



CLIMATE CHANGE AND DISPLACEMENT: THE CASE OF BANGLADESH

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Bangladesh is one of the most vulnerable countries in the face of climate change. The country has a history of extreme climatic events causing enormous sufferings to the lives and livelihoods of millions of people. It has made life unsupportable in different disaster prone areas and resulted into the displacement of an increasing number of people from rural and coastal areas of the country. In this regard, the paper aims to understand the process through which people get displaced in the face of climate change in Bangladesh. To understand this scenario, the paper particularly discusses four types of natural calamities i.e. floods, riverbank erosion, tropical cyclones and sea level rise and their resultant consequences on human movement. It is obvious that such calamities have increased in terms of frequency and intensity in recent times and led to a situation of homelessness, landlessness and destruction of livelihood opportunities and compel the victims to move into new places for the sake of their sustenance.

Keywords: Climate change, Natural calamities, Displacement, Bangladesh.

Introduction

The Fourth Assessment Report (AR4) of the Inter-governmental Panel on Climate Change (IPCC) published in 2007 gives us a clear picture of how climate change and its consequences are unfolding to the humanity. The AR4 is a reflection of consensus among the scientific community that climate change is happening in an unpredictable manner and human activity is largely responsible for this. The report also shows that the planet is already facing the consequences of climate change and the extent and physical consequences of climate change will be even more severe in the coming decades (Smith and Vivekanada 2007). The purpose of this paper is not to examine the findings of the scientific community about how climate is changing. Instead, the point is made to highlight that climate change is no longer a matter of rhetoric rather it is a reality and the consequences of which are unfolding to the humanity in a number of forms.

Climate change is reducing the human carrying capacity of the earth's environment. Because, various consequences of climate change are making many areas uninhabitable or decreasing the basis of subsistence due to the changes in the pattern of rainfall which consequently leads to drought and floods, increases in extreme weather patterns, the melting of polar icecaps contributing to sea level rise and a rise in temperature with its severe impact on agriculture (Gleditsch et al. 2007). In this way, climate change is damaging many aspects of human environment and thereby increasing the vulnerabilities of millions of people in different climate-sensitive areas of the world.

Among different consequences of climate change, human displacement caused by natural disaster, both sudden and gradual, is one of the most obvious scenarios in the twenty first century. International Organisation for Migration (IOM) in a study shows that in 2008 alone, 20 million people were displaced in the face of extreme weather events compared to 4.6 million internally displaced by conflict and violence (Laczko and Aghazarm 2009). Stern Review (2007) further predicts that by the middle of the twenty first century, 200 million people are likely to be climate refugees because of sea level rise, frequent floods and intense drought. There are different ways through which climate change contributes to displace people from their place of origin. For instance, sea level rise would submerge the low-lying coastal areas whereas desertification will lead to a decline of productivity thereby forcing people to move into new places for the sake of their sustenance. Besides, changes in the weather pattern will increase sudden natural disasters such as hurricanes, typhoons, extreme cold etc. which will disrupt human settlement in many areas and a change in the pattern of rainfall will make certain areas uninhabitable because of increases in floods and droughts (Gleditsch et al. 2007).

Climate change and its adverse consequences are likely to be experienced at global scale but poor and developing countries are particularly vulnerable in this regard because of their lack of technical capacity to adapt with the situation as well their high dependence on agriculture which is likely to be most affected by climate change (IOM 2008). In this regard, Bangladesh is one of the most vulnerable countries in the face of climate change due to its unique geographic location. To assess the risk of climate change, a German-based organization named 'Germanwatch' developed a dataset-The Global Climate Risk Index 2010 (CRI)-where Bangladesh is identified as the most vulnerable country in the face of extreme weather events as well as the most affected between the period of 1990-2008 (Harmeling 2010). The vulnerability of Bangladesh is relatively very high in the face of climate change because of its "flat and low-lying topography, high population density, high levels of poverty, reliance of many livelihoods on climate sensitive sectors, particularly agriculture and fisheries and inefficient institutional aspects" (Patwary 2009:69).

One of the biggest consequences that Bangladesh is currently facing is an increasing number of displaced people due to sudden and gradual natural disasters. Every year an ever-increasing number of people are being displaced in Bangladesh due to various natural disasters such as flood, river bank erosion, tropical cyclones and sea level rise, the frequency and intensity of which have increased significantly in recent times (Walsham 2010). In the previous three decades, Bangladesh has been affected by six devastating floods, of which the floods of 1988 and 1998 displaced forty five million and thirty million people respectively (Shamsuddoha et al. 2012). Besides, approximately one million people is adversely affected by riverbank erosion every year in the country (RMMRU 2007). The three largest rivers of the country- the Padma, the Jamuna and the Ganga, have eroded 1,590 km floodplains since 1973 and made 1.6 million people homeless in the process (Nishat and Mukherjee 2013). Furthermore, the threat from sea level rise is even more ominous. According to a study of World Bank (2000), Bangladesh will experience 10, 25 and 100 cm rise in sea level by the years of 2020, 2050 and 2100 respectively. IPCC predicts that 15 million people in Bangladesh will be displaced from coastal areas if sea level rise by 1 meter and in the case of sea level rise by 1.5 meter 18 million people will become climate refugees (Bose 2013).

