

# Adaptation towards Climate Change Effects on Coastal Agriculture by the Farmers of Patuakhali District of Bangladesh

**Md. Sumon Howlader**

Department of Agricultural Extension and Rural Development, Faculty of Agriculture, Patuakhali Science and Technology University, Bangladesh  
Email: sumonpstu10@gmail.com  
Phone: +8801744989355

**Prof. Md. Golam Rabbani Akanda**

Department of Agricultural Extension and Rural Development, Faculty of Agriculture, Patuakhali Science and Technology University, Bangladesh

**Prof. A. K. M. Mostafa Zaman**

Department of Geo-Information Science and Earth Observation, Faculty of Disaster Management, Patuakhali Science and Technology University, Bangladesh

**Abstract** – The study examined the adaptation strategies used by farmers in some selected areas of Bangladesh to mitigate the harmful effects of climate change on coastal agriculture. Both quantitative and qualitative approaches Rapid Rural Appraisal (RRA), focus group discussions, and semi-structured interview were used to collect information from a total of 101 farmers, which were selected using multistage random sampling technique. Pearson product moment correlation was used to determine the relationship between variables. Majority (79.10 percent) of the respondents had medium to low adaptation and only 20.90 percent had high adaptation practices to climate change affecting agriculture in the study area. Among ten selected characteristics of the coastal farmers the correlation coefficients of 6 variables were positively significant. These were age, education, farming experience, communication exposure, agricultural knowledge, and fatalism. Adaptation strategies taken by the farmers in coastal area of Bangladesh included: cultivating short duration crop, poultry rearing, homestead gardening, practicing crop diversification, practicing crop rotation, practicing intercropping, *sarjon* method of vegetable cultivation, cultivation of saline tolerant variety, changing sowing/ planting time etc. As the back bone of the national economy is agriculture, government has paid attention though not sufficient to take adaptation measure. Inadequate credit facilities have been reported as major constraints of adaptation in agriculture. The study concludes that there is need for government and other stakeholders to make noticeable efforts to enact appropriate policies on climate change adaptation and assist local farmers to improve their resilience to climate change effect.

**Keywords** – Adaptation, Coastal Agriculture, Climate Change, Farmers, Strategies.

## I. INTRODUCTION

Agriculture is the backbone of economy of Bangladesh. Climate change is a major challenge to agricultural development in the country like Bangladesh and the world at large. It is not only challenge to agricultural development but to food security and the general livelihood conditions of any population. According to Adger *et al.* (2003) [1], adaptation is the adjustment of a system to moderate the impacts of climate change, to take advantage of new opportunities or to cope with the consequences. Stern (2006) [21] relates adaptation to building resilience, and recognizes that it will be a key response to reduce vulnerability to climate change.

Adaptation is not limited to discrete projects (Leary, 1999) [18], such as dams and sea walls. It includes a wide range of adjustments by entities such as households, firms and other institutions in response to the effects of climate change and variability. These include such activities as managing natural resources, input mixes in production, and changes in laws, programmes, policies and investments.

Around the world by 2020 it is projected that, from 500 to 750 million people will be affected by water stress caused by climate change. Bangladesh, are vulnerable to sea level rise and increased occurrence of intense extreme weather conditions such as the cyclones from 2007–2009. In most countries like Bangladesh, yields from rain fed agriculture could be reduced to 50% by 2020. Global Circulation Model (GCM) results predict an average temperature increase in Bangladesh due to climate change of 1.0°C by 2030 and 1.4°C by 2050. (IPCC, 2007) [16]. The monetary cost of climate change is expected to be very high and developing countries will suffer more (Stern, 2006) [21]. However, the nature of damage and losses depends on the nature of impacts. Here some of the major and recent climate change impacts on coastal agriculture of Bangladesh have been discussed.

