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GEOGRAPHY AS A FACTOR TO THE ENVIRONMENT
SECURITY OF BANGLADESH

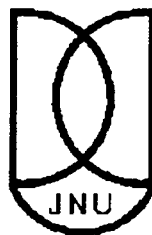
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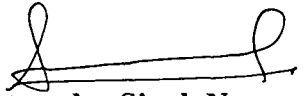
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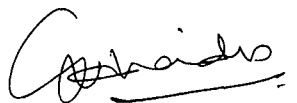
DECLARATION

I declare that the dissertation entitled “**Geography as a factor to the Environment Security of Bangladesh**” submitted by me for the award of the degree of **Master of Philosophy** of Jawaharlal Nehru University is my own work. The dissertation has not been submitted for any other degree of this University or any other University.


Satyendra Singh Narwaria


CERTIFICATE

We recommend that this dissertation be placed before the examiners for evaluation.


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DEDICATED

TO

Those who are vulnerable to natural

Hazards

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
BANCID	Bangladesh National Committee of ICID
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BDR	Bangladesh Border Guard
BSF	Border Security Force
BUET	Bangladesh University of Engineer and Technology
BWDB	Bangladesh Water Development Board
BWFMS	Bangladesh Water and Flood Management Strategy
CDMP	Comprehensive Disaster Management Plan
CEGIS	Center for Environment and Geographic Information Services
CHT	Chittagong Hill Tract
COP	Conference of Parties
CRI	Climate Risk Index
DDM	Department of Disaster Management
DSSAT	Decision Support System for Agro-technology Transfer
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organisation

FAP	Flood Action Plan
FCDI	Flood Control Drainage and Irrigation
FY	Fiscal Year
GBM	Ganges-Brahmaputra-Meghna
GCM	Global Circulation Model
GDP	Gross Domestic Product
GFDL	Geo Fluid Dynamic Laboratory
GHG	Greenhouse gasses
GoB	Government of Bangladesh
IGCSE	International General Certificate of Secondary Education
ICID	International Commission on Irrigation and Drainage
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IWFM	Institute of Water and Flood Management
IWRM	Integrated Water Resource Management
MAF	Million Acre Feet
MDG	Millennium Development Goals
MFDM	Ministry of Flood and Disaster Management
MoEF	Ministry of Environment and Forest
NAPA	National Adaptation Programme of Action
NBR	National Bureau of Asian Research

NGOs	Non-governmental Organisation
NTS	Non-traditional Security
NWP	National Water Plan
OECD	Organization for Economic Cooperation and Development
PPT	Parts Per Thousand
PRECIS	Providing Regional Climates for Impact Studies
SAARC	South Asian Association for Regional Corporation
SMRC	SAARC Meteorological Research Centre
UNDP	United Nation Development Programme
UNEP	United Nation Environment Programme
UNFCC	United Nation Framework on Climate Change
WAPDA	Water and Power Development Authority
WARPO	Water Resources Planning Organization
TK	Taka

GLOSSARY

Aman	Rice crop cultivated in Kharif-2 season (July to December)
Aus	Rice crop cultivated in Kharif-1 season (April-July/August)
Baor	A Baor is known as oxbow lake in Bangladesh, it is synonyms to Beel
Beel	A beel is a term for a pond with static water in Bangladesh
El Nino	A warm ocean current of variable intensity that develops after late December along the coast of Ecuador and Peru and sometimes causes catastrophic weather condition
Haor	A haor is a wetland and back swamp in the north eastern part of Bangladesh
La Nina	A cooling of the surface water of the eastern and central Pacific Ocean. occurring somewhat less frequently than El Nino events but causing similar, generally opposite disruptions to global weather patterns
Plabon	Exceptionally severe floods and these devastate the livelihoods of people and cause havoc to the national economy
Taka	Currency of Bangladesh

CHAPTER I

INTRODUCTION

Security is the ultimate quest for all (Islam 1995: 326). It is a universal experience and constant preoccupation of mankind in its individual, social and corporate existence (Hafiz and Khan 1987). Traditional definitions of national security “encompass the security of the nation state. This includes protection of its territorial integrity, its sovereignty and its basic national interests.” With the change in security scenario, it becomes difficult to separate internal and external threats to security. Protection of the state from any attack by other states is seen as the traditional definition till the Cold War. But, post Cold War, a new as well as dynamic theme was added in the study of international security. As several scholars also say that the traditional concepts and definitions for instance the notion of state-centric security, defined by military aspects, is insufficient to explain emerging security threats.

During the cold war period, the notion of security was mainly understood in relation to the security of the State; in terms of conserve its regional integrity and political sovereignty. In the 80’s the idea of security was expanded that included not only the military and territorial security of a state, but also human, economic and environmental issues. Pathania (2003) argues that “still the central objective of security remained the state, even as this concept was broadened, the taboo to deepen it i.e. to enlarge the notion of security in order to reach the human being was still there, it was only during the 90’s that the security paradigm was deepened and the security of the individual was put at the center of security strategies (human security). The paradigm shift in the concept of the security studies has been from State towards individual and second, expansion in the analysis of military dimension in order to reach non-military threats to the individual. The late 20th century has seen a rise or prominence of non-traditional security issues.”

The world has witnessed in silence substantial change in threat perception post-Cold War era. The traditional security concerns have now given way to a comprehensive approach to security. Four main types of threats have been identified: territorial, economic, political and environmental threats. Barry Buzan has suggested that “there are primarily five major

sources of threats to any nation-state's national interest. namely. military, political, economic, social and environmental, though these are not in ascending order of importance" (Buzan 1991: 431-451).

However, national security also includes national defence and foreign relations of a state. Specially, it refers to the requirement for a state to maintain its sovereignty and survival by employing economic, political and military power and through the application of diplomacy. Core component of national security are geopolitical and geostrategy, which rely heavily on spatial analysis and interpretation of spatial patterns and dynamics within discrete natural and human landscapes. Geopolitics is the practice of exerting political power over world space to attain national objectives and also involves the influence of geography on politics. The fundamental principle of geopolitics and by extension national security is that power can be derived from geographical space (Galngano 2011: 221). Gray (1998) describes that "the development of geopolitical strategy is thus achieved by examination of the political, economic and strategic significance of geography, with geography being defined in terms of the location, size, function, resources and relationship of places" (cited in Galngano 2011: 221).

Halford Mackinder first recognised geopolitical reality in 1904 when he published his seminal précis on global strategy that define that geostrategic analysis, world history demonstrated a pervasive struggle between land and sea power. However his core hypothesis was that the Heartland power had interior lines, central position, expanded productivity and impenetrability, which provided a clear advantage over sea power states regions along the margin. Thus, the Mackinder's theory says that "Who rules East Europe Command the Heartland; who rules the Heartland Commands the World Island; who rules the World Island Command the World" (Mackinder, 1904).

In Barnett's (2004) point of view the national security geography suggested that underlying reasons for the emergent threats in the pervasive spread of failing states (countries), especially in the so called non-integrating gap, that are readily exploited by all ill-intentioned groups. The role of geography will expand to include the national security aspects of cross-border migration, import commodities and the international of money, all which are spatial phenomena lending themselves to spatial analysis.

National security is the most significant determinant of the any nation-states foreign policy. "Foreign policies perforce, have to take into account the prevailing regional and international

strategic realities with which a nation has to strike workable equations based on one's own existing power attributes and strategic utility to the key global powers" (Kapila2004). Foreign policies of country should be bilateral support, with the change of political power national interest should not be changed.

Furthermore, Singh describes that "the fast depletion of natural resources, resulting in the scarcity of resources and the degradation of the environment, and the growing conflict over resources within and between the states have given rise to a gearing concern for environmental security all over the world. It is accepted globally that environmental degradation poses a threat to the national security" (Singh 2011: 186-86). Riftin (1991) describes that "there is close relation between the environment degradation and national security. In the recent years, it has been widely accepted that environmental security is a significant dimension of the national and regional security frameworks of the nation-states" (cited in Singh 2011:186).

1.1 Security: A Traditional Concept

The word "security" is taken from the Latin term *sine cura* which means "freedom from care". The concept of security being a fundamental one is elastic and ambiguous. Robert Art (1993) defined "security in subjective aspect that is; to be secure is to feel free from threats, anxiety, or danger" (cited in Brauch, 2003:53). "The traditional concept of national security is concerned with direct that is military threats to security that may influence on the sovereignty or territorial integrity of a state. This may vary from direct military attack to intimidation through the purposeful display of force." (Osmany and Ahmad 2003:71)

The military approach to national security is based on assumption that the main threat to nation comes from other nations. Walter Lippmann, who has defined national security in absolute terms, said, "a nation is secure to the extent to which it is not in danger of having to sacrifice core values, if it wishes to avoid war and is able, if challenged, to maintain then by such victory in such a war" (cited in Naruzzaman 1991: 369). Traditionally, the purpose of security "was limited to the security of territory external aggression or the protection of national interest in foreign policy or of nuclear holocaust." Today, the purpose of security has been considerably broadened and now it has become state centric to individual centric.

Thakur (1997:52) defines that "the term security has never had a precise definition and any attempts to provide a precise definition in fruitfulness, as the concept in weakly conceptualized, increasingly contested and notoriously slippery. With changes in the nature of

threat to national security, we are also seeing parallel changes in the approaches to the attainment of national security. The predominant geopolitical understanding of security was tied closely with state secrecy, nuclear and military power, diplomacy and intelligence.” According to Dalby (1990), “Cold War version of security has usually been understood in spatial terms as moves for exclusion and protection is a spatial exercise in distancing and boundary making”. Alam (2002:28) describes that “the concept of security by raising the following questions by way of a preamble.

- a) What are the threats to security: security from what threats-military, political, nuclear, economic or environmental?
- b) What are the instruments of security: by what means is security to be achieved- military, political, nuclear, economic, diplomatic or environmental?
- c) Who are the objects or referents of security: for whom are security intended- individuals, community, regime, state or world?
- d) What are the needs for security: security for what territorial integration, freedom from fear and wants or development?
- e) What are the costs of security: at what price to the economy and to social and political values can security be achieved?”

To answer the above mentioned five questions by scholars have been changing since the end of cold war. Traditionally national security weaved into a statist military framework. According to Kaldor (1990), “cold war understanding of security emphasized military, ideological definitions and social problems.” Richard Ullman (1983: 129-153) has advocated “an extension of security concept to include a wide range of threats from natural disaster and diseases to environmental degradation. Further Ullman argues that the reformulation of national security in terms of protecting against events that threaten to degrade the quality of life for the inhabitant of the state: among these threats the instability to meet basic needs, environmental deterioration and natural disasters. From the economic perspective Robert McNamara defined security means development” (cited in Islam, 1995: 326).

In McNamara (1966) point of view, “security is not military hardware, though it may include it; security is not military force, though it may involve it, security is not traditional military activity, though it may encompass it. And security is development and without development there is no security.” Azar and Moon (1984) states that “the security situation of many third world countries is often far more concerned with internal factors: threats to state security

arising from various combinations of ecological, economic, military, ethnic and secessionist difficulties” (cited in Dalby 1992:103).

“Traditionally, the purpose of security was limited to the security of territory from external aggression or the protection of national interest in foreign policy or the global security from the threats of nuclear holocaust” (Alam 2002: 32). Jackson (1992) view of security is that “the purpose of security has been considerably broadened, security is necessary so that vulnerable human may enjoy the economics and other advantages of living together in the society while limiting the risks” (cited in Alam, 2002:32). Alam further describes that “as a matter of fact, draconian poverty, rising unemployment, increasing socio-economic inequalities, rapidly growing population, massive external debt and deteriorating environmental resources are responsible for insecurity of the third world countries. The socio-economic development of the people of the country is the major security concern for the third world nation.”

1.2 Non-Traditional Security

The concept of non-traditional security became an integral and significant part of the international security discourse since the end of the Cold War. “There was a debate that grew out of dissatisfaction with the intense narrowing of the field of security studies imposed by the military and nuclear obsessions of the Cold War” (Buzan 1998: 2). “Scholars have reflected on what the field of security studies should be and the direction it should take” (Emmers 2005: 2). According to several scholars, the non-traditional security issues include ecological degradation, HIV/AIDS, drugs and human trafficking, ethnic conflicts, illegal migration among others.

“In January 1992, the first Summit of Heads of State and Government of the Security Council issued a statement that the traditional view of national security was no longer applicable in the late twentieth century, and now extended to various other issues, including humanitarian needs and the environment. Non-traditional security threats can thus be defined as challenges to the survival and well-being of peoples and states that arise from non-military sources, such as climate change, resource scarcity, infectious diseases, natural disasters, illegal migration, food shortages, human trafficking, drug trafficking and transnational crime” (RSIS 2010).

Kanti Bajpai (2000) argues that “the most important forerunners of the idea of NTS/ human security were the reports of a series of multinational independent commissions composed of prominent leaders, intellectuals and academicians. Non-traditional security is the major issue in

the top of the security agenda of many countries and Bangladesh is one among them. However the security is also defined by states in economic, environmental and demographic terms.”

In 1991, a Stockholm initiative on Global Security and Governance issued “a call for common responsibility in the 1990s which referred to challenges to security other than political rivalry and armaments and to a wider concept of security, which deals also with threats that stem from failures in development, environmental degradation, excessive population growth and movement, lack of progress towards democracy.”

In 1992, Agenda for Peace, the United Nations secretary general Boutros Boutros-Ghali stated that, “Drought and disease can decimate no less mercilessly than the weapons of war”. The present study links the geographical degradation and security threat in the terms of non-traditional aspects. Also, the notion of the security in this way is confined in the non-traditional term that includes environment security, human security, energy security, water security, etc.

Thus, it can be said that the present world is facing the most critical non-traditional security threats and they are enumerated as follows:

- 1) Problems related to environment: This includes pollution and water dispute; energy and food shortage; natural calamities and change in climate.
- 2) Problems related to population for instance growth of population, migration, refugees and health-related issues.
- 3) Another is drug trafficking at global level; organised crime; internal turmoil; and marauding.

These problems vary from country to country. These threats can be reduced by the management of resources, policy and public awareness. As per the analysis the report published by National Bureau of Asian Research (2011) on Ecological and Non-traditional Security Challenges in South Asia states that “the last two decades have witnessed growth in a wide range of domestic and international non-traditional threat, such as environment disasters, ecological degeneration, air and water pollution, contagious diseases, drug and small arm trafficking, cross border movement and internal displacement, financial shocks, cybercrime, terrorism and organised crime and religious, ideological and ethnic extremism.

1.3 Environment and Security Linkages

Environmental security has introduced an interdisciplinary perspective into security studies. “Environmental security encompasses the interactive dynamics of the diverse human and natural networks that constitute the modern world” (Matthew and Mcdoland 2004: 36). “The link between environment and Security has a long history that suitable to understand relation between both of these. Furthermore, environment as a resource has strategic significance for nation-states who build power through natural resources like water, oil, gas, and various other minerals” (Biswas 2011: 1).

After 1980s, there are mainly two groups that define relationship between environment and security:

(1) The environmental policy community group that addresses the security assumption of environmental change and security.

(2) Second group of security community, which will look at new definitions of national security especially in post-cold war era.

In the past, the security concept was normally seen as a synonym for national security with two main objectives:

(1) To secure the regional integrity of the State

(2) To protect the approved form of government, through political and military means.

“Additional to the traditional security aspects, other non-traditional threats to security, e.g. economic decline, social and political instability, ethnic rivalries and territorial dispute, international terrorism, money laundering and drug trafficking as well as environmental stress, have been incorporated” (Dixon 1991).

The American Council for the UN University (ACUNU, 2003) has undertaken an environmental security study under its millennium projects, which attempted “to link environment and security”. According to this study, “the elements of the definition of environmental security clustered around two central concepts:

a) Repairing damage to the environment

b) Preventing damage to the environment from attacks and other forms of human abuse.

This project suggested five definitions which were presented to the international panel but the following two suggestions received the highest rating and they are as follows

- a) Environmental security is the relative safety from environmental dangers caused by natural or human processes due to ignorance, accident mismanagement or design and originating within or across national borders and
- b) Environmental security is the state of human environment dynamics that includes restoration of the environment damaged by military action and amelioration of resource scarcities, environmental degradation and biological threats that could lead to social disorder and conflict.

Traditionally, the realist understanding of security does not include the environment as a matter of concern. However, post-realist scholars do include the environment as an important security concern." Hassan (1991:56) discusses "the relationship of environmental degradation of a nation and its effect on the economy. By his argument, continuous environmental calamities decrease the economic growth of a nation, hamper its social cohesion, and destabilize its political structure. Environmental change reduces economic opportunities for a country by causing demographic displacement within states and across international borders. Environmental stress can also cause an affected sub-national group to shift its allegiance from the centre to the periphery, increasing the possibilities of political disorder, civil strife, and even insurgency." (Hassan 1991:58)

According to Deudney (1991), "the concept of national security, as opposed to national interest or well-being, has been centred upon organised violence. He gives the example of natural calamities like earthquakes or hurricanes that had caused excessive damage; he opposes the notion that such events are threats to national security. In 2000 International Union for Conservation of Nature (IUCN) and Organization for Economic Cooperation and Development (OECD) report advocates the idea that security and insecurity are closely related to poverty, resource scarcity, and social discrimination. This approach also advocates that environment-induced conflict is one of the many factors influencing individual or societal security."

Lodgaard (1990: 17) relates that "there is a conceptual kinship which makes it natural to speak of security in both connections, under certain circumstances, irreparable environmental degradation or ecological system in dramatic change may increase the likelihood of violent

conflict erupting.” The Oslo Workshop (1986) on the linkages between environment and security emphasised, theorist must move beyond traditional thinking about security concepts and being considering a series of environmental factors underpinning the material welfare and these factors include such natural resources as soil, water, forests, grasslands and fisheries, all prime component of nation’s natural resources base. They also include climate patterns and physiologic cycles that maintain the life support system of nation.” (Islam1995: 327). Therefore there are number of aspects by which environment security relationship can be viewed. Conflict over the resources is another dimension of environment and security relationship that share by the number of countries.

Today, the environment security has become an important dimension of the national and regional security frameworks of the countries and it has been widely accepted by the research scholars. Therefore, the concern of human beings to the environment has been always and obvious. But it is now only that the concern for the environmental security is being advocated.

So the link between environment and security is still being worked out. The Stockholm Conference on Environmental Stress and Security in 1988 stated that “so far, most of these statements of interconnections between environmental degradation and security are hypothetical. It further argues that a need for sound empirical research to find out whether these hypotheses are valid or should be scrapped as only apparent truths.”

1.4 Environment Security: A Conceptual Framework

Environmental security represents a significant departure from traditional approaches to study. The environmental security as a concept was precisely brought up the first time in 42nd Session of the General Assembly of the United Nation in 1987. Since then, it has become a significant aspect of security studies both in theoretical and empirical contexts. At the Stockholm conference on Environmental Stress and Security in 1988, the Swedish minister of Environment and energy pointed out, “so far most of these statements of interconnections between environmental destruction and security are hypothetical”.

According to the World Commission Report (1987) on environmental and development (Brundtland Commission Report) titled “Our Common Future: The whole notion of security as traditionally understood in terms of political and military threats to national sovereignty must be expanded to include the growing impact of environmental stress locally, nationally, regionally, and globally. There is no military solution to environmental security.” The report

further says, “We have in the past been concerned about the impacts of economic growth upon the environment. We are now forced to concern ourselves with the impact of ecological stress upon our economic prospects.” (Ibid 5). “It has been widely accepted that the indiscriminate attitude of the people and the governments towards the environment, the self-interest, over exploitation of resources, etc., have caused scarcity of resources and their fast depletion as well as degradation of the environment. This has caused conflicts and violence among and between the states.” (Thomas and Dixon 1999).

According to Buzan (1983:83). “threats to national security might also come in ecological forms, in the sense that environmental events, like military and economic ones, can damage the physical base of state, perhaps to sufficient extent to threaten its idea and institution.” Similarly, Lodgaard (1986:251) feels that “the concept of environmental security challenges established frames of mind and political conflicts and it conveys a message that environmental problems have a legitimate claim for status as military problem have.” Brock (1991:408) defines environmental security “as the avoidance of negative linkage between environment and human activities. This includes the avoidance of warfare, war over natural resources and also environmental degradation, which he defines as a form of war.

Above mentioned arguments gives an idea that environmental security threat of a nation and its people are not only traditional but also economic as well ecological.” Another scholar Myers (1989: 23-41) states that “there is the clear cut link between environment and security beyond the realist framework of environment security. Further he argues that if a nation’s environmental foundations are depleted, the idea goes, its economy may well decline, its social fabric may deteriorate and its political structure may become destabilised. Lodgaard defines it from the realistic perspective that the environmental security is being a dependent variable, thus takes on the meaning of security of the environment involving three elements” (cited Gaan, 2005:198). He further describes environment security in the following ways

- a) “The sustainable use of renewable and non-renewable resources
- b) Protection of the elements- air, water, soil so as to prevent pollution from shifting natural regeneration and
- c) The maximum reduction of hazards related to industrial activities.”

Table 1.1 is giving general idea about the major threat to environment security.

Table 1.1 Threats to Environmental Security

Scale of threat	By Ignorance and /or mismanagement	By intention	Mix of natural and human action.
Within a Country	Oil spills in coastal areas.	Sarin gas attack in Tokyo subway.	Floods
	Aral sea depletion in Russia.		Famine
	Haze from forest blaze.	Chemical attacks and draining marshes in Iraq.	Salinization
	Ground water contamination Arsenic problem.		Earthquakes
	Fresh water scarcity.	Poisoning, diversion or misuse of water resources.	Introduction of exotic species.
	Hazard wastes and soil erosion.		
	Human settlement and development pattern.		
Trans-border	Forest depletion.	Burning oil field in Kuwait.	Global warming.
	River usage (Jordon, Nile, Tigris, Euphrates, Ganges).	Dam construction and water diversification.	New emerging and drug resistant diseases – AIDS and others affecting human, plants and animals.
	Chernobyl nuclear accident.	Biological weapons.	Desertification.
	Diminishing bio-diversity.		Population growth.
	Ozone depletion.		Rich-Poor gap.
	Fisheries depletion.		
	Global climate change.		
	Acid rain and air pollution.		
	Poverty		
	Radioactive waste.		

Source: Adapted from ACUNU study on environmental security, 2003 in Khan (2005), Environment security in the context of Bangladesh, Dhaka, *BISS publication*, Vol, 26, NO 2, p 165

“So the correlation between national security and its environment components is seen from, first, the direct environmental causes of conflict, where the environmental problems such as water, trans-border pollutions, are directly the bone of conflict between nations and second the indirect environmental factors of conflicts where environmental problems not the main insecurity factor but the accessory insecurity factors in association with pre-existing, political, economic, social and military contexts exacerbate the situation adding a new dimension to them or acting as catalysts.” (Ibid 123) .

Before going into details, first it is important to know in general about geographical characteristics of Bangladesh that underpin the environment security from both internal and external sources. The location of Bangladesh, physiography, river system and climatic behaviour of country has put significant impact on the environment of the country that makes environment as a security threat to the Bangladesh. The major geographic aspects of Bangladesh are as follows:

1.5 Geography of Bangladesh

Geographically Bangladesh is small country (143999 sq. km) with huge population size (142.5 million in 2011) (BBS, 2011). The country has more concentration of population compared to its resource availability. Agriculture employs directly or indirectly three-fourth of the country's population and contributes nearly 30 per cent to the GDP (BBS 1997). Land, water, forest, fisheries are the most significant natural resources of the country that is steadily declining. Thus, the major source of income in Bangladesh is mainly derived from agriculture sector.

1.5.1 Geographic Location

“Bangladesh is located between 20°34' to 26°38' north latitude and 88°01' to 92°42' east longitude” (Rashid 1991: 1). The country is surrounded from three sides by the three Indian states (Assam, Tripura and West Bengal) and on the southeast by Myanmar. Southern part of Bangladesh is surrounded by the Bay of Bengal (See Map 1.1.).

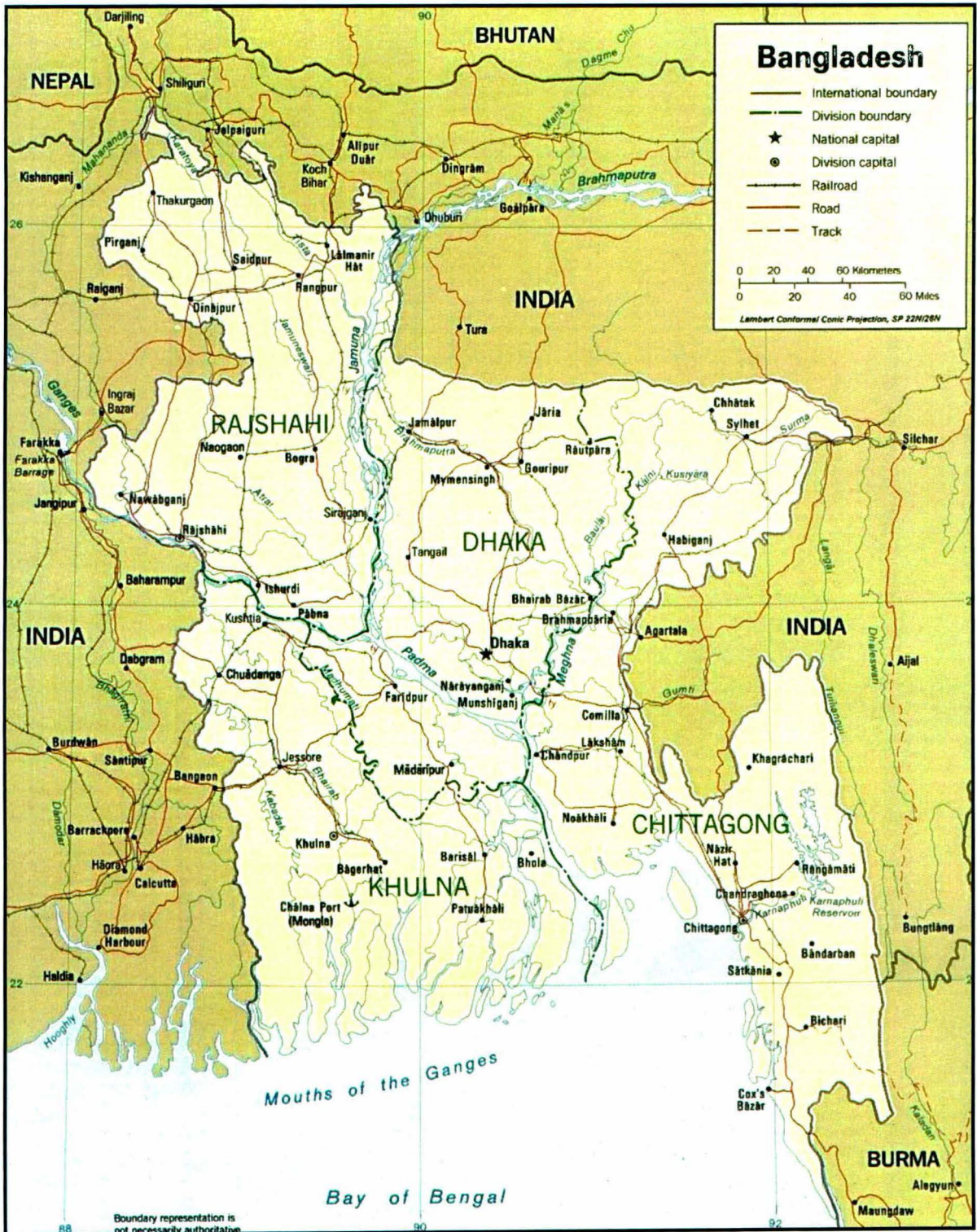
1.5.2 Physiography

Physiography in simple parlance means the physical nature of objects, especially of natural features. Rashid said that the physiographical Bangladesh can be classified into three incisive regions

- Floodplains
- Terraces
- The hills” (Rashid, 1991:1)

“Floodplains are possessed of recent alluvial deposits and cover 80 per cent of the total area of country and the terraces occupying about 8 per cent of area include the Madhupur tracts in the center and the Barind tracts in the north east” (Huq and Hoque 2012: 3). The hills occupy the remaining 12 per cent of the total area of the country and are confined in the south eastern

Map 1.1 Location Map of Bangladesh



Source: URL: http://www.lib.utexas.edu/maps/middle_east_and_asia/bangladesh_pol96.jpg access on 21 June 2013

Chittagong hill tracts (CHT) and north eastern Sylhet district. Based on the regional differences of these factors they are further divided in to 20 major physiographic units (See map 1.2). The physiography of Bangladesh is acutely decumbent with relief ranging between 1 and 2 metres. About 20 per cent of the country area dwells under the tidal plains where elevation is less than 3 metre above mean sea level. Because of flat terrain rivers having extremely low inclination that causes severe threat to the country.

