

**CLIMATE CHANGE IMPACT AND
DISASTER VULNERABILITIES IN THE
COASTAL AREAS OF BANGLADESH**

Climate Change Impact and Disaster Vulnerabilities in the Coastal Areas of Bangladesh

Written by

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This is the first joint publication of COAST Trust and Equity and Justice Working Group and 3rd
Publication of EJWG.

COAST Trust Since 1980s has been working in the remote coastal districts, out-reach coastal islands
for the socio-economic development of the marginalized people and also support the livelihood
support of the coastal population.

The coast of Bangladesh is known of a zone of multiple vulnerabilities. It is prove to several natural
dijasters like cyclones, storm surges, erosion etc. which have been increasing with of high frequency
and intensity with the changes of global climate. Therefore since 2000 COAST is working both in local
and national level to find the ways of reducing climate change impact in the coastal areas of
Bangladesh.

On the other hand EJWG has been working for justice and equity in all aspect. Campaign for climate
justice is one of the major focus of group's work.

It is not only the matter of advocacy, but also a matter for educational awareness to the new
generation that an intellectual base should be built supportive to transformation. There are a lot of
activists in micro level who should be linked and supported with appropriate communication and
activism for macro policy influences.

The group has taken a vision that it's like to see a world and Bangladesh with an economy of equity
and justice and a society with a culture of human right and democracy. Its mission is to promote policy
debate and practice / behavioral changes by activism of campaign and mass mobilization with micro
macro linkages.

Details of the group is available in: www.equitybd.org

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1. Geo-Social Context of Bangladesh's Coast

The coastal areas of Bangladesh is different from rest of the country not only because of its unique geo-physical characteristics but also for different socio-political consequences that often limits people's access to endowed resources and perpetuate risk and vulnerabilities. Coastal areas include coastal plain islands, tidal flats, estuaries, neretic and offshore waters. It extends to the edge of a wide (about 20 km) continental shelf. A vast river network, a dynamic estuarine system and a drainage basin intersect the coastal zone, which made coastal ecosystem as a potential source of natural resources, diversified fauna and floral composition, though there also have immense risk of natural disasters.

This coastal area represents an area of 47,211 km², 32 percent of the country's geographical area, wherein 35 million people i.e. 28 percent of the country's total population live at 6.85 million households (Population census in 2001). In terms of administrative consideration, 19 districts out of 64 are considered as coastal district. A study of IPPC (Inter Governmental Panel of Climate Change) in 2001 reveals that 20 percent and 40 percent of the world population live within 30 kilometers and 100 kilometers of the coast respectively, which is very true in regards to Bangladesh's perspective.

Households in a rural setting perceive land as the most important natural asset. Land is scarce; it is even scarier in the coastal zone. According to 1996 agriculture census, per capita availability of homestead land is 0.004 ha. in the coastal zone which is lower than the outside of coastal zone, per capita 0.005 ha. In regards to distribution and ownership of cultivable land, gross cropped area and net cultivable area the situation is even worse. The

| Area (Acre/Decimal) | % of households | Amount % | Remarks |
|-----------------------|-----------------|----------|--------------------------------|
| No land | 0.2 | 0.0 | 53.4% are functional land less |
| No Agri Land | 21.3 | 4.7 | |
| Agri land ≤ 0.05 Deci | 8.0 | 4.6 | |
| 5-49 Deci | 23.9 | 10.2 | |
| 50-99 Deci | 13.8 | 10.0 | |
| 100-149 Deci | 9.6 | 10.7 | |
| 150-249 Deci | 10.5 | 16.2 | |
| 250-749 Deci | 11.1 | 33.1 | |
| 750 Gi Deci | 1.6 | 13.5 | |
| Total | 100.0 | 100.0 | |

Table1: Distribution of land ownership in the coastal areas;Source: Coastal Livelihoods, ICZM June 2003

1996 agriculture census reveals that 53.4 percent coastal households are functionally land less (house hold in rural setting owning less than half an acre land is considered as functional land less) and these 53.4 percent households together own only 17 percent of land. On contrary, 12 percent people own 47 percent of total available land.

| Year | Population(million) | | | Urban Population (%) |
|------|----------------------|---------------|-------|----------------------|
| | Coastal rural | Coastal urban | Total | |
| 2001 | 27 | 8 | 35 | 23 |
| 2010 | 25 | 14 | 39 | 36 |
| 2020 | 22 | 22 | 44 | 50 |

Table 2: Population growth trend in the coastal areas
Source: Coastal Livelihoods, ICZM June 2003

Again, population growth rate in the coastal areas is higher than the national average. In between 1991- 2001 the average population growth rate was 1.29, if so continued then by 2020 the coastal population will be 44 million, more people will be landless, and more people will be city bounded for livelihood earning.

Though agriculture is one of the major ways of livelihoods earning of the coastal population but dependency on agricultural practices has been declining with the changes of land ownership pattern. In the 1996 agriculture census, households are grouped into four broad strata on the basis of the distribution of farm land. These are;

- Non farm households owning less than 0.05 acre of land
- Small farm households owning 0.05 to 2.49 acres of land
- Medium farm households owning 2.50 to 7.49 acres of land
- Large farm households owning 7.50 acres or more

During the inter-census period between 1960 and 1996 it has been found that the agriculture dependency of the households changed significantly. In 1996, the number of medium farm households reduced to 10 percent from 31 percent in 1960. In 1960 the number of non-farm households was 19 percent which increased to 30 percent in 1996. This statistics clearly mean that;

- The medium farm households are losing their cultivable land and are gradually becoming small farm households and then to non-farm households; and,
- The number of marginal and non farm households are increasing

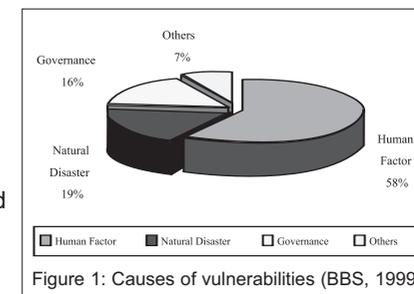
Moreover, different survey data shows that the living standard, average life expectancy, per capita farming land, access to education, health and other basic

services, social security etc in the coastal areas are not at expected level in comparison to national average. Besides increasing trends of climate change related vulnerabilities and natural disasters gradually making people's life more helpless.

There is a close proximity between livelihoods of the coastal people and such vulnerabilities, because the way of livelihood earning of one people class became the catastrophes to others. Although affect of natural catastrophes i.e. flood, cyclone, tidal surge etc. are common for all but coping with these is quite different among different class of people, as the coping capacity is a function of the asset base (both ownership and access too). The poor are more vulnerable as their asset base is weak and scanty. The poverty monitoring survey of Bangladesh Bureau of Statistics (BBS) summarized crises in the coastal areas in four categories, are-

| Land in decimal | Household Strata | % of Families | |
|-----------------|----------------------|---------------|------|
| | | 1960 | 1996 |
| Agri land < 51 | Non farm household | 19 | 30 |
| 51-249 | Small farm household | 41 | 58 |
| 250-749 | Medium farm HH | 31 | 10 |
| 750 or more | Large household | 9 | 2 |
| | Total | 100 | 100 |

Table 3: Land ownership pattern in the coastal districts



Human factor i.e. sudden death of the main income earner, large medical expenses due to illness, crop loss, social conflict etc.

