

Climate Change: A Challenge to Coastal Agriculture in Bangladesh

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Introduction

In the twenty first century, climate change is one of the greatest threats to the world community; especially to the developing world. Climate change is a global, slow, long term, multidimensional phenomenon with plenty of adverse impacts on socio-economic aspects. Geographic location, low topography (dominance of flood plains and low elevation from the sea), demographic (high population density and growth rate) and poor socio-economic (high poverty level, climate dependent traditional rural agrarian economy, institutional weakness etc.) features make Bangladesh one of the most vulnerable countries in the world to climate change. Particularly, the coastal area (southern and south-eastern part) of Bangladesh is more vulnerable to climate change as it locates at the tip of inverted funnel shape of Bay of Bengal. Climate change and its induced natural hazards (i.e. frequent intense tropical cyclones and its related storm surges, long term saline water stagnancy after storm surges, sudden flood, salinity intrusion, inundation of low laying landmass due to sea level rise, coastal erosion etc.) hinder the socio-economic development in the coastal area through declining coastal agriculture.

Bangladesh is an agricultural country. Agriculture contributes 19.41% (including fishery) of the total GDP in fiscal year 2011-12 and major portion of the country's labor force, about 47.5% engages in agriculture [1]. Socio-economic development and improvement of people's life quality in Bangladesh is closely related with agriculture. Now, agriculture is the most vulnerable sector to climate change as it is very susceptible to change in climatic phenomena (i.e. change in temperature, rainfall, relative humidity, air flow and pressure etc.) and its effects. Agriculture in the coastal area of Bangladesh is more vulnerable to climate change than other parts of the country due to its geographical location and this article is confined within the coastal area of Bangladesh.

Climate Change and Its Trend

Global warming is mainly responsible to worldwide climate change. Forth assessment report of IPCC (Intergovernmental Panel on Climate Change) reveals that anthropogenic activities are responsible for global warming and global climate change [2]. Due to various anthropogenic activities, it is expected that current century will warm quicker than any time in the past 10,000 years [3]. IPCC predicts that global temperature will rise between 1.8°C and 4°C by the end of twenty first century [4]. In case of Bangladesh, observing the temperature data of Rangpur station from 1978 to 2002, it has found that overall annual maximum and minimum temperature is increasing annually at the rate of 0.035°C and 0.027°C respectively. Similarly, observed data of the Bogra station from 1971 to 2002 shows increasing trend in overall annual maximum and minimum temperature at the rate of 0.008°C and 0.003°C, respectively [3].

This increase in temperature changes the normal climatic phenomena i.e. timing and duration of monsoon period, wind flow and pressure, relative humidity, increasing both of frequency and intensity of natural calamities etc. which hinders the agricultural production of Bangladesh; especially in the coastal belt.

Climate Change and Challenges to Coastal Agriculture in Bangladesh

Various studies imply that the agricultural production of Bangladesh will reduce due to temperature rise and climate change. The GFDL (Geophysical Fluid Dynamic Laboratory) model has predicted that change of 4°C in temperature decline about 17 % of overall rice production and as high as 61% of wheat production in compared to the baseline situation of 1990 [3]. So, according to the global warming prediction of IPCC (which has mentioned earlier), by the end of twenty first century the GFDL model's prediction on agricultural production decline may come in reality in Bangladesh. Agriculture in the coastal area of Bangladesh is severely vulnerable to natural hazards and it is expected that climate change will decline coastal agricultural system through intensifying and frequenting the natural hazards.

Frequent tropical cyclone and its related storm surges is one of the main threats to coastal agriculture. Cyclone SIDR (15th November 2007) and AILA (25th May 2009) two frequent history breaking and most devastating cyclones hit the coast of Bangladesh and stopped the life and livelihood of the people. In every three years on average, a severe tropical cyclone hits Bangladesh [4] and the fourth assessment report (AR4) of IPCC indicates that the future tropical cyclones, storm surges and its related saline water flood will be more severe in the coast of Bangladesh due to

climate change [5]. Another study using Regional Climate Model (RCM) shows a significant increase in the frequency of highest storm surges (considering the current and future climates) for the Bay of Bengal, despite no significant change in frequency of cyclones (Unnikrishnan et al. 2006, cited from [5]). Generally, one year (actually one rainy season) needs to wash away the storm surges occurring salinity and recovery of arable land. Frequent cyclones, storm surges and yearlong recovery period of agricultural land after storm surges instigate the farmer to switch their occupation; even force them to migrate [6]. This trend of frequent intense tropical cyclone and storm surges is an obvious impedance to coastal agriculture and according to the mentioned predictions this scenario will be more problematic.

After cyclone AILA, a long term water logging of saline water over 2 years occurred in some parts of coastal area (specifically some parts of Dakop upazila of Khulna, Tala and Shamnagar upazila of Satkhira District). This water logging occurred due to failure of protection dams by AILA induced storm surges; which has increased both soil and water salinity and ultimately declines the agriculture. Delay in reconstruction of protection dams makes havoc of people's life and livelihood [6] [7]. On the other side, erratic nature of rainfall has really increased and Bangladesh NAPA (National Adaptation Programme of Action) states that the duration of rainy season has been decreased with a slight change in total annual rainfall. It means within a short period a heavy rainfall is occurred; which is one of the main causes of increase in sudden flood [8]. In fourth assessment report (AR4), IPCC also predicts that coastal areas of South Asia (including Bangladesh) will be at greatest risk due to increased flooding from both the sea and the rivers [2]. This long term saline water stagnancy and increase in flood simultaneously hamper our coastal agriculture and local food security.

