J. Environ. Sci. & Natural Resources, 7(2): 31–35, 2014 ISSN 1999-7361

Assessing Vulnerability and Adaptation to Climate Change by Farming Communities in Southwestern Coastal Bangladesh

M. B. Ullah and M. H. Rahman

Department of Agricultural Extension Education,
Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Abstract

Southwestern coastal Bangladesh is characterized by low-lying topography, high productive mangrove ecosystem and unique biodiversity. At the same time, the region is highly prone to cyclones, coasting flooding, and salinity, which causes huge losses to agriculture production and rural livelihoods. Marginal and small farmers are affected more. The objective of this paper is to examine the extent of climatic variations and to analyze farming communities' vulnerabilities and adaptations to climate change in the saline prone southwestern coastal Bangladesh. We used both primary and secondary data for this study. We collected primary data from Atulia and Padmapukur unions of Shyamnagar upazila under Satkhira district of Bangladesh in April 2013. We collected secondary data from published statistics. We did not find significant changes in temperature and rainfall over time but salinity level has increased over time. Major vulnerability faced by farming communities due to climate change were saline water intrusion, scarcity of safe drinking and irrigation water, and problems on crop production, livestock rearing, fresh water fish culture, and sanitary latrines. Major adaptations practiced by farmers were culturing saline water shrimp in farms, harvesting rain water, drinking pond's water, catching fish from the sea and river, and desalinization of river water by constructing embankments. Agricultural adaptation practices such as saline tolerant rice varieties cultivation, crabs fattening, sowing and planting date shifting, mulching, soil flashing, fertilizers management, seeds sowing using dibbling method, raise or slopping bed method crop cultivation in embankments, pit method crop cultivation, changing cropping patterns, zero tillage, and sorjan method crop cultivation can helps minimize the impacts of climate change, particularly to vulnerable smallholder farmers. Policies and programs are needed to develop and disseminate these adaptation practices complemented by farmers' training on these practices.

Key words: Adaptation, Climate change, Farming community, Vulnerability

Introduction

It is recorded that the global temperature has increased on an average at 0.74° C from 1906 to 2005. Likewise, the global sea level has increased on an average at 1.8 mm in 1961 and at 3.1 mm in 1993. It has been projected that the world temperature will increase on an average from 1.8 to 4° C within 2100. There are strong evidences that global temperature and sea level are rising at an increasing rate and will continue to rise during this century. Pertaining to these, small islands will be disappeared and peoples will fall in great threats (IPCC, 2007). Bangladesh, with an area of 147 thousand km^2 and population of 150 millions, is prone to climatic natural hazards (PHC, 2011). The low-lying topography, funnel shaped coast, exposing the land to cyclones and tidal surges, seasonal flooding, widespread poverty, large population base, and poor institutional development have particularly made Bangladesh vulnerable to climate variability and change. The average monsoon season (June to August) maximum and minimum temperatures were shown an increasing trend annually at the rate of 0.05°C and 0.03°C, respectively. On the other hand, average winter time (December to February) maximum and minimum temperatures were shown a decreasing and an increasing trend annually at the rate of 0.001°C and 0.016°C, respectively (Rahman *et al.*, 2003). The lengths of winter, summer and rainy seasons have increased and the length of spring season has decreased. These changes in seasons are expected to impact the whole cropping cycle (Chatterjee and Khadka, 2011). The southwestern coastal zone encompasses part of the Sundarbans mangrove forest. The area is characterized by low-lying topography, high productive mangrove ecosystem and unique biodiversity. Upazilas numbering 147 under 19 districts are considered as coastal districts of Bangladesh along with shoreline from Teknaf to Shyamnagar. It represents an area of 47,211 sq. km., which is 32% of the country's geographical location. It is estimated that about 21% i.e. 35 million people of Bangladesh live in the coastal districts**.** The coastal area of Bangladesh is already suffering from various destructions. These effects are exacerbating further by climate change. Statistics show that saline water has penetrated about 100 km from the sea to inland through the coastal rivers**.** Total saline affected area in Bangladesh has increased by 3.5% from 1.02 million ha in 2000 to 1.06 million ha in 2009. Total saline affected area in our study district Satkhira has also increased from 125 thousand ha to 131,000 thousand ha in the same period (Ahsan, 2010).

