lesser amount of catch per annum and perhaps lesser income. Those of whom would try to minimize the ‘apparent loss’ by defying warnings and taking chances, they might have to risk their lives frequently.

People in Bhola in general also face cyclones and occasional tidal surges. Cyclonic adverse effects during October-November severely affect Aman production, as well as early Rabi season vegetable production. Cyclones will probably affect everybody in the island, though the loss burden for the poor will be relatively higher than others. However, the poor farming communities depending on year-round crop production will face increasing vulnerability due to climate change.

4.3.2 Water logging

Waterlogged situation, depending on the duration of water logging, can potentially destroy land based production system, as has been observed in Keshabpur and Manirampur Upazilas of Jessore District and Tala Upazila of Satkhira District. Therefore, water logging particularly influence perpetuation of poverty, especially among those who depend on small land holding for their sustenance.

From the FGD involving poor and marginal farmer representatives of Keshabpur Upazila, it appears that most of the lands in the area are inundated year round. However, the intensity of water logging varies seasonally: all the lands undergo deep water during peak monsoon, while in the dry season the water column on the lands are generally knee high and the roads and other notable infrastructure become inundation-free. The seasonality map of water logging intensity (in relative scale) is provided in Figure-17.

However, in Noakhali District (Sadar and Subarna Char Upazilas) the condition of water logging appears to be somewhat different compared to that in Jessore. In Noakhali, productive lands become water logged only seasonally, during the period July-October. When the peak period for HYV Aman transplantation approaches (usually in early August), the lands are mostly water logged and a significant proportion of the lands are left fallow. Forfeiting Aman season hits poor farmers hard and reduces their food security. Similarly,

those of whom find employment as agricultural labours, they face food insecurity due to loss of employment.

Unfortunately, the farmers face the second blow when their opportunities for Boro production is significantly diminished due to salinity in groundwater aquifers. Boro crop now a days provides the best yield compared to other paddy crops. When Boro potential is diminished, poor and marginal farmers find it extremely difficult to maintain food security. Likewise, agricultural labours also face the similar fate, though at a much bigger extent.

Other than food and employment security, poor households experience many other forms of vulnerability due to water logging condition. Poor people's houses are naturally poorly built, which rot during prolonged water logging. Inundated roads and other physical infrastructures are severely damaged in water logged conditions. Biomass based walls and earthen walls are completely destroyed even in one water logging event and the family members easily become homeless. Poor and marginal people find it difficult economically to reconstruct their houses, fully knowing that their efforts will again be destroyed in the next water logging period.

In permanent water logging condition, most of the latrines are found to be destroyed by standing water. The poor are forced to defecate in open water that surrounds them, while the women in the family wait till dusk to avoid social harassment. Open defecation spread water borne diseases and skin ailments, especially when people need to bath in the same water. A village doctor use to treat a large number of skin patients in Keshabpur by prescribing cheap ointments, fully knowing that a large number of his patients would not be cured without antibiotic medicines. Since antibiotic medicines are costly, finds the cheaper solution as a compromise.

Under water logged condition, the only mode of communication is navigation. However, frequent boat ride can be quite costly. Alternatively, one has to purchase a boat to maintain uninterrupted communication with the neighbourhood. For a poor and marginal household, such an alternative isn't viable either. Lack of communication often adds to their problems.

Trees are regarded as assets for the poor people in rural Bangladesh. However, under water logged conditions, poor households lose their assets quite quickly. Most of the common species cannot withstand year-long water logged condition and perish easily. It is ironical that Jessore appears to be the most successful District in terms of vegetation cover, the water logged parts of Jessore is becoming devoid of standing trees.

Maintaining livestock is another major hassle under water logged condition. Providing feed, fodder and safe drinking water becomes a nightmare for most of the population. Those of whom tend to maintain cattle heads as draught animals, due to loss of agricultural lands they sell their cattle. By loosing assets such as livestock and standing trees, economic vulnerability of poor households only aggravates.

In terms fisheries, water logging has been helping the poor households in Jessore while it brings in new problems in Noakhali region. People benefit from open water fishing in Jessore. However, the wealthy people can no longer use their ponds for aquaculture. In contrast, the potential for aquaculture in Noakhali has been totally shattered as a result of seasonal water logging. Although the fish grow well in standing water, it becomes a nightmare for the investors once the fish is escaped from captivity.

Poor households' vulnerability increase due to lack of energy security under water logging condition. Those of whom depend largely on biomass, due to lack of crop agriculture in the locality; they require cash to purchase biomass energy and to transport it to their households. This adds to their economic burden.

4.3.3 Salinity Ingress

An increase in salinity generally affects crop production, thereby poor and marginal farmers' vulnerability is directly linked with salinity ingress. Soil salinity above a threshold would reduce potential for the production of Boro, the most preferred crop in Rabi season. There are areas which are less saline at the initial cropping stages, become increasingly saline as Boro reaches reproductive stages in April. In such cases, adequate irrigation can still ensure a considerable harvest. However, under climate change and induced sea level rise effects, slightly saline areas will become moderate to highly saline and surface water based irrigation will not be possible. A combination of salinity and lack of adequate irrigation might result in a drastic reduction of crop production in the southwestern region of the country.

At poor and marginal farmers' household level, reduced crop production will result in food insecurity. Poor farmers do believe that under climate change *monga*-affected areas will be extended to many other parts of the country.

4.3.4 Drought

Devastating and recurrent droughts caused by varying rainfall patterns occur frequently in many parts of Bangladesh, causing substantial damage and loss to agriculture and allied sectors. Drought impact, associated with late or early occurrence of monsoon rains or even complete failure of monsoon, spreads over a large geographical area – much larger than areas affected by other natural hazards.

The impact of climate variability and change on agricultural production is a global concern. However, the impact is particularly important in Bangladesh where agriculture is the largest sector of economy, accounting for some 35 per cent of GDP and 63 per cent of the labour force. Agriculture in Bangladesh is already under pressure from increasing demands for food and the simultaneous problems of depletion of agricultural land and water resources from over exploitation and contamination. Climate variability and projected global climate change make the issue particularly urgent. The impacts of climate variability and change in the form of drought cause additional risks for agriculture.

Drought can affect rice crops in three different seasons, which accounts for more than 80 per cent of the total cultivated area in the country. Drought affects Boro crop profusely, especially during March and April. Lack of irrigation during peak drought period can result in *chita* formation and reduce yield significantly. Occasional lack of appreciable rainfall in late July and August can jeopardize land preparation for Aman transplantation. Aman also falls victim to moderate drought, especially during its ripening period in November-December.

Focus group discussion on drought issues in different vulnerable region reveals that it is one of the most pressing issues in Bangladesh. From field experience it appears that, rice, jute and other crops are usually greatly affected. Since rice production ensures micro-scale food security, drought comes as a curse to the poor and marginal farmers. Jute also suffers

significantly because of lack of water for retting. Livestock also suffers, with many farmers having to sell their cattle at very low prices because they lack both fodder and drinking water.

4.3.5 Flood

Bangladesh is known for its high vulnerability to floods of varied intensity. Flood occurs when rainfall runoff swells the rivers and overtops their banks.

Living in a flood plain, Bangladeshi poor people accept moderate floods, even sometimes utilize flood water for various purposes. A moderate flood, called *Bonna*, is perceived to be beneficial for rejuvenation of crop lands with clayed silts and minerals (Rahman, 1994). A short duration moderate flood does not affect cropping practices, only brings in slight discomfort in rural lives. However, a prolonged flood can have catastrophic implications as it has been observed time and again in the recent past: the floods of 1988 and 1998 are considered to be catastrophic events, while the most recent flood of 2007 is also rated as a very high intensity flood that brought extreme human sufferings, colossal damages to agriculture and infrastructure and high costs on national economy.

Once a prolonged flood continues past mid-August, it becomes a nightmare for poor and marginal farmers because of the fact that they cannot transplant Aman paddy timely. Even before transplantation, they accept certain levels of crop loss. If the flood event continues upto September, as it happened in the deluge of 1998, the farmers lose as high as 40 per cent of projected yield – a huge blow to micro-scale food security and a macro-scale (i.e., national) economic catastrophe. In such a case, it becomes almost impossible to cope with the aftermath of the flood, especially in terms of food insecurity and hunger.

In addition, flood brings in many forms of human misery. Flood waters inundate large areas, destroy houses, deteriorate living conditions, and force people to abandon their homes to look for temporary shelters. Many people suffer from hunger and water borne diseases. Tube wells are often found contaminated and a large number of people require immediate medical attention.

A large number of people, especially the poor who live in low lying areas, take shelter in designated flood-shelters. It becomes a nightmare on the part of the authority to provide for various services: food, fuel, drinking water, primary health care, even physical security. In most cases, public institutions such as schools are transformed into flood shelters, while the academic activities suffer automatically.

Although the poor and marginal farmers suffer the most during a deluge, it is also found that the post-disaster relief is often distributed amongst the poor. Both the government agencies and the NGOs come forward with relief and rehabilitation activities. A fraction of the poor find themselves employed in post-flood rehabilitation processes, especially under the FFWP. Road and embankment reconstruction, public works etc, provide employment for the poor to maintain their livelihood. However, in most cases these activities can only provide for a part of the employment demand, the unlucky poor still face food insecurity and hunger.

It is feared in the latest IPCC report that (a) monsoon in Asia will be invigorated with detrimental effect on aggravation of floods, and (b) the rice basket of Asia will shrink considerably. In view of such apprehensions, it appears evident that climate induced high intensity floods will be increasingly devastating, perhaps with increasing frequency and

duration. The poor and the marginal farmers will have to suffer to a great extent if adequate adaptation measures are not considered well in advance.

4.3.6 Flash Flood

Flash floods are among the major constraints of crop production. Quickly occurring flash flood mauls crop lands and destroy standing crops just before its harvest. Especially Boro production is affected severely in the central and North-eastern foothills and depression (*haor*) areas.

Crop loss due to flash flood often brings food security to a poor farmer's household. Since Boro cropping requires modern inputs and considerable investments, crop loss due to flash flood devastate hopes of poor and marginal farmers who often become loan defaulters following such a disaster. Flash flood also destroys mud built houses, which often belong to poor farmers. Loss of crops and house sometimes put poor farmers in extreme economic hardships.

Sometimes coarse sand casting occurs in the aftermath of a flash flood, which significantly reduce future potential of prime agricultural lands in the neighbourhood. During the FGDs in Chokoria and Sunamgonj, such problems were identified by the marginal farmers.

4.3.7 Coastal Tidal Flood

Coastal tidal flood resembles the adverse effects of temporary water logging, where the only major difference being the high levels of salinity in water. Since it occurs in the coastal polders, an event suddenly shatters the sense of security within the polder. Standing crops, especially vegetables and *Aman* seedlings often ruin due to strong reverse osmosis caused by salinity. Loss of *Aman* season is often translated into food insecurity and hunger for poor and marginal farmers. Once seedlings are ruined, it becomes a costly affair on the part of the poor farmers to replace the seedlings. If such inundation occurs late (say, in September), poor farmers forfeit the *Kharif* season altogether.

The early symptoms of coastal tidal flooding within the embankment system have already been experienced, which is very likely to be intensified after a few decades (CEGIS, 2006). A number of such risky embankments have already been identified where the entire polder will eventually hold saline water pool and no agriculture will be possible there – an apprehension which is scary enough to prompt out-migration of poor farming community. The question remains whether their exodus will lead to a secured life somewhere else. Only time will answer such a thought provoking question.

4.3.8 Urban Flood

Urban flooding is a fairly new phenomenon in Bangladesh. However, it might become a frequently occurring event under climate induced invigorated monsoon. By examining the flood conditions of Dhaka in 1998, 2004 and 2007, and probing into extreme vulnerability of the poor communities in flooded conditions, one can only hope that poor people out migrating from environmentally stressed rural areas would not dare to find their places in Dhaka in the coming decades.

Most of the poor in Dhaka live in unacceptable conditions, mostly in marginalized lands at the outskirts of Dhaka. Of course there are better areas where people cannot easily find a place – the price tag is way too high for even higher middle class. Consequently, poor and marginal people fall easy victims to flood related hazards. The marginal lands are inundated first, water recedes from those lands months after the recession of water from the adjoining rivers. Poor people are often left with no choice but to become floating people. Their dignity is totally shattered, their employment opportunities are lost, and their food security is diminished.

Urban water supply system even during a moderate flood becomes so hopeless that a large number, in hundreds of thousands, face sudden deterioration of health condition. Urban health care system has thoroughly become inadequate to face the service demand to treat diarrhoeal patients in Dhaka during 2007 flood. That too has taken place only in one marooned part of the city – fortunately the other part has remained mostly dry.