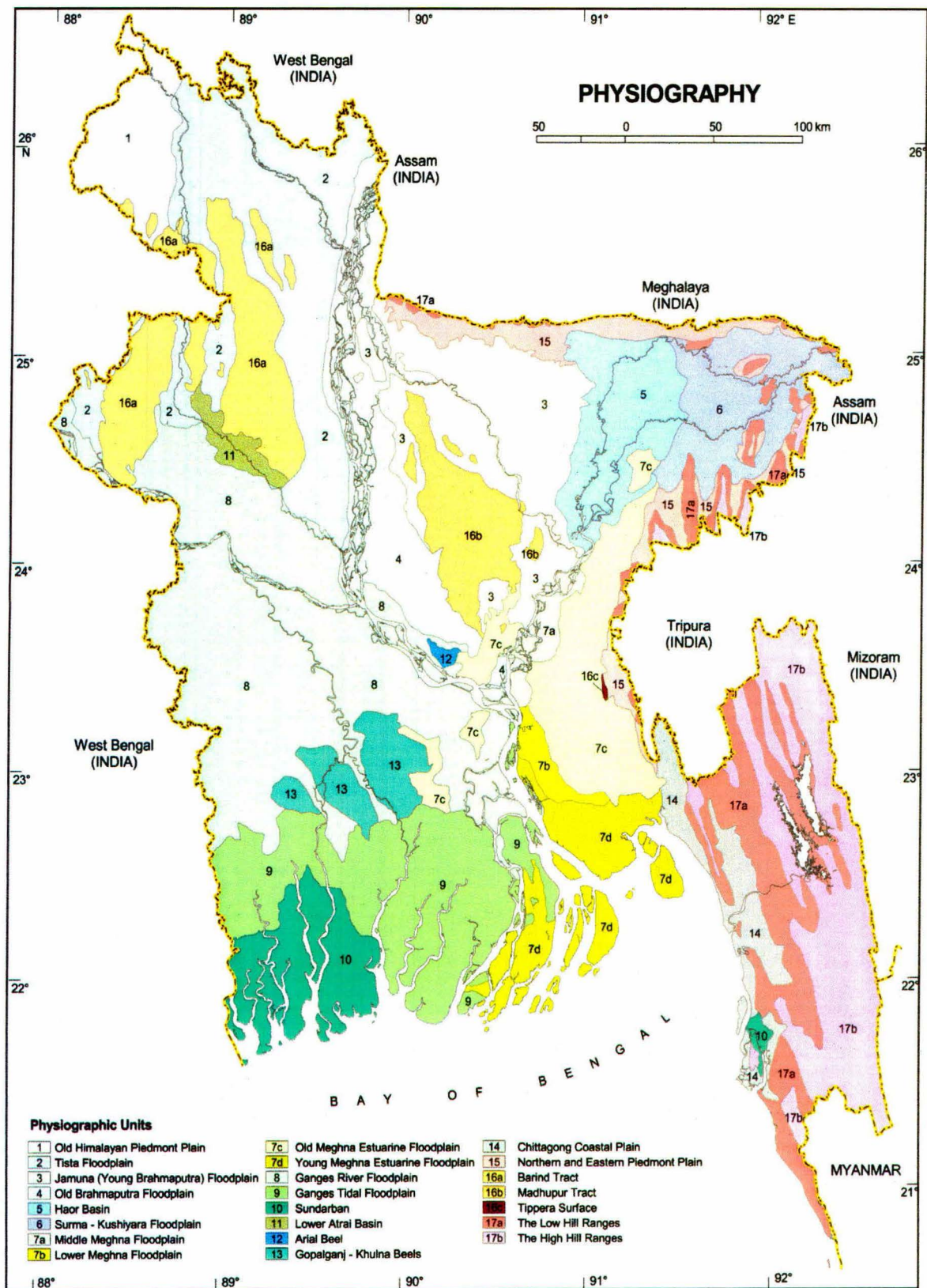
“This delta is classified by flat terrain interlaced with the intricate system of rivers and tidal channels, which brings an enormous quantity of sediment-laden water downstream. It is estimated that in an average year 870 million acre-feet of water flow into the country from India.” (Rashid 1991: 43)

River System

Rivers compose the most important geographical aspect of Bangladesh. Therefore the country generally called the land of rivers (See Map 1.3). The Ganges, Brahmaputra and Meghna river systems together, drain the extensive surplus water generated from large area with the maximal precipitation areas in the world. “Several large rivers and their tributaries (a total of 230) create a river delta that comprises nearly 90 per cent of the country.” (World Bank 1989). “Three major rivers of Bangladesh, The Ganges-Padma, The Brahmaputra-Jamuna and the Meghna along with their diverse tributaries and distributaries scatter the whole country apart from Chittagong sub-region where the Karnaphuli River and other bitty mountain stream flows Ganga that originated from the southern slopes of Himalayas and it has length 2200 km (1370 miles) up to Goalundo and 2526 km (1570 miles) to the mouth of Meghna and a drainage area of 977500 sq. km up to Goalundo.” (Rashid 1991: 58) “It adjoins with Brahmaputra-Jamuna at Goalundo after flows another 112 km in Bangladesh. Mahananda is the major tributary of Ganga which adjoins it left bank at Rajshahi.

“Brahmaputra-Meghna is second largest river which enters in to Bangladesh from Indian State Assam. In the rainy season the river is nowhere less than five kilometres broad, and often ten kilometres or more.” (Ibid 50) The main course of river flows to the south through a wide and highly unstable channel, filled with island and sandbars, built from its own sediments, until it meets the Ganges-Padma at Goalundo. The third major river Meghna has its catchment area the north-eastern plateau of India. Therefore, its river system has a deep impact on

Map 1.2 Physiographic Regions of Bangladesh



Source: URL: Banglapedia.org/map/mp_0166.GIF access on 21 June 2013

Bangladesh's culture, economy and politics. These rivers have less than the required amount of water in the dry season and cause floods in the monsoon. The river system creates an ecological imbalance in Bangladesh. Country is also richly endowed with numerous perennial and seasonal water bodies known locally as haors, beels, baors, khals, pukurs and dighies. Rivers, canals, beels, lakes, and haors are open wetlands, while baors, dighis, ponds, and ditches constitute closed ones.

1.5.4 Climate

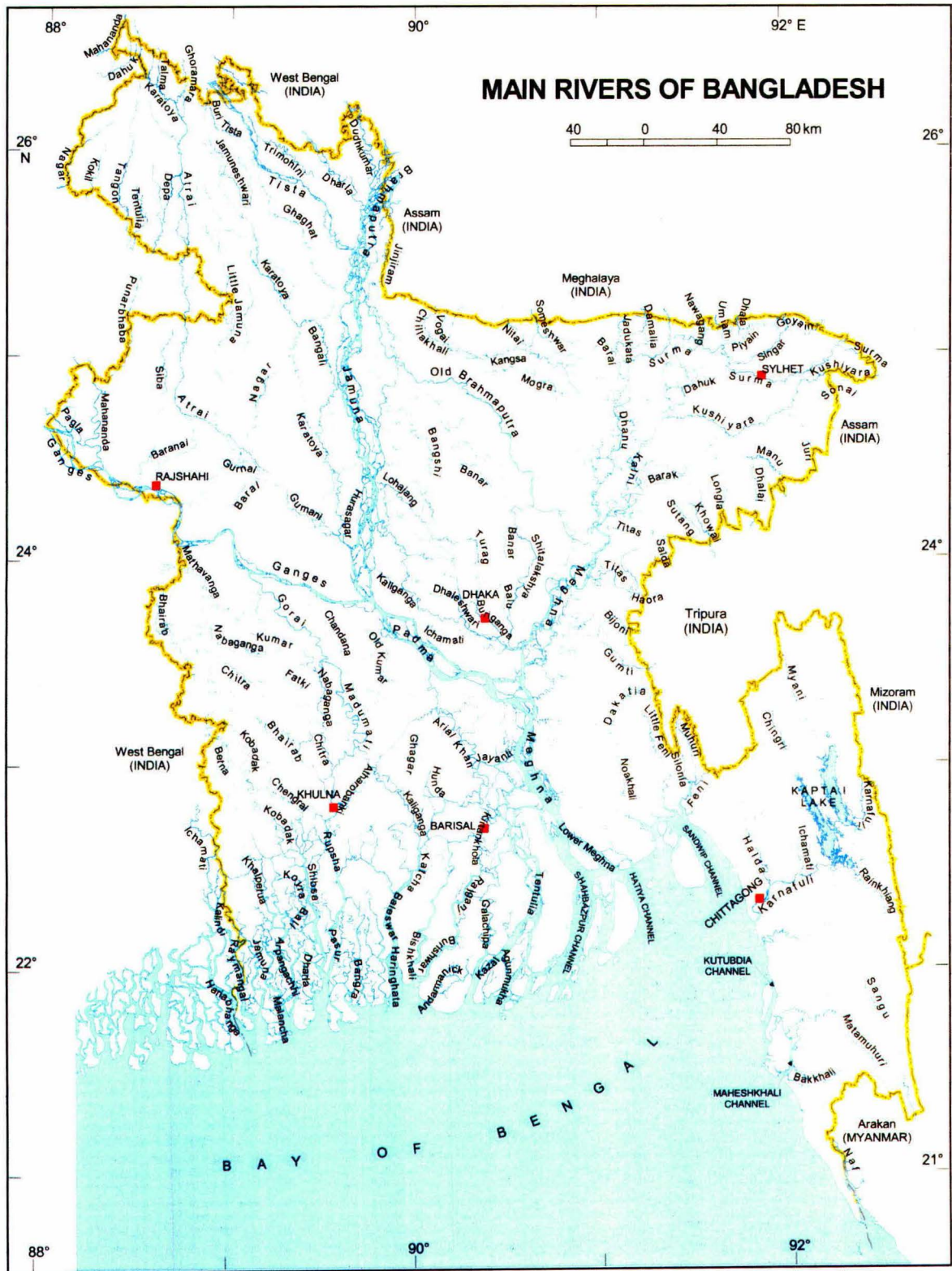
“Bangladesh’s climate can be identified by high temperatures, enormous humidity, and adequately clear seasonal departure of precipitation. Though more than half the area of Bangladesh is situated in north of the tropics, the effect of the Himalayan mountain chain makes the climate more or less tropical throughout the year.” (MoEF 2005)

“The climate is contained essentially by summer and winter winds, and partly by pre-monsoon and post-monsoon circulation. The country has an almost uniformly humid, warm, tropical climate. There are three main seasons

- a) A hot summer season, with high temperatures (5-10 days more than 40 °c maximum in the west), higher rate of evaporation and erratic but heavy rainfall March to June
- b) A hot and humid monsoon season (temperatures ranging from 20 to 26 °c), with heavy rainfall from June to October
- c) A relatively cooler and drier winter from November to March (Temperatures ranging from 8 to 15 °c), when minimum temperature can fall below 5 °c in the north though frost is extremely rare (MoEF, 2005). Rashid describe that Bangladesh can be broadly divided into seven climatic zones. (Rashid: 1991)

Report published by Ministry of Environment and Forest (2005) sates that “in recent years, due to global warming, Bangladesh environment is under threat. Besides the regular disasters like drought, flooding, Nor`wester, tornado, cyclone and tidal surge, Bangladesh is also susceptible to sea-level rise and large scale inundation of its low lying land due to global warming.” So it can be said that the above mentioned geographic character provides major threat to the environment of Bangladesh. If the geography of a country declines then there is pressure on resources. Frequent occurrences of flood in Bangladesh also creates problem for the environment and people of Bangladesh.

Map 1.3 Major Rivers of Bangladesh



Source: URL: http://www.bpedia.org/R_0207.php access on 21 June 2013

If there is decline in geography that will adversely affects the natural resources on the country and that will create a problem for the development of the nation. Bangladesh is situated in the Bengal Basin, which is one of the largest geosynclinals in the world. It is bordered on the north by the steep Tertiary Himalayas, on the northeast and east by the late Tertiary Shillong Plateau, the Tripura hills of lesser elevation and the Naga-Lusai folded belt, and in the West by them order at Ely high ancient Chota Nagpur plateau. The geographical setting makes Bangladesh particularly vulnerable to cyclones, storm surges and tornadoes.

1.6 Significance and Scope of the Study

The present study is done as Bangladesh is one among the most vulnerable places on the earth in the terms of its geography, resources, location and its physiographic landscape. "Bangladesh is extremely vulnerable to non-traditional security threats that include food and water security, health security, environmental security, illegal migration and human trafficking and transnational crime and transnational terrorism, among others." (Sobhan 2012: 3). These threats vary in severity and the level of exposure by groups or individuals depend on their geographic location as well other issues such as the level of income and access to aid.

"Bangladesh is surrounded on three sides by India along a 4,094-km land border). These results in near total geographical domination of India except for the 193 km. land border that Bangladesh shares with Myanmar" (MoEF 2011). India's overarching presence in South Asia has been a major cause for concern for all its smaller neighbours and especially to Bangladesh as this country is clearly locked by India in land and water except a little border with Myanmar. Geographical location of Bangladesh and fragile topography play a vital role for people from both the sides to cross the border. North Eastern India is directly connected to Bangladesh. As per the government survey, "the geographical proximity and uneven topography provide the people to cross the border that causes the conflict in both the sides."

"The geographical location of Bangladesh also makes it subject to various climatic features that make it more susceptible to abnormal storms and tornadoes. Intense ground heating during pre-monsoon months can influence the normal seasonal winds that bring rain, the Nor'westers, into forming the swirling, high-speed winds of a tornado. The location of various major and minor faults near Bangladesh also makes it vulnerable to the effects of earthquakes and tremors. The Bay of Bengal is the breeding place of catastrophic cyclones. It occupies an area

of about 2.2 million sq. km, and is 1,609 km wide, with an average depth of more than 7912 metres, and the minimum depth is 4,500 metres.” (Rashid 1991: 41)

“The main sources of degradation of environment in Bangladesh are rooted in factors like, high concentration of population in the country; scarcity of resources, underdevelopment, chronic poverty and the drive for telescopes the development in more advanced countries. About the 149 million people live in Bangladesh with a surface area of 147 thousand square kilometres” (BBS 2011). Report published by Bangladesh Bureau of Statics on the Population and Housing Census of Bangladesh (2011) states “the density of population as 964 people per square kilometre. The country lies at the confluence of the three of the world’s major rivers. the Brahmaputra, the Ganges and the Meghna which originates from the Himalayan system and flow through China, Nepal and India before passing through Bangladesh as they drain out into the Bay of Bengal.”

Report Published by the Ministry of Forest and Environment on state of environment Bangladesh (2001) describes that “Bangladesh is criss-crossed over 200 rivers which pass through the country on a north to south trajectory. With a total length of approximately 24000 kilometres, these rivers cover about 7 per cent of territory of Bangladesh” (Ibid 41). “Flood plains occupy 80 per cent of the territory, hills 12 per cent and uplift block 8 per cent of the total territory of the country” (Sabur,2001: 92). The most dangerous threat from the geographical degradation is perhaps the arsenic contamination of its ground water, almost the sole source of drinking water in the country. According to study publish by the World Health Organisation (WHO) in 2000 in Geneva, “Bangladesh is facing the largest mass poisoning of a population in history because of arsenic contamination of its drinking water supplies. But the naturally occurring inorganic arsenic poisoning in the ground water has overturned these health benefits.”

More significant are Bangladesh’s attempts to woo an extra-regional power, namely China, to prevent New Delhi from asserting regional supremacy in its relations with Dhaka, something for which other states in the region, including both Pakistan and Nepal, have also frequently used China. The geography provides it’s a great condition to develop a favourable relation with the East Asian nation and the west nation also. The maritime boundary also has significant impact on the neighbouring countries relations in the context of political, economic, as well as geographical. The non-traditional threats posed to emanate considerably from the regional and global sources.

This study seeks to explore about the geography as a factor to environmental security threat to Bangladesh. This study mainly talks about the non-traditional security that includes environment security. That further includes the degradation of environment, causes and impact on Bangladesh. It also talks about the degradation of environment in Bangladesh and its causes and impact on the nation.

Bangladesh the largest deltaic region of the world is a small state overarched by the geographical presence of India. Its idea of security is in tune with the Barry Buzan's idea that "domestic threats to a weak state can almost never be isolated from the influence of outside powers, thus entangling domestic security problems with its external relations. Buzan further states that the tyranny of geography is the most important factor in the defence-vulnerability of the small states," (cited in Pathania 2003).

Moreover these studies suffer from serious limitations. Most of these studies have dealt with a dispute between Bangladesh and India over specific environmental issues (e.g. Ganges water dispute, dispute over New Moore Island, dispute inflow of environment refugees from Bangladesh to India etc.). Other studies are over local conflict in Bangladesh over access to land and water. As a result they have failed to note the linkages between environmental crisis and national security of Bangladesh. The degradation of geography leads to socio-political as well as economic turmoil which in turn endanger the security of the people and the country. To this affect, all the environment related issues (for example, overpopulation, unequal access to resources, land degradation, water security, the depletion of forest, environmental hazards, sea level rise and environmentally induced migration etc.) that have generated security concern of Bangladesh have been comprehensively dealt with.

Environmental devastation caused by neighbouring countries can exacerbate regional conflict and harm progress towards regional security and regional cooperation. Environmental factors also have the potential to play a debilitating effect on the domestic politics of Bangladesh. This can upset domestic power balances and cause political instability. The greater degradation in geography of Bangladesh the greater will be the political and economic deterioration, thus leading to more national and international insecurity.

1.7 Hypothesis

The present study is an attempt to analytically assess the validity of the hypothetical statements of inter-connection between environmental security and geographical location from the case study of Bangladesh

- Geographical location of Bangladesh stands as a non-traditional security threats to Bangladesh.

1.8 Research Objectives

The main objective of the present study is to demonstrate the environmental security concern in Bangladesh which mainly determines by the geography of Bangladesh. The main areas of enquiry of the study are as follows:

- To critically examine the geographical location of Bangladesh in the terms of non-traditional security Threat.
- To make an inquiry into the causes of geographical degradation as well as its effects on Bangladesh.
- To study how geography is responsible for the distressed out-migration from Bangladesh.
- To study how the lower riparian geography provides the scope for international concern towards the region.

1.9 Research Questions

Following are certain research questions which this study tries to answer. They are:

- How the geographical locations of Bangladesh stand as a non-traditional security threat?
- What are the causes of geographical degradation and how does it affect the environment of Bangladesh?
- How the geography of Bangladesh is responsible in the out-migration from Bangladesh?
- Does the lower riparian geography provide scope for Bangladesh regarding the international concern towards the region?

1.10 Sources of Data

Although the linkages between environment and security in Bangladesh are complex, this study maps out the causal role of geography as a source of threat to the environment security of

the country. As the nature of the research is enormously complex and the unit of study are very large, the proposed analysis is faced with serious limitations in data quality and quantity. The study is mainly based on the research findings by scholars of different disciplines like environment, demography, economy and security in Bangladesh. The relevant data and information have been collected from publications of different government and non-government organisations such as statistical yearbooks, annual reports, journals, books, unpublished report from authentic organisations etc. Other relevant data has been taken from the major institutions such as Bangladesh Bureau of Statistics (BBS), MoEF Bangladesh, DDM, BWDB, WARPO, IWF, WB, BCAS UNDP, UNEP, UNFCCC, IPCC, and many non-governmental organisations (NGOs) running in Bangladesh. The data may vary to some extent due to different sources of information.

1.11 Research Methodology

The research methodology for this study would be descriptive and analytical in nature. Nature and concept of security in the both traditional and non-traditional and its development would be described by applying an analytical approach that recognises paradigm shift from traditional to non-traditional security threats. From an academic point of view, it is always a challenging task to demonstrate causal linkages between environment and security.

Geography forms a bridge between the natural and social sciences as its concepts and analytical tools have been derived from both the faculties of the sciences. Its special characteristics are its breadth of study, methodology, synthesis of work from other disciplines, including the natural sciences and the humanities and its interest in the management of people environment inter relationships. The theme of environmental security has a strong geographical dimension as it is concerned with the impact of environmental crisis on the well-being of society and conflict over social and spatial distribution of environment resources and hazards.

The major environmental problems of the country have been identified. The impact on the society and economy has been noted down. From the various socio-economic effects, the types and nature of environmental degradation will be studied. The security implications of these issues on Bangladesh have been noted. Finally, some suggestions have been proposed which may help to solve the pressing environmental problems of the country.

1.12 Chapterisation

Keeping in view the objectives, the study has been divided into five chapters.

Chapter I- Introduction

The first chapter begins with the introduction about the security concept in the traditional term and non-traditional, explores the link between environment and security, environmental security concept also discussed in brief, general description about the geography of Bangladesh, and it also discusses the non-traditional security threats aspect in context of Bangladesh. And the chapter would present the objective, research questions, methodology, data sources and hypothesis of the research. Finally it gives a brief description about other chapters of research study.

Chapter II – Geography as a Factor to the Environment Security Threat to Bangladesh

This chapter will make an account environment security threat that exposed by its geographic location, identify the environment security threat to Bangladesh, major causes of environmental degradation and impact of environment degradation in Bangladesh. The major focus will be on environment security of Bangladesh.

Chapter III- Climate Change and its Impact on Bangladesh

The third chapter defines climate change concept, link between climate change and security, climate change in Bangladesh and causes of climate change, impact of climate change in various sectors in Bangladesh, climate change mitigation measure is also described in this chapter.

Chapter IV- Flood in Bangladesh: Nature and Impact

Fourth chapter provides an overview of the flood in Bangladesh, its nature and impact. The chapter also analyses the general description of flood characteristics, history of flood in Bangladesh, types of flood, causes of flood in Bangladesh and impact of flood in Bangladesh and as well as the policy implication towards the flood control in Bangladesh.

Chapter V- Conclusion

The fifth chapter outlines three approaches to strengthen the environmental security of Bangladesh. These are (1) management of environmental degradation (2) mitigating natural, social and economic impacts of environmental security and (3) future initiative to tackle the environment degradation and management of the environment security in Bangladesh.

CHAPTER II
GEOGRAPHY AS A FACTOR TO THE ENVIRONMENT SECURITY
THREAT TO BANGLADESH

Geographically Bangladesh is a small country, riverine flood plain with huge population size in the terms of numbers, elongated coastline and environmental exposure is much high. Being located in lower riparian in Bengal basin the insecurity of Bangladesh comes from both internal and external terms. Bangladesh faces both traditional and non-traditional threats in serious magnitude. Buzan (1998: 19-20) divides threats into five distinct sectors namely military, economic, environmental, political and societal. At the primary level, the inputs of insecurity of Bangladesh are three folds: size, underdevelopment, dependency and geopolitical and geo strategic location at the secondary level. The third or critical level is vulnerabilities and external/internal threats, both traditional and non-traditional.

