Climate Change and Mitigation Strategy in Coastal Areas of Bangladesh

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Abstract

The purpose of the study is understands of climate change by the vulnerable people and to identify the elements of mitigating climate change disasters in coastal areas of Bangladesh. The coastal areas are affected regularly by flood frequency probabilities, erosion, inundation, erratic rainfall, increasing cyclone, storm surge, rising water tables, biological effects and salinity due to climate change. As a result, soil fertility, crop productivity, and food security seriously threatened and causing substantial reduction in food production and affecting rural livelihoods which impacted on agriculture, fisheries, livestock, environment, human health and infrastructure directly. This research study is descriptive-cum-empirical as well as suggestive in nature. The study is survey type. The present study has been included secondary resources consisting of books, newspapers, periodicals, articles from national and international level. Internet sources have been used for the research. Attempts have been made to include the latest information whenever available. At the same time primary data have been collected through interview with some officials and experts on the topic. Baseline data was collected from January to April in 2017. The study shows that the overall awareness and response of the problem was only 51%. It indicates that the elements of climate change and disasters are not clear to the resident peoples and even the educated citizens. Finally, it may be concluded that planting trees around their houses to reduce the intensity of storm surge attack, reduce erosion, diminish pressure on natural forest for household consumption as fuelwood. Unplanned industries and excess use of natural resources should be demoralized. Raising homestead and plinth level of houses to mitigate severe effects of coastal flooding. Farming of different varieties of climate resilient HYV crops, nationwide programs should be conducted to increase the awareness of the people about the elements of climate change.

Key words: *Elements, Mitigation, Climate Change, Disasters, Adaptations and Vulnerability*

I. Introduction

Coastal communities are facing much more vulnerability across the globe (Shaw and Krishnamurthy 2012). Anthropogenic stress in terms of over exploitation of coral reef and fisheries and land based activities (i.e., agriculture intensification) already increased stress in natural system of the coasts. Climate change adds to lower recovery or resilience of the natural system for human well-being and livelihoods (Adger et al. 2005; Lebel 2012). Impacts of climate change tremors affect coastal livelihoods differently and govern vulnerability and adaptive capacity. Some of the disasters are fast in coastal areas in terms of its sudden affects to coastal life and livelihoods like tropical cyclone and storm surges, where others are slow in events like salinity or inundation increase, but these have long-term impacts on social and economic functions (Nicholls et al. 2007). The tropical cyclone of 2007 caused loss of valuable mangroves, social and physical resources and livelihood bases that post-disaster recovery has not yet been possible in Bangladesh (Mallick et al. 2011). With changing frequency of cyclonic wind and storm surges and inundation coastal agriculture and domestic fisheries and open fishing have been highly affected which are significant livelihoods sources to majority coastal people. Salinity level is slowly increasing over the time and causing serious threats to traditional agriculture farming and mangrove ecosystems (Moniruzzaman 2012).

Social inequality in terms of limited resource ownership and external support affect adaptive capacity of particular poor and marginalized groups in coastal areas (Nandy and Ahammad 2012). Coastal development interventions largely focused on land stabilization, structural protection measures for disaster risk reduction (Agrawala et al. 2003) and by contrast, ignored embedded social construction and resource ownership legacy in changing climate (Nandy and Islam 2010). As result, long-term institutional inertia caused fragmented resource management which was neither integrative livelihood practices nor socially inclusive towards incorporating the emergent coastal adaptation in Bangladesh. Though protective engineering measures by building earth embankment reduced physical vulnerability to storm surges this was not planned and based on anticipatory impacts of climate change related stress like increased storm surge height and water logging on livelihood to

adjust to current and future changes (Mallick et al. 2011). The paper mainly presents the elements of mitigating climate change disasters and understanding of climate change in coastal areas of Bangladesh of Bangladesh NAPA priority project implementation. Several adaptation practices are also discussed to understand the diversity of practices and strength towards long-term adaptation.

II. Objectives

To understands of climate change by the vulnerable people and to identify the elements of mitigating climate change disasters in coastal areas of Bangladesh.