Natural disaster like cyclone, tidal surge, water logging, erosion, salinity intrusion, etc.

Governance i.e. deterioration of law and order situation (*dacoity*, money extortion, abduction, snatching, death threat, case expenditure, occupying of govt. *khas* land, natural resource base e.g. destruction of mangroves, over exploitation of natural resources etc (PDO-ICZMP, 2003).

2. Climate Change and Global Environmental Scenario

The UNEP Global environment outlook describes global warming as the serious environmental problem. Though until the late 1990s, it was difficult to state categorically that the Earth's atmosphere is getting warmer, but several year of record breaking temperature now add strong support to that contention. Thermometer records, which stretch back 130 years, and evidence from tree rings and ice cores confirms that the Earth is the hottest it has been since at least the Middle Ages.

The major cause of global warming is the increasingly regular emission of the green house gases-(GHG), like carbon-di-oxide, carbon-mono-oxide, methane, chloro-fluro carbon, nitrous oxide etc. heat trapping gases. Among the GHGs, the heat trapping efficiency of chloro-fluro carbon is 10000 times more than that of carbon-di-oxide and the emission of chloro-fluro carbon in the atmosphere is growing at a rate of 5 percent annually. Globally the following activities are considering as the potential Carbon- dioxide emitting sources;

| Parameter | CO ₂ | Methane | N ₂ O | CFCs |
|--|-----------------|-----------|------------------|-----------------------------|
| Pre-industrial Concentration (1750-1800) | 280 ppmv | 800 ppbv | 288 ppbv | Nil |
| Concentration in 1990 | 354 ppmv | 1720 ppbv | 310 ppbv pptv | CFC11=280 pptv CFC12=484 |
| Recent annual growth rate | 0.5% | 0.6-0.8% | 0.2-0.3% | CFC11=4% CFC12=4% |

Table 4: Pre-industrial and 1990 concentrations of major greenhouse gases and their recent annual growth rate

- Combustion of fossil fuel annually adding 5.7×10^9 tons of carbon in the atmosphere.
- Deforestation, particularly in the growing industrialized countries, annually adding $0.6 - 0.5 \times 10^9$ tons
- Massive utilization of natural coal in China, annually 200 tons of coal, could contribute upto 3 percent of world's Carbon-di-oxide emission.
- Increasing trend of cement production, 5 percent annually, also adding considerable Carbon in the atmosphere.

The UNEP Global Environment Outlook 2000 report also predicts the following Carbon- dioxide emitting sources in the near future;

- There will be one billion cars by 2025, which was 40 million in 1945
- A quarter of the world's 4630 types of mammals and 11 percent of the 9,675 bird species are at serious risk of extinction
- More than half of the world's coral is at risk of global warming
- 80 per cent of forests have been cleared
- One billion city dwellers are exposed to health risk of air pollution
- The global population will reach 8.9 billion in 2050
- Global warming will raise temperatures to 3.6 degree centigrade, triggering a devastating rise in sea levels and more severe natural disasters
- Global pesticides use is causing 5 million acute poisoning incidents each year.

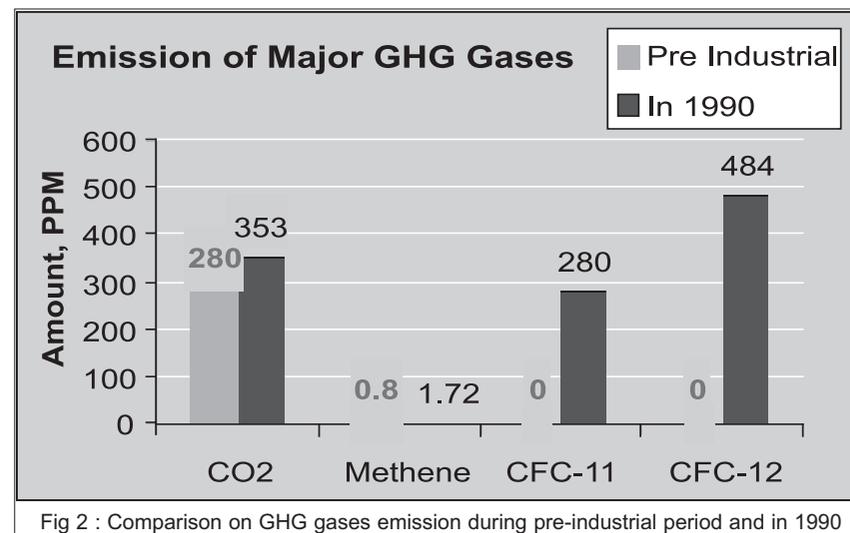


Fig 2 : Comparison on GHG gases emission during pre-industrial period and in 1990

It has been stated that since the industrial revolution the atmospheric concentration of green house gases has been increasing, primarily due to human activities, such as combustion of fossil fuel, changes in the land use resulting deforestation, and expansion and commercialization of agriculture. Carbon-di-Oxide concentration of 280 parts per million by volume (ppmv) in 1880 has risen to 354 ppmv in 1990, an increase of about 25 per cent, and currently raising at rate of about 1.8 ppmv per year (0.5 per cent) due to anthropogenic emission.

Therefore, increasing of atmospheric Carbon-di-Oxide and other green house gases would affect the Earth's radiation budget and thus, lead global warming and they would have consequences of sea level change.

Meantime, a number of scientific studies have been conducted to measure the sea level rise and its possible consequences. These studies shows that during

last 100 years the average mean annual sea level rise was from 0.5mm to 3.0 mm; also some study showed 10 to 25 cm sea level rise.

Although there have different opinion on the casual relationship between global warming and glacier melting in the Antarctic and the Arctic region but there is no question on the expansion of sea water with the rises of temperature, as water density and temperature is reversely correlated. The connection between global atmospheric warming and the behavior of the ocean surface would mean an increase in ocean water volume due to acceleration of ice melting process in Greenland and Antarctic and also by thermal expansion of ocean water. The IPCC report in 2001 also predicted 0.3 to 0.5 meter and 1 meter sea level rise respectively by 2030 and 2100.

The 2001IPCC report's pivotal assertion was that mankind or human activities, that emitted huge volume of 'heat trapping' gases in the earth's atmosphere, was to blame for this warming effect.

Therefore a number of factors are involved for such environmental crisis, these are;

- Developments in technology throughout the history, which have given people a better ability to exploit the environment and its resources from their own ends
- Rapid increase in human population in recent centuries, which has significantly increased population densities in many countries
- A significant rise in human use of natural resources particularly over the last centuries
- The emergence of free market economies and neo-liberal policies, in which economic factors play the central role in decision making about production, consumption, use of resources etc.
- Consumerism attitudes and culture of people and countries
- Tendency of many people, companies and countries for short term profit maximization rather thinking for sustainable development and sustainable use of resources.