Environmental changes or degradation does not simply mean the inter-action between human beings and their surrounding environment. It implies a destabilising interferences in the ecosystem equilibrium which having negatively affected human society, express precisely what is meant by environmental change of conflict. According to Dixon(1994), “environmental changes referred to human induced decline in the quantity of a renewable resource which occurs faster than it’s renewable by natural processes. Dixon further states that there are three sources of environmental degradation or environmental scarcity of resources. There are as follows:

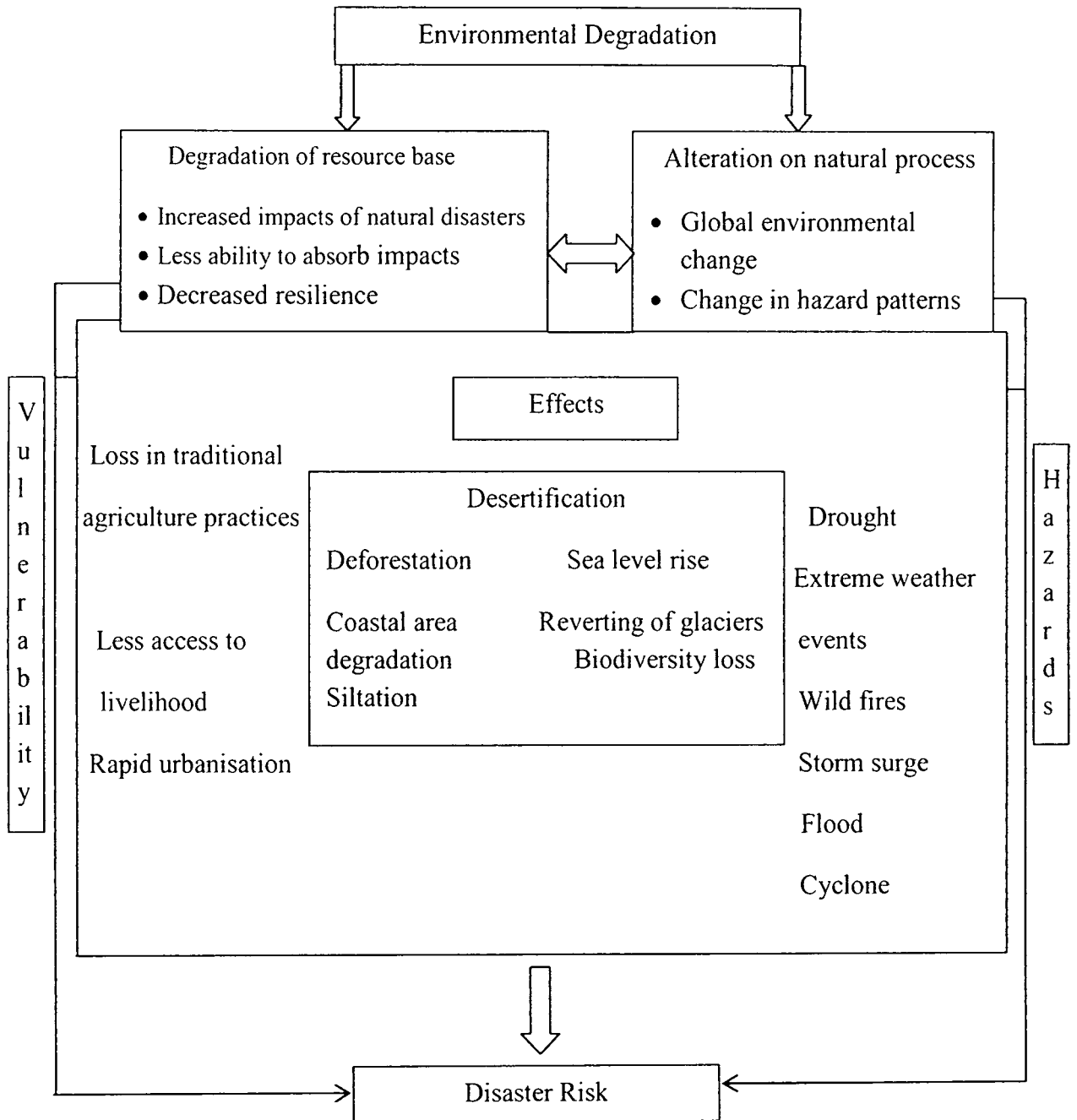
- a) The decline in the quality and quantity of renewable resources like water, land, atmosphere, climate and biodiversity
- b) Population growth which reduce per capita availability of resources by dividing it among the spawning population and
- c) Uneven distribution of resource concentrating in the hands of a few people and subjects the rest to greater scarcity.”

As per the above analysis, Bangladesh possesses similar kind of environmental problems. Security concern of Bangladesh are generic in nature; some are very specific to it, which have been modified by its geographic environment, structure of demography, natural resource base, socio-economic conditions, and historical evolution as a nation state. Bangladesh is a nation-state which has a huge population but if we look from the security's point of view, the country is pretty small. "If compared with the larger states the demands of the security of small states are more complex in nature and challenging. From the natural resource endowment point of view Bangladesh is poor country" (UNDP 2010).

Bangladesh is a region of extreme environmental stress and the most important security threat to the country and its people mainly comes from scarcity of resources, environment degradation, and exploitation of resources. The country has a subsistence economy. It is highly dependent on natural resource base for its socio-economic development. However, the scarcities of natural resources caused by over population environmental degradation and change, environmental hazards and developmental activities are producing grave socio economic problems.

Bangladesh is drastically exposed to environment security threats that compose environment degradation, land degradation, soil erosion, fresh water availability, arsenic water, loss of biodiversity, decline in forest, and desertification etc. These threats vary in austerly and the exposure level by aggregation or human being depends on their geographic location as well other issues such as the income level and admittance to assist. Geography of Bangladesh provides an extreme environmental stress to the resources and the most important threat to the security of the country and natural hazards in various manners. "Bangladesh presents a good case study of environmental security because of its geographical location and other physical and socio-economic parameters" (Khan 2005). There is a relationship between environmental degradation in the hazards and their vulnerability. Figure 2.1 illustrating the inter-linking nature of environmental degradation, natural hazard and vulnerability. The severity of these hazards can be seen in the different aspects. And the effects are more vulnerable to environment as well as the human society.

Figure 2.1 Inter-linking Nature of Environmental Degradation, Natural Hazard and Vulnerability



Source: ADRC, ISDR, UN, WMO, 2002, URL: <http://helid.digicollection.org/en/d/Js2653e/6.2.html> access on 7 July 2013

In the context of security of nation foreign policy is the major instrument to delineate the geostrategic environment in the region. Narain argues that “foreign policy is basically an instrument for mobilising material and political support in the international arena with a view to achieving the socio-economic and political objectives of a country” (cited in Abdus et al. 2008). For the security perspective the geography of country is major determinant of foreign policy of a nation. For the small states like Bangladesh it works in a wider sense. Hence, geographically and strategically Bangladesh becomes more vulnerable as it is land locked within India, also affecting its contacts with other regions (Kabir and Hassan, 1989:257). In Bangladesh almost all conceivable type of environmental degradation is going on at a dangerous level.

The main objective of this chapter is to make an account of environment security threat that is exposed to Bangladesh, identify the role of geography in Bangladesh’s environmental security, identify the environment security threat in Bangladesh perspective, major sources of environmental degradation in Bangladesh, and their impact on Bangladesh economy, society and environment.

2.1 Environment Security in Bangladesh

As Bangladesh’s environment security is declining, it is negatively affecting the economic development, erode social unity which further lead to the degradation of political institutions.

The rise in population, lowering of economic opportunities through environmental decline will cause demographic displacement with in Bangladesh as well as outside the nation. As environment threat leads to “push theory” and it further lead to migration towards the neighbouring nation-states which will create the regional imbalances and bilateral conflicts. The environment degradation and migration can also rise to secessionism and insurgency. Thus, there are a variety of reasons why the environment security in Bangladesh should be studied. .

“Bangladesh is most vulnerable place on the earth in terms of natural hazards. Bangladesh represents a good case study of environmental security because its security comes from external and internal sources” (Sobhan 2012). Present time environmental security is treated

as a component of national security. “Environmental security strives to protect humankind from both the short and long-term damage of nature, human made threats in nature, as well as the deterioration of the natural environment.

“Environmental disasters like cyclones mostly tropical, storm surges, floods, tornadoes and droughts demolish the country almost every year, even several times a year. Over the last 50 years at least one cyclonic storm or a storm with hurricane intensity has hit the coast of the Bay of Bengal every 1.5 years. Between 1980 and 2008, Bangladesh adept 219 natural disasters, affect over US\$16 billion in total damage” (BWDB 2010). According to the Asia Pacific Disaster Report (2010), “Bangladesh is the most vulnerable country in the Asia Pacific Region in terms of floods situation, fifth in terms of storms and in terms of earthquakes is eighth. Most recently, rare back-to-back cyclones hit the coastal belt in 2007 and 2009 causing great loss to life and property.” “Bangladesh ranks as one of the most disaster-prone and environmentally vulnerable country of the world. Population displacement and environmental degradation in Chittagong Hill Tract in Bangladesh have resulted in the insurgent movement in that area which is a great political and security concern for Bangladesh” (Islam 1995: 337).

Environmental devastation which is done by neighbouring countries can lead to regional conflict and harm progress towards regional security and regional cooperation. Environmental factors have the capacity to play a debilitating effect on the domestic politics of Bangladesh. The greater the environmental degradation in Bangladesh, the greater will be the political and economic deterioration, thus leading to more national and international insecurity.

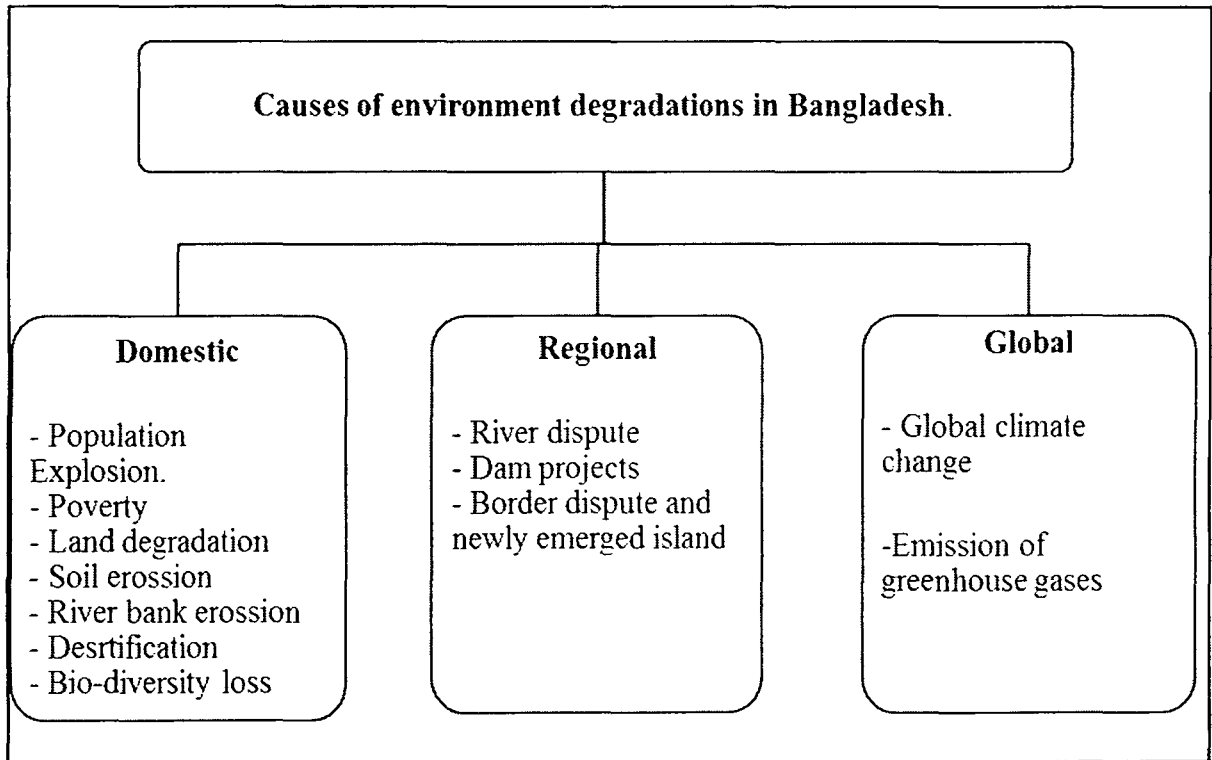
2.2 Causes of Environmental Degradation in Bangladesh

Bangladesh faces environmental problem the most as compared to the other developing countries. Bangladesh is low riparian country and the major causes of environmental degradation are of three types. The major sources of environment degradation in Bangladesh come from mainly three sources. Figure 2.2 is showing the major causes of environment degradation in Bangladesh.

2.2.1 Domestic Causes

The main domestic sources of the degradation of environment in Bangladesh are rooted factor like, population explosion, poverty, urbanization and industrialisation, river bank erosion, soil erosion, land degradation, deforestation, scarcity of freshwater, natural hazards etc.

Figure 2.2



2.2.1.1 Population Explosion

Population growth is one of the main actors behind environmental security in Bangladesh. The greatest problem that Bangladesh faces is an unusually huge population size in a small land area. According to 1991 census, “the population of Bangladesh has reached nearly 116 million with a growth rate of 2.16 per cent from 42 million in 1951. It is projected to reach 166 million in 2015” (BBS 2011). Report published by Bangladesh Bureau of Statistics (2011) states that “the growth rate of population in the last 20 year of the 20th century was 2.1 per cent from 2001 to 2015 it is projected to grow 1.6 per cent per year. The fast decline in

population growth the less would be the negative effects on its environment. Zero population growth would be of inestimable value of the environment in Bangladesh.”

The burgeoning population growth in Bangladesh and its increasing demands in natural resources to the point of degradation will show how the traditional perception of security threats will be replaced by the environment security. Increase in energy consumption will require more burning of traditional fuels, which in turn will boost greenhouse gas emissions leading to increase in local temperature.

2.2.1.2 Poverty

The World Bank defines poverty as “the inability to attain a minimal standard of living” (World Bank 1990:26). Poverty is “generally defined in the following two ways: lack of means in relation to needs and .lack of means in relation to means” (Sen 1999: 12). There is a direct correlation between population, poverty and environmental degradation. The poor countries are more vulnerable to environmental changes. Hence, they are more prone to environmentally induced conflicts. Poverty and underdevelopment affect the environment by causing environmental depletion and scarcity thereby contributing to environment related conflicts. Report published by World Bank (2008) describes that “about 33 million of the 150 million population in Bangladesh cannot afford an average daily intake of more than 1800 kilocalories that is below from the minimum standard for nutrition set by the World Food Programme. Poverty increases vulnerability to effects of environment degradation and on the other hand, environmental degradation or environmental scarcity of resources contributes to the continuation of poverty” (Gaan 2000: 128-129). So, poverty and environmental degradation are mutually reinforcing.

2.2.1.3 Land Degradation

Apart from erosion and loss of soil, land degradation is also occurring through water logging, cattle grazing and salinity which are also a major concern of environmental degradation in Bangladesh. According to UNEP (1992), “land degradation is the temporary or permanent lowering of the productive capacity of land. In the case of Bangladesh, per capita unit land resources are well below the world average of 0.26 hectares.” (FAO 2002)

In the flood plains in Bangladesh land degradation takes place primarily due to organic matter depletion and improper use of chemical fertilizer. River bank erosion is the most important cause of land loss and degradation which have increased due to river depth. Every year large areas along river banks erode during the monsoon creating environmental imbalances in terms of physical and social aspects in Bangladesh. Unplanned human settlement in the urban area is also major reason for land degradation in Bangladesh.

2.2.1.4 River Bank Erosion

River bank erosion is quite a disaster every year especially in deltaic country like Bangladesh. A number of people become displaced due to river bank erosion. Table 2.1 is showing bank erosion in various rivers of the country.

Table 2.1 Length of Bank Erosion in Various Rivers

Rivers	No of location of bank erosion	Length of erosion in km
Brahmaputra-Jamuna	30	160 (total of two banks)
Ganges-Padma	30	94.4
Meghna	6	12.8
Teesta	8	35.2
Minor rivers	18	31.2
Floshy and other river	165	77.6
Tidal rivers	118	83.2

Source: Huda and Chowdhury, (1989)

According to the report of River Research Institute (2000) in Bangladesh, “135632 families became homeless due to erosion of 12 major rivers including three major rivers, within the last five years. In the several studies it is noted that deforestation with soil erosion, siltation, flood, the meandering river courses and water withdrawal by the upper riparian state, India causing siltation and reduction in the river depth and deforestation in the Himalayas causing flood by reducing sponge effect of soil, have all contributed to river bank erosion when heavy rainfall enter into the river” (Chakravarty 2004:155).

2.2.1.5 Soil Erosion

The soil in Bangladesh is developed under three physiographic positions such as northern and eastern hills, Madhupur and Barind Tracts and Flood Plain areas. In Bangladesh factors that contribute to soil erosion are as follows:

- a) Water erosion
- b) Wind erosion
- c) Human factor

The deposition of silt material on farming land is a natural process of soil degradation. Desertification and shifting cultivation in the many regions of the Bangladesh causes soil erosion. Irrigation is an important reason for the degradation of soil. Traditional practices in agriculture are another causal factor to erode soil in various manners. The rapid expansion of urban and industrial development around cities and new settlement created by rapidly increasing population in villages of Bangladesh poses a serious threat to valuable agriculture land that create problem for the soil in nearby area. Mining of sand and shingles from agriculture land also causes the soil erosion in Bangladesh.

2.2.1.6 Deforestation

Undoubtedly, forest plays a vital role in maintenance of ecological balances. The tropical climate and the fertile soil combine to clothe most of Bangladesh in an evergreen mantle (Rashid 1991: 104). According to Forest department of Bangladesh (2007), “there are four types of forest in Bangladesh:

- a) Hill forest,
- b) Salforest
- c) Mangrove forest
- d) Village forest.”

The condition of forest and plantation have deteriorated due to population explosion and increased demands for forest produce or industry, fuel, fodder and food. According to UNEP (2002), “the loss of forest in Bangladesh is about 0.015 Mha (million hectare area).” The

National Biodiversity Strategy and Action Plan (2006), also points out that the “forest cover in Bangladesh has come down to 6 per cent from 10 per cent of the area of the country. If the continues loss in forest cover is going on then there is threat to local biodiversity. The decline in forest will directly affect the environment of the country that will lead security threat to Bangladesh in the environment context. The loss in tree covers lead to the uneven distribution of rainfall over the year, loss of fertile topsoil and soil nutrients, excessive soil erosion, landslide, river clogging and so on” (Sabur 2001: 98-99)

2.2.1.7 Scarcity of freshwater

In the country, the main sources of fresh water are rain water, surface water and ground water. The freshwater issue has national security in Bangladesh. Sabur (2001: 93) argues that “the most dangerous threat emanating from environmental degradation is perhaps the arsenic contamination of its ground water, almost the sole sources of drinking water in the country.” According to WHO (2002) study on Bangladesh states that “country is facing the largest mass poisoning of population in history because of arsenic contamination of its drinking water supplies.” As reported in The Daily Star (2000), “arsenic contamination in drinking water in Bangladesh has more impact on people’s health. According to the survey between 33 and 77 million people are at risk.” Sabur (2001: 94) states that “the arsenic contamination of its ground water remains the single-most environmental challenges facing today in Bangladesh.”

2.2.1.8 Natural Hazards

Bangladesh is a disaster-prone country which includes flood, cyclone, drought, storm surges and earthquakes are major natural hazard in Bangladesh. Bangladesh is vulnerable to a range of natural hazards with varying severity. Country alone experienced some of the most devastating flood in the recent decades.

As per from different sources, data compiled of flood affected area in various years table 2.2 giving a general idea of major flood in the country.

Table 2.2 Major Flood and Land under Inundation

Year	1974	1987	1988	1998	2004	2007
Affected area sq. km	53	57	90	100	56	62
Percentage of total land of Bangladesh under Inundation	37	40	63	69	39	42

Source: Islam and Mechler (2007). BWDB (2007)

It can be said that the flood in Bangladesh has more intensity rather than the other natural hazards. This occurrence of flood in every year causes serious environmental problems. Apart from flash flood in Bangladesh, due to her geographical location and plain land elevation is the worst victim of longest period of inundation. The year 1988 and 1989 are the worst affected year, due to these floods serious devastation were taken place. Too many people killed and large section of population was displaced in to country and outside the country by these floods.

Cyclone also hit Bangladesh every year. Sidr and Aila cyclone are in 2007 recent example of severe cyclone that hits the country. Records of the past 200 years show that at least 70 major cyclones have hit the coastal belt of the country. For the degradation of coastal environment rises of sea level has more importance. The country is more vulnerable to inundation due to the flat topography.

2.2.2 Regional Causes

Bangladesh also manifests severe environmental threats that have come from regional sources. The country is located in lower riparian of the common rivers share by the Himalayan states viz., India, Nepal and Bhutan. "Bangladesh is flat alluvial plain with an average elevation above sea level of only 10 meters into which flow no less than 57 rivers and of which 54 flow into the country through India" (Sabur 2001: 95-96). Developmental activities in the upper riparian like various flood control and irrigation projects on the rivers as much as the continued deforestation process in the Himalayas and their impact on the

environment, agriculture and economy of the countries downstream significantly influence the relationships among the co-riparian country. “Due to unprecedented siltation, the Ganges and Brahmaputra river systems are to carry over 22 billion tons of sediment each year” (Kabir 1989: 101). “This result in the rise of river bed in between 6 and 12 inches a year thus, making it impossible for the rivers to manage the water” (Kabir 1989:101).

River water dispute between India and Bangladesh determine the assorted behaviour of the strong upper riparian serving its own interest at the expense of the lower riparian's environment as well as socio-political and economic stability. These disputes are cause of security concern for the both countries. The major river water dispute between India and Bangladesh are the main regional causes for the degradation of environment in Bangladesh. For the security concern of Bangladesh this water dispute have severe threat to environment of Bangladesh.

2.2.2.1 Indo-Bangladesh Water Dispute and Environment Security of Bangladesh

In the case of surface water flow Bangladesh' position is more critical since 90 per cent of the catchment area of total river system is places outside of the country. Ganga is the prominent river of Bangladesh that originated from the Gangotri at the southern slop of Himalayan range, flows is a south easterly direction, then further downstream is an easterly direction through India to Bangladesh and finally merge into the Bay of Bengal.

For the Bangladesh River Ganga is lifeline. It provides water nearby 37 per cent of her total area and about one third of Bangladesh's population depends on the waters of the Ganges (Upreti, 1994:136). The Indian government approved the Farakka Barrage project approved by the India in April 1960. The project was to divert the water of the Ganges through a feeder canal into the Bhagirathi-Hooghly River for the advancement of navigation for the Calcutta port. Extracting of Ganges water by built of Farakka Barrage is direct threat to the environmental security of Bangladesh. An interim agreement signed between India and Bangladesh on 18 April 1975 under it the Barrage and the feeder canals were finally commissioned.

Hossain describes that the Farakka Barrage is also designed to improve communication facilities drainage sanitation and water supplies if Calcutta, as well as inland transports throughout West Bengal, with a rail and road project over the Farakka (cited in Ahmed, 1984:34). From the emergence of Bangladesh to present time agreement has been signed in many times due to sharing of waters. But no solid reasonable solution has come out yet. If India executes new river link programmed then it will be a new environmental security threat to Bangladesh.

The river Brahmaputra originated in Tibet in China in northern slopes of Himalayas flows eastward, than turn into south and enter in to Arunachal Pradesh (India) and west flow in Assam (India) and it's again turn into south and enter Bangladesh. Due to its large broad catchment area Bangladesh is largely dependent on the Brahmaputra River for the process of irrigation, navigation, fisheries, forestry, and for checking of salinity intrusion. But the developmental activities by the India on Brahmaputra in the upper riparian of river are posing an enormous threat to the economy and lower riparian in Bangladesh.

The Teesta River is another water dispute problem between both countries. In rainy season Teesta loaded heavy sediment and deposits it in Bangladesh. It creates problem for both people and environment of the country. Another serious concern for Bangladesh is Gazoldoba barrage project in Teesta River. On the Barak River Tipaimukh dam project in Manipur state in India is a new extension that will affect country. As reported in the daily star (2013) it will have drastic and adverse impacts on the hydrology, morphology, and ecology of the lower riparian region in Bangladesh.

Apart from this the construction of the dam is the upper riparian river likes, Buri Teesta, Kherua, Sangli, Ghoramara; spurs and weirs on the river Kaljani, Dhalai; blockage of the Sonai river embankment on the Manu and Chiri; river training programme on the Torsa, Jaldhaka, Raidak etc.; are seriously damaging the environment and socio-economic life of people of Bangladesh.

2.2.2.2 Border Dispute and Environment Security of Bangladesh

Border dispute is another major important issue between India and Bangladesh which is exhilarating conflict and threat and also affecting the environment security of Bangladesh. From the security perspective of Bangladesh the territorial dispute with India can identified as follow as:

- Conflicts Over the Border Area
- Newly Emerge Islands, like New Moore or South Talpatti Island
- Chhitmahal (Enclaves) Crisis

2.2.2.3 Conflict over the Border Area

The emergence of Bangladesh has long bloody history. In the 1971 the large portion of her boundary with India has already been demarcated. The maritime boundary between India and Bangladesh is not delineated and both the countries cover 180 km of maritime borderline. After 20 year of land boundary agreement the process of border demarcation has not been completed yet. Indian government is trying to fence border in Tripura state from too many years but there is no successful results come out yet. Sources from BDR (Border Guards Bangladesh) and Home Ministry state that since 1996 till date BSF (Border Security Force, India) has crossed into Bangladesh territory many times. According to Human rights organisation (2000) Adhikar Published a report states 56 soldiers (of BDR) includes person died, 94 were abducted and 3 were raped by miscreants and BSF soldiers from across the border (Table 2.3).

Table 2.3 Border Demarcation Area between India- Bangladesh

Area between both countries	Total length of the boundary (miles)	Demarcated area over which pillars had been erected as in 1965 (miles)	Demarcated area over Which pillars had been erected as in 1968 (miles)
Assam-East Pakistan	620	423	426
Tripura-East Pakistan	559	184	228
West Bengal –East Pakistan	1349	1079	1254
Total	2519 (4032 km)	1686 (2696 km)	1908 (3056 km)

Source: Kemp, D. D. (1996), Global Environmental issues, Routledge, London and New York, pp. 59

The conflicts in the border area have significant environment effect to the border people of Bangladesh. These conflicts create uncertainty and security threat to local environment as well as to the local people settled near border area (Table 2.4).

Table 2.4 Incidents over the Indo-Bangladesh border (1996-2000)

Year	Firing	Death	Injury	Abduction
1996	130	15	25	-
1997	39	11	12	-
1998	56	23	29	-
1999	43	33	38	88
2000	32	25	21	53
Total	300	107	125	141

Source: Bangladesh Disaster report 2000, p-164

2.2.2.4 Newly Emerge Islands like New Moore or South Talpatti Island

Environmental degradation between Indo-Bangladesh border has new concern that is newly emerged island. This island dispute is about 24 by 12 kilometers and situated in the mouth of the river Hariya Bhanga. In 1971 the island was first discovered by India which laid claim to it and notified the British Admiralty of its location. India named it New Moore Island in 1979 while Bangladesh decided it to call it South Talpatti Island in 1981. The dispute over this island still continues and it had become militarized (Gaan 1996: 127-188). This island dispute has serious implication for both countries. The delimitation of maritime boundaries between both countries it is a part of large conflict. Diversion of river water in upper riparian cause's erosion in the Bangladesh and new island formation of the Indian side of the rivers has now become a bone of contention between the two countries. The territorial dispute is a serious threat to the environmental security of Bangladesh.

2.2.2.5 Chhitmahal (Enclaves) Crisis

“Chhitmahal crisis is one kind of environmental threat to the security of Bangladesh. There are 119 exchangeable enclaves with an area of 1715772 acres in Bangladesh and 72 Bangladesh enclaves with an area of 716085 acres in India” (Ali 2005: 6). As stipulated in land boundary agreement, the enclaves were to be exchanged between the two countries without any claim of compensation (Ibid, 6). The Chhitmahal issue still remains unresolved to both countries.