III. Methodology

Research methodology is a collective term for the structured process of conducting research. It usually encompasses the procedures followed to analyze and interpret the data gathered. This research study is descriptive-cum-empirical as well as suggestive in nature. The study is survey type. The present study has been included secondary resources consisting of books, newspapers, periodicals, articles from national and international level. Internet sources have been used for the research. Attempts have been made to include the latest information whenever available. At the same time primary data have been collected through interview with some officials and experts on the topic. Baseline data was collected from January to April in 2017. Data were collected from the capital and the field level conducting interview, discussion and observation using primary source i.e. interview with the respondents from the selected study areas. Primary data were collected through interview. Data were also collected from secondary source through literature review i.e. reference books, newspapers, periodicals, articles from national and international level. Internet sources have been used for research. An attempt was made to include the latest information whenever available. The nature of the study requires combining analytical and empirical approaches in the methodology. Accordingly, both qualitative and quantitative information and data were required. In order to generate database of the study, all necessary information was collected from different primary and secondary sources. Data were also analyzed and presented through the use of necessary figures, tables and charts. In the empirical study field work plays an integral role. The study relied on four main data collection tools namely: in-depth interview guideline/checklist; observation of respondent, cross checking of data collected from field using mobile/telephone and review of related documents. All these tools are closely related. Although different approaches were applied in this study, the main purpose was to ensure that they complemented each other. The findings were presented in table and narrative way because this article is both quantitative and qualitative in nature. The study areas were Barisal, Khulna, Noakhali, Chittagong, district of Bangladesh. Respondent of this study are Government Officers, Teachers, Elites, Farmers. They are age group were 25-40 years, 40-65 years, 65+ years. Disaster Events Flood, Cyclone, Storms, Droughts were selected for study. Sample Population was at least 100 from each Professional group balancing other variable criteria with sufficient diversity found.

Secondary information i.e. references books, journals, research report, newspaper; magazines etc were used in this study. The sources have not been analyzed and explained. But this study was dependent on primary information i.e. face to face interview. Review of document has positive aspects. Knowledge explains the positive side of this approach; this method views the author as a self-conscious actor addressing an audience under particular social and political circumstances. Collected data were tabulated and analyzed by using computer program SPSS & Microsoft Excel.

IV. Results and Discussion

The results obtained from present research are sequentially produced here as per objectives. The results are given in the Tables and Fig.

Table 1: Elements of mitigating climate change and disasters %response in favor

	Barisal	**Khulna**	**Noakahli**	**Chittagong**	**Mean**
Unplanned industries	25	71	36	89	55
Industrial pollution	41	53	37	69	50
Use of motor vehicle	28	57	45	84	54
Excess use of natural resources	57	88	51	82	70
Deforestation of forests	25	21	39	47	33
Intensifying	28	35	71	54	47

agriculture					
Mean	34	54	47	71	51

The results are given in the Table 1 and Fig 1 to 3 shows that the overall awareness and response of the problem was only 51%. It indicates that the elements of climate change and disasters are not clear to the resident peoples and even the educated citizens.

