

# Climate Change and Conflict in Bangladesh



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## **Preface**

This Master Thesis is the final assignment for my Master 'Conflict, Territories, and Identities' at the Radboud University Nijmegen. I have been in Bangladesh for two months, for an internship at the Bangladesh Institute of Peace and Security Studies (BIPSS), and intensively travelled to coastal areas, like Noakhali, Chittagong, Cox's Bazaar, Khulna, Bagherhat, Mongla, and Bhola. I have eye-witnessed the impact of cyclone Aila, that hit Bangladesh on May 21, 2009, and killed over 330 people and left about 1 million people homeless. In order to shape my thoughts, I have spoken to over twenty experts in the subject of climate change and conflict, listed in appendix I.

First of all I like to thank my colleagues at the BIPSS for the wonderful time I had in Bangladesh. I like to thank General Major Munirazzaman for giving me the chance to work with the BIPSS. I also like to thank Bert Bomert and Mahmud Ali for guiding and supervising me in this academic expedition.

## Abstract

Bangladesh is located in a very difficult area of the World. The geographic shape and location make the country vulnerably for tropical cyclones and floods. Many experts indentify Bangladesh as 'frontline state' for climate change. Bangladesh would be one of the first and the hardest hit countries in the World if the climate changes. There's almost a general consensus that the impact of climate change would affect millions of people and could potentially lead to large scale violent conflict. In this master thesis the relationship between climate change and violent conflict has been explored.

Starting point is climate change. Climate change is a change in climate over a period of time. It contains four elements: temperature change, precipitation change, sea level rise, and extreme mega events. The changing elements of climate change have two consequences. Fist a scarcity of resources like food, water, and agricultural land. Second an increase of the number of natural disasters like floods, storms, and tropical cyclones. These consequences lead to three social effects: political instability, economic instability, and migration. The social effects could potentially cause violent conflict. Two types of conflict are distinguished: intrastate conflict (civil war), and interstate conflict (conflict between Bangladesh and India or Myanmar).

The climate in Bangladesh has changed the previous thirty years. This has not led to a scarcity of food, freshwater or agricultural land. It is also unlikely that the change of climate has led to an increase of natural disasters. The political situation in Bangladesh has been relatively unstable during the last ten years. The economic situation is improving, but Bangladesh has still a long way to go in order to meet the millennium goals. Migration is mainly motivated by economic improvement. Thereby, there is no evidence for a connection between climate change and an increase in cyclones. The climate has changed over the last thirty years but the number of cyclones has decreased. Cyclones are already taking place on a frequent basis in Bangladesh. Even if there was a connection, it is doubtful whether one additional cyclone would trigger conflict.

The list of problems in Bangladesh is very long. It is possible that conflict will occur in Bangladesh in the coming years. It is not likely, however, that the phenomenon of climate change is to be a paramount factor explaining this conflict. Poverty, population pressure, quality of leadership (from Bangladesh, India or Myanmar), lack of opportunities and inequality are all factors that will have to be the subject of serious scrutiny in any research aspiring to truly explain the cause of future conflict in Bangladesh.

### 1.1 Problem definition and central question

According to the UN's Intergovernmental Panel on Climate Change (IPCC) climate change is advancing rapidly. The Fourth Assessment Report (AR4) of the IPCC expects a global rise of temperatures of 2–7 °C to occur by 2100, unless resolute counteraction is taken (IPCC, 2007). This global warming will cause more frequent and more severe extreme weather events such as heavy rains, droughts, heat-waves and storms. There is also a danger of tropical cyclones not only becoming stronger but also occurring with greater frequency in extra tropical regions. At the same time, sea levels continue to rise. According to the IPCC these direct impacts of climate change will have far-reaching effects upon societies and the lives of people around the world (IPCC, 2007).

A number of high-profile individuals and policy groups have published alarming reports claiming that climate change will have enormous impacts on humanity. According to Robert D. Kaplan, in his influential article "The Coming Anarchy", the core foreign policy challenge for the twenty-first century is the 'political and strategic impact of surging populations, spreading disease, deforestation and soil erosion, water depletion, air pollution, and possibly, rising sea levels, developments that will prompt mass migration and, in turn, incite group conflicts' (Kaplan, 1994). Along the same lines, Thomas Homer-Dixon argues that 'climate change will help produce insurgencies, genocide, guerrilla attacks, gang warfare, and global terrorism' (Homer-Dixon, 2007). Former UN Secretary-General Kofi Annan and the Global Humanitarian Forum in Geneva stated that each year the impacts of climate change are responsible for hundreds of thousands of deaths with hundreds of millions of people directly and severely affected. According to Annan climate change is a serious threat to over half the world's population; half a billion people are at extreme risk (Global Humanitarian Forum, 2009). In a report to the Pentagon on implications of climate change for US national security, Schwartz and Randall sketch scenarios of epic proportions, including the risk of reverting to a Hobbesian state of nature whereby humanity would be engaged in 'constant battles for diminishing resources' (Schwartz & Randall, 2003). The UK Treasury-commissioned Stern Review (2006) and the Fourth Assessment Report (AR4) of the UN's Intergovernmental Panel on Climate Change (IPCC, 2007), are more reserved in their conclusions about the link between climate change and conflict. They do warn, however, for potentially dire societal consequences of climate change.

Bangladesh is seen as one of the most vulnerable countries in regards to climate change. The German Advisory Council on Global Change (WBGU) sketches a scenario in which at least three million people are forced to migrate from the coastal areas because of the rising sea level. Most of these migrants move to urban slums. Valuable agricultural land disperses under water. The country will be heavily

affected by increasing tropical storms and cyclones. The annual cost of natural disasters rises to an amount of 15 percent of the GDP. Economic instability grows. The incompetence of the Bangladeshi government to protect its citizens and to reconstruct the damage leads to political crisis (WBGU, 2007).

According to the United Nations Development Program (UNDP) Bangladesh is vulnerable for the impacts of climate change for three reasons. 1) Bangladesh is located in a delta of a major river basin, making it susceptible to floods and cyclones. 2) The country is heavily populated in a small area, and one of the most densely populated countries in the world. 3) The country is also very poor and a majority of the population lives below subsistence level, making them already vulnerable (UNDP, 2007). According to the UNDP *Human Development Report 2006*, the population living on an income of less than one US Dollar a day is 36 percent, while 82.8 percent of the population is living on an income below two US Dollars a day (UNPD, 2006).

According to a number of high-profile individuals and policy groups (as discussed in paragraph 1.1) climate change will have enormous impacts on humanity and can cause violent conflict. Bangladesh is seen as one of the most vulnerable countries in regards to climate change. The aim of this research project is to explore the suggested link between climate change and violent conflict in the context of Bangladesh. Therefore the central question of this master thesis is formulated as:

Can climate change cause violent conflict in Bangladesh?

## **1.2 Target**

The aim of this study is to explore the relationship between climate change and conflict in Bangladesh. We want to give a clear insight into pathway from climate change to conflict in Bangladesh. At the end of the study the central question should be answered.

## **1.3 Relevancy**

Many scholars have suggested that there is a link between climate change and violent conflict. This suggested link is characterized by two paradoxes. Firstly, many of the processes associated with climate change and global warming have taken shape only over the last fifteen years. In fact, during this period the number of violent conflicts diminished (Buhaug et al., 2008). Conclusions regarding current and future causal relationships cannot be based on this simplistic comparison. However, but can identify a contradictory trend. Secondly, the empirical foundation for a link between climate



change and violent conflict is weak. Several case studies suggest that climate change, represented as a resource scarcity, contributes to the outbreak of violent conflict – always in interaction with other conflict enhancing factors, however. There is no decent empirical foundation for a direct link between climate change and violent conflict (Buhaug et al., 2008).

This study aims to contribute to the climate change and conflict debate. Bangladesh is seen as one of the most vulnerable countries with regard to climate change. Bangladesh represents the perfect case study to get insight into the relationship between climate change and conflict. The objective is to give a clear insight into the casual links and intermediate steps between climate change and conflict in Bangladesh. A clear insight into the relationship between climate change and conflict in Bangladesh could reveal a framework for analyzing climate change related conflict in other parts of the world.

A clear insight into the relationship between climate change and conflict in Bangladesh will pave way for finding constructive solutions in order to prevent (future) conflicts. Insight into the cause and origin of conflict creates the opportunity to prevent social mechanisms, that can lead to conflict, from mobilizing. This would be of significant social relevance for Bangladesh, neighbouring countries, and the world.

## 2 Literature Research

Scientific research on climate change and conflict is imbedded in the literature of environmental conflict. The literature of environmental conflicts dates back to the early 1970s. It was not until the 1990s that scholars entered into serious debate and systematic study of the causal links between environmental degradation and violent conflict. Four groups in particular within the community of internationally established conflict researchers have dealt in detail with the relevance of environmental problems regarding the causes and dynamics of armed conflicts. Pioneers were Homer-Dixon and a group of scholars around him, and the Environment and Conflicts Project (ENCOP) set up by Bächler and Spillmann. During the early 1990s both groups undertook empirical studies of the assumed connections between environmental degradation and the violence of conflict.

### 2.1 Schools of thought

#### 2.1.1 The Toronto group around Homer-Dixon

Homer-Dixon examined the circumstances under which environmentally induced stress causes acute conflicts both within and between states. In order to find out how conflicts induced by environmental problems progress, he conducted a number of qualitative case studies on conflicts in developing countries where a close link between environmental stress and acute conflict was assumed. Homer-Dixon and his colleagues concentrated on environmental problems that can be put down to the scarcity of renewable resources and environmental changes. In the context of the project, six types of environmental change were looked at: climate change, depletion of the stratospheric ozone layer, degradation of agricultural land, deforestation, degradation of water resources, and depletion of fish stocks. The scarcity of renewable resources has a central role in the research of Homer-Dixon. No evidence was found for a direct connection between resource scarcity and the violent escalation of conflict. However, Homer-Dixon's studies indicate that environmentally induced resource scarcity, in combination with political, economic and social factors, can indeed lead to a destabilization of states and societies likely to cause conflict. Furthermore, the destruction or scarcity of environmental resources has already contributed to a dynamic of violent conflicts in many developing countries. (Homer-Dixon, 1990, 1991, 1994, 1999)

#### 2.1.2 The Zurich group around Bächler and Spillman

In 1996 the ENCOP project presented a final report based on qualitative case studies (Bächler & Spillman, 1996). The focus was on developing countries that had to deal with both environmental problems and armed conflict. The basic assumption behind ENCOP is that environmental change may

lead indirectly to conflict by intensifying the existing potential for socio-economic conflict to the point of violent escalation. According to this view, conflicts are primarily socially or politically motivated, not an irreversible consequence of environmental change. The particular aim of ENCOP was to devise a typology of conflict that links a particular kind of environmental degradation to its socio-economic consequences and the affected parties to the conflict. Drawing on an analysis of 40 environmental conflicts, the following categories were developed:

- Centre-periphery conflicts
- Ethno-ecological conflicts
- Regional, cross-border and demographically-induced conflicts
- Migration conflicts
- International water conflicts
- Conflicts arising from distant sources

The ENCOP typology shows that contextual factors other than the impacts of resource degradation ultimately determine whether competing actors will seek a peaceful or a violent solution to conflict. Among the most important socio-economic factors identified by the Zurich group as making environmentally induced conflicts more likely, are a lack of societal mechanisms for regulating conflict, an instrumentalization of environmental degradation for group-specific interests, group identities, the organization and arming of parties to a conflict, and the influence of past conflict.

From the mid-1990s onwards, two additional approaches have been developed, based on the criticism of the work by Homer-Dixon and ENCOP. The main representatives of these approaches are the group of scholars around Gleditsch, whose work is based on quantitative studies, and Matthew's Global Environmental Change and Human Security (GECHS) Project based in Irvine, California, that focuses on the adaptive capacity of human societies.

### **2.1.3 The Oslo Group around Gleditsch**

At the International Peace Research Institute Oslo (PRIO), Gleditsch started an independent quantitative research approach as a process of critical engagement with the studies of Homer-Dixon and the ENCOP. His aim was to counter the excessive complexity of the qualitative models and to provide a correction to their deficiencies regarding the selection of case studies, in particular the tendency to study countries with acute conflicts over resources (Gleditsch, 1998). According to Gleditsch robust conclusions regarding the influence of various factors on armed conflict can be reached only when cases in which resource conflicts are conducted violently are compared with

those in which there is no escalation of violence. Gleditsch argues that an abundance of resources is more likely to lead to violent conflict, because rebel groups, for example, draw their funding from the exploitation of natural resources. Like the Homer-Dixon and ENCOP studies before, the Oslo group's quantitative studies confirm the basic link between environmental problems and armed conflict (Hauge & Ellingsen, 1998; Diehl & Gleditsch, 2000). Gleditsch emphasizes strongly that environmental stress is only one of several variables that may contribute to the escalation of conflict. While environmental factors such as deforestation, soil degradation and water scarcity increase the risk of violent conflict within states, economic and political factors remain crucial as explanations for the outbreak and intensity of such conflicts (Hauge & Ellingsen, 1998).

#### **2.1.4 The Irvine group around Matthew**

The Global Environmental Change and Human Security (GECHS) project headed by Matthew has been set up at the Centre for Unconventional Security Affairs at the University of California in Irvine. Matthew examined the impacts of environmental change on individuals and societies, and took human security as a theoretical starting point. Matthew's critique at environment and conflict research aimed at fostering a new theoretical orientation focused more on the long-term adaptability of humans and societies. According to Matthew research has lacked qualitative frames and foundations. In order to gain a better understanding of the key interconnections and impacts involved, it would be helpful to extend the range of methods and instruments used. This could be done by engaging in interdisciplinary cooperation, making use of research on conflict and cooperation and carrying out microanalyses. What is also lacking, according to Matthew, is quantifiable empirical research regarding the relevance of demography as a factor, the question of whether resource abundance or resource scarcity hold the greater risk of conflict, and whether environmental degradation might actually promote cooperation rather than stoking conflict. Matthew also stresses the role of 'network threats' for future environmental security research. This is a reference to transnational threats to security arising through an informal, transnational network of individual behaviour, such as decisions about personal energy consumption in the case of climate change (Matthew & Fraser, 2002; Matthew & McDonald, 2004; Matthew et al., 2004).

## **2.2 Consent**

Despite fundamental objections towards each other in the environment and conflict literature and the pointed critique of its premises and methods, there is a considerable degree of agreement about the main research findings:

- *Multi-causality*: All approaches emphasize the multi-causality of the conflicts observed. There is a consensus that environmental degradation is always only one of several complexly connected causes of conflict and that environmental degradation rarely is the decisive factor.
- *Locality*: There is also consensus regarding the locality of the conflicts believed to involve an environmental element. They are predominantly intrastate conflicts; even when they can be categorized as cross-border conflicts, they are generally not classical interstate conflicts in the sense of large-scale wars between countries but rather regionally limited clashes at the sub-national level, such as between states that border on the same rivers and lakes.
- *Problem-solving capacity*: All approaches emphasize the central role of a state's or society's problem-solving capacity with regard to the emergence and management of conflicts. In places where political and societal institutions are weak, there is a higher probability of conflict occurring. Future crisis hotspots are therefore assumed to be located in countries and regions considered problematic in terms of their problem-solving capacity.

So far, there has been no evidence that environmental problems are the direct cause of war. There have been no 'environmental wars' manifesting the most extreme form of interstate conflict. At least no evidence exists to date to suggest any unambiguous causal links between environmental change and violent interstate conflict. Indeed, there are some striking examples in which efforts to solve environmental problems have led to constructive and cooperative engagement between fundamentally hostile parties (e.g. water use between Israel and Palestine or Egypt-Israeli cooperation in the context of the Mediterranean Action Plan). However, it certainly cannot be ruled out that environmental degradation can have destabilizing impacts that may lead to conflict. This link between environmental change and violent conflict remains a plausible possibility.

### **2.3 Fundamental critique**

There are a number of scholars in the scientific debate that fundamentally criticise the very notion of dealing with ecological issues in the context of security discourse (Deudney, 1990, 1991; Brock, 1992; Levy, 1995). Both Daase and Brock, for example, argue that overloaded concepts such as environmental security are suitable neither as a means of scientific description nor as a way of explaining new critical developments. The lack of high analytical resolution that characterizes such approaches makes it difficult to make empirical distinctions. It levels the differences between relevant fields of policy and suggests that the interests of one party coincide with the interests of all others (Daase, 1992, 1996; Brock, 1992, 1997, 2004). In the view of these authors, environmental security is more an empty formula that serves different political agendas than a theoretical

innovation. Discourse about ecological security can therefore serve to legitimate new areas of military deployment, while lessening the problem of public acceptance of the armed forces and promoting repressive tendencies in the sphere of internal security policy. In addition, preventive conflict resolution efforts aimed at achieving environmental security are also a means of legitimating violence.

A fundamental critique of the idea of environmental security has also been expressed in the context of the North-South discourse, with critics highlighting the inappropriate 'colonization of environmental problems' by security discourse (Barnett, 2000; Dalby, 2002). According to these critics, the literature on environmental security suggests that the underdeveloped South poses a physical threat to the prosperous North, in that population explosions, migration and resource scarcity necessarily lead to disputes over distribution and conflicts of interest that can be solved only by military means. According to Barnett the industrialized countries are under suspicion of exploiting such scenarios of threat in order to attack the 'uncivilized South' and to close off their own borders. In this view environmental security is committed less to the security of people on the ground than to the national interests of the industrialized world. The actual causes of environmental problems, as well as the large scale injustices that exist in the global use and distribution of natural resources are hidden in favour of shoring up the global political status quo.

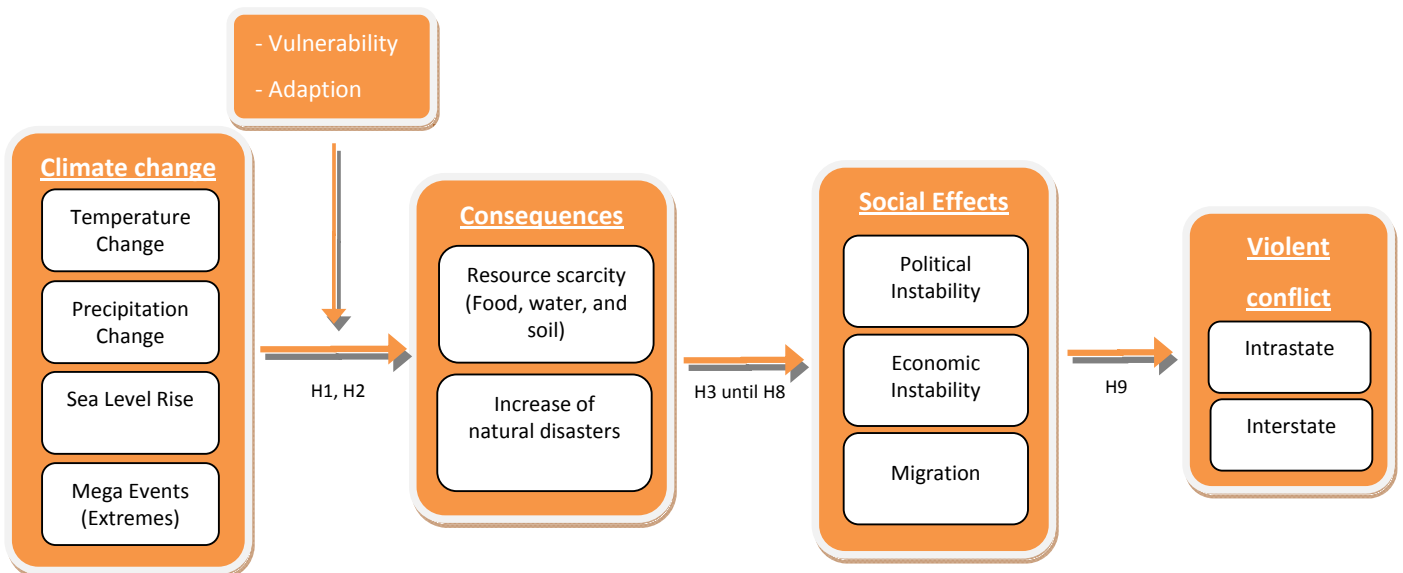
### 3 Research model

There are very few scholars that claim that there is a direct link between climate change and violent conflict. Most assessments of environment and conflict sketch a causal story where climate change leads to scarcity of resources and migration, but only relates to violent conflict in combination with other conflict enhancing factors. Homer-Dixon states that ‘environmental scarcity is never a sole or sufficient cause of large migrations, poverty, or violence. It always joins with other economic, political, and social factors to produce its effects’ (Homer-Dixon, 1999). Along this line, a study by eleven retired US generals and admirals concludes that climate change is likely to act as a ‘threat multiplier’ in volatile regions, e.g. by decreasing food production and freshwater availability (CNA, 2007). According to the generals, ‘such changes will add significantly to existing tensions and can facilitate weakened governance, economic collapses, massive human migrations, and potential conflicts’ (CNA, 2007). A recent report by International Alert (2007) comes to similar conclusions. In their wording, understanding the influence of climate change on conflict requires tracing the ‘consequences of consequences’ (International Alert, 2007).

#### 3.1 Conceptual framework

To explore the link between climate change and violent conflict in Bangladesh, a conceptual framework has been developed. This framework is based on academic literature in the field of environmental change and conflict.