2.2.3 Global Causes

“As indicated, unrestrained and unplanned exploitation of nature by man without adequate concern for it has far reaching consequences and is the root-cause of the environmental degradation” (Sabur 2000: 99-100). According to Inter-governmental Panel on Climate Change (IPCC) 4th assessment report (2007) describes that “in the case of Bangladesh, one third of the country may be submerged by 2050 due to sea level rise. It has been estimated that the one meter rise in sea level would cover 14 per cent land area of the country and thereby-displacing 10 per cent of its total population.”

Today's world witnesses a rise in global temperature that is termed by the scientist as the Green House Effect. It is caused by a number of greenhouse gases, like carbon dioxide (55 per cent) originated from the fossil fuel burning, chlorofluorocarbons (CFC, 24 per cent) originated from industrial uses, methane (15 per cent) and other (6 per cent) (Islam 1991: 5-7). "Greenhouse gases generated in individual countries has truly comprehensive impact. Layers of these gases accumulating in the upper atmosphere contribute to the global warming. Continuous increasing in global temperature is causing sea level rise, cyclones, storm surges, and the disruption of agriculture." In this case, Bangladesh has witnessed many floods in the recent years and the frequency of cyclone is much higher than recognised at international level. In the past such kind of calamities devastated environment and also killed thousands of people of the country. In 1998 country experienced the worst flood in its history.

Bangladesh did not contribute as such in global warming Due to global warming as a result of the emission of greenhouse gases caused by developed countries Bangladesh will face sea level rise and submerge in to sea because of the average mean sea level of Bangladesh in around 10 metre. According to IPCC (2001), "the concentration of greenhouse gases would be double in the year 2025 with respect to pre-industrial levels. It is predicated that this would lead to an increase in global temperature by about 0.3° C per decade with accompanying sea level rise of 6 cm per decade" (BCAS, 1991:5). This will directly affect the coastal environment of the countries and Bangladesh is one of them.

Greenhouse gases are produced in large quantities by the developed countries. As reported in the Economist (2001), "In this case, Singapore produces more than six tons of carbon per person in 1997, the US more than five tons, Australia more than four tons, Finland and Germany more than three tons, Russia, Britain and Japan more than two tons and Italy, France and Switzerland more than one tons" (The Economist 2001:74). Today, the United States of America is leading in the terms of total emissions of greenhouse gases. As reported in Time (2001), "with 4 per cent of the total world production the US produces 25 per cent of greenhouse gases." Human Development Report (1994) mentions that "Bangladesh which produces 0.3 per cent of global emissions could see its land area shrink by 17 per cent is case

of one metre in sea level rise due to global warming. It will degrade coastal environment of Bangladesh and that will adversely cause the environment security concern to Bangladesh.” “While Bangladesh is not responsible for the situation, it is also absolutely powerless to reverse the trend. The country has to rely on the increasing consciousness at the global level with regard to the consequences of greenhouse effect and resultant international efforts aimed at curbing the emission of greenhouse gases” (Sabur 2001: 102).

In December 1997 the Kyoto climate conference held in Japan “was aimed at reaching an agreement on binding targets for cutting the emissions of six greenhouse gases. The major points of this protocol are as follow as:

- Six greenhouse gases subject to mandatory cuts: carbon dioxide, methane, nitrous oxide, hydro fluorocarbons, perfluorocarbons, and sulphur hexafluoride (SF₆).
- A total of 38 industrialised countries agreed to cut the emission of these six greenhouse gases by 5.2 per cent from 1990 levels between 2008 and 2012.
- Japan, USA and the 15 member of EU to reduce emission by 6, 7 and 8 per cent respectively.
- Iceland and Australia to be permitted to increase emission by 10 and 8 per cent respectively.
- Russia, Ukraine and the developing countries, including China and India, to be exempt from the new commitment.
- Countries to be permitted to trade emission quotas.”

So countries like Bangladesh should need more attention toward the greenhouse gases emission reduction in the country and also at the global level. Because the global climate change will directly affect the environment of the country and that will pose threat to the environment security of the nation.

Therefore it can be said that there are too many factors that cause degradation of environment in Bangladesh. These factors vary in their level of exposure. This kind of degradation in environment causes serious problems for the Bangladesh and major concern to the environment security of the country.

2.3 Impact of Environment Degradation and Security Threat to Bangladesh

The degradation of environment has great impact on Bangladesh. These impacts can be classified in to three major categories. These are as follows:

2.3.1 Threat to Social Life

2.3.2 Threat to Economy

2.3.3 Environmental Threat

2.3.1 Threat to Social Life

Environmental degradation or scarcity of resources may cause innumerable social impact in any country. In Bangladesh's social life water always played a significant role. The fluctuating and decreasing in the river flows have not only disrupted the environment and economy of the Bangladesh but also disrupted the social stability. Land degradation of millions of acres has rendered thousands people unemployed in Bangladesh. Apart from agriculture, industry, navigation and fisheries various other sectors on which large number of people depend for their survival have also been affected very seriously. The problem created by the flood, drought, river erosion frequently render thousands of people homeless who have migrated to the capital city. In 1985 the United Nation Environment Programme introduced "the concept of environment refugee who were defined as those people who have been forced to leave their habitat temporarily or marked environmental disruption. So it has been ascertained that environmental degradation has been major and predominant cause for flight or migration of people whether intra or interstate" (Gaan 2000: 106).

2.3.1.1 Population Displacement/Migration

"It is major social impact of environmental degradation in Bangladesh. People migrated from the disaster prone areas to another area. In Bangladesh the magnitude of rural poverty and rate of migration to urban areas would show the extent intensity of environmental degradation and

its social effect all over the country. In Dhaka city alone, about 7.5 million people live in slums.” (Hassan and Khan 1989: 87) Most of these are environmental refugees. Diversion of river water from the Indian side has reduced seasonal work of millions who cannot find sufficient surface and ground water to sustain their livelihood during the dry season.

“Apart from floods, cyclones have contributed to population displacement in Bangladesh. In case of severe floods like the ones in 1988 and 1989, the rate of displacement was large and around 30 million people were displaced due to this flood” (World Bank 1989:19). “The flood of 1989 displaced nearly 45 million people as per an estimate apart from other huge damage to human lives, livestock, land and agriculture” (Ibid, 35). According to Bangladesh Bureau of Statistics (1990), “three million rural housing structures were damaged in the 1988 flood and more than 2 million hectares of crop were damaged. In the 1990 and 1991 two major cyclones hit the country and totally destroyed the coastal area of the country. The 1970 storm with range in the height of 4.5 to 9.0 metre killed 5000,000 people, destroyed 4,000,000 houses and 3800 educational institutions and decreasing tendency in the agriculture productivity due to intrusion of saline water into the agriculture land” (Mirza and Pal 1992: 104). “The 1991 cyclone with a tidal surge ranging from 6 to 10 metre destroyed agriculture of 110,965 hectare area of land 642,442 houses and killed 138,000 people” (Ibid. 104). “People of these coastal areas were settled in Chittagong Hills Tracts.” (Hassan 1991: 45)

“Due to environmental degradation, river bank erosion is the primary source of population displacement in the country. The rivers Padma, Jamuna, Meghna are more vulnerable to erosion. As estimated that within a period of 1974-81, 17632 persons have become environmental refugees in Kazipur alone.” (Elahi 1990: 104) Sea level rise has a greater intensity to population displacement. As predicted by environmental policy (1991:64) about “65 per cent of greater Khulna, 90 per cent of Barisal, 100 per cent of Patuakhali, 44 per cent of Noakhali and 12 per cent of Faridpur will be inundated destroying 13.74 per cent of the net cropped area and 401,000 hectare of mangrove forest along with all its resources and displacing 10 per cent of the country’s people to the unaffected urban areas and neighbouring Indian states.” Table 2.5 shows the extent of erosion and population displacement within a period from May to July 1992.

Table 2.5 Erosion and Population Displacement from May to July 1992

Date	Riverbank	Population and displacement
3 May 1992	Brahmaputra and Teesta	50000 erosion hit people and people living on embankment
20 May 1992	Jamuna	100000 people by devouring 12 villages
31 May 1992	Padma	20000
11 July 1992	Brahmaputra	100 homeless in Jamalpur, Rangpur
11 July 1992	Jamuna	800 people homeless
16 July 1992	Jamuna and old Brahmaputra	15000 families

Source: As reported in The Daily Star, 3, 20, 31 May and 16 July 1992 access on 15 June 2013

Migration of population is not only confined within the Bangladesh territory it is also beyond it. Millions of people over the four decade have migrated and is continuing to migrate to Indian states of Assam, Tripura and West Bengal.

2.3.1.2 Impact on Human Health

Besides from natural causes like flood, cyclone, storm surges and tornado, man-made causes have affected the environment which often influence human health in Bangladesh. Rapid growth and unplanned urbanisation, decreasing forest cover, dam's construction, wrongly designed road development efforts such as industrialisation, use and disposal of bio-medical and industrial wastes, extraction of gases, use of fertilizer and pesticides in agriculture practices and above all population explosion have wrought immense adverse impact on the ecology and the human health also. In Bangladesh mostly population settled in rural area generally use water from rivers, canals, tanks, well and other unsafe sources for all purposes. Only few percentage of population has access to safe drinking water. The pollution of environment has led to the proliferation of a number of water borne disease like diarrhea,

dysentery, typhoid and paratyphoid. Other disease such as hepatitis, poliomyelitis cancer, tuberculosis, lung inflammation and skin diseases is also the product of this pollution (GoB, 1989:14).

Malnutrition which is widely spread in Bangladesh is a matter of serious concern for the human health especially for the children. In the BBS Household Survey a chronic malnutrition rate of 56.1 per cent and wasting rate 8.1 per cent was observed indicating acute malnutrition (Gaan 2000: 102). The highest record of stunting and wasting occurs among rural female children in the 12-13 month age group which is 63.3 per cent and 23 per cent respectively (Ibid, 102).

2.3.1.3 Ethnic Divide

The ethnic crisis in Bangladesh exists between the tribal Chakmas and non-tribal Bengalis in the Chittagong Hill Tracts had its root history from the British rule. It subjected the hill people to all kinds of subordination and exploitation by their British overlords and was from being a charter for regional autonomy (Hutchinson, 1906:32. Cyclone and flood forced the people to migrate from the low lying of the plains to CHT in large number. However in the earlier period a deliberate policy of depopulation was undertaken by the government (Rizvi 1989: 42). This was by encouraging massive influx of plain's people into bountiful CHT. The rehabilitation and resettlement of the hazard prone and affected people from the lower area resulted in outnumbering the original tribal to the utter disenchantment of the latter (Gaan 2000: 120). According to an estimate, "the ratio of tribal and non-tribal, which were 90.9:1 and in 1951 plummeted to 67.1:33.9 in 1980." (Ibid.120). Lal argues "that there is continues resource scarcity due to massive migration and they being rejected to minority with lack of access to power and economic livelihood of the tribal people, combined together to turn their long history of passive resistance against the state into an open armed rebellion against the government of Bangladesh" (cited in Gaan 2000:120).

2.3.2 Threat to Economy

"Siltation, soil erosion and decreased level of surface water and salinity intrusion in drinking water has combined effect to the economy of Bangladesh. These factors create instability in

the country's economy. Sectors like agriculture, industry, navigation, aquaculture of the northern as well as south western part of the Bangladesh have been suffering serious setbacks. Agriculture which is one of the prime sectors of Bangladesh's economy contributes more than 50 per cent share to GDP of the country during 1990 and employs 65 per cent of the civilian labor force." (BBS 1991) "Of the total net cropped area of 6.85 million acres 1.57 million acres are partially or fully affected." (Islam 1995: 355) "This amounts to 22.92 per cent of the net cropped area." (GoB, 1976:8) "The 3 per cent food grain output per annum in the mid 1970's lowered down to 2.2 per cent in the 1980's." (Gaan 2000:83) Another serious problem in continuous growth of population can bring shortfalls in agricultural productivity and per capita productivity will also decline.

"Reduction in water flows of river in upper riparian due to various reasons like excessive water withdrawal from the Ganges over the Farakka unlimited general water withdrawal and shortage of rainfall accompanied by other factor and consequences like deforestation, salinisation, siltation, soil erosion, frequently flood and cyclone vast sum of agriculture land in being eroded every year. The area degraded by the water shortage during the year 1988-89 was estimated to be 38449 hectare against 11215 hectare damaged during the year 1987-88." (Hafiz and Islam 1993: 39) Salinity affected in the year 1988-89 was nearly 43254 hectare against 8218 hectare of the previous year.

Accordingly the estimated net loss of the area solely dependent on the Ganges water stands at US 85 million dollar during the year 1988-89 (Ibid, 39). "Flood in Bangladesh has severe constraint on agriculture production in Bangladesh. Normally each year the large area of country is used to inundation due to flood. This kind of intensity of flood create problem to crop production of the country. In 1987 flood rice production was estimated at 3.5 million tonnes, in 1988 it was 2 million tonnes." (BWDB 1987 1988)

Varying intensity in drought seems to have affected the entire country, though the most hit is the North West and South West region. According to the environment policy report (1991:64), "during the perennial dry season crops about 0.574 million hectares of T. Aman crops are damaged and more than 1.748 million hectares T. Aman crops are severely affected by drought."

Table 2.6 is showing the magnitude of losses due to flood in 1987 and 1988 and damage of economy in Bangladesh.

Table 2.6 Official Estimates of Losses and Damaged by Floods in 1987 and 1988

Loss/damages	1987	1988
Area flooded (km ²)	57000	82000
House totally/partially damaged (million)	2.5	7.2
Rice production lost (millions tons)	3.5	2
Road: trunk(km)	1523	3000
rural(km)	15107	10000
bridges, culverts	1102	898
Railways: embankments (km)	698	1300
bridges	166	270
Industrial units	n/a	1000
Health centres flooded	1305	1400
School flooded	6689	19000
Irrigation and drainage canals (km)	222	283
Livestock, Cattle, goats, etc.	64700	172000
poultry	206000	410000

Source: BWDB, 1987 and MOI 1988. na= not available

Water withdrawal by India at Farakka has brought about drastic change in hydrological and hydro-biological conditions in the lower riparian of the Ganges and its distributors causing an alarming reduction in fish production during the post Farakka era (Gaan 2000: 84). Various flood control measures taken up in 1990 making 336 million hectares of inundable flood plains flood free, have marked an 11.4 per cent decline in fish production (Ibid, 101). The forest of Sundarban which provides raw materials for paper mills, match factories, furniture

factories and all varieties of construction activities in affected by salinity and has approached deterioration, causing heavy loss which would be in fact irreparable (GoB, 1976:9). This affected those people who are directly engaged with these industries.

The greenhouse gases increasing and climate change have downward effect on agriculture production. Coastal crop land of the Bangladesh will directly be affected by these changes. Sea level rise as projected in various climate change conferences, the frequency of this hazard will severely affect crop land, livestock and fisheries in Bangladesh. A rise in sea level by the middle of the next century will cause inundation of 2.915 million acres on net cropped land resulting in production losses or more than 2 million tonnes of vegetables, 10000 tonnes of jute, 97000 tonnes of pulses, 37000 tonnes of oil seeds and 97000 tonnes of species (Gaan 2000: 85).

Agriculture of Bangladesh is much constrained by adverse environmental conditions. The natural calamities in country like flood, cyclone, and salinity further compounded by environmental degradation impact on the crop production and efficiency at time crops were totally destroyed. The economic life of the country, especially in south-western and north western regions is disrupted largely due to the diversion of overflow of water from the upper riparian. According to an estimate the 20, 711 million Tk. losses since 1975 due to withdrawal of Ganges water towards the lower riparian region in Bangladesh. It accounts for 75 per cent of the total loss (Islam 1995: 356).

2.3.3 Environmental Threats

The physical geography of Bangladesh is also found to be responsible for environmental degradation which threatens the environment security of the country. Although Bangladesh is situated on the largest and one of the most fertile deltas of the world, yet there are a number of geographical factors which make country ecologically and environmentally vulnerable. The country is located in the most hazard prone area of the world. Every year flood, cyclone, and storm surges are common for the people of Bangladesh. In the upper riparian for the development activities diversion and blockage of waters of various river changes the hydrology in the lower riparian region in Bangladesh. "These changes in water flow affect the environmental balance of the country. Withdrawal of the Ganges water level of Hardinge

Bridge fell below the minimum ever recorded i.e., 23000 causes as compared to a historical average of 64, 4300 causes.” (Begum 1987:131)

“The water level registered at 17 feet compared to 22 feet while the ground water level fell by 5 feet.” (Ibid 131) Ganga’s main distributary is at the point of extinction because of heavy siltation. This change in hydrology is affecting the ecological balance and the local environment of the country. The entire north western part region of Bangladesh which is totally dependent on the Ganges water for both surface and ground water supply is major affected region of the country.

Islam (1995: 350) describes “the consequences of hydrology change due to upper stream diversion are as follows:

- Siltation and rise of river beds leading to flood demolition of river embankment, changed river course.
- Decreased soil moisture and salinity leading to desertification
- Decreased water level leading to problem agriculture, industry, navigation, fishery and domestic use;
- Decreasing upstream flow leading to saline intrusion in the coastal area and damage to the mangrove forest and
- The overall change in weather pattern.”

Due to degradation of environment in Bangladesh the feeling of security in the perspective of environment is much higher than the other security factors. If there is degradation in environment it will directly affect the whole country in terms of economy, society, ecology, and scarcity of natural resources. The major environmental threat can be seen in the following way:

“Due to her geographical location, flat topography, heavy rainfall during the monsoon period, low river depth, erodible bank makes Bangladesh more vulnerable to annual and frequent floods. Ganga and Brahmaputra river having much severity of flood when these two river in the peak of Synchronisation. “More than 25960 sq. km of country is normally flooded every year with a flooding depth of 1 to 3 meter and in the severe case the area may rise to even

65,600 sq. km.” (Khan 1986: 7) “More than 80 per cent of the flood run off in Bangladesh is delivered from the outside the country which about 90 per cent is contributed by major river Ganga, Brahmaputra and Meghna” (Islam 1995: 350). “These rivers carry 2.4 billion tons of sediment annually resulting in gradual deterioration of morphological characteristics of the rivers.” (Shahajahan 1986: 7)

“Estimated bed load discharge is 100 million tons per year for the Brahmaputra and 40 million tons per year for the Ganges and annual suspended sediment discharge for the Brahmaputra at Bahadurabad is 400 million tons” (Huda and Chowdhury 1986: 7). “Sediment load and flood intensity in the country result in recurring environmental degradation and also causes security concern for the people of the country. As per the above analysis it can be said that if the rapid degradation of environment will continue in the county it will adversely impact on the environment and the ecology of the country. Gradual degradation in environment of the country will create pressure on the resources. So the negative impact of environment degradation can be identified in Bangladesh as follows

- Soil erosion in many part of the country leads to the deforestation and it will erode ecological-biodiversity of the country.
- Frequent intensity of flood in the county will impact on the ecosystem of the river hydrology.
- Increasing intensity of cyclone, and storm surges will affect the coastal environment of the country and country will loss marine bio-diversity.
- Salinity in the water is another major environmental threat to the Bangladesh. It will directly impact the forest and plantation in the country.
- Due to global temperature increase there is another environment threat to the country that is sea level rise. This will create flood problem in the coastal area of the country because due to this kind of flood the coastal area of the country will submerge to the ocean.
- Groundwater depletion emerged as a major concern in Bangladesh. In Bangladesh, a fall in water table in the northern and central parts has resulted in severe water shortage. However like other sectors of Bangladesh ecology, the diverse biological

resources are also threatened by human intervention. The threat is most visible in the fisheries and forestry sectors.” (Ibid.)

The severity of environment security threats in Bangladesh is very high. It must be noted that these threats are all interconnected and therefore attention must be given to the most significant ones without ignoring the importance of the others. “With more than 160 million people, Bangladesh is the most crowded place on earth. It sits on the world’s largest river delta, close to sea level, which exposes it to tsunamis and the possibility of rivers jumping their banks in the event of earthquake. Rapid unplanned urbanization and lax construction laws have resulted in ill constructed buildings, bridges and multi-story buildings that are extremely vulnerable to seismic activity.” (Ibid)

After analysing, one can say that -people in Bangladesh are facing insecurity from several environmental factors. One of the most relevant questions in today’s Bangladesh would be the significance of assessing environment security threats in the Bangladesh by formulating appropriate policy and programme. Awareness programme towards the environment degradation should be started at the macro and community level in the country.

CHAPTER III

CLIMATE CHANGE AND ITS IMPACT ON BANGLADESH

Climate change has emerged as an important environmental issue, ever to confront humanity. It is the greatest environmental challenge to human kind that world is facing today. According to the Inter-governmental Panel on Climate Change (IPCC, 2007), “Over the past 150 years, global average surface temperature has increased 0.76°C.” Report of FAO published in 2007 states that “Least Developed Countries like Bangladesh are facing challenges related to climate change and variability because of their strong economic reliance on natural resources and rain-fed agriculture.” “Global Circulation Model (GCM) predicted an average temperature increase in Bangladesh due to climate change which is 1.0°C by 2030 and 1.4°C by 2050. Furthermore, climate change has posed a mortal threat to Bangladesh because of its low elevation from the sea, high level of population density and poverty and an overwhelming dependence on nature” (Khan, 2009). For these reasons the country might be affected most in near future. McDonald (2013) describes that “in the 1980s global climate change emerged as a significant international political issue, when the science of climate change began to solidify and momentum for international political action developed.”

Bangladesh is one of the vulnerable countries which may be affected adversely due to heavy rain fall, sea level rise, flood and salinity associated with climate change though the country contributes little to global greenhouse gas emissions which is the main reason of climate change. “Due to the physiographical location and as it is situated on lower riparian region Bangladesh is going to be the worst hit place on the planet from extreme climate events such as droughts, heavy rainfall, tropical cyclones, flood and storm surges” (Rawlani and Sovacool 2011). It has humid, warm, tropical climate, which is fairly uniform throughout the country. Most parts of the country have an elevation of less than 10 metre above sea level. The geographical location of Bangladesh is such that the impact of climate change will be of higher magnitude. The flat terrain, low economic growth, highly concentrated population, mostly dependence on agriculture and agriculture production, lack of infrastructure etc., combine to make the country vulnerable to any nuance in climate and sea level rise.

Low-lying terrain and with disaster prone events Bangladesh climate change may act a dignified threat to the national security of a nation and this is all the more prevalent. The fourth assessment report of the Intergovernmental Panel on Climate change (IPCC, 2007) states that, “1 metre raises in sea level will displace 14.8 million people in Bangladesh. Climate change affects the state of environmental security by increasing the acuteness and intensity of natural calamities such as cyclones, floods, tornadoes and droughts.” “Climate change also affects the suitability of land for different types of crops, livestock, fish and pasture is predicted to have an impact on health and productivity of forests, the incidence of pests and diseases, biodiversity and ecosystems.” (Sobhan 2012: 9). Thus, Climate change causes severe environmental threats to Bangladesh, may further aggravate environment, food and water security threats.

“Devastating impacts of climate change will be visible on both economy and society of Bangladesh. These changes could roll back the significant achievement that Bangladesh has made over the last 20 years in increasing income and reducing poverty, hampering its efforts to achieve the Millennium Development Goals” (MDGs 2010: 9).

The main aim of this chapter is to analyse the concept of climate change, link between climate change and security, climate change in Bangladesh and causes of climate change, impact of climate change in various sectors in Bangladesh, climate change mitigation measure will also be described in this chapter.

3.1 Climate Change: Meaning and Definition

“Climate change scenario is defined as a physically plausible set of change in meteorological variable consistent with generally accepted projections of global temperature change.” (Strezapak and Smith 1995: 2) According to National Snow and Ice Data Center, “the term climate change is often used in a more restricted sense to denote a significant change such as a change having important economic, environmental and social effect in the mean values of a meteorological element in particular temperature or amount of precipitation in the course of a certain period of time where the means are taken over period of the order of a decade or longer. It is conceived as any long-term change in the patterns of average weather conditions of a specific region or the earth as a whole. It reflects abnormal variations to the earth’s

climate and subsequent effects on other parts of the earth, such as ice caps over durations ranging from decades to millions of years. The concept of climate change is new in the research study. Climate change refers to a change in the state of the climate that can be identified by changes in the mean and the variability of its properties and that persists for an extended period, typically decades or longer.” (IPCC 2007:2)

“Fouries (1827) is generally recognised to have been the first person to have made argument about the green house like properties of the atmosphere and to suggest that the atmosphere was important in determining the temperature of the earth surface” (cited in Patterson, 1996:17). According to Trewartha (1968: 370), “Climate change is identified as an average weather condition of an area characterised by its own internal dynamics and by changing in external factors that affect climate.” “UN conference on the Human environment was organized first in 1972 at Stockholm. The conference marked a turning point in the development of international politics. Greene describes that some of the principles were agreed and established had an enduring effect.” (cited in Baylis and Smith, 1997:316)

The conference led to the establishment of the United Nation Environmental Programme (UNEP 1992), which was tasked with coordinating the environment related activities of other UN agencies and promoting the integration of environmental considerations into their work. Moreover it worked as catalyst in the growth of green movements and green politics through most of the development countries. In the erstwhile USSR and Eastern Europe environment concern grew strongly in the 1980’s.

The 1972 conference led to series of conference on climate change from late 80’s but the most important among the conference are Earth Summit of 1992, Kyoto Summit of 1997. Earth summit is a major breakthrough in the policy of climate change, in which developing and developed countries participated for the first time in large number to prepare framework on climate change.

United Nations Framework Convention on Climate Change (UNFCCC 1992:4) defines “Climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. On the other hand, the

weather is a set of all the phenomena occurring in a given atmosphere at a given time. In 2003 climate science of IPCC derive that there are many factors in the climate change process.”