Study of SAARC Meteorological Research Council (SMRC) shows that Sea level is rising in the coast of Bangladesh. Observing 22 years tidal data of three coastal stations, SMRC reveals that sea level rise in the Bangladesh coast is many folds higher than the mean rate of global sea level rise over 100 years. Trend of sea level rise in the Bangladesh coast is given bellow:

Table 1: Tidal trend in three coastal stations

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

Source: SMRC, No. 3, cited from [8]

This sea level rise will reduce agricultural production of the country by inundating the agricultural land in the coastal area and IPCC has predicts that around 10% of Bangladesh area will inundate for 45 cm sea level rise (IPCC, 2001 cited from [3]). Long term water stagnancy (which has mentioned earlier) indicates the introduction of this inundation process. Sea level rise coupled with reduced flows from the upland during winter season expedites the saline water intrusion in land and salinity increase. Bangladesh Agricultural Development Corporation (BADC) reveals that the concentration of ground water in Tala and Devhata upazila of Satkhira district has increased up to 5000 micro-siemen/sq.cm; which indicates sea water advancement towards north. Observing the existing data, it assumes that some part of coastal area may experience underground salt water intrusion by the next 30 years [9] and it will decline the coastal agriculture.

So, it is clear that climate change declines the coastal agricultural system of Bangladesh through intensifying the natural hazards and it is a great challenge to Bangladesh to secure country's food security.

Climate Change and Coastal Fisheries

Fishery is a sub-sector of our agriculture and it contributes 4.39% of total GDP in fiscal year 2011-12 [1]. World Fish Center (WFC) reveals that climate change may globally affect fisheries and aquaculture directly influencing the fish stock or indirectly influencing the cost of goods and services needed by fishers and fish farmers [10]. Climate change and increasing trend of climate change induced natural hazards (which is mentioned earlier) will hamper the coastal fisheries and aquaculture in Bangladesh. It is expected that Sea Surface Temperature (SST) rise, sea level rise, sedimentation of river bed, increase of natural disasters, salinity intrusion etc. are the potential impedance to preserve our natural fish stock and continue ordinary coastal aquaculture.

Surface temperature rise of Bay of Bengal and its tributaries due to global warming will reduce the natural fish stock and species. Effects of Sea Surface Temperature (SST) rise on natural fish stock are given bellow:

Table 2: Effects of SST on coastal fisheries

Biophysical Effects of SST rise	Detrimental effects on coastal fisheries
Blooming harmful alga	Infestation of fouling organisms, pests, pathogens , nuisance species etc. will reduce the natural fish stock
Reducing dissolved oxygen	
Increasing incidence of disease and parasites	
Altering local ecosystems	
Changing in plankton composition	
Changing in timing , success of breeding and spawning	Potential loss of species and impacts on seed availability for aquaculture
Damaging coral reefs of Saint Martin	Reduction of fish species (as coral reefs serve as breeding habitats)

Source: World Fish Center, 2007 [10]

Sea level rise will reduce the fish production directly inundating the coastal areas and species by altering the eco-system. Effects of sea level rise on coastal fishery are given below:

Table 3: Effects of sea level rise on coastal fisheries

Biophysical Effects of sea level rise	Detrimental effects on coastal fisheries
Inundation of low laying landmass	Reduction of available area for fisheries and aquaculture.
Salt water intrusion	Loss of freshwater fisheries, species and bio-diversity
Changes to estuary systems	Shifts in species distribution and composition of fish stocks and aquaculture seed.

Source: World Fish Center, 2007 [10]

Rise in inland water temperature due to global warming will be a great challenge to coastal fish culture as it will reduce the primary productivity in ecosystem and ultimately food supplies for fish species; spoil water quality especially in terms of dissolved oxygen and increase of pathogens [10].

Mitigation, Adaptation and Our Government's Steps to Combat the Climate Change

In order to address climate change and its impacts there are two main approaches. These are mitigation (reduction of Green House Gases) to halt severe climate change and adaptation to address the impacts of climate change. Mitigation is the main response measure to reduce future climate change impacts and it is better than adaptation. Adaptation includes the efforts to cope with the avoidable effects of climate change (due to failure of mitigation efforts). Delay in reducing emission will increase the cost of adaptation and increase the risk of global climate change [3]. So, most carbon emitting countries should reduce their carbon emission and most vulnerable countries should adapt with the effects of climate change i.e. mitigation and adaptation may complement of each other.

Bangladesh is one of the countries which are in the front lines of climate change battle. Bangladesh Government has already been taken some adaptation measures to save its coastal agriculture and these are development of climate change resilient cropping systems through agricultural research, using indigenous knowledge, introducing existing innovative crop technologies to deal with flood, drought and salinity etc. Bangladesh Government is also trying to introduce of fish culture techniques to increased flood levels and diversification of aquaculture techniques in coastal regions [11].

Conclusion

In conclusion, declining in agriculture and fisheries due to climate change in coastal area may hinder the local food security and protein supply. The severity of mentioned adverse effects of climate change on the people living in coastal areas demands strong foundations for constructive, responsive, modern and adaptive agricultural technologies, rules, regulations and policies.

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