4.3.9 Coastal and Riverbank Erosion

Erosion generally occurs quickly and results are often devastating. Again, the poorest are the worst hit, since they do not have enough cash to relocate themselves following such an event. Erosion takes away crop lands, the major source of survival for the poor and marginal farmers. Moreover, erosion makes people rootless and forces affected people to out migrate. Unless one is properly rehabilitated, a poor has to face in any case, one cannot escape economic hardship, physical and emotional pains, social injustice, and even they cannot survive without having to deal with lengthy legal processes to establish claims of their non-existing land.

It is ironic that an erosion event can bring a rich and a poor family on the same level. However, the rich family, owing to their better economic organization and much improved social resilience compared to that for the poor family, can bounce back. If one carefully does a life cycle analysis of two such families, one has reached an inference that the social and economic vulnerability of erosion is again disproportionate on the part of the poor family.

5.0 COPING PRACTICES AGAINST CLIMATE INDUCED HAZARDS

Bangladeshi people are familiar with climate induced hazards for a long time and as a result they have developed unique coping practices against such hazards. Since agriculture has a profound impact on the economy of the country, farmers always practice their self innovative coping mechanism for survival. Millennia old traditional knowledge plays a significant role towards modifying and adjusting coping practices. As women are differently vulnerable than men under climate variability, they also have developed their own coping mechanisms. Many of their practices are needs-based, appear to be so obvious. However, these apparently ‘obvious’ practices have all passed the true test of time and have contributed immensely to reduce their vulnerability against vagaries of nature. A few observed coping practices in relation to specific climate induced vulnerability, as pointed out by the women and poor farmers in various field FGDs and consultations, have been discussed in this section.

5.1 Coping Practices among Women

5.1.1 Coping with Cyclone and Storm Surge

In the coastal areas of Bangladesh people are always aware of the fact that they might be affected by cyclone anytime when the cyclone-prone period of the year approaches. As a result, they have naturally developed coping mechanisms to face cyclones. In the cyclone-prone areas, women tend to build mud-structures as housing unit with a notion that even it might be completely demolished by high intensity winds and tidal boar, nobody would be hurt by flying corrugated sheets. By preferring to have mud built house, reinforced with straw²² and wooden/bamboo pillars, women take the burden of rebuilding such units along with their male counterparts following a cyclone.

There is a preparatory phase when generally women store dry foods in their houses. Coastal



Figure-22: House built on stilts – an example of coping practices

people now keep at least one radio in most of the household. People listen to regular updates in relation to cyclone warning. Coping of cyclone is generally associated with capacity building training such as quick evacuation training, management training of household resources as well as of children and domestic animals during cyclones etc.

Women monitor the flag warning and take necessary steps. Women put safe water in a plastic canister and bury it along with polythene-wrapped dry food, match sticks, candles, and life

²² Clay is reinforced with straws.

saving medications in a designated place so that following the storm they can reclaim those important things quickly.

Taking temporary refuge in a nearby cyclone shelter is becoming more and more common. Those who cannot go to the cyclone shelters, especially due to poor accessibility, they take shelters on the embankments. In the cyclone shelters, women help each others; provide comfort to traumatized neighbours and toddlers. Collectively, women help adolescent girls to avoid sexual harassment and occasional assault.

Following the cyclone event, almost every family of the cyclone prone areas repair their dilapidated houses and for this both male and female members participate in the physical labor. Erosion of assets in a bid to gather cash for the purchase of building material is a common practice, where women do participate by voluntarily giving away ornaments etc. Women also participate in micro-credit programs of various NGOs and accept credit to facilitate household rehabilitation.

5.1.2 Coping with Waterlogging

In waterlogging prone areas, coping for women is the other meaning of survival. They cope with permanent water logging all the time. Women are generally given the responsibility to safeguard virtually everything valuable as well as perishable in moist conditions. They take care of themselves, maintain household physical security, maintain the well being of the children and elderly people, nurse young children, prepare food and still do everything psychologically possible to maintain household harmony. In Jessore, where the prevailing water logging condition is continuing for years, they 'live through the water world' amid otherwise hopeless circumstances, even when their male counterparts are in pursuit of earning money and avoiding the water world during the peak water logged conditions.

In Noakhali, it is the temporary version of water logging and the conditions are slightly better. Houses inside the embankment has ceiling-like raised/ high platforms, locally termed as "Darma", which offer safe storage for all their valuables: ownership documents/ deeds of lands, other important papers/ documents, dry food e.g. fried swollen rice ('Cheera', 'Muri' etc.), rice, and pulse, salt, sugar ('gur'), matches, candle, kerosene, quilt/'kantha', etc. Women climb up the bamboo made stairs and fetch anything needed as many times as required.

Since the problem there is seasonal, women continue to maintain poultry and livestock. Feeding these animals require extra bit of effort on the part of the women. Cooking becomes a hazard, especially if biomass based cooking stoves are being used. Women suffer through unhealthy smokes and subsequent bronchial diseases. Fetching safe drinking water becomes another major daily hurdle. If the household tube well is inundated and/or contaminated, the woman goes to the neighbours' courtyard to collect safe drinking water. "We do not cope, we just try to survive. Who wants to live like this?" snapped a young woman in Keshabpur. She just represents tens of thousand other women in the water logged area.

5.1.3 Coping with Salinity

In saline prone region of Bangladesh, unavailability of suitable drinking water is the major problem. Traditionally women shoulder the responsibility to fetch non-saline drinking water,

even if the source is located far away from her household. It might sound so simple, yet it can be quite hazardous. The onus one woman has to take under specific circumstances can be quite dramatic. For example, a pregnant woman at advanced stage has to continue the duty unless other women in the community relieve her by sharing her responsibility. Kinship plays a major role here. However, the primary responsibility remains on the part of women.

Ironically, one of the respondent in the FGD held in Tala informed that she had to fetch water the next day following the birth of her first child, that too during her teen age. It affected her reproductive health severely and she had ever since been suffering from various related diseases. Another anecdotal story suggested that a woman left one of her toddler at home and took the other on her lap to fetch non-saline water from a few kilometers adrift. On her return to her household, she found the child dead due to snake bite. Women, in their daily struggle to collect potable water, face difficult circumstances, even sexual harassment and assault.

Women are aware of the fact that a few select species grow well in saline conditions. They plant palm, battle nut, sofeda, etc. saplings which provide little cash for the family. In doing so, they actually utilize the condition which otherwise poses threat to their better life.

In Satkhira, due to proximity of *gher* fisheries, women raise a few ducks. This provides them to avoid dearth of animal protein. Women also engage in handicraft production, based individual skills. Due to mainly on lack of time, many women cannot simply make best use of their acquired skills.

5.1.4 Coping with Drought

Not many options are available or practiced to cope with a drought situation. Usually in a drought condition, it is widely accepted that agriculture production and livestock suffer the most. But the sufferings of women, their hardship and initiatives to combat the situation is hardly recognized. The most observed survival mechanism is to sell the mere assets that women own, such as, gold, poultry (chicken, ducks, goats etc.), as price hike of essentials is very common in this situation. Often they are compelled to sell these at a lower price. Crisis of drinking water during drought give women enormous extra burden adding to their miseries. As women are solely responsible to collect water for the family, as designed by the gender based role in the society, women have to take extra burden and effort to fetch water in this water crisis condition. They have to walk a long way to find a tube well where water level supports water supply adequately. Sometimes women take part in pre harvest and post harvest activities. They collect and preserve seeds for next cultivation. Women try different types of vegetables for their courtyard production which are moderately drought tolerant.

5.1.5 Coping with Riverine Flood

Bangladesh is a flood prone delta. In some areas regular inundation is very common during peak monsoon. People live with this natural phenomenon and build up their coping mechanism mainly based on indigenous and ancestral knowledge. Women perform patriarchy defined gender-based roles and responsibilities, despite being in marooned conditions.

Floodwaters often limit their movement. They move with extreme discomfort when in need, however they show clear reluctance to leave their children with the fear that they might get drowned if slip into the water. They keep a close surveillance to avoid occasional snake bite. Many poor women collect wetland based food items, often on the way to fetch drinking

water. When they socialize with neighbours, they keep on stitching local quilt called 'Nakshee Kantha' – a very popular handicraft. Not a single minute is passed unjustified!

Floodwaters bring great difficulty when it comes to defecation. When flood creates an unsanitary condition, the male members of the family often go to the nearby forest or upper land for defecation. But a respectable woman cannot defecate under open sky due to prevailing social and religious norms. Either she waits with extreme physical difficulty till the night fall or she defecates inside the house and throws the excreta in open water. Unfortunately, she has to bath in that water too and therefore, she accepts health related consequences.

Maintaining poultry and livestock becomes extremely hazardous for women, since it is expected that they would take care of the 'valuable assets'. Bringing in fodder for the animals, collecting biomass for cooking, and even daily cooking for the entire family – all the usual gender biased activities become so much troublesome in marooned conditions.

And yet, Bengali women dream of hazard free days. She provides comfort to her children and murmurs a melodious song or two to keep a bored and hyperactive child quiet. She even indulges herself in a long boat ride to see her parents.

5.1.6 Coping with Flash Flood

Flash flood is a quickly occurring hazard which does not often permit any lead time to prepare. Therefore, it causes physical injuries and risk of drowning. In absence of any form of warning, women rely on traditional knowledge (physical observation)

As flash flood is a quick incidence, people do not get enough time for preparation and as a result in the flash flood prone areas people develop different types of self protective mechanism. For example, women generally tie up empty plastic bottles on the body of their children so that they can survive in case of falling into the water.

Flash flood deteriorates sanitary condition and in such circumstances women have to face difficulties. They generally defecate at night in open water with great risk of insecurity and health vulnerability. To maintain the food security in flash floods, many women sell their poultry, cows/bullocks, and small livestock and also borrow money from relatives in case of emergencies such as diseases of children etc. In the flash flood prone areas, women generally follow the coping mechanism such as preservation of dry foods such as '*muri*', '*chira*', '*khoi*' etc underneath their roof with polythene, preservation of fuel wood in the same way etc. In many households, women sell their trees in emergencies for the survival of the family.

5.1.7 Coping with Urban Flooding

In a situation of urban flooding the poor suffer the most as they usually live in the low lying areas of the city. Quick relocation to higher areas, often school buildings, acts as the primary shelters. Poor people relocate to these shelters with their families and assets; middle income families prefer to take shelters in relatives' houses and are reluctant to go to any public shelter because of social pride. Often community takes responsibility of the destitute families by distributing food, cloths, money among the affected people. In some cases, there are collective cooking arrangements in some shelters, which make women a bit relieved from cooking in this condition.

Outbreak of diseases is a common aftermath. Often diarrhea and dysentery take an epidemic form just after recession of flood water. Different volunteer medical teams appear to be active to intervene and monitor the situation. A holistic approach to combat flood is often noticed in such disastrous situation.

5.1.8 Coping with Coastal and River Bank Erosion

Out migration is the only coping when river bank erosion takes place. This is a phenomenon which takes away almost everything from the affected dwellers. People affected by river bank erosion have reported that they do not even have the incentive to plant trees for future security as they know their fate. This is a real disaster for the whole of the affected community which leaves nothing but widespread waterbed. The destitute people take shelters on the nearby embankments or adjacent *khas* lands. As a result the families, especially young women face enormous harassment and insecurity. Often the male members of the family go to big cities for employment leaving their families almost in an unbearable situation. In FGDs, it is reported that many male members leave their families forever. In the areas where river bank erosion is acute and common, women headed households are very common as husbands go outside the area for employment and never come back and take the responsibility of the poor family. Young women sometimes are compelled to go for prostitution without having any other alternative income generating activities to survive.

Still people constantly try to cope with the adversities. They build the houses in a manner that they can easily pack it into parts and shift it to the safer place.

5.2 Coping Practices among Poor Farmers

5.2.1 Coping with Cyclone

Coping with cyclone is generally related with the understanding of different signals and awareness. Issuance of cyclone forecast and warning are commonly practiced non structural coping measures towards reducing cyclone-related damages and losses. Taking shelter in the cyclone shelters is a common coping mechanism in Bangladesh though evacuation rate is not high due to lower capacity of cyclone shelters.

After 1971, another practice of taking shelter at the time of cyclone emerged as that people with their cattle take refuge in a land made highly raised. The inhabitants usually tie-up their houses in a strong manner so that these can withstand the severity of storms. They keep food, by digging earth, in pots made of mud. People use to keep seeds in polythene bags and keep those bags digging earth.

During post disaster phase people use to give efforts to rebuild their affected houses. In some cases they are compelled to take loans with high interest from the local *mahajans* just to meet their mere survival needs in an emergency.