3.2 Climate Change as a Security Issue

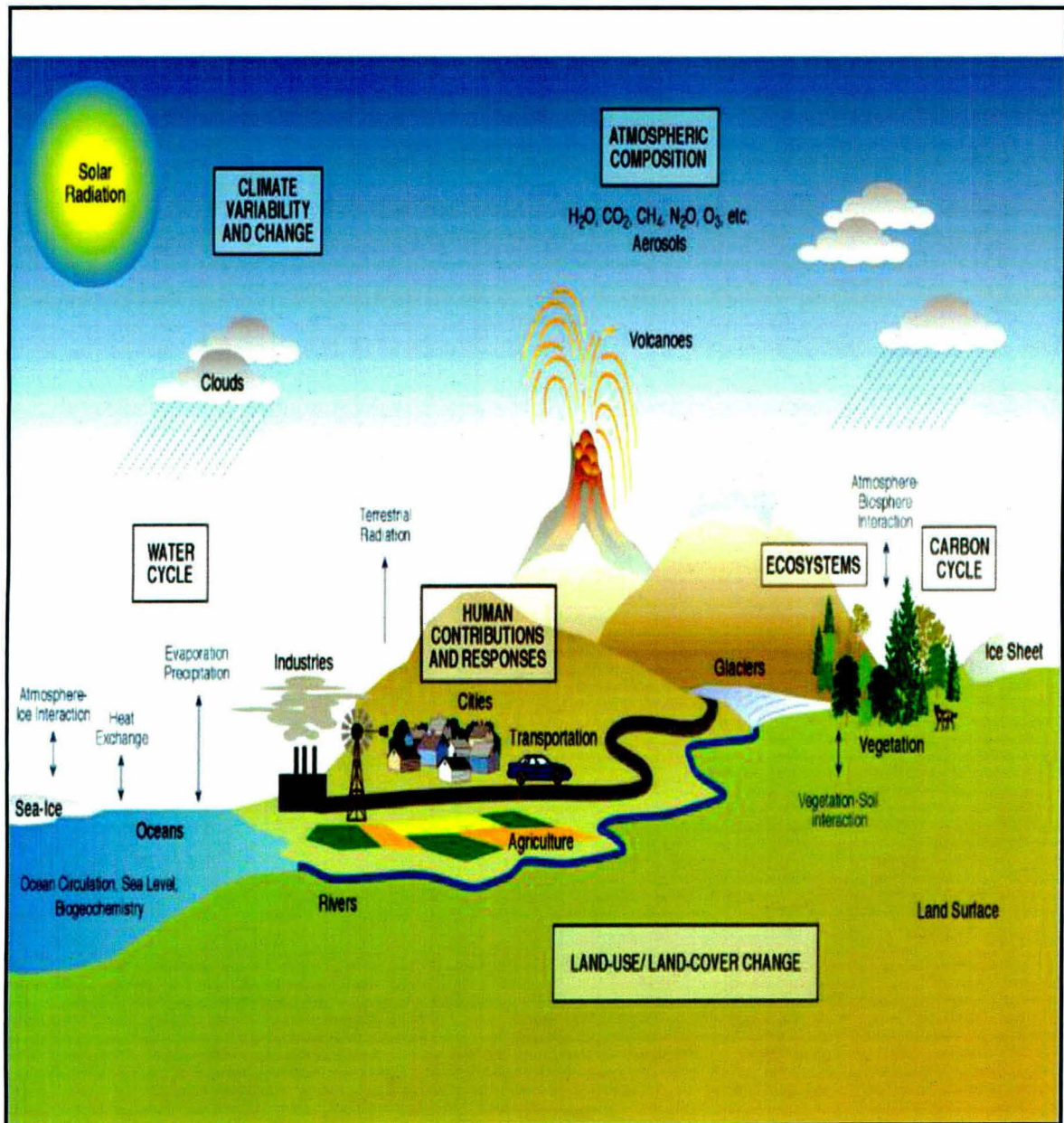
A pursuit to link climate change with security is not without its rationale. There is a growing acknowledgment that in the national and international security environment, climate change could threaten to add new hostile and stressing factors. In other word, phenomenon of climate change could become a critical factor in international events, both by causing tensions in its own right and by identifying on-going factors and conflicts. The UN Human Development Programme’s (UNDP 1994) “identified climate change as a threat to human security. Traditionally, phenomenon of climate change has been viewed as an environmental issue of peripheral concern. The reluctance to include climate change in any security scheme stems largely from the vast nature of issue. The vastness is explained by the limitless geographical expanse of the problem a case not found in other problems of national or at best regional dimension.”

Although in the last few decades one witnesses many of intellectual fermentation to redefine security in environment threat terms. According to Richard Ullman (1981: 133), “a threat to national security is an action or sequence of events that:

1. Threatens drastically and over relatively brief span of time to degrade the equality of life for inhabitants of a state or
2. Threatens significantly to narrow the range of policy choices available to the government of state or to private, non-governmental entitles (persons, groups, corporations) within the state

Sir David King the chief scientist of the British government suggested that climate change is far greater threat to world stability than international terrorism.” (cited in Brown et al., 2007) According to John Ashton, the UK foreign secretary’s special representative for the climate change argues that “the climate change is creating the most difficult security problem since the cold war.” Map 3.1 showing major components of climate change in the various aspects.

Map 3.1 Major Components of Climate Change



Source: IPCC, third assessment report, climate science, 2001a

“UNDP’s (1994: 22) initial human security formulation recognised environmental security as a core component of human security and sought to illustrate the ways in which issues such as climate change could threaten security defined in terms of human life and dignity. There is now a growing recognition that the global climate change presents a new and very different type of national security challenge and the concept of climate security has been linked to

national as well as international security.” (Afroze 2009: 156-57). In other words, the link between environment, more specifically climate change and security should be established and studied (Ibid. 157). Jaspardo and Taylor (2008: 235), “focus on climate change as a transnational security threat, defined as non-military threat that cross borders and either threaten the political and social integrity of a state or the health and quality of life of its inhabitants”.

Constant climate hazards like flood, cyclone, drought and sea level rise create human displacement, forcing large scale migration especially of the poor and the vulnerable population both inside nation and across existing national borders. The degrees of migration in turn socially inundate the inland areas and dragged the exiting demographic and ethnic imbalance triggering ethnic tensions. While these tensions pose threat to intra and inter security. They also undermine the social and political stability and internal cohesion of states.

“Further the unpredictable shifts and changes in the weather system increase vulnerability in the economy, in particular the agriculture of the low lying coastal and delta region. This consequently increase social and economic disparity, in some cases the disparities stresses and tension may render a state dysfunctional. State institutions fail to provide security as law and order dissolve into a Hobbesian state of anarchy thereby making human security the ultimate victim.” In Global Climate Change (2007:49), “it is examined that there are many historical examples of climate shifts or extremes of weathers triggering conflicts and even contributing to the rise and fall of civilization and nation.”

Recently McDonald (2013: 6) describes that “climate change will trigger profound global change, and these changes could pose genuine risks to international peace and security. Handling these changes will require well-assume activity within the UN climate change system.” (Purvis and Busby, 2004:72) Hajer’s (1995:44) “conception of climate change that comes in to frameworks of meaning in this case of security, climate change and its relationship can be powerful and indeed constitutive.”

“Case studies of Northern Pakistan, South Asia, The Niger Delta, the Pacific Island, Ethiopia and Bangladesh show that environmental changes can be a significant factor that undermines Human security.” (Afroze 2009:157) The studies have focussed on the local dynamics that

limit individuals and groups access to environmental, economic and social resources compulsory to respond to the climate instability and change. In the context, security dimensions effects of climate change have several dynamics. Hence, there is clear relation between climate change and security emanating from climatic change induced conflict over resources, large scale migration, tension resulting from ethnic imbalances, intense and frequent extreme weather events and failed states. It is no curiosity then that climate change has been differentiating by some as a threat diverse in numerous cases.

3.3 Causes of Climate Change

“Climate change is a long-term change in local weather conditions and can be identified by changes in average temperature, rainfall, winds, and climatic indicators. It can involve both modulation in average conditions and changes in temperature variability, including, for example, extreme events like flood, cyclone, and storm surges etc.” In geological time scales, the earth’s climate is naturally variable. After all, its long-term condition and mean average temperature are regulated by the balance of both incoming and outgoing energy, which drive by the Earth’s energy balance.

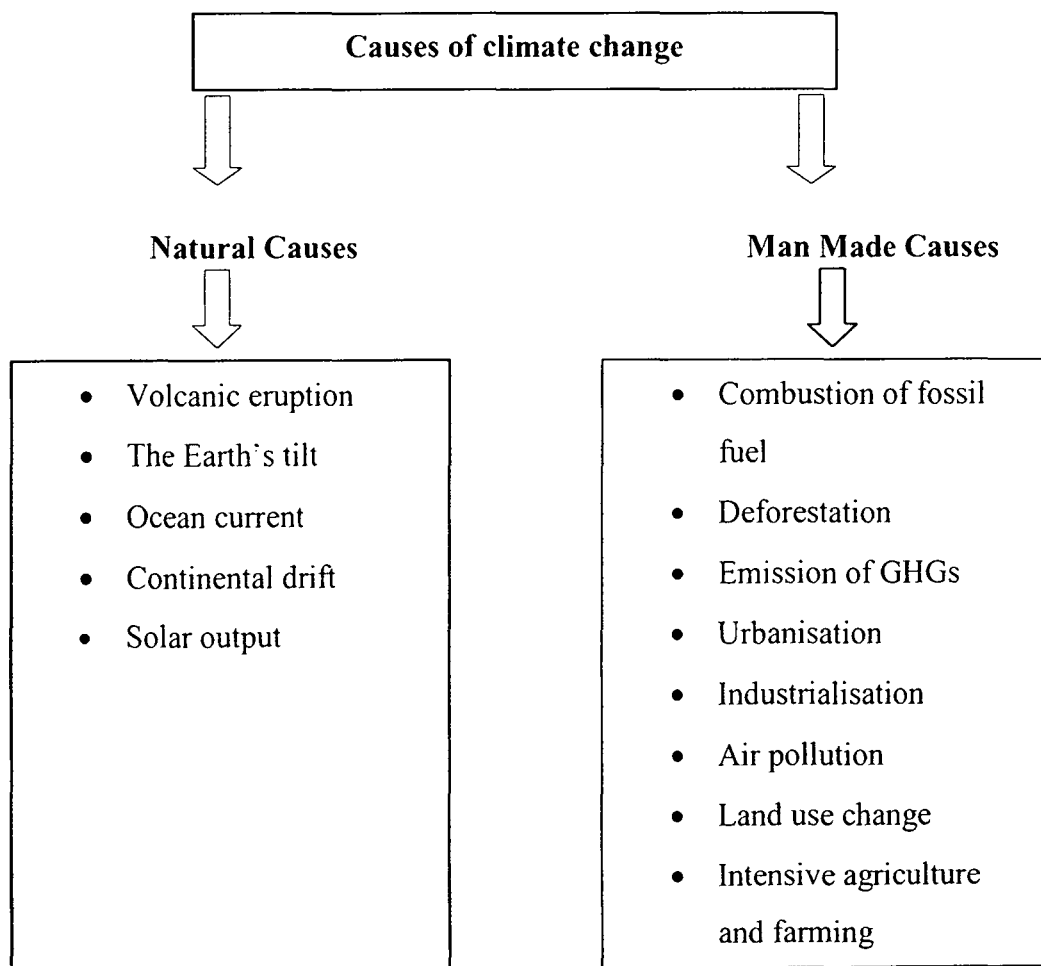
3.3.1 Natural Causes

“There are numerous natural factors responsible for climate change. The earth's climate can be influenced by external natural sources like, changes in volcanic activity, solar output, and the earth's orbit around the sun, continental drift, ocean current, etc. About 2/3rd of the short wave solar radiation is absorbed by the atmosphere, ocean, land, ice and biota and 1/3rd is radiated back.” (IPCC 2001) “In this way climate of the earth is controlled by the difference between incoming solar radiation from the sun and outgoing infrared radiation emitted by the earth atmosphere system the radiation balance.” (Mirza et al. 1994: 8)

“According to physical geography dictionary the earth’s climatic system is driven by solar energy. Changes in the state of climate system can occur externally (from extra-terrestrial systems) or internally (from ocean, atmosphere and land systems) through any one of the described components. Continuous drift of landmass over millions of year change the physical features of landmass causing climate change. A volcanic result is massive gasses, dust and ash

and sudden change in the local temperature. Explosive volcanic eruptions can create a short-lived (2 to 3 years) negative forcing through the temporary increases that occur in sulphate aerosol in the stratosphere.” (IPCC 2003). Changes in the solar radiation level may have some impact on climate of earth. This increased in solar activity cause short term climate change on the earth. Ocean current is another natural factor to change in the earth’s climate. At the end of the ice age the above natural causes contribute to change in global climate which was last affirmed to have appeared around 14 thousand years ago. Factors that antecedent to climate change can be divided into two categories that mainly related to natural causes and second one related human activity (figure 3.1).

Figure 3.1 Causes of Climate Change



3.3.2 Human Activity

IPCC (2007) describes that “human activities contribute to climate change by causing changes in Earth’s atmosphere in the amounts of greenhouse gases, aerosols (small particles), and cloudiness. The burning of fossil fuels and the conversion of land for forestry and agriculture are the major component of human activity. These human influences on the climate system have increased substantially from the beginning of industrial revolution. This overall impact of human intervention since the industrial revolution has been a warming effect, driven primarily by transmission of carbon dioxide and enhanced by emissions of other greenhouse gases. However the long wave temporal radiation emitted by the earth’s surface is partially absorbed and then re-emitted by number of trace gases in the atmosphere collectively known as greenhouse gases (GHGs). The main GHGs include Water vapour, Methane, Carbon dioxide, Nitrous oxide, CFC & Ozone in the atmosphere and stratosphere.” Table 3.1 is giving the main source of origin of greenhouse gases and their percentage in the earth climate.

Table 3.1 Origins of Greenhouse Gas Emission

Originator	Percentage	Gases	Effects and impacts
Energy including traffic	50	40 CO ₂ , 10 CH ₄ and O ₃	Use of fossil energy carries
Chemical product	20	FCKW, Halon (Halogenated, hydrocarbon) etc.	Direct emission
Destruction of tropical rainforest	15	10 CO ₂ , 5 vestige gases	Destruction of tropical forest
Other e.g., agriculture	15	CH ₄ , N ₂ O, CO ₂	Cattle, fertilizer, waste, deposits, cement

Source: Henrichs, Ralf (2001), p-7

Rapid growth of urbanisation and industrialisation, also the major man-made cause to change in the climate. For this purpose forest destruction lead to the deforestation and that will adversely affect climate. Although fossil fuel combustion, pollution, intensive use of land in agriculture also act as climate change forcers.

3.4 Climate Change in Bangladesh

Bangladesh is located in one of the most disaster prone areas of the world in terms of geography. Several types of natural calamities occur frequently and often affect the country adversely. The frequencies of the calamities are likely to be accentuated due to change in the climate. It has a tropical monsoonal climate, humid and warm seasons which is uniform throughout the country. Most parts of the country have an elevation of less than 10 meter above sea levels.

Bangladesh is recognised worldwide as one of the most vulnerable country to the impacts of global warming and climate change. This is due to her unique geographic location, dominance of floodplains, and low elevation from the sea, high population density, high levels of poverty, and overwhelming dependence on nature, its resources and services. The country has a history of extreme climatic events claiming millions of lives and destroying past development gains. “Impacts of climate change thus have the potential to challenge our development efforts, human security and the future. The geographical location of Bangladesh is such that the impact of climate change will be of higher magnitude. According to UNEP the five coastal South Asian countries are the most vulnerable countries due to climate change, Bangladesh and Maldives being in list of ten vulnerable countries.” (cited in Khann, 1997: 425).

According to National Geographic, climate change in Bangladesh is an extremely crucial issue and Bangladesh ranks first as the most vulnerable nation to the impacts of climate change in the coming decades. Various other models predict the nation’s vulnerability. Research carried out by the German Watch’s Global Climate Risk Index (CRI, 2011) states that “Bangladesh is the most vulnerable nation due to global climate change in the world. This is based on the analysis of impacts of major climate events that occurred around the world in the twenty year period since 1990.” UNDP (2009) observed “climatic data from 1971 to 2002

indicate that the temperature is generally increasing in the monsoon season (June, July and August). Observed data indicates that average monsoon maximum and minimum temperatures show an increasing trend annually at the rate of 0.05°C and 0.03°C, respectively. On the other hand average winter time (December, January and temperatures show a decreasing and an increasing trend annually at the rate of 0.001°C and 0.016°C respectively.” (Rahman and Alam, 2003) “It is also revealed that 1998 was the warmest year in the last 30 years.” (NAPA 2009: 20). SAARC Meteorological Research Centre (SMRC, 2003) has studied ground “climatological data on monthly and average annual maximum and minimum temperature, and monthly and annual rainfall for the period of 1961-90.”

The study showed an increasing trend of mean maximum 1961-90 and Regional variations have been observed around the average trend. According to UN (2007-08), “it is estimated that climate change could affect more that 70 million people of Bangladesh due to its geographic location, low elevation, high population density, and poor infrastructure, high levels of poverty and high dependency on natural resources. It was found in the study that the population settled in the coastal area is more vulnerable than the population in other areas.” (Alam and Laurel 2005) Organization for Economic Cooperation and Development (OECD, 2003) recognised “coastal resources upon which the most people depend are likely to be affected severally due to climate variability and change.” According to Climate change cell (2007), “it is predicted that for 45 cm rise of sea level may inundate 10-15 per cent of the land by the year 2050 resulting over 35 million climate refugees from the coastal districts.”

Study carried out by NAPA with UNDP in 2009 on Bangladesh climate change adaptation describes, “General Circulation Model (GCM) used by the US Climate Change Study team for Bangladesh reported that in theyears 2030 and 2070, there is an average increase in temperature from 1.3°C to 2.6°C. It was found that there would be a seasonal variation in temperature changed with 1.4 °C in the winter and 0.7°C in the monsoon months in 2030.” (NAPA, 2009:22). In the year 2070 the variation would be 2.1 °C and 1.7 °C for winter and monsoon season. “The PRECIS model result shows that temperature (maximum and minimum) and rainfall vary over space and time. Prediction indicates that rainfall in monsoon and post-monsoon seasons will increase while rainfall in the dry season will remain closer to historical amount.” (BUET, 2008) study predicts that rainfall will increase about 2.3 and 6.7

per cent in 2030, 2050 and 2070, consequently in associating to the observed baseline years 1961-1990.” Table 3.2 is showing future scenario of climate change in Bangladesh.

Table 3.2 Future Scenario of Climate Change in Bangladesh

Model	Year	Temperature change (°C)			Precipitation change (%)			Sea level rise (cm)
		Mean (standard deviation)			Mean (standard deviation)			
		Annual	DJF	JJA	Annual	DJF	JJA	
GCM	2030	1.0	1.1	0.8	5	-2	6	14
PRECIS	2030	0.3	-0.02	1.3		-8.7	3.8	
	(Max)							
	2030	1.18	0.65	1.78	4	-5	8	
	(Min)							
GCM	2050	1.4	1.6	1.1	6	-4.7	3	32
PRECIS	2050	0.2	0.07	0.89				
	(Max)				2.3			
	2050	1.24	0.59	1.65				
	(Min)							

Source: MoEF, 2005, BUET, 2008

Note: DJF stands for December, January and February, JJA Stands for June, July and August and September

In the global climate change negotiation process, the year 2009 was an important year for Bangladesh. In this year Bangladesh attended regular sessions of UNFCCC as well as in the World Climate Change Conference-3 organised by World Meteorological Organisation (WMO). In the end of year Bangladesh participated in United Nations Conference on Climate Change (COP-15). “This summit was very important for Bangladesh in terms of international

binding agreement on emission reduction and ensuring commitment for receiving fund for taking measures on climate change adaptation.” (Afroze et al., 2009:175).

From the above analysis it can be said that change in climate of Bangladesh will adversely impact on several sectors in the country. This will damage the environment and ecological balance of the country. The major sectors of the country affected by climate change are as follows:

3.5 Impact of Climate Change in Bangladesh

To the contemporary Bangladesh’s community climate change presents significant challenges for its serious environmental threats. Located in flat and low terrain country (except in the northeast and south east region) with half of its total landmass remaining less than two metres above sea level. “Many projected impacts of climate changes will reinforce the baseline environmental, socio-economic and demographic stresses faced by Bangladesh climate change is likely to result in

- a) Increasing in inundation, both in terms of magnitude and frequency, linked with sea level rise, heavier monsoon rainfall and increased glacial melt.
- b) Increased vulnerability to cyclone and storm surges
- c) Increased moisture stress during dry periods leading to increased drought
- d) Increased salinity intrusion
- e) Extreme climate Event.”

3.5.1 Sectoral Impacts of Climate Change in Bangladesh

The impact of climate change on Bangladesh has significant implications for its development. It is likely to be experienced by various sectors, prominent among it are loss of land due to sea level rise and agriculture. The coastal land area would experience the adverse impact. There is possibility of intensification of internal strife among the peoples for the land and there is also possibility of dispute with India due to migration to adjoining territory of India. There are many sectors in Bangladesh identified as most vulnerable to climate change impact, shortage of fresh water, impact on agriculture, loss of biodiversity, population, increased natural

extreme events, risk to human life, saline water, food insecurity, environmental induced migration and conflicts. Table 3.3 is showing the impact of climate change in the different sector in Bangladesh.

Table 3.3 Sectoral Impact of Climate Change in Bangladesh

Climate Change	Major Sectors
	fresh water shortage , extreme climatic event, sea level rise, intrusion of saline water, loss of biodiversity
	impact on agriculture, risk to human health
	food insecurity, environment induced migration, conflict,

Sources: Adopted from Golam Mohammad eds. (2010), *National Security Bangladesh 2009*, Dhaka, BIIS, the University Press Limited, pp. 158

3.5.2 Fresh Water Shortage

“Bangladesh is naturally vulnerable due to the quantity and poor quality of water that flows into it from the upstream and entire major river flowing through Bangladesh originates outside its border” (Afroze 2009: 159). Reported in the Daily Star (2013), “about 80 per cent rivers are going to die out in Bangladesh, while many lost their natural characteristics due to withdrawal of water in the upstream by structure such as dams and barrages in the upstream. Thus the scarcity of drinking water is a major threat to the people of the country. The internal dimension of water scarcity addresses contaminated ground and surface water. For domestic and irrigation purposes 80 per cent people of the country use ground water mainly. Thus frequent flood and droughts, salinity, intrusion, unplanned urbanisation as a result of huge migration, arsenic contamination, loss of forest resources etc. due to climate change will aggravate the scarcity of fresh water resources in Bangladesh. Another fresh water source of Bangladesh is rain water. In the year 2009 Bangladesh monsoon posed severe risk of drought. The drought phenomenon is more frequent in north western part of the country so this region is more prone or vulnerable to safe drinking water.”

3.5.3 Extreme Climatic Events

“Extreme climatic events are increasing in frequency and intensity in Bangladesh. Study conducted by German Watch in 2010 that put Bangladesh on the top of Global Climate Risk Index 2010 as country was most affected by extreme weather events like cyclone Sidr and Aila and Floods.” (cited in Harmeling, 2010). Much of the future vulnerability due to climate change would enhance both the frequency as well as the intensity of natural disaster events. The area prone to floods, cyclones and salinity intrusion may increase in the coming decade. Flash flood can also be a problem in the north-eastern and south eastern region of the country. “It is assumed that by the year 2030, an addition 14.3 per cent of the country would become extremely vulnerable to flood while the existing flood prone areas will face higher level of flooding.” (Muyeed and Rahman 2009). It is reported that between 1991 and 2000, 93 major disasters occurred in Bangladesh and it is revealed from the disaster records of last three decades that frequency of natural disasters has increased over time. It has been observed that major cyclones that hit Bangladesh were El Nino or La Nina years in the country history. At an average of one, every three years tropical cyclone hits Bangladesh. The storm surges are higher magnitude in Bangladesh than its neighbouring countries because of narrow shape of the Bay of Bengal towards the north, where country is located. In recent years general cyclonic activity in the Bay of Bengal has become more frequent, creating rougher seas.

According to Bangladesh Bureau of Statistics (2003), “it is found that the number of occurrence of major cyclone has drastically increased in the recent decades. Bangladesh is one of the most susceptible countries to flood disasters. Although regular flood is not a new phenomenon, the magnitude of flooding appears to be downfall between 30-70 per cent of the country is normally flooded each year. Floods and erosion are part of life in Bangladesh. Flooding is vital for the renewal of land but due to climate change they are becoming more frequent and intense in appearance.” Table 3.4 is showing the frequency of natural calamities in the past three decades.

Table 3.4 Frequency of Natural Hazards

	No. of events			
	Flood	Cyclone	Tornado	Drought
Decades				
80s	1	7	2	3
90s	3	4	1	3
00s	9	7	6	1
01s	6	1	5	0
Total	19	19	14	7

Source: BWDB (2007). CEGIS & SMRC

Climate change is likely to exacerbate flooding for two reasons in Bangladesh:

- 1) Higher intensity of glacier melt due to higher temperatures in the Himalayas into the Ganges and the Brahmaputra rivers; and
- 2) Heavy rainfall during the monsoon season leading to increased water flow.

In a 5 year gap Bangladesh experienced major droughts. During the pre-monsoon period the western part of country is more vulnerable to drought. According to NAPA (2009), "current severe drought can affect yield in 30 per cent of the country, reducing national production by 10 per cent. Further report argues that by 2030 temperature increase of 0.5°C and annual rainfall decreasing of 5 per cent could reduce runoff into the Ganges, Brahmaputra and Meghna Rivers by 14, 11 and 8 per cent, respectively and with 12 per cent reduction in runoff, the population living in severe drought-prone areas increases from 4 to 9 per cent under moderate climate change."

Table 3.5 showing areas and sectors vulnerable to climate change in Bangladesh.

Table 3.5 Areas and Sectors Vulnerable to Climate Change in Bangladesh

Climate and Related Elements	Critical Vulnerable Areas	Most Impacted Sectors
Temperature rise and drought	North West	Agriculture (crops, livestock, fisheries) Water Electricity supply Health
Sea level rise and salinity intrusion	Coastal areas Islands	Agriculture (crop, fisheries, livestock) Water (water logging, drinking water) Human settlement Electricity supply Health
Floods	Central Region North East Region Char Land	Agriculture (crops, fisheries, livestock) Water (urban, industry) Infrastructure Human settlement Health Energy
Cyclone and storm surge	Coastal and Marine Zone	Marine fishing Infrastructure Human settlement Life and property
Drainage congestion	Coastal area South West Urban areas	Water (navigation) Agriculture (crops)

Source: adopted from NAPA, 2009, p, 39

3.5.4 Impact on Agriculture

Bangladesh's agricultural crop is determined by seasonal changes and different component of climate such as temperature, rainfall, humidity, day-length etc. Decision Support System for Agro-Technology Transfer (DSSAT) model result shows that yield reduction will vary by types of crops and their growing season. IPCC (2007) predicted that by the year 2050, rice production would decline by 8 per cent and wheat by 32 per cent. "Agriculture accounts for 63 per cent of its labor force and 35 per cent of its gross domestic product and rice occupies 80 per cent of total cultivated land area but droughts during the winter season threaten all three major types: aman, aus, and jute." (Rawlani and Sovacool 2011: 9). Karim et al. (2010) said that "a 17 per cent loss in overall rice production and as much as a 61 per cent decline in wheat production in the next few decades are likely; they caution that any positive increases in yield will be more than offset by moisture stress." ADB (2007: 5) "calculates that agriculture growth in 2008 fiscal year (FY) is moderate declining to 2.2 per cent from 3.2 per cent in FY 2007 caused by flooding in July-September and impacts of Cyclone Sidr in November. Cyclone Sidr in November 2007 destroyed most of the coastal area plantation." Table 3.6 is showing the major hazard year and loss of agriculture production in Bangladesh.