Material and Methods

Study area

Satkhira district, an area of 3,858 square kilometer, and population of 1.85 million is one of the most vulnerable coastal districts. It is comprised of 7 sub-districts, among them Shyamnagar and Assasuni is exposed coast (Ahmed, 2008). Sathkhira district is highly climate induced hazards prone area especially cyclone, tidal surge, coastal flood, drought, salinity and arsenic contamination. Shyamnagar upazila is characterized by large area facing towards the sea ; severely affected by A*ila*, a severe cyclone occurred on 25 May 2009, saline water intrusion both in surface and sub-surface water, serious scarcity of safe drinking and irrigation water, commercial shrimp farming using saline water, and high level of poverty led large rural out-migration. This study focused on extent of climate variations, vulnerability and adaptations to climate change.The specific objectives of the study were to examine the extent of climatic variations, and to analyze farming communities' vulnerabilities and adaptations to climate change in the saline prone southwestern coastal Bangladesh.

Methodology

The study was conducted applying a mixture of both primary and secondary qualitative and quantitative data. Primary qualitative data were collected by conducting 5 Focus Group Discussions (FGDs) in five villages under Atulia and Padmapukur unions, Shyamnagar Upzail, Satkhira District in April 2013 and seven consultation meetings with various organizations engaged in the field of climate change in Bangladesh during different months in 2013. Secondary data were collected from different sources including reviewing the literatures published statistics, field visits, and sharing and validation workshops.

Primary quantitative data were collected from 81 households including 28 women respondents from 5 villages under Shyamnagar upazila of Satkhira district. Separate FGDs were conducted in five categories of respondents, namely farmers, fishermen, traders, mixed (men and women) and women group. The share of individual FGD group in total FGD was 19% farmers, 19% fisherman, 19% traders, 19% mixed of men and women and 24% women only. Group comprising of 15-20 members were selected based on their experiences and knowledge about the locality. The purpose of those discussions was to gather opinions of households regarding vulnerabilities and practical solutions to climatic variability. Prior to FGD, various templates such as means of livelihood, vulnerability, and existing adaptation strategy were prepared for collection of more authentic information from households. Two workshops were also conducted at union level ensuring the participation of chairmen and members of union Parishad, service providers, NGOs representative, teachers and religious leaders in regards to justify, validate and further improvement the findings gathered from village level discussion.

Results and Discussion

Overall temperature and change

Sixty six years of data on maximum, minimum temperature and rainfall were collected from the meteorological stations at Satkhira. These data were used for assessing changing pattern of climatic parameters particularly temperature and rainfall.

Maximum temperature

Figure 1 shows that the annual average maximum temperature at Satkhira was 31.28°C during 1948 - 2013. The highest maximum temperature was recorded as 32.43°C in 1987, while the lowest was 30.06°C in 1981 (BARC, 2014). The positive slope of the maximum temperature trend line shows that maximum temperature has increased over the last six decades but this increase is not statistically significant in Satkhira District. This means that there is no significant change of maximum temperature in Satkhira District.