3. Sea Level Rise and Bangladesh

Being a low laying deltaic country, Bangladesh will face the serious consequences of sea level rise including permanent inundation of huge land masses along the coast line. There is a clear evidence of changing climate in Bangladesh which is causing changes in the precipitation, increasing annual mean temperature and sea level rise. During a period from 1961 to 1990 the annual mean temperature increased at the rate of 0.0037 degree Celsius but during 1961 to 2000 the rate was 0.0072. This mean, in the last decade, annual mean temperature rise was almost double than the previous years.

| Year | Sea Level Rise (cm) | Temperature Rise (°C) | % of Changes in precipitation (base 1990) |
|---|---------------------|------------------------------------|--|
| 2nd IPCC projection (World Bank 2000) | | | |
| 2030 | 30 | +0.7 in Monsoon +1.3 in Winter | - 3 in Winter + 11 in Monsoon |
| 2050 | 50 | +1.1 in monsoon + 1.8 in Winter | - 37 in Winter + 28 in Monsoon |
| 3rd IPCC Projection (Agarwala et. al 2003) | | | |
| 2030 | | +0.8 in Monsoon +1.1 in Winter | - 1.2 in Winter + 4.7 in Monsoon |
| 2050 | | +1.1 in monsoon + 1.6 in Winter | - 1.7 in Winter + 11.8 in Monsoon |
| 2100 | | + 1 in Monsoon + 2.7 in Winter | - 3.0 in Winter + 11.8 in Mons |
| Table- 5: Predicted changes in temperature and precipitation. | | | |

We all opined that climatic change is occurring all over the world due to green house effect, and anticipated sea level rise is likely to destroy most of the existing coastal areas, if preventive measures can not be taken with integrated effort globally.

Factual information regarding the extent of sea level rise in Bangladesh is very limited. Over the last 100 years Bangladesh has warmed up by about 0.5 °C and 0.5 m rise of sea level in the Bay of Bengal (BUP 1993). In the

South western Khulna region 5.18-mm/year sea level rise is recorded which may reach to 85 cm by 2050. World Bank's study on the impact of Sea level rise in Bangladesh reveals that, 100 cm sea level rise within next 100 years will inundate 15 to 17 percent of country's land area i.e. 22135 to 26562 square kilometers, which will make 20 million people environmental refugee and a country like Bangladesh might not be able to accommodate such huge uprooted people.

Again, 2 degree temperature and 45 cm sea level rise would increase 29 percent risks of flooding of country's low laying areas and may cause permanent inundation of 145 km long coastline stretches from Cox'sbazar to Badar Mokam. A report published in 1998 shows that sea level rise would inundate 58 thousand hectares of agricultural land.

| Year | Sea Level Rise (cm) | Temperature Rise (°C) | % of Changes in precipitation (base 1990) |
|------|---------------------|--|---|
| 2030 | 30 | 0.7 and 1.3 rises respectively in monsoon and winter | 3% less in winter and 11 percent more in monsoon |
| 2050 | 50 | 1.1 and 1.3 rises respectively in monsoon and winter | 37% less in winter and 28 percent more in monsoon |

Table- 6: Predicted changes in temperature and precipitation.

Global climate experts, including IPCC, warns that Bangladesh will face acute climate vulnerabilities, water related crises will be increased as the country is not high above from the mean sea level. Analysis of metrological data from 1977 to 1998 clearly shows annual sea level rise at the rate of 7.88 mm, 6 mm and 4 mm respectively in Cox,sbazar, Chardanga at Hatiya and Hiron Point in Sundarban.

Although changes in climatic condition seems little and slow even, but related consequences of climate change like frequency and impact of flood, cyclone, drought, irresistible diseases etc. are in increasing trend. On the basis of changing trend SMRC predicts increase of annual mean temperature 0.22° C till 2050 and 0.41°C till 2100. Similarly annual mean precipitation would increase 296 mm till 2050 and 543 mm till 2100.

| Parameters | Average Scenario | | Worst Scenario | |
|-----------------------------------|------------------|------|----------------|------|
| | 2050 | 2100 | 2050 | 2100 |
| Total relative sea level rise, cm | 83 | 340 | 153 | 460 |
| Absolute sea level rise, cm | 13 | 200 | 13 | 220 |
| Land subsidence, cm | 70 | 70 | 140 | 240 |
| Shoreline erosion, km | 1 | 2 | 1.5 | 3 |
| Loss of habitable land, skm | 1 | 26 | 16 | 34 |
| Population displaced, % | 7 | 30 | 13 | 40 |
| Reduction of Mangrove areas | 50 | 75 | 79 | 95 |

Table 7: Predicted picture of sea level rise by 2050 and 2100 (Woods Hole Oceanographic Institute, 1986).

4. Bangladesh's Coast: The Worst Victim to Natural Disasters

Any change in climate would lead to destabilization of environmental and social conditions around the globe. These disturbances could jeopardize the conservation of natural ecosystems and sustainability of socioeconomic systems. According to the Intergovernmental Panel on Climate Change (IPCC), global average temperature rise has reached 0.6 ± 0.2 °C over the twentieth century.

There has been a widespread retreat of mountain glaciers in non- Polar Regions. In the Northern Hemisphere spring and summer sea-ice extent has decreased by about 10% to 15% since the 1950s. The global ocean heat content has increased since the late 1950s and the global average sea level rose by at least 0.1 m during the twentieth century. These changes in global climatic condition has been increasing the risk of hydro-metrological disasters globally and causing substantial environmental and economic loss including loss of lives, especially in the least developed countries like Bangladesh that is highly exposed to those disasters.

4.1 Salinity and Water Logging

The coastal areas of Bangladesh have already been facing salinity problem which is expected to be exacerbated by climate change and sea level rise, as sea level rise is causing unusual height of tidal water. In dry season, when the flows of upstream water reduce drastically, the saline water goes up to 240 kilometers inside the country and reaches to Magura district. Presently around 31 upazillas of Jessore, Satkhira, Khulna, Narail, Bagerhat and Gopalganj districts are facing severe salinity problem. Agricultural activities as well as cropping intensities in those upazillas have been changing; now farmers can't grow multiple crops in a year.

As sea level continues to rise the associated effects of permanent inundation is likely to increase the salinity near coastal areas. A recent study shows that 5 ppt saline front will penetrate about 40 km inland for SLR of 88 cm which is going to affect the only fresh-water pocket of the *Tetulia* River in *Meghna* Estuary. A big chunk of the fresh- water zone that will be disappearing due to sea level rise near to the estuary will have a far reaching effect on the country's ecology and will extinct some of its endangered species (marked by IUCN) for ever.

4.2 Ingression of Soil Salinity

Salinity ingress also causes an increase in soil salinity, especially when farmers irrigate their lands with slightly saline surface water at the beginning of the low flow period. SRDI (1997; Soil Resource Development Institute of the Government of Bangladesh) reported that, soil salinity levels south of Khulna and Bagerhat towns ranged between 8 to 15 dS/m during the low flow season. It is also reported that, several sub-districts (such as *Kachua*, *Mollahat*, and *Fultali*) south of the Sundarbans „ known to be non-saline in the pre-Farakka period „ have began to develop soil salinity during the low flow seasons of 1980s. The anticipated results of salinity ingress will be, at a minimum, of the same order for climate change induced low flow regime compared to similar effects shown by deliberate withdrawal of flows at *Farakka* barrage.

The anticipated sea level rise would produce salinity impacts in three fronts: surface water, groundwater and soil. Increased soil salinity due to climate change would significantly reduce food grain production. Even at present, some parts of coastal lands are not being utilized for crop production, mostly due to soil salinity; and this situation would aggravate further under a climate change scenario. A modeling exercise has indicated that, under the changed climate conditions, the index of aridity would increase in winter (Huq, et al. eds.1999). Consequently, higher rates of capillary action from an increased rate of topsoil desiccation would accentuate the salinity problem.