Table 3.6 Loss of Agriculture Production by Natural Hazards

Year	Loss in production (metric tons)					
	Flood			Cyclone/Storm		
	Aus	Aman	Boro	Aus	Aman	Boro
1998	274875	927357	23558	-	-	-
1999	26510	242605	-	-	-	-
2000	-	197970	-	1572	-	317460
2001	27540	34870	-	-	-	18440
2002	52030	131890	-	-	-	247760
2003	177880	43880	-	-	-	15610
2004	150590	954500	-	-	-	497210

Source: UNDP (2009), report on Bangladesh, p.62

The GFDL model predicted about 17 per cent decline in overall rice production and as high as 61 per cent decline in wheat production compared to the baseline situation by 2100 and the highest impact would be on wheat followed by rice (aus variety) (NAPA 2009: 31). The aus rice (grown during the summer, monsoon period under rain-fed conditions) seems to be the most vulnerable among the three rice variety grown in Bangladesh.

An estimate by Government of Bangladesh (2009: 17) by 2050, rice production could decline by 8 per cent throughout the country and wheat production by 32 per cent and in eastern Bangladesh alone 14,000 tons of grain production could be lost to sea level rise in 2030 and 252,000 tons lost by 2075. Habibullah et al., (2010) predicted “that a significant loss of food grain production in coastal belts because of soil salinity, making affected lands unsuitable for a variety of crops. Climate change can bring major changes to agriculture productivity in Bangladesh. Farming practices has been changed over the past 30-40 years.” Rahman et al., (1999) describe “that prolonged inundation, drought; salt water intrusion coupled with loss of land due to erosion is a risk for the agricultural sector.”

“Among other sectors, agriculture will face the deadliest experience from flood, drought, tornado, cyclone, tidal surge and soil salinity.” (Rashid and Islam 2007). The World Watch Institute published a report on 22 October 2007 realising that 21 countries of the world including Bangladesh are under serious risk due to rise of sea level from climate change. So it can be said that natural events causes by climate change have a great impact on the agriculture and plantation sector of the Bangladesh.

3.5.5 Sea Level Rise and Intrusion of Saline Water

Coastal areas in Bangladesh are on the front line of climate change, directly affected by sea level rise. Rahman (2011: 16) describes “that most of Bangladesh is less than ten metres above sea level, with almost ten per cent of the country lying 1 metre, making it more vulnerable to high tides. With expected rise in sea level by an average of two to three mm per year during the first part of this century the effects on the coastal areas will be severe, and include erosion, coastal land submerge, siltation of river water, decreased sedimentation, waterlogging, and saltwater intrusion” (Ibid 16). Coastal areas will also be affected by salinity intrusion. Saltwater from the Bay of Bengal already penetrates 100 kilometres inland during

the dry season, and climate change is likely to exacerbate this (IGCSE, 2013). The study carried out by SMRC, (2003) on recent relative sea level rise of Bangladesh reveals that “the rate of sea level rise during the last 22 year is many folds higher than the mean rate of global sea level rise over 100 years, which showed the important effect of the regional tectonic subsidence.” The IPCC, (2001)3rd assessment report estimated that “the global rise in sea level from 1990 to 2100 would be between 9 and 88 cm.”

The World Bank (2000) has warned “that a 25 cm increase in sea level, more than likely given recent projections, would force Bangladesh to lose 6 thousand three hundred square kilometers (4 per cent of its land), make the country prone to a 1991 level cyclone of 10 per cent greater intensity, provoke monsoonal floods increase crop losses, inundate 40 per cent of the Sundarbans, and increase the salinity of soil and water.” Agrawala et al., (2003: 19) predicted that “a 1 metre rise in sea level would adversely impact on 18 per cent of population, inundate one-eighth of the country’s agricultural land, destroy 8,000 km of roads, threaten the major port of Mongl, and resettlement of communities living in Khulna region, it is alone costing 13 US billion dollars.”

A quarter of the population lives in the coastal areas, with the majority of the population reliant on an affected by coastal activities. As reported in Financial Express in 2013 if sea levels rises up to one metre this century, Bangladesh could lose up to 15 per cent of its landmass and up to 30 million people could become climate refugees. Even at present some parts of coastal lands in south-western part of Bangladesh are not being utilised for crop production, mostly due to soil salinity. Surface water in Bangladesh is highly saline in the period of monsoon. For coastal eco-system, fisheries and agriculture salinity and its seasonal variation are dominant factor in Bangladesh. “Therefore any changes in present spatial and temporal variation of salinity will affect the biophysical system of the coastal area” (NAPA 2009: 29). An analysis shows that in the period of dry season the salinity will intrude more landward due to sea level rise. Sea level rise of 27cm will cause a 6 per cent increase of brackish water area compared to the base condition and an additional area of about 327,700 ha would have highly saline water (>5 ppt-part per thousand) during the dry season due to 60 cm sea level rise (Ibid, 30). It is 6 per cent in the monsoon that will affect around 276,700 ha of sweet water area in the Bangladesh.

3.5.6 Biodiversity Loss

“Bangladesh is endowed with a number of natural forest ecosystems including inland Sal forest, dipterocarp forest, savanna, bamboo bushes in the hilly regions and freshwater swamp forests Government of Bangladesh.” (GoB 2005:15). “Climate change has a detrimental impact on all of the forest ecosystems in Bangladesh, and the Sundarbans are likely to be the worst affected.” (Rahman and Alam 2003:2) “Biodiversity (in forests, wetlands, and other ecosystems) is undergoing threats due to human interventions and fragmenting of habitats but climate change impacts will add an extra dimension to these ongoing stresses.” (NAPA 2009: 33).

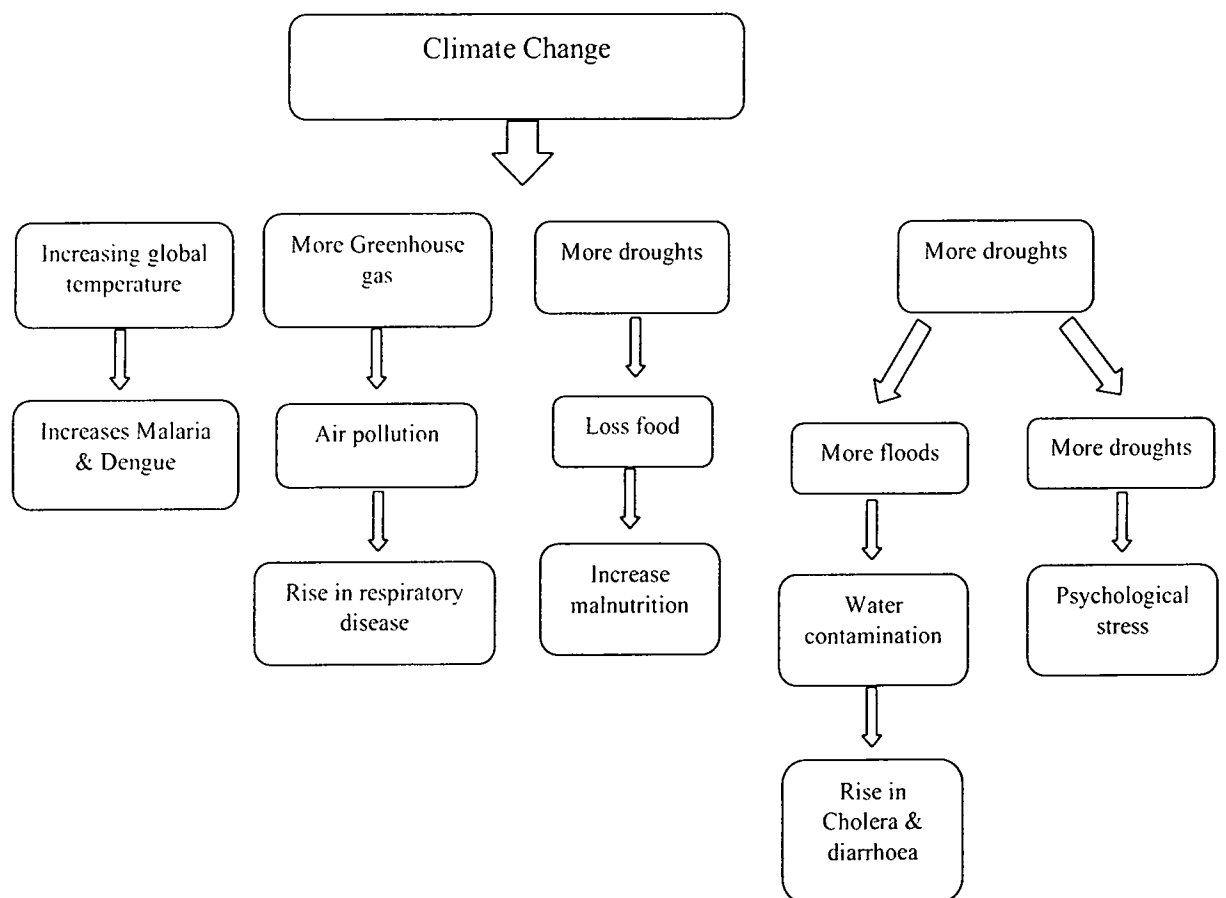
High intensity of evapotranspiration and in winter low-flow in river water, the salinity of the soil would increase and it will adversely affect the forest productivity. It negatively impacts on the growth of freshwater loving species. “Subsequently the species within dense canopy cover would be displaced by non woody shrubs and bushes, while the overall decline in forest productivity would be notable. The degradation of forest quality might cause a gradual depletion of the rich diversity of the forest flora and fauna of the Sundarbans ecosystem.” (Ahmad et al., 1999) According to the Bangladesh climate change study during the monsoon heavy rainfall would cause increased runoff in the forest floor alternative of infiltration into the soil. This results in the soil erosion in the forest floor. Frequent flood is severe problem in Bangladesh to loss of biodiversity in the large area.

3.5.7 Impact on Human Health

Climate change affects health directly and indirectly. IPCC (2001) “describes that global warming would increase the vector borne and water borne diseases in the tropics”. The most direct impacts of climate change on human health occur through extreme events, for example the floods in Bangladesh in 2004 caused 800 deaths, while the recent cyclone affected more than 8.5 million people, causing more than 3,500 deaths.” Banu (2010: 3) elaborates that “climate change will also affect the distribution of climate sensitive diseases and malaria is a frequently cited example, because its prevalence increases in line with the warmer, wetter climates that are anticipated with climate change. While a causative connection between climate change and these diseases is of course difficult to verify, the conditions associated

with climate change and the impacts on water supply, sanitation and food production, generate favourable environments for the incidence and spread of such diseases.” (Reid and Sims, 2007:13). Incidences of malaria have increased dramatically in Bangladesh over the last 30 years, and it is now a major public health problem, with 14.7 million people in Bangladesh classified as high risk of the disease. Figure 3.2 is showing the linkage between climate change and human diseases.

Figure 3.2 Relationships between Climate Change Impact and Spread of Disease



Source: Drawn from Climate Change Cell (2008), in Golam Mohammad, *National Security Bangladesh 2009*, BISS, the University Press Limited, Dhaka, 2010, pp. 167

“Other diseases such as dysentery, diarrhoea, dengue, hyper tension associated with heat stress, asthma and skin diseases are also increasing in Bangladesh, particularly during the summer months.” (Banu 2010:3). “A case study in Chittagong Hill Tracts found positive

correlations between monthly incidence of malaria and monthly mean maximum and minimum temperatures and monthly total rainfall NAPA.” (2009:34)

Adding to this another study of Bangladesh Centre for Advance Studies (BCAS 2007) states that “minimum temperature seems to play a more important role in the transmission of the disease than maximum temperature does. More than 20 million people were affected and many suffered shortages of water, skin infections, and communicable diseases.” (Matthew 2007: 167) “In Bangladesh more than 80 per cent of diseases are directly linked to water-borne diseases.” (Ericksen et al 1993: 17)

3.5.8 Food Insecurity

Other impacts of climate change such as extreme temperature, drought and salinity intrusion are also affecting crop yield in Bangladesh. Several studies have been conducted in Bangladesh to assess the vulnerability of food grain production to various climate scenarios. One such study noted that a 4 °C increase in temperature would have a severe impact on food production in Bangladesh, resulting in a 28 per cent reduction in rice and a 68 per cent reduction in wheat (Huq and Ayers, 2008:6). Temperature and rainfall changes have already affected crop production in many parts of Bangladesh and the area of arable land has also decreased. The coastal area of Bangladesh is much experienced of salinity intrusion having serious threat of the quality of the soil in areas that were conventionally used for production of rice. As reported in Dhaka Mirror (2008) that “under a moderate climate scenario the decline in yields due to salinity intrusion could be 0.2 metric tonnes which increased to 0.56 metric tonnes under more severe scenario. The IPCC noted that the production of rice and wheat could fall by 8 per cent and 32 per cent respectively by 2050.”

The climate change implications for agriculture and food production are more significant, not only because of the livelihood of the majority of the population but also for significant to those who depend on agriculture outputs and system. The population of Bangladesh almost doubled in less than thirty years from 1961 and now stands at over 143 million (Hossain et. al, 2005). Rapid growth of population in Bangladesh will create more pressure on resource and that will cause conflict. Continuous growth rate will adverse effect food production of the

country. The Increase vulnerability of crop production and food grains to climate change is likely to creel the acquirement of food security for the people of Bangladesh.

3.5.8 Environment-Induced Migration

“According to the Population References Bureau, migration is one of survival strategies used in time of environmental threats. In the face of climate related environmental change such as the decline of productive agriculture land, rural residents may be forced to migrate in search for work.” (PRB 2007) “They are forced to move away their homes as a result of the loss of their livelihood and living space due to environmental changes (natural as well as anthropogenic) and migrate (both temporary and permanently) to nearest possible place (within the country or outside the country) in search of their sustenance.” (Swain 1996:16)

“The failure of agriculture system due to impact of climate change might force the rural population to migrate to nearby town. In the recent times a number of environmental disasters have a push factor for displacement of population. A survey conducted during 1998 flood found that at least one in thirteen people had been forced to change their occupation, while the floods left 27.4 per cent of the people unemployed.” (Akhtar 2009: 5). Therefore increased migration to urban areas in search of non-agricultural employment put greater pressure on scarce housing, water, sanitation and energy service increasing the number of vulnerable urban poor who are particularly at risk from climate related disasters in Bangladesh. Table 3.7 is showing the estimated potential migrant rates in Bangladesh under the severe climate change scenarios.

Table 3.7 Environment Induce Migration

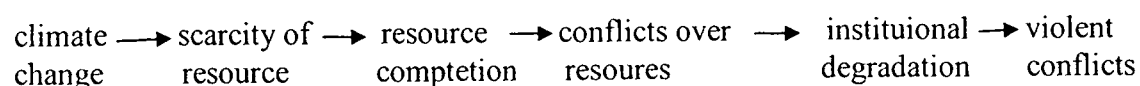
Climate driven issues	Loss of livelihood to (number to people/year)	Potential out migration (people/year)	Frequency
Erosion(both Coastal and riverine	50000, 200000	60000	Annual
Strom surges and Rough sea	300000	10000-120000	Once in three to five years
Water logging	350000	30000	Annual
Salinity	1200000	10000-15000	Annual

Source: Ahmed and Neelormi (2008), pp.4-5

3.5.9 Increased Conflict

“Climate change factors may not cause violent conflict directly but affect the parameters that are sometime important in generating violent conflicts.” (Barnett and Adger, 2005: 5). “In the developing world the pressure of a changing environment such as drought, desertification and rising sea levels will pose significant challenges for both states and regions as social, political and economic dynamics come under pressure leading to conflict.” (Afroze, 2009:171). The following figure defining broadly the linkage between climate changes and conflicts:

Figure 3.3: Link between Climate Change and Conflicts



Source: adopted from Golam Mohammad (2009), pp. 172

The above figure advocated that in an event like scarcity of resources due to environmental changes, resource competition may arise among the users of scarce resources which may ultimately lead to conflict. It demonstrated at three levels: conflicts with neighbouring states, conflicts between states and groups and conflicts among social groups.

3.6 Mitigation Adaptation to Reduce the Impact of Climate Change in Bangladesh

“The irony for Bangladesh is that its own emission is miniscule i.e. 0.1 per cent of the total global but total but its geographical location is such that the magnitude will be very high. 55 per cent of the total energy consumed in Bangladesh comes from the traditional organic fuels, 24 per cent comes from natural gas, 19 per cent comes from the import of coal and mineral output and 2 per cent comes from hydroelectric generation.” (Hasin, 2009:296). Ahmad and Alam (1999: 19) advocated that “for the assessment of climate change vulnerability for Bangladesh four types of scenario are considered:

- a) Climate change scenarios which would give changed values for different climate parameters (e.g.; temperature, evaporation, precipitation etc.) having impacts on the physical events.
- b) Socio-economic scenarios providing information on development aspects which would have effects (positive and negative) on the impacts of climate change.
- c) Sea level rise scenarios which would give absolute values for changes in sea level at a reference point of time in future.
- d) Watershed development scenarios which denotes changes in watershed likely to be occurred within the country and beyond the territorial boundary.

The challenges of Bangladesh will be to receive fund from the developed partner as well as utilising that fund in home. Availability of these funds will depend on prudent project formulation and successful implementation by the Bangladesh government. Bangladesh government has already allocated Taka 7000 million as Bangladesh Climate Change Fund from its own budgetary allocation without waiting for the donor’s fund disbursement in the fiscal year 2009-10.” The Ministry of Environment and Forest (MoEF), Government of

Bangladesh, has “introduced the two major policy documents describing government policy on climate change. The main policy documents on this issue are as follows.

a) National Action Plan for Adaptation, 2005 (NAPA, 2005)

b) Bangladesh Climate Change Strategy and Action Plan, 2009 (BCCSAP, 2009).”

The NAPA (National Adaptation Programme of Action 2005) was prepared by the MoEF as a response to the decision of the UNFCCC Seventh Session of the Conference of the Parties (COP 7) according to the generic guiding principle of NAPA annotated guideline. It was prepared by consulting with the stakeholders drawn from different spheres of governments, scientist, researchers, academicians, civil society organisations, community based organisations, teachers, indigenous community and grassroots people. “The NAPA 2005 placed adaptation as the main focus on intervention for Bangladesh as it emits GHG far less than the global average GHG emission.” (NAPA 2009)

According to the Bali Action Plan (2009), “the present government of Bangladesh has also incorporated emission reduction as long run objectives in its climate change strategy and action plan. The action plan is a ten years programme from 2009-2018 aiming at capacity building and increasing resilience of the country to tackle the challenges. Six major themes under this programme are as follows:

- Food security, social protection and health
- Comprehensive disaster management
- Infrastructure
- Research and knowledge management
- low carbon development and mitigation
- Capacity building and strengthening of institutional”

BCCASP (2009) “has identified priority actions for climate change. These are very wide ranged and diversified in nature.” Some of the major policy priorities of the government have been given below:

3.6.1 Develop Cyclone Settlement and Training to the People

With rising temperature, incidence of cyclone will increase with higher wind speed and storm surges leading to more damage in the coastal region. It is imperative on the part of Bangladesh to take adequate measures.

3.6.2 Flood preparation and Monitoring System

The IPCC has predicted that in the future due to climate change, heavier and more erratic rainfall will occur in the Ganges-Brahmaputra system. As a result, there will be higher river flows that will cause over topping and breaching of embankments and widespread flooding in rural and urban area, riverbank erosion, loss of homes and agricultural land. It will also be accompanied by increased sedimentation in riverbeds which will cause congestion and water logging. So Bangladesh needs to make preparation for this situation.

3.6.3 River Training and Management

Global warming may lead to melting of the Himalayan Glaciers, leading to higher river flows during rainy season, followed by lower river flow and increased saline intrusion in the aftermath of the shrinking or disappearance of the glacier. The government needs to enhance its capacity for the river training and management.

3.6.4 Develop Alternate Livelihood Options

Low lying Coastal areas of Bangladesh are likely to get submerged with the rise of sea level. As a result, a large number of people will face displacement and loss of livelihood. The government needs to arrange training and education projects so that displaced people can shift to alternative livelihoods.

3.6.5 Measure for Combating Diseases

Hot and more humid weather would increase the prevalence of disease and its vectors. So, the country needs to prepare its health service system. It needs training programmes for its health workers and has to ensure the availability of medicine.

3.6.6 More Attention to Agricultural Productivity

Climate change will affect agriculture in severe manner. It will increase a variability of weather. Lower and more erratic rainfall may result in increased drought, especially in the drier northern and western region of Bangladesh. The IPCC estimates show that, by 2050, rice production in Bangladesh may decline by 8 per cent and wheat by 32 per cent. Bangladesh needs to develop new variety of rice to avoid that situation. Besides, if part of Bangladesh submerges due to the increase in the sea level, area of agricultural land will be reduced. Therefore, the government needs to take measures to save agricultural lands as well increase agriculture productivity.

3.6.7 Arrangement of Drinking Water

In the coastal belt of the country, pure drinking water is likely to be scarce. This will impose hardship on women and children as they usually collect drinking water of their families. More saline drinking water may also result in health hazards. There is need for making available of pure drinking water. All of these changes threaten the food security, livelihood and health of the poor. In the coastal and char areas of Bangladesh, incidence of poverty is high. People living there will be affected seriously because of the loss of their land to river erosion. Climate change is likely to increase the incidence of water and air-borne disease.

To sum up, it can be said that climate change may pose a grave threat to the national security of a nation and this is all the more prevalent in a low-lying disaster prone country like Bangladesh. It is recognised as yet another threat to the prospect of a peaceful and relatively stable world. Bangladesh is recognised worldwide as one of the most vulnerable countries due to hydro-geographical and socio-economic factors that include geographical location, flat

deltaic topography with low elevation, extreme climate variability, high population density, high level of poverty, and overwhelming dependence on crop agriculture, highly influenced by climate vulnerability and change. The country has a history of extreme climatic events claiming millions of lives and destroying past development gains.

CHAPTER IV

FLOOD IN BANGLADESH: NATURE AND IMPACT

“The nation is faced with a disaster of highest order. All signs, as they become more and more visible, lead to one conclusion: we are faced with a disaster with catastrophic dimensions. It is not just another flood; it is The Flood, which all Bangladeshis will remember for generations to come. This will be the reference point for many of our national events. This will set the standard of our capability or incapability. We’ll measure ourselves with this standard in future. So will the rest of the world.”
(Muhammad Yunus 1998)¹

“For a society to develop in a sustainable manner, it has to cope with destabilising influences such as natural disasters” (Plate 2000: 11). Such kind of disasters arise when a natural or human intervention for the developmental activities with the natural resources. It results in loss of human life, damages to public infrastructure and private property, land resources, severe impact on agricultural production. Floods may cause physical devastation, risk to human health and safety, threat to ecosystems, and extreme economic losses to individuals and to society. “Flood disasters account for about one third of all natural catastrophes in the world (by number and economic loss) and are responsible for about one half of the fatalities” (Berz 2000: 3). In the 1990s, there were two dozen floods that caused more than thousand fatalities or one billion dollars (US) equivalent material damages (Kundzewicz and Takeuchi 1999: 420). The potentially devastating consequences of major floods justify attempt to reduce both their frequency and severity.

“In the term of frequency and occurrence, flood is the most common and the third most damaging natural hazard after storms and earthquakes in the world. Anthropogenic climate change is expected to increase flood risks through more frequent heavy precipitation, increased catchments wetness and sea level rise” (Wilby and Keenan 2012:1). Floods are a normal and very common part of the ecology of Bangladesh. Geographically, Bangladesh is located in one of the most hazard prone areas of the world. Several types of natural calamities

¹These statements originally reported in “The Daily Star”, a major English-language newspaper in Dhaka, Bangladesh, September 11, 1998, in the midst of what has been called “the flood of the century.”

such as tropical cyclones, storm surges, and monsoon river erosions occur frequently and often affect the country adversely but the intensity and frequency is of flood much higher degree in the country. The frequencies of the calamities are likely to be accentuated due to change in the climate. "In recent years the intensity of abnormal floods has increased essentially and create serious problem to lives and property in the country. The country has about 130 million populations with an area of approximately 147,000 sq. km. It is one of the densely populated country on the earth. Every year different magnitude flood and high intensity flood occur because of its unique topography and geographical location. Past 50 year data shows that at least eight extreme flood hazards occurred and affected about 50-70 per cent of land area".

The purpose of this chapter is to provide an overview of Bangladesh's historical experiences with flood. The nature, types, causes and impacts of flood in Bangladesh are analysed in detail. The chapter also deals with flood characteristics along with the flood management strategy, flood control projects and national water policy regarding flood management in Bangladesh.

4.1 Flood History in Bangladesh

Literary evidence on flood history in Bangladesh is numerous. They also show a great variety of opinions. In some cases the statements are even contradictory within the same source. Several authors speak of non-existent or even declining trend of flooding; others support the assumption of increasing trends. Some authors suggest that flood have increased not in terms of dimension or frequency, but rather in terms of the impacts resulting from the extension of land use into flood-prone areas. History of Flood, in this country, perhaps is inseparable from the history of this land. "In every century, this delta witnessed the events of about half dozen floods, around equal to the magnitude and intensity of the 1988 year flood and of as many, with lesser magnitude" (Rahman, 1989b:45). Flood is natural and generally occurred disaster in Bangladesh. We had it in the past, we have it now, and we will continue to have it in future also (Miah 1988:88). Due to human activities of human beings floods have intensified in Bangladesh. "The construction of railways, roads and homesteads in the flood plain obstruct the flow of the flood (Hossain et al., 1987:17)." "Each year's highest flood record has been

broken by the subsequent years” (Rahman 1989a:132). “It remains unclear whether an increase in the frequency of extreme flooding in Bangladesh has actually taken place. There is some evidence to suggest that an increase in the extent and duration of inundation has occurred during the period of 1954-1988, but the reasons for this remain unclear (Hughes et al., 1994:20)”.

Bangladesh has been experiencing many floods throughout its history. Flood occurs in the country almost every year. Some of them are very catastrophic and some are normal. Due to its geographical location at the deltas of the Ganga-Brahmaputra-Meghna Bangladesh is highly vulnerable to flood hazards. Ahmed and Mirza (2000) analyse “records of past floods and indicate that about 21 per cent of the country is prone to annual flooding and in addition to this around 42 percent is at risk of floods with extreme intensity.”