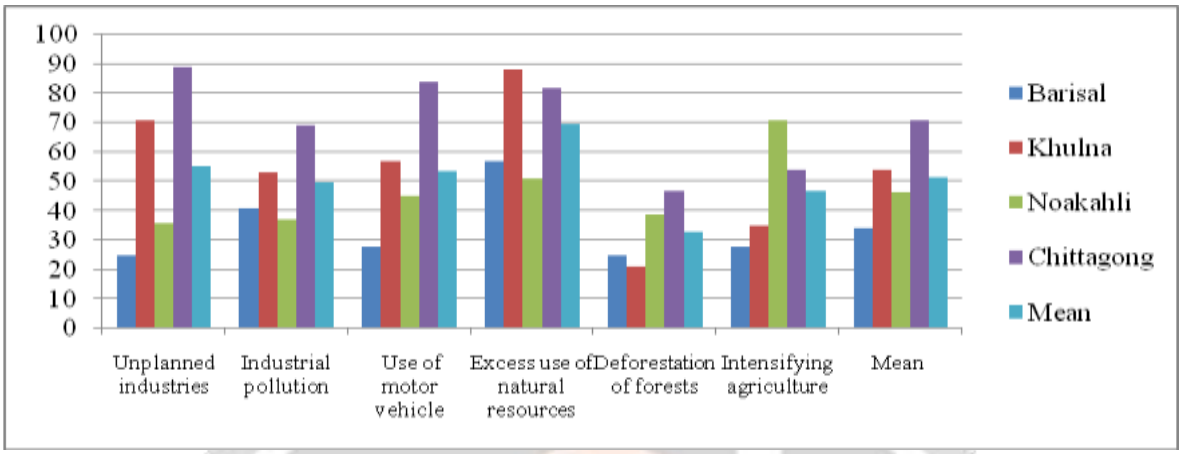

Fig 1: Elements of mitigating climate change and disasters as per sites.

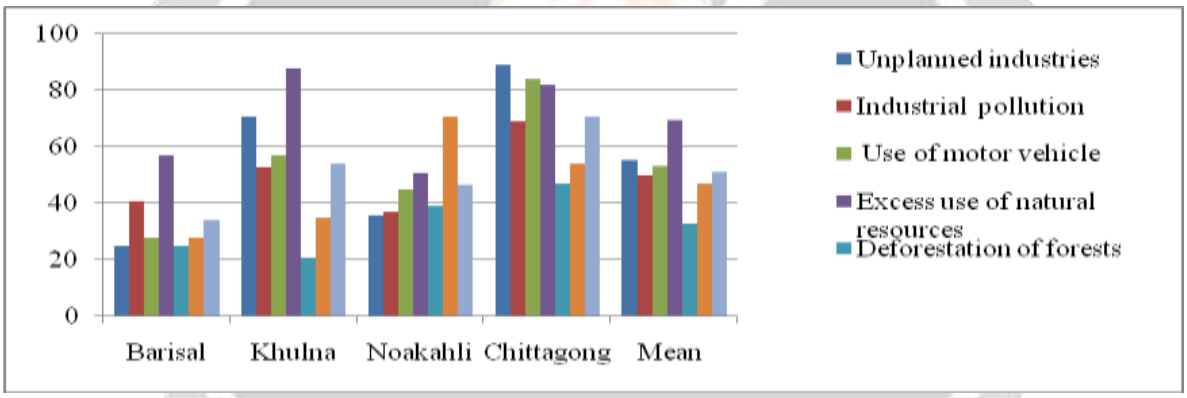

Fig 2: Elements of mitigating climate change and disasters as per manipulations.

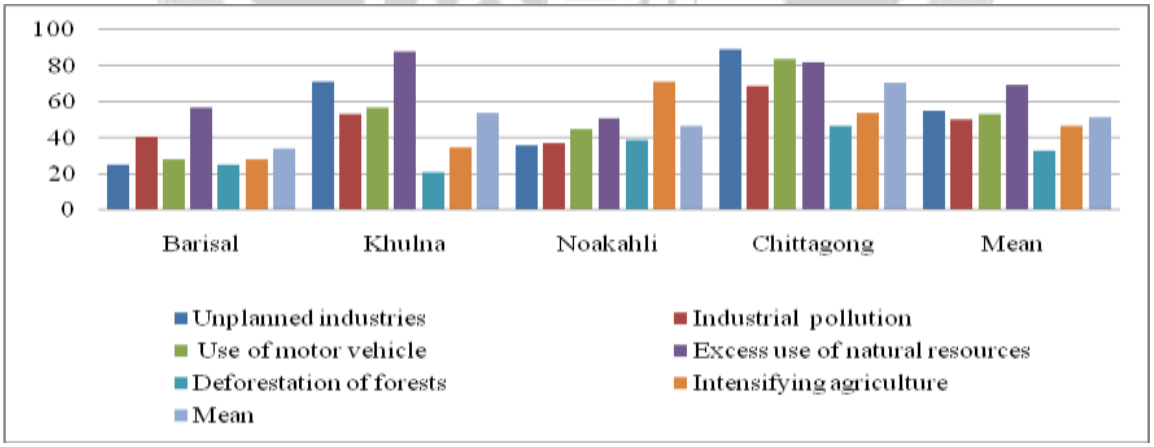

Fig 3: Elements of mitigating climate change and disasters as per manipulations.