5.2.2 Coping with Waterlogging

To cope with waterlogging people generally build houses with fences made of bamboo (*'muli'* bamboo) and wood. The foundation floors of the houses are raised so that water does not enter very easily, until it attains a certain level.

In the case of crop-agriculture, late varieties of ‘Aman’ rice viz. ‘kazal-shail’, ‘raje-shail’ (both black and golden), ‘chakraish’, ‘kartik-shail’, ‘dholamota’, ‘leiccha’, ‘nazir-shail’ are sown with a view to coping with water-logging. During the water-logging period cattle are reared/ kept by raising the floor. Seed-beds are also prepared by raising the piece of land with soil/ mud. In some places crop-land is raised to some extent for cultivating winter crops (‘rabi’ crops). In many areas as a precautionary and safety measure, the levees (sides) of the fishing ponds are raised up to a certain level so that fish cannot leave the ponds.

Ceiling-like raised/ high platforms, locally termed as “Darma”, are built inside the houses so as to keep ownership documents/ deeds of lands, other important papers/ documents, dry food e.g. fried swollen rice (‘Cheera’, ‘Muri’ etc.), rice, and pulse, salt, sugar (‘gur’), matches, candle, kerosene, quilt, ‘kantha’, etc. safe and stored in the wake of emergency during the water-logged period. Rainwater is harvested/ collected in some areas of the country with a view to using as drinking water since all tube-wells go under water during the waterlogged period. Besides this measure, wood/ branches of trees are stored on “Darma” to be used as firewood for boiling pond-water. During the waterlogged/ flood time, water is made purified by some families either by boiling or by using alum (‘fitkiri’). But most of the people are not that much aware in Bangladesh. Ovens are made using mud, tin, and cement and kept on “Darma” in order to use during waterlogged period/ flood time. Cooking is done on top of beds using those ovens, which the participants have learned from mimic demonstration/ publicity performed in mass communication campaign.

5.2.3 Coping with Salinity

Bangladeshi rural people of saline prone region previously used drinking water from shallow tube-wells, when they did not have any specific knowledge about salinity. But now-a-days, with the dissemination of knowledge, they usually drink water from deep tube-wells since the chance of water being saline is much lower in the latter case. They used to drink water from ponds as well. Now even when people drink water from shallow tube-wells, they do purify it using alum (‘fitkiri’). As a noticeable effect of salinity, the complexion of peoples’ skin becomes darker. But people have been used to/ adjusted to this phenomenon for being with it for a longer period of time. For cultivation, farmers use fertilizers viz. gypsum, TSP²³, potash, etc. to reduce salinity in land. The extent of salinity is different for different sections of an uneven land. Hence to make the extent of salinity equal all over the land the farmers first make the land even and then use various types of fertilizers mentioned above.

5.2.4 Coping with Drought

Since ancient times, farmers have practiced irrigation using surface water from nearby sources for a variety of crops including Aman and a number of nongrain rabi crops. There have been local Aman species/cultivars that require very low level of supplementary irrigation. Traditional irrigation techniques have been used extensively. The surface water systems of the country are largely dependent on upstream countries: India, Nepal, Bhutan and China. Increasing water withdrawal upstream and the diversion of water from the main transboundary courses reduced the flow in Bangladesh significantly during the dry months (Rahman et al., 1990; Ahmad et al 1994; Halcrow and associates, 2001). Consequently the possibility of surface water irrigation in the country has been reduced considerably.

²³ Triple Super Phosphate (TSP), a phosphorous containing fertilizer. Single Super Phosphate (SSP) fertilizer was also observed in stores, bearing evidence that SSP was also being used as fertilizer.

To maintain self sufficiency in food production, farmers have adapted to the use of modern irrigation techniques. Mechanized pumps have replaced the traditional methods of transferring water. Ground water irrigation involves high production costs, especially for the poor farmers engaged

People cope with drought condition in different angle in different poverty level. Marginal people take risk if it rains they might get some production without irrigation. But rich farmer do cultivation with irrigation. Marginal people collect drinking water far away from their homes. It makes many social problems. Women have to take burden in their shoulder to collect safe drinking water from a long distance.

With the onset of drought, since lands become covered with a thin layer of salt farmers thoroughly plough their land upside down in order to reduce salinity. Since water becomes scarce and less available farmers bring water from ponds to use it in their lands for cultivation.

Farmers usually use pitchers for fetching water from nearby ponds to use for cultivation in lands. Relatively well-off farmers use shallow machines for channeling water from ponds. Throughout the drought period there arises crisis for drinking water since water cannot be withdrawn using shallow tube-wells. People have to look for deep tube-wells in nearby locality in their drive for drinking water.

5.2.5 Coping with Riverine Flood

Depending on the depth of flooding, farmers use a number of indigenous varieties of paddy and other crops that ensure subsistence for the whole year. A particular type of deep water paddy is still in use in very low lands, which can withstand any level of inundation and provide a certain minimum yield.

High intensity floods affect crop agriculture the most. In areas where the recession of flood waters occur late, farmers find no opportunity to begin paddy cultivation afresh due to unavailability of seedlings. People living in less flood prone areas make paddy seedbeds in prospect of marketing the seedlings in highly flooded areas following recession of water. By transplanting these seedlings, farmers in deep flooded areas maintain food security. In some areas, farmers resort to restructuring the usual cropping calendar suited for local hydro-climatic regime and use the remainder of the wet season for alternative crops requiring shorter period for the harvest. The official agricultural extension services and local-level non-government organizations provide various support services to facilitate flood-coping mechanisms.

5.2.6 Coping with Flash Flood

In the flash flood prone areas, farmers always have to cultivate crops with the fear of sudden flash flood. *Aman* is a variety which cannot be grown in the flash flood prone areas because of the hydro-geological formation of the soil. As a result *Boro* is the only suitable option for the farmers in such region. In these circumstances, 10th May is the ideal time for harvesting *Boro* paddy. But unfortunately late April and the first week of May are the most vulnerable period for severe storms as well as flash floods. And now if farmers keep the crops on the field till the first week of May, then there is great risk of crop damage. To overcome this uncertainty farmers now a days use a modified variety of *Boro*, for which early harvesting is

possible (2nd or 3rd of May). Through this preponement of crop calendar, risk of flash flood related damages can be avoided to some extent.

Still there is risk that flash flood might occur in late April. To cope with this difficulty, many farmers of the flash flood prone areas in Bangladesh have adopted submergible embankment technology. Farmers use a special type of embankment which they call dwarf embankment. This is a low height earthen embankment which is submergible but can protect river water to come into the locality at least up to 10th of May. For this reason they can maintain their level of productivity. Also with proper operation and maintenance of the embankment, farmers make fish cultivation possible because the embankment also holds the water inside the locality. Through this unique coping mechanism of the farmers, *Boro* and fish cultivation both have become possible in the flash flood prone areas of Bangladesh.

5.2.7 Coping with Tidal Flood

At the very outset of the study the team made a reconnaissance visit in selected areas. Other than Pouroshova²⁴, in most of the unions “*kacha*” houses made of bamboo (‘*muli*’ bamboo) and tin roof are very common; even jute sticks are also used as the walls and jute fabrics as ceiling. People who are very poor use mud as house material. These types of houses are more vulnerable to sudden shocks as natural disasters than brick-built houses of comparatively wealthier families.

Every section of people tries to strengthen their houses before the seasons of rainfall, cyclones start. They do this in a manner which is within their capacity. Usually the foundations of all the houses are raised so that the rain water can not enter into the house. Usually people raise the platform at a height which can protect the houses from regular/average flooding with rain water. The families who have some extra money to invest on houses, they use to raise their platform of houses above the average height just in anticipation of extra caution to protect from excessive rainfall which causes devastating water logging condition. The kitchens are also paced on raised platforms.

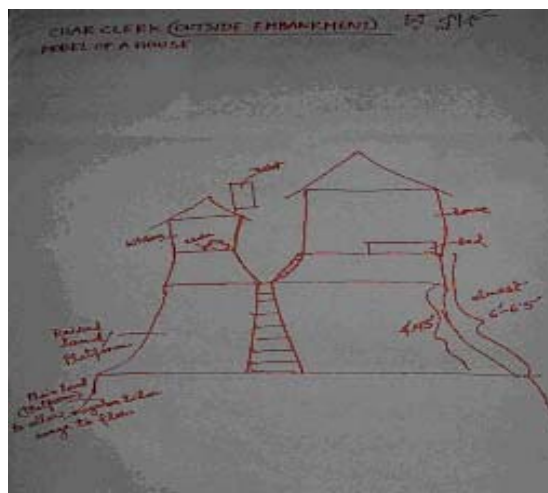


Figure-23: Coping with Water Logging

²⁴ Urban Centre, where an elected body takes care of local level development and management issues.

Raised platform are made of bamboo in order to use for urination and defecation purposes during that time. Houses outside the embankments are usually raised on even a higher platform, allowing the regular tidal surges to flow without any protection. This platform is about 4-5 feet high. Then on this raised platform people again raise another platform, say about 1-2 feet high, building houses on this secondary raised platform. This secondary raised platform helps to protect the houses from unusual tidal surges. They use to do post harvesting activities on the primarily raised platform. Other than this Two-stage raised platform, the internal arrangements of the houses outside the embankments are almost the same as the houses inside the embankments. It can be sensed that the financial condition of the habitats outside the embankments are the worst. Most of the houses here are built of mud. There are some latrines in some houses, but the overall sanitation condition is not satisfactory at all.

People take some preparation before the season of cyclone gets start. Preparation again depends on their capacity to invest. Usually they use to tie the corners of their houses with strong ropes or still wires. To protect from rain they use to repair their ceiling almost every year. Especially those houses, walls made of mud and ceiling made of jute sticks or leaves are specially taken care of before rain comes or cyclone strikes. People who are very poor and do not even have that much to repair the house with minimal efforts, they use to take shelters in neighbor's house, adjacent schools, madrasa²⁵. During the devastating situation of water logging due to excessive rainfall cattle, chicken, ducks all get shelter under the same room where the family lives. Very few families have that luxury to keep a separate cattle house which is locally called "*Goal Ghar*".

²⁵ Schools having bias towards religious form of curricula.

6. WHITHER ADAPTATION TO CLIMATE CHANGE

The necessity of mainstreaming adaptation strategies into national development plans has been recognized in the climate change related literature (Huq *et al.*, 2003). It is important to note that adaptation to climate change has not yet become a topic of high policy priority in most developing countries, as policy makers are preoccupied with other priorities such as poverty alleviation, sanitation, education, and equitable social development (Adger *et al.*, 2003; Simms *et al.*, 2004). Likewise, most donors and development agencies are still at early stages of understanding on ways to address adaptation. However, climate change has already evolved as from a mere environmental issue to a developmental issue (especially because adverse impacts of climate change can nullify the developmental progress in short time). Several policy researchers and development practitioners have argued for mainstreaming adaptation into development planning and sectoral decision making at both policy and implementation levels (Adger *et al.*, 2003; Brook *et al.*, 2005). Mainstreaming entails making more efficient and effective use of financial and human resources. It is aimed to ensure the long-term sustainability of investments as well as to reduce the sensitivity of development activities to both today's and tomorrow's climate. The link between adaptation and development is particularly relevant when seeking to enhance the capacity of vulnerable women and disadvantaged vulnerable groups and communities to adapt to climate change.

According to the IPCC and other concerned agencies, developing countries are expected to suffer the most from the negative impacts of climate change (DFID, 2004a; DFID, 2004b). This is because climate sensitive sectors such as agriculture and fisheries are particularly important in economic terms and because these countries have limited human, institutional, and financial capacity to anticipate and respond to the direct and indirect effects of climate change. Many sectors providing basic livelihood services to the poor are not able to cope even with today's climate variability and stresses (Sperling, 2003). This is particularly true for Bangladesh (Ahmed, 2000; Ahmad and Ahmed, 2000). The frequent occurrence of extreme weather events such as the floods and tropical cyclones in Bangladesh can set back development in the country for decades (Mirza, 2003).

The adaptive capacity of affected poor communities to climate change clearly needs to be increased but it is important to acknowledge that the impacts of climate change on people's lives and livelihoods will greatly vary depending on the current contexts of their vulnerabilities, as highlighted in section 4.1 and 4.2 earlier. For many people in developing countries such as Bangladesh, climate change is not at the forefront of the concerns but rather one of many factors which keeps them in a poverty strangle hold. Vulnerability to climate change is determined by geographic location and hydro-geophysical realities; prioritization and concerns of individuals, households and social groups; economic, social and cultural characteristics including human capacity; social organization as well as institutional and political constraints. So far a considerable amount of research has been focused on investigating changes in the hydro-meteorological processes, identifying the locations particularly at risk to certain climate induced primary physical effect(s), and on characterizing and quantifying the impacts (e.g. changes in the frequency and intensity of tropical cyclones, max depth and extent of flood water inundation, number of people at risk, etc.). Relatively few efforts have been made to understand the social, cultural, organizational, and institutional factors which lead to the differential vulnerability of certain groups of people, including those of women, to adverse impacts of climate change (Cannon, 2002; RVCC, 2003).