At present, Bangladesh faces serious flooding that may submerge over 60 per cent of the country every 4 to 5 years (GoB, 2009). Flooding in Bangladesh is a result of a combined set of factors. Most of Bangladesh’s geography is covered by deltas of three major rivers, the Ganges, the Brahmaputra and the Meghna. Irregular trans-boundary flow of river water, the low and flat topography, excessive rainfall in monsoon season, high vulnerability tidal waves and cyclonic storm surges and closed river channels contribute to the inundation problem in the country.

The earliest meteorological report on flood of this region was prepared by a famous meteorologist and statistician of that time, Professor Mahalanabis in 1927. “This report included a list of floods occurring between 1870 and 1922 (BANCID 1995 and Rasheed, 2008).”

Records of past flood events indicate that Bangladesh was severely inundated by a convincing number of *above-normal* floods between the years 1890 to 2007. Temporal analysis of flood events indicates *above-normal* flooding in Bangladesh has not followed any ordinary pattern historically. “A period of frequent flooding event from 1892 to 1922 was followed by few *above normal* flood but on the other side frequency of *above-normal* floods is showing an increasing trend since 1950” (Hofer and Messerli, 2006). “During 1954 to 2011 flood

hazard data shows that country has witnessed 2 major *catastrophic*, 4 *exceptional*, 4 *severe* and 11 *moderate* floods between this time periods”.

“There are no authentic records of floods data for the period of 1923-1953. But after this from 1954, flood events in this region have been relatively well recorded. Floods which inundated 33 percent or more than of the country are identified as catastrophic, and in the case of 25-33 percent inundation floods are called severe” (Rasheed 2008). The severe and catastrophic flood affected areas since 1954 to 2011 and the percentage of area inundated by each flood are also shown in figure 4.1. From this figure, it can be said that Bangladesh experiences floods almost every year with considerable damage. The floods of 1987, 1988, 1998, 2004 and 2007 have high magnitude and more affective in nature. In an average year, approximately one quarter of the country is inundated because of flood. Inundation extents recent floods reveal the affected area may exceed even two-thirds of the total area of Bangladesh during severe floods.

Based on the historic data of floods, it is accessible that during the last few decades the frequencies of flood, magnitude level, and duration of floods have increased essentially. From the above analysis all major floods covering more than 30 per cent of the country (total area of Bangladesh is 144,000 km²) occurred after 1974. During the last 25 years, four extreme floods of such great magnitude (1974, 1987, 1988, and 1998) took place on average once in every 6 years. According to Elahi (1991 and 1992) “in 1980 and 1984 also inundated more than 30 per cent area, and frequency of such floods to be 6 since 1974” (it is one in every 4 years). “In addition, the total area inundations by major floods have been regularly increasing since 1974, but in the year of 1984 it is decreasing in nature” (Islam, 1999). “The data showing the total inundation area varies widely from one source to the other source. The area affected by major floods has increased from 35 per cent in 1974 to 68 per cent in 1998”.

4.2 Nature of Flood in Bangladesh

Flooding is a natural phenomenon occurring every year in Bangladesh. Flooding usually occur in the beginning of the month of June, lasts until October to mid-November and inundates about one third of the area of Bangladesh. Farmers usually benefit from this normal annual flood event. It is called *borsha* which helps farmers to cultivate their farming lands

within the flood waters, and the *aman* crops which need flood water in order to grow normally. Flooding is thus productive in a way for water and fertilizing the agriculture lands.

On the other hand the catastrophic flood brings large scale destruction of agricultural lands, damage property and crops, homesteads and infrastructure, and even cause loss of life.

“This is called *bonna* which means it brings havoc and disaster. Sometimes, exceptionally severe flood, known as *plabonoccur* and devastate the livelihoods of people and cause havoc to the national economy” (Ahmad et al., 2004). These floods are generally river-induced and often triggered by monsoon rainfall throughout the GBM region.

Younus (2010: 102) identified some major characteristics of floods in Bangladesh. “They are as follows:

- In a year of normal precipitation 20-30 per cent of the land is inundated annually during the monsoon season.
- The 1988 flood inundated 61 per cent of the total land, and the 1998 flood inundated almost 68 per cent of the total land.
- During April to May, the normal sequence of flood starts with flash floods in the northern and eastern hills; in flash flood, river rise sharply and recess rapidly, usually within a few days or hours.
- Bangladesh is one of the largest deltas in the world. The delta is characterised by flat terrain of alluvial soil crisscrossed by an intricate system of over 230 rivers, canals and streams (MFD, 2006).
- The total drainage area of the GBM catchment is 1.75 million sq. km spreading over five countries: India (63 per cent catchment of the GBM Basin), China (19 per cent), Nepal (8 per cent), Bhutan (3 per cent) and Bangladesh (7 per cent). Out of the only seven per cent falls within Bangladesh; but the area dominates the socio-economic life

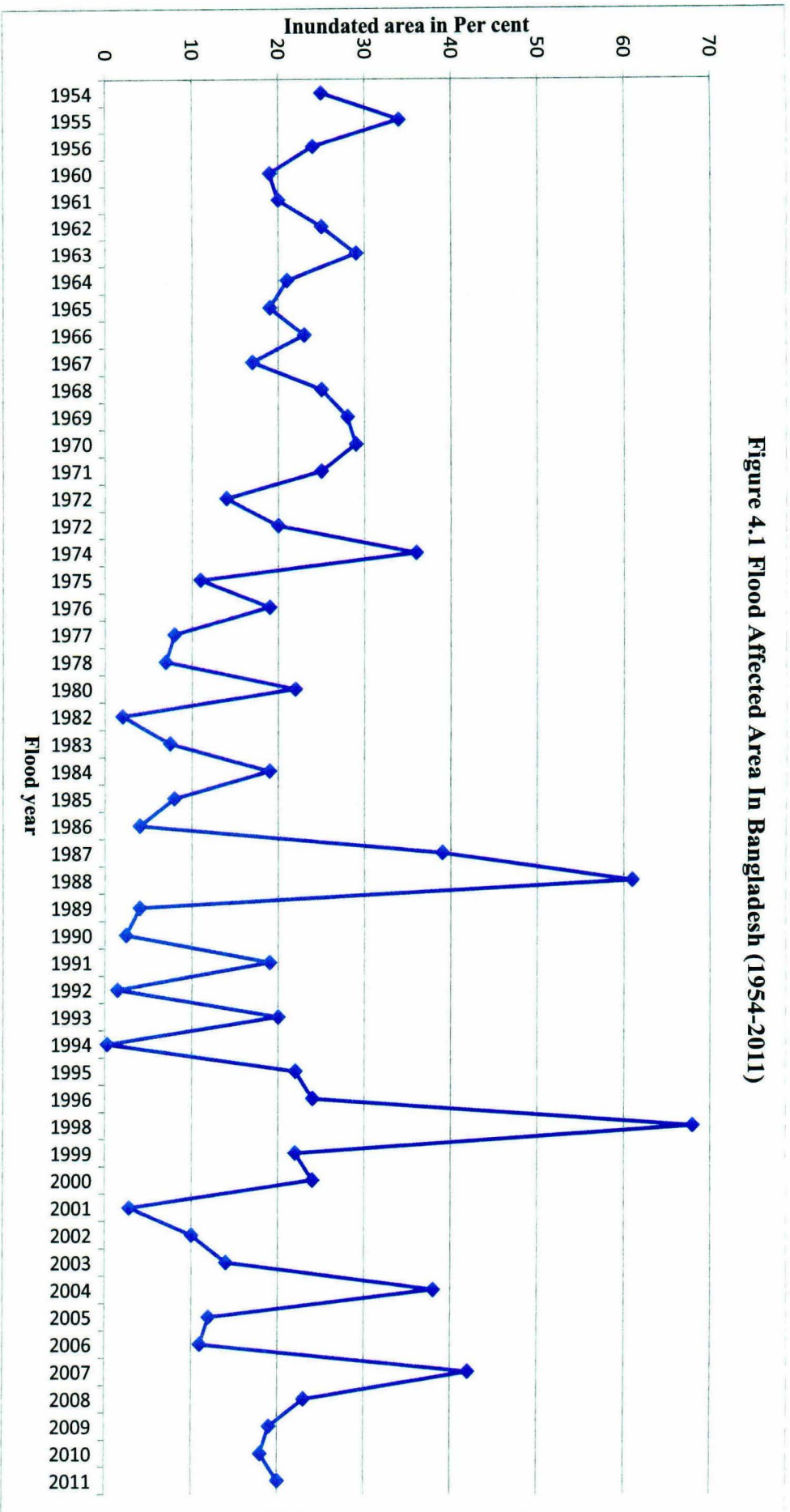


Figure 4.1 Flood Affected Area In Bangladesh (1954-2011)

Source: Annual Flood Report 2011, FFWC (Flood Forecasting and Warning Centre), BWDB (Bangladesh Water Development Board)

of the country as it constitutes 84 per cent of its land and is occupied by 93 per cent of its population (Ahmad, et al. 1994 and Rasheed, 2008).

- Bangladesh has to drain the runoff of an area which is 12 times larger than its size.
- The amount of water that passes over the country's entire geographical area.
- During the month of June-October around 1360,000 cubic millions of water discharge is generated annually."

Apart from the hilly region in the southeast and northeast area Bangladesh geography has low and flat land. GBM (Ganges-Brahmaputra-Meghna) river network criss cross the whole country with their numerous distributaries and tributaries. Located in fluvio deltaic region, the relief of the country is low and it's varying between one and two meters. Rasheed (2008: 11), "stated about 50 percent of the country land has an elevation of less than 10 meters above sea level. But the southeastern parts of the country altitude exceed 300 meters above sea level. About 20 percent of the land confined in low-lying tidal plains, with elevations of less than three meters above sea level."

"The GBM river basins have very low gradients 6-10 cm/km for the Brahmaputra, 4-5 cm/km for the Ganges and 3 cm/km for the Meghna" (Rashid and Pramanik, 1990) "On the basis of geological time scale and process of formation, there are three major physiographic units which have been recognized in Bangladesh: Hills, Terraces and Floodplains. Bangladesh flood plains cover 80 percent of the country which is formed by the deposition of alluvial soil by the network of GBM Rivers. The alluvial plain slopes gradually southeastwards from an elevation of about 90 meters at Tetulia in the far northwest to the coastal plains in the south less than three meters elevation" (Rasheed, 2008). The flood plain is essentially lowland in terms of elevation.

FAO (1998) has classified "Bangladesh into 30 agro-ecological regions. In this FAO study Bangladesh has been divided into 30 physiographic units, 16 of them in the flood plains". Rasheed (2008) has divided "the floodplain into nine physiographic subunits which were based on FAO's agro ecological zone study. The major subunits are, Old Himalayan piedmont Plain, Teesta Floodplain, Brahmaputra-Jamuna Floodplain, Ganges Floodplain, Meghna Flood Plain, Surma-Kusiyara Floodplain, Ganga Tidal Floodplain, Meghna Estuarine Floodplain, and Chittagong Coastal Plain".

4.3 Types of Flood

Bangladesh generally experiences four types of floods. It is seen that every year Bangladesh faces this kind of floods. According to Hosain et al., (1987), Miah (1988), Ahmad (1989) and Brammer et al., (1993), “the four type of flood in Bangladesh are:

- Flash flood
- River/Monsoon flood
- Rain water flood
- Storm surges”

4.3.1 Flash Flood

When there is fast rise and fall of water level in the rivers it is characterised as flash flood. It has much potential to cause huge damage to crops and infrastructure including roads, railways and flood protection embankments along the river. “This type of flood mainly occurs in the flood plains area along the river channel in the hilly areas also in the foot hills. Ten days maximum rainfall exceeding 300 mm is considered as an index for a flash flood in any given area” (BANCID, 1995 and Rasheed, 2008). This type of flood is common in Bangladesh along the northern, north eastern and south eastern parts.

4.3.2 River Flood

It is the most common flood in Bangladesh. This type of flood is identified by a slow rise of water levels and gradual inundations of large areas through over bank discharge. It is caused by excessive rainfall in the river catchment area in upper riparian that is outside of the country. About 30 percent of the land area is inundated and in the case of destruction in country it rises from 50 to 70 percent. The flood becomes demolish in nature when there is concurrent rise of water in the three main rivers, for example, the 1998 flood was the most devastating in the last century.

Rasheed (2008) argues, “that in the month of March the Brahmaputra generally starts rising due to snow melt and it causes its first peak in late May and early June, followed by subsequent peaks up to the end of August due to a heavy monsoon rain over the catchment. Usually river flood affects large flood plain areas, it causes severe damage to

crop, homes, livestock, plants, and infrastructure and it also causes river bank erosion in large area. Timing, intensity and extent of flood arbitrate the duration of havoc from river flood”.

4.3.3 Rain Water Flood

Rain water flood is caused by heavy rainfall occurring over flood plains. Heavy rainfall rise in to water volumes and it overload the drainage capacity. This type of flood is most common in low-lying and drainage blocked areas of Bangladesh. The amount of water, intensity of local rainfall and the water level of major rivers cause the extent, depth and duration of rain water flooding. When it coincides with the high river flood, the damage in country is much higher in intensity.

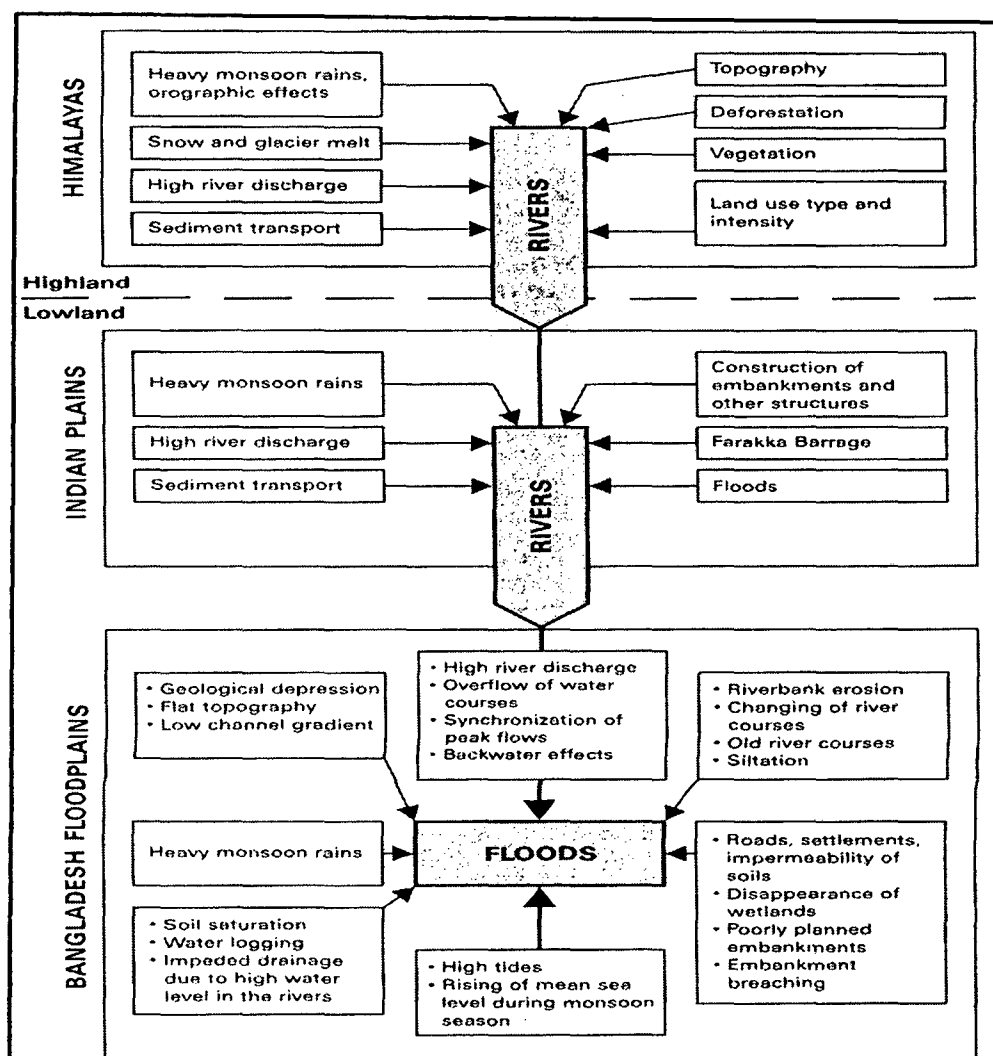
4.3.4 Storm Surges

Storm surges are characterised by sudden but temporary flooding of coastal areas with brackish or saline sea water. In fact storm surges are raised sea-levels caused by a combination of low barometric pressure and strong onshore winds associated with tropical cyclones. Brammer (2004) describes that “the extent of storm surges floods depends on several factors”. “The height of the storm surge at the coast, the relief of the adjoining land, whether or not a coastal embankment exists, the impedance of water flow by settlement, trees, crops and road embankments” (Rasheed, 2008)

4.4 Causes of Flood

The causes of floods are numerous, heterogeneous and complex. Floods are often produced by a combination of factors that differ for each flood (GoB, 1992). Hughes et al., (1994) state that “a key feature of flooding in Bangladesh is that each flood is different and there are a number of reasons for that”. “Flood in Bangladesh is caused by a combination of a complex set of factors” (Ahmad et al., 1994 and Rasheed, 2008) Therefore it is important to analyse the floods causes keeping in mind their unlikeness. Figure 4.2 showing the causes of flood in the country. They are divided in to three major regions that are: the highlands, the Indian plains of the Ganga and Brahmaputra and the flood plains of Bangladesh. It is showing that the factors outside Bangladesh having indirect impact to the causes of flood in Bangladesh. Some major causes of flood in Bangladesh are described below:

Figure 4.2 Causes of flood in Bangladesh



Source: Compiled From BWDB (1975), Brammer (1987), Hossain et al. 1987), Rasid and Paul (1987), Miah (1988), USAID (1988), Abbas (1989), Ahmad (1989), Choudhury (1989), Haq (1989), Huda (1989), Khan (1989), Latif (1989), Ives (1991), Pearce (1991), GOB (1992), Hughes et al. (1994) in Hofer and Messerli (2006: 36)

4.4.1 Location of Bangladesh

The physiographic location of Bangladesh itself makes it extremely vulnerable to floods. The land is located in the lower riparian section of the GBM basin along the low lying topographic nature of the terrain. As it is located at the lower part of the entire GBM River basin the territory provides the outlets of the basin into the Bay of Bengal. Therefore, Bangladesh is on the floodway of an immense area of the GBM basins. With Indian Ocean to the South and Himalayas to the North, the prevailing monsoon has made it one of the wettest countries of the world. Large area of central India and the southern Himalayas

slope down towards the country makes way to flow the major rivers toward the Bangladesh and it creates severe havoc during the flood. Three major rivers of this region draining a total of nearly 16 million sq. km. area and adjoins each other in this small country and merges in to the sea.

4.4.2 Flat Terrain

“Bangladesh is a flat delta with numerous abandoned channels inside the country, and many depressions known as *beels*, *boars* and *haors*. These natural depressions together have an area over 1230 sq. km (Hossain et al., 1987). Furthermore Hossain describes that the flatness of the land surface gives a minimal slope to the flood producing rivers. During flood time, the average slope of the Brahmaputra is of the order of 6 cm/km and the Ganges and the Meghna have even smaller gradients. It helps the flood waters to easily inundate the surrounding river catchment areas”. “The depressions, which are confined mainly in north-eastern districts and Rajshahi and Pabna districts, hold large volume of water and easily inundate huge areas along the periphery” (Younus 2010:126). *Haors* and *beels* of the flood prone region overflow and easily inundate the surrounding flat surface areas causing havoc (Ibid 126).

4.4.3 Cross Boundary River Water Flow

Bangladesh receives heavy monsoonal rainfall in every year. “Around 80 percent of this rainfall occurs in mainly five months, from June to October. Rainfall coupled with snow melt water from the Himalayas, finds as outlet to the sea through the Bengal basin sharing approximately 7.5 percent of the total basin area of the great river systems” (Islam 1995). Flood water mainly comes from outside the large GBM basin. The whole basin on the other hand comes under the influence of monsoon. “Monsoonal or orographic rainfall hits the entire GBM river basin especially in the Khasi-Jaintia range of hills in Assam, India which extends towards the north of Bangladesh where lies Cherrapunjee, the place with the heaviest rainfall (12.7 m) in the world” (Hossain et al. 1987). During the summer monsoon rainfall running off from this huge area coupled with Himalaya’s snowmelt brings a huge inflow of water to Bangladesh.

4.4.4 Rainfall Intensity

The tropical monsoonal climate of country provides a huge rainfall intensity which compounds the flooding in the region. “The average rainfall varies from 1270 mm near the western border to about 5600 mm in the bordering areas of the North-East. The mean annual rainfall is about 2320 mm, but there are some places which receive mean annual rainfall of 6000 mm or more. A long extent of heavy rainfall associated with Nor Wester thunderstorms is very common that create local floods”. Hossain (1987)“estimated that about 125 thousand cubic meters of runoff is generated by rainfall within Bangladesh”.

The local rainfall runoff compounds the entering flood from the inter-national GBM Rivers catchments. Local rainfall runoff causes flood havoc even in comparatively small areas due to unplanned drainage system. Another statistic, mentioned by Islam (1995), “is that the amount of rainfall occurring within Bangladesh amount to an average of 960 million acre feet (MAF). Further he describes that an average of 700 MAF of water is carried by three major river systems of Bangladesh. If the remaining 260 MAF water is distributed within 30 million areas of land, then approximately 2.74 metres of water would be accumulating over the flood plain in the 5 month from June to October every year”.

4.4.5 Human Intervention

The population of Bangladesh is living in much higher density than other south asian countries. The concentration of population is much higher than its land area. Human intervention in its local environment is also a major cause for the flooding in Bangladesh. Construction of dam in the upper riparian and development work along the bank of the rivers, particularly along the upper catchment area (India, Nepal, and Bhutan) has reduced the original floodplains thus the diverted water causes flood. “Deforestation in the upstream for the purpose of development has intensified flood frequency in Bangladesh in several ways. It causes acceleration of water flowing from the upper riparian region. It also causes soil erosion thus increasing the sediment loads carried by the rivers. This reduces channel flow and consequent overflows on the floodplains occur” (Islam, 1995). Infrastructure development in the ways of roads, railways and homesteads in the floodplains obstructs the flow of the water. Sufficient openings for an undistributed flood flow are barely maintained which intensifies the flow and also cause drainage congestion aggravating flood problems.

4.4.6 Sediment Deposition

River's soil in Bangladesh is generally of alluvial type and erosion and sediment deposition are a continuous process. Older literature indicates that gradual siltation of many channels, reducing the river flow and at the same time it decreases the depth of the river beds, reducing their water containing capacity. Thus sediment deposition by the rivers can add more intensity and severity floods. The channel boundaries of the rivers are more adaptable and they are also subject to changing course. "Increased flood discharge, faulting of sediment deposits from previous flood years or combination of both, commonly cause shifts of the major flow, leaving behind abundant channels and low lying area which tend to be affected again by floods" (Hossain et al., 1987 and Islam, 1995).

4.4.7 Tidal Effect

Bangladesh's one third area comes under tidal effects. Over a period of twenty four hours a moderately strong semi-diurnal tide with two high waters and two low waters affect the coast of country, backwater effects of tides, from the Bay of Bengal, particularly the spring tides, prevent efficient drainage of flood waters. "It causes flooding in the low lying coastal areas of the country. Flooding of the *Haor* areas of Sylhet and Mymensingh is also affected by the tidal effect as it obstructs drainage of water of the river Meghna at Chandpur" (Younus 2010: 130).

4.4.8 Sea Level Rise

It is long term cause of flood and if there is any change in sea level it will lower the coastal area elevation. According to IPCC (2007), "Bangladesh is more vulnerable from global climate change. It will adversely affect the coastal plain of the country. This will raise the base level of rivers, which also reduces the gradient of river flow". As a result, rivers water discharge decline and water flow becomes down, creating a backwater effect in inland region of the country. Khan (2007) "identifies that the backwater effect caused by sea level rise can result in more flooding of land from accumulation of river water inland which certainly seems to be one of the reasons for the increase in flood intensity in Bangladesh in recent years".

4.4.9 Deforestation in the Upstream Region

“The amount of deforestation is increasing in the hills of Nepal due to rapid increase in population in the Indian subcontinent over the course of the present century to meet the increasing demand for food and fuel wood” (Khan 2007: 20). “Deforestation in steep slopes is assumed to lead to more soil erosion and cause landslides during monsoon season. It contributes to destructive floods in the lower riparian regions of Bangladesh”.

4.4.10 Earthquake

“A vibration in the earth or the movement between two plates causes earthquake. This can change the physical structure of a region and also changes river course. Bangladesh lies on the Indian plate, which is pushing against the Asian plate, causing growth of the Himalayas and occasional earthquakes in the region” (Islam, 2012). “An abrupt change in a river course can cause abundant flooding. Historical evidence states that floods of 1988 and 1991 synchronise with earthquake hazards in northern region of the country”. Floods can be either a cause or an effect of an earthquake. Flood water put an extra hydrostatic pressure on unstable and changeable crustal blocks. Earthquake can change the river drainage pattern and this change in river course causes sudden flooding in an area.

From the above analysis it can be described that the floods in Bangladesh are generally caused by different sources. They can be induced by natural as well as human intervention. Therefore causes of flood in Bangladesh can be summarized as follows:

- Huge trans-boundary flows from the upstream catchment resulting in over spilling of the main rivers.
- Runoff generated by heavy local precipitation that cannot drain out due to high stage in the outfall rivers.
- High tides in the Bay of Bengal coupled with wind set up caused by southwesterly monsoon winds that obstruct drainage of the upland discharge.
- Excessive sediment load of the river channels which have reduced their carrying capacity.
- Storm surges due to tropical cyclone in the Bay of Bengal.

- Unplanned infrastructural development activities and inadequate drainage facilities leading to drainage congestion, together with excessive rainfall runoff, inducing high magnitude flooding that inundated large areas.
- Excessive destruction of natural vegetation and changing land use patterns in all the headwaters of the major rivers.”

4.5 Impact of Flood in Bangladesh

In developing countries, the flood related problems are far-reaching, affecting the environment, economy and development of the region. “Impacts of flood on livelihood have been a major issue, especially in the rural areas, where agriculture, aquaculture are the major livelihoods” (Few 2003 Wisner et al., 2004 Moench and Dixit 2004).