Fig 1 to 3 show that unplanned industries and excess use of natural resources caused intensive disasters.

Problems:

In terms of agriculture;

Different studies showed that temperature rise by 1.00 C would inundate 18% area of Bangladesh. The country is affected regularly by flood, drought, dry spell, erratic rainfall, cyclone, and salinity due to climate change. As a result, soil fertility, crop productivity, and food security would be seriously threatened causing substantial reduction in food production and affecting rural livelihoods. Climate change has also accelerated hunger, poverty, malnutrition and incidence of diseases, especially in developing countries (IPCC, 2007). It is basically the poor that would be worst victims of climate change. In Bangladesh, about 1 million ha of the coastal region is saline. But very few varieties are available for fighting salinity. Drought affects annually 2.5 million ha in kharif and 1.2 million ha in dry season. Kharif drought affects T. aman rice severely. Besides, about 2.6 m ha are affected by flood in a normal year (Z. Karim, 1997). The devastating flood of 2004 inundated 40 districts and caused substantial loss of crops and human life. But very limited technologies are available that are tolerant to flood and drought. According to Intergovernmental Panel on Climate Change (IPCC, 2001), coastal area of Bangladesh may go under saline water by 2050. Due to the rise in temperature, crop production will be reduced by about 30%. Climate change, especially temperature rise would decrease the yield of boro rice by 55-62% and wheat by 61% by 2050 in Bangladesh (New Age, 2008). Frequent felling of green trees by the influential, especially in coastal belts for building shipyards has also become a threat to climate change. As agricultural production reduced most of the people suffer from food security, malnutrition and livelihood insecurity.

In terms of fisheries;

It is reported by Haque (2007) that seasonal variations of rainfall and temperature have diverse implications on fishing, hatchery operations, fish production and livelihoods of a wide range of people directly and indirectly involved with fisheries and aquaculture. Climate change has both direct and indirect impacts in fish stock which are exploited commercially. It is evident that natural fish stock will be more resilient to climate impacts with significant food security consequences for certain populations. Climate changes directly effects on physiology and behavior of fish and alter growth, reproductive capacity, mortality and distribution.

In terms of livestock;

Livestock are affected by air temperature, humidity, wind speed and thermal radiation which influence their growth, milk production, reproduction, health and wellbeing. Moreover due to grazing facilities and shortage of food that makes unfavorable environment for the livestock. Sometimes, cattle and poultry suffer from heat stroke and affected by different diseases like black quarter, anthrax and so on.

Bangladesh has one of the largest livestock populations in the world, and one of its notable characteristics is that almost its entire feed requirement is met from crop residues and by-products; grasses, weeds and tree leaves; and grazing on common lands and harvested fields (Dikshit & Birthal, 2009). Climate change affects livestock production by altering the quantity and quality of feed available for animals. Climate change is expected to change the species composition (and hence biodiversity and genetic resources) of grasslands as well as affect the digestibility and nutritional quality of forage (Thornton et al., 2009). Droughts and extreme rainfall variability can trigger periods of severe feed scarcity, especially in dry land areas desertification leads to soil compaction and hardening, making the land unable to absorb rainwater (FAO, 2008), with devastating effects on livestock populations and increased level of salinity in cultural lands as sea level rises and finally consequences low fodder production. Reductions in the quantity and quality of feed could make the impacts of climate change on livestock systems severe in certain places.

Climate changes create stress in livestock and poultry. A high temperature will increase body metabolism which will cause less growth in livestock. This leads to less meat, milk and egg production (MoEF, 2009). Conversely, increased ambient temperature lower feed intake consequences less production (Mack et al., 2013).