Bangladesh: The Context

Bangladesh, situated in South Asia, is one of the largest deltas in the world which is formed by the combined delta of the Ganges-Brahmaputra-Meghna rivers. It has a land area of 147,570 square kilometer, most of which are low and flat (MoEF 2005). Almost 75 percent land area of the country is less than 3 meter above the sea level. The country has a network of approximately 700 rivers including its tributaries and distributaries under three large and complex river system i.e Ganges-Padma River System, Brahmaputra-Jamuna River System and Surma-Meghna River System (Islam and Miah eds. 2012). On the basis of geological formation, the country's landmass can be classified into three categories such as

floodplain, pleistocene terrace and tertiary hills. Among these, floodplain constitutes 80 percent of the land whereas pleistocene terrace and tertiary hills constitute 8 percent and 12 percent respectively. Floodplains which are situated in the north-west, central, south-central and north-eastern part of the country are exposed to regular flooding whereas coastal plain land areas are exposed to cyclones and storm surges, salinity intrusion and coastal inundation. Pleistocene terrace land area is affected by moisture stress whereas flash flood is a regular phenomenon in the hilly areas (MoEF 2005).

Bangladesh has a population of approximately 150 million of whom almost 75 percent live in the rural areas. Agriculture is the biggest sector of the economy and almost 63 percent of the workforces are involved in the agricultural sector (Walsham 2010). It is evident that since Bangladesh got its independence in 1971, it has experienced more than three-fold increase in its GDP as well as food production which contributed to reduce the percentage of people living under poverty line from 59 percent in 1991 to 40 percent in 2005. But, still, more than 50 million people are engulfed by poverty and majority of them live in the remote and ecologically fragile areas such as flood plains, river islands and coastal regions which are extremely susceptible to different types of natural calamities (MoEF 2009). The economy remains extremely vulnerable due to the presence of high population density, lack of adequate resources and exposure to high incidence of natural disasters (MoEF 2005). Climate change is likely to aggravate many of these vulnerabilities with predicted increases in the frequency and intensity of various natural disasters such as floods, cyclones, storm surges, droughts etc (Walsham 2010). It is also predicted that in the worst case scenario, the increasing natural disasters due to climate change can lead to the displacement of millions of people from the ecologically fragile parts of the country which will adversely affect the livelihood of a significant part of the population (MoEF 2009).

IPCC in its Fourth Assessment Report (2007) mentioned Asian mega deltas in general and Bangladesh, in particular, as an area of significant concern due to the country's lack of adaptive capacity, huge number of flood plain population who are directly exposed to natural hazards and a sensitive coastal system. IPCC (2007) notes that whereas physical exposure depicts the vulnerability of the people and natural systems in the face of climate change, the lack of adaptive capacity is an area of greater concern as it leads to a hotspot of human variability. Furthermore, it is also argued that the range of adaptive capacity is largely dependent on a country's level of development because whereas resource and technology enhance the capacity, poverty limits such capacity (IPCC 2007). In this regard, as a Least Developed Country (LDC), Bangladesh is facing a greater danger in a climate change scenario which will lead to a significant disruption in national life as well as cripple the economy of the country.

The Scenario of Climate Change in Bangladesh

Bangladesh is one of the most vulnerable countries in the face of global environmental change. The country has already been subject to climate change as increasing surface air temperature is quite evident and the pattern of rainfall is also changing which are damaging many aspects of lives and livelihoods of the people of Bangladesh. The Fourth Assessment Report of the IPCC (2007) presents a number of observed changes in the climate trends, variability and extreme events in Bangladesh. The Fourth Assessment Report (2007) suggests that from 1985 to 1998, an increasing trend was obvious in case of average temperature in Bangladesh. During that period, the average temperature is observed to be increased by approximately 1°C in May and 0.5°C in November. The report also indicates that there has been an increasing trend in the average rainfall in the country. Since 1960s, there have been high anomalies in the case of decadal rain average. The country has been subject to severe and recurring floods since 1980s. An increasing trend has also been observed in the frequency of monsoon depressions and cyclones formation in the Bay of Bengal (Patwary 2009).

However, a more comprehensive picture about the state of climate change in Bangladesh is quite obvious from the study of Nishat and Mukherjee (2013). According to the findings of Nishat and Mukherjee (2013), there have been changes in the temperature and the rainfall pattern of the country. The study found that in the previous 40-years time span (from 1967 to 2007), the mean seasonal temperature

increased between 0.4 to 0.65 degree Celsius. During that time winter became warmer with simultaneous rise in the level of minimum temperature. Similarly, summer becomes hotter with an increase in the level of maximum and minimum temperature. During the time of winter (December to February), the minimum temperature increased by 0.45 degree Celsius and during the time of the monsoon (June to early-October) the rise of minimum temperature happened by 0.52 degree Celsius. The level of maximum temperature is also observed to be increased over the years. The pre-monsoon period (March to May) maximum temperature increased by 0.87 degree Celsius and the post-monsoon (late- October to November) experienced a rise in the level of maximum temperature by 0.42 degree Celsius. An increase in the level of minimum temperature during the time of winter is reported in the 25 out of 34 climate observatories of Bangladesh Meteorological Department. An increase in the level of maximum temperature is reported in almost all the stations of the Bangladesh Meteorological Department (Nishat and Mukherjee 2013).