This section highlights the specific needs of women and marginal farmers for adapting to climate change in the light of their perceptions, aspirations and expressed demands. The analyses also take note of current policy as well as institutional regime which could have facilitated the various processes of adaptation given their contexts of vulnerability. First, adaptation for each of the major hydro-geophysical aspects are discussed, which is followed by a few cross-cutting and common adaptation issues.

6.1 Cyclone and Storm Surge Related Adaptation

Managing quick on-setting severe form of hazard such as a cyclone along the coastal areas of the country has been recognized globally as a success story. A combination of model-based highly advanced warning system, social mobilization of a large number of volunteers to reach out to millions of coastal poor households with the words of warning, building of over 2200 coastal cyclone shelters to safeguard lives and many other earthen *killas* to safeguard lives of livestock has clearly demonstrated that Bangladesh can effectively reduce otherwise staggering death tolls due to cyclone and storm surges. The innovation is certainly praiseworthy, allowing everyone involved in the process to take pride in.

However, such a mechanism has otherwise been proved to be gender blind, as in many other hazard management practices in the country. As explained in section 4.2.1, and 5.1.1, the contexts of women's vulnerability in an event of cyclone and storm surge have only slightly been changed due to the innovative approach such as the 'Cyclone Preparedness Programme (CPP)'. Yes, women can now save their lives, as all the males in the neighbourhood. However, many of them do not even get the warning well ahead of time and accept consequences. In many cases they also are forced to accept sufferings due to (a) patriarchal maltreatment and harassment, and (b) prevailing societal norms and practices. For obvious reasons, an opportunity to survive the onslaught alone can be considered as a great advancement. However, women aspire more from the society, as they deserve to be treated with honour and dignity. Mere survival and subsequent social maltreatment can no longer fulfill the needs of coastal women in quest of adapting to climate change.

Women require to be informed adequately and well ahead of time of occurrence of an event. They require training on translating the flag signs, preparatory measures etc. Moreover, they want their respective male counterparts to be responsible enough to take equal part in the preparatory processes before running to the closest cyclone shelter. Furthermore, a woman asks for freedom to make decisions with regard to leaving the assets and households upon issuance of a warning in a bid to save the lives of herself and her children. It is understood that training can be designed and imparted to equip the coastal women towards responding to cyclone warning better. However, changing patriarchic norms and behaviour would certainly require social mobilization and awareness and cannot be achieved with rhetoric in the policy regime.

The harassment and occasional misconduct faced by young women on their way to a shelter need to be managed in order to facilitate the temporary relocation process. Social mobilization is a must to bring about a change in this regard. To win the heart of those women who are in need of privacy during feeding their infants, the adolescent and those in their advanced stage of pregnancy, provisions have to be made in cyclone shelters. Pregnant women particularly need ramps in such facilities. The approach roads should also be made user friendly, especially for women with pregnancy and for elderly women. Women require a separate toilet in each of the shelters, designated for women and not necessarily occupied by

the caretaker of the shelter. Carefully responding to such needs of women could have been facilitated gender-sensitive adaptation in the wake of climate change induced cyclones and storm surges.



Figure-24: A Multi-purpose Cyclone Shelter, where the only Toilet is located outside

The number of available cyclone shelters and their total capacity is not adequate, especially in view of gradually increasing population throughout the coastal zones. The cramped state in each of these shelters is clearly a deterrent factor for women to be reluctant to go to a shelter. Unfortunately, since late 1990s, the process of creating increasing number of such shelters has been stalled. No new *killas* has been built since 2000 to safeguard livestock. Coastal people's adaptation to cyclone and storm surge could have been greatly facilitated with increasing investment on shelters and *killas*.

Women's plight increases with the destruction of their dwellings and damages to assets. However, rehabilitation processes often undermine the needs of the women. Even if housing loans are disbursed in a devastated area, a structure is usually built similar to the one which has just been destroyed, often with the similar kind of material. Innovative structures with slightly changed design could be built. In that case, the local masons and carpenters need to be provided with adequate training. This is how the borrowings on the part of the poor people would have been utilized properly and the objectives would have also been fulfilled.

The destruction to standing crops caused by a storm surge can have a significant bearing on the status of poor and marginal farmers. Saline water can potentially destroy crops even within an embankment if trapped inside. There is hardly any preparation throughout the embankment system to quickly remove saline water logging following a tidal/storm surge. Investment in this regard and preparing the relevant authority, the Bangladesh Water Development Board (BWDB), could greatly facilitate poor people's adaptation to cyclonic storm surge.

The provisions of the safety net programme, as highlighted in the Poverty Reduction Strategy Paper³⁰ (PRSP), are not so specific to tackle food insecurity following a cyclonic storm surge event. The provisions created for poor must cater the needs of the cyclone battered coastal poor.

It is heartening to notice that coastal green belt programme has indeed created a safety barrier to decelerate the onrushing storm surges in many places. This will greatly help adaptation along the coastal zones. However, it is also noticed that the tree density in many of those places are being reduced due to poaching and illegal felling, which would negate the benefits of such green belts. Efforts must be made to keep the uprising green belt intact. It would not only require strengthening the current surveillance and monitoring capacity of the Bangladesh Forest Department, it would also require active support of local administration, local communities (particularly the beneficiaries) and the Bangladesh Coast Guard Authority. If the coastal green belts are properly maintained, this would not only facilitate adaptation against tidal surge, it would also become a successful example of adaptation co-benefit of a otherwise mitigation programme.

6.2 Waterlogging Related Adaptation

The problems associated with water logging and women's particular vulnerability contexts are described in section 4.2.2. The survival coping of women is illustrated in section 5.1.2. Water logging, especially the saline form in the southwestern region, brings unsurpassed miseries to women. Unfortunately, water logging appears to be a rather 'new phenomenon' and the institutional approach to reduce such vulnerability hasn't yet been adequately addressed.

Since the nature of the problem is similar to that of flood, where the water remains standing throughout the year (as in the case of SW region), existence within the waterlogged condition itself becomes synonymous to that of coping: women cope with such a persisting hazard in every minute of their existence in it. In a patriarchal society, males are just males, even in water logged conditions. Male members of the families often go to the nearby relatively higher and dryer places for employment; as transportation is not easy and is expensive, these people often stay at those places and do not frequently come back to their families. Even the male members show the attitude that they do not feel like staying every single day in this water logged situation. Only women are full time water-bound in this '*saline water world*'. This social reality makes the life of women more miserable coupled with insecurity. Food insecurity can be placed in the foremost problem as a consequence of unemployment and extreme poverty. Children suffer from acute malnourishment though mothers try to feed their kids with whatever they have, being themselves half fed or even starving.

Facilitating drainage of water is the greatest perceivable adaptation, which is far beyond the capacity of individual woman or a small water logged community. Only the authority can plan and execute an emergency water removal/drainage programme, much to the benefit of the helpless people. However, little has actually been done so far.

Since food security is severely constrained in the absence of land based productive system, food relief generally helps maintain nutrition and contain hunger. NGOs have been generous

³⁰ GED-PC, 2005. Unlocking the Potential, General Economic Division (GED), Planning Commission (PC), Ministry of Planning, Government of the People's republic of Bangladesh, Dhaka, p. 349.

enough to provide food assistance. However, the regular safety net programmes of the government (i.e., the Food for Works programme, the Vulnerable Group Feeding programme etc.) could not be initiated in the affected areas as yet. The local people and their representative, the *Pani Committee* (i.e., Water Committee), has been requesting the Government to declare the affected region as designated 'vulnerable zone' (*Durgato Elaka*) so that these people could be brought under such safety net programmes. However, their requests have so far been ignored. Meanwhile, more and more new areas are being inundated every year, especially in the SW region.

People opine that, excavation of Kobadak river in the SW region and the *Noakhali Khal* (i.e. the major rivulet in Noakhali) could have been greatly facilitated local drainage of standing waters. Unfortunately, neither of the two projects has so far been approved/implemented in their full capacities to effectively solve the problems.

In absence of a long term solution to the problem, short term adaptation measures could have been designed. For example, when rural roads rise above water level during the dry season, a few designated roads could have been raised significantly to facilitate people's movement. This could also be done by implementing Food for Works Programme, which could also generate local employment. Though these are known coping strategies, being practiced after every major disastrous events in the country, it is not yet designed for the two affected regions.

People want to have health care services. The KII involving local NGOs clearly suggested that qualified health care practitioners were not interested to stay in marooned conditions and employments offered to them in this regard were not accepted. No wonder, the government's effort to keep doctors in their respective stations in the affected areas has so far failed. The local health practitioners, mostly village doctors (i.e., *Palli Chikitshaks*) cannot treat the ailing people properly. Simultaneously, they consider the poverty status of the people and refrain themselves from prescribing costly but effective medicines. Consequently, the poor continue to suffer with ailments.

Making provision of safe drinking water is a major task. It is praiseworthy to note the proactive approach by the NGOs as well as the recent steps considered by the Department of Public Health Engineering (DPHE), which established a number of tube wells placed in high lands in each of the Unions of the affected region. These tube wells do not become contaminated, even during the peak water logging season. As a consequence, during the flood of 2007, most of these newly established tube wells were found to provide safe drinking water for the local people. Women living in the area however feel that their vulnerability could be further reduced if (a) similar community based solutions in relation to public toilets could be implemented and (b) the approach roads to both the tube wells and toilets for women could be raised above standing water.

Unless the schools are rebuilt at higher grounds, or raised (applicable only for shanty structures) adequately, the academic activities have to be curtailed during the peak water logging season. As because the problem is caused by a new phenomenon, there have been no effort to adapt in this respect. In dilapidated dwellings, however, studying is often seen as a strange activity to those who have been just surviving amidst water and despair.

No personal level coping can further improve the situation. Bangladesh Water Development Board (BWDB) must come forward to initiate the whole hydrological planning in a

participatory method. This may require involvement of local Union Parishad (UP) members to involve the local peoples' representatives in this matter. BWDB can initiate re excavation of adjoining flooding rivers, where local people can participate. Attention must be given so that the flow of the rivers sustains and BWDB can initiate the process to prevent the choking of the rivers, dredging is one of the options to do. Much research, surveillance and monitoring are needed into the whole planning and implementation phase.

Adequate macro political blessing is needed in the whole process, because resource allocation to implement all the planning and implementation phase is extremely important where political parties can intervene with their administrative hats.

The experience of development and subsequent management of the tidal basin for the rehabilitation of the choked drainage system in the Khulna-Jessore area, under the Khulna-Jessore Drainage Rehabilitation Project (KJDRP), is a positive example of how to approach adaptation in low lying areas that will be subject to tidal inundation and water logging – the anticipated biophysical effects of sea level rise along the coastal zones. The Tidal River Management (TRM) approach appears to be highly acceptable among the key stakeholders and the cost of implementation is rather low compared to many other coastal development projects (EGIS, 2002). It will be worthwhile to promote such an adaptation only if the early experience yields satisfactory results towards solving the emerging problems along the coastal Zones of the country.

At household level, plinth height of houses and toilets need to be raised. However, it is easier said than done, given the prevailing poverty situation and poor financial ability of the poor households. NGOs can come up with credit facilities. Many of the school buildings are dilapidated structures and special arrangement must be made by Facilities Department of Ministry of Education and Local Government Engineering Department (LGED) to reconstruct the school buildings and uplift the approach roads to the schools. Regular health awareness related NGO activities can continue their activities in a regular pace. Special safety net social security programs must be initiated for this community people through the Ministry of women and social welfare.

In Noakhali coastal belt, the dimension of the problem of water logging is quite different from that of the southwestern region. Agricultural activities, though hindered by water logging, are still the major economic activities in this region. However, the land based productive system is severely constrained during the peak water logging season.

In Noakhali, excessive rainfall leads to water logging condition which inundates most of the latrines and gets contaminated with pathogens. Lack of potable water, especially lack of fuel for boiling, often forces people to drink contaminated water and succumb to water borne diseases. However, water related vulnerability to human health can be reduced significantly if community representatives are trained to prepare and use low cost water purifying techniques. To train community people, Department of Health and Engineering (DPHE) and local NGOs can come forward and initiate training programs.