As global temperatures increase, the effects will be quite complex and vary from region to region. Though the extent of these effects is uncertain, it is known that those communities and regions with the least resources (IPCC, 2007), such as rural agricultural areas (Halweil, 2005) will be the most vulnerable to climate change. Warmer and wetter weather will increase the risk and occurrence of animal diseases. The direct effect of climate change such as temperature fluctuation and uneven rainfall can introduce vector-borne diseases and attack of parasites and transmissions of new diseases (Thornton and Herrero, 2008). Certain existing parasitic diseases may also become more prevalent or their geographical range may spread, if rainfall increases (Epstein & Mills, 2005) this may contribute to an increase in disease spread including zoonotic diseases. The viral infection Blue tongue Disease, for example, was once only a threat in Africa, now affects cattle and sheep in the whole of Europe (Clarke, 2007). Incidences of bovine respiratory diseases are known to be increasing (Duff & Gaylean, 2007) because of climate change. Outbreaks of diseases such as Foot &Mouth Disease or Avian Influenza affect very large numbers of animals and contribute to further degradation of the environment and surrounding communities' health and livelihood (Romarao, 1988).

In terms of human health;
It is well known that weather affects our health directly when it is too hot or too cold. When there are extreme weather and climate events, there is flooding or drought. Greater levels of air pollution and higher level of pollen can affect respiratory diseases. The vector borne disease are changing their ranges, so mosquitoes and ticks are carrying diseases (malaria and dengue) and harm human health are expanding geographically with warmer temperatures. Therefore, climate change poses a great threat to public health and it is surprising that few people understand it. Strategies that address climate have the potential to considerably benefit human health, yet public health engagement at the intersection of climate change has been limited. Due to lack of safe drinking water, people of coastal areas uses pond water that also leads to various water borne diseases such as; dysentery, diarrhea etc.
Death resulting from cardio-respiratory diseases associated with high and low temperatures. Higher malnutrition rate among coastal residents due to reduction of food security. Rise of tidal levels and frequent coastal flooding increase salinity in ground water. Drinking of saline contaminated water increase eclampsia and hyper tension among women in coastal areas. Rise of tide levels and frequent coastal flooding Khan et al. (2008) Increase salinity in groundwater. Drinking of saline contaminated water increases eclampsia and hyper
tension among women in coastal areas Deaths and injuries Deaths resulting from cardio-respiratory diseases Rashid et al. (2013) associated with high and low temperatures Malnutrition Higher malnutrition rate among coastal residents Khan et al. (2011) due to the reduction of food diversity Safe drinking water Rise of tide levels and frequent coastal flooding Khan et al. (2008) Increase salinity in groundwater. Drinking of saline contaminated water increases eclampsia and hyper tension among women in coastal areas Gender dimensions of effects A decrease in women income and stressful social life Pouliotte et al. (2009) Increase of climate extreme Mosquito-borne diseases, tick-borne diseases Rashid et al. (2013) related disease and sickness (e.g. malaria, dengue) and air pollution related mortality and morbidity Deaths and injuries Deaths resulting from cardio-respiratory diseases Rashid et al. (2013) associated with high and low temperatures Malnutrition Higher malnutrition rate among coastal residents Khan et al. (2011) due to the reduction of food diversity Safe drinking water Rise of tide levels and frequent coastal flooding Khan et al. (2008) Increase salinity in groundwater. Drinking of saline contaminated water increases eclampsia and hyper tension among women in coastal areas Gender dimensions of effects A decrease in women income and stressful social life Pouliotte et al. (2009) Increase of climate extreme Mosquito-borne diseases, tick-borne diseases Rashid et al. (2013) related disease and sickness (e.g. malaria, dengue) and air pollution related mortality and morbidity Deaths and injuries Deaths resulting from cardio-respiratory diseases Rashid et al. (2013) associated with high and low temperatures Malnutrition Higher malnutrition rate among coastal residents Khan et al. (2011) due to the reduction of food diversity Safe drinking water Rise of tide levels and frequent coastal flooding Khan et al. (2008) Increase salinity in groundwater. Drinking of saline contaminated water increases eclampsia and hyper tension among women in coastal areas Gender dimensions of effects A decrease in women income and stressful social life Pouliotte et al. (2009) Increase of climate extreme Mosquito-borne diseases, tick-borne diseases Rashid et al. (2013) related disease and sickness (e.g. malaria, dengue) and air pollution related mortality and morbidity

In terms of environment;
Climate change causes environmental degradation. Natural disasters destroy the forests that cause huge losses of bio-diversity. Many plant and animal species destroy due to habitat loss. Environmental degradation, degradation of land resources ultimately reduces food and health securities etc.It was mentioned that the mangrove forests of the Sundarbans, the Bengal tiger and hundreds of bird species may disappear (Daily Star, 2011).