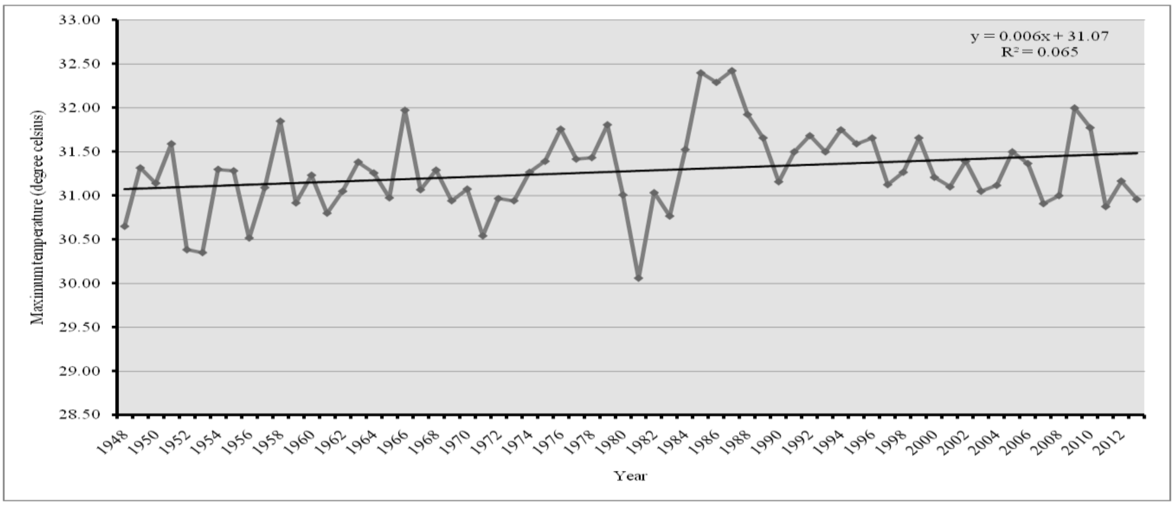

Fig.1. Annual maximum average temperature (Degree Celsius) of Satkhira district (Source: BARC, 2014)

Minimum temperature

Figure 2 shows that the annual average minimum temperature at Satkhira was 21.45°C during 1948 - 2013. The highest minimum temperature was recorded as 22.73°C in 1979, while the lowest was 20.55°C in 1999 (BARC, 2014). The positive slope of the minimum temperature trend line shows that minimum temperature has increased over the last six decades but this increase is not statistically significant in Satkhira District. This means that there is no significant change of minimum temperature at Satkhira District.

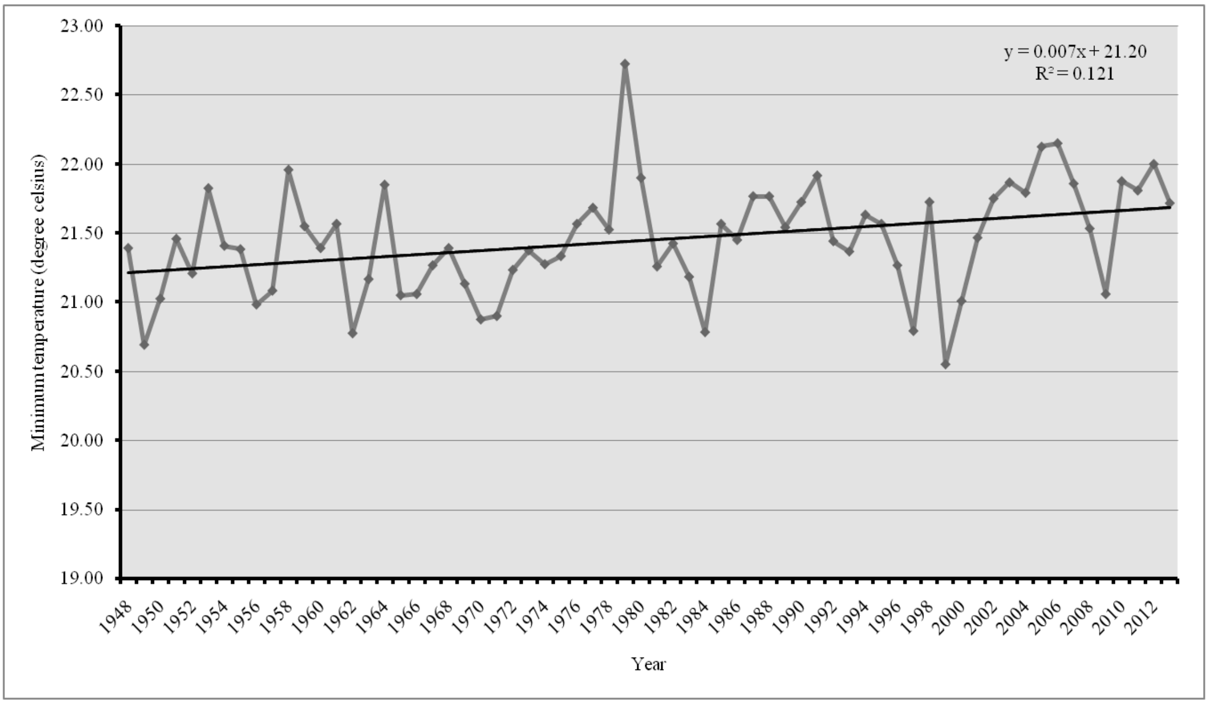

Fig.2. Annual minimum average temperature of Satkhira district (Source: BARC, 2014)