Coping with water logging-affected agriculture requires special skills as well as ability to invest in input-based cropping. Seedbeds are by choice prepared in raised lands; however such a well practiced measure is generally out of reach of poor farmers. Coping in such a case is synonymous with ability to either purchase high lands or paying more to purchase seedlings from highland areas, which may be located in other districts. If water could have

been drained off, farmers could easily utilize the *Aman* season and maintained their food security. Such an obvious adaptation however depends on how and when the water management condition will be improved throughout the affected areas.

Unless the local water management situation improves drastically, much to the delight of the poor farmers, efforts need to be made to help farmers utilize the remainder of the *Aman* (*Kharif*) season to grow cash crops such as vegetables. National Agriculture Research System must initiate research for inventing suitable crop species and cultivation pattern, high value crops suitable for this region. The government should strengthen the existing extension network to provide agricultural services up to the grass root stakeholders through the Department of Agricultural Extension (DAE).

6.3 Drought Related Adaptation

Other than creating problems in collecting safe drinking water and by causing occasional food insecurity, the actual vulnerability caused by a drought event to women is rather low compared to other forms of hydro-geophysical hazards. Because of meager supply of water, food and fodder both humans and livestock suffer unfold miseries. Drought extends its ominous tentacles slowly but certainly. In some places women has to wake up at midnight to track even some kilometers to a well to fetch a pitcher full of drinking water, as a result women can contribute lesser time to other household and economic activities. The lack of drinking water is related to the falling of the water table as experienced by the drying up of ponds, wells and even hand tube wells- the major sources of drinking water. For the farmers, for the same reason, the shallow tube wells also become inoperative. Drought tends to deplete soil moisture, cause dryness in the soil, create dust blow, ultimately leading to slow degeneration of natural vegetation and cultivated crops. Besides, there is a long-term consequence of drought for which the people tend to suffer much. Some of these include shortage of food (nutritional erosion), shortage of fodder, lack of employment, price hike of essentials, etc.

Because of lack of assistance in drought condition the people do not have any option but to adopt a number of strategies to cope with the event. The first option is to sell livestock, mainly cattle, to cope with the event. Selling of livestock serves two purposes, i.e., to arrange ready cash to buy food and other essentials, and to get released from feeding the livestock, when fodder is scarce. Department of livestock can come forth in this situation with supplying fodder at lower subsidized prices for this drought season. Bangladesh livestock research institute can do research on drought tolerant variety of fodder.

To reduce the problem of drinking water, community drinking water system can be developed. In this system, in a community there can be a number of deep tube wells from where families can collect their required drinking water. To promote this facility, credit to buy deep tube wells must be facilitated either under the hats of government or NGOs. DPHE (Department of Public health Engineering) can contribute to the system promoting the technology in the community. BIRD (Bangladesh Institute for Rural Development) may take active participation to disseminate the technology and to support in initial management training to the community. There are other low cost options to address the issues of drinking water in drought. There can be designated drinking water ponds in the community, holding rainwater in the monsoon. Community management to use this pond should be developed and other human uses must be prohibited to arrest pollution and other forms of contamination.

There is another household level potential adaptation which entails adoption of “water saving technology” and/or “water reuse technology”. In this modality, farmers using irrigation may be made aware of the fact that they could have easily gained as much yield by applying irrigation up to field capacity, thereby saving huge quantum of water for other uses. Moreover, household level water resource users may also be made aware of potential misuses and/or saving potential wherever possible. For Example, after washing their kitchen utensils people can conserve that water in a separate bucket and reuse that in their courtyard vegetable garden. Lots of such options can be explored and implemented with little orientation and training. To disseminate these options, imparting training to the communities including women is a must. Local NGOs can be a good partner in doing such capacity building training to the community. Optimization of irrigation at field capacity, however, needs more intense training involving both the farmers as trainees and Bangladesh Academy of Rural Development (BARD) or similar other national organizations as training partners.

Deep Tube Well (DTW) irrigation seems to be a solution to protect crops from drought. Often farmers, especially poor and marginal farmers cannot afford deep tube well irrigation. Farmers can arrange funds forming cooperatives. Local NGOs, Krishi Bank, Other financial institutions can provide easy loans for this purpose. For deep tube well irrigation, the associated problems are unreliable electricity supply, no access to electricity in many areas, high price of diesel. All these factors hinder the process of using the advantage of DTW irrigation. Since irrigation is the only conceivable direct modality to adapt to moisture stress and drought, all forms of institutional facilities for drought management will increase farmers’ adaptability to a great extent. However, it has to be borne in mind that over exploitation of groundwater resources from shallow ground water aquifers, as found in the southwest region, may lead to salinization of such lenses. Ground water abstraction, particularly for irrigation, needs to be regulated to avoid aquifer salinization. A simultaneous indirect modality to adapt to moisture stress will be to promote crops such as millet and/or sorghum, which require much less moisture than paddy. However the thrust must be placed on crop diversification which also promotes water saving irrigation technologies. Water saving Irrigation can be explored and extensive research must be needed in this case. Bangladesh Agriculture research Council (BARC), Bangladesh Forest Research Institute (BFRI) may take the lead to do the needful.

Bangladesh Agriculture research Council (BARC), Bangladesh Forest Research Institute (BFRI) can contribute in choosing drought tolerant species both for courtyard vegetation and crop production in the land, for which lesser irrigation water will be needed.. Department of Agriculture Extension (DAE) may take the key role to disseminate the technology to field level. Water saving irrigation techniques should be made available with the help of these government offices.

6.4 Salinity Related Adaptation

Salinity severely affects the well being security of the community population, especially for the women in this area, it is the most pressing concern. Living in a society where gender biased activities compel women to shoulder most of the household activities, salinity in drinking water causes enormous hardship to them. There are some places (south of the south west) where women have to fetch water from long distance, even walking 5 kilometers all the way. This naturally results in health hazards. Coastal Zone Policy clearly mentions that women suffer a lot to collect water due to poor availability of ‘safe water’. This is also regarded as a barrier for the development of women. Unfortunately, while the policy theme is

divided in a number of policy issues, the issue of poor availability of safe drinking water is dropped. The policy must address this issue, with due emphasis, and provide solutions to the long lasting problems. A mere identification of a problem is not enough to solve the problem. The Environmental Policy and Implementation Program (EPIP) for Bangladesh was pronounced by the Ministry of Environment and Forest (MOEF) in 1992, in the wake of the environment-hyped First World Summit, the United Nations Conference on Environment and Development. In its proposition and scope, the EPIP states "... *natural disasters such as frequent flooding, drought, cyclone and storm surge; preliminary symptoms of desertification in the northern zone; salinity ingress along the river systems; land erosion; rapid reduction of forested areas; variability of climate and/ or weather and other environmental problems are observed in the country*". The statement certainly sets the tone and correctly points out major environmental concerns, with the exception of high salinity in drinking water.

Deep (hand) tube wells must be made adequately available to face the problem of salinity in drinking water. If the number of deep (hand) tube wells are made adequate in the community, then women need to travel less or even they do not have to travel at all to collect water for drinking. DPHE (Department of Public Health Engineering) must take necessary initiatives to meet the necessary steps. Combination of pond sand filter and rain water harvesting in ponds can be an alternative to avoid the salinity problem in drinking water to some extent. Extensive research should be taken place in this issue and training on rain water harvesting and pond sand filter can be given to the affected people. Local NGOs coupled with other government offices can take initiatives to this technology transfer.

The National Water Policy under the policy theme titled Water Supply and Sanitation, clearly states "*salinity intrusions from sea water deep into the land in the southwest are rendering groundwater unfit for consumption*". It is anticipated that, due to reduced dry season flows under climate change, surface water salinity will be on the rise along the coastal rivers and the salinity front is likely to ingress further north. Unfortunately, in the following statements (i.e., 4.6 a through e), no policy item was prescribed as such to tackle the issue. Salinity affects both agriculture production and human well being adversely.

Agriculture production is greatly hampered by salinity in the coastal region in general and in the southwest region in particular. During the past few years, two cultivars (BRRI 40 and BRRI 44) have so far been developed by Bangladesh Rice Research Institute (BRRI), which can sustain upto 10 ppt of soil salinity. Since a large tract of coastal land becomes saline much above the threshold concentration in late March and April, it becomes very difficult to gainfully cultivate Boro in those affected lands. The new discovery in terms of salinity tolerant cultivars can potentially facilitate adaptation in agriculture to a significant extent. Even such limited options are not being explored by most of the saline affected farming houses, because of lack of proper extension services. Wide scale extension of BR41, a variety that can tolerate up to 10 ppt of salinity, and 'on-farm water management technologies' to efficiently manage irrigation may be taken up as an 'institution-led' adaptation immediately. More research must be done to invent saline tolerant crop varieties. Bangladesh Rice Research Institute (BRRI) and Bangladesh Agriculture research Council (BARC) can essentially lead the process. Extensive extension services are needed in field level to disseminate the saline tolerant varieties.

Current forms of agriculture in areas with high vulnerability to climate change might not be possible in many parts of the country. There are millions of households that are already vulnerable to climate variability, especially in the south western part of the country (RVCC,

2003). Due to climate change related complexity, the vulnerability to salinity will be exacerbated and therefore, agriculture may not be found as a viable livelihood option in saline affected areas. Often in many statements, the promotion of shrimp culture in saline affected areas attains much attention. But only the large farmers (*gher* owners) can be benefited out of this shrimp farming at the expense of impoverishment of thousands of poor and marginal farmers. Livestock rearing can be a viable alternative livelihood options in these areas. Saline tolerant grass varieties, such as “NIPA” can be promoted as fodder in this region. Associated service like, vaccination, veterinary health facilities, credit facilities must be made available to the affected community.

Given the increasing pressure on surface water systems during the dry season, arresting soil salinity as a consequence of salinity ingress along the coastal river systems may not be possible. However, soil salinity may effectively be reduced below threshold limits through rational interventions. The National Water Management Plan has given emphasis on arresting in-stream salinity through scientific interventions. If planned and implemented early, the southward push of the isohaline line above threshold levels will not only help in-stream salinity, it will also facilitate lowering of soil salinity by increasing chances of flushing of crop lands with river water. In doing so, the population forced to accept saline affected water can be immensely benefited, with or without climate change.

6.5 Flood Related Adaptation

Flood is a millennia old hazard and the general people possess the most enriched knowledge regarding flood management at micro scales. It is made possible due to wealth of ancestral behaviour and traditional knowledge regarding people’s coping practices. Despite such profound understanding regarding the most common hazard, a large proportion of the population still found to be less than prepared when it comes to flood management. As in the case of yet another major flood event in 2007, it is realized that the knowledge base of common Bangladeshi people is not so adequate to reduce the overall vulnerability of the country and its people. In such a major flood event, the burning questions revolve around how the rivers in the vast floodplain can facilitate drainage of floodwaters and how mass people along with women and the disadvantaged would be able to enhance resilience against flood related adversities.

As mentioned earlier, a flood affected woman faces the same event somewhat differently than her male counterpart, which may be largely attributed to ground realities that surround her: (a) the status of economy and access of the woman to resources, (b) the patriarchal norms and taboos (both social and religious) prevailing in the society, and (c) the geographical location of the woman that defines the extent of the hazardous event. As explained in section 5.1.5, women too try their level best to cope with the situation. And yet, they cannot cope with certain sense of vulnerability that emanates from



Figure-25: ORS has been widely used for treating diarrhea affected patients

complex 'gender behaviour', dictated by the prevailing relationships between women and men under a patriarchal society.

Flood management in Bangladesh generally encompasses three broad categories of measures: measures to moderate the flooding; measures to moderate the damage caused by the flooding; and measures to provide relief and succor to the people affected by the flooding and to secure their eventual rehabilitation. Flood moderation is thought to be the responsibility of the state and the Bangladesh Water Development Board (BWDB) is given the authority to provide the services required – at all levels. However, the planning for water sector in general, and for flood management is done by the Water Resources Planning Organization (WARPO). Several planned 'flood containment' and 'drainage' projects have so far been implemented. Despite such institutional 'coping' trials, the occurrence of smaller flood events has shown a declining trend while the same for high intensity events has clearly shown an increasing trend (Ahmed, 2005).

There were national water plans in 1987 and 1991, respectively. The Flood Action Plan (FAP), triggered by severe floods in 1987 and 1988, introduced the concept of controlled flooding instead of full flood control for rural flood plains. The business-as-usual 'flood containment' approach, therefore, has been severely criticized and challenged by academics and civil society advocacy groups (Rashid, 1998; Rahman and Chiowdhury, 1998; Adnan, 1994; Boyce, 1994). Consequently, the government has been looking for 'non-structural' measures, in addition to the business-as-usual 'structural' measures to reduce the overall flood vulnerability of the land and its people. In 2004 a National Water Management Plan (NWMP) was approved by the government (MOWR, 2004). The 25 year planning document emphasized the importance of management of recurring floods, instead of containment by erecting investment-intensive embankments.