Figure 3.1: Conceptual framework



The framework draws a possible pathway from climate change to violent conflict. Figure 3.1 shows the conceptual framework. Based on the conceptual framework nine hypothesis are formulated. These hypothesis are related to the steps of the conceptual framework. In the next paragraphs all steps and variables of the conceptual framework will be discussed.

### 3.2 Climate change

The Intergovernmental Panel on Climate Change (IPCC) defines, in its fourth assessment report (p. 30) climate change as: “a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity”.

Climate change is defined as a change in climate from situation A to situation B in a period of time due to natural variability or as a result of human activity. The causes of the change of climate are outside the conceptual framework and the scope of this master thesis. This master thesis focuses on the possible consequences of climate change and the relationship with conflict. According to The Fourth Assessment Report (AR4) of the IPCC experts climate change contains four elements:

- *Temperature change*: changes of average temperature over a period of time. This rise of average temperatures on a global scale is referred to as ‘global warming’.
- *Precipitation change*: changes of precipitation patterns over a period of time. This includes an overall increase or reduction in annual snow and rainfall.
- *Sea level rise*: increase of the level of the sea over a period of time.
- *Extreme events*: change in frequency and/or intensity of extreme weather events over a period of time. According to the IPCC heat-waves and heavy precipitation have become more frequent over most land areas. Cold days, cold nights and frosts have become less frequent over most land areas, while hot days and hot nights have become more frequent (IPCC, 2007).

### 3.3 Vulnerability and adaptation

The extent to which changing climate is constituted as a threat, is determined by the affected society’s level of vulnerability. The IPCC defines vulnerability as ‘the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes’ (IPCC, 2007). The vulnerability concept thus captures both the risk and degree of exposure and the ability to handle the challenges imposed by the environment.

Vulnerability to climate change is crucially dependent on the type of hazard and the nature of the



context. There are certain determinants of vulnerability that apply in many cases, like poverty, health, education, inequality, and governance (Brooks et al., 2005).

Societies and communities that are affected by changing climate have several coping strategies. First, they may seek to adapt to the new challenges. Adaptation is defined by the IPCC as 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities' (IPCC, 2007). Adaptation can occur on any scale, from the individual to the international level. The most extreme forms of adaptation involve pursuing alternate modes of livelihood or finding substitutes for the necessary but increasingly scarce commodities. Less drastic means of adaptation include conservation programs and efforts to reduce consumption, investment in technology to enhance production/consumption efficiency, and trade.

According to Homer-Dixon, societies and communities that are unable to adjust to the new circumstances are left with two main options: fight or flee (Homer-Dixon, 1999). The first option contains competition for the diminishing resources. Homer-Dixon refers to this process as a 'resource capture mechanism'. Elites take control over the increasingly precious resources at the expense of the poor (Homer-Dixon, 1999). Conflicts over oil or water are examples of resources competition (Klare, 2001). The second option is to migrate to another area. Whether a society or community adapts, fights or flees depends on the nature of the changing environment, the vulnerability of the population, and contextual factors.

Intensifying climate variability and natural hazards, in contrast, exhibit much shorter temporal traits, ranging from mere minutes (landslides) to months (drought). Such environmental challenges will require almost immediate action. If the exposed population is unprepared or lacks the necessary ability to adapt successfully, rapid migration and resource contention become plausible strategies for remedy (Homer-Dixon, 1999).

The inability to adapt plays a central role in the environmental security literature. Homer-Dixon argues that a low level of development means less money to spend on research, resource conservation, and the development of resilient systems to tackle unexpected events (Homer-Dixon, 1999). Although he acknowledges that scarcity can promote adaptation through innovation, Homer-Dixon argues that in the developing world market failure, social friction, narrow self-serving coalitions, lack of capital, cognitive limits to ingenuity, and growing costs of research are more likely

outcomes of climate change (Homer-Dixon, 1999). It is this 'ingenuity gap' that makes these countries more prone to instability and conflict.

### **3.3.1 Context of Bangladesh**

#### *3.3.1.1 Geographical location*

Bangladesh is situated in the north eastern region of South Asia and is bounded by India to the west, north and northeast, by Myanmar to the southeast and the Bay of Bengal to the south. It has an area of 147,570 km<sup>2</sup> and a population of about 150 million. The country has a very flat and low topography except in the northeast and southeast regions. About 10 percent of Bangladesh is hardly 1m above the mean sea level and one-third is under tidal excursions. The country has two contrasting environments to the north and the south. It has the Himalayas and the Khasi-Jaintia hills to the north and the Bay of Bengal and the northern Indian Ocean to the south. Both of these geographical settings control, modify and regulate the weather and climate of the country and the region (Ali, 1999).

Bangladesh is basically a deltaic plain of three mighty rivers, namely the Ganges, the Brahmaputra and the Meghna (GBM) which form one of the largest river systems in the world. These rivers have large number of (sub-)distributaries and (sub-)tributaries. The country has a total number of 230 rivers covering a length of about 24,140km. These rivers carry huge amounts of water and sediments into the Bay of Bengal in the south where they are subjected to dynamic actions by the conditions in the Bay, leading to coastal erosions, accretions and other phenomena.

The country has three distinct coastal regions, namely the western, central and eastern regions. The western zone is very flat and low and is criss-crossed by numerous rivers and channels. It houses the mangrove area called the Sundarbans. The central region is the most active one; a continuous process of accretion and erosion is going on there. The eastern region is covered by hilly areas and it is more stable and has a long beach (Ali, 1999).

The geographical location and geo-morphological conditions of Bangladesh have made the country one of the most vulnerable ones to disasters in the world (Ali, 1999). According to the UNDP, Bangladesh is the most vulnerable country for tropical cyclones, and the six's most vulnerable to floods.

**Figure 3.2: Most vulnerable countries to floods and cyclones**

Most vulnerable countries to floods or cyclones (Deaths/100,000 people exposed to floods or cyclones)					
Floods			Tropical cyclones		
1.	Venezuela	4.9	1.	Bangladesh	32.1
2.	Afghanistan	4.3	2.	India	20.2
3.	Pakistan	2.2	3.	Philippines	8.3
4.	China	1.4	4.	Honduras	7.3
5.	India	1.2	5.	Vietnam	5.5
6.	Bangladesh	1.1	6.	China	2.8

\* Of major flood-affected countries reporting an average of over 200 deaths/year.

Source: UNDP, 2004: A Global Report: Reducing Disaster Risk: A Challenge for Development

### 3.3.1.2 Economic importance of the coastal areas

Economically, the coastal area plays a very important role in Bangladesh. The country has a coastline of about 720 km. The coastal waters are a big source of marine and coastal fisheries and inland and marine transport. Shrimp farming has been a very lucrative business. There are two seaports located in the coastal area, namely Chittagong and Mongla. A number of industrial complexes are situated in the coastal area. The Sundarban mangrove area is a big source of the country's economy. The newsprint mill established there is based on the basic raw materials drawn from the Sundarbans. The coastal area is very fertile for rice production. Above all, the country has big prospects of oil and gas in the coastal area (Ali, 1999).

Figure 3.3: Map of Bangladesh



### 3.3.1.3 Population pressure

The population pressure can be defined as a combination of the high rate of growth and the large size of the population. Bangladesh is the eighth most populous country in the world with a population of over 150 million people. The annual population growth rate is about 1.6 percent

(UNPD, 2005). Even with a slowing down of the population growth rate, the size of the population will continue to grow due to the young age structure of the population. Bangladesh is the most densely populated country in the world, with the exception of some island states. Its population density is three times that of neighbouring India and seven times that of China. The government of Bangladesh has, over the past several decades, intensified and strengthened the family planning programme. (UNPD, 2005)

#### 3.3.1.4 *Current climate*

Bangladesh has a humid, warm, tropical climate. Its climate is influenced primarily by monsoon and partly by pre-monsoon and post-monsoon circulations. The southwest monsoon originates over the Indian Ocean and carries warm, moist, and unstable air. The monsoon has its onset during the first week of June and ends in the first week of October, with some inter-annual variability in dates. In addition to monsoon, the easterly trade winds are also active, providing warm and relatively drier circulation (WAPRO, 2008). In Bangladesh there are four prominent seasons, namely, winter (December to February), Pre-monsoon (March to May), Monsoon (June to early-October), Post-monsoon (late-October to November). The general characteristics of the seasons are as follows (WAPRO, 2008):

- Winter is relatively cool and dry, with the average temperature ranging from a minimum of 7.2-12.8°C to a maximum of 23.9-31.1°C. The minimum occasionally falls below 5°C in the north, though frost is extremely rare. There is a south to north thermal gradient in winter mean temperature. Generally the southern districts are 5°C warmer than the northern districts.
- Pre-monsoon is hot with an average maximum of 36.7°C, predominantly in the west for up to 10 days, a very high rate of evaporation, and erratic but occasional heavy rainfall from March to June. In some places the temperature occasionally rises up to 40°C or more. The peak of the maximum temperatures is observed in April, the beginning of pre-monsoon season. In pre-monsoon season the mean temperature gradient is oriented in a southwest to northeast direction with the warmer zone in the southwest and the cooler zone in the northeast.
- Monsoon is both hot and humid, brings heavy torrential rainfall throughout the season. About four-fifths of the mean annual rainfall occurs during monsoon. The mean monsoon temperatures are higher in the western districts than the eastern districts. Warm conditions generally prevail throughout the season, although cooler days are also observed during and following heavy downpours.
- Post-monsoon is a short-living season characterised by a withdrawal of rainfall and a gradual lowering of night-time minimum temperatures.

The mean annual rainfall is about 2,300mm, but there is a wide spatial and temporal distribution. Annual rainfall ranges from 1,200mm in the extreme west to over 5,000mm in the east and northeast (WARPO, 2008).

### **3.4 Consequences of climate change**

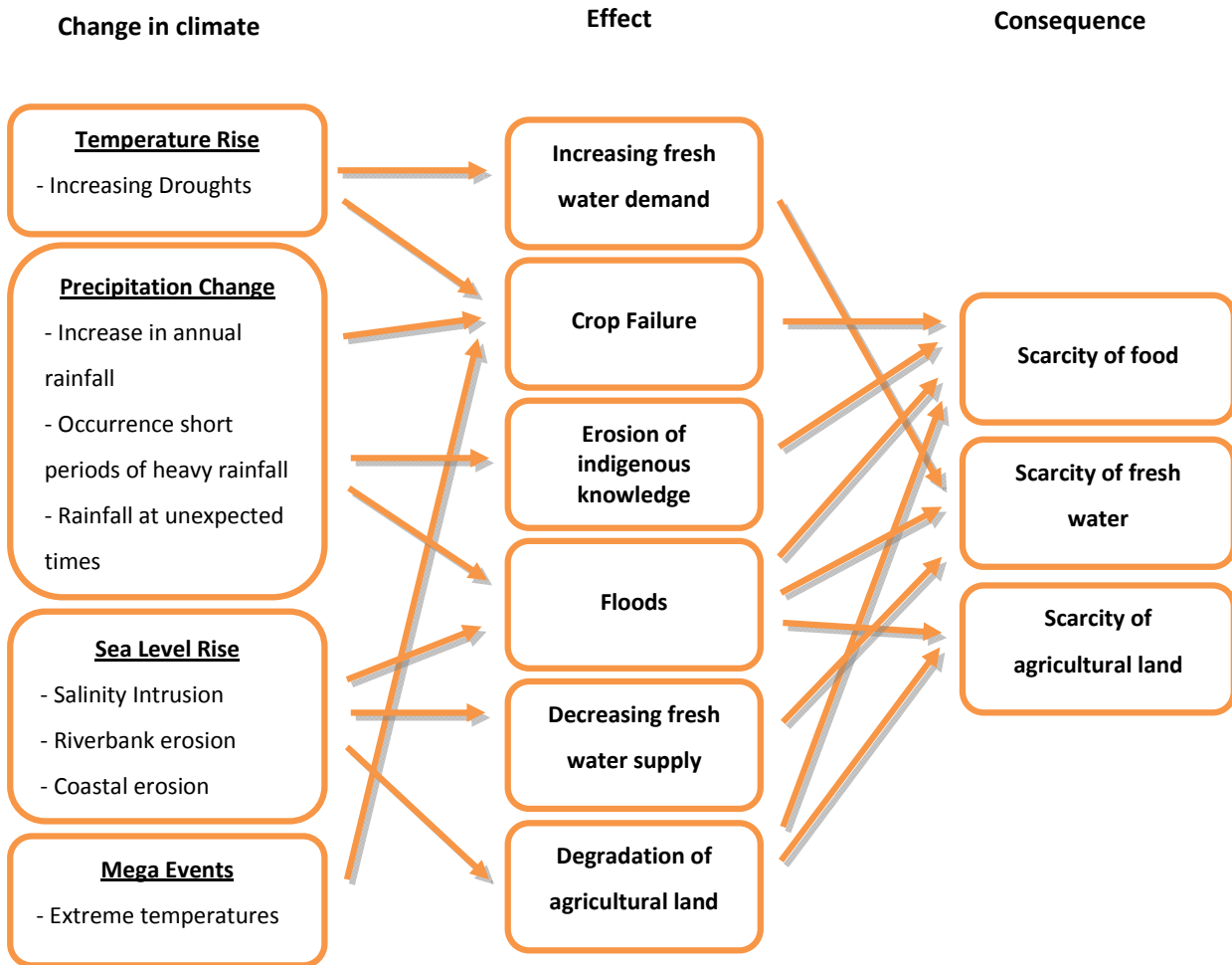
#### **3.4.1 Scarcity of resources**

The first consequence of climate change in the conceptual framework is 'scarcity of resources'. Climate change may have consequences for the availability of necessary resources for sustained livelihood like soil, food, and freshwater. Scarcity is defined as 'low per-capita access to a resource'. Scarcity of resources is therefore a low per capita availability of renewable resources, such as food, freshwater, and soil. In general scarcity of resources can occur in two ways. First, a decrease of supply or dwindling resource base, and second, an increase of demand, caused by an increasing population pressure or increasing consumption.

According to the IPCC and similar studies, the environmental impacts of climate change will vary enormously between regions. Some areas, including Northern Europe, are likely to benefit from an increase in average temperatures as it is expected to result in increased crop yields, increased forest growth, decreased energy demand for heating, and reduced mortality from cold exposure (IPCC, 2007). However, the IPCC predicts that most parts of the world will not benefit from the change of climate. According to the IPCC, increasing temperatures, changing precipitation patterns, overall reduction in annual rainfall, rising sea levels, and increasing frequency of extreme events can lead to an increase of scarcity of resources (IPCC, 2007).

The impacts of climate change vary enormously between regions, according to the IPCC (IPCC, 2007). The vulnerability and the power to adapt to new circumstances depend highly on contextual characteristics. Figure 3.4 shows in which way climate change could lead to scarcity of resources in the context of Bangladesh.

Figure 3.4: Climate change and resources scarcity in Bangladesh



According to the IPCC climate change will lead to a rise of temperatures, a change in precipitation patterns, a rise of the sea level, and an increase of mega events. A rise of temperatures is expected to increase the periods of droughts. The IPCC predicts that even small local temperature increases of 1–2°C will decrease agricultural output and increase the risk of hunger (IPCC, 2007). The rise of temperatures would be likely to increase the demand for freshwater and enhances the chances of crop failure. The change of precipitation is expected to lead to an increase of the annual rainfall and a change in rainfall patterns. The increase of annual rainfall could be beneficial for crop production and freshwater supply. The combination with changing patterns however is expected to lead to short periods of heavy rainfall and rainfall at unexpected times (IUCN, 2009). Agriculture in Bangladesh is highly adjusted to monsoon periods. About four-fifths of the mean annual rainfall occurs during monsoon. Farmers depend on their knowledge of precipitation patterns for cultivating crops. Short periods of heavy rainfall and rainfall at unexpected times can lead to an erosion of indigenous

knowledge and crop failures. The increase of annual rainfall and the short periods of heavy rainfall can also lead to floods. The rising of the sea level can enhance salinity intrusion, riverbank erosion, and coastal erosion. Salinity intrusion due to sea level rise can reduce agricultural production through unavailability of freshwater and degradation of agricultural land. Salinity intrusion degrades soil quality which in turn reduces crop production (Islam, 2004, p. 190). The three mighty rivers, the Ganges, Brahmaputra, and Meghna (GBM) form one of the largest river systems in the world (Ali, 1999). A rise of the Bay of Bengal and melting Himalaya glaciers could lead to riverbank and coastal erosion. This could lead to degradation of agricultural land. A growing frequency of mega events could lead, in the context of Bangladesh, to longer periods of high or low temperatures. This could lead to crop failures. Increasing freshwater demand, crop failure, erosion of indigenous knowledge, floods, decreasing freshwater supplies, and degradation of agricultural land could lead to the scarcity of food, freshwater, and agricultural land related to climate change.

In the conceptual framework these consequences of climate change are considered to be an intermediate stage between climate change and violent conflict. The first hypothesis of this Master Thesis is therefore:

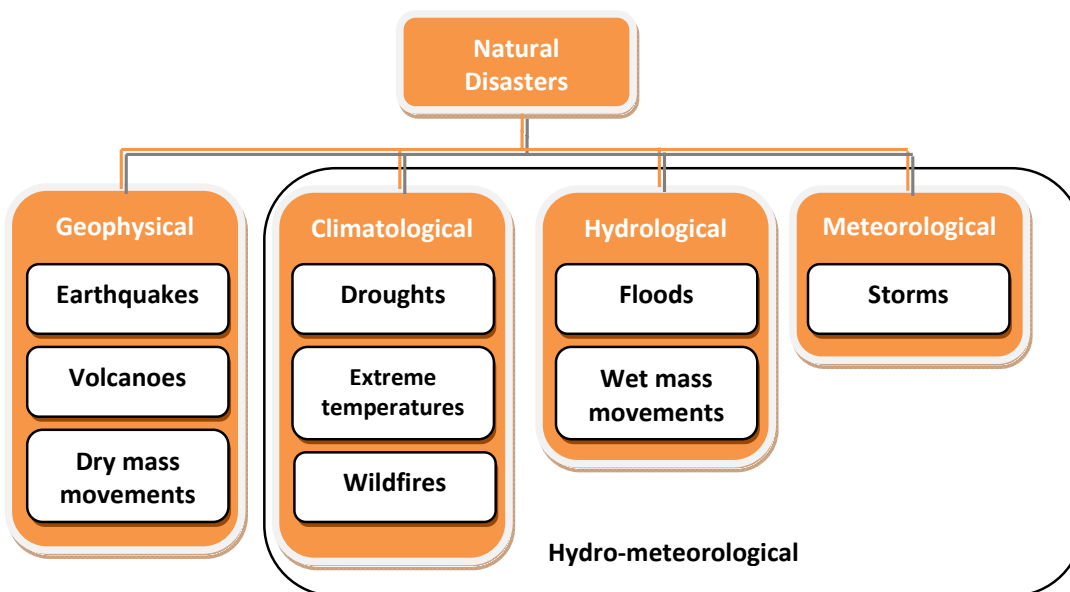
H1: Climate change will lead to scarcity of resources in Bangladesh.

### **3.4.2 Increase of natural disasters**

A second consequence of climate change, or potentially intermediate stage between climate change and violent conflict, are increasing natural disasters. Global warming is predicted to increase the frequency and intensity of tropical storms, floods, landslides, and wild fires. The UNDP defines a disaster as ‘a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources’ (UNDP, 2004). From this definition it follows that natural disasters are usually associated with a temporary local collapse of state functions. The devastation of infrastructure blocks external consignments of relief, water and energy supplies are disrupted and hospitals are overstretched. This lack of state power to intervene in disaster situations can result in political instability and violent conflict. The 20th century saw a dramatic increase in the number of disasters. The Centre for Research on the Epidemiology of Disasters (CRED) categorizes natural disasters in the following way (figure 3.5).



Figure 3.5: Categories of natural disasters



Almost all of the temporal increase in disaster frequency is accounted for by the hydro-meteorological category. Floods constitute the most prevalent disaster type. More than one-third of the world's landmass and 82 percent of the world's population are located in flood-prone areas (CRED, 2008). In 2007 the number of reported disasters confirmed the global upward trend in natural disaster occurrence. This upward trend is mainly driven by the increase in the number of reported hydro-meteorological disasters. Hydrological (essentially floods) and meteorological (storms) disasters are the major contributors to this pattern (CRED, 2008).

Asia is the region hardest hit and most affected by natural disasters in 2007. Indeed 37 percent of the year's reported disasters occurred in Asia, accounting for 90 percent of all the reported victims and 46 percent of the economic damage due to natural disasters in the world. Asia was especially hard hit by monsoon related events. This was particularly the case for India, China, and Bangladesh (CRED, 2008). The trends for the human and economic impact of natural disasters are highly influenced by the occurrence of "mega-disasters" affecting tens of millions of people and causing billions of dollars worth of economic damage. These exceptional events lead to a high variation from one year to the next. This great variability makes it difficult to identify clear trends in the human and economic impacts of disasters over time (CRED, 2008).

### 3.4.2.1 Link between climate change and natural disasters

Bangladesh is the most vulnerable country in the world for tropical cyclones (UNDP, 2004). One necessary condition for tropical cyclone formation is a sea surface temperature of a minimum of 26-27°C. A rise of the sea surface temperatures due to climate change is likely to be accompanied by an increase in cyclone frequency (IUCN, 2009).

**Figure 3.6: Natural disasters leading to conflict**

In view of the growing risks from storm and flood disasters, the German Advisory Council on Global Change (WBGU) has undertaken a study to determine in which historical cases such disasters had a positive or negative impact on violent conflict.