Impacts of Salinity

- 10% more land (relative to 1990) will be saline-affected and intensity will be increased by 10 %
- Decreases availability/productivity of agricultural land;
- Increased food insecurity as naturally-growing species disappear;
- Serious scarcity of safe drinking water;

Sea Level Rise and Salinity Intrusion

A direct consequence of sea level rise would be intrusion of salinity with tide through the rivers and estuaries. It would be more acute in the dry season, especially when freshwater flows from rivers would diminish. According to an estimate of the Master Plan Organization, about 14,000 sq km of coastal and offshore areas have saline soils and are susceptible to tidal flooding. If some 16,000 sq km of coastal land is lost due to a 45 cm rise in sea level, the salinity front would be pushed further inland. The present interface between freshwater and saline water lies around 120 to 160 km inland in the southwest, and this could well be pushed northward as far as central Jessore region in the event of a sea level rise (BIDS/ADB 1994)

- Loss of biodiversity, e.g. decrease in tree species and freshwater fish;
- Creates socioeconomic problems, generally women will be more vulnerable.

4.3 Flood and Water Logging

Due to geographical setting Bangladesh has to receive and drain-out huge volume of upstream waters. The flows of mighty rivers the *Meghna*, *Padma* and *Bhrammaputra*, originated from the Himalayans, drain-out in the Bay of Bengal flowing through-out the country. In the summer, from May to August, the melting of glaciers in the Himalayans make the rivers in Bangladesh live. The rainy season, which is strongly influenced by monsoon wind from the South-West, also sets on at the same period and causes huge precipitation. Therefore, the combined effect of upstream flows, precipitation and terrestrial run-off resulted to over flooding, causing water logging and prolong flood almost every year. But the worsening condition is that the trend of melting ice along with rainfall has been increasing due to rising temperature in th Himalayans. As result the frequent floods are happening causing devastating affect to the people's live and livelihoods.

On the other hand, rising sea level is causing water level rise in the rivers and thereby accelerating risks of flood and water logging. Again, as the elevation our coastal plain is only 3-5 meter from the mean sea level, a vast coastal areas, approximately 18% of total land, would submerge by 1 meter sea level rise. The major reason behind this assumptions are a) no defense mechanism for the protection of coastal plain land and b) sea level will rise following the *contour line*. But in fact, the coastal plain lands in central zone, the sediment rich and fresh water flow dominated areas are naturally well protected. Nonetheless some areas are remaining under risk of over flooding due to back water effect.

The problem of water logging might be more dangerous than flooding. Already many coastal places, where sustainable drainage network system hasn't developed, are facing water logging problem and the intensity of problem is appearing as a catastrophe day by day. This is to keep in mind that in the beginning years of dam/ embankment construction there was no EIA (Environmental Impact Assessment) and those embankments hampered the natural siltration process and slowing down the creation of delta. Therefore, the unplanned dam/embankment construction, in one hand, is causing flood and water logging problem, and on the other hand provocating severity of sea level rise through hampering natural siltration process. To face this problem effective measure should be taken, especially in the coastal areas. Likewise densely

populated coastal areas, *Sundarban*, the world's largest stretch of mangrove forest, is also vulnerable to the consequences of global warming and sea level rise. As the tidal flow and wave action is high in the mangrove forest area so only 45 centimeters sea level rises would inundate about 75 percent of forest area and 67 centimeters rise in sea level would submerge the entire *Sundarbans*. Though, in congruence with sea level rise, siltration process would cause relative elevation of *Sundarban* but this relative elevation might not be enough to combat the risk of sea level rise. In fact the risk of over flooding and inundation of *Sundarban* is still a concern.

4.4 Intrusion of Saline water

Salinity intrusion in Bangladesh coast is very seasonal. In the rainy season (June-October) intrusion of saline water is minimum due to extreme flow of fresh water, but in the dry season, especially in winter, saline water goes upward gradually. In the rainy season where saline water ingress to 10 percent of country's area, in the dry season saline water reaches to country's 40 percent area even. Due to changing climate the ingression of salinity might be increased through following way.

- Increased sea level will cause water ingression in the rivers.
- Decreasing trend of fresh water flow from the upstream will cause intrusion of saline water.
- Upward pressure of the saline and fresh water interface in the level of underground Aquifer
- Downward seepage of saline water from surface and salinisation of underground water
- The pace of evaporation in winter will increase soil salinity
- Frequency and intensity of tidal surges will increase ingression of saline water.

5. Other Natural Disasters and Bangladesh

The coastal geomorphology of Bangladesh is characterized by its funnel shaped, vast network of river, strong tidal and wind action and enormous river discharge laden with bed and suspended sediments. Aside with these, wide and open coast, strong current and wind, dynamics of erosion and siltration, natural slopping of the continent etc. are considered as the salient features behind the causes of natural disasters. The poverty monitoring survey of Bangladesh Bureau of Statistics (BBS) in 1999 identified different natural disasters like cyclone, river bank erosion, salinity intrusion, water stagnation, heavy rainfall etc. as the main causes of perpetuating coastal poverty.

5.1 Cyclone and Bangladesh's Coast

The entire coastal zone is prone to violent storm and tropical cyclones during pre monsoon and post monsoon season. Therefore, the Bangladesh coastal zone could be termed a geographical 'death trap' due to its extreme vulnerability to cyclones and storm surges. Nearly one million people have been killed in Bangladesh by cyclones since 1820. As many as 10 percent of the world's cyclone develop in the Indian Ocean but they cause 85 percent of the world's cyclonic havoc (Gray, 1968). The massive loss of life from cyclones is due to the large number of coastal people living in poverty within poorly constructed houses, the inadequate numbers of cyclone shelters, the poor cyclone forecasting and warning systems and the extremely low laying lands in the coastal zones.

Sometimes cyclone associated with tidal waves caused great loss of lives and property. The physiology, morphology and other natural conditions have made it vulnerable to disaster, cyclonic storms and floods which are very devastating and cause immense suffering and damage to people, property and the environment. Cyclonic storms have always been a major concern to coastal plains and offshore island of Bangladesh.

Usually, cyclone is a vortex of low

Risk of Cyclone: Bangladesh is in number 1 in Asia

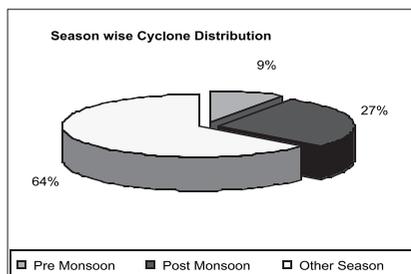
A UNDP report titled 'Reducing Risk of Natural Disasters: A Development Challenge' says that among the Asian countries Bangladesh is highly prone to cyclonic disaster. The report also says, during 1980 to 2000 cyclone caused death of 250 thousand people worldwide, of which 60 percent were in Bangladesh. Although, the Philippines is more vulnerable to cyclone than Bangladesh but cyclonic death is 10 times more in Bangladesh than the Philippines.

pressure system characterized by large scale convergence of moist air in the boundary layer which forces to ascend vertically upward causing strong columns convection and releasing large amount of latent heat due to condensation. Whenever a convective cloud mass develops over the southern Bay and sustain for a number of days without decaying then there is a probability that the system may develop into a tropical cyclone and it is needed to keep watch on such a system. There are some other characteristics in the structure and dimension of the cloud mass which provides indication of a probable cyclogenesis and these can be monitored through satellite image.