Moderation of floods could have been facilitated greatly by enhancing drainage capacity of small and medium rivers, which have been silted up (even in cases, significantly choked) over the past half a century. It is understandable that desiltation is of course a costly affair and the weak economy having severe financial limitations cannot commit to large investments. However, people in the flood affected areas including women firmly believe that there should have been state run efforts to desilt the rivers and facilitate drainage during peak monsoon. It is recommended earlier that, in case large scale excavation cannot be initiated in short to medium terms, projects can be envisaged easily to remove localized drainage congestions and to facilitate water passages with adequate drainage infrastructure (World Bank, 2000; Ahmed, 2005). The relevant national policies are found to be conducive to such 'adaptation' measures (Ahmed, 2004).

The state, however, has been embarking on other aspects of non-structural measures such as developing and improving its flood warning system. Its potential to reduce flood vulnerability of both men and women is highly regarded, however the otherwise excellent facilities of the Flood Forecasting and Warning Centre (FFWC) under the aegis of the BWDB is currently underperforming due to its poor dissemination process (Refs). A parallel community-based flood forecasting mechanism has already been piloted in three small pockets, which shows early success to become a major adaptation modality in near future. Since people, especially women, prefer to have early warning, any advancement in this regard would help them prepare better and allow them to reduce their flood vulnerability. The ability to effectively forecast a flood with adequate lead time and to effectively disseminate the information to all

concerned so that resources and people can be adequately mobilized for the tasks involved can go a long way to mitigating the hazards of even severe floods.

If a comprehensive flood management strategy is in place, the mobilization of resources and



Figure-26: Safe relocation during high flood or water logging becomes a major concern

services, including the deployment of human resources, can be implemented swiftly and in a coordinated fashion. This is another non-structural adaptation measure to flood. This can contain the losses at a bare minimum level. To get the people prepared, training should be given to women and young people how to pack their valuables and store them. Each individual alone may not have much capacity; a community approach can mobilize considerable resources. Boats can

be made ready in assistance with local community and NGOs before water comes in, which can help to migrate people to a higher and safer place. Livestock, which is the most precious assets for poor people can be shifted by the boats. A common deep tube well can be arranged in assistance with LGED before flood from where the community can be served with safe drinking water. It is a crying need during flood. Mostly women are responsible to collect drinking water for their families and they have to travel by boat or raft a long way to find a tube well not submerged under the water. Often helplessly the entire family has to use flood water for drinking as well, as there is no alternative. This leads to outbreak of many diseases; diarrhea and dysentery are very common among them. If the community can arrange a common source of water for safe drinking during flood, it will help people enormously. The rest of the time this deep tube well can be used for irrigation.

Local adaptation of floods consists of adjustments and responses at the local level aimed at minimizing adverse consequences. People in flood affected areas have learnt to deal with certain aspects of flooding by making certain preparations — for example, by adjusting crop calendars; by keeping certain commodities in store; by arranging for the temporary migration of the children, the elderly, and the sick; by arranging for supplies of safe drinking water; and by procurement of commonly needed medicines. The responses that local people undertake can be grouped into three categories: before a flood, during a flood and after a flood. Knowledge at the local level, acquired through centuries of experience, can be put to proper use. Furthermore assistance from government and non-government organizations in terms of supplying information and providing certain critical inputs at the appropriate time would go a long way to wards strengthening the ability of local people to respond more effectively to flood hazards. Nevertheless, when flooding affects extensive areas, is of long duration, and/or causes large scale losses and damage, the local response, while still essential, needs to be augmented by major external assistance from the government and/or from other organizations.

Flood shelters should be designated and during flood it can be managed by local disaster management committees, government offices can be involved in the process. There must be coordination among the local committees and government offices. Security of women and young girls must be put into a priority. Regular patrol by local committees and police can improve the situation. A temporary medical team must be there to give emergency services. Drugs for treating snake bite, adequate number of packets of oraline to treat patients with dehydration and diarrhoea, and water purification tablets must be available in emergency first aid kit. Midwife's service is absolutely necessary as the pregnant women often are unattended during this situation. Special care must be given to shift pregnant women, elderly, persons with disability and children. Adequate latrines must be there so that people, especially women can maintain their hygiene. Male can go outside for defecation, but women in this situation often wait till dark and go outside for defecation, which often leads to insecurity and harassment. Local committee can get prepared before the disaster by making a comprehensive planning. All the services needed during this period need pre disaster preparation as well as during and post disaster interventions.

Usually in an area where flood is a recurrent phenomenon, people use to build houses at a higher platform just to let the regular height of flood water flow away without causing any devastation to their dwellings. But extra ordinary flood often causes destruction to mud made houses. Government can arrange housing loans for the affected people with no or almost negligible interest and with easy repayment schedule, without taking any collateral. Community can also help each other by giving their voluntary labor to build the houses.

For the common interest of the community members, there may be a huge number of activities that would enable the farmers to safeguard their livestock, agricultural machinery and equipment, unutilized fertilizer and most importantly, seeds. An Agriculture sub-committee under Disaster management committee in association with local police and administration can

- make arrangements for safe storage of agricultural equipment, fertilizers and seeds, preferably in a common place where vigilance is possible, even during high floods;
- make arrangements in order to resist theft and avoiding mishandling.

A community can greatly facilitate regeneration of economic activities in a flood affected area. The following activities deserve special attention:

- Increasing access to seedlings; Thana Agriculture Office can offer assistance for arranging seedlings collection and distribution. A community can collectively negotiate with credit offering lending institutions (banks) for soft term loans for various purposes, particularly for purchasing seedlings from elsewhere.
- Homestead Agriculture: It is necessary to take measures to grow vegetables within the homestead. Thana Agriculture Officers can play vital roles in enhancing support for extension of homestead horticulture by providing seeds and quick growing varieties.

Unemployment during flood is one of the most daunting problems. For the most flood vulnerable areas, government can strengthen social safety net programs. It is however, given adequate attention in the Poverty Reduction Strategy Paper (PRSP). Implementation of rehabilitation programme by involving destitute women under 'Food for Works' arrangement has already been proven as a major coping measure to assist flood vulnerable women (Benson and Clay, 2004). Issuance of Vulnerable Group Feeding (VGF) cards and supplying relief during post-flood lean period has also been successful to avoid hunger following the

2004 deluge. Such adaptation programmes will have to be continued, especially with a particular focus on female-headed households and hardcore poor households.

6.6 Flash Flood Related Adaptation

Flash floods are severe flood events that occur with little or no warning and people are suddenly caught off guard. Following are the features of a flash flood event:

- rapid water level rise above natural channels
- reaches peak flow within minutes and continues up to a few hours
- rapid recession / quick dissipation (within minutes to few hours)
- not necessarily related to base flow levels
- short lag times

Flash floods are unpredictable in nature. However, in the flash flood prone areas, people generally know when to expect flash flood. With the dwarf submersible embankments being in place, people are more or less assured of their major harvest, the *Boro* rice. Therefore, the major livelihood concern has already been addressed by the BWDB. Moreover, the National Agriculture Research System institutions have come up with new variety of *Boro* paddy which virtually preponed the date of maturity by a few days, thereby reducing the risk of the matured paddy to be completely drowned within the *haor* basin. A combination of submersible embankment and such varietal development has given rise new hopes to poor people living in the flash flood prone areas.

However, the sudden onrush of water can still destroy dwellings and other assets. Adaptation measures to safeguard assets at risk could have been further developed if warnings could be generated and properly disseminated. The issue associated with flash flood is that it is very difficult to forecast. The following potential measures can help to escape losses from flash flood:

- Early warning system
- Community preparedness and awareness
- Appropriate emergency measures
- Establishment of suitable structural measures to protect crops (such as submergible dikes in Sunamganj)

The strategy for flash flood and riverine flood management in Bangladesh explicitly includes collaboration with upstream countries in the exchange of data and for joint assessments. Since 2000, Bangladesh has been developing flash flood forecasting. Improved forecasting for the flash flood prone rivers of the Manu-Dhalai-Kushiyara-Khowai river system has been proposed as an initiative for the Regional Water Management Plan. Feasibility studies have been carried out for improved flood warning on the Juri River. At present, more detailed evaluation of a pilot flood-forecasting model for the Khowai river is being carried out. A one-dimensional MIKE 11 Flood Forecasting Module has been applied to forecast water levels and discharge at ungauged locations along the Khowai River. Warning modules for other flash flood prone rivers should be prepared. The most important aspect of mitigation is to disseminate the warning at understandable level to the communities vulnerable to this hazard with a substantial lead period. Local administration must be aware of the hazard and take the responsibility to disseminate the warning properly. Government must focus on the issues:

- improving the understanding of the community of the warning system in use
- establishing early warning systems

- community training by private/ NGOs involved in hydropower infrastructure
- creation of interfaces between flood forecasting agencies and communities.

Community outreach programs can carry out regular drills to familiarize people with the different signals and procedures. Communities should be empowered with information and access to institutions and resources; empowerment of communities should, therefore, be a part of national disaster plans.

6.7 Erosion Related Adaptation

It is evident that poverty increases the burden of women's work. Erosion-induced displacement places women on the margin of survival. When all the men, even the adolescent boys, temporarily leave their houses in search of employment, the women take the onus and run the family all by themselves. Their existence becomes a series of coping. In such a condition, any assistance provided to these overburdened women can be regarded as adaptation.

These women face immense physical insecurity. A poor woman is definitely more insecure than a poor man as she is more vulnerable to different crisis events. Inadequate income means their families remain malnourished. Low quality living environment and poor housing condition lead to more exposure to the elements of nature. This is why illness and inadequate access to medical care increase their vulnerability. These households are especially vulnerable to disease and sickness. Women and the disadvantaged aspire for access to health care facilities, however their inability to bear costs, no matter how small, leaves little room for coping against health related vulnerabilities. Establishment of health camps in the neighbourhood and creating provision for free medical support (no-cost but appropriate medication) could have been greatly facilitated their struggle to survive.

Significantly, women play a prominent role alongside with men in several situations where they work side by side with men in rebuilding their shattered shelters and livelihood activities. Home-based activities for income generating seem to be beneficial for women who have to do all sorts of household works. Credit programs where loans are made to women for the purchase of poultry and livestock should be initiated by NGOs. Also marketing of products made by them should be built-in such programs. For continuing success, women's organizations and Ministry of women and Social Affairs can have positive roles to play in mobilizing women organized in groups and speak out their needs and problems in specific areas of work they are involved in. Landless, women headed and poor women working in groups can find more economic stability and security because they are also able to draw upon group's fund and social support system. Incidents of trafficking of women are common among these erosion affected ultra poor families. Special security alert against trafficking must be taken up by the police and local administration. Unfortunately, little has so far been done to prevent women trafficking and forced prostitution of young girls.

Given the small scale of most land holdings in the rural areas, farming households cannot afford to lose any land, be it agricultural or homestead. Unlike other natural hazards like cyclones, storm surges, floods, drought, the damage created by riverbank erosion is irreplaceable as the affected people lose everything they have- their entire land and resource base for income, employment and habitation. Displaced people are limited by local level power structure. Small landowners consistently appear to be losers while large land owners gain control over most of the accretion and *charlands*.

The people living in the riverine environment of chars are the most desperate people in the country, who lose almost everything in erosion and take shelters in the ever erosion prone *charlands*. The emergence of *charlands* with seasonal promise is seen as potential wealth, but access to such wealth is controlled by the elites- the group of people who control the way of life in the remote and isolated environment from behind the scene. The poor peasants in the *chars* depend entirely on agriculture, livestock rearing and by selling labor to work others' land. For the landless, the rich farmers are the main source of employment and income. By any standard, the landless char people survive through periods of extreme 'deficit budget'. Deficit for the peasants is the curse in which they become perpetually mired and which obligates them to rich people at different level of exploitation. The rich farmers demand guarantee for the loans taken by the poor during crises like crop failures, for social (marriage, educational support for the children, etc.) and health reasons. Generally people sell or mortgage their valuables to the rich when pressed for cash. These are common forms of financing the poor. As a technique for securing quick returns, the rich usually finance a peasant whose financial ability is fast deteriorating. Thus, credit to the poor ensures control of the creditor over the land and also helps him to secure support as and when mass gatherings are needed to show of strength against opponents. There are hardly any credit facilities present in *charlands*. NGOs are not even working with ultra poor. To ensure credit, people need to show their permanent address so that they can be traced back by the lending institution. For erosion driven ultra poor *charlanders*, there do not exist any permanent address and in most cases they are not provided with credits. Even access to primary education and primary health care facilities are almost absent in this area. Special safety net social security schemes must be taken by the government for this section of people which enable them to have some resources of their own. In some *charlands*, the credit amount offered by the NGOs are not helpful for them at all. The aspiration of the people is to do better out of this credit. The inhabitants of char Harirampur, for instance, do not accept any loan less than 10,000 *Taka*, as they buy cows with that money and sell them in the season of Eid-ul-ajha³¹. So an amount less than 10,000 *Taka* cannot provide them with the resource to invest on an animal. Not only giving credits but also giving the credit in an effective manner is the most challenging part of the whole game. A rationale approach could have been greatly facilitated the currently practiced modalities to relieve the poor people from economic miseries.