171 cases were identified and their impact on conflict examined using newspaper reports, disaster research literature and historical documents. In 13 cases a clear connection was established (see figure 3.6) between storm and flood disasters and an intensification of conflict, violent unrest and/or political crisis. In several cases, storm and flood disasters triggered domestic political crises.

1. Hurricane Hazel in Haiti, 1954
2. Typhoon in East Pakistan (current Bangladesh), 1970
3. Flooding and typhoon in Bangladesh, 1974
4. Flooding in Orissa (India), 1980
5. Flooding in Bihar (India), 1987
6. Flooding in Bangladesh, 1988
7. Hurricane Mitch in Nicaragua and Honduras, 1998
8. Flooding of the Yangtze in Anhui (China), 1998
9. Typhoon in Orissa and West Bengal (India), 1999
10. Flooding and landslides in Venezuela, 1999
11. Flooding in West Bengal (India), 2000
12. Hurricane Ivan in Haiti, 2004

Drury and Olson establish a clear relationship between disasters and political unrest. Although disasters can occasionally consolidate the political leadership in its position, as a rule disasters tend to heighten dissatisfaction with the ruling government. In disaster situations governments often lose their capacity to act. Any mismanagement and incompetence on the part of the government and the administration are likely to be ruthlessly exposed during and after disasters (Drury & Olson, 1998). These kinds of incidents marked the course of conflicts in Haiti (1954), East Pakistan (1970) and Bangladesh (1974 and 1988).

The temporary breakdown of state functions can be abused by a wide variety of groups for their own ends (e.g. looting by gangs). In such situations, the risk of armed uprisings by rebel groups tends to be low, because they are equally exposed to the organizational and logistical constraints imposed by

the natural disaster. Looting generally begins about 48 hours after the actual disaster (Ebert, 2006) and ends when state functions are restored. However, disaster-related breakdown of state functions does not necessarily bring looting and higher crime in its wake. There are more reports of a wave of mutual goodwill within affected societies and a fall in the crime rate (Fuentes, 2003; O’Leary, 2004). Inaccurate or distorted reports of looting and violence can result in the disproportionate use of security forces and harsh treatment of suspected perpetrators. A historical example that can be cited is the deployment of the army in Venezuela (1999), but security forces were similarly deployed in Bihar (1987), Anhui (1998) and New Orleans (2005). There is no known case in which foreign armies or rebel groups have exploited a natural disaster to mount an invasion.

In the conceptual framework, natural disaster as a consequence of climate change is considered an intermediate stage between climate change and violent conflict. The second hypothesis of this master thesis is therefore:

H2: Climate Change will lead to an increase of natural disasters in Bangladesh.

### **3.5 Social effects**

#### **3.5.1 Political Instability**

Social effects related to the consequences of climate change, scarcity of resources and natural disasters, could play an important role in today’s interstate en intrastate conflicts. The will and ability of the state to manage and solve resource competition are crucial in determining whether latent conflicts escalate to the use of violence (Buhaug et al., 2008). The majority of violent conflicts can be explained, at least partly, by scarcity of fundamental resources. There are several aspects to this. First, responses to the impact of resource degradation, by for example providing emergency shelter or compensation for crop losses are costly. Poor and institutionally weak regimes may simply not be able to respond in a manner that is satisfying for the population (Buhaug et al., 2008). Second, responses to disasters may affect the redistributive capacity of governments and drain attention and capital away from other important programs, like health, education, infrastructure, and security. Regimes may also seek to gain politically from adverse environmental developments by playing out social groups against each other. It has been argued that such ‘state exploitation’ behaviour is characteristic of several contemporary resource conflicts (Kahl, 2006). A weakened state may also give rise to opportunistic challengers who do not themselves suffer from worsened environmental conditions. Finally, political elections in systems with little tradition for democratic rules of

government are associated with enlarged levels of uncertainty and a higher risk of violence. Social tensions, including those emerging from climate-related degradation, are particularly likely to manifest themselves through anti-governmental movements during times of elections (Hegre et al., 2001).

There is substantial empirical evidence for a connection between political instability and increased risk of violent conflict. A recent comprehensive empirical evaluation of proposed conflict-inducing factors in the quantitative literature found political instability to be among the relatively few robust correlates of civil war (Hegre & Sambanis, 2006).

Given the robust and powerful statistical link between political instability and violent conflict, any systematic consequence of climate change for the type and quality of state institutions (e.g. loss of public support due to poor economic performance) is likely to have an indirect influence on the risk of violent conflict. The third and fourth hypotheses of this master thesis therefore are:

H3: Scarcity of resources will lead to political instability in Bangladesh.

H4: Increase of natural disasters will lead to political instability in Bangladesh.

### **3.5.2 Economic instability**

A second social effect related to the consequences of climate change that can cause violent conflict is economic instability. Food, freshwater, and soil insecurity affect the livelihood directly. This can result in poverty at the individual as well as the national level. Poverty (typically measured as low per capita income) has long been considered a major cause of civil war (Collier et al., 2003).

Political economists usually attribute the poverty-conflict association to factors that increase individuals' inclination to criminal behaviour relative to normal economic activity (Berdal & Malone, 2000; Collier & Hoeffler, 2004; Grossmann, 1991). Along this line of reasoning, poor opportunities for legal income earning, as well as food insecurity more generally, lower the threshold for joining a rebellion. Loss of livelihood in agricultural societies increases the pool of potential rebel recruits, resulting in a higher conflict risk. Climate change related events, such as more frequent droughts, floods, tropical cyclones, and degradation of agricultural land may decrease the expected returns to farming compared to joining criminal and insurgent groups (Mehlum et al., 2006). In addition, loss of income may force affected people to migrate, which constitutes a separate, indirect potential for population pressure, resource competition, and rebel recruitment (Raleigh et al., 2007). When the

income position of individuals is weakened, this also weakens the capacity of the state at a national level. Accordingly, the concentration of civil wars in poor countries is explained as much by unusually favourable conditions for insurgency, such as poor counter-insurgency capability, limited infrastructure, and lack of local governance. Further, a lack of economic growth reduces popular support for the regime. Poor economic performance means an increasing 'ingenuity gap' between the developed and the developing world, whereby the latter have less to spend on adaptive buffers against more extreme weather related events, such as more resilient infrastructure, irrigation systems, and desalinization plants for freshwater generation (Homer-Dixon, 1999).

If climate change results in increased poverty and widespread loss of livelihood, it's likely to have a substantial negative impact on prospects for (sustained) peace. The fifth and sixth hypotheses of this master thesis are therefore:

H5: Scarcity of resources will lead to economic instability in Bangladesh.

H6: Increase of natural disasters will lead to economic instability in Bangladesh.

### 3.5.3 Migration

A third social effect related to the consequences of climate change that can cause violent conflict is migration. There are different types of migration. Migration can be rapid or gradual, and migration can be permanent or temporary. The type of migration depends on the nature of the threat. For example, sudden alterations, such as from natural disasters, are more likely to cause temporary displacement. Migrants can also be divided into those who move only as far as necessary to avoid the immediate danger and those who travel long distances and (attempt to) settle in the safe, developed world.

Climate change related migration is argued to lead to violent conflict in receiving areas through at least three complementary processes (Reuveny, 2007). First, the arrival of newcomers can lead to competition over diminishing natural and economic resources, especially if property rights are underdeveloped. Second, a wave of migrants of a different ethnic origin than the local population may give rise to ethnic tension and solidification of identities. Third, large flows of migrants may cause mistrust between the sending and receiving state.

While there is some evidence for a link between transnational refugee flows and the outbreak of violent conflict (Buhaug & Gleditsch, 2008; Salehyan, 2007), it is not obvious that environment-

induced population flows will have the same security implications for the host population as migrants escaping armed violence. Due to data limitations and lack of conceptual clarity, no empirical study has been able to explore the general consequences of 'environmental migration' across cases. Nevertheless, the seventh and eighth hypothesis of this master thesis are:

H7: Scarcity of resources will lead to migration in Bangladesh.

H8: Increase of natural disasters will lead migration in Bangladesh.

### **3.6 Violent conflict**

In the conceptual framework the social effects political instability, economic instability, and migration related to the consequences of climate change could cause violent conflict. In the conceptual framework a distinction has been made between intrastate (conflict within a state, civil war) and interstate (conflict between two or more countries) conflict. According to the UCDP/PRIO Armed Conflict Dataset Bangladesh historically has had two conflicts. The first one is the war of independence against (West) Pakistan, the second the conflict in the Chittagong Hill Tract between 1974 and 1997.

Social effects, like political instability, economic instability, and migration related to the consequences of climate change could cause violent conflict. The ninth hypothesis is therefore:

H9: Political instability, economic instability, and migration caused by the consequences of climate change will lead to intrastate and interstate conflict in Bangladesh.

## 4 Methodology

### 4.1 Method of research

In this study we explore the relationship between climate change and violent conflict in Bangladesh. The aim is to discover if a change of climate could cause violent conflict in Bangladesh. The conceptual framework (see figure 3.1) describes the possible pathway from climate change to violent conflict. Based on this conceptual framework nine hypotheses are formulated. The nine hypotheses each explore an intermediate step between climate change and violent conflict. In the next chapter the formulated hypotheses will be tested. To test the hypotheses, the main variables from the conceptual framework are grouped. There are five main groups of variables and sixteen subgroups. Table 4.1 shows the main- and subgroups of variables.

**Table 4.1: Main- and subgroups of variables**

Groups of variables	Sub-groups
<b>Climate change</b>	Temperature change, precipitation change, Sea level rise, Mega events
<b>Scarcity of resources</b>	Scarcity of food, scarcity of freshwater, scarcity of soil
<b>Natural disasters</b>	Natural disasters, tropical cyclones, floods, storms
<b>Social effects</b>	Political instability, economic instability, migration
<b>Violent conflict</b>	Intrastate conflict, interstate conflict

The main- and subgroups of variables are represented by one or more indicators. The indicators are representative for the variables. Table 4.2 shows the main- and subgroups and the indicators. The indicators include historical quantitative data on the subject.

**Table 4.2: Indicators of main- and subgroups**

Variable	Elements	Indicator	Description	Source
<b>Climate Change</b>	<b>Temperature change</b>	Temperature anomaly	An anomaly is a deviation from a typical or normal condition. A temperature anomaly could be expresses the difference between an unusually low temperature measured at an oceanographic station on one date and an average temperature for that same station based on many years of data.	NASA Goddard Institute for Space Studies (GISS), Columbia University
		Average temperature changes in Bangladesh	Average temperature changes in Bangladesh	Bangladesh Meteorological Department (BMD)
	<b>Precipitation change</b>	Average rainfall in Bangladesh	Average rainfall in Bangladesh	International Union for Conservation of Nature (IUCN)
	<b>Sea level rise</b>	Global average sea level rise	Global average sea level rise	Fourth Assessment Report (AR4)of the Intergovernmental Panel on Climate Change (IPCC)
		Average annual mean sea level Bangladesh	The average is based on the annual measurements of sea level of four measuring stations (Cox's Bazaar, Khepupara, Charchanga, and Hiron Piont) across the coastline of Bangladesh from 1979 until 2003.	Permanent Service Mean Level (PSMSL) database from the Proudman Oceanographic Laboratory.



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	<b>Mega Events</b>	Number of floods in Bangladesh	Significant rise of water level in a stream, lake, reservoir or coastal region	EM-DAT, The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)
		Extreme temperatures and droughts in Bangladesh	A drought is an extended period of time characterised by a deficiency in a region's water supply that is the result of constantly below average precipitation. A drought can lead to losses to agriculture, affect inland navigation and hydropower plants, and cause a lack of drinking water and famine.	EM-DAT, The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)
<b>Scarcity of resources</b>	<b>Scarcity of food</b>	Food production index	Food production index covers food crops that are considered edible and that contain nutrients. Coffee and tea are excluded because, although edible, they have no nutritive value.	Worldbank, 2009: World Development Indicators, DPP Quick Query
		Crop production index	Crop production index shows agricultural production for each year relative to the base period 1999-2001. It includes all crops except fodder crops. Regional and income group aggregates for the FAO's production indexes are calculated from the underlying values in international dollars, normalized to the base period 1999-2001	Worldbank, 2009: World Development Indicators, DPP Quick Query
	<b>Scarcity of freshwater</b>	Renewable internal freshwater resources (billion cubic meter)	Renewable internal freshwater resources flows refer to internal renewable resources (internal river flows and groundwater from rainfall) in the country.	Aquastat Database Query, Food and Agricultural organization of the United Nations (FAO)
		Renewable internal freshwater resources per	Renewable internal freshwater resources flows refer to internal renewable resources (internal river flows and groundwater from rainfall) in the country. Renewable internal freshwater resources per	Aquastat Database Query, Food and Agricultural organization of the United

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		capita (cubic meters)	capita are calculated using the World Bank's population estimates.	Nations (FAO)
	<b>Scarcity of agricultural land</b>	Agricultural land in Bangladesh (sq. Km)	Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures.	Worldbank, 2009: World Development Indicators, DPP Quick Query
<b>Natural disasters</b>	<b>Natural disasters</b>	Number of natural disasters is Bangladesh	Natural disaster, at least one of the following criteria: - Ten or more people reported killed. - Hundred or more people reported affected. - Declaration of a state of emergency. - Call for international assistance.	EM-DAT, Centre for Research on the Epidemiology of Disasters (CRED)
	<b>Tropical cyclones</b>	Number of tropical disturbances	A tropical cyclone is a non-frontal storm system that is characterised by a low pressure center, spiral rain bands and strong winds. Usually it originates over tropical or sub-tropical waters.	International Union for Conservation of Nature (IUCN)
		Number of days with tropical disturbances	A tropical cyclone is a non-frontal storm system that is characterised by a low pressure center, spiral rain bands and strong winds. Usually it originates over tropical or sub-tropical waters.	International Union for Conservation of Nature (IUCN)
<b>Social effects</b>	<b>Political instability</b>	Voice and accountability	Extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media	Worldwide Governance Indicators, World Bank, 2009
		Political stability and absence of violence	The perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including domestic violence and terrorism	Worldwide Governance Indicators, World Bank, 2009
		Government	The quality of public services, the quality of the civil service and the	Worldwide Governance

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		effectiveness	degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies	Indicators, World Bank, 2009
		Regulatory quality	The ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development	Worldwide Governance Indicators, World Bank, 2009
		Rule of law	The extent to which agents have confidence in and abide by the rules of society, in particular the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence	Worldwide Governance Indicators, World Bank, 2009
		Control of corruption	The extent to which public power is exercised for private gain, including petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.	Worldwide Governance Indicators, World Bank, 2009
	<b>Economic instability</b>	Gross Domestic Product (\$ millions)	The gross domestic product (GDP) is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad.	World Bank, 2009: World Development Indicators, DPP Quick Query
		Gross Domestic Product per capita (\$)	GDP per capita, converted to U.S. dollars using the World Bank Atlas method, divided by the midyear population.	World Bank, 2009: World Development Indicators, DPP Quick Query
	<b>Migration</b>	Overseas employment	Number of Bangladesh citizens that went overseas for employment in 2009.	Bureau of Manpower Employment and Training (BMET)

## **4.2 Data collection**

The data is collected using open sources. A limitation of this study is that it depends on the availability of the data. Not all required historical data is available. The used sources are mainstream accepted datasets. The climate change indicators are, for example, mainly based on the sources used in the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC). Data on scarcity of resources is based on the World Development Indicators from the World Bank and the Aquastat Database Query from the Food and Agricultural Organization of the United Nations (FAO). Data from the EM-DAT database of the Centre for Research on the Epidemiology of Disasters (CRED) is used for the indicators of natural disasters. The data on political instability is based on the Worldwide Governance Indicators of the World Bank. The timelines of the datasets differ. This is also caused by the fact that the study depends on availability of open sources.

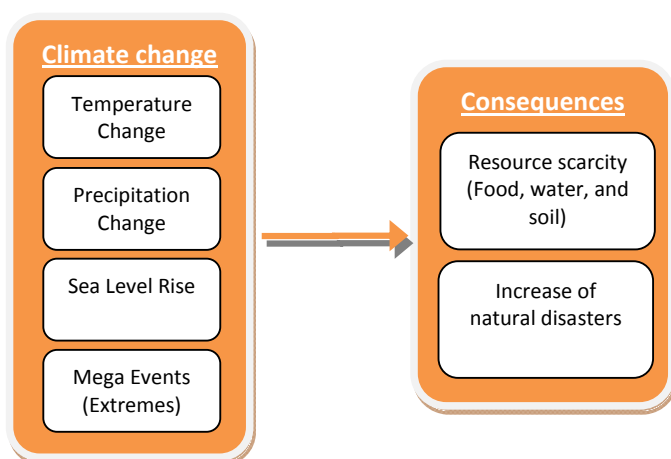
## **4.3 Correlation Analysis**

The indicators represent the main- and subgroups of variables in the conceptual framework. The next step is to explore the relationship between the groups of variables. The relationship between the variables can be measured with a correlation analysis. Correlation analysis measures the strength of the linear association between two variables (Mann, 1995). The linear correlation coefficient measures how closely the points in a scatter diagram are spread around the regression line (Mann, 1995). In a situation where the correlation between two variables is positive and close to 1, it is assumed that the variables have a strong positive linear correlation. If the correlation between two variables is positive but close to zero, then the variables have a weak positive linear correlation. On the other hand, if the correlation between two variables is negative and close to  $-1$ , then the variables are assumed to have a strong negative correlation. Again, if the correlation between variables is negative but close to zero, that means a weak negative correlation exists between the variables. The abbreviation of the correlation coefficient is  $R$ .

## 5 Analysis and results

### 5.1 Climate change

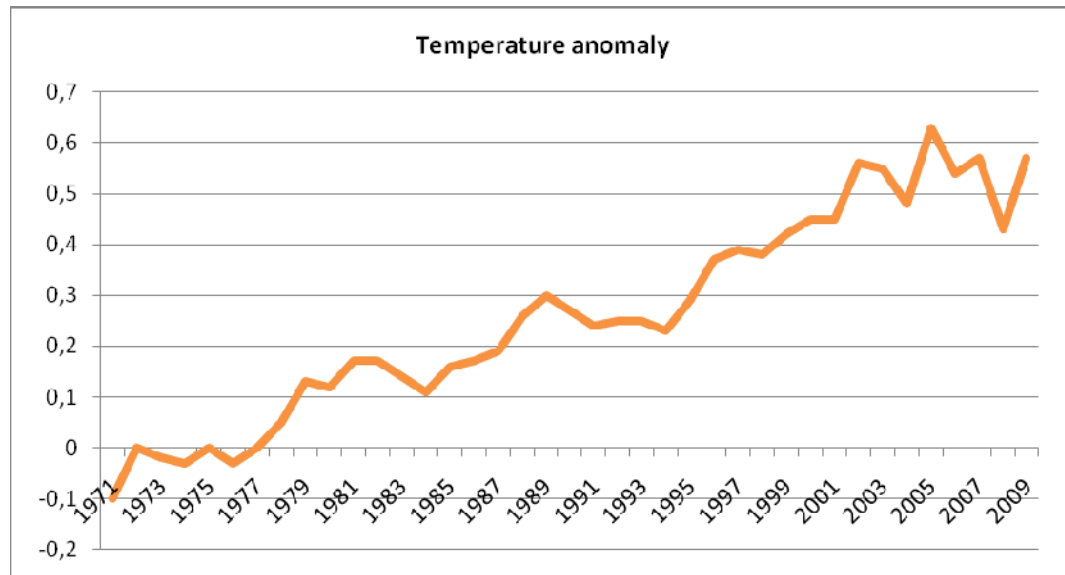
The first relationship that we will explore is the relationship between climate change and the consequences of climate change, being scarcity of resources and increase of natural disasters. The first step of the analysis of this relationship is to explore the historical development of the climate in Bangladesh. In the next paragraphs we will analyse the temperature change, precipitation change, sea level rise, and mega events in Bangladesh.