**Flood:** Since very long time Bangladesh is affecting by floods annually that brought untold suffering and economic losses in Bangladesh. Floods affect agriculture production considerably. Karim *et al.* (1996) [17] reported that the 1988 flood caused reduction of agricultural production by some 45 per cent. In the case of the most devastating flood of recorded history, in 1998, Aman production potential of some 2 to 2.3 M ha could not be realized. Prolonged flood can also cause death of livestock through a number of direct and indirect mechanisms (Ahmad and Mirza, 2000; Choudhury *et al.*, 2003) [3],[9]. It is already known that climate change has increased the extent of monsoon flooding. Therefore, the potential threat to culture fisheries has also increased under climate change (GOB, 2005) [13]. Furthermore, every year government has to spend huge money for flood control in Bangladesh.

**Cyclone and storm surge:** Cyclone and storm surge have both immediate and long term consequences on agriculture. Sometimes many people become so vulnerable that they have no options except begging (Uddin, 2012) [22]. The saline water hampers the productivity of

the soil for several years. In recent cyclone SIDR, among the productive sectors, damage was highest (BDT 30.2 Million) in agriculture. According to the latest estimates, about 800,000 to 1300,000 MTs of paddy has been destroyed in SIDR which created severe food insecurity among the affected people (GoB, 2008)[14]. Losses by cyclone AILA in 2009 was also severe. Along the coast rice crop was totally destroyed and even after three years it could not back to its previous position. Shrimp culture now a days a big business in the coastal districts of Cox's Bazaar, Satkhira, Khulna and Bagerhat. These *ghers* both inside and outside embankments are threatened by high tides (World Bank, 2000)[24]. In addition to affecting human beings, natural disasters cause tremendous sufferings for the livestock population of Bangladesh. Livestock suffer large-scale death in cyclonic storm surge (Haideret al., 1991)[15].

**Drought:** Droughts prevent land preparation and ploughing activities from being conducted on time, delaying the broadcasting, sowing and the planting of crops. *Boro*, wheat and other crops grown in the dry season are also affected by drought. After independence major droughts occurred in 1973, 1978, 1979, 1981, 1982, 1989, 1992, 1994, 1995, 1998 and 2000, causing substantial reduction in food production. The 1997 drought caused a reduction of around 1 million tons of food grain, of which about 0.6 million tons were transplanted *aman*. FAO(2008)[12] forecast that, dry season rainfall may decrease by 37 percent, which will increase the risk of droughts significantly. During droughts, lack of water increases livestock's vulnerability to diseases in Bangladesh but do not suffer death (Ahmed, 2005; GOB, 2005)[4],[13]. The local elder persons said that, gradual increase in salinity also increased competition for freshwater resources; the livestock suffered the brunt of such a calamity (RVCC, 2003)[20]. Due to drinking of poor quality water these animals fell victim to diseases, which reduce their economic efficiency (draught power, milk production etc.).

**Sea level rise:** Bangladesh has been ranked as the 3rd most vulnerable in the world to sea level rise in terms of the number of people and in the top ten in terms of percentage of population living in the low elevation coastal zone. World Bank (2000)[24] estimated that by the year 2020, 2050 and 2100 the sea level of Bangladesh would increase 10 cm, 25 cm and 1 m. Sea level rise could potentially force around 33 million people to lose their home by 2050 and up to 43 million by 2080 (Mohal&Hossain, 2007)[19]. CEGIS (2006)[7] has shown that rice suitable areas would decrease significantly due to sea level rise along the southwestern region of Bangladesh. Sea level rise has increased coastal flood frequency which caused salinity intrusion and the secondary impact is a significant reduction of rice yield in coastal area (Ali, 2005)[5]. A World Bank (2000)[24] study suggest that increased salinity alone from a 0.3 meter level sea rise will cause a net reduction of 0.5 million metric tons of rice. Sea level rise in the coming decades will create over 25 million climate refugees (Climate Change Cell, 2007)[10].

Therefore, study of farmers' adaptation strategies should be appraised and identify gaps where scientists and other stakeholders including extension agents could provide vital inputs to assist farmers. Considering the above factors the study has been carried out to fulfill the following objectives:

1. To determine and describe the extent of farmers' adaptation strategies towards climate change on coastal agriculture
2. To explore the relationship between the farmers' adaptation strategies and the farmers selected characteristics.