Government should prepare a comprehensive plan of action for the displaced population. Within the locality, *khaslands* should be made available for their settlement under the direct surveillance of DC (District commissioner) or UNO (*Upazila Nirbahi Officer*³²). Skill development possibilities or capacity building training for both men and women to increase non-agricultural income should be undertaken by NGOs or Bangladesh Institute for Small and Cottage industries or other government offices. Plans should be developed by the Ministry of Land for the distribution of land among the displaced people and make it available in the event of the re-emergence of new land. All extension services of the government should play an active role towards this end, particularly public health which includes water and sanitation, family planning, health services and credit facilities.

A well organized public awareness campaign should be initiated by the government targeted at people living on the embankment to explain how they can continue to live on the embankment without causing any damage to this structure. At the same time, they should be prepared to carry out maintenance of the embankment on which they are living.

³¹ A Muslim festival, when animals are sacrificed in the name of Allah.

³² The Official in charge of a sub-District.

7. CONCLUDING REMARKS

The study probed into women's differential vulnerability in relation to men under the same exposure to hydro-geophysical hazards likely to be perturbed under climate change. Women's vulnerability is context specific. The overall vulnerability of marginal people (such as poor, physically/mentally challenged, ethnic minority etc.) in any given hazardous geophysical context is high. However, among any such group of marginal people, vulnerability of women is of the highest order.

Women try to 'cope' with the altered hydro-geophysical condition the most. Their utmost attempt to survive through the bad times takes a lot of personal sacrifice and compassion as well as accepting psycho-physical burden. However, the anticipated intensity of changes in geophysical contexts under climate change appears to be so overwhelming in the backdrop of women's current vulnerability context that mere 'coping' will not be sufficient even to ensure survival coping.

Women's coping efforts are severely challenged by gender relationships and handicapped by power structure both within the household as well as within the community. Despite having provisions for inclusion of women representatives in (local) governance processes, gender relationship having a bias towards males does not allow women to meaningfully participate in any decision making fora, while lapses in good governance practices alienate women's voices further, leaving virtually no room to meaningfully contribute towards the reduction of their vulnerability.

The patriarchal elements of vulnerability of women will further eliminate women's opportunity to overcome their vulnerability.

Women, entrapped in water world due to prolonged water logging appears to be the most vulnerable group compared to other vulnerability contexts of women in various known geophysical set ups. Salinity affected women are also extremely vulnerable.

Women's resilience building demands women's empowerment in all aspects of life: physical and mental, social, economical, political, and cultural. The State must assume responsibility to remove common and known barriers towards empowering women.

Special attention is also required to ensure that similar barriers for other disadvantaged groups are removed with needs-based targeted programmes and practices.

Though it appears obvious that simple coping would not help women much to reduce their vulnerability, raising awareness regarding the anticipated elements of risks and early warning could facilitate them to strengthen their approaches to coping. However, such programmes must be tailor-made to cater the needs of the target audience – the women and the disadvantaged.

The role of social safety net (SSN) towards helping communities in any geophysical contexts of vulnerability is becoming increasingly important. Efforts must be made to enhance allocation to maintain a healthy social safety net. However, new modalities will have to be sought and developed so that vulnerable women can directly receive the benefits from SSN practices. The current barriers in relation to rather illusionary access to SSN for women, especially for women headed households, should be eliminated with proper planning and implementation of programmes.

To complement State-run programmes, the donor and NGO communities must devise matching plan and programmes, taking special care to the above-mentioned issues. To facilitate inter-agency coordination and monitoring, a gender caucus may be developed and nurtured.

In cyclone prone areas, adequate number of new cyclone shelters need to be built on the basis of population density. Despite the recognition that the existing cyclone shelters have saved millions of lives already, new structures should be built on modified design having provisions for women: at least one separate toilet designated for women, preferably a separate floor for women, at least one room designated for pregnant and elderly women, a ramp to accommodate the needs of physically challenged and women with advanced stage of pregnancy, etc.

The hydro-morphological causes of water logging must be addressed with adequate participatory planning and financing. Maintaining a sustainable drainage system is a must in order to address the issue of water logging. Emergency floating medical service is of utmost need in the waterlogged areas. Separate community latrines for women can be built, connected through a raised road network, and maintained under the supervision of female members of local government institutions. Roads connecting to schools must be raised. In absence of a land based production system, alternative sustainable livelihoods must be sought for.

Carefully planned efforts must be made to push saline front towards the estuary – a long-term solution is provided in National Water Management Plan, which requires immediate attention and financing. Meanwhile, sustainable solutions to address salinity in drinking water must be sought and implemented. The State must facilitate to increase coverage of safe and non-saline water supply in the saline affected areas. The relevant national institutions must pay attention towards surveillance and monitoring of salinity and of women's health. Public health care system needs to be strengthened in saline affected areas.

Since extent and duration of floods will only increase under climate change, a good coverage of multipurpose flood shelters in flood vulnerable areas needs to be established. Each of these structures must cater to the particular needs of women, as in the case of cyclone shelters. Instead of curative measures towards fighting against water borne diseases including diarrhea, efforts must be made to popularize alternative 'preventive measures' to reduce the health cost of women and children – the major victims of such diseases.

Credit flow needs to be strengthened in drought prone regions to facilitate supplementary irrigation. Safety net program for poor women and children needs to be strengthened.

This study has been the pioneering one to reveal gender specific vulnerability to climate change in Bangladesh. However, given the urgency of the issue and the dimension of the problems(s) this modest study is deemed extremely limited to address all the issues and contexts of vulnerability in relation to climate change and gender. Taking it as a stepping stone, new impetus is necessary with adequate support to build on these findings and to devise proper adaptation tools to help the cause of women in the volatile future dictated and complicated by climate change in Bangladesh.

References

- AAI, 2002.** Participatory Vulnerability Assessment. Action Aid International (AAI), UK.
- ADB, 1994.** Climate Change in Asia: Bangladesh Country Report. Asian Development Bank (ADB), Manila.
- Adger, W.N., Huq, S., Brown, K., Conway, D. and Hulme, M., 2003.** Adaptation to Climate Change in the Developing World. *Progress in Development Studies* 3 (3), 179-195.
- Adnan, S., 1994.** Floods, People and the Environment Reflections on Recent Flood Protection Measures in Bangladesh. In A.A. Rahman, S. Huq, R. Haider and E.G. Jansen (eds.), *Environment and Development in Bangladesh*. University Press Limited, Dhaka. pp 182-219.
- Agrawala, S., T. Ota, A.U. Ahmed, J. Smith and M. van Aalst, 2003.** Development and Climate Change in Bangladesh: Focus on Coastal Flooding and the Sunderbans. Organisation for Economic Co-operation and Development (OECD).2003, Paris.
- 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., Ahmed, A.U., Karim, Z., Prasad, K., and Poudel, S.N., 2004.** Community Based Flood Management in South Asia. *Asia Pacific Journal on Environment & Development*, Special Issue, 12(1-2).
- Ahmed, A.U. and Alam, M., 1998.** Development of Climate Change Scenarios with General Circulation Models. In S. Huq, Z. Karim, M. Asaduzzman, and F. Mahtab (eds.), *Vulnerability and Adaptation to Climate Change for Bangladesh*. Kluwer Academic publishers, Dordrecht. pp 13-20.
- Ahmed, A.U. and Schaerer, C., 2004.** Sustaining Livelihoods Opportunities for the Coastal Poor under Climate Change: A Case Study from Bangladesh. In Anonymous (ed), *Proceedings of Coastal Zone Asia Pacific*, Brisbane, 7-9 September 2004.
- Ahmed, A.U., 2000.** Adaptability of Bangladesh's Crop Agriculture to Climate Change: Possibilities and Limitations. *Asia Pacific Journal on Environment and Development*, Volume 7, No. 1, pp 71-93.
- Ahmed, A.U., 2004.** A Review of the Current Policy Regime in Bangladesh in Relation to Climate Change Adaptation. CARE-Bangladesh, under Reducing Vulnerability to Climate Change (RVCC) Project, Khulna.
- Ahmed, A.U., 2005.** Adaptation Options for Managing Water Related Extreme Events under Climate Change Regime: Bangladesh Perspectives. In M.M.Q. Mirza and Q.K. Ahmad (eds.), *Climate Change and water Resources in South Asia*. Balkema Press, Leiden. pp 255-278.
- Ahmed, A.U., 2006.** Bangladesh Climate Change Impacts and Vulnerability: A Synthesis. Climate Change Cell, Department of Environment, Dhaka. p 70.
- Ahmed, A.U., Alam, M. and Rahman, A.A., 1998.** Adaptation to Climate Change in Bangladesh: Future Outlook. In S. Huq, Z. Karim, M. Asaduzzaman, and F. Mahtab (Eds.),

Vulnerability and Adaptation to Climate Change for Bangladesh. Kluwer Academic Publishers, Dordrecht. pp 125-143.

Alam, M., Nishat, A., and Siddiqui, S.M., 1998. Water Resources Vulnerability to Climate Change With Special Reference to Inundation. In S. Huq, Z. Karim, M. Asaduzzaman, and F. Mahtab (Eds.), *Vulnerability and Adaptation to Climate Change for Bangladesh*. Kluwer Academic Publishers, Dordrecht. pp 21-38.

Asaduzzaman, M, Reazuddin, M. and Ahmed, A.U. (Eds.), 1997. *Global Climate Change: Bangladesh Episode*. Department of Environment, Government of Bangladesh, July 1997.

Asaduzzaman, M., Ahmed, A.U., Haq, E. and Chowdhury, S.M.Z.I., 2005. *Climate Change and Bangladesh: Livelihoods Issues for Adaptation*. Bangladesh Institute for Development Studies (BIDS), Dhaka.

BCAS, 1994. *Rivers of Life*. Edited by Kelly Haggart et al. Bangladesh Centre for Advanced Studies, Dhaka, Bangladesh.

Boyce, J.K., 1994. Birth of a Mega-Project: Political Economy of Flood Control in Bangladesh. In A.A. Rahman, S. Huq, R. Haider and E.G. Jansen (eds.), *Environment and Development in Bangladesh*. University Press Limited, Dhaka. pp 465-480.

Brooks N, Adger W.N. and Kelly P.M., 2005. The Determinants of Vulnerability and Adaptive Capacity at the National Level and the Implications for Adaptation. *Global Environmental Change* 15, 151-163.

Burton I., Huq S., Lim B., Pilifosova O. and Schipper E.L. 2002. From Impacts Assessment to Adaptation Priorities: the Shaping of Adaptation Policy. *Climate Policy*, Volume 2, Number 2, pp. 145-159(15)

Cannon, T., 2002. Gender and Climate Hazards in Bangladesh. In R. Masika (ed.), *Gender, Development and Climate Change*. Oxfam publication, Oxfam GB, Oxford.

Cannon, T., Twigg, J. and Rowell, J. 2003. *Social Vulnerability, Sustainable Livelihoods and Disasters*. Report to the DfID, United Kingdom.

CEGIS, 2006. *Impacts of Sea Level Rise in the Southwest Region of Bangladesh*. Center for Environmental and Geographic Information Services (CEGIS), Dhaka. p 90.

CEGIS, 2007a. *Prediction for Bank Erosion and Morphological Changes of the Jamuna River 2007*. Center for Environmental and Geographic Information Services (CEGIS), Dhaka. p 55.

CEGIS, 2007b. *Prediction for Bank Erosion and Morphological Changes of the Ganges and the Padma Rivers 2007*. Center for Environmental and Geographic Information Services (CEGIS), Dhaka. p 50.

Chew, Lin and Ramdas, Kavita, 2005. *Caught in the Storm: The Impact of Natural Disasters on Women*. San Francisco (USA), The Global Fund for Women.