Overall rainfall pattern and change

The information presented in Figure 3 shows that the annual average rainfall in Satkhira was 140.35 mm during 1948 -2013. The highest rainfall was recorded as 200.17 mm in 1959, while the lowest was 58.08 mm in 1966 (BARC, 2014). The positive slope of the rainfall trend line shows that rainfall in Satkhira District increased in the past six decades but this increase is very small and it is not statistically significant.

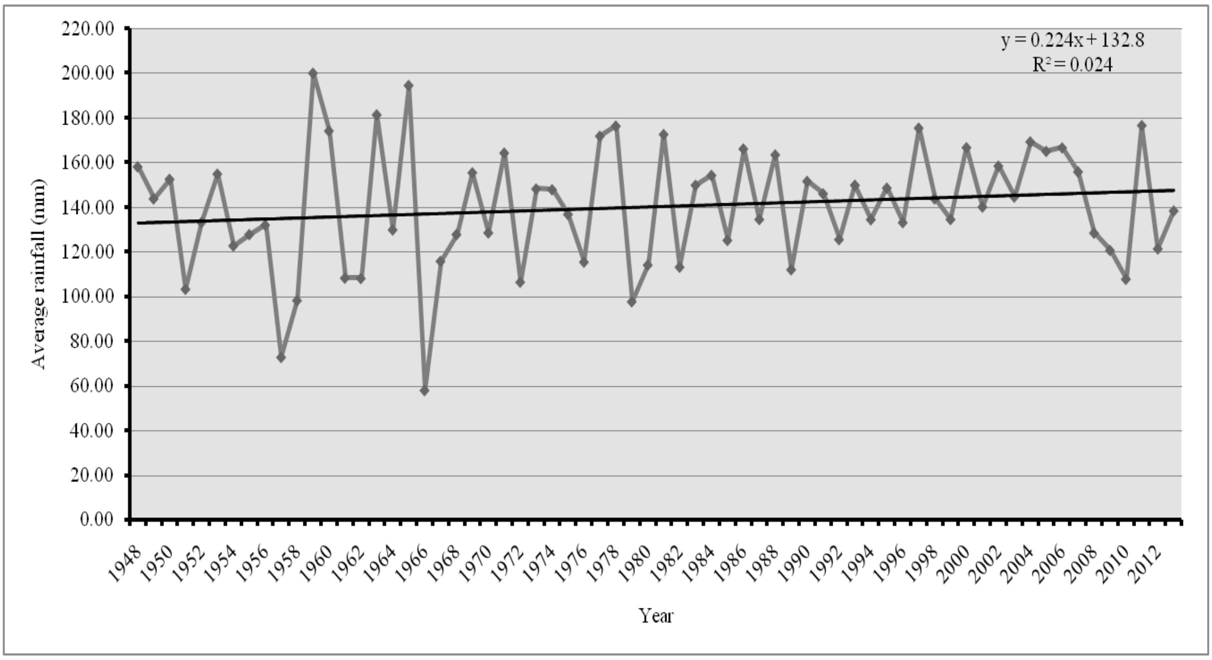

Fig.3. Annual average rainfall (mm) of Satkhira district (Source: BARC, 2014)

Trend of sea level rise in coastal stations of Bangladesh

SAARC Meteorological Research Centre (SMRC) has carried out a study on sea level rise in the coastal Bangladesh. The study was done based on tidal data during 1977-1998 at three coastal stations which are Hiron point, Char Changa and Cox´s Bazar. It reveals that the rate of sea level rise during the last 22 years is many times higher than the global rate of increase of 1.0-2.0 mm per year in the last century (SMRC, 2003). Table - 1 shows the trend of tidal level in three coastal stations. We can conclude that the sea level has risen in Bangladesh in the past three decades.