#### 5.1.1 Temperature change

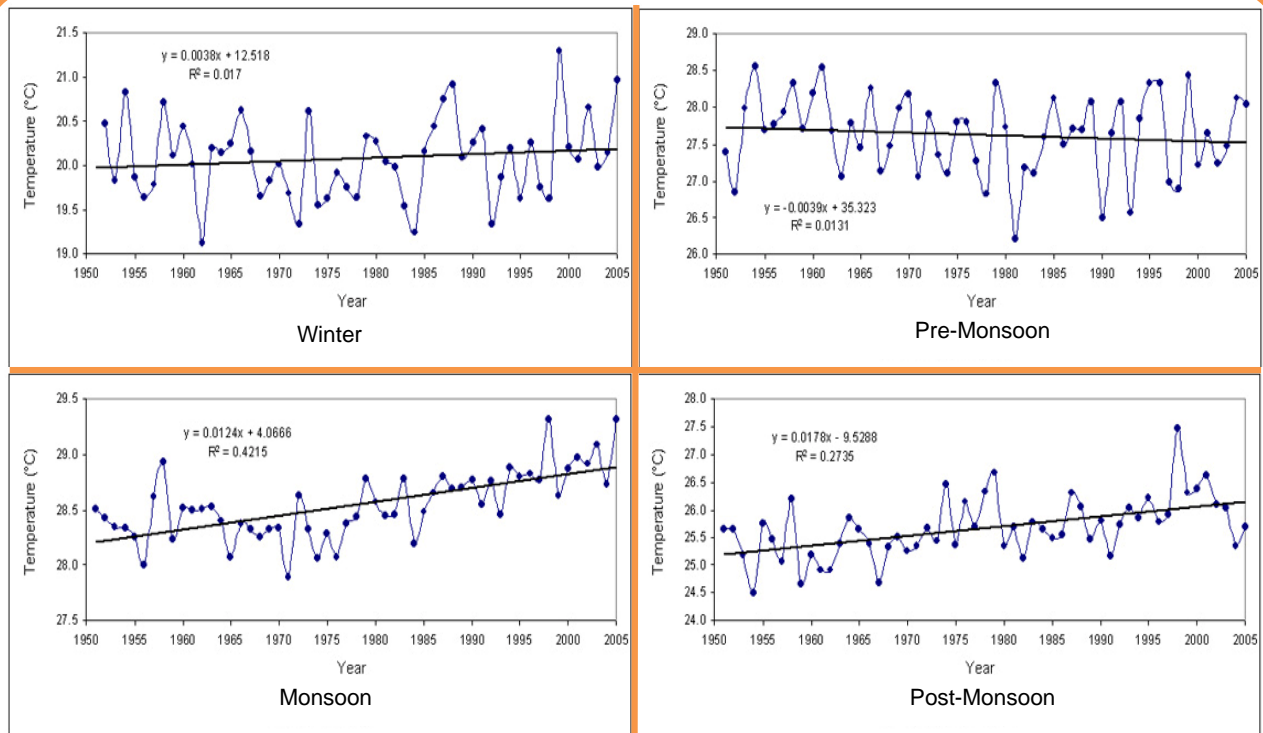
Eleven of the twelve years between 1995 and 2006 rank among the twelve warmest years in the instrumental record of global surface temperature since 1850 (IPCC, 2007). Figure 5.1 shows the temperature anomaly during the past forty years. This overview is used by the IPCC and concerns only temperature anomalies, not absolute temperature. Temperature anomalies are computed relative to the base period 1951-1980. The reason to work with anomalies, rather than absolute temperature is that absolute temperature varies markedly in short distances, while monthly or annual temperature anomalies are representative of a much larger region (Hansen & Lebedeff, 1987). According to the IPCC, the temperature increase is widespread over the globe. Land regions have warmed faster than the oceans. Observations since 1961 show that the average temperatures of the global ocean have increased to depths of at least 3,000m and that the ocean has been taking up over 80 percent of the heat being added to the climate system (IPCC, 2007).

Figure 5.1: Temperature anomaly



Source: NASA Goddard Institute for Space Studies (GISS), Columbia University

Figure 5.2 shows the average temperature changes in Bangladesh in the four seasons (winter, pre-monsoon, monsoon, post-monsoon) from 1950 until 2005. Unfortunately the datasets from the Bangladesh Meteorological Department (BMD) were not available. Analysis is only possible based on the pictures of figure 5.2. In the remaining of this master thesis the dataset of the global temperature anomaly of the NASA Goddard Institute for Space Studies (GISS) will be used. Temperatures vary highly from year to year in Bangladesh. Based on figure 5.2 there appears to be a rise in average temperatures in the monsoon and post-monsoon seasons during the last fifty years. The average winter season temperature has remained stable. The average pre-monsoon season temperature has declined.

**Figure 5.2: Average temperature change Bangladesh**

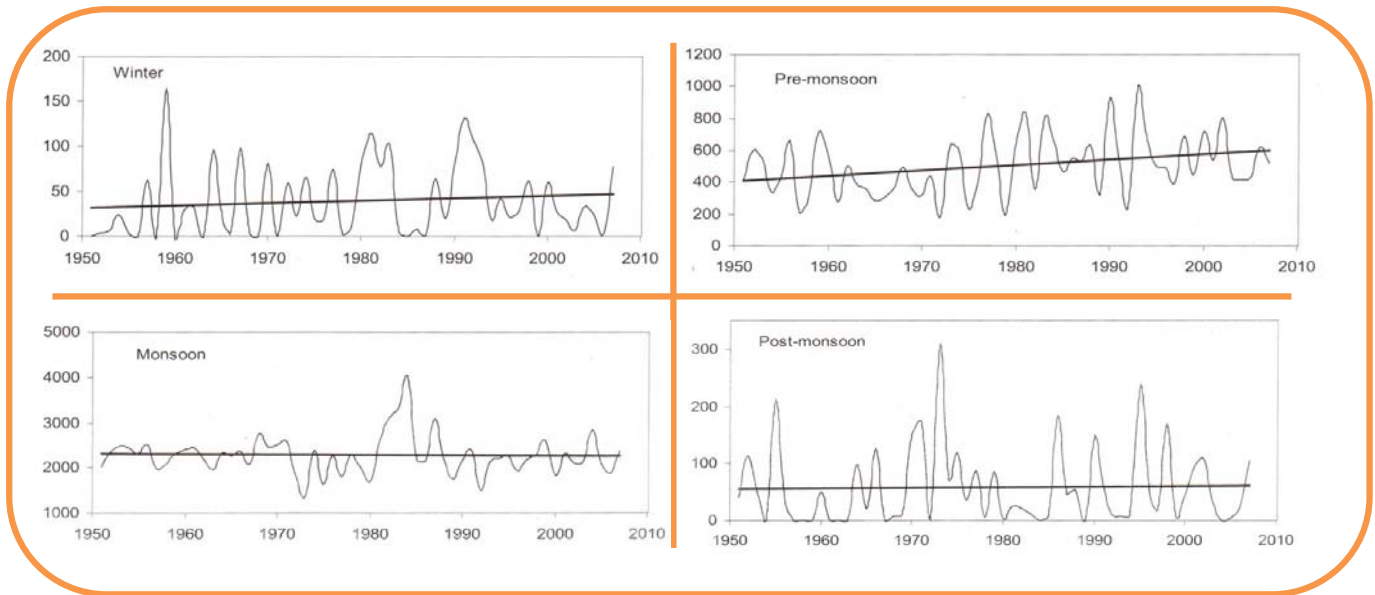
Source: Bangladesh Meteorological Department (BMD)

**5.1.2 Precipitation change**

According to the IPCC the precipitation trends from 1900 to 2005 have changed in many large regions. Over this period, precipitation increased significantly in eastern parts of North and South America, northern Europe and northern and central Asia, whereas precipitation declined in the Sahel, the Mediterranean, southern Africa and parts of southern Asia. Globally, the area affected by droughts has likely increased since 1970 (IPCC, 2007). Figure 5.3 shows the average rainfall in Bangladesh in the four seasons during the period from 1950 until 2005. These graphics are adopted from a report of the International Union for Conservation of Nature (IUCN) from 2009.

Unfortunately, the datasets from the IUCN were not available. Rainfall varies highly from year to year in Bangladesh. Based on the graphics, there appears no significant change in average annual rainfall over the last fifty years. Only in the pre-monsoon season there has been a slight increase in rainfall.

**Figure 5.3: Average rainfall in Bangladesh**

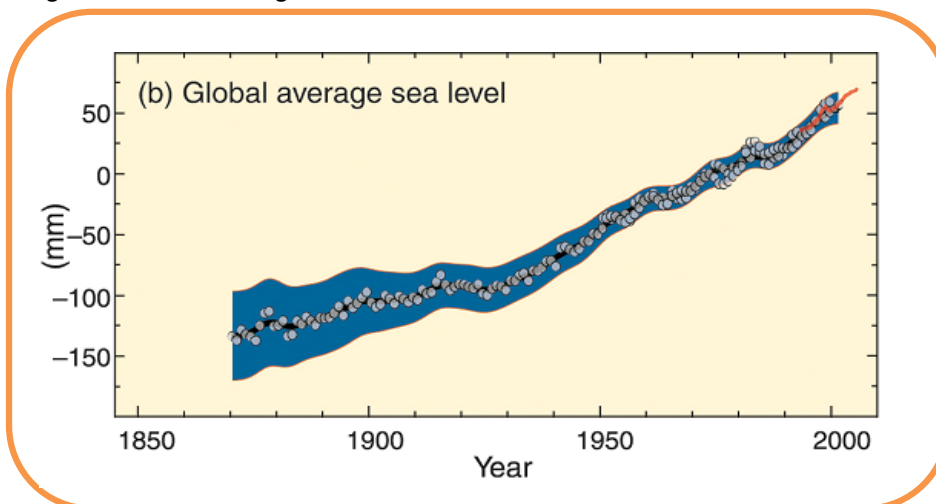


Source: International Union for Conservation of Nature (IUCN)

### 5.1.3 Sea level rising

According to the IPCC increases in sea level are consistent with global warming. Global average sea levels rose at an average rate of 1.8 [1.3 to 2.3] mm per year over 1961 to 2003 and at an average rate of about 3.1 [2.4 to 3.8] mm per year from 1993 to 2003. Since 1993 thermal expansion of the oceans has contributed about 57 percent of the sum of the estimated individual contributions to the sea level rise, with decreases in glaciers and ice caps contributing about 28 percent and losses from the polar ice sheets contributing the remainder.

**Figure 5.4: Global average sea level rise**

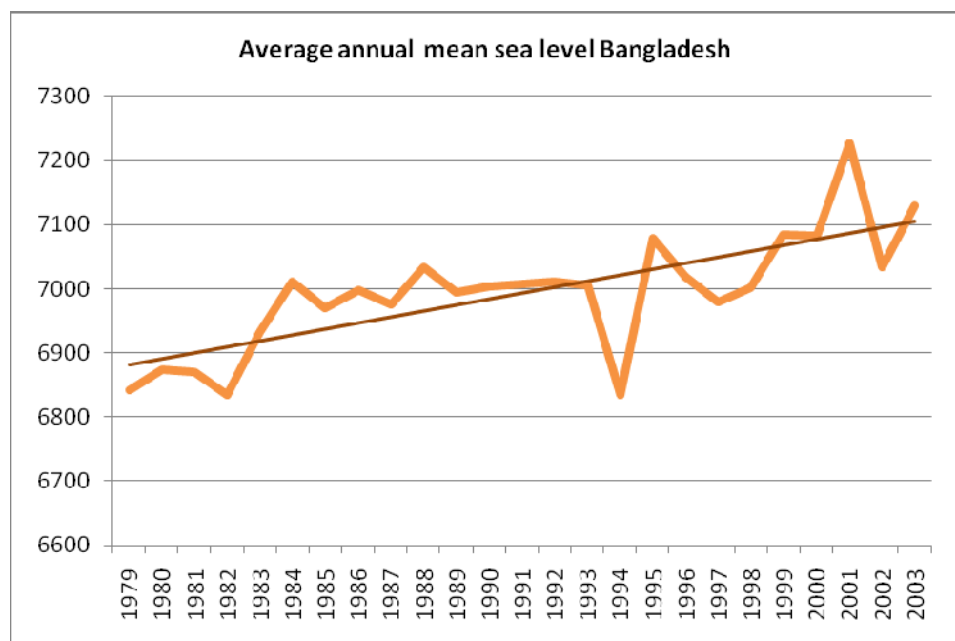


Source: Fourth Assessment Report of the Intergovernmental Panel on Climate Change



To get a specific view of the rising of the sea levels in Bangladesh, an average mean sea level is calculated based on the Permanent Service Mean Level (PSMSL) database from the Proudman Oceanographic Laboratory. The Proudman laboratory collects mean sea level data from measure stations all over the World. Four measure stations are located in Bangladesh. The average is based on the annual measurements of mean sea level of four measuring stations (Cox's Bazaar, Khepupara, Charchanga, and Hiron Piont) across the coastline of Bangladesh from 1979 until 2003. Figure 5.5 shows the average annual mean sea level in Bangladesh.

**Figure 5.5: Average annual mean sea level Bangladesh**



Source: Permanent Service Mean Level (PSMSL) database, Proudman Oceanographic Laboratory

Figure 5.5 shows that the average mean sea level in de Bay of Bengal has risen from 1979 until 2003. This is in line with the global sea level rise.

#### 5.1.4 Mega events

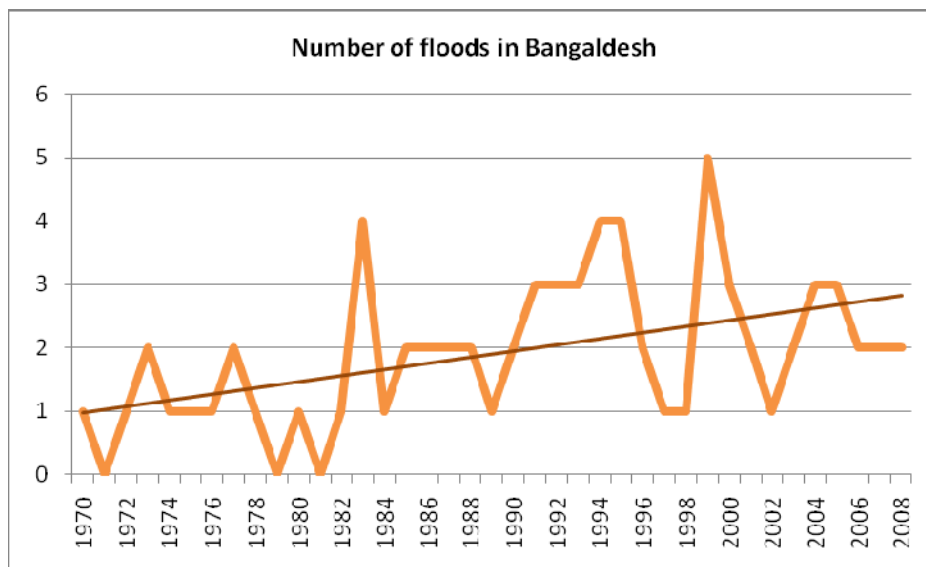
According to the IPCC some extreme weather events have changed in frequency and/or intensity over the last 50 years. Cold days, cold nights and frosts have become less frequent over most land areas, while hot days and hot nights have become more frequent (IPCC, 2007). Heat-waves have become more frequent over most land areas. According to the EM-DAT database of the Centre for Research on the Epidemiology of Disasters (CRED) there have been 4 major drought periods in Bangladesh. Table 5.1 shows the number of affected people by extreme temperatures and droughts period from 1970 until 2009.

**Table 5.1 Extreme temperatures and drought periods in Bangladesh**

Year	Number of affected people	
	Extreme temperatures	Drought periods
1974		0
1979		20,000,000
1983		5,000,000
1989		25,000,000
1998	34,000	
2002	50,000	
2005	1,000	
2007	100,000	
2009	110,000	

Source: EM-DAT, The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

This table does not provide evidence for a change of frequency extreme temperatures and drought periods in Bangladesh. These events occur, but based on these data we cannot conclude that there is an increase or decrease. In Bangladesh there has been an increase in the number of floods. Figure 5.6 shows the number of floods in Bangladesh in the period of 1970 until 2008. Figure 5.6 shows an increase of the average annual number of floods in Bangladesh from one to three, between 1970 and 2008.

**Figure 5.6: Number of floods in Bangladesh**

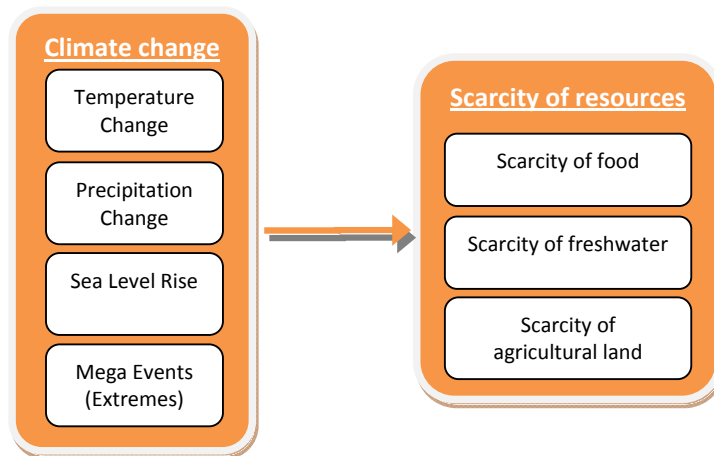
Source: EM-DAT, The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

### 5.1.5 Results

The climate in Bangladesh is changing. The last fifty years temperatures have risen in the monsoon and post-monsoon seasons. The average winter season temperature has remained stable. The average pre-monsoon season temperature has declined. Globally the temperature has risen. There appears no significant change in average annual rainfall over the last fifty years. Only in the pre-monsoon season there has been a slight increase in annual rainfall. The annual rainfall varies highly from year to year. Based on the available data it is not possible to conclude that precipitation patterns have changed in Bangladesh. The average mean sea level in de Bay of Bengal has risen from 1979 until 2003. This rise of sea level is in line with the global sea level rise. There is no evidence for a change of frequency of extreme temperatures or drought periods. There is a significant increase of the number of floods in Bangladesh. Since 1970 the average number of floods has increased from one to three a year.

### 5.2 Climate change and resource scarcity

The next step is to analyse the relationship between climate change and the scarcity of resources in Bangladesh. Has a change of climate effect on the availability of resources like food, freshwater and agricultural land. In paragraph 5.1 we concluded that the temperature in Bangladesh has risen, the sea level has risen, and the number of floods has increased. In this paragraph we will compared these findings with the change in availability of food, freshwater, and agricultural land. The aim is to find a relation between climate change and scarcity of resources.

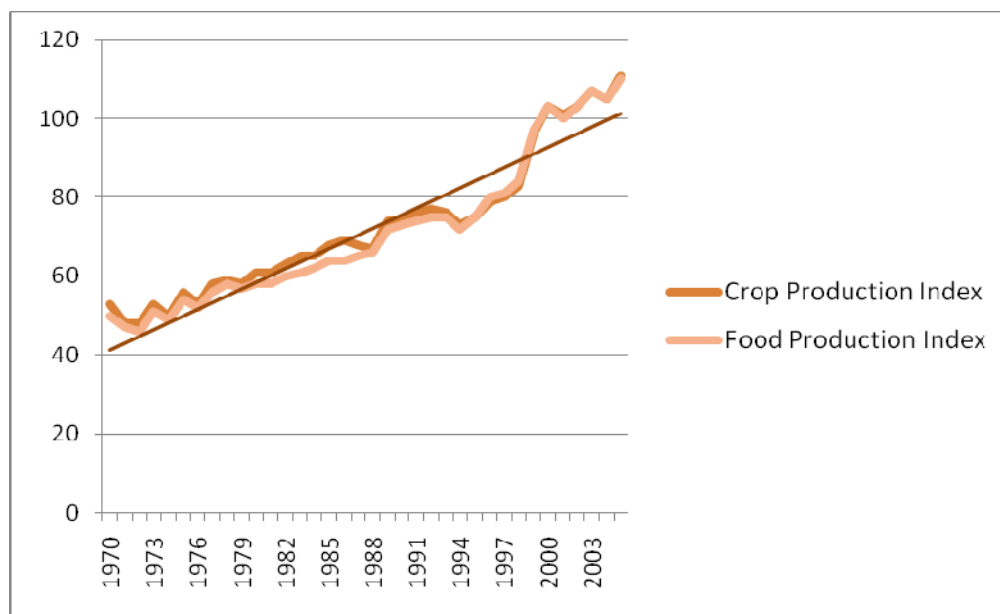


Hypothesis 1 suggests that there is a relationship between the climate change in Bangladesh and the availability of food, freshwater, and agricultural land. Paragraph 5.1 shows that the climate in Bangladesh has changed during the last fifty years. To verify this hypothesis, this should lead to a decrease of food, freshwater and agricultural land.

### 5.2.1 Scarcity of food

To analyse the availability of food in Bangladesh, we will look at the food production- and crop production indexes. The food and crop production indexes are the indicators for the 'scarcity of food'. Figure 5.7 shows the food and crop production indexes for Bangladesh from 1970 until 2005. The 'Food production index' covers food crops that are considered edible and that contain nutrients. The 'Crop production index' shows agricultural production for each year relative to the base period 1999-2001.

**Figure 5.7: Food and Crop production Index**



Source: World Bank, 2009: World Development Indicators, DPP Quick Query

Both the production of food and the production of crops have increased in Bangladesh from 1970 until 2005. In this period of time the temperature and sea level has risen in Bangladesh. There is a strong correlation between the temperature anomaly and the food production index ( $R=0.96$ ) and the crop production index ( $R=0.96$ ). This suggests that there is a positive relation between these variables. When the temperatures rise, the food and crop production increases in Bangladesh. There is a weak correlation between the sea level rising and the food production index ( $R=0.77$ ) and the crop production index ( $R=0.75$ ). The correlation coefficient suggests that there is a positive relationship between the two variables. When the sea level rises, the production of food and crops rises. There is no correlation between the increasing number of floods and the food production index

( $R=0,47$ ) or the crop production index ( $R=0,46$ ). Based on these indicators there is no relationship between the increasing number of floods and the production of food and crops.

### 5.2.2 Scarcity of freshwater

Freshwater is the second resource that could become scarce because of a change in climate. In this paragraph we will compare the climate change indicators with the availability of freshwater. It is plausible that there is a relationship between the climate change indicators and the availability of freshwater. A rising of the sea level and an increase of floods could reduce the freshwater availability due to salinity intrusion. If saline water intrudes in freshwater, it becomes impossible to consume. The data regarding freshwater resources in Bangladesh is limited. Table 5.3 shows the renewable internal freshwater resources in Bangladesh.