In addition to a rise in temperature, Bangladesh has also experienced an increase in the pattern of rainfall throughout the year. The mean annual rainfall in the country is approximately 2347 mm of which fourth-fifth of the rainfall happens during the period of monsoon (June to early October). The data of the Bangladesh Meteorological Department shows an increase in the mean seasonal rainfall. It is observed that the pre-monsoon (March to May) and monsoon (June to early October) experienced about 100 mm increase in the mean seasonal rainfall. Though, the rainfall is minimum during the time of winter compared to other time of the year, but, the recent trend shows an increase in the winter rainfall. An increasing trend in the winter rainfall is observed in the 27 out of 32 rainfall observatories of Bangladesh Meteorological Department. This trend is significant in the coastal areas of Sitakunda, Patuakhali, Kutubdia and in Khulna where the mean seasonal rainfall during the time of winter increased by 1.2-2.1 mm/year. A rise in the pre-monsoon rainfall is also obvious in the 18 out of 32 meteorological stations of Bangladesh Meteorological Department and the increase is significant in the coastal regions of Kutubdia, Mongla, Sandwip and Rangamati (one of the three hill districts) where the mean seasonal rainfall is observed to be increased by 8-13 mm/year. The monsoon rainfall is found to be increased in 18 out of 32 meteorological stations of Bangladesh Meteorological Department which is significant in the coastal districts of Kutubdia, Mongla, Sitakunda and Teknaf where the mean seasonal rainfall is observed to be increased by 21-42 mm/year. The post-monsoon rainfall is found to be increased in the 24 out of 34 meteorological stations of Bangladesh Meteorological department which is significant in the coastal regions of Khepupara, Kutubdia, Mongla and Teknaf where an increase in the mean seasonal rainfall is happened by 12-24 mm/year (Nishat and Mukherjee 2013).

So, it is obvious that Bangladesh has experienced an increasing trend in the case of average temperature as well as rainfall pattern. Over the past few decades, summer has become hotter due to an increase in the level of both maximum and minimum temperature. Similarly, winter has also become warmer and shorter with simultaneous rise in the level of minimum temperature. An increase in the pattern of average rainfall is also quite evident throughout the year. Even an increasing trend of rainfall is evident during the time of winter which used to experience minimum rainfall in the past. Such changes in the pattern of temperature and rainfall adversely affect the lives and livelihoods of millions of people in Bangladesh.

Climate Change and Displacement: The Case of Bangladesh

Bangladesh is suffering immensely due to the impacts of climate change which are making enormous losses on life and livelihood options of the millions of people across the country. One of the scenarios that is obvious in recent times is a growing number of displaced people in the face different kinds of natural hazards. The following discussion is an attempt to understand the magnitude of the problem and underlying factors which force people to leave their traditional habitat behind and settle into new places. Based on a review of secondary literature four types of natural hazards have been discussed i.e. floods, river bank erosion, tropical cyclones and sea level rise to understand its impacts on the lives and livelihoods of the affected communities. The discussion is made to understand how such natural

calamities which are increasing in terms of frequency and intensity due to a climate change scenario are pushing millions of people into marginal lines and displacing them from their roots.

Flood

Flood is one of the most common forms of natural disaster in Bangladesh. Almost one-quarter of the country is affected by flood every year and in every four to five years the country is afflicted by a massive flood which inundates almost sixty percent of the country and incurs enormous sufferings to the lives of the affected people and destroys infrastructure, housing, agriculture and livelihoods (MoEF 2009). It happens due to the low-lying topography of the country which is crisscrossed by several hundred rivers and tributaries (Rayhan and Grote 2007). Besides, the two-thirds area of Bangladesh is less than five metres above sea level which makes the country more vulnerable to river and rainwater flooding and tidal flooding in the coastal areas (MoEF 2009). The combination of geographical location, population density, and poverty adds complication to such scenario. In the last few decades, the country has experienced an increase in the intensity and frequency of floods. A record of 53 years (1954-2007) depicts that most of the devastating floods of the country happened after 1980 and small scale flood have also become more frequent since 1975 (Nishat and Mukherjee 2013).

Table 1. Some major floods in recent past

Year of flood	Consequences
1984	Submerged over 50,000 sq. km with an estimated loss of US\$ 378 million
1987	Submerge over 50, 000 sq. km with an estimated loss of US\$ 1 billion.
1988	Submerged 61% area of the country with an estimated loss of US\$ 1.2 billion and made more than 45 million homeless.
1998	Submerged about 100,000 sq. km.(out of total land area of 147,570 sq.m.) with an estimated loss of US\$ 2.8 billion which also created 30 million people homeless.
2004	Submerged 38% area of the country with an estimated loss of more than US\$ 2 billion and affected the life and livelihoods of 3.8 million people.
2007	Submerged around 32,000 sq. km with an estimated loss of more than US\$ 1 billion.

Source: MoEF (2009:9)

It is argued that flood has become more frequent due to the impacts of climate change. Nishat and Mukherjee (2013) suggest that there are several ways that climate change affects the scenario of the flood. Due to climate change, the pattern of extreme rainfall changes in terms of its frequency and intensity which inevitably increase the intensity of flood. Besides, due to the rise of sea level, the discharge of upstream river water happens slowly which consequently raise the level of river water and flood the inland. Furthermore, changes in the temperature and the precipitation pattern change the soil moisture, groundwater recharge and runoff which can intensify the flood in climate sensitive areas (Nishat and Mukherjee 2013). In this connection, Arnell et al. (1996) argue that global warming is likely to increase the frequency and intensity of flood in many parts of the world. IPCC (2001) also suggests that a minor change in the state of the climate is likely to affect the frequency and intensity of flood in Bangladesh and India. McGuffie et al. (1999) suggest that the intensity of rainfall is likely to increase due to the concentration of greenhouse gases. Karmakar and Shrestha (2000) suggest that the yearly rainfall in Bangladesh would increase 295.94 mm by 2050 and 542.55 mm by 2100 as global warming is likely to increase the intensity of south-west monsoon. To assess the impact of climate change on the pattern of the flood in Bangladesh, Mirza et al. (2001) conducted a study and argued that future change in the pattern of precipitation will increase the magnitude, frequency and duration of floods in Bangladesh. The study

shows that if the temperature rises by 2-degree celsius than a twenty year return period of the flood in the Ganges, Brahmatpura and Meghna river will be changed to 13, 15 and 5.5 years respectively. World Bank (2013) also predicts that there will be a 29% increase in the average flood areas in Bangladesh if temperature increases by 2.5%.