Table 1. Trend of sea level rise in coastal stations of Bangladesh, 1977-1998

Tidal Station	Region	Latitude (N)	Longitude (E)	Datum (m)	Trend (mm/year)
Hiron Point	Western	21°48’	89°28’	3.784	4.0
Char Changa	Central	22°08’	91°06’	4.996	6.0
Cox’s Bazar	Eastern	21°26’	91°59’	4.836	7.8

Vulnerability, its causes, and adaptation

The vulnerability of different sectors to climate change causes of vulnerabilities, and farming communities adaptation strategies to climate change are presented in Table 2.

Table 2. Vulnerabilities, its causes, and adaptation

Vulnerability to	Causes of vulnerability	Adaptation
Safe drinking water	Salinity in the pond’s water, surface and sub surface water. Lack of deep tube well and high expensive to drill deep tube wells.	Supplying safe water through water vending, raising the edge of ponds, changing the saline water of ponds, digging saline free new ponds, rain water harvesting during monsoon, construction of sub-surface water supply system, drilling deep tube wells and construction of desalination plants. Construction and repairing Pond Sand Filters (PSFs).
Saline water intrusion	Sea level rise due to global warming, and occurrence of cyclone *Aila (*25 May 2009).	Cultivation of saline tolerant crops and crop varieties, construction of embankment considering long-term planning, and afforestration.
Crop production	Saline water intrusion to pond, surface, and ground water by natural disaster as well as sea level rise.	Cultivation of saline tolerant fodders and crops, dredging and desalination of rivers, repairing the roads, culturing fresh water shrimp (*galda*), awareness raising of farmers through training, encourage farmers to cultivate saline tolerant crops, and re-excavation of canals.
Fresh water fish culture	Saline water intrusion by natural disasters and sea level rise.	Culturing saline tolerant fish, releasing fry in ponds observing natural disaster, construction of saline free ponds with edging the boundary, cancellation of the lease system of canal by the government, and desalinization of rivers constructing embankments.
Saline water shrimp farming	Virus diseases, foreign fry of shrimp, lack of capital and saline water supply, natural disaster and saline water shortage due to canal controlled by rich, lack of shrimp fry in rivers, and culture fragile shrimp fry.	Arrange training for shrimp farmers, provide proper dose of limes and fertilizers, test Ph and salinity of water, establishment of resource centre in the locality, awareness raising of people, arrangement of proper drainage system, changing water of farms in optimum time, use local fry instead of imported fragile fry, release fry in farms observing cyclone, repairing the boundary of shrimp farms, fattening crabs, and culture fresh water fish.
Livestock and poultry rearing	Drinking saline water, shortage of fodder with grazing field and shortage of keeping place.	Desalinization of land and cultivation of saline tolerant rice and fodder.
Embankment	Breaching embankment due to low height, thin and fragile construction, lack of overhauling and plantation.	Construction of wide and raised embankment following new and improved design, revetment of open embankment, preparation of long term planning, repairing the embankment, and enormous plantation along with embankment and foreshore.
Sanitary latrine	Destroying latrines by natural disasters.	Construction of elevated sanitary latrines.
Housing	Damaging houses by natural disasters	Construction of strong and raised houses including homestead.
Communication	Destroying road by natural disasters and shrimp farming.	Repairing the damaged roads and construction of new roads with brick soling, andincrease surveillance during constructing roads.
Skin diseases	Rotten water of shrimp farms, drinking and bathing in saline water.	Use safe fresh sweet water, and ensure the presence of doctors.
Employment opportunity	No land based production, lack of industry, and frequent natural disasters.	Cultivation of saline tolerant crop, grocery, small business, craftsmanship, fish culturing and livestock rearing and enhancement of local employment opportunity.
Agriculture equipment	Lack of fund to purchase agricultural equipments.	Purchase of equipments by taking low interest loan, protection of adulterate pesticide and insecticides.
Migration	Destitution because of natural disaster.	Utilization of loan in proper way, construction of cyclone resistant housing, and creation of employment opportunity in the locality.