**Table 5.2: Renewable internal freshwater resources**

Year	Renewable internal freshwater resources (cubic meter)	Renewable internal freshwater resources per capita (cubic meters)
1972	105 billion	1.440
1977	105 billion	1.259
1982	105 billion	1.101
1987	105 billion	972
1992	105 billion	870
1997	105 billion	789
2002	105 billion	720
2007	105 billion	666

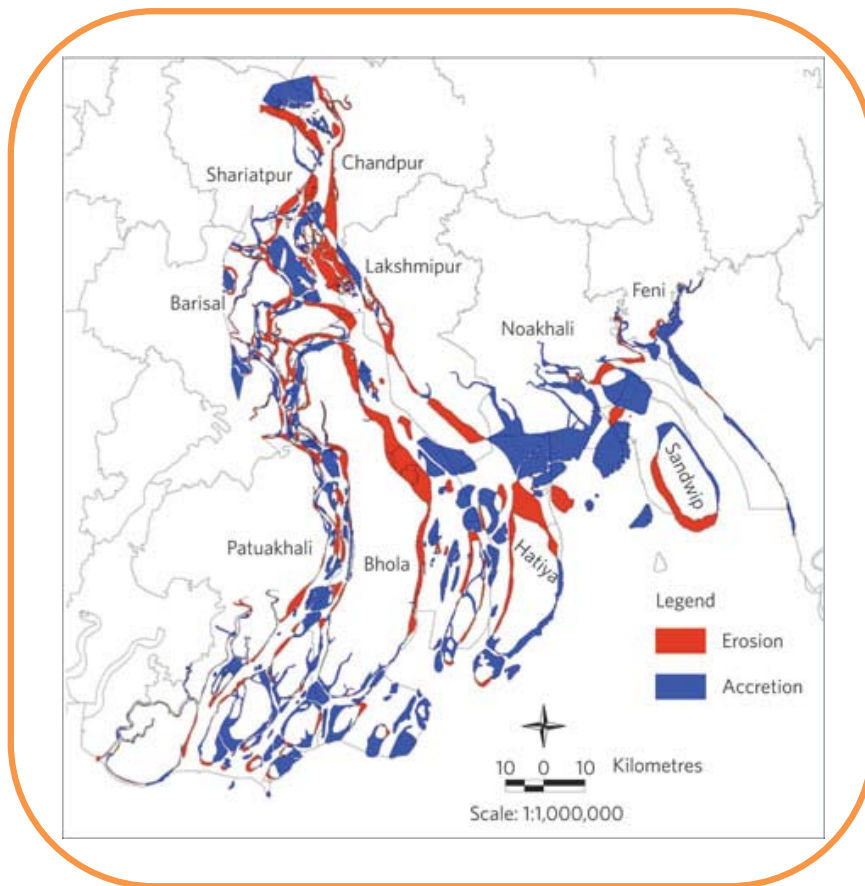
Source: Aquastat Database Query, Food and Agricultural organization of the United Nations (FAO)

According to the Aquastat database the renewable internal freshwater resources have not changed from 1972 until 2007. As we have seen in paragraph 5.1, the climate change indicators have changed in this period. There appears no relationship between the change of climate and the availability of freshwater. Per capita freshwater resources have decreased since 1972. It is more likely that this is caused by a growing population. There is not relation between climate change and a growing population. It's therefore unlikely that a decrease of freshwater resources per capita is related to climate change. Based on the available data, there is no link between climate change and scarcity of freshwater resources.

### 5.2.3 Scarcity of agricultural land

A third resource that could become scarce because of climate change is agricultural land. Before analysing the agricultural land, two misconceptions regarding soil in Bangladesh will be addressed. The first misconception is that a rising sea level would permanently incorporate large areas of Bangladesh. According to the World Bank a rise of the sea level of one-metre would swallow about 17 percent of the of Bangladesh's land area, where about 20 million people live today (Worldbank, 2000). According to the International Union for Conservation of Nature (IUCN), one of the leading environmental organizations in Bangladesh, this estimate is misleading because it doesn't factor in the embankments that protect much of the coast (IUCN, 2009).

**Figure 5.8 Erosion and accretion on Bangladesh**



Source: Courtesy of Maminul Haque Sarker and CEGIS.

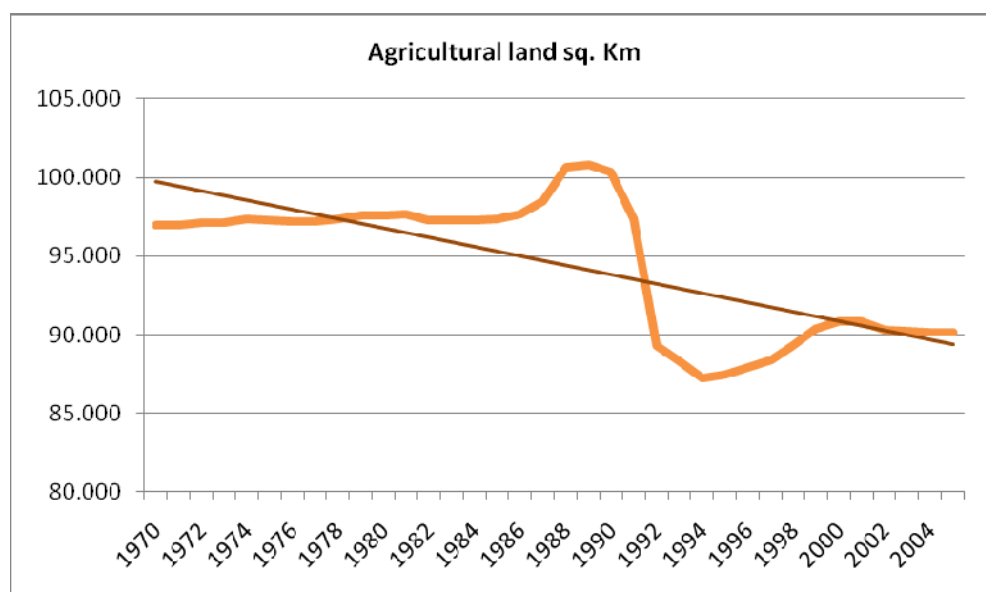
The second misconception is that coastal areas of Bangladesh are diminishing due to riverbank and coastal erosion. According to Haque, Bangladesh has a dynamic coastline. Some areas erode, and because of the sediments settling along the coast new land is created. Bangladesh's delta is now

expanding. Every year nearly 20 square kilometres is added to the coastal areas (CEGIS, 2008). Figure 5.8 shows the erosion and accretion along the Bangladeshi coastline from 1973 to 2005, based on an analysis of satellite images. Bangladesh has been gaining land for decades. The erosion and accretion are almost in balance. Bangladesh has a dynamic coastline. Land is lost and gained at the same time.

In this paragraph we explore the relationship between the climate change indicators and the availability of agricultural land. Bangladesh is gaining land, but not all land is arable. Agricultural land refers to the share of land area that is arable, with permanent crops and with permanent pastures.

Figure 5.8 shows the total surface of agricultural land from 1970 until 2004.

**Figure 5.9: Agricultural land in Bangladesh**



Source: World Bank, 2009: World Development Indicators, DPP Quick Query

Since 1970 agricultural land in Bangladesh has decreased. From 1970 until 1990 the surface of agricultural land remained steady. In the early 1990s a major decrease in surface of agricultural land in Bangladesh can be observed. The amount of agricultural land does not correlate with the rising of temperature ( $R=-0.63$ ), the rising of the sea level ( $R=-0.34$ ), or the increase of the number of floods ( $R=-0.48$ ). The change of climate cannot explain the major decrease of agricultural land in the 1990s. An alternative explanation can be the emergence of a great number of shrimp farms in the early 1990s. Nowadays, there are 60 shrimp hatcheries and 124 shrimp processing plants in the coastal zone (Haque, 2003). Shrimps are exported abroad and bring in foreign currency into Bangladesh. In order to cultivate shrimps, agricultural land is intruded with saline water. This makes the land useless for agriculture.

#### 5.2.4 Results

Hypothesis 1 suggests that there is a relation between climate change and the scarcity of resources like food freshwater and agricultural land.

H1: Climate change will lead to scarcity of resources in Bangladesh.

According to this hypothesis, a change of climate will lead to a degradation of resources like food, freshwater and agricultural land. This degradation can lead to a scarcity of these resources. In paragraph 5.1 we concluded that the climate in Bangladesh is changing. The temperature has risen, the sea level has risen, and the number of floods has increased. The indicators for these changes are the temperature anomaly, the average annual mean sea level, and the number of floods. These indicators are compared with the indicators representing the availability of food, freshwater and agricultural land.

The food and crop production in Bangladesh has increased from 1970 until 2005, according to the World Bank food and crop production indexes. There is a positive relation between the temperature anomaly and the food and crop production. If the temperature rises, the food and crop production increases. There is a weak relationship between the rising of the sea level and the food and crop production. This relationship is also positive. If the sea level rises, the food and crop production increases. Both effects contradict hypothesis 1. There is no relation between the increase of the number of floods and the food and crop production. The available freshwater resources in Bangladesh have remained stable at 105 billion cubic meters from 1972 until 2007. There is no relation between the change of climate and the availability of freshwater. Although the amount of agricultural land in Bangladesh has decreased since 1970, there is no relationship with the rising temperature, the rising sea level or the increase on the number of floods. The degradation of agricultural can more likely be explained by the emergence of large scale shrimp farming in the 1990s. Table 5.4 shows an overview of the correlations between the climate change indicators and the scarcity of resources indicators.



**Table 5.3 Correlation analysis climate change and scarcity of resources**

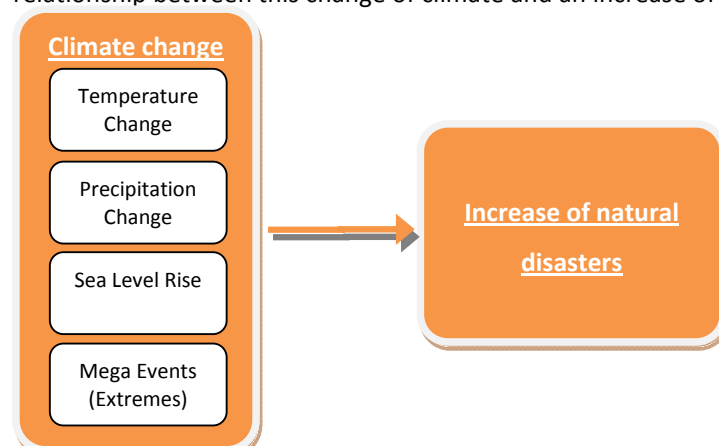
Scarcity of resources Climate change	Food production index	Crop production Index	Renewable internal freshwater resources	Agricultural Land
<b>Temperature change</b>				
- Temperature anomaly	0.96	0.96	*	-0,63
<b>Precipitation change</b>				
- Average rainfall	*	*	*	*
<b>Sea level rise</b>				
- Average annual mean sea level	0.77	0.75	*	-0,34
<b>Mega Events</b>				
- Number of floods	0,46	0,47	*	-0,48
- Drought periods	*	*	*	*

\* No data available for correlation analysis

Based on the historic data there is no evidence that there is a relationship between climate change and a scarcity of resources like food, freshwater and agricultural land in Bangladesh. Since 1970 the change of climate has not led to degradation or scarcity of resources. There is no reason to believe that it will in the next years. Based on these findings we reject hypothesis 1.

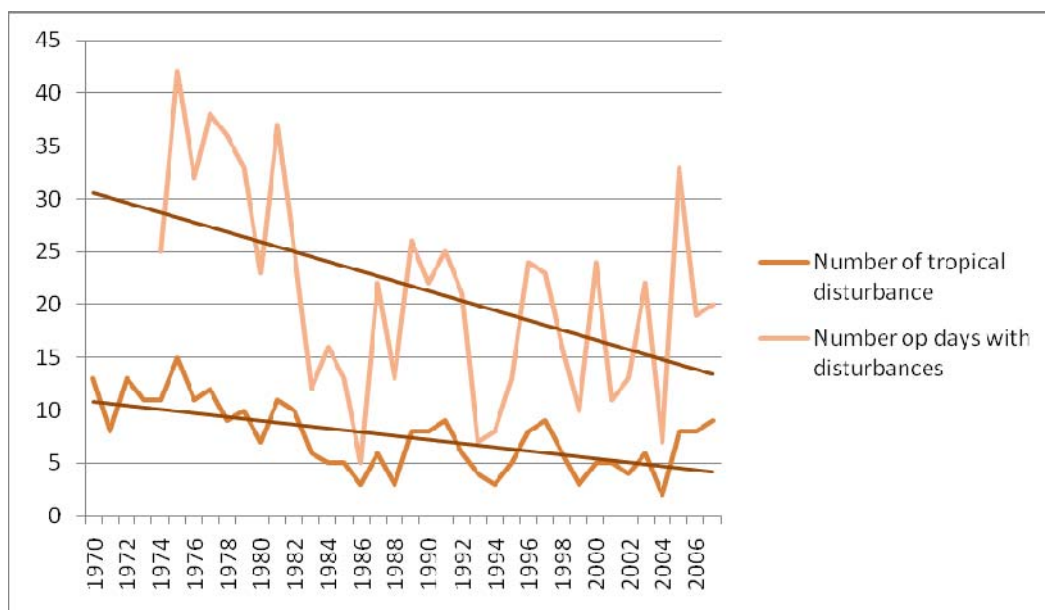
### 5.3 Climate change and natural disasters

The second hypothesis of this Master Thesis suggests a link between climate change and an increase of natural disasters. Can a change of climate cause an increase of natural disasters in Bangladesh? In paragraph 5.1 we concluded that the temperature in Bangladesh has risen, the sea level has risen, and the number of floods has increased. In the next paragraph we will analyse if there is a relationship between this change of climate and an increase of natural disasters.



According to the UNDP Bangladesh is the most vulnerable country for tropical cyclones (UNDP, 2004). Tropical cyclones are one of the types of natural disaster that is expected to increase related to a change of climate. One necessary condition for tropical cyclone formation is a sea surface temperature of a minimum of 26-27°C. A rise of the sea surface temperatures and a rising sea level due to climate change could increase the tropical cyclone frequency (IUCN, 2007). Theoretically a rise of the temperatures would enlarge the period of time that the sea surface temperature of the Bay of Bengal is above 26°C. This creates a longer 'window of opportunity' for tropical cyclones formation. Figure 5.9 shows the number of tropical disturbances and the number of days with tropical disturbances.

**Figure 5.10: Number of tropical disturbances and number of days with tropical disturbances**



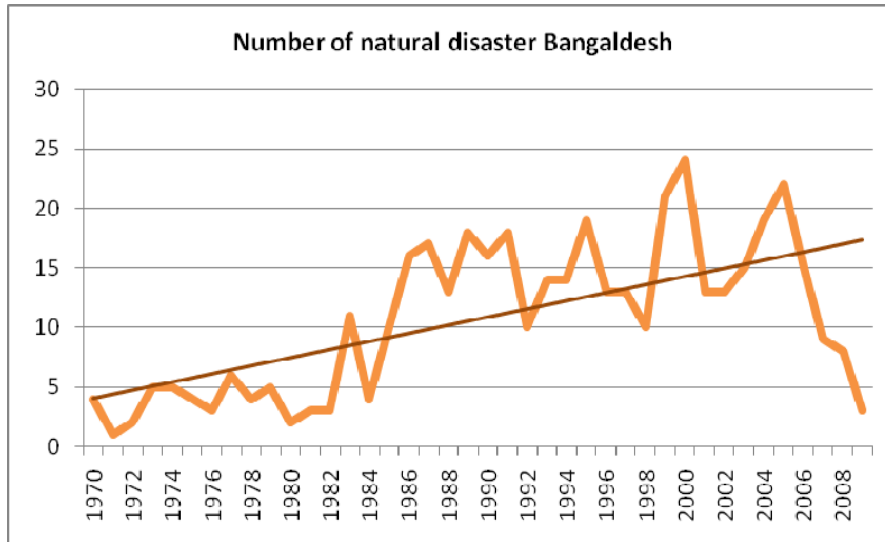
Source: International Union for Conservation of Nature (IUCN), Tropical Cyclones: Impact on Coastal Livelihoods

The trend lines for the number of disturbances as well as the number of days with tropical disturbance go down from 1970 until 2006. There is no correlation between the temperature anomaly and the number of tropical disturbances ( $R=0,49$ ) or the number of days of tropical disturbances ( $R=0,36$ ). There is also no correlation between the average annual sea level and the number of tropical disturbances ( $R=-0,44$ ) or the number of days of tropical disturbances ( $R=-0,35$ ).

Figure 5.9 shows the total number of natural disasters in Bangladesh from 1970 until 2008. The number of natural disasters varies annually. The average number of natural disasters has increased since 1970. There is weak evidence that the increase of the number of natural disasters is related to

the climate change indicators. The correlation between the number of natural disasters and temperature anomaly ( $R=0,60$ ) and average annual sea level rise ( $R=0,59$ ) are weak, but possible.

**Figure 5.11: Number of natural disasters in Bangladesh**



Source: EM-DAT, Centre for Research on the Epidemiology of Disasters (CRED)

### 5.3.1 Results

Hypothesis 2 suggests that there is a relation between the change of climate in Bangladesh and the increase of natural disasters.

**H2: Climate Change will lead to an increase of natural disasters in Bangladesh.**

According to the second hypothesis, there will be an increase of natural disasters due to a change of climate. The most likely relationship between climate change and natural disasters in the context of Bangladesh is tropical cyclones. Bangladesh is located in a high-risk cyclone-prone area. 16 of the 35 tropical cyclones with death tolls in excess of 5,000 people occurred in Bangladesh (53 percent). Major cyclone disasters occur regularly in Bangladesh. For example, in 2009 cyclone Aila killed over 330 people in Bangladesh. Although there appears to be a relationship between the rising temperature and sea level and an increase on tropical cyclones, there is no evidence support this conclusion. The number of tropical disturbances and days of tropical disturbances went down the last thirty years, while the temperature and sea level went up. There appears to be a correlation between the total number of disasters and the indicators of climate change. But this relationship is

very weak. Table 5.5 shows an overview of the correlations between the climate change indicators and the scarcity of resources indicators.

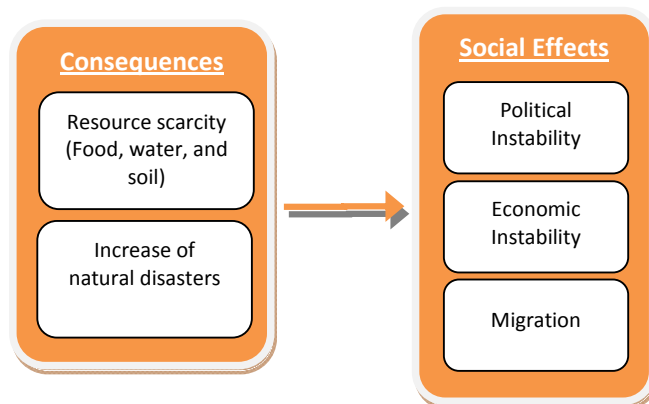
**Table 5.4 Correlation analysis climate change and increase of natural disasters indicators**

Climate change \ Increase of natural disasters	Number of natural disasters	Number of tropical disturbances	Number of days with tropical disturbances
<b>Temperature change</b>			
- Temperature anomaly	0.60	0.49	0,36
<b>Sea level rise</b>			
- Average annual mean sea level	0.59	-0.44	-0.35

Based on the historic data there is very weak evidence that there is a relation between climate change and an increase of natural disasters in Bangladesh. The number of natural disasters has increased, but it is doubtful that this is related to climate change. Based on these finding we neither reject nor accept hypothesis 2.

#### 5.4 Consequences of climate change and social effects

According to the conceptual framework the consequences of climate change can have social effects like political instability, economic instability and migration. The next step is to analyse the relationship between the consequences of climate change (scarcity of resources and an increase of natural disasters) and the social effects.

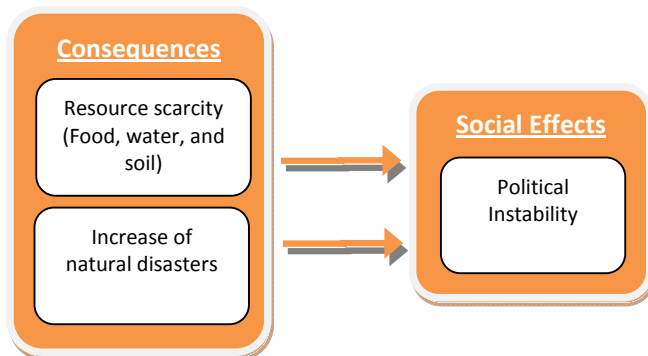


In paragraph 5.2.4 we concluded that there is no relation between the indicators of climate change and scarcity of resources. In paragraph 5.3.1 we concluded that there could be a relation between

the climate change indicators and an increase of natural disasters, but it is weak. In this stage of the analysis we will look isolated at the intermediate step (consequences of climate change – social effects). In the final conclusion we will analyse the entire framework.

#### 5.4.1 Political instability

The consequences of climate change, scarcity of resources and an increase of natural disasters could have an effect on the political stability in Bangladesh.



##### 5.4.1.1 Political situation Bangladesh

Before we analyze the relationship between political instability and scarcity of resources and an increase of natural disasters, we give a sort overview of the current political situation in Bangladesh. Since Bangladesh won its independence from West Pakistan in 1971, two parties have dominated the country's politics, the Awami League (AL) and the Bangladesh National Party (BNP). Since 1990, Bangladesh has been a parliamentary democracy with a separate judiciary and an active civil society. Although a democracy, Bangladesh faces challenges central to a successful working democratic system, for example freedom of speech and political opposition. According to Freedom House, media are active but not free, journalists feel threatened by political and religious opposition (Freedom House, 2006).