A number of studies were made in Bangladesh on the linkage between the occurrence of flood and people's decision to migrate and the findings of those studies suggest that flood is one of the underlying factors in influencing people to leave their traditional habitat behind and settle in a new place. However, the studies suggest that displacements that happen due to flood are both temporary and permanent. In most of the cases, people tend to back to their places of origin when the flood ends. But, if people are subject to recurrent flood and hope for survival fades away in their place of origin then they decide to move to a new place permanently (Walsham 2010). Rahane and Grote (2007) conducted a study on the impacts of the flood on rural-urban migration in Bangladesh and found that the frequent incidences of flood lead to homelessness, landlessness and force people to migrate to new places. Rahane and Grote (2007) found that people in the rural areas of Bangladesh cannot cope with the prolong effects of disruptions in the labour market, price fluctuation and consumption deficiency due to flood and in such cases, their choice of migration is often influenced by the desire to replenish the asset values damaged by the floods. The study found that the movement happens in three forms i.e. village to village, village to nearby city and village to outside of the country. The study was conducted on 589 households and found that 89 percentage of the migration happened from village to nearby city. The study also found that people who are employed in the agriculture sector and depend on the local labour market are the most affected by the flood and more likely to migrate to cope with the losses. Eighty-three percent respondents of the study identified unemployment and lack of capital market formation because of the flood as the underlying factor for migration (Rahane and Grote 2007).

The study of Paul (2003) following 1998 flood in Bangladesh found that the decision to migrate is motivated due to the damages in assets which make it difficult for the affected people to survive during and the aftermath of the flood. The study found that in areas where victims get adequate compensation for their losses through an organized relief initiative are less likely to migrate to a new place (Paul 2003). The Comprehensive Disaster Management Programme (CDMP) (2014) conducted a study in nine districts of Bangladesh which are relatively more vulnerable to environmental hazards to assess the trend of displacement due to the impacts of disaster and climate change. The study was conducted on 926 households and found that due to floods 62 percent of the households faced temporary displacement and 0.4% displaced permanently. In this case, the study suggests that flood is more likely to cause temporary displacement and the victims are likely to move into embankments, elevated roads, shelter center and neighbours and relatives houses. The study also found that people who are employed in the agricultural sector constitute the highest percentage of the displaced people as they are the worst victims in the situation of the flood (CDMP 2014).

The findings from different studies show that flood is a common natural calamity in Bangladesh which causes enormous sufferings to people's lives as it destroys the infrastructure, housing, agriculture and livelihoods of the affected people. The situation of climate change is aggravating the situation further due to an increase in the frequency and intensity of rainfall, sea level rise which consequently slows down the discharge of river water and a rise in temperature. It is evident that over the years flood has contributed to displace a significant number of people from their place of origin. It is obvious from the study that flood leads to homelessness, landlessness and destruction of livelihood opportunities and thereby force people to move into new places for the sake of their sustenance. It is evident that people who are employed in agriculture and depend on the local labour market are the worst victims of flood and constitute the highest percentage of displaced people. The findings of the study show that displacements that happened due to flood are both temporary and permanent and people generally are more likely to return their original places aftermath of the flood. Permanent displacement happens when people are subject to recurrent floods and their hope for survival completely fades away in their traditional habitat.

River Bank Erosion

Bangladesh is popularly known as a land of rivers which consists of around seven hundred rivers including its tributaries and has a length of approximately 24,140 kilometer, which makes it as one of the largest networks of rivers in the world (Islam and Miah eds. 2012). While these rivers are regarded as blessings for the country as millions of people depend on it for their livelihoods, but it is also a source of sufferings for many people as they are exposed directly to different kinds of natural disasters. Riverbank erosion is one of them which causes enormous sufferings to millions of people living along the banks of those rivers (Nishat and Mukherjee 2013). The north-west part of the country is particularly more vulnerable to riverbank erosion. Riverbank erosion adversely affects about one million people every year in Bangladesh. It creates social marginalization for the affected people by destroying their households and weakening social and material circumstances (RMMRU 2007). It is found that three largest rivers of the country- the Padma, the Jamuna and the Ganga have eroded 1,590 km floodplains since 1973 and made 1.6 million people homeless in the process (Nishat and Mukherje, 2013). Another study shows that from 1982 to 1992, 106,300 hectares of mainly agricultural land was lost due to the erosion of the Ganges, Brahmaputra and Meghna rivers (RMMRU 2007).