Gender dimension of effects
A decrease in women income and stressful social life.

Impact on women to climate change;

- Impact on the lives and health of women;

Warning information was conveyed by men to men in public places; women were not hear the message clearly or allowed to leave the house. A few studies following the cyclone and flood disasters of 1991 revealed that, among women aged 20-44, the death rate was 71 per 1000 compared to 15 per 1000 for men (UNEP-2005). Women death rate was high because diseases, injuries, drowning, slipping, large trees and structure falling on women, malnutrition, lack of warning information, medical facilities, pure drinking water and sanitation facilities.

- Impact on women's physical security and dignity

Women in Bangladesh still experience various types of violence; physical, sexual, and emotional violence increase during and after a disaster (UNDP-2002).

1. Domestic violence
2. Harassment and loss of privacy in flood and cyclone shelters
3. Harassment in relief ques

- Impact on women's economic livelihoods
  1. Housing and homestead
  2. Crop production loss
  3. Livestock death
  4. Loss in productivity
  5. Supply shortage and price of inputs
  6. Limited access to market
  7. Loss of income savings and employment

Adaptation:

Agricultural Adaptation in coastal zones:

- Climate resilient rice varieties (Bina-8, BIRRI-40, 41, 47, 53, 54) and saline resilient non rice crop varieties (Mug bean-BM 08, Maize, Mustard, Cowpea, Tomato) should be cultivated.
- Some agricultural adaptation technologies such as raised bed, floating vegetables, hydrophonic fodder cultivation, mulching, water storage in crop fields, ditch and dyke method in farming, mound plantation, agro-forestry, drip irrigation, non-traditional crop varieties should be practices.

Aquaculture based adaptation

- Crab fattening
- Mono-sex tilapia farming
- Fish culture with repeated stocking and repeated harvesting
- Cage aquaculture
- Shrimp farming
- Fish culture in Bioflock system
- Sea bass farming
- Some aquaculture technologies such as closed system bagda farming, golda mono farming, mono-sex tilapia farming in pond, pangas farming, carp poly ulture, cage culture in open water, carp brood development, mola with carp culture, sing, magur, koi demonstration may be extension.

Aquaculture based adaptation

- Genetically improved duck (Khaki Campbel, Xinding) rearing
- Nacked neck hen rearing
- Goose rearing
- Quail rearing
- Improved fodder cultivation
- Hydrophonic culture.

Water based adaptation

- Rain water harvesting
- Pond sand filter
- Desalinization for drinking water
- Piped watering system

Disaster related adaptation

- Houses on raised plinths
- Settlement on raised lands
- Mud wall housing
- Cyclone resistant housing
- Reinforcement of coastal fishing of boats

Coping practices among women;

- Predicting and preparing for disaster
- Protecting houses and homesteads
- Storing essential items
- Teaching children

V. Summary and Recommendations

The purpose of the study is to identify the elements of mitigating climate change disasters and understanding of climate change in coastal areas of Bangladesh. Finally, it may be concluded that;

- Planting trees around their house to reduce the intensity of storm surge attack.
- Raise homestead and plinth level of houses to mitigate severe effects of coastal flooding.
- Unplanned industries, excess use of natural resources and deforestation should be stopped from now on.
- The disaster management programs should be drawn from the grass root levels where the event is happening.
- Teachers should be given more importance in implementing disaster programs.
- Government should emphasize introducing climate resilient agricultural practices that ensure productivity and employment.
- Crop and livelihood diversification system should be introduced to reduce yields gap.
- Local weather forecasting should be developed.
- Nationwide programs should be conducted to increase the awareness of the people about the elements of climate change.
- Coastal people should be trained up on Climate Risk Assessment (CRA) and prepare Climate Resilient Management Plan (CRMP).

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