Unavailability of systematic time series data on flood damage and loss in Bangladesh exclude us from drawing any clear loss of the event. Flood causes direct as well as indirect loss to the country. The direct losses include damage to the infrastructure, agricultural and industrial products, human death and loss of livestock. “The indirect losses include the damage to the economic activities that cannot remain operative due to lack of communication facilities during and immediately after flood. The indirect losses, particularly losses due to damage of transportation facilities may be substantial and warrant special attention” (Alam et al., 20003).“It has been reported that although the recent floods are not physically different than many previous occurrences and the degree of economic losses, agriculture damage, infrastructure losses, and vulnerability of population has dramatically increased in the recent decades” (Rogers et al., 1989).

“It is a very difficult task to present a complete statistics on damage reports from flooding in Bangladesh as data on damage has not been collected systematically. Even though data can be found they lack consistency and reliability since each organization calculates flood damage from their own point of view” (Paul, 1997, Chowdhury and Sato, 1996). Present chapter will use collected data from ample literature sources and try to provide a realistic statistics on flood related damages in Bangladesh during different flooding years.UNDP (2004) has “identified Bangladesh to be the sixth most vulnerable country to floods” (table 4.1).

Table 4.1 Most Vulnerable Country to Floods

Country	Deaths (deaths/100,000 people exposed to floods)
Venezuela	4.9
Afghanistan	4.3
China	2.2
Pakistan	1.4
India	1.2
Bangladesh	1.1

Source: UNDP (2004). A Global Report: Reducing Disaster Risk: A Challenge for Development

URL: <http://www.undp.org/bcpr>

In the last 25 years, Bangladesh has experienced six severe floods. An analysis of flood loss in Bangladesh reveals that the people are highly adaptive to flood more than other extreme natural events. Table 4.2 is giving a general scenario about the flood affected area in the major flood.

Table 4.2 Major Flood and Affected Area in Bangladesh

Year	1974	1987	1988	1998	2004	2007
Affected area sq. km	53	57	90	100	56	62
Percentage of total land of Bangladesh under inundation	37	40	63	69	39	42
Return period (years)	9	13	55	90	12	14

Source: Islam and Mechler (2007), BWDB (2007)

As per the data compiled from different sources available from flood affected area in various years, it is clear that flood occurs more frequently in Bangladesh than other natural hazards. The 1998 flood in Bangladesh covers almost the whole country with about 69 percent of the total geographical area under the flood. The year 1998 saw the major catastrophic flood of the century. Inundation extents of recent floods reveal that affected area may exceed even two-thirds of the total area of Bangladesh during severe floods.

There are different sectors which are directly affected by flood every year in Bangladesh. Impact on various sectors is described below:

4.5.1 Economic Aspects

“Bangladesh is probably the most flood prone country in the world and some authors describe that it is the most disaster prone country in the world” (Cutter, 1996 and Zaman, 1999) “It is observed that every year's highest flood record has been broken by the subsequent years and, simultaneously, damage from floods has been surpassed by the following year's damage.” (Dewan et al., 2003:53). The economy of Bangladesh is mainly dependent on the agricultural sector. Every year flood events carries destructive impact to the sector affecting the total economy. Table 4.3 is giving the data of the damage to economy of the country in major flood.

Table 4.3 Major Flood and Damage of Economic Aspect in Bangladesh

Year	1974	1987	1988	1998	2004	2007
Crop damaged (million Hact)	NA	NA	2.12	1.7	1.3	2.1
Asset losses (million US\$)	936	1167	1424	2128	1860	1100
Asset losses as percentage GDP	7.5	4.9	5.5	4.8	3.3	1.6

Source: Islam and Mechler (2007), BWDB (2007), NA= Not Available

It can be said from the Table 4.3 that an asset loss is much higher in percentage during the major floods in Bangladesh. It was highest in 1974 flood (7.5 per cent) and lowest loss of asset in the year of 2004 flood (1.6 per cent). Damage of flood is very crucial for the agriculture based economy of Bangladesh. The crop damage is highest in the 1998 flood it was 2.12 million hectare. And the lowest can be seen in the year of 2004 where it was 1.3 million hectare damage of crop.

4.5.2 Loss of Human Life

Bangladesh has a “population of over 145 million, and with more than 830 persons per sq. km, it is the most densely populated country in the world” (BBS, 2011). Population concentration is much higher than its total land area.

Table 4.4 Major Flood Years and Loss of Human Life in Bangladesh

Year	1974	1987	1988	1998	2004	2007
Affected population (million)	30	30	47	31	33	14
Fatalities	28700	1657	2379	918	285	1110

Source: Islam and Mechler (2007), BWDB (2007)

Table 4.4 is giving general information about the loss of human life in major flood years. People of Bangladesh face catastrophic floods every year. In 1988, 47 percent population were affected by flood and numbers of fatalities were 2379 while in the 1974 flood, 30 percent population was affected but the fatalities were much higher because of mismanagement in the policy of the flood management. Flood in Bangladesh every year causes deaths in higher numbers. According to the Bangladesh Red Cross more than 45 million people are directly affected by flood.

4.5.3 Infrastructure Loss

Besides immense loss of agriculture, economy and human, the growing physical infrastructure too is severely damaged by flood every year. The destruction of these infrastructural facilities was primarily caused by poor planning strategies with regard to potential risk of excessive run-off (Table 4.5).

Table 4.5 Infrastructure Loss in Bangladesh

Year	1974	1987	1988	1998	2004	2007
House damaged	NA	989	2880	2647	896	1000
Road Damaged (km)	NA	NA	13000	15927	27970	31533

Source: Islam and Mechler (2007), BWDB (2007), NA= Not Available

Due to the availability of data sources it is easy to describe about the loss of infrastructure during the major flood years. In the years of 1998, 2004 and 2007, the road damage is much higher in terms of km. The highest damage was in the year 2007. In the 1988 flood the house damage was much higher than the other flood years.

“With a return period of 50 years, all national and regional roads in country were designed to be built above the highest flood level and feeder roads were designed above normal

flood levels” (Siddiqui and Hossain 2006). Yet, these designed were not sufficient to prevent huge losses in road infrastructure during major catastrophic floods. For example, during the 1998 flood the road damages accounted for 15 per cent of the total damages or about 0.7 per cent of GDP” (Islam and Mechler 2007).

4.6 Flood Management in Bangladesh

Flood management consist exercise that anticipate flood, reduce the intensity of a flood, or lessen the damaging effects of unavoidable floods. About the middle of the last century, the approach to floods was mainly flood control, such as building levees, dams, and local protection works. White (1945) proposed “a fundamentally different approach, namely human adjustment to floods”.

In the process, disaster management in Bangladesh has emerged as a crucial, sophisticated and a challenging national endeavour. Disaster management in Bangladesh has, however, undergone a complex process of development. “The disaster management strategy as articulated by Government of Bangladesh, over time, is holistic and comprehensive to the extent that it integrates the tasks of disaster management with those of the broader development strategy of the country. In the process, the tasks of disaster management and those of broader and long-standing socioeconomic development became intertwined and interwoven “(Rego and Roy 2007)

After the extreme floods in 1988, the Government of Bangladesh adopted a World Bank sponsored scheme of flood alleviation measures through their Flood Action Plan (FAP). The main objective of this FAP is to regulate flood levels inside proposed flood-control compartments.

4.6.1 Overview of Flood Management in Bangladesh

Before 1954 and 1955 extreme floods the flood management programme in Bangladesh did not have much attention. After two frequent big floods, the East Pakistan (presently known as Bangladesh) government collaborates with the United Nations to tackle flood problem of the country. In the year 1964, a master plan was built up by the US International Engineering Company Inc. (IEC) with the aegis of WAPDA (Water and Power Development Authority) presently known as Bangladesh Water Development Board (BWDB), introduces a large scale flood control, drainage and irrigation programs.

This master plan was failed to deliver betterment and was lacking with faulty design and formation, lack of maintenance in the structures and implementation. In 1987 and 1988 successive floods again devastated Bangladesh. After 1988 the catastrophic flood Government of Bangladesh appealed to the World Bank to coequal and formulate plan that could reduce the flood problems of Bangladesh.

As a result of this catastrophic flood, Flood Action Plan (FAP), was formulated by the World Bank in collaboration with Government of Bangladesh. In November 1989 FAP was finalised as a result of various studies conducted by the World Bank. As expected due to various delays and controversies implementation of this plan has not progressed. FAP comprising 26 components as an initial stage in the development of a long term comprehensive system of flood control and drainage works in Bangladesh (Younus 2010: 110). Rasheed (2008) describes that “the eleven main component of the FAP covered in four categories of study groups those are namely as:

- Rehabilitation of present flood embankments
- Flood management planning at regional level
- Flood protection at urban area
- Flood warning and alertness”

Under different component of FAP the most significant benefit from implementation of this plan was that the huge amount of new technical and socio-economic information were produced. In the study of Bangladesh water and flood management (BWFM) in 1995 the “flood action plan finally published and completed its program. After this program several small scale projects on the flood control were formulated and implemented by the government of Bangladesh in various years.

The major types of flood control projects constructed so far in Bangladesh are:

- Embankments along the river side which built in the form of roads and railways,
- Flood embankment in the form of Submersible
- Drainage regulators by the making of polders

- Pump irrigation and drainage with the help of polders
- Development of irrigation projects with pumping stations along the major rivers”

Furthermore with various technical problems in the planning process of flood control projects in Bangladesh is delaying the flood management strategy

4.6.2 Flood Management Strategy in Bangladesh

Generally there are three major ways that societies have attempted to manage floods:

- Structural measures: land drainage modification, reservoirs, embankments, diversions, platforms, polders
- Non-structural measures: regulations, flood defense, flood insurance
- Do nothing: learn to live with floods

Frequent occurrence of flood in country is creating obstacle in flood management strategy from the past three decades. According to its development flood management strategy can be divided into three distinct time period which are as follows:

- Phase 1-1960 to 1978
- Phase 2- 1978 to 1996
- Phase 3- 1996 to 2000 onwards

4.6.2.1 Phase 1

After 1954 and 1955 two consecutive disastrous floods the United Nations commissioned a mission that was led by Mr. Krugg and it analysed the problem of flood in Bangladesh and suggested mitigation measures. In 1956 the Krugg mission submitted their report to Government of Pakistan (Before Independence of Bangladesh). “The essential recommendations of Krugg mission were following:

- Prepare a master plan for water and power development;
- To deal with water and power development establish a statutory body

- Strategy about intensive hydrological survey and investigations”

“Main focus of this mission was to protect the agricultural land from the flood because of the fact that at that time agriculture was the main basic source of economy of the country. As a result the government realised that only through structural measures flood problems could not be solved or mitigated” (Hossain, 2003:7). In 1972 the Government decided to also go for non-structural measures to developing e.g. flood forecasting and warning system to mitigate flood problems” (Ibid, 7).

4.6.2.2 Phase 2

In this phase some large scale flood control, drainage and irrigation (FCDI) projects were implemented in the country. After this government of Bangladesh came to realise that the implementation of this kind of large projects having too much investments as well as longer duration and at the end it takes long time to assume more benefits. Then to provide early benefits government of Bangladesh opted small and medium scale (FCD) flood and coastal defence projects and implemented it. Environmental protection also came in to the force. As a result of this issue the formulation of national water plan (NWP) came in the notice of the Government. In 1982 government realised to formulate NWP and looking into heterogeneous aspects of water use and demand and interest of different organisation involved in the water sector.

After extreme floods of 1987 and 1988, formulation of a national water and flood management strategy came to forefront again for obvious reasons. All the international development partners supported a project entitled flood action plan (FAP) from 1990 to 1996 to formulate a national flood and water management strategy. After this in 1996 government of Bangladesh formulated a flood and water management strategy (BWFMS) on the basis of FAP activities. In BWFMS policy guidelines for water resources development and management were featured public participation, environmental impact assessment (EIA), and multi criteria analysis during planning process were made mandatory in all future water sector policy.

4.6.2.3 Phase 3

This phase started from 1996 to 2000. In this phase government realised that all the issues concerning the water resources development and utilization have not been addressed in the

light of integrated water resources management (IWRM) in the flood action plan studies. Then the government again launched a national water management plan (NWMP) with cutting national economy in different sectors for the implementation of IWRM in 1998. In order to guide the formation of NWMP, the government introduced a national water policy (NWPO) in 1999. NWMP was prepared in 2001 with 25 year projection. But it is waiting for government approval.

The major program of this policy was divided into three phases:

- Short term for 5 yrs.
- Medium term for 10 yrs.
- And long term for 25 years period

It was formulated with a program approach, not with a project approach. It identified that various loop hole in the policy and the implementation has a major obstacle in safe drinking water use and balanced flood management in the country.

4.6.3 National Water Policy

In the year of 1998 national water policy articulated by WARPO (Water Resources Planning Organization) with collective effort of many government institutions and NGOs. And it was published in the year 1999. The major goal of NWP is “to ensure progress towards fulfilling national goals of economic development, poverty alleviation, food security, public health and safety, a decent standard of living for the people and protection of the natural environment” (Rasheed, 2008: 48). Further Rasheed describes that “NWP has six broad objectives:

- To direct the issues related to furnish and development of all forms of surface water and ground water and management of these resources in an efficient and equitable manner.
- To assure the availability of drinking water to all elements of society.
- To accelerate the development of sustainable public and private water delivery system with appropriate legal and financial measures and incentives including delineation of water rights and water pricing.

- To bring institutional changes to help decentralise the management of water resources.
- To develop a legal and regulatory environment that will help the process of decentralisation.
- To develop a state of knowledge and capability that will enable the country to design future water resources management plans with economic efficiency, gender equity, social justice and environment awareness.”

It is emphasized that management of water resources need good co-ordination of present institutions and some require reform and creation of new community based institutions. Specific objective of this policy is to provide guidelines to all institutions and sectors related to water resources. Bangladesh and its people have been one of the worst victims of natural disasters from time immemorial. Flood is a perennial problem for Bangladesh. Floods are normal events in the deltaic plains of Bangladesh. Although the lifestyle of the people in Bangladesh is well adapted to normal monsoon flood phenomena, the damages due to inundation, riverbank erosion or breach of embankment, etc. still occur in various regions in almost every monsoon season. They often have disastrous consequences: major damage to infrastructure, great loss of property, crops, cattle, poultry etc., human suffering and impoverishment of the poor.

With every major flood in Bangladesh, food security and poverty situation has been worsening. The preventive; protective and mitigation policies of Bangladesh government are not proving enough to overcome the flood problems. The government should go for more effective and more suitable policy. Sustainable flood plain development can be envisaged as an important measure. It can be concluded that a policy of sustainable floodplain development would be right measure for the prevailing circumstances in Bangladesh. Historical experiences of the country with flood and the inefficiency of existing policies to deal with floods strongly supports such a measure. Along with reduction in the risk levels this would also promote an approach to live with floods and other natural processes and make it tolerable by developing measures for human preparedness and loss reduction.

CHAPTER V

CONCLUSION

The conventional definition of security primarily confined with the military and territorial security. It has not been adequate to meet the needs of people. But with the end of cold war the paradigm sifted in the security's definition from conventional to non-conventional security. It includes human security, water security, energy security, environment security etc. The concept of non-traditional security is mainly human centric. This idea of security is human centric. At a time when there is already an intellectual debate on redefining security, comes in the form of environment perspective, environmental threats and prompt them to rethink the conventional security in terms of environmental security. Environmental security comes too close to become a national security issue in the terms of its nature, dimensions and scope. The environmental impacts on global and national security are now being slowly recognised by concern groups which had led to a reconceptualisation of the term security (Raghavan, 2000:378).

Land degradation, deforestation, effects of greenhouse gases, global warming, and ozone layer depletion due to anthropogenic sources has been a global or worldwide phenomenon. The devastating impacts of environment degradation on society, state's economy, and natural resources is the major phenomena in the lower riparian country. These create obstacles in the development of the country. The affected country considered this as new kind of security threat though unintentional. Further in a condition of economic crisis, declining agriculture productivity, as social effects of the environmental degradation, it forced displacement of population as environmental refugees not only within region but also in the intra-state.

Environment degradation of a country will adversely lead to different kind of natural calamities like flood, cyclone, drought, storm surges, and ecological imbalances. Despite environment threats poses serious concern for the all countries while the developing world is more vulnerable to this because of low economic development, social imbalances,

mismanagement of natural resources or adequate use of resources. Dixon (1994) argues that the poor countries are more vulnerable to environment changes than rich one and conflicts arise through environment are likely first seen in the developing world. The threat to environment security must be seen as threats to the wellbeing and quality of life of the populations that are every bit as serious as military threats. Apart from the land degradation or scarcity of resources, the pressure of population growth, and underdevelopment, rapid growth in urbanisation is more vulnerable threat to environment. In the recent decades the degradation of environment poses a serious national security threat to the low lying country, and the human being.

In the field of security, strategic doctrine, very few researches have been done, addressed to or even conceptualised the potential security implications of climate change, despite its many observable manifestations of catastrophic nature. So there is need for more research on the subject to assess its vulnerability in terms of population, areas at risk and potential for adaptation because the level of understanding of people's vulnerability is still sufficiently uncertain for the purpose of designing effective adaptation strategies.

A like Bangladesh is more fit in this case. The causes and problem of environmental degradation when connected with the economic activities and population growth in terms of land degradation, desertification, deforestation, flood, drought, sea level rise, emission of greenhouse gases, climate change, have been identified as the environment security threat to the Bangladesh. The various effects of these environmental degradation in the various aspect has been identified like, climate change, biodiversity loss, extreme weather events, population displacement, sea level rise, saline water intrusion, shortage of safe drinking water, desertification etc. in the case of Bangladesh. The level of exposure of these threats to the environment of Bangladesh is high degree. The environmental degradation in Bangladesh emanating from the, domestic, global and regional sources. Various human and economic development activities in Bangladesh are the major domestic sources of the degradation of the natural resources.

The geographical location and socio-demographic features of the country makes Bangladesh more vulnerable to the natural calamities. Low lying in the lower riparian, long coastline, low deltaic plain, high population density, agriculture dependent society would be more affected due the natural calamities. This will directly affect the environment of Bangladesh and it will give the feeling of security to the environment of the country. For this purpose Bangladesh government needs to initiate an environmental security oriented policy. There is also a need to sectoral policies to address these threats and it can be tackled through the integrated approaches toward the degradation of environment. In Bangladesh the absence of coherence among the policies and no integrated approaches to tackle environmental degradation and resource conservation. however it can be tackled through the inter-ministerial decision and coordination. Country's environment is also more vulnerable because of the developmental activities that take place in the upper riparian region. Constructions of dam in India for the hydro-power purpose divert in the river water flow in the upper riparian also environmental threats to the Bangladesh. For this regard Bangladesh need to buildup coalition and strengthen lobbying with the Indian government. It may also be recall that he Dhaka declaration on the 13th SAARC summit stressed the need of regional cooperation in areas including water resources.

Another major environmental threat to Bangladesh is climate change. The fragile topography of the county, located in the lower elevation from the sea the country is more vulnerable to climate change. If climate change will continue in the same rate then in the upcoming future, several natural hazards will directly affect not only the environment but also the population of the country in severe manner. Impact of climate change can be seen in the various sectors like agriculture, economy, environment and population in the form of human health. Rise in the sea level will submerge coastal area of the country and it will negatively affect the coastal environment and biodiversity of the coastal region of the country.

For the impact of climate change in country the government should need appropriate policy to mitigate the climate change. According to several studies on climate change in Bangladesh a major gap has been identified in the mitigation process, it is mostly related to the lack of institutional efficiency, lack of data availability and research gap particularly in climate

change impact assessment and lack of action programs for implementation of policy. The impact on environment due to climate change the major future concern for the country's sustainable development are ecosystem, proper sanitation, healthy and safe life, safe drinking water, management of natural disasters are highly sensitive. Therefore it is more important to develop adaptation strategy to mitigate the impact of climate change particularly the severe natural calamities such as floods, cyclones, droughts, and storm surges. This impact assessment policy also has to be interlinked with the other exiting sectoral policies.

Regarding the extreme vulnerabilities because of climate change Bangladesh already has some good will from the global community. Bangladesh needs to build up on that. Based on the UNFCCC climate change mitigation principle Bangladesh can lead the least developed country and other developing country groups through serving as the creative hub for climate negotiations. Another major change in the country's governmental and non-governmental organisation should beneeded tointegrate with the long term sustainable development strategy. As the effect of human induced and due to natural activities, climate change in long term phenomena, building capacities at different segments for facing the frequent natural calamities from the climate change variability Bangladesh need to prepare long term policy to reduce environmental threats and also to ensuring the environmental security. From the past natural disasters Bangladesh need to learn lesson for the future generation and aware them about the consequences and management of land or environment degradation. For this Bangladesh needs to do lots of work in the different sectors. They are as follows:

- To tackle the problem of land degradation, Bangladesh government should promote bio-fertilizers, use of legume/green manure crops, crop diversification and adopt integrated plan nutrition system. It will improve soil quality, increased crop production and protect the land degradation in the future. Another major cause for the degradation of environment in Bangladesh is poverty. To reduce poverty government needs to focus more oneducation and create job opportunity to poor people. Family planning should be introduced to control explosive growth of population. Because it is also a major threat to the environment of the country.

- To tackle from the natural calamities Bangladesh government should need real time forecasting and alertness for the natural disasters. It will help in attrition in loss of human life and economic damage also. This can be done through the awareness in the mass population and to give an idea about the primary step whenever the natural disaster occurs.
- To tackle the impact of climate change in various sectors there is need to integrated sectoral approach should be followed and the more emphasis on how to reduce these impact and finally
- To protect environment from the external and internal threats country need to sustainable approach to environment degradation. For the long term purpose there should be environment friendly activities and production process at the different levels of country must be started as soon as possible.
- To reduce the impact of flood there should be programme related to flood preparedness and also people awareness programme must be included in the flood reduction policy.
- There should be combined effort of both structural and non-structural measure to reduce the flood intensity. And as for the management of flood activities, should be done in a sustainable manner.

Finally it can be concluded from the above analysis that the country is highly environmental sensitive from the perspective of its geographical location, and different aspects and threat to the environment generated from the many sources, which degrade the whole country environment in extreme level. So there is need to think about the protection of environment of the country and also rethink about the policy, programmes that are introduced by the government to procure or secure the environment. That will help to redefine the security of environment and also rethink about its geography as a factor to the environment security threat to country in broader perspective.

APPENDIX- A

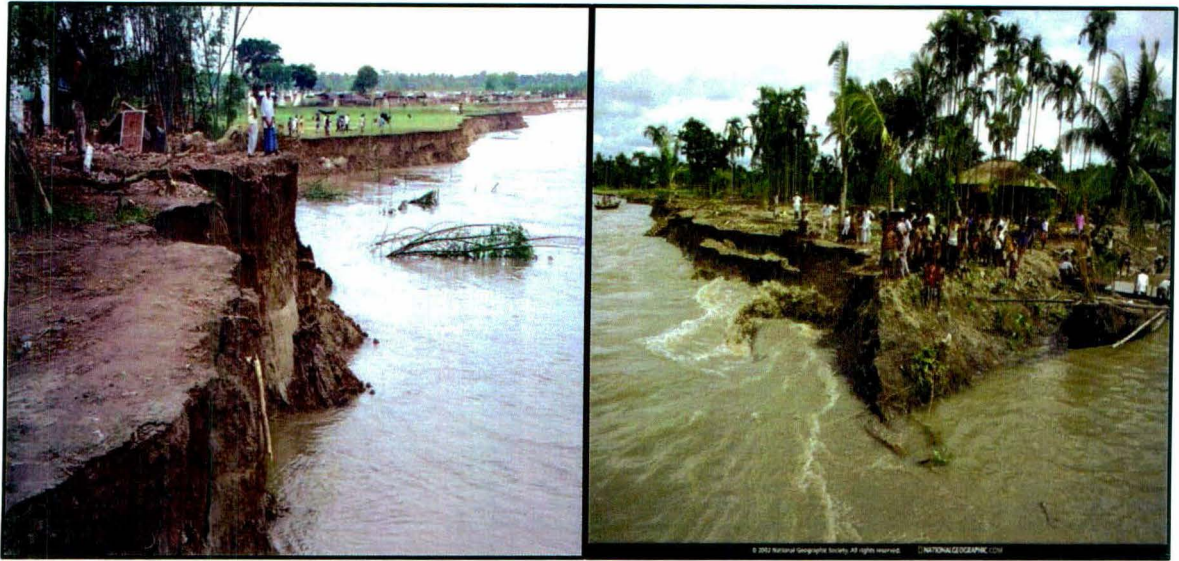
Bangladesh faces flood in every year. And the policy work toward the flood management in country done by different decision making body of Bangladesh. Around 53 centralised institutions and 13 ministries are involved in this work. There are many organisations also contributing their efforts in the management of flood. Institutions those are responsible for flood management in Bangladesh is as follows:

- ***Water Resource Planning Organisation:*** it is working on macro level management of water resources
- ***Bangladesh Water Development Board:*** data collection, implementation, flood forecasting and early warning, broadcasting of flood information at national as well in regional level.
- ***Joint River Commission:*** for the negotiation trans-boundary river conflict and information regarding trans boundary river data
- ***Bangladesh Meteorological Department:*** it help in the weather forecasting and publication of weather data at three level; long, medium and short range
- ***Institute of Water and Flood Management*** under the *Bangladesh University of Engineering and Technology (BUET)*: major aim of this institute in the research and mechanism development in the field of water and flood management.
- ***Local Government Institution:*** it provides the relief and rehabilitation of flood and also from the other natural hazards.
- ***Disaster Management Bureau:*** it publish the all information on the natural hazards,
- ***Non-governmental Organisation:*** assistance for flood management, relief and rehabilitation of flood victims.
- ***Ministry of Natural Disaster Management and Relief:*** the major objective of this government institution is “to abundance a major shift in disaster management from traditional response and more holistic approach. Also promote food security as a significant factor in securing the flexibility of community to hazards.”

APPENDIX- B

Below some pictures are showing damage in the county not only in physically but also the people of the country in severe manner.

Picture1: *River bank erosion in Bangladesh*



Source:URL: <http://www.hrsolidarity.net/mainfile.php/2007vol17no03/2552/> access at 7 July 2013

Picture 2: *Human disturbance and infrastructure loss*



Source:URL:<http://www.blogcdn.com/www.gadling.com/media/2008/01/bangladesh.jpg> access on July 2013

Picture 3: *Arsenic contamination in water and impact on health*



Source:URL: http://www.siliconeer.com/past_issues/2000/may_00_arsenic_3.jpg access in 7 July, 2013

Picture 4: *Destruction after the cyclone in Bangladesh*



Source:URL: http://upload.wikimedia.org/wikipedia/commons/3/38/US_Navy_071124-M-3095K

31_An_aerial_view_of_damage_to_villages_and_infrastructure_following_Cyclone_Sidr,_which_swept_into_southern_Bangladesh_Nov._15.jpg access on 7 July 2013

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