Source: Focus Group Discussion Summary

Based on opinion of community, self observation and literature review, the following adaptation options are suggested as appropriate in saline prone coastal areas: Cultivation of saline tolerant rice varieties such as BRRI dhan40 and BRRI dhan41 (seedlings and reproductive stage salinity level of 8 *dS/m),* BRRI dhan53 and BRRI dhan54 (vegetative and reproductive stage salinity level of 8 -10 *dS/m)* in *aman* season, BRRI dhan47 (seedlings stage salinity level of 12-14 *dS/m) and* BRRI dhan55 (salinity level of 8-10 *dS/m* up to 3 weeks) in *boro* season (BRKB, 2004), and Binadhan-8 (seedling stage salinity level of12-14*dS/m*, and tillering to maturity stage salinity level of 8-10*dS/m)* in both *aman* and *boro* season (Islam et al. 2011). Biswas *et al.*, (2010) reported that sowing and planting date shifting, mulching, soil flashing, fertilizers management, seeds sowing in dibbling method, raise or slopping bed method in embankments, pit method and changing cropping pattern can help minimize the negative effects of salinity rise. Miah (2010) stated that zero tillage (e.g. potato, garlic and maize), sorjan method (year round vegetables in raised beds and fish culture in ditches), rice-fish dual culture and k*alshi* or ring method (e.g. watermelon) cultivation may be introduced in the areas to minimize the effects of salinity rise.

Conclusions

Coastal communities affected by climatic variability and change do not have much knowledge on technology to adapt with vulnerability to salinity. They have very poor adaptive capacity on cropping practices, livestock and fresh water fisheries. The adaptive capacity on non-farm livelihood aspect was also unsatisfactory. Government and development communities should invest more on agricultural research and development to develop and disseminate suitable climate-smart agricultural technologies for coastal areas. Policymakers should ensure that improved agricultural technologies for saline prone coastal areas are easily available for the community. At the same time, some specific programs should be launched for crops, livestock, fisheries and other aspects to minimize the impacts. Appropriate trainings should also be arranged for the community on adaptive technology and other issues. Government should come forward to cultivate fresh water fishes with crops instead of saline water shrimp farming. These options will pay favorable return for the saline prone coastal community. Necessary inputs and technology should be provided to the community with a purpose to adapt so that the adverse impacts of climate variability and change are minimized.

References

Ahmed, A.U. 2008. Assessment of Vulnerability to Climate Change and Adaptation Options for the Coastal People of Bangladesh, Practical Action Bangladesh, Dhaka.

Ahsan, M. 2010. Saline Soils of Bangladesh, SRMAF Project, Soil Resource Development Institute (SRDI), Ministry of Agriculture, Government of the People's Republic of Bangladesh.

Biswas, J.K.; Ali, A.M.; Mahbub, M.A.A.; Ansary, T.H. and Hassan, A.O.R. 2010. Rice - based Adaptation in Saline Area, Bangladesh Rice Research Institute (BRRI), Gazaipur, Bangladesh.

BARC, 2014. Bangladesh Agricultural Research Council (BARC), Climate and Land Resource Information, Dhaka, Bangladesh. Available at http://www.barc.gov.bd/dbs.

BRKB, 2004. Bangladesh Rice Knowledge Bank (BRKB), Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh, founded by International Rice Research Institute (IRRI), Philippines.Available at: www.knowledgebank-brri.org.

Chatterjee, B. and Khadka, M. 2011. Climate Change and Food Security in South Asia, CUTS International, India

IPCC, 2007. Inter-governmental Panel on Climate Change (IPCC), Fourth Assessment Report 2007, UNFCCC, New York, United state of America.

Islam, M.M.; Begum, S. and Haidar, M.R. 2011. Folder, BINAdhan-8, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Bangladesh.

Miah, M.M.U. 2010. Assessing Long-term Impacts of Vulnerabilities on Crop Production Due to Climate Change in the Coastal Areas of Bangladesh, Final Report PR #10/08, Bangladesh Center for Advanced Studies.

PHC, 2011. Population and Housing Census (PHC), Bangladesh Bureau of Statistics (BBS), Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Bangladesh. Available at: www. bbs.gov.bd.

Rahman, A. and Alam, M. 2003. Mainstreaming Adaptation to Climate Change in Least Developed Countries (LDCs). Working Paper 2: Bangladesh Country Case Study, IIED, London, UK.

SMRC, 2003. The Vulnerability Assessment of the SAARC Coastal Region due to Sea Level Rise: Bangladesh Case, SMRC-No.3,SMRC.