Table 2. Status of bank erosion along the rivers of Jamuna and Ganges

Bank erosion along the Jamuna River during the period 1973–2009			Bank erosion along the Ganges River during the period 1973–2009		
District	Eroded area (ha)	Accredited area (ha)	District	Eroded area (ha)	Accredited area (ha)
Kurigram	18,510	40	Nawabganj	5,160	11,990
Gaibandha	9,220	920	Rajshahi	1,220	1,340
Jamalpur	11,810	4,880	Natore	1,920	140
Bogra	10,500	1,880	Kushtia	12,180	1,220
Sirajganj	22,400	2,410	Pabna	2,440	8,290
Tangail	10,920	-	Rajbari	5,470	2,700
Pabna	1,770	-	Total	28,390	25,680
Manikganj	5,700	10			
Total	90,830	10,140			

Source: CEGIS (2010)

Climate change is likely to aggravate the situation of river bank erosion due to increased rainfall and consequent flooding of the mainlands. The IPCC in its Fourth Assessment Report (2007) suggests that climate change will lead to an increased rainfall during the time of monsoon in the region of South Asia which will significantly increase the flow of water in the river systems. Rahman et al. (2010) suggest that such increase of river water flow will contribute to change the flood regimes and increase bank erosion. Walsham (2010) also argues that an increase in the pattern of average monsoon rainfall will lead to a higher level of erosion along the major rivers of Bangladesh which consequently further the sufferings of millions of people by destroying their homes and agricultural land. According to a study of CDMP (2014), it is argued that 10 percent increase in the discharge of Jamuna river-one of the three largest rivers in Bangladesh, will increase river bank erosion by 25 percent along its banks. In the case of the river Padma, 10 percent increase in the discharge of river water will increase the risk of erosion by 9 percent (CDMP 2014).

Displacement due to riverbank erosion is quite severe in different areas such as Sirajgonj, Jamalpur and Gaibanda where people have lost their houses, agricultural land and local level small industries in the face of erosion. The magnitude of the scenario is also obvious from different studies. A survey by CDMP (2014) on 926 households in 29 severely hazard prone unions under 8 districts shows that 20 percent household under the study were displaced permanently due to river bank erosion and 79 percent households found to be belonged to the 'in-between' temporary and permanent displacement category. The study refers 'in-between' category to three kinds of displaced people i.e. people who were displaced due to the fear of erosion but their homestead land still exists in their place of origin, people who were displaced to a place which is very close to the erosion prone area and thereby at constant risk of further displacement and people who have displaced to a nearby embankments and do not have any willingness to be permanently displaced. The study finds that these people have either stronger connection to their place of origin or they don't have the better opportunity to resettle permanently in a safer place or their lives and livelihoods evolve around rivers which compel them to stay close to rivers. The study shows that people were displaced as erosion destroyed their homestead and agricultural land in their place of origin and didn't have any alternative option to sustain their life in their place of origin (CDMP 2014).

Uddin and Basak (2012) conducted a study in the districts of Sirajganj and Gaibanda to assess the effects of riverbank erosion on the livelihood of the affected communities and its associated displacement. The study shows that riverbank erosion leads to loss of homestead, agricultural lands and production of the affected households. The combined effects of these losses lead to an erosion of income of the affected households which consequently force them to leave their place of origin and resettle in a new place, particularly in the urban areas. However, the study shows that at the initial stage of displacement, people generally relocate themselves in the nearest possible areas and search for employment opportunities to sustain their life. They decide to migrate to a distant place or urban centers when they fail to sustain themselves in those areas (Uddin and Basak 2012).

An empirical study by Arseneault et al., (2015) conducted in 10 chars (river islands of Bangladesh) of Kurigram and Gaibanda, two districts in the north-western part of Bangladesh, involving 350 participants to assess the impact of riverbank erosion on char lands (river islands of Bangladesh) shows that almost all of the participants experienced multiple displacements (on an average six times) in their life time. This scenario of multiple displacements is also obvious from a study of Abrar and Azad (2004) which was conducted on 200 erosion affected household in the North West of Bangladesh and found that the affected households were displaced 4.46 times on an average. The study shows that the victims of erosion were subject to loss both in material terms and social terms. The erosion lead to a loss in assets, savings and income due to damages in homes, crops, land, trees, poultry and livestock (Abrar and Azad 2003). The displacements are mainly found to be happened at the local level, within the same char (river island) or the nearby chars (Arseneault et al. 2015). This trend of local level displacement in the erosion-prone areas is also obvious from a study of Zaman (1991) which was conducted in eight villages of Kazipara upazilla (sub-districts) in the Brahmaputra-Jamuna floodplain and found that 88 percent of the households which were displaced in the face of erosion resettled within 3.2 kilometres of their last area of displacement. Abrar and Azad (2003) argue that the lack of adequate opportunity to sustain their life and livelihoods compel the affected households to remain near to the riverbank in spite of having the risk of further displacement. However, the study of Arseneault et al. (2015) suggests that in addition to environmental issues in the erosion-prone areas, forced migration also happen due to corruption, lack of transparency and complexity in the legal system of land redistribution which is a clear indication of poor governance on the part of the state in the erosion affected.

The abovestated findings show that riverbank erosion has become a nightmare for millions of people in Bangladesh living close to rivers. Climate change has a negative impact in this regard as it causes an increase in the rainfall pattern which consequently increases the flow of river water and makes the erosion more severe and destructive. It is obvious that erosion increases social marginalization of the affected people by destroying their households, lands and livestock which consequently displace them from their roots and compel them to resettle in new places. It is evident that riverbank erosion results into a loss of assets, savings and income due to the destruction of people's homes, crops, land, trees, poultry and

livestock. To cope with such losses people force to move into new places to maintain their sustenance. Though some people move into urban areas but the majority of the displacement is obvious to happen at the local level. Furthermore, the situation of multiple displacements is obvious in the case of riverbank erosion which is found to happen as people continue to live close to the rivers despite the risk of further displacement.