The Awami League is characterized as a centre-left, secular-democratic political party, drawing support from minorities such as Shiite Muslims and Bangladeshi Hindus. Minority groups have long been targets of radical Sunni Islamists. The leader of the AL is Sheikh Hasina, she is also the current Prime Minister. Sheikh Hasina is the daughter of the founder of Bangladesh Sheikh Mujibur Rahman. One of the AL's most contentious attributes is its pro-India stance.

General Ziaur Rahman (General Zia), a former officer in the Pakistani Army, established the BNP in September 1978. Currently, Khaleda Zia, the General's widow, leads the party. The BNP is viewed as right of centre, nationalistic, conservative and business-oriented. The party takes an overtly hard line approach to India and is openly pro-Pakistan. The BNP is known for its mixture of traditional Bengali customs with Islam, though it has remained secular. The BNP is responsible for numerous attacks on AL members, including the 2004 attack in which 13 grenades were thrown during an AL rally where Sheikh Hasina was present. Over 20 were killed and Hasina was left deaf in her right ear. Further, many AL-sympathizing journalists, academics, and high-profile AL members have been assassinated by BNP members.

The key difference between the AL and BNP is the latter's alliance with Islamist organizations, which they rely on in order to stay in power. The BNP's political allies are the Jaamat i-Islami (JI). The JI openly supports the Pakistani military and is alleged to have been involved in massacres and targeted killings of various intellectuals in Dhaka, as well as other acts of terrorism. The JI also calls for the implementation of Shari'a (Islamic Jurisprudence) and the establishment of a theocratic system in Bangladesh (Sreeram, 2006).

Bangladesh's political instability stems from a number of issues, including widespread corruption, weak government institutions, illegal migration to and from Bangladesh, radical Islamist terrorism, and an increase in Islamist influence, which has successfully exploited the political vacuum that the AL-BNP rivalry has allowed to open. The main areas of concern are corruption, education and poverty, all of which are being exploited by Islamist groups.

#### *5.4.1.2 Political instability in Bangladesh*

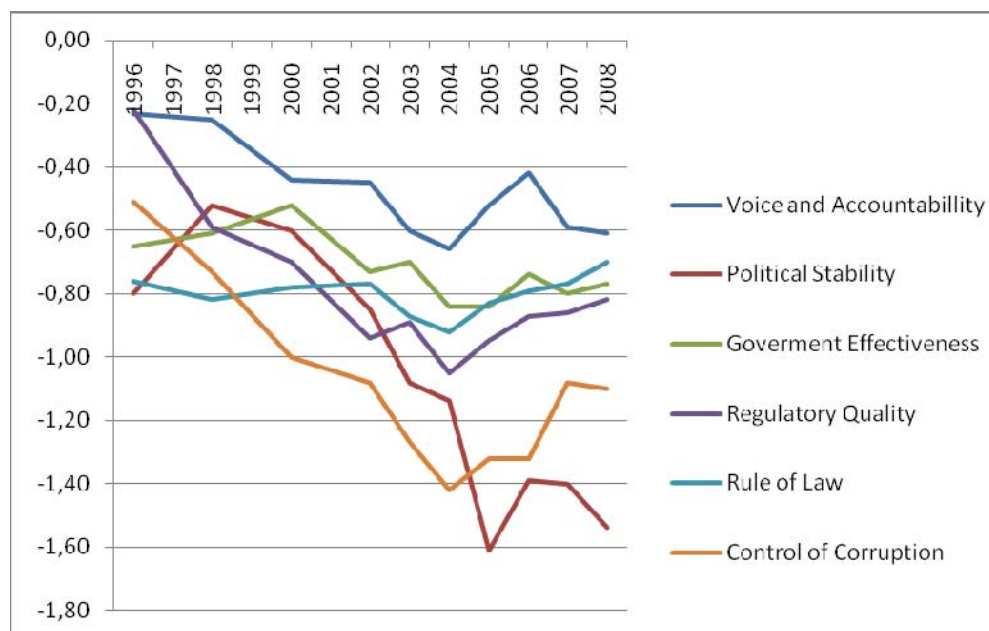
Now that we have taken a brief look at the current political situation, we will explore the relationship between the consequences of climate change and political instability in Bangladesh. There is limited data available regarding the political stability of Bangladesh. In this study we will use the Worldwide Governance Indicators (WGI) of the World Bank. The WGI's gives an indication of the state of governance in a country over the period 1996–2008. The WGI indicators are:

- Voice and accountability
- Political stability
- Government effectiveness
- Regulatory quality
- Rule of law

### Control of corruption

The aggregate indicators combine the views of a large number of enterprise, citizen and expert survey respondents in industrial and developing countries. The individual data sources underlying the aggregate indicators are drawn from a diverse variety of survey institutes, think tanks, non-governmental organizations, and international organizations. The indicators are measured on a scale from -2,5 to 2,5. Higher values correspond with better governance. Figure 5.11 shows the Governance Indicator for Bangladesh.

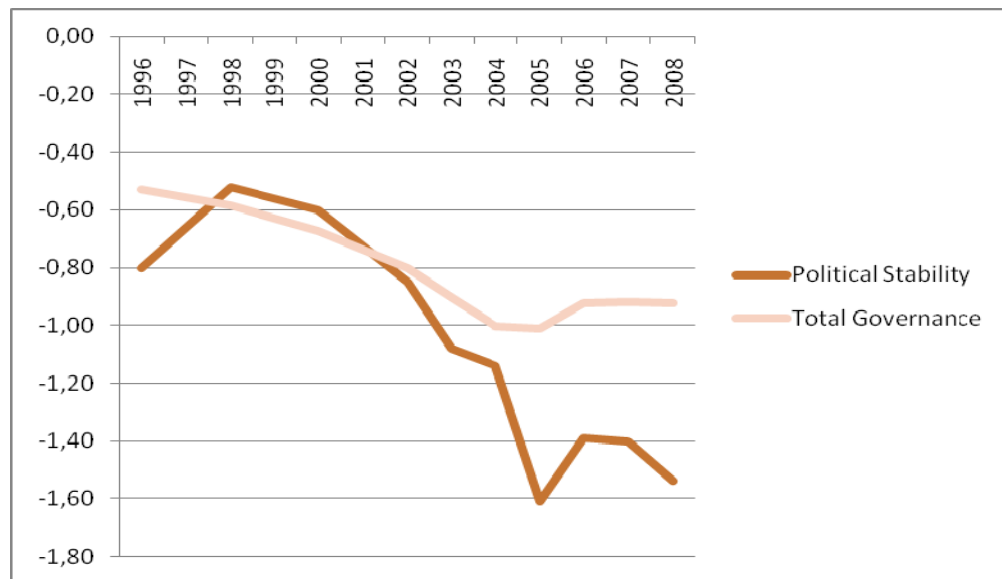
**Figure 5.12: Worldwide Governance Indicators (WGI) Bangladesh**



Source: Worldwide Governance Indicators, World Bank, 2009

According to the WGI 's of the World Bank the political stability of Bangladesh has decreased since 1998. To explore the relationship between scarcity of resources and increase of natural disasters we look at the indicator 'political stability'. Additionally, we will look at a combination of all indicators combined. This indicator is called 'Total governance'. Figure 5.12 show the historic development of the two indicators.

Figure 5.13: Political stability Bangladesh



Source: Worldwide Governance Indicators, World Bank, 2009

Table 5.6 shows the correlation between the indicators of scarcity of resources and increasing natural disasters on one side, and the indicators of political stability and total governance on the other side. There is a weak negative relationship between the food and crop production and political stability ( $R=-0.65$ ) and ( $R=-0.64$ ). The negative relation is even stronger with the food and crop production and total governance ( $R=-0.88$ ) and ( $R=-0.87$ ). This implies that the food and crop production goes up when the quality of governance in Bangladesh goes down. This is a remarkable finding. It suggests that the government has little influence on the production of food and crops. There is no relation between the amount of agricultural land and the political stability or total governance of Bangladesh.

Table 5.5 Correlation analysis consequences of climate change and political instability

Consequences of climate change \	Political instability	Political Stability	Total Governance
<b>Scarcity of resources</b>			
- Food production index		-0.65	-0.88
- Crop production index		-0.64	-0.87
- Renewable internal freshwater resources		*	*
- Agricultural land		-0.20	-0.60
<b>Increase of natural disasters</b>			



- Number of natural disasters	0.10	0.01
- Number of tropical disturbances	-0.41	0.08
- Number of days with tropical disturbances	-0.29	0.65

\* No data available for correlation analysis

There appears to be no relationship between the increase of the number of disasters and the political stability ( $R=0.10$ ) and total governance ( $R=0.01$ ) of Bangladesh.

#### 5.4.2 Results

Hypothesis 3 suggests that there is a relationship between the scarcity of resources, like food, freshwater and agricultural land and the political stability of Bangladesh. Hypothesis 4 suggests that there is a relationship between the increase of natural disasters and the political stability in Bangladesh.

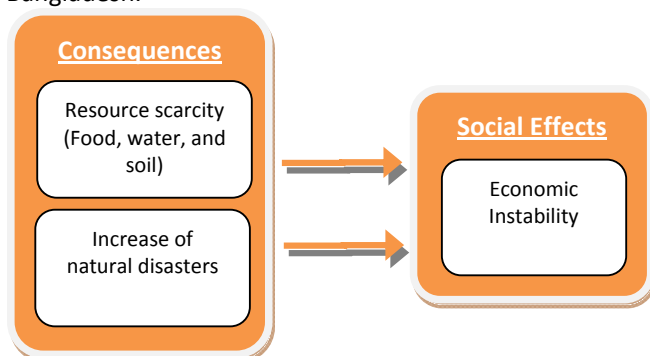
H3: Scarcity of resources will lead to political instability in Bangladesh.

H4: Increase of natural disasters will lead to political instability in Bangladesh.

There appears to be no relationship between the scarcity of resources and the political stability in Bangladesh. There is a negative relation between the food and crop production and the total governance in Bangladesh. This implies that the food and crop production goes up when the quality of governance in Bangladesh goes down. This shows the independence of the variables, rather than in interconnectedness. It suggest that the government of Bangladesh has little influence or control over the production of food and crops. The other indicators do not correlate with each other. There is no relationship between the increase of the number of disasters and the political stability and total governance of Bangladesh. The political situation in Bangladesh has been relatively unstable over the last ten years. There is no evidence that scarcity of resources or an increase of natural disasters contributed to political instability in Bangladesh. Preparedness and adoption to natural disaster has not been a crucial issue in the 2008 elections. Both AL and BNP are willing, albeit unable, to solve these problems. The same goes for the responses to the impact of natural disasters. AL and BNP are equally incompetent to provide service to the people. There appears to be a broad acceptance that the government (whether AL or BNP) is not able to respond in a proper manner to the impact of natural disasters. Based on these finding we reject hypothesis 3 and 4.

### 5.4.3 Economic instability

The consequences of climate change (scarcity of resources and increase of natural disasters) could also have an effect on the economic stability in Bangladesh. Hypothesis 5 and 6 are related to the impact of scarcity of resources and increase of natural disasters on the economic stability in Bangladesh.



#### 5.4.3.1 Economical situation in Bangladesh

Before we analyze the relationship between economic instability and a scarcity of resources and increase of natural disasters, we give a sort overview of the current economic situation in Bangladesh. Bangladesh is one of the world's most densely populated and poorest countries of the World. In 2005 approximately 40 percent of the people lived below the poverty line (see table 5.7).

**Table 5.6 Percentage of population living below the poverty line**

Percentage of population living below the poverty line	
Year	
2005	40%
2000	48.9%
1996	51%

Source: World Bank, 2009: World Development Indicators, DPP Quick Query

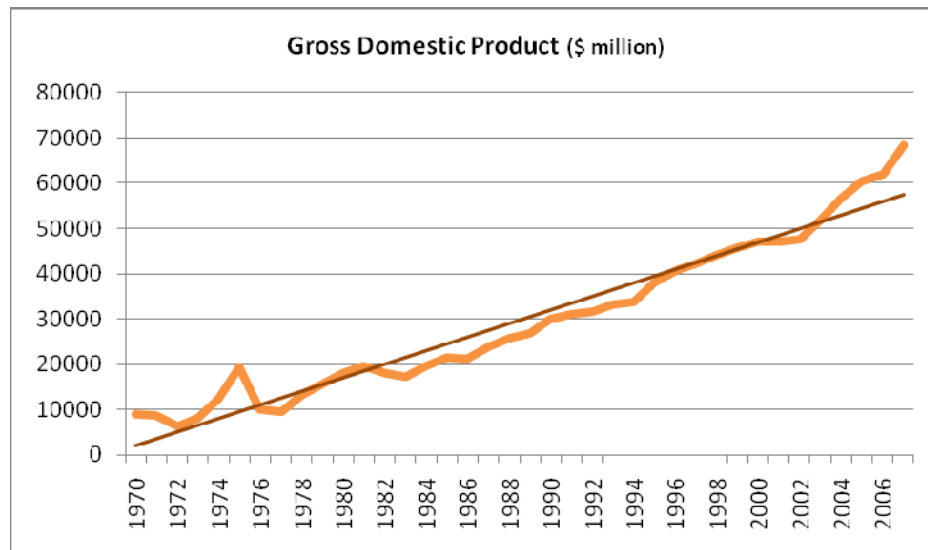
Rapid liberalization in the 1990s saw Bangladesh's GDP growth increase from an annual average 3.4 percent in the 1970s and 1980s to almost 5 percent in the 1990s. Recent GDP growth of 7 percent was achieved in 2008, but this figure is expected to decline in 2009 – 2010 as a result of the global financial crisis. Bangladesh's growth rate remains significantly below the levels required to meet the millennium goals. Agriculture contributes over 23 percent of GDP and employs over 60 per cent of the labour force. Rice is the dominant crop (over 70 per cent of the total value of agricultural production). Other crops include wheat, jute, sugar cane, pulses, spices, tea and various fruits and

vegetables. Bangladesh has a liberal foreign investment regime, but apart from energy exploration and production, foreign investment in Bangladesh in general is limited. The garment industry currently accounts for over 70 percent of total exports and is under competitive pressures. Remittances from workers employed overseas remain an important income stream for Bangladesh, although this has been adversely affected by the global financial crisis.

#### 5.4.3.2 *Economic instability in Bangladesh*

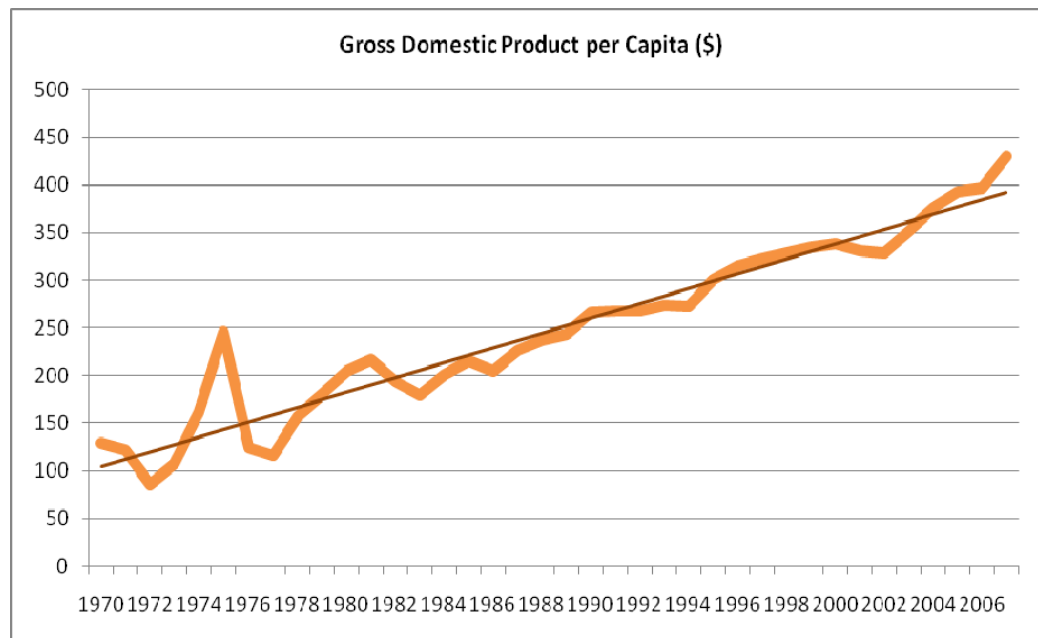
Now that we have taken a look at the current economic situation, we will explore the relationship between the consequences of climate change and economic instability in Bangladesh. Indicators for the economic situation in Bangladesh are the Gross Domestic Product (GDP) and the Gross Domestic Product per Capita.

**Figure 5.14 Gross Domestic Product Bangladesh**



Source: World Bank, 2009: World Development Indicators, DPP Quick Query

The Gross Domestic Product (GDP) is the sum of value added by all resident producers plus any product taxes (minus subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad. The GDP of Bangladesh has increased since 1970s. Figure 5.13 shows the GDP of Bangladesh from 1970 until 2007.

**Figure 5.15 Gross Domestic Product per Capita**

Source : World Bank, 2009: World Development Indicators, DPP Quick Query

The GDP per capita show a similar pattern as the GDP. Since 1970 the GDP per capita has increased. Figure 5.14 show the development of the GDP per capita in Bangladesh. The next step is to explore the relationship between the indicators of economic stability and the indicator of scarcity of resources and increasing natural disasters. Table 5.9 show the correlation analysis of the scarcity of resources and increase of natural disasters indicators on one side, and the economic stability indicator on the other side.

There is a strong relationship between the food and crop production and the GDP ( $R=0.97$  and  $R=.96$ ) and the GDP per Capita ( $R=0.93$  and  $R=0.92$ ). It is a positive relationship. If the food and crop production increases, the GDP and GDP per Capita increase. The production food and crops influences the economic stability of Bangladesh. There is a weak negative correlation between the amount of agricultural land and the GDP ( $R=-0.74$ ) and the GDP per Capita ( $R=-0.70$ ). This relationship is remarkable. This can be explained by the emergence of shrimp farming in the 1990s. The amount of agricultural land decreased rapidly in this period. The benefits from the shrimp farming added to the GDP and the GDP per Capita. From an economic perspective, Bangladesh benefited from the decrease of agricultural land.

**Table 5.7 Correlation analysis consequences of climate change and economic instability**

Consequences of climate change \ Economic instability	Gross Domestic Product (\$ millions)	Gross Domestic Production per Capita (\$)
<b>Scarcity of resources</b>		
- Food production index	0.97	0.96
- Crop production index	0.93	0.92
- Renewable internal freshwater resources	*	*
- Agricultural land	-0.74	-0.70
<b>Increase of natural disasters</b>		
- Number of natural disasters	0.56	0.53
- Number of tropical disturbances	-0.48	-0.43
- Number of days with tropical disturbances	-0.35	-0.31

\* No data available for correlation analysis

There is no relationship between the increase of natural disasters and the economic stability of Bangladesh.

#### 5.4.4 Results

Hypothesis 5 suggests that there is a relationship between the scarcity of resources, like food, freshwater and agricultural land and the economic stability of Bangladesh. Hypothesis 4 suggests that there is a relationship between the increase of natural disasters and the economic stability in Bangladesh.

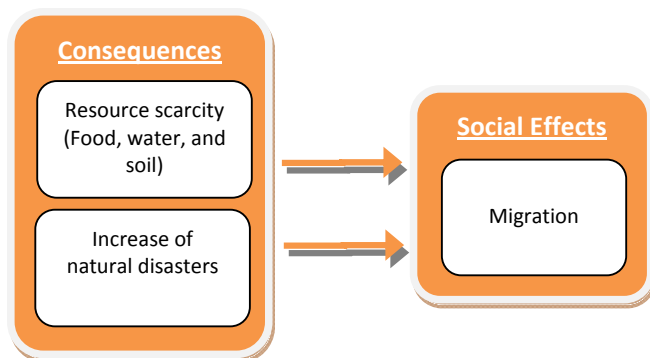
H5: Scarcity of resources will lead to economic instability in Bangladesh.

H6: Increase of natural disasters will lead to economic instability in Bangladesh.

There is a strong relationship between the scarcity of resources and the economic stability of Bangladesh. A degradation of resources in Bangladesh could cause economic instability. But its relationship is not absolute. The degradation of agricultural land has not caused economic instability in Bangladesh. On the contrary, the GDP increased in this period of time. This effect can be explained by the emergence of large scale shrimp farming in the 1990s. The resource is replaced by an alternative. Based on these findings, we accept hypothesis 5. There is no evidence that there is a relationship between the increase of natural disasters and the economic stability of Bangladesh. Therefore we reject hypothesis 6.

### 5.4.5 Migration

The consequences of climate change, scarcity of resources and an increase of natural disasters could also have an effect on the migration flows in Bangladesh. Hypothesis 7 and 8 are related to the impact of scarcity of resources and increase of natural disasters on migration in Bangladesh.