Cyclones usually forms in the Bay of Bengal under some metrological conditions, these are;

- At least 27 degree Celsius temperature in an extended sea surface area creating huge volume of water vapor.
- Absence of vertical air or strong presence of depression area
- Presence of Coriolis force.

Cyclones those hit the coastal areas of Bangladesh, usually forms in the 'Intertropical Convergence Zone' situated between 5 and 10 degree latitudes of the Indian Ocean. These cyclones, afterward, directed above 6-9 km from the sea surface towards the coast through accelerating speed and force by wind blowing.



Therefore, the cyclone accompanied with torrential rain and devastating tidal surge causes havoc to lives and property in the cyclone path, and the environment in the affected area. In the islands and coastal mainland of Bangladesh the major aftermaths of a cyclone are loss of human lives, livestock's, fishes, agricultural properties and production, inundation of land and ponds by saline water, loss of houses, break-down of sanitation system, non-availability of safe drinking water and food stuff.

From the historical records it can be seen that there are two peaks in the annual distribution of the tropical cyclone formation in the Bay of Bengal, one is May and another is the November within the peak season pre-monsoon (April-May) and post monsoon (Oct- Nov) respectively. During 1891-1990, 700 cyclones occurred, of which 62 in pre-monsoon and 192 in Post-monsoon season.

The submersion of the industrial machinery, electrical equipment and vessels cause them to be useless hardware; dispersion of wastes, oil and toxic materials from them make an environmental concern. The calamity brings in a major and sudden change in the ecosystem and it takes a long time for restoration.

| Damage caused by cyclone SIDR | |
|--|------------|
| Particulars | |
| Population affected | 69,00,000 |
| Total family affected | 16,00,000 |
| Death | 3199 |
| Missed | 1180 |
| Crop land damaged (hector) | 16,10,000 |
| Livestock perished | 468000 |
| Education Inst. damaged | 9,248 |
| Embankment damaged (Km) | 614 |
| Roads (both earthen and brick-built) damaged | 89,428 |
| Total economic loss | USD 3.00 b |

Preliminary Assessment by Ministry of Food & Disaster Management, Source New Age on 26.11.07

Approximately 45 damaging cyclones were reported in the coastal areas of Bangladesh from 1793 to May 1997, thus cyclone frequency during this period averaged once in every 4.5 years. Among which the devastating cyclones occurred in 1961, 1963, 1965, 1966, 1970, 1985 and 1991 and in 1996. Besides, the historic book 'Ain e Akbari' quoted a devastating cyclone in the Barishal region in 1854. The last devastation cyclones that hit Bangladesh occurred respectively 12 November 1970, 29 April 1991 and 15 November 2007. Cyclone in 1970 caused death of 300,000 people with a financial loss of USD 86.4 million. In 1991 cyclone an estimated 131,000 to 139,000 people died, with the majority of those dying being below the age of 10, and a third of them below the age of five; also more women than men died (Talukder and Ahmed, 1992). An estimated 1 million homes were completely destroyed, and a further 1 million damaged. Up to 60% of cattle and 80% of poultry stocks were destroyed and up to 280,000 acres of standing crops destroyed; 740 km of flood embankments were destroyed or badly damaged, exposing 72,000 hectares of rice paddy to salt water intrusion. The floodwaters brought disease and hunger to the survivors. The total economic impact of the cyclone was US\$2.4 to 4.0 billion (Kausher et al., 1996).

On the other hand cyclone SIDR that hit Bangladesh coast on 15 November 2007 caused death of 3199 people with huge economic loss estimated as USD 3 billion.

Historical Background: Cyclone 1970, 1991

A number of devastating cyclones hit Bangladesh's coast in 1797, 1822, 1876, 1897, 1901, 1941, 1960, 1961, 1963, 1965, 1969, 1970, 1985, 1991 and 1996, among which cyclones of 1970 and 1991 caused huge loss of lives and assets. A study conducted by the Bangladesh Bureau of Statistics in 1991 showed, people aged between 15 and 49 managed to secure themselves, while children, elderly people, women were died more. During 1970 the coastal areas were not well protected with encircling embankment, even, early warning and cyclone tracking system was not so modern and adequate, which caused huge loss of lives.

Confusion on High Danger Signal

Usually the high danger signal mean 125 km wind speed hourly. There is no more signal although wind speed goes high. It also observed that a cyclone declared as danger one was not so violent in terms of the loss of the properties and human life; that grows people's mistrust on issuing high danger signal. In fact the cyclonic havoc depends on some other factors like time of passing the coast either low or high tide period, possible surge heights relative to ground levels etc. Cyclone passing the coast during low tide time usually does less harm. The cyclone that hit Bangladesh on 29 November 1988 was of 200 km/h speed but its damage was not as huge as predicated as it passed during low tide period.

That is why; coastal people very often do not consider the warning signals as of high importance even it is at upper scale.

After 1970 cyclone, though government constructed coastal embankment and modernized cyclone forecasting and tracking system but these couldn't save coastal people when another diabolic cyclone hit in 1991, because appropriate preparedness measures were not taken and people also were reluctant to find a safe place. Even now level of cyclone preparedness is not so adequate, there have political as well as policy negligence in this relation.

Cyclone Warning System

As soon as the depression formed in the Bay of Bengal, the warnings are issued by the Metrological Department using a system for warning shipping of an impending cyclone. The related information on cyclone formation and its tracking are collected from international satellite images. The warning system uses a scale from 1 to 11 for the sea ports and 1 to 4 for river ports. The differences in cyclone severity indicated by the 11 point scale have limited use for the coastal inhabitants because they do not contain specific information

regarding the wind speed and direction, possible surge heights relative to ground levels, possibilities of inundation and damages etc. However, there is general comprehension that the higher the number, the more urgent the need to react.

Table 8: Major Cyclones: What damage we had

| Date | Wind Speed Km/hr. | Tidal Height (Meter) | Human death (million) | Financial Loss (USD) |
|----------------|-------------------|----------------------|------------------------|----------------------|
| Nov.12 1970 | 196 | 4.5-6 | 0.3 Govt. 1.2 Media | 86.4 m |
| April 29, 1991 | 225 | 6-10 | 0.13 Govt. | 1780m |

5.2 Coastal Erosion

River erosion and loss of coastal habitable and cultivable land is an acute national problem and one of the major natural hazards. Although erosion does not cause loss of lives, but it cause huge economic loss; makes people asset and rootless.

Mr. Bob Makenro, the regional chief of the International Federation of the Red Cross and Red Crescent Societies (IFRCS) in 2000 identified the river erosion as the largest concern of Bangladesh. But very few people concerned about it. He mentioned that the complexity of the issue is critical enough to be addressed in the mass media properly. According to him, this is a slow, silent disaster. Another report (DFID, in association with Disaster Forum) identified the river erosion as the country's topmost disaster concerning the losses. The World Disaster Report 2001 published by IFRCS, reveals that in Bangladesh annually 1 million people displaced and 9 thousand hectares of land inundated by river erosion.

Since long years, erosion has been becoming a regular natural phenomenon along the belts of out reach coastal islands like *Bhola*, *Sandwip*, *Hatia*, *Kubdia*, which has been turned to massive in the recent years. The major causes of erosion are observed as;

- The Ganges Brahmaputra Meghna (GBM) river system carries immense volume of water silt. During the monsoon, GBM system carries about 1.7

billion tons of silts per year causing severe turbulence the rivers. This results in gradual undercutting of riverbanks leading to erosion.