Tropical Cyclone

Bangladesh is affected by tropical cyclones nearly every year of which a severe cyclone strikes in every three years (MoEF 2009). The cyclones generally hit during summer (April-May) and post-monsoon seasons (October-November). From 1887 to 1995, 154 tropical cyclones hit the country of which 43 were severe cyclones. From 1995 to 2009, the country further hit by five severe cyclones of which two in 1997 and one in 1998, 2007 and 2009 respectively (Dasgupta et al. 2010). For this reason, UNDP labels Bangladesh as the most vulnerable country in the world in the face of tropical cyclones (UNDP 2004). Murty and El-Sabh (1992) state that Bangladesh is the receiver of 40% of damages of storm surges in the world.

Climate change is likely to increase the intensity and frequency of tropical storms in countries like Bangladesh. Different studies claim that in the last 35 years the intensity and frequency of tropical cyclones increased due to climate change (Emanuel 2005). Scientific study suggests that the intensity of tropical cyclone and storm surges will increase due to the rise in the surface temperature of the sea (Dasgupta et al. 2010). The IPCC in its Fourth Assessment Report (2007) also shows that since mid-1970s the greater intensity of cyclones can be attributed to the increased trend in the surface temperatures of the sea. The report also suggests that climate change and its resultant warming of sea-surface will result into more severe cyclones with higher peak wind intensity and precipitation (IPCC 2007). Furthermore, the World Meteorological Organisation (2006) argues that if the projected one-meter rise in sea level happens within this century because of global warming, it will significantly increase the vulnerability to tropical cyclones and storm surges.

The vulnerability of Bangladesh to tropical cyclones and storm surge is severe due to its long coastal zones and high population density in the coastal areas. The coastal areas of Bangladesh consist of approximately 47,000 square kilometers which cover around 32 percent of the total land area of the country (Karim and Mimura 2008). Besides, 28 percent population of the country resides in the coastal areas which make them directly exposed to tropical cyclones (Mallick, 2011). For this reason, tropical cyclones and storm surges bring enormous cost to the lives and livelihoods of the millions of people living in those areas.

Displacement due to such calamity in the coastal areas is a common phenomenon. Though there is no exact data available on the total number of displaced people from coastal areas due to tropical cyclones and storm surges but there are some studies which present the general pattern of displacement in those areas. Walsham (2010) conducted a study to assess the evidence of migration due to the impacts of climate change in Bangladesh. The study of Walsham (2010) suggests that tropical cyclone is responsible for huge displacement during and after the storm. For instance, cyclone Aila which hit the country in 2009 affected 3.9 million people and displaced 76,478 families only in Satkhira and Khulna- two of the affected districts in the coastal regions (Walsham 2010). However, the study suggests that such displacement happened locally and people are likely to return to their original places as soon as possible. But, many people in the affected areas are found to live in the high embankments for a longer period of time as their villages are faced with repeated inundation during high tide due to the damage of breached embankments caused by storm surge. In such situation, affected people are faced with severe consequences and tend to move into new places in search of livelihoods. The study also found that when the victims receive adequate assistance to recover their losses, they are less likely to migrate into new places (Walsham 2010).

Islam et. al (2015) conducted a study in four of the most vulnerable coastal districts in the face of cyclones and storm surges- Shatkhira, Bagerhat, Barguna and Bhola, to assess the scenario of displacement from cyclone-affected coastal areas of Bangladesh. Islam et. al (2015) conducted a micro level investigation on forty displaced people to understand their reasons of displacement. The study found that people in the coastal areas are primarily employed in agriculture and fishing. But, the recurrent cyclones and storm surge led to the destruction of arable land and fishing equipment which consequently result in a loss of income and capital and force people to migrate to new places. People are likely to move into urban areas due to better earning opportunities. The study suggests that if the victims are provided with adequate financial support and alternative employment opportunities in the post-cyclone period, they are more likely to stay in their place of origin and recover their damages due to calamity.

Mallick and Vogt (2014) conducted an empirical study after Cyclone Aila in 2009-which incurred enormous sufferings to the lives and livelihoods of the millions of people to understand the scenario of the population in the cyclone affected areas. The empirical study was conducted in the 12 villages of Satkhira district which were severely hit by the cyclone Aila in 2009. The study shows that people are forced to migrate to new places due to losses and damages in their livelihood options in the face of cyclones and storm surges. The study finds that most of the people in the coastal areas are small-scale marginal farmers and fisherman which make them more vulnerable in the face of natural hazard like cyclone. In such situation, people are forced to leave their place of origin in search of new employment opportunities to maintain their family. It is also found that due to the breaches of embankments, the agricultural lands were submerged for a long time which limit both the productivity and labour options in the affected areas after the cyclone. The study shows that after cyclone Aila in 2009, people in the affected areas received emergency assistance to sustain their life. But, with the end of emergency support and because of the victims lack of capacity to maintain livelihoods, they started to move into other places particularly in the urban areas (Mallick and Vogt 2014).