## II. METHODOLOGIES

The study area was coastal area namely Galachipaupazila of Patuakhali district of Bangladesh. The geographic location of the study area is 22.1639°N 90.4306°E. Galachipaupazilahas 13 unions from which Galachipa union was selected randomly. From 12 villages 5 villages viz. Boalia, East Ratandi, Gorabala, Kalikapur and Pokkhia were selected randomly. Landless and absentee farmers were discarded from the farmers list with the help of SAOs. Thus the sample population was 1012. Then 10 percent of the sample population from each village was selected separately as the sample of the study by simple random sampling procedure. Thus the sample size was 101.



Fig.1. Map showing the data collection site at Galachipaupazila of Patuakhali District of Bangladesh.

Data were collected personally by the researcher himself through face to face visit to all the selected farmers during 1<sup>st</sup> August, 2014 to 10<sup>th</sup> September, 2014. Two focus group discussions also done to acquired deep information. The collected data were systematically recorded, edited, arranged, compiled, tabulated, computerized and analyzed

in accordance with the objectives of the study. Different statistical treatments like frequency, range, mean, percentage, distribution, standard deviation, categories and indices etc. were used to describe, represent and explaining the relationships among the variables in this study.

In the present study, ten selected characteristics namely age, education, farm size, farming experience, annual income, training experience, communication exposure, organizational participation, agricultural knowledge and fatalism were selected as the independent variable, which measured using the prevailing standard methods.

Adaptation strategies practiced by the coastal farmers was dependent variable. To assess farmers' adaptation twenty statements were considered. A-four point rating scale was developed to measure the extent of adaptation towards climate change in affected areas ranked as "regularly", "sometimes", "seldom" and "not at all" scored as 3, 2, 1, 0 respectively. The extent of adaptation towards climate change found by the farmers was computed by adding all scores obtained from 20 strategies practiced towards climate change by respondents. The adaptation of climate change score of the respondents ranged from 0 to 60 where zero (0) indicating no adaptation of climate change and 60 indicating maximum adaptation.

To find out the relationship between the farmers' adaptation towards effects of climate change on agriculture and the selected characteristics of the farmers, the Pearson's Product Correlation co-efficient (r) was computed.

### III. RESULT AND DISCUSSION

The adaptation scores of the farmers ranged from 30 to 55 against the possible range of 0 to 60. The mean and standard deviation were 41.85 and 5.36 respectively. On the basis of adaptation scores of the farmers were classified into three groups viz. "low adaptation", "Medium adaptation", High adaptation". The distribution of the farmers based on their perception score shown in Figure 2.

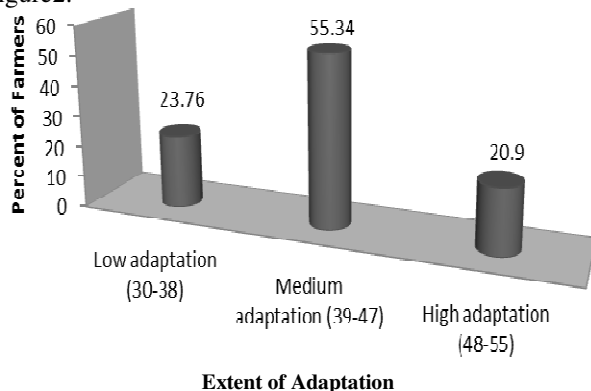


Fig.2. Distribution of the farmers according to their extent of adaptation towards climate change effects on coastal agriculture

As shown in Figure 2, the majority (79.10 percent) of the farmers has low to medium adaptation and 20.90 percent high adaptation was found in this area. It is logical because most of the farmer belongs to low income family, low communication exposure, lack of training exposure, lower organizational participation, their illiteracy rate also significant and most of them have high fatalism. So they are both unable and unwilling to adapt with climate change effects on coastal agriculture.