#### 5.4.5.1 Migration flows in Bangladesh

Before we analyze the relationship between the consequences of climate change and migration, we take a look at the current migration patterns in Bangladesh. We can distinguish two types of migration:

- Internally displaced persons (IDP)
- Economic migrants

An internally displaced person is someone living in situations of internal displacement as a result of conflicts or human rights violations. According to the Internal Displacement Monitoring Centre (IDMC) in 2000, between 60,000 and 500,000 people are internally displaced in Bangladesh. The majority the IDP's are indigenous Jumma tribal people from the Chittagong Hill Tracts (CHT). In 1976, armed conflict broke out in Bangladesh's Chittagong Hill Tracts (CHT) as the government rejected indigenous Jumma tribal people's demands for greater recognition and constitutional safeguards. As the conflict escalated, the Bangladeshi government began relocating poor and landless Bengalis (approximately 400,000) from the plains to the CHT between 1979 and 1983. Forced evictions, atrocities related to the conflict, confiscation of land for military camps, and clashes with the new settlers displaced tens of thousands of tribal people within the country and into neighbouring India. Members of the Hindu minority were also displaced in Bangladesh after the demolition of the Babri Mosque in Ayodhya (India) in 1992, in a political rally by Hindu extremists. After the Bangladesh National Party (BNP) came into power in 2001 together with Jaamat i-Islami (JI) the Hindu minority was also targeted. There is no current information on these situations.

The second type of migration is economic migrants. According to the Bureau of Manpower, Employment and Training (BMET) internal and international economic migration has increased significantly over the last years. Amongst international flows, the region shows three distinct trends: 1) emigration for settlement to Europe, Australasia and North America, 2) contract labour migration to Middle-Eastern and South-East Asian countries, and 3) the movements of people in border areas. Table 5.9 show the net migration in Bangladesh from 1970 until 2005.

**Table 5.8 Net migration Bangladesh**

Year	Net Migration
1970	-87,334
1975	-87,334
1980	-300,000
1985	-380,000
1990	-435,000
1995	-500,000
2000	-550,000
2007	-700,000

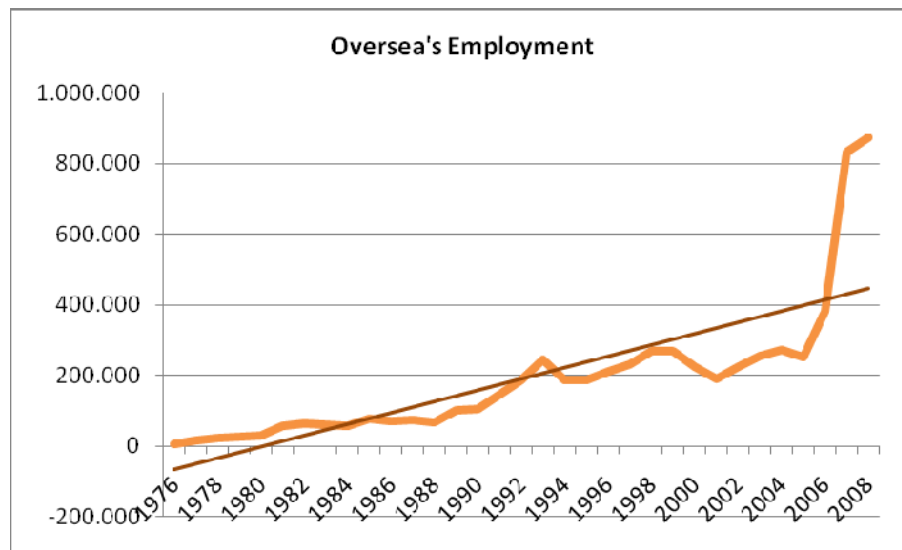
Source: World Bank, 2009: World Development Indicators, DPP Quick Query

The majority of the Bangladeshi migrants come from the rural coastal areas. Hossian analyzed the migration patterns of ten rural villages in the coastal area of Bangladesh for five years (Hossian, 2001). The average migration rate among the people in the rural areas was 7.4%. According to Hossian, the migrants were adult and more educated. Most of them were engaged in studies or unemployed before migration. About half of the migrants migrated for temporary service and about one quarter for a permanent job. According to Hossian educational attainment of the migrants was related with the permanent type of migration, whereas temporary type of migration mainly associated with illiterate migrants. The migration rate was significantly higher for educated as well as unemployed people, and also for the people belonging to the ages 20-29. Poverty, job searching and family influence were the main push factors for migration, while better opportunity, prior migrants and availability of job were the main pull factors behind migration. One third of the migrants migrated to foreign countries (mainly UAE and Malaysia), and about one third to Dhaka division (mainly Dhaka city), followed by Chittagong division (mainly Chittagong city) and local urban areas. The remaining one third of the migrants migrated in their own district.

#### 5.4.5.2 Migration in Bangladesh

Now that have taken a look at migration in Bangladesh, we will analyze the relationship between scarcity of resources and increase of natural disasters and migration. There is very limited data available regarding migration in Bangladesh. The only available data is related to the overseas employment of Bangladeshis. According to Hossain, overseas represents one third of the total migration. Figure 5.15 shows the overseas employment from 1976 until 2008.

**Figure 5.16: Overseas employment**



Source: Bureau of Manpower Employment and Training (BMET)

Since 2006 the overseas employment has increased rapidly. In 2007 the overseas employment increase with almost 50 percent compared to 2006. There appears to be a positive relationship between the food ( $R=0.88$ ) and crop ( $0.86$ ) production and overseas employment. There is a negative relationship between the amount of agricultural land ( $R=-0.85$ ) and overseas employment.

Consequences of climate change	Migration	Overseas Employment
<b>Scarcity of resources</b>		
- Food production index		0.88
- Crop production index		0.86
- Renewable internal freshwater resources		*
- Agricultural land		-0.85
<b>Increase of natural disasters</b>		



- Number of natural disasters	0.20
- Number of tropical disturbances	-0.13
- Number of days with tropical disturbances	-0.25

\* No data available for correlation analysis

There appears to be no relationship between the increase of natural disasters and overseas employment.

#### 5.4.6 Results

Hypothesis 7 suggests that there is a relationship between the scarcity of resources, like food, freshwater and agricultural land and the migration in Bangladesh. Hypothesis 8 suggests that there is a relationship between the increase of natural disasters and the migration in Bangladesh.

H7: Scarcity of resources will lead to migration in Bangladesh.

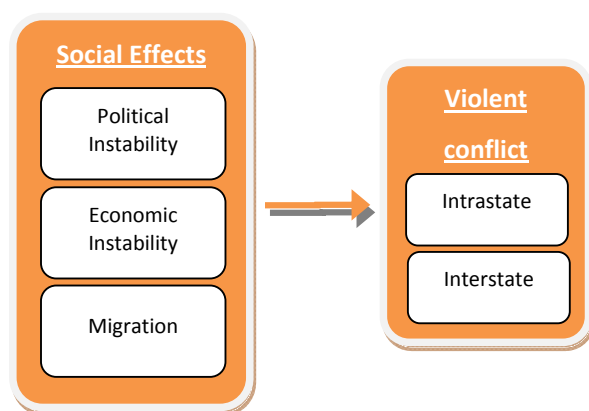
H8: Increase of natural disasters will lead migration in Bangladesh.

The available data on migration in Bangladesh is limited. Only data regarding the overseas employment was available. It is difficult to draw a conclusion based on this data. The analysis is therefore more indicative. The cause of the displacement of the majority of the IDP's was related to the conflict in the CHT or to religious violence. Both conflicts are related to ethnic conflict rather than climate change. The second type of migration is economic migration. According to Hossain one third of the migrants migrates overseas. In 2008, 875 thousand people went overseas. An educated guess would be that the total migration of Bangladesh would be approximately 2.6 million people. According to Hossain about half of the migrants migrated for temporary service and about one quarter for a permanent job. Based on the educated guess of 2.6 million, the permanent annual migration would be 650 thousand. This is in line with the estimated net migration from the World Bank of 700 thousand. The Global Humanitarian Forum suggests that 22 million Bangladeshis would become refugees due to climate change impacts by 2050. If 650 thousand people would leave Bangladesh annually for the next forty years, this would be 26 million people. The question is, if this migration is related to climate change. What is the distinction between a climate change refugee and an economic migrant? According to Hossain the migration rate is significantly higher for educated as well as unemployed people. This does not indicate a connection with climate change.

Because of the limited available data regarding migration in Bangladesh, it is very difficult to get insight into the motivation of migration flows. Therefore Hypothesis 7 and 8 are neither rejected nor accepted.

### 5.5 Social effects related to climate change and violent conflict

In the conceptual framework the social effect related to the consequences of climate change could explain future conflict in Bangladesh. In the coming paragraph we will analyze the historical conflict of Bangladesh, starting with the war of independence. We will analyze if there is a relationship between the social effect like political instability, economic instability and migration and violent conflict.



According to the UCDP/PRIO Armed Conflict Dataset there have been two violent conflicts in Bangladesh. UCDP defines a conflict as: “a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths.” The first conflict in 1971 evolved in response to the independence of Bangladesh. The second conflict is the civil war between the Bangladeshi government and the indigenous Jumma tribes in the Chittagong Hill Tracts (CHT). Additionally we will also look at the political violence in Bangladesh. The number of conflicts in Bangladesh is limited. It will not be possible to find an empirical relationship between political instability, economical instability or migration. In the next paragraphs we will describe the conflicts and causes of conflict.

#### 5.5.1 War of independence, 1971

Bangladesh became independent in 1971, when the country seceded from Pakistan. Prior to this separation the area had been known as East Pakistan, having been grouped together with present-

day Pakistan at the Partition of India in 1947. The partition took place when the UK granted independence to the colony of British India, which subsequently divided itself along religious lines into one predominantly Islamic country (present-day Pakistan and Bangladesh) and one predominantly Hindu country (present-day India). The area of East Pakistan however suffered marginalisation and economic neglect from the main Pakistani entity, being located approximately 1,600 kilometres to the west. Linguistic issues also divided the two parts of Pakistan. These issues together brought on demands of autonomy during the 1960s and an upswing of popularity for the Awami League political party.

The 1970 Bhola cyclone hit the East Pakistan coastline during the evening of 12 November, killing an estimated 300,000 people (CRED, 2009). The Islamabad government lacked an understanding of the magnitude of the disaster and failed to respond properly. After the Awami League had made a grand performance in the parliamentary elections in 1970, the central government in West Pakistan blocked the party from assuming office, and instead launched a military operation against East Pakistan. This resulted in an intrastate conflict between the government of Pakistan and the Mukti Bahini (Liberation Force) over the territory of East Pakistan in 1971. The Mukti Bahini was formed by scattered elements of resistance fighters and Bangladeshi's who deserted the Pakistani army, brought together under one organisation on the behalf of the Awami League's leader, Mujibur Rahman. With the intervention of India in early December of 1971 the nine month conflict ended in a military victory for the Bangladeshi nationalists and India. Bangladesh thus became independent in December of 1971. During the war, approximately 3 million people were killed.

### **5.5.2 Chittagong Hill Tract conflict, 1974 – 1997**

Bangladesh's population is predominantly Bengali, with a small minority of tribal groups, living primarily in Chittagong Hill Tracts (CHT) on the borders with India and Myanmar. Aspirations for autonomy and self-rule among these groups grew as the Pakistani government revoked laws that prohibited settling in areas deemed to belong to the tribes. The government of independent Bangladesh likewise made no moves to preserve the rights of tribal groups, who felt marginalised by an influx of Bengali settlers onto their ancestral lands. To make their demands felt, a tribal rebel outfit, the JSS/SB (Jana Samhati Samiti/Shanti Bahini), initiated an armed struggle against the government of Bangladesh in the mid-1970s. An intrastate armed conflict took place between 1974 and 1992. As the conflict escalated, the government began relocating poor and landless Bengalis from the plains to the CHT. Between 1979 and 1983 over 400,000 settlers moved to CHT. Forced evictions, atrocities related to the conflict, confiscation of land for military camps, and clashes with

the new settlers displaced tens of thousands of tribal people within the country and another 65,000 into neighbouring India. A peace agreement between the two sides was signed in 1997, mandating wider autonomy for the tribal groups. This promise has not been fully implemented.

### 5.5.3 Political conflict

The first Prime minister of Bangladesh, Mujibur Rahman, was facing an enormous task. The economy had to be redressed immediately and the military, whose overall image had been tainted by the brutalities since March 1971, had to be reorganized. The opposition of the Jaamt i-Islami to the liberation of Bangladesh and its collaboration with Pakistan during the war generated additional tensions and misgivings in the minds of the secular forces in the country. To make matters worse, in 1974 Bangladesh witnessed successive droughts and cyclones causing havoc and misery to an already impoverished country. Mounting internal problems, resource limitations and short-sighted political leadership brought the country to a situation where a violent upheaval became inevitable. Unable to respond to growing public unrest and protests, the leadership turned authoritarian. On December 28, 1974, Mujibur Rahman declared a state of emergency and suspended all civil and democratic rights. In a session that lasted no more than a few hours, on January 25, 1975, the *Jatiya Sangsad* (national parliament) hastily approved the Fourth Amendment. This fundamentally altered the political system and replaced the parliamentary system with the presidential system and institutionalized single-party rule in Bangladesh.

On August 15, 1975, a group of army officers struck back and assassinated Mujibur Rahman as well as almost his entire family. Khondkar Moshtaq, who then assumed power, was similarly ousted by a few military officers led by Brigadier Khaled Mosharraf, a known supporter of the Awami League. The saga of violence, however, continued and four liberation leaders – Syed Nazrul Islam, Tajuddin Ahmed, M. Mansur Ali and A.H.M. Kamruzzaman of the Awami League – were killed in November 1975. The situation finally stabilized when General Zia-ur Rahman took over as Chief Martial Law Administrator in 1976 (and formally became President in 1977). But with the assassination of General Zia-ur Rahman in Chittagong on May 30, 1981, the political uncertainty returned and in less than a year, in March 1982 Chief of Staff H.M. Ershad took over from President Abdus Sattar who had assumed power after Zia-ur Rahman's death. Ershad's dictatorship continued till 1991 when he was overthrown by a wave of popular protests.

#### 5.5.4 Results

Hypothesis 9 suggests that social effects like political instability, economic instability and migration are related to climate

H9: Political instability, economic instability, and migration caused by the consequences of climate change will lead to intrastate and interstate conflict in Bangladesh.

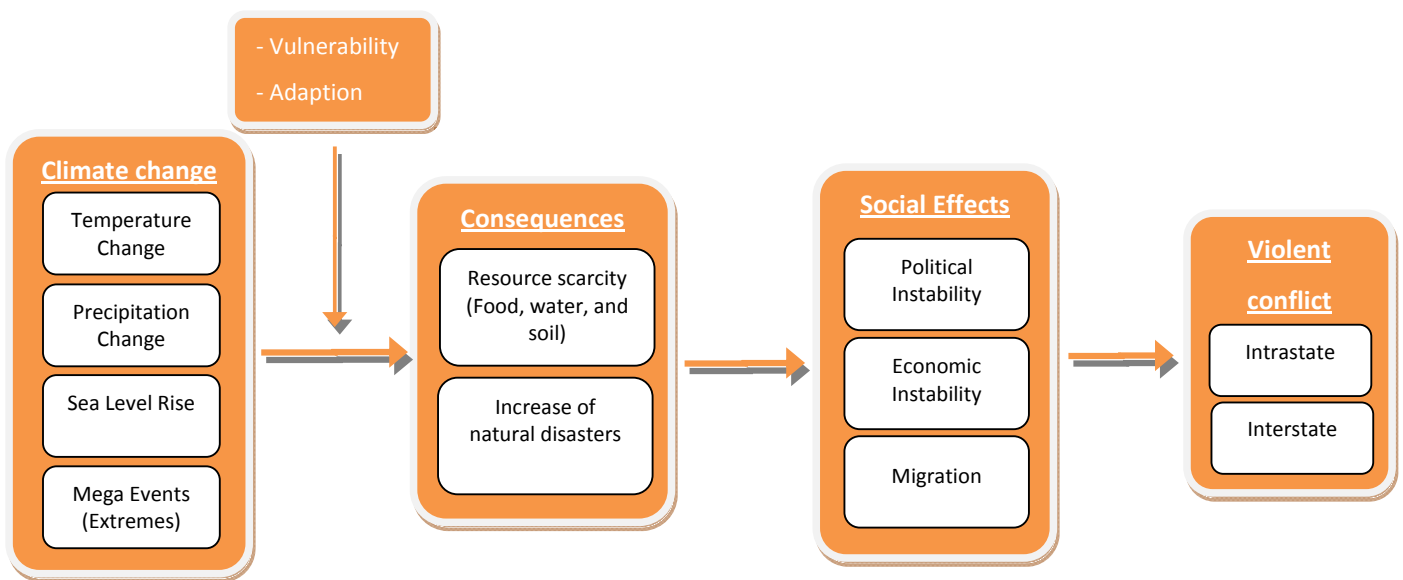
The number of conflicts in Bangladesh is limited. It is not possible to find a relationship between political instability, economic instability or migration based on the few historical cases. It is possible to determine some connections between the causes of the conflict and the impact of natural disasters. Before the war of independence in 1971 and the military coup of 1975, Bangladesh was hit by natural disasters. In 1970 the Bhola cyclone hit the entire coast. Most affected were Chittagong, Barguna, Khepupara, Patuakhali, north of Char Burhanuddin, Char Tazumuddin and south of Maijdi, Haringhata. The official death toll was 300,000 (CRED, 2007). Damages include destruction of approximately 20,000 fishing boats, and also property and crops. Total loss of cattle reached more than one million. More than 400,000 houses and 3,500 educational institutions were destroyed. In 1974 Bangladesh was hit by a number of cyclones, floods and droughts. The death toll was approximately 50,000. The weak responses from the Pakistani government triggered an uprising of separatists, which led to the independence of Bangladesh. The breeding ground for an uprising of a separatist movement was already present. Bangladesh (East Pakistan) was economically neglected by the Pakistani government. In 1974 Mujibur Rahman was unable to respond to growing public unrest and protests and turned authoritarian, which triggered the military coup. In both cases the quality of leadership appears to be an explaining variable. The natural disaster was only one of the triggers.

There appears to be no relationship with the conflict in the Chittagong Hill Tracts (CHT) between the Bangladeshi government and the Jumma tribal people. The Bangladeshi government argues that the movement of Bengali settlers from the plains to the CHT is motivated by the scarcity of land. But is widely accepted that this was a political and military strategy to oppress the Jumma tribal people. Based on the historical data we neither reject nor accept hypothesis 9.

## 6 Conclusion

Bangladesh is located in a very difficult area of the World. The geographic shape and location makes the country vulnerable for tropical cyclones and floods. Many experts identify Bangladesh as 'frontline state' for climate change. Bangladesh would be one of the first and the hardest hit countries in the World if the climate changes. There is almost a general consensus that the impact of climate change would affect millions of people and could potentially lead to large scale violent conflict. In this master thesis the relationship between climate change and violent conflict has been explored.

The fundament of this master thesis is the conceptual framework. This framework is used to analyse the relationship between climate change and violent conflict in Bangladesh. The conceptual framework represents a possible pathway from climate change to conflict.



Starting point is climate change. Climate change is a change in climate over a period of time. It contains four elements: temperature change, precipitation change, sea level rise, and mega events. The changing elements of climate have two consequences. Firstly, a scarcity of resources like food, water, and agricultural land. Secondly, an increase in the number of natural disasters like floods, storms, and tropical cyclones. These consequences lead to three social effects: political instability, economic instability, and migration. The social effects could potentially cause violent conflict. Two types of conflict are distinguished: intrastate conflict (civil war), and interstate conflict (conflict between Bangladesh and India or Myanmar).

### *Climate change*

The climate in Bangladesh is changing. Over the last fifty years temperatures have risen in the monsoon and post-monsoon seasons. The average winter season temperature has remained stable. The average pre-monsoon season temperature has diminished. There has been no significant change in average annual rainfall over the last fifty years. Only in the pre-monsoon season there has been a slight increase in annual rainfall. The annual rainfall varies highly from year to year. The sea level of the Bay Bengal has risen from 1979 to 2003. This rise in sea level corresponds to the global sea level rise. There is no evidence that supports a change of frequency of extreme temperatures or drought periods. However, there has been a significant increase in the number of floods in Bangladesh.

### *Scarcity of resources*

A change of one or more of the climate change variables could have two consequences. First the change in climate could lead to the scarcity of resources like food, fresh water, and agricultural land because of increasing droughts, changing precipitation patterns, floods, salinity intrusion, riverbank and coastal erosion, and increasing extreme events. This would lead to increasing fresh water demand, crop failure, erosion of indigenous knowledge, floods, decreasing freshwater supply, and degradation of agricultural land. Although this story sounds plausible, there is little evidence that supports a casual relationship between a change in climate and shrinking food or freshwater supply. The temperature and the sea level have risen since 1970. In this period the food and crop production has increased, and the freshwater resources have remained stable. Possible scarcity, at an individual level, of these resources will more likely be caused by the growing population. If the population grows, the demand for resources like food and freshwater increases. If the supply remains the same, more people are competing for the same amount of resources. Population growth is not related to climate change. Possible conflict related to this process cannot be established as a consequence of climate change.