- During high tide 30868 m³ sea water flows upward through the cannels of Kutubdia, Sandwip and Hatia. Again these channels carry down the upstream fresh waters from 38,896 m² coastal and midland areas of Bangladesh. The immense pressure of the downwards flows, strong tidal circulation etc. results unprecedented erosion of coastal habitats.

By river bank erosion Hatiya has reduced from 1000 sq. km to only 21 sq km over 350 years and Swandip has lost 180 sq km in the last 100 years. Such erosion adversely affect on the ecosystem, navigation, planned agriculture development and drainage system. It has also affect on inland navigational route as of shifting and migration of channels. Factors those are accelerating riverbank and land erosion are: a) destruction of coastal mangroves for shrimp farming and b) unplanned dam and cross road construction etc.

Apart from this, in each year the GMB river system carries 6 million cusecs of water with 2179 million metric tons of sediments resulting water logging in the rainy season and causes flooding. Siltration raises river bed up that reduces the intensity of water flowing as well as hampering the breeding and nursing ground of *Hilsa ilisa*, the major open water fishery in Bangladesh. As force of upstream water flow reduces, seawater tends to flow upstream. Such intrusion of saline water affect to the coastal agriculture. Top dying disease of *Sundari* tree in the *Sundarban* Mangrove forest is also caused for saline water intrusion in the fresh water areas.

Kutubdia under constant threat of erosion

Kutubdia, an outreach island of 97 Square Miles(250 km²) is under threat of continuous erosion, which has been happening through the process of strong tidal action and cyclonic effect. The pace of erosion is so high that with a 100 year period from 1880 to 1980 Kutubdia reduced to 23 square miles ;

- 57/ 58 square mile during 1880 to 1900
- 26/27 square mile during 1960 to 1977
- 40/42 square mile during 1900 to 1947
- 22/ 23 square mile during 1978 to 1986
- 34/ 35 square mile during 1947 to 1959

During July to September 2004, a research work on river bank erosion has been conducted in *Bhola* district, which reveals the followings;

- 3332 family lost their houses for river erosion

- Among the homeless families 48.23% families took shelter beside the embankment, 39.89% took shelter on the river bank and, only 3.48% families had their own land to shift their houses
- 21 schools were affected, 7 were abolished completely and 14 were under constant risk of being eroded. There is no available resources like land, construction materials etc to rebuild the school elsewhere in the community.

During last 40 years, *Bhola* Island has been squeezed to 3400 km² from 6400 km² in 1960. This mean, *Bhola* suffered net loss of 3000 km². A huge number of households and commercially important places in *Bhola* island like *Daulatkhan*, *Mirzakalu*, *Molongchara*, *Sarajgonj*, *Chowmohoni*, *Tazumiar* have completed been eroded within couple of decades. If this pace of erosion continues, it has been apprehending that *Bhola* may disappear completely by next 40 years. But there is also opposite feature which has been happening due to accretion.

Kutubdia, an outreach island situated in the south-eastern part of the Bay of the Bengal, has been eroding fast due to strong tidal action, as well as by cyclonic action and storm surges. This island, once which was 250-squire kilometer is size, lost around its 65 percent during last 100 years and more than 60 percent of its population migrated in urban areas and, many others are thinking to be migrated as presently 2700 people live in per square kilometer areas.

Table 9: Cyclone centers in the coastal districts

| District | No of center | % of people could take shelter |
|------------|--------------|--------------------------------|
| Bagerhat | 82 | 11 |
| Borguna | 70 | 17 |
| Barishal | 57 | 5 |
| Bhola | 208 | 24 |
| Candpur | 5 | - |
| Chittagong | 492 | 15 |
| Cox'sbazar | 455 | 52 |
| Feni | 106 | 18 |
| Jhalokathi | 26 | 8 |
| Khulna | 34 | 3 |
| Laxmipur | 110 | 15 |
| Noakhali | 202 | 16 |
| Patuakhali | 196 | 27 |
| Pirojpore | 42 | 8 |
| Satkhira | 48 | 5 |
| Total | 2133 | - |

Embankment Construction and Corruption: What's the Alternative?

Embankments are designed to dissipate the energy of cyclone wave and allow overtopping. Following the cyclone of 1970, government has taken massive initiative for coastal embankment construction for the protection of human lives. Since then, in relation of embankment construction, an ill-beneficiary group comprising of contractor, civil servant, political party leaders has emerged who in many ways are involved in looting money. Although embankment is not the only solution of protection but, it is thought that if the embankments were constructed following proper design criteria then these could last for a longer period and could save the people at risk. In many places coastal embankments were washed out either by cyclone or erosion. In *Kutubdia*, during 1991 cyclone, the embankment was washed away due to poor design and construction. The embankment which was constructed in *Kutubdia* after 1991 cyclone also was damaged by erosion within 3 years of its construction. The major causes of damages are;

- a) Post construction maintenance was not done adequately
- b) Using inadequate and low-quality construction materials and looting of project money. There is a popular saying that 'tidal flow washed away all the construction materials –says the contractors as an excuse of not using adequate soil, sand bags, boulders etc.'
- c) The other factors of construction like building as per design, forest creation outside the embankment, slopping etc were not considered during embankment construction.

In *Kutubdia* Island, it was widely recognized that people those who were involved in embankment construction became richer overnight, presently those who are the richest person even some also involved in party politics. During the onset of rainy season these vested politicians and contractors manages local journalist for news publication on the importance of embankment construction and then they lobby for emergency construction fund; maximum of which are being looted. But there are also instances of proper construction; especially those were constructed under direct supervision of armed forces. Therefore the proposals of embankment construction are; a) ignore contractor system and ensure direct involvement of armed forces, b) using permanent structure rather than earth filling only, c) ensuring participation of local people in planning and implementation process, and c) creation of natural forest based on local and indigenous experiences.

6. Disaster Preparedness in Bangladesh

6.1 Cyclonic Disaster Preparedness in Bangladesh

The immense pressure on the land and resources forces people to remain in the areas vulnerable to cyclones. These pressures are likely to increase with an annual increase of more than 1 million people, exposing people frequently to the dangers of cyclone and flooding. Although the risks of cyclone and other natural disasters are increasing but still sustainable disaster risk reduction practices are far away from the reality. Also there have inadequacies cyclone shelters to ensure protection of the exposed people. In 1991 cyclone despite raising mass awareness number of death was high for not having adequate cyclone shelter.

Actually, cyclone shelter, reinforced concrete buildings designed to save human life from cyclones are the second part of the CPP program. A five-year shelter construction program was initiated in 1972, but was abandoned after only 23 shelters were built-an estimated of the 10 percent of the actual demand (Talukder and Ahmad 1992). The program was re-started after the 1985 cyclone and further 62 shelters were constructed. Besides, after 1970's cyclone the government Bangladesh constructed 238 cyclone shelters under IDA credit, each of which can accommodate 800 people.

Since 1985, the Bangladesh Red Crescent Society has constructed 60 shelters, which can accommodate over 499 people each, but during 1991 cyclone there were only 3 hundred cyclones shelters in Bangladesh where as requirement was 5 thousand, and at that time many people, especially women and elderly people, didn't find any shelter to save themselves. Presently there are 2133 cyclone shelters in 15 coastal districts many of which were broken down and there is no regular repairing and maintenance. Apart from this, in 1996 there were 190 killa, an elevated ground basically to provide shelters to the cattle.