The abovestated findings clearly present the vulnerability of Bangladesh in the face of tropical cyclones which bring enormous sufferings to the lives and livelihoods of many people in the coastal areas of Bangladesh. This situation is aggravated by the fact that coastal areas cover almost 32 percent areas of the country and 28 percent population live in those areas. It is obvious that climate change contributes to increasing the severity of the cyclones due to increasing sea surface temperature and a rise in sea level which cause higher peak wind intensity and storm surges. The discussion shows that displacement due to tropical cyclones has become a common phenomenon in the coastal areas of Bangladesh as it destroys the source of sustenance of the people. It is obvious that majority of the people in the coastal areas consist of small-scale farmers and fisherman which increase their vulnerability in the face of cyclones and storm surges. It is evident from the study that cyclones and storm surge destroy arable land and fishing equipment which lead to a loss of income and capital and push the victims to move into new places to maintain their sustenance.

Sea Level Rise

Bangladesh is one of the most vulnerable countries in the face of sea level rise due to its flat and low-lying topography and high population density. The country has witnessed a change in the trend of tidal level in different coastal stations and the future projection is even more ominous. A study by SAARC Meteorological Research Council (SMRC) (2003) which was carried out to assess the relative sea level rise in the coastal areas of Bangladesh gives an understanding about the severity of the problem. By using a 22 years of historical data (from 1977 to 1998) at three tidal stations of Hiron Point, Char Changa and Cox's Bazar, the study found that sea level increased by 4.0 mm/year at Hiron Point, 6.0 mm/year at Char Changa and 7.00 mm/year at Cox's Bazar which are many times higher than the mean rate of global sea level rise over 100 years (SMRC 2003).

Table 3. Trends of sea level rise in three tidal stations of coastal areas in Bangladesh

Tidal Station	Region	Trend of sea level rise (mm/year)
Hiron Point	Western	4.0
Char Changa	Central	6.0
Cox's Bazar	Eastern	7.8

Source: SMRC (2003)

Different studies predict a further rise in sea level which is likely to incur huge losses on the habitats and the biodiversity in the coastal areas. According to a study of World Bank (2000), Bangladesh will experience 10, 25 and 100 cm rise in sea level by the years of 2020, 2050 and 2100 respectively. The National Adaptation Programme of Action (NAPA) predicts a sea level rise of 14, 32 and 88 cm in Bangladesh by the year of 2030, 2050 and 2100 respectively (MoEF 2005).

The predicted sea level rise is likely to have severe consequences on human settlement. According to Bose (2013), about 35.1 million people (28% of the total population) live in the coastal zones of Bangladesh which inevitably increases the vulnerability of the country to the predicted sea level rise. The IPCC predicts that Bangladesh will lose 17000 square kilometers of its land if sea level rise by 1 meter which will affect 15 million people living in the coastal areas and in the case of sea level rise by 1.5 meter, 22,000 square kilometers of the country's land will be submerged under water and 18 million people will become climate refugees (Bose 2013). World Bank projected a rise of sea level by 1 meter in the coastal areas of Bangladesh by the end of the 21st Century which will inundate 15 to 17 percent of the total land areas of the country and displace approximately 20 million people from their place of origin (World Bank 2000). According to a study of Ali (2000), approximately 2500, 8000 and 14000 square kilometers of the land of the country will be flooded in the face of a sea level rise by 0.1m, 0.3m and 1.0m respectively. Another study by Barnett (2003) suggests that 5.5 million people living on the delta of the Ganges in Bangladesh will be displaced in the face of a sea level rise by 45cm. The study of Rabbani et al. (2010) shows that only 10 centimeters rise in sea level will flood 15 percent area of Sundarban- the largest mangrove forest in the world which locates in the south-west coast of Bangladesh and a rise by 60 centimeters would submerge the forest completely. It is worth noting that 500,000 to 600,000 people completely depend on Sundarban for their livelihood by extracting natural resources from the forest such as fishing, woodcutting and collecting thatching materials, honey, beeswax and shells (Rabbani et al. 2010). So, the likely disappearance of the forest in the face of a 60 centimeters of sea level rise would also destroy the employment opportunity of half a million of people who would have no other option but to move into other places for the sake of their sustenance.

Furthermore, one of the most severe consequences that is affecting the livelihood pattern in the coastal areas due to sea level rise is salinity intrusion. Salinity intrusion from the sea destroys productive capacity of agricultural land and fresh water fisheries and damages river-based irrigational systems. As a result, millions of affected villagers over the last few decades have streamed into urban centers, especially in Dhaka-the capital of the country. According to a study of Shamsuddohea et.al (2007) saline water from sea enters about 250 kilometers inside the sea during the time of the dry season. National Adaptation Programme of Action (NAPA) (2005) shows that out of 2.85 million hectares of land in the coastal and offshore region of Bangladesh, approximately 1.2 million hectares of arable land have been affected by different labels of soil salinity. Sea level rise creates salinity impacts on three areas i.e. surface water, groundwater and soil which is contributing a decline in agricultural productivity by degrading soils and reducing the availability of fresh water (Patwary 2009). Different studies show that the salinity in some coastal land has become so severe that those lands are no longer being used for the agricultural purpose and the predicted scenario of climate change is likely to aggravate the situation further (Shamsuddohea et.al 2007). However, the problem of salinity and its resultant consequences on the pattern of people's livelihood is also affecting the human settlement in the coastal areas. Some studies show that people are moving into new places for the search of employment opportunities as their livelihood options have been

reduced in their place of origin due to salinity intrusion and its resultant consequences on the agricultural sector. A study by Comprehensive Disaster Programme (CDMP) (2014) shows that 14% households under study were displaced permanently and 82% of the households under study were displaced temporally due to salinity intrusion. However, the study shows that salinity intrusion was not the sole reason for such displacement. Rather, it combined with other factors such as river bank erosion, flood and cyclones which forced them to move into a new place for the sake of their survival (CDMP 2014).