Another resource that could diminish is agricultural land. There is a persevering conception that the rise in sea level would swallow large quantities of the coastal areas of Bangladesh. According to the World Bank 17 percent of Bangladesh's land, home to 20 million people, would disappear into the sea if the sea level rises by one metre. These estimations are misleading, because they do not factor in the embankments that protect the coastal areas. The coastal areas of Bangladesh are not diminishing. Bangladesh has a dynamic coastline. Some areas erode, and because of the sediments settling along the coast new land is created. Bangladesh's delta is now expanding, every year nearly

20 square kilometres are added to the coastal areas. There has been a significant degradation in agricultural land in the last forty years, but the correlation with changing climate circumstances is weak. It is most likely that the emergence of a great number of shrimp farms in the 1990s has caused the degradation of agricultural land. Shrimp farmers intrude large areas of agricultural land with saline water to foster the cultivation of shrimps. Shrimps are currently the second largest export product of Bangladesh, and bring in foreign currencies. In this process human activity has deliberately increased the vulnerability of Bangladesh, because embankments were destroyed for intrusion. Because of this intrusion, the land loses its agricultural utility for many years. A small group of investors profit from the shrimp farming activities. Before and after the 'shrimp period' the agricultural land was and is stable. This process is not related to climate change. Human activity caused this degradation of agricultural land.

#### *Natural disasters*

The second consequence of a change in one or more of the variables that are used to indicate climate change is an increase of natural disasters. The most likely relation between climate change and natural disasters in the context of Bangladesh is tropical cyclones. Bangladesh is located in a high-risk cyclone-prone area. 16 of the 35 tropical cyclones with death tolls in excess of 5,000 people occur in Bangladesh (53 percent). Major cyclone disasters occur regularly in Bangladesh. For example, in 2009 cyclone Aila killed over 330 people in Bangladesh. Although there appears to be a relationship between the rise in temperature, sea level, and the increase of tropical cyclones, there is no evidence support this hypothesis. The number of tropical disturbances and amount of days displaying such disturbances, diminished over the last thirty years. All the while, the temperature and sea level increased. The total number natural disasters has risen in the last thirty years. There is no evidence to support the hypothesis that this increase is related to changing climate variables.

#### *Political instability*

There is no evidence that a scarcity of recourse, related to the change of climate, contributed to political instability in Bangladesh. The political situation in Bangladesh has been relatively unstable over the last ten years. There is no evidence that a scarcity of resources or an increase in natural disasters contributed to enhanced political instability in Bangladesh. Preparedness and adoption to natural disaster has not been in crucial issue in the 2008 elections. Both the AL and the BNP are willing, but unable to solve these problems. The same goes for the responses to the impact of natural disasters. AL and BNP are equally incompetent to provide service to the people. There appears to be



a broad acceptance that the government (AL or BNP) is not able to respond in a proper manner to the impact of natural disasters.

#### *Economic instability*

Bangladesh is one of the world's most densely populated and poorest countries of the World. In 2005 approximately 40 percent of the people lived below the poverty line. But the situation is improving. In 1996, 51 percent of the population was living below the poverty line. Liberalization in the 1990s led to a rapid growth of the Gross Domestic Product (GDP). The growth increased from an annual average of 3.4 percent in the 1970's and 1980's, to almost 6 percent in the 1990's. Bangladesh's growth rate remains significantly below the levels required to meet the millennium goals. There is a relationship between the scarcity of resources and economic stability in Bangladesh. A degradation of resources in Bangladesh could cause economic instability. But this relationship is not absolute. For example, the degradation of agricultural land has not caused economic instability in Bangladesh. On the contrary, the GDP has increased in this period of time. This effect can be explained by the emergence of large scale shrimp farming in the 1990's. These resources are replaced by an alternative.

#### *Migration*

Between 60,000 and 500,000 people are internally displaced in Bangladesh. The majority of these people belong to the Jumma tribe of the Chittagong Hill Tracts (CHT) and Hindu minorities. The cause of the displacement of the majority of the IDP's was related to the conflict in the CHT or to religious violence. Both conflicts are related to ethnic violent conflict rather than climate change. Annually, approximately 2,6 million Bangladeshis migrate: one third of the people internationally, and others internally to urban areas. About half of the migrants migrated for temporary service and about one quarter for a permanent job. The migration rate is significantly higher for educated as well as unemployed people. These people are economic migrants and cannot be classified as climate change refugees.

#### *Conflict*

There have been two cases of large scale violent conflict in Bangladesh. The first conflict in 1971 evolved in the aftermath of the independence of Bangladesh. The second conflict is the civil war between the Bangladeshi government and the indigenous Jumma tribes in the Chittagong Hill Tracts (CHT). The most likely connection between climate change and conflict is the trigger effect of natural disasters. There is one case of conflict in Bangladesh that can be related to a natural disaster: the

cyclone that raged in the Bay of Bengal in 1970, causing an estimated 300,000 deaths. Bangladesh, which at that time was part of Pakistani state territory (East Pakistan) and which was dominated politically and militarily by the western part of the country (West Pakistan), was seriously affected. Dissatisfaction over paltry aid measures provided by the Pakistani central government, as well as the apparent indifference of political leaders towards human suffering led to a separatist movement and a struggle for independence. In this case the natural disaster, the cyclone, triggered the war of independence. However, the cyclone could only trigger the separatist movement in East Pakistan due to the existence of an already developed breeding ground of grievance. The cyclone was merely 'the straw that broke the camel's back'. In the absence of such a breeding ground, the violent conflict would not have erupted.

Thereby, there is no evidence for a connection between climate change and an increase in cyclones. The climate has changed over the last thirty years but the number of cyclones has decreased. Even if there was a connection, it is doubtful whether one additional cyclone would trigger conflict. Cyclones are already taking place on a frequent basis in Bangladesh. It is unlikely that one more natural disasters would trigger a new conflict. In addition, Bangladesh has become better prepared over the last years. In 2007, Cyclone Sidr hit the lowly situated, densely populated coastal areas. Disaster preparation measures such as early warning systems and storm-proof houses kept the death toll to 3,400 and limited the economic damages to \$1.6 billion. In comparison, the highly populated delta region of the Ayeyarwady River in Myanmar was not prepared for Hurricane Nargis in 2008. The death toll in Myanmar was 146,000 and economic damages amounted to around USD 4 billion. Human activity can influence the impact of for example cyclones.

The list of problems in Bangladesh is very long. It is possible that conflict will occur in Bangladesh in the coming years. It is not likely, however, that the phenomenon of climate change is to be a paramount factor explaining this conflict. Poverty, population pressure, quality of leadership (from Bangladesh, India or Myanmar), lack of opportunities and inequality are all factors that will have to be the subject of serious scrutiny in any research aspiring to truly explain the cause of future conflict in Bangladesh.

## Bibliography

- Ali, A., 1999. Climate change impacts and adaptation assessment in Bangladesh, *Climate Research* 12: 109 – 116
- BBS, 2003. *Statistical Yearbook of Bangladesh*, Bangladesh Bureau of Statistics (BBS), Government of the People's Republic of Bangladesh, Dhaka.
- Bächler, G. & K.R. Spillmann (1996a) *Kriegsursache Umweltzerstörung. Länderstudien von externen Experten. Volume 3*. Rüegger, Chur, Zurich.
- Bächler, G. & K.R. Spillmann (1996b) *Kriegsursache Umweltzerstörung. Regional- und Länderstudien von Projektmitarbeitern. Volume 2*. Rüegger, Chur, Zurich.
- Bächler, G., 1999. *Violence Through Environmental Discrimination*. Dordrecht: Kluwer Academic
- Barnett, J., 2000. 'Destabilizing the environment–conflict thesis'. *Review of International Studies* 26(2): 271–88.
- Berdal, M. & D.M. Malone, 2000. *Greed and Grievance: Economic Agendas in Civil Wars*. Boulder, CO: Lynne Rienner.
- Blimes, R.J., 2006. 'The Indirect Effect of Ethnic Heterogeneity on the Likelihood of Civil War Onset', *Journal of Conflict Resolution* 50(4): 536–547.
- Brammer, H., M. Asaduzzaman & P. Sultana, 1993. *Effects of Climate and Sealevel Changes on the Natural Resources of Bangladesh*. Briefing Document No. 3, Bangladesh Unnyan Parishad (BUP), Dhaka.
- Brock, L. (1992) 'Security through defending the environment: An Illusion?' In Boulding, E (ed) *New Agendas for Peace Research*. Lynne Rienner, Boulder, CO, pp79–102.
- Brock, L. (1997) *The Environment and Security: Conceptual and Theoretical Issues*. Conflict and the Environment. Kluwer, Dordrecht.
- Brock, L. (2004) *Vom erweiterten Sicherheitsbegriff zur globalen Konfliktintervention. Eine Zwischenbilanz der neuen Sicherheitsdiskurse*. Arbeitspapier. Hessische Stiftung Friedens- und Konfliktforschung (HSFK), Frankfurt/M.
- Brooks, N., W.N. Adger & P.M. Kelly, 2005. The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation, *Global Environment Change* 15: 151 - 163
- Buhaug H., S. Kristian & N.P. Gleditsch, 2008. 'Contagion or Confusion? Why Conflicts Cluster in Space', *International Studies Quarterly* 52(2)
- Buhaug, H., N.P. Gleditsch & O.M. Theisen, 2008: Implications of Climate Change for Armed Conflict, World Bank Group: 'Social Dimensions of Climate Change' workshop
- Bureau of Manpower Employment and Training (BMET), 2009. Reports on overseas employment, [www.bmet.org.bd/report](http://www.bmet.org.bd/report)
- Cederman, L.-E. & L. Girardin, 2007. 'Beyond Fractionalization: Mapping Ethnicity onto Nationalist Insurgencies', *American Political Science Review* 101(1): 173–185.
- Center for Environmental and Geographic Information Services (CEGIS), [www.cegisbd.com](http://www.cegisbd.com)

- Chaulia, S.. "New Playground of Jihad." *World Press*. 20 February 2006.
- Choudhury, D (1994) *Constitutional Development in Bangladesh – Stresses and Strains*. Oxford University Press, Oxford, New York, Karachi.
- CNA, 2007. *National Security and the Threat of Climate Change*. Report from a panel of retired senior US military officers.
- Collier, P., L. Elliot, H. Hegre, A. Hoeffler, M. Reynal-Querol & N. Sambanis, 2003. *The Conflict Trap. Civil War and Development Policy*. Oxford: Oxford University Press.
- Collier, P. & A. Hoeffler, 2004. 'Greed and Grievance in Civil War', *Oxford Economic Papers* 56(4): 563–596.
- CRED, 2008. *Annual Disaster Statistical Review: Numbers and Trends 2007*. Centre for Research on the Epidemiology of Disasters,
- Daase, C (1992) 'Ökologische Sicherheit: Konzept oder Leerformel?' In Wellmann, C (ed) *Umweltzerstörung: Kriegsfolge und Kriegsursache. Friedensanalysen. Band 27*. Suhrkamp, Frankfurt/M, pp21–52.
- Daase, C (1996) *Vom Ruinieren der Begriffe. Eine Welt oder Chaos. Friedensanalysen Band 25*. Suhrkamp, Frankfurt/M.
- Dalby, S (2002) 'Environmental change and human security'. *Isuma - Canadian Journal of Policy Research* 3(2): 71–9.
- Deudney, D (1990) 'The case against linking environmental degradation and national security'. *Millennium* 19(3): 461– 76.
- Deudney, D (1991) 'Environment and security: muddled thinking'. *The Bulletin of the Atomic Scientist* 47(3): 23–8.
- Diehl, P.F. & N.P. Gleditsch (Hrsg.) (2000) *Environmental Conflict: An Anthology*. Westview Press, Boulder, CO.
- Drury, A.C. & R.S. Olson (1998) 'Disasters and political unrest: an empirical investigation'. *Journal of Contingencies and Crisis Management* 6: 153–61.
- Ebert, C., 2006. 'Nasty Social Behavior Common after a Disaster'. Press Release University at Buffalo
- EM-DAT, the international disaster database, Centre for Research on the Epidemiology of Disasters (CRED)
- Food and Agricultural organization of the United Nations (FAO), 2010, Aquastat Database Query, [www.fao.org/nr/water/aquastat/main/index.stm](http://www.fao.org/nr/water/aquastat/main/index.stm)
- Fearon, J.D.; K. Kasara & D. Laitin. 2007. 'Ethnic Minority Rule and Civil War Onset', *American Political Science Review* 101(1): 187–193.
- Fuentes, V E., 2003. *The Political Effects of Disasters and Foreign Aid: National and Subnational Governance in Honduras after Hurricane Mitch*. University of Florida, Gainesville, FL.
- German Advisory Council on Global Change (WBGU), 2007: *Climate Change as a Security Risk*
- Gleditsch, N P (1998) 'Armed Conflict and The Environment: A Critique of the Literature'. *Journal of Peace Research* 35(3): 381–400.
- Gleditsch, N.P.; R. Nordås & I. Salehyan, 2007. *Climate Change and Conflict: The Migration Link*. New York: International Peace Academy

- Global Humanitarian Forum, 2009: The anatomy of a silent crisis
- Grossmann, H.I., 1991. 'A General Equilibrium Model of Insurrections', *American Economic Review* 81(4): 912–921.
- Hagmann, T (2005) 'Confronting the concept of environmentally induced conflict'. *Peace, Conflict, and Development* 6: 1–22.
- Hansen, J. S. Lebedeff (1987) 'Global trends of measured surface air temperature'. *J. Geophys. Res.*, 92, 13345-13372.
- Haque, A.K.E., 2003. Sanitary and Phyto-sanitary Barriers to Trade and its Impacts on the Environment: the Cases of Shrimp Farming in Bangladesh, International Institute for Sustainable Development (IISD), Winnipeg.
- Hauge, W. & T. Ellingsen (1998) 'Beyond environmental scarcity: causal pathways to conflict'. *Journal of Peace Research* 35(3): 299–317.
- Hegre, H., T. Ellingsen, S. Gates & N.P. Gleditsch, 2001. 'Toward a Democratic Civil Peace? Democracy, Political Change, and Civil War, 1816–1992', *American Political Science Review* 95(1): 33–48.
- Hegre, H., Sambanis N., 2006. 'Sensitivity Analysis of Empirical Results on Civil War Onset' *Journal of Conflict Resolution* 50(4): 508–535.
- Heitzman, J. & R.L. Worden (1989) *Bangladesh: A Country Study*. Federal Research Division. Library of Congress Washington, DC.
- Holt, A.. "Islamists Pose a Growing Threat to Stability in Bangladesh." *Global Terrorism Analysis. Terrorism Focus*, Vol. 3, Issue 2. 18 January 2006.
- Homer–Dixon, T F (1990) *Environmental Change and Violence Conflict*. Canadian Environment and Sustainable Development Program. Institute for Research on Public Policy, Ontario, Canada.
- Homer–Dixon, T F (1991) 'On the threshold. Environmental changes as causes of acute conflict'. *International Security* 16 (2): 76–116.
- Homer–Dixon, T F (1994) 'Environmental scarcities and violent conflict. Evidence from cases'. *International Security* 19(1): 5–40.
- Homer–Dixon, T F (1999) *Environment, Scarcity, and Violence*. Princeton University Press, Princeton.
- Homer-Dixon, T., 2007. 'Terror in the Weather Forecast', *New York Times* 24 April.
- Hossain, M. Z., 2001. 'Rural-Urban Migration in Bangladesh: A Micro-Level Study' For presentation in a Poster Session on internal migration at the Brazil IUSSP Conference during August 20-24, 2001.
- Internal Displacement Monitoring Centre (IDCM), 2009, Bangladesh: Indigenous people and religious minorities still affected by displacement, A profile of the internal displacement situation. [www.internal-displacement.org](http://www.internal-displacement.org)
- International Alert, 2007, A Climate of Conflict. International Alert Report.

- International Union for Conservation of Nature (IUCN) Bangladesh, 2009. Tropical Cyclones: Impact on Coastal Livelihoods
- IPCC, 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge: Cambridge University Press
- Islam, M.R. (ed.), 2004. Where Land Meets the Sea: A Profile of the Coastal Zone of Bangladesh, The University Press Ltd., Dhaka.
- Islam, M.S., Haque, M., 2004. The Mangrove-based Coastal and Nearshore Fisheries of Bangladesh: Ecology, Exploitation and Management, Reviews in Fish Biology and Fisheries 14, pp. 153–180.
- Kahl, C., 2006. States, Scarcity, and Civil Strife in the Developing World. Princeton, NJ: Princeton University Press
- Kaplan, R.D., 1994. 'The Coming Anarchy', Atlantic Monthly, 2(2): 44–76.
- Klare, M.T., 2001. Resource Wars: the New Landscape of Global Conflict. New York: Metropolitan Books.
- Levy, M.A. (1995) 'Is the environment a national security issue?' *International Security* 20(2): 35–62.
- Matthew, R, M. Brklacich & B. McDonald (2004) 'Analyzing environment, conflict and cooperation'. In United Nations Environment Programme (UNEP) (ed) *Understanding Environment, Conflict and Cooperation*. pp5–16.
- Matthew, R. & B. McDonald (2004) 'Networks of threats and vulnerability: lessons from environmental security research'. *ESCP Report* 10: 36–42.
- Matthew, R A & L. Fraser (2002) 'Global Environmental Change and Human Security: Conceptual and Theoretical Issues'. Irvine, CA: University of California.
- Mehlum, H., Miguel, E., Torvik R., 2006. 'Poverty, and Crime in 19th Century Germany'. *Journal of Urban Economics* 59(3):370–388.
- O'Leary, M., 2004. The First 72 Hours: A Community Approach to Disaster Preparedness. iUniverse Inc. Book Publisher, Lincoln, NE.
- Raleigh, Clionadh & Henrik Urdal, 2007. 'Climate Change, Environmental Degradation and Armed Conflict', *Political Geography* 26(6): 674–694.
- Reuveny, Rafael, 2007. 'Climate Change-Induced Migration and Conflict', *Political Geography* 26(6):656–673.
- Reynal-Querol, Marta, 2002. 'Ethnicity, Political Systems, and Civil Wars', *Journal of Conflict Resolution* 46(1): 29–54.
- Salehyan, I., 2007. 'Transnational Rebels: Neighboring States and Sanctuaries for Rebel Groups', *World Politics* 59(2): 217–242.
- Sarwar, G. M. & Khan M. H., 2007. 'Sea Level Rise A Threat to the Coast of Bangladesh', *Internationales Asienforum*, Vol. 38 (2007), No. 3–4, pp. 375–397

Schwartz, Peter & Doug Randall, 2003. An Abrupt Climate Change Scenario and Its Implications for United States National Security. Report prepared for the U.S. Department of Defense.

Stern Review, 2006. Stern Review on the Economics of Climate Change.

UCDP/PRIO Armed Conflict Dataset version 4-2009, Gleditsch et al. (2002)

United Nations Development Programme (UNDP), 2004: A Global Report: Reducing Disaster Risk: A Challenge for Development

United Nations Development Programme (UNDP), 2006: Human Development Report, Beyond Scarcity: Power, poverty and the global water crisis

United Nations Population Fund (UNPF) Bangladesh, 2005: Containing Population Pressure for Accelerating Poverty Reduction in Bangladesh

Water Resources Planning Organization (WAPRO), 2008. Annual report July 2007 – June 2008

WorldBank, 2000. Bangladesh: Climate Change & Sustainable Development, Report No. 21104 BD, Dhaka.

WorldBank, 2009. Worldwide Governance Indicators, [www.worldbank.org/governance/wbi](http://www.worldbank.org/governance/wbi)

Worldbank, 2009. World Development Indicators, DPP Quick Query, <http://ddp-ext.worldbank.org/ext/DDPQQ/member.do?method=getMembers&userid=1&queryId=135>

## Appendix I: List of expert interviews

Name	Organisation	Position
Ainun Nishat	International Union for Conservation of Nature (IUCN)	Country Representative
Remeen Firoz	International Union for Conservation of Nature (IUCN)	Programme Officer
Bea ten Tusscher	Embassy of the Kingdom of the Netherlands	Ambassador
Niels Veenis	Embassy of the Kingdom of the Netherlands	First Secretary
Pieter Terfstra	Embassy of the Kingdom of the Netherlands	Second Secretary
Panaki Roy	The Daily Star	Senior Staff Correspondent
Imtiaz Ahmed	University of Dhaka	
Touhidul Islam	University of Dhaka, department of Peace and Conflict Studies	
Mamunul Khan	United Nations Development Program (UNDP)	Project Manager
Ayreen Khan	Bangladesh Institute of Peace and Security Studies (BIPSS)	Research Associate
Khaled Iqbal Chowdhury	Bangladesh Institute of Peace and Security Studies (BIPSS)	Research Associate
Sonia Taleb	Bangladesh Institute of Peace and Security Studies (BIPSS)	Research Associate
Shawpna Neer	Socio-economic Development Programme (SDP)	Executive Director
Masud Akbar	Char Development and Settlement Project 3 (CDSP-III)	Advisor
D. K. Chowdhury	Char Development and Settlement Project 3 (CDSP-III)	Land Settlement Advisor
Koen de Wilde	Char Development and Settlement Project 3 (CDSP-III)	Project Leader
Harun ur Rashid	Former UN Ambassador	
Netai Chandra Dey Sarker	Disaster Management Bureau (DMB)	Assistant Director
Mahjabeen Khaled Hossain	Institute of Hazrat Mohammad (SAW)	Director Programs
Wang Xuemei	Xinhua News Agency, Dhaka Bureau	Correspondent
Atiq Rahman	Bangladesh Centre for Advanced Studies (BCAS)	Chairman
Shah Ashraful Admin	Bangladesh Centre for Advanced Studies (BCAS)	Senior Research Officer
Dwijen L. Mallick	Bangladesh Centre for Advanced Studies (BCAS)	Research Fellow
Shahid Hossain	Department of Environment (DOE) / UNDO / GEF	Agriculture Extension Officer