Though, the weather department of the government of Bangladesh forecasts weather bulletin and early warning signal but people have little trust on these, because forecasted news, in many cases, treated as fake. On the other hand the language of weather bulletin is fair and the outreach coastal people often can't follow and understand the bulletin as they are used to communicate in local language.

6.2 Rescue and Coping

Bangladesh cyclone preparedness program has three components viz. warning, shelter construction and disaster relief. This system relies heavily on the grassroots support system based on 2089 units of 10 volunteers each. But the real fact is that the number of cyclone center is very few to ensure shelter to the increasingly population, moreover in many places structure itself is vulnerable to natural disaster. On the other hand post disaster rescue, relief

World Disaster Report of the Red Cross and Red Crescent Societies in 2006 says, 'the number of disasters have been increased during last century with a dramatic increase during last 10 years'.

- During the period from 1991 to 1999 annually there were 354 natural disaster world wide
- During 2000-2004 annually there are 728 natural disasters world-wide, which is more than double than the annual average disasters of previous decade.
- During last decade on an average 258 million people have been affected annually by any of disasters.
- Almost 75% of world population live in such places that were affected by any forms of disaster during 1980-2000

Financing disaster preparedness still too low

15 coastal districts, out of 19, are highly exposed to tropical cyclones and tidal surge. Among 20 million people living in those districts, 9 millions are highly exposed at risk and they require at least 3500 cyclone shelters whereas there have only 2000 cyclone centers which could shelter only 1.5 people.

This situation even worse in the outreach coastal islands namely char *Zahiruddin, Monpura, Dhalchar, Patila, Nizam, KukriMukri, Sakuchia*, etc. where homeless and river eroded people have been residing since a century. Presently 1.5 million people are living in those 7 islands. These out-reach islands are completely unprotected from cyclonic disasters (as there is no embankment). There are only 32 shelters which can accommodate as high as 13050 people; remaining 137,000 people don't know their safe whereabouts. Besides, many of the cyclone shelters itself became vulnerable due to lack of maintenance, there is no facilities of safe water supply, sanitation facilities, storage facilities of essential medicine and food stuffs etc. Here this to mention that people those rushed to cyclone shelters during 1970 and 1991 cyclones could be able to save their life.

A news report published in the Daily Jugantor on 7 Dec. 2006 reveals that per capita government's expenditure on cyclonic disaster preparedness is only 1 taka.

and rehabilitation is also a gruesome process. It is fact that after every cyclone huge money has been allocated from government and donor agencies for relief and rehabilitation but somehow affected were deprived from getting these. In this circumstances it is important to develop own mechanism to cope with the situation and to support to the survival strategies of coastal population.

6.3 Initiative to Protect Erosion

Water and Power Development Authority (WAPDA) of the government of Bangladesh bears the responsibility to protect coastal areas through constructing embankment and also repairing the old ones. It is true that government has no adequate resources to do needful construction, government also has no proper planning and monitoring system. In many cases new embankment was build within a short distance of eroding ones, which again become risky by the following years. On the other hand, due to not having proper monitoring, the constructing agents don't use required boulders or sand bags.

In fact, the role of the coastal embankment is not to protect land completely from storm surge flooding. Instead they are designed to dissipate the energy of waves and to allow overtopping. However, 'for the protection of human lives a coastal embankment that is breached is worse than no coastal embankment' (FAP 7, 1992). Embankments can give residents a false sense of security. As a result, upgrading coastal embankment and coastal forestation is only a partial solution. (Kausher et. al 1993). However it is thought that if the embankments are constructed following proper engineering design criteria, and post

construction maintenance is done adequately, the chance embankment failure is minimal. In Potenga, during the 1991 cyclone, the embankment was washed out due to poor design and construction; the embankment was unable to resist the force exerted by the turbulent storm surge, resulting in a huge loss of life in the country side villages.

On the other hand, to protect Kutubdia Island from erosion WAPDA constructed 40 kilometers embankment, of which 24 kilometers were damaged in 1991 cyclone. After 1991 WAPDA took initiatives to build up new embankment keeping about 5 villages outside of the embankment areas, which further reduces the land areas of that island. Although 10.5 kilometers embankment is under risk but WAPDA is constructing only 0.420 kilometer, in this situation if another disaster hit Kutubdia, there will have no way left to save its population.

7. Disaster and Global Scenario

The last decade (especially the last five years) has been identified as disaster decade. In 2004, 280,000 people died due to *Tsunami* and million of people become rootless and environmental refugee. Devastating floods and cyclones caused huge loss of life and properties in China, India, USA and some parts of Europe. Around 240,000 people have been affected with famine in Nizare and presently people in Malawi are facing the drought and periodical food shortage. The devastating affect of cyclones *Hurricane, Katrina and Rita* etc. again remind us that, nowhere in the world is free of risk of natural disaster. Simultaneously, besides the natural calamities, we are facing man made disaster like war, insurgency, pollution etc.

Analyses shows that during the last decade both the hydro-meteorological (e.g. drought, flood, cyclone) and geographical disasters (e.g. earthquake, tsunami, volcanic eruption) have been increased worldwide with more prevalence of hydro-meteorological disasters compared to the geographical disasters. This trend clearly indicates the impending risks of changing global climate those will be more dangerous in the coming years, as scientists predict. As a result the devastations of cyclone, hurricane will increase, drought and rainfall might be prolonged.

8. Governance: A Critical Concern that Increases Insecurity

In May-August 2002 a survey on Perceptions on Direct Stakeholders on Coastal Livelihoods (PDSC) was carried out in the coastal belt of Bangladesh.

Carbon Trade & Consumerism of the Rich Countries

There is a prediction of rising world temperature from 1.4-1.8 0 C compared to the industrial period by 2100 if the present trend of green house gas emission continues. This rise in temperature may cause 1 meter sea level and will inundate small island states and the low laying areas of Bangladesh leaving millions of people environmental refugee. Apart from this, occurrence of natural disasters like flood, drought, cyclone etc will be increased which will hamper crop production. Out break of irresistible disease also will appear. Therefore, the climate change impact will be more severe in the poor countries as the poor countries have no financial, even technical capacity to face such risks. Though countries of rich economy are mostly responsible for endangering the world but their response to mitigate the crisis is still beyond satisfaction level. The United State is solely responsible for 25% of total CO2 emission in the world, wherein Bangladesh contributes less than 1%. To safe the world from growing environmental risk an initiative of reducing green house gas emission was taken by the world climate scientists during 1980s. Following this event in 1992 an agreement (Framework Convention on Climate Change-FCCC) was adopted in the United Nation conference (UN conference on Environment and Development-UNCED). In this historic conference the world leaders agreed that 'every country has the common and specific responsibilities of Green House Gas reduction; countries of big economies (industrialized countries) who are the major GHG emitters should take the initial and prime role of GHG reduction. But still the rich nations are reluctant towards reducing green house gases. Nevertheless the industrialized nations have been asked in FCCC conference to formulate their own national policies of GHG reduction to 1990 level by 2012.

In 1997 the third UNFCCC conference was held in Kyoto, Japan. The prime objective of this conference was to review the commitment of industrialized countries (Given in FCCC conference in 1992) on GHG reduction. In Kyoto conference industrialized nations agreed to reduce GHG emission at least 5.2% from the level of 1990 during the period of 2008-2012. The Kyoto Protocol also offers 'alternative ways' of contributing to GHG reduction for the industrialized nations through investing on 'Clean Development Mechanism' and 'Green Technologies' in the developing countries. This flexibility would allow major GHG emitters to continue emission in another way. Development of CDM and Green Technologies is a requirement but GHG mitigation is an urgent.