The abovementioned findings depict that sea level rise is no longer a matter of prediction rather it is a reality in Bangladesh and the global climate change scenario is likely to aggravate this situation further. The most worrying picture is the rate of such rise which is clearly much higher than the average global sea level rise. It is obvious from the findings of a 22 years record of sea level rise at different coastal points in Bangladesh which show that the recorded sea level rise in those areas is significantly higher than the average global sea level rise over 100 years. This gives us an indication about the danger that the country is facing right now which can become a nightmare if the predicted rise of sea level happens in future. The severity of the problem can reach beyond imagination as 28% population of the country live in the coastal areas. For this reason, different studies show that 15 to 20 million people are likely to displace in the coastal areas of Bangladesh by the end of the 21st century due to the predicted sea level rise as people living in the coastal areas will lose their living space in the face of predicted sea level rise. It is also evident that sea level rise is increasing salinity intrusion in different coastal areas of the country which is reducing agricultural productivity due to soil degradation and the lack of fresh water availability and thereby forcing people to migrate into new areas to sustain their life. However, the findings from available studies show that salinity intrusion alone does not create displacement. Rather, it combines with other natural hazards such as riverbank erosion, flood and tropical cyclones to influence people's decision to leave their traditional behind and settle into a new society.

Conclusion

The above-stated discussion suggests that climate change has become a reality to Bangladesh as the country has already been subject to increasing surface temperature. Summer has become hotter due to the increase in the level of both maximum and minimum temperature. Similarly, winter has become warmer and shorter with the simultaneous rise in the level of minimum temperature. Besides, an increase in the pattern of average rainfall is also evident throughout the year. Such changes in the state of climate are affecting many aspects of lives and livelihoods of the millions of people in Bangladesh.

It is evident that climate change is contributing to increasing the frequency and intensity of natural calamities in the country. The study has identified and discussed four types of natural calamities such as floods, riverbank erosion, tropical cyclones and sea level rise- the frequency and intensity of which have increased significantly due to a scenario of climate change. It is evident that flood has become more frequent and severe due to a combination of increased rainfall, sea level rise and a rise in temperature. The study shows that the country has experienced most of the devastating floods after 1980 and the frequency of small-scale floods have also increased since 1975. The findings show that the increased rainfall is also aggravating the scenario of riverbank erosion on the banks of all major rivers in Bangladesh as it increases the flow of water in the river system. The severity of the erosion is obvious from the erosion rate of three largest river of the country- the Padma, the Jamuna and the Ganga which combinedly have eroded 1,590 km floodplains of the country since 1973. In the case of tropical cyclones, it is evident that Bangladesh is affected by tropical cyclone almost every year of which a severe cyclone strikes in every three years. The country is also rated as the most vulnerable country in the world in the face of tropical cyclones by a study of United Nations Development Programme (2004). It is evident that the greater intensity of cyclones since mid-1970s has largely been caused due to the increases in sea surface temperature. The increased temperature is also causing sea level rise which is posing even more danger to the lives and livelihoods of the millions of people in Bangladesh as 28 percent population of the country presently live in the coastal areas. It is evident from a record of 22 years (1977-1998) in three

coastal areas of the country that the rate of sea level rise in those areas during that time frame is many times higher than the mean rate of global sea level rise over 100 years.

The findings of the study suggest that various natural calamities such as flood, riverbank erosion, tropical cyclones and sea level rise which are increasing in terms of frequency and intensity due to climate change are displacing people from their roots in the rural and coastal areas of Bangladesh. It is obvious that such calamities lead to a situation of homelessness, landlessness and destruction of livelihood opportunities which result into the loss of assets, savings and income of the affected people. In such situation, people are forced to leave their traditional habitat behind and move into new places for the sake of their sustenance. The study shows that displacements are both temporary and permanent. In the case of flood and tropical cyclones, the victims are more likely to return to their places of origin when the calamity ends. Permanent displacement takes place when the victims hope for survival completely fades away in their origin and become subject to recurrent disasters. In the case of riverbank erosion, the situation of multiple displacements is also obvious. It happens because in the case of riverbank erosion majority of the displacement happen at the local level and people continue to live close to the river despite the risk of further displacement. It is also evident from the study that people who are employed in fishing, agricultural sector and local labour market are the worst victims in the face of such calamities and constitute the highest percentage of displaced people. The findings show that the mobility of the displaced people takes into three directions i.e. nearby villages, urban areas and outside of the country. Furthermore, it is evident from the findings that in addition to environmental factors relief and rehabilitation programme as well as the issue of transparency and complexity of the local government can also influence the individual decision to migrate. When victims get enough assistance in the post-disaster situation to cope with the losses and damages they are less likely to leave their places of origin. Besides, the problem with land redistribution due to the excessive corruption of the local level government and complexity in the legal system also has an influence on the individual decision to leave their locality from the erosion-affected areas.

Finally, it can be said that climate change has become a nightmare to the people of Bangladesh. The various consequences of climate change are destroying the pattern of livelihoods of millions of people and uprooting them from their roots in the process. This has severe implications on the social and economic life of the country. On the one hand, climate change is destroying the traditional way of life of the affected people, and on the other hand, it is posing serious challenges to the economy of the country. A resource limited country like Bangladesh, which is already engulfed by numerous socio, economic and political crisis like poverty, unemployment, political instability etc. is likely to succumb to the increasing pressures created by the increasing trend of climate refugees which can become a source of destabilization at different levels of state and society.

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