Choudhury, A.M., Neelormi, S., Quadir, D.A., Mallick, S. and Ahmed, A.U., 2004. Socio-economic and Physical Perspectives of Water related Vulnerability to Climate Change: Results of Field Study in Bangladesh. *Science and Culture (Special Issue)*, 71(7-8): 225-238.

- Climate Alliance, 2005.** Climate Alliance 2004/2005 Annual Report. Climate Alliance, Frankfurt am Main. p 74.
- Dankelman, I., 2002.** Climate Change: Learning from Gender Analysis and Women's Experience of Organizing for Sustainable Development. In R. Masika (ed), Gender, Development and Climate Change. Oxfam publication, Oxford.
- DAW-UNISDR, 2001.** Environmental Management and the Mitigation of Natural Disasters: A Gender Perspective. Report of the Expert Group Meeting, Ankara, Turkey, 6-9 November 2001.
- Denton, F. and Parikh, J., 2003.** Gender: A Forgotten Element. *Tiempo* 47, 27-28.
- DFID, 2004a.** Climate Change Deepens Poverty and Challenges Poverty Reduction Strategies, DFID Key Sheet #1. Department of International Development (DFID), UK.
- DFID, 2004b.** The Impact of Climate Change on the Vulnerability of the Poor. DFID Key Sheet #3. Department of International Development (DFID), UK.
- Elahi, K.M. and Rogge, J.R., 1990.** Riverbank Erosion and Population Displacement in Bangladesh: A Report on the Riverbank Erosion Impact Study. Jahangirnagar University, Savar.
- Enarson, E. and B. Hearn Morrow (eds.), 1998.** The Gendered Terrain of Disaster: Through Women's Eyes. Praeger. Westport, U.S.A. 1998.
- Enarson, E., 2001.** Promoting Gender Justice in Disaster Reconstruction: Guidelines for Gender-Sensitive and Community-based Planning. Disaster Mitigation. Ahmedabad (Pakistan): Institute of Ahmedabad.
- Enarson, E., 2002.** Environmental Management and Mitigation of Natural Disasters: A Gender Perspective. Panel II, Commission on the Status of Women, 46th Session, March. UN, New York, 2002.
- Ericksen, N.J., Ahmad, Q.K. and Chowdhury, A.R., 1996.** Socio-economic Implications of Climate Change for Bangladesh. In R.A. Warrick and Q.K. Ahmad (eds), The Implications of Climate and Sea-level Change for Bangladesh. Kluwer Academic Publishers, Dordrecht. pp 205-287.
- GOB, 2005.** National Adaptation Programme of Action (NAPA): Final Report. Ministry of Environment and Forests, Government of the People's Republic of Bangladesh (GOB), Dhaka. p 48.
- GTZ, 2005.** Linking Poverty Reduction and Disaster Risk Management. A. Schmidt, L. Bloemertz, and E. Macamo (eds.), GTZ, Bonn. p 88.
- Haider, R. (ed), 1992.** Cyclone '91 Revisited. Bangladesh Centre for Advanced Studies, Dhaka.
- Haider, R., A.A. Rahman and S. Huq (eds.), 1991.** Cyclone'91: An Environmental and Perceptual Study. Bangladesh Centre for Advanced Studies, Dhaka, 91 pp.
- Halcrow and Associates, 2001.** Options for the Ganges Dependent Area, Draft Final Report: Main Report. Sir William Halcrow and Associates, for Water Resources Planning

Organization (WARPO), Ministry of Water Resources (MOWR), Government of the People's Republic of Bangladesh, Dhaka, 198 p.332.

Heijmans, A., 2001. Vulnerability: A Matter of Perception. Paper presented at the International Conference on 'Vulnerability in Disaster: Theory and Practice, organized by Wageningen Disaster Studies, 29-30 June, 2001.

Available at: <http://www.abuhrc.org/research/dsm/Pages/publications.aspx> (Working Paper 4)

Houghton, J.T., L.G. Meira Filho, B.A. Callander, N. Harris, A. Kattenberg, and K. Maskell (eds.), 1996. Climate Change 1995: The Science of Climate Change. Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, England: Cambridge University Press.

Huq, S., Ahmed, A.U. and Koudstaal, R., 1996. Vulnerability of Bangladesh to Climate Change and Sea Level Rise. In T.E. Downing (Ed.), Climate Change and World Food Security. NATO ASI Series, I 37, Springer-Verlag, Berlin, Hiedelberg, 1996, pp. 347-379.

Huq, S., Rahaman, A., Konate, M., Sokona, Y., and Reid, H., 2003. Mainstreaming Adaptation to Climate Change in Least Developed Countries (LDCs). International Institute for Environment and Development (IIED), London, 38 p.

Huq, S., Z. Karim, M. Asaduzzaman and F. Mahtab (Eds.), 1998. Vulnerability and Adaptation to Climate Change for Bangladesh. Kluwer Academic Publishers, Dordrecht, pp. 135.

IPCC, 2001a. Climate Change 2001: The Scientific Basis, Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK.

IPCC, 2001b. Climate Change 2001: Impacts, Adaptation and Vulnerability, Summary for policymakers. Working Group II, Inter-governmental Panel on Climate Change (IPCC), Geneva.

IPCC, 2007. Working Group II: Summary for Policymakers, Intergovernmental Panel on Climate Change (IPCC).

IUCN, 2006. Earthquake in Pakistan: An Assessment of Environmental Risks and Needs. Based on IUCN field missions to NWFP and AJK.

Johnson, J., Hill, J. and Evan-Smith, E., 1995. Listening to Smaller Voices: Children in an Environmental Change. Action Aid, London, p. 109.

Kandaswany, D., 2005. Media Forgets Female Face of Tsunami. Global Media Monitoring Project (GMMP), Web: <http://www.womensenews.org/article.cfm/dyn/aid/2390>

Karim, Z., 1996. Agricultural Vulnerability and Poverty Alleviation in Bangladesh. In T.E., Downing, (Ed.), Climate Change and World Food Security. NATO ASI Series I37.

Karim, Z., Hussain, S.G. and Ahmed, M., 1990. Salinity Problems and Crop Intensification in the Coastal Regions of Bangladesh. Bangladesh Agricultural research Council (BARC), Dhaka.

Karim, Z., Hussain, Sk.G. and Ahmed, A.U., 1998. Climate Change Vulnerability of Crop Agriculture. In S. Huq, Z. Karim, M. Asaduzzaman and F. Mahtab (Eds.), Vulnerability and

Adaptation to Climate Change for Bangladesh. Kluwer, Academic Publishers, Dordrecht. pp 39-54.

Kelly, P. M. and Adger, W. N., 2000. Theory and Practice in Assessing Vulnerability to Climate Change and Facilitating Adaptation. *Climatic Change*, Vol 47, Part 4, pages 325-352.

Kenward, L. R., 1999. Assessing Vulnerability to Financial Crisis: Evidence from Indonesia. *Bulletin of Indonesian Economic Studies*, Vol 35, Part 3. pp 71-96.

Masika, R. (ed.), 2002. Gender, Development and Climate Change. Oxfam Publication, Oxfam G.B., Oxford, p. 104.

Mirza, M.M.Q., 1997. Modeling the Effects of Climate Change on Flooding in Bangladesh. Unpublished D.Phil. Thesis, International Global Change Institute (IGCI), University of Waikato, Hamilton, New Zealand.

Mirza, M.M.Q., 2003. Climate Change and Extreme Weather Events: Can Developing Countries Adapt? *Climate Policy*, 3: 233-248.

Moss, R.H., 1995. Avoiding 'Dangerous' Interference in the Climate System: The Roles of values, Science and Policy. *Global Environmental Change*, Vol 5(1), pp. 3-6.

MoWR, 2004. National Water Management Plan, Water Resources Planning Organization, Ministry of Water Resources, Dhaka.

MPO, 1991. National Water Management Plan: Phase II, Final Report. Master Plan Organization, Ministry of Irrigation, Water Development and Flood Control, Government of the People's Republic of Bangladesh, Dhaka.

Nasreen, M., 1995. Coping with Floods: The Experiences of Rural Women in Bangladesh. Unpublished Ph.D Dissertation, Massey University, New Zealand.

O'Neill, B.C. and Oppenheimer, M., 2002. Dangerous Climate Impacts and the Kyoto Protocol. *Science* (296), pp. 1971-1972.

Rahman, A.A., Huq, S., and Conway, G.R., 1990. Environmental Aspects of Surface Water Systems of Bangladesh: An Introduction. In A. A. Rahman, S. Huq and G. R. Conway (Eds.), *Environmental Aspects of Surface Water Systems of Bangladesh*. University Press Ltd., Dhaka, Bangladesh.

Rahman, R. and Chowdhury, J.U., 1998. Impacts of Flood Control Projects in Bangladesh. In M.M. Ali, M.M. Hoque, R. Rahman, and S. Rashid (eds.), *Bangladesh Floods: Views from Home and Abroad*. University Press Limited, Dhaka, pp. 55-66.

Rashid, H., 1998. Some Environmental Concerns about Water Resources Development Plans in Bangladesh. In M.M. Ali, M.M. Hoque, R. Rahman, and S. Rashid (eds.), *Bangladesh Floods: Views from Home and Abroad*. University Press Limited, Dhaka, pp. 115-124.

RVCC, 2003. Report of a Community Level Vulnerability Assessment Conducted in Southwest Bangladesh. A report prepared by the Reducing Vulnerability to Climate Change (RVCC) Project, CARE Bangladesh, Dhaka.

Schaerer, C. and Ahmed, A.U., 2004. Adaptation to Climate Change in Vulnerable Communities: Lessons from Practice in Southwestern Bangladesh. In A.U. Ahmed and

Haque, N. (eds.), *Adaptation to Climate Change: Knowledge Sharing for Capacity Building*. Proceedings of Workshop held on 10 December 2003 at COP 9 Milan, Climate Action Network South Asia (CANSA) and RVCC, Dhaka.

Schnellhuber, H.J., Cramer, W.P., Nakicenovic, N., Wigley, T. and Yohe, G. (eds.), 2006. *Avoiding Dangerous Climate Change*. Cambridge University Press, Cambridge. p 406.

Scoones, I., 1998. *Sustainable Rural Livelihoods: a Framework for Analysis*. IDS Working Paper 72, Brighton: Institute of Development Studies.

Simms, A., MaGrath, J. and Reid, H., 2004. *Up in Smoke: Threats from, and Responses to, the Impact of Global Warming on Human Development*. New Economic Foundation (NEF) and International Institute for Environment and Development (IIED), London. pp 37.

Smit, B. and Wandel, J., 2006. *Adaptation, Adaptive Capacity and Vulnerability*. *Global Environmental Change* 16. pp. 282-292.

Smit, B., Burton, I., Klein, R.J.T., and Wandel, J., 2000. *An Anatomy of Adaptation to Climate Change and Variability*. *Climatic Change*, Vol 45(1). pp 223-251.

Smithers, J. and Smit, B. 1997. *Human Adaptation to Climatic Variability and Change*. *Global Environmental Change* 7(2). pp129-146.

Sperling et al. (eds.), 2003. *Poverty and Climate Change: Reducing the Vulnerability of the Poor through Adaptation*. Vulnerability and Adaptation Resource Group, The World bank, Washington D.C.

Thomalla, F., Cannon, T., Huq, S., Klien, R.J.T. and Schaerer, C., 2005. *Mainstreaming Adaptation to Climate Change in Coastal Bangladesh by Building Civil Society Alliances*. An IIED Publication. Available at <http://www.iied.org/pubs/pdfs/G00016.pdf>

UN, 2004. *Women 2000 and Beyond - Making Risky Environments Safer*. Division for the Advancement of Women, Department of Economic and Social Affairs, United Nations, New York.

UNDP, 2005. *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures*. B. Lim (ed.). Cambridge: UNDP and Cambridge University Press.

Warrick, R.A. and Ahmad, Q.K. (Eds.), 1996. *The Implications of Climate and Sea-Level Change for Bangladesh*. Kluwer Academic Publishers, Dordrecht, Boston, London. pp 415.

WB, 2000. *Bangladesh: Climate Change and Sustainable Development*. Report No. 21104-BD. Rural Development Unit, South Asia Region, The World Bank (WB), Dhaka. pp 95.

WHO, 2005. *Gender Considerations in Disaster Assessment*. World Health Organization, Geneva.

This document is produced by

Climate Change Cell
Department of Environment
Ministry of Environment and Forests

with the assistance of

Ministry of Food and Disaster Management
Comprehensive Disaster Management Programme (CDMP)
Phone: 880-2-9890937
Email: info@cdmp.org.bd
Url: www.cdmp.org.bd