This survey identifies deteriorating law and order as a major worry among the people, resulting in restricted mobility (particularly women) and increased insecurity. This phenomenon has also been acknowledged in the PRSP (Poverty Reduction Strategy Paper) documents and has been attributed to weakening of governance, criminalization of politics, corruption, violation of citizen's right, breakdown of traditional moral order and intolerant political culture.

9. Climate change, Disaster and Development Challenges

In 2004 worldwide disaster caused economic loss of \$ 123 billion most of which were in the poor countries as the countries face multidimensional problems of economic backwardness, poverty, unplanned urbanization and different man made & natural disasters.

Development Aid for Unsustainable Development

During the final decade of the nineteenth century the theory of classical economic liberalism emerged that defined 'the market' as the proper guiding instrument of economic development. This policy calls for reducing the roles of government in providing social welfare, in managing economic activity at the aggregate and scrotal level, and in regulating international commerce. This proposition is applied to all nations engaged in world commerce, whether they are rich or poor, agricultural or industrial, creditors or debtors. |

However to ease the multilateral trading and to deregulate market the same policies have been carried out throughout the South and East under the guise of structural adjustment, which is merely another name for neo-liberalism. The international financial institutions e.g. the World Bank, IMF etc. have been imposing neo-liberals to the LDCs as the conditions of giving loans. Such loan conditionalities have concentrated all their efforts only on the point that countries, in any way, must earn foreign currency for stabilizing 'balance of payment'.

Therefore to facilitate Bangladesh in export earning World Bank supported the country for shrimp farming extension culture under a project called Shrimp Culture Project (World Bank Credit no 1651 BD), at it has potential export market

This project resulted total destruction of the 'Chokoria Sundarban" once the pristine forest and the second largest mangrove forest of Bangladesh, which completely destroyed for shrimp culture. Total disappearance of Chakoria mangroves in Cox,bazaar is 21020.45 acre. According to official sources as of 1996 a total of 67500 acre has been brought under shrimp cultivation in Cox'sbazar of which 30346 are govt. land (12182 acres khas land, 17026 acres forest and 1138 acres other govt. land).

According to the World Bank report, \$ 7.5 billion will be needed to overcome the loss of Tsunami in Indonesia, India and Srilanka and \$ 5 billion will be needed to recover the earthquake loss in Kashmir, Pakistan. Again, EC-HAD (Humanitarian Assistance Department) reported that the poor countries are facing at least 3 percent loss of their expected GDP income annually. Due to this crisis many poor countries are being compelled to borrow the loan from IMF & WB with hard conditionalities or have to depend on assistance from rich countries. Thus, to pay back incurred loan government, very often, reduces social expenditure and impose increased taxes to its population.

10. Disaster Preparedness: Needs a Long Term Planning

Conventional outlook to disasters like disaster preparedness, capacity building to face disaster, relief and rehabilitation activities etc are not adequate enough to face climate change vulnerabilities and development challenges- says Hilary Ben, State Secretary of the International Development affairs, UK. The extent of social and economic impacts of climate associated disasters will be huge and it will require national and international efforts and planned investment to face the disaster shock.

In fact, the risk of economic loss could be reduced through adequate and planned financing on disaster preparedness and capacity building. A study of the World Bank and the US Geological Survey calculate that USD 280 million economic losses of disasters in 1990s could be saved if USD 40 million were invested in preparedness. Alternatively we could say that 1 dollar investment would save 7 dollar loss. During the last 40 years China invested USD 1.3 billion for flood protection which saved county's USD 12 billion forecasted loss.

Bangladesh also should integrate disaster preparedness in its long term development planning, although it would be very expensive. Different study calculates that Bangladesh will require USD 1 billion to face the impact of sea level rise, USD 13 billion to rehabilitate 13 million ousted coastal population, and USD 12 million to safeguard coast. However the loss of decreasing productivity which is assuming 28 to 57 percent reduction of crop production from the present level by 1 meter sea level rise would never be repairable.

11. Capacity Building: The Only Way

May be, we can not prevent the hazards of natural disasters completely, but we can reduce disaster risk and vulnerability through increasing our capacity. Capacity building also depends on the economical condition as well as political commitment of a country that is why; global cooperation is required as priority basis.

| Root Causes | Dynamic Pressures | Unsafe Conditions | Disaster | Hazard |
|--|---|--|---|--|
| <p>Limited Access to Power Structures Resource</p> <p>Ideologies Political systems Economic System</p> | <p>Lack of Local institutions Training Appropriate skills Local investments Local markets Press freedom Ethical standards</p> <p>Macro Forces Rapid population growth Rapid urbanization Arms Expenditure Debt repayment schedules Deforestation Decline in soil productivity</p> | <p>Fragile Physical Environment Dangerous locations Unprotected buildings and infrastructure</p> <p>Fragile Local economy Livelihoods at risks Low income levels</p> <p>Vulnerable society Special groups at risk Lack of local institutions</p> <p>Public actions Lack of disaster preparedness Prevalence of endemic disease</p> | <p>Risk =</p> <p>Hazard +</p> <p>Vulnerability</p> | <p>Earthquake High winds (Cyclone/ hurricane/ typhoon)</p> <p>Flooding</p> <p>Volcanic eruption</p> <p>Landslide</p> <p>Drought</p> <p>Virus and pests</p> |

Fig : Progression of human vulnerability to disasters. Disasters are caused by hazards events, but the impacts on people are strongly influenced by degree of vulnerability. This in turn is a product of unsafe conditions, which result from important root causes and compounded by dynamic pressures.
Source: Blaikie, P, T. Cannon, L. Davis and B. Wisner (1994); At risk: natural hazards, peoples' vulnerability and disasters.

There is a co- relation between capability and risk-

$$C_v = H_r$$

The more the Capacity the Less the Vulnerability,
Thus, Less Risk, in contrary;

$$cV = HR$$

The Less the Capacity, the More the Vulnerability, thus, High risk
H, Hazard Remains Constant

12. Considering Factors for Capacity Building

Local Level

- Training on disaster preparedness involving local institution/ local government
- Weather forecast and disaster bulletin has to broadcast in easy and local language
- Infrastructure development such as cyclone shelter, coastal embankment and ensure their regular maintenance
- More consultation and discussion on climate change related consequences
- Establishment of community radio station

National Level

- Initiate rural centric development activities and create rural employment that will reduce urban migration.
- Increase more budgetary allocation for disaster preparedness and rehabilitation activities
- To increase coastal forestation
- Salinity tolerant crop variety development and increase research initiative on it.
- Proper initiative to reduce population growth
- Banning on the establishment of harmful and pollutant producing industries like Cement Brick field, ship breaking etc
- Preserve rights of marginalized community people such as fishermen and tribe etc
- Plantation those trees that can reduce disaster vulnerabilities e.g. Coconut, Palm, Betel nut , Bamboo etc
- Stop commercialization and corporatization of natural resources,
- Stop chemicalization of agriculture

International Level

- Make alliance with the countries, which will be affected more due to climate change and GHG emission and lobby with the industrially developed countries to reduce GHG emission

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