#### *Adaptation towards climate change effects on Coastal Agriculture of Bangladesh:*

Adaptability refers to the degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual changes of climate. Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of change in conditions (Watson *et al.*, 1996). Bangladesh government has already formulated policy for climate change adaptation though not adequate enough as compared to the loss. However, the government took Integrated Coastal Zone Management Plan in 2005, National Adaptation Programmes of Action (NAPA) 2004/2005 and Bangladesh Climate Change Strategy and Action Plan in 2009 through food security, social protection and health, comprehensive disaster management, infrastructure, mitigation and low carbon development, research and knowledge management, capacity and institutional development etc.

Crop agriculture in Bangladesh is highly susceptible to variations in the climate system. It is anticipated that crop production would be extremely vulnerable under climate change scenarios, and as a result, food security of the country will be at risk. Despite being highly vulnerable, very little efforts have so far been made to understand potential of agricultural adaptation in Bangladesh. Ahmed (2000)[2] made an early attempt to analyze the adaptation potential of the country's crop agriculture in a warmer world.

Based on this study a brief account of adaptation types according to the rank order are provided below-  
*Adaptation strategies practiced by coastal farmers towards climate change*

It was necessary to have an understanding about the comparative adaptation strategies of the farmers in the 20 selected aspects. An Adaptation Index (AI) for selected 20 aspects was computed to serve the purpose by using the formula.

$$\text{Adaptation Index (AI)} = A_l \times 1 + A_m \times 2 + A_h \times 3$$

Where,

$A_l$  = Percentage of farmers having low adaptation.

$A_m$  = Percentage of farmers having medium adaptation.

$A_h$  = Percentage of farmers having high adaptation.

Adaptation Index (AI) for any of the selected aspects could range from 0 to 303, where 0 indicating minimum adaptation and 303 indicating maximum adaptation. However, computed Adaptation Index (AI) ranged from 92-295.

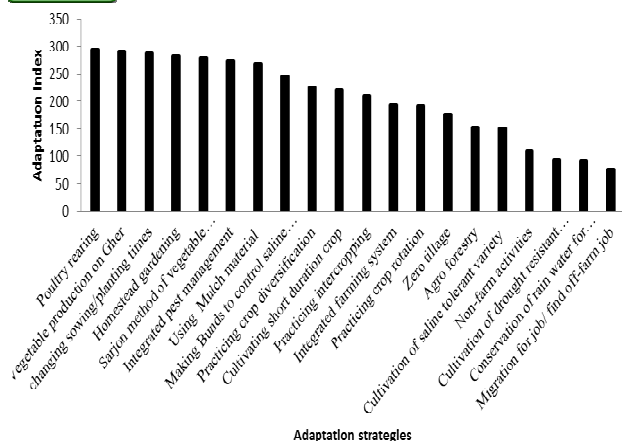


Fig.3. Adaptation strategies practiced by coastal farmers towards climate change effects on coastal agriculture

Bangladesh government has taken some projects for climate change adaptation in agriculture with the help of Bangladesh Climate Change Trust Fund and Bangladesh Climate Resilience Fund. Some of those are given below (Table 1).

Ahmed (2000)[2] reported that the existing corresponding institutions had inherent inefficiencies, lack of foresight in planning for the future, poor coordination among relevant institutions, poor information assimilation capacity and lack of trained and motivated personnel. As a result, those often proved to be ineffective. Warrick and Ahmad (1996)[23] were recommended strengthening of the agricultural extension services as an institutional adaptation towards safeguarding future agricultural activities. Financing investments in agriculture especially amongst poor farmers may appear a major issue. Requirements for cash investment soon after a major flood event limit cultivation of cash crops such as vegetables and spices. Early investments in relatively highlands for seedbeds could not be possible, even though the benefits of doing so were known to the farmers of the same region (Choudhury *et al.*, 2005)[8]. Lack of adequate credit facilities is reported as major constraints of coping in agriculture (Ericksen *et al.*, 1996; Asaduzzaman *et al.*, 2005) [11],[6].

Table 1: Climate change adaptation projects for coastal agriculture in Bangladesh

S.No.	Adaptation Projects in Agriculture	Budget (USD)
1	Innovation & Extension of rice based technology to reduce the adverse impact of climate change.	0.75 Million
2	Stress tolerant rice, wheat, pulses & oil seed production, processing & distribution project	3.1 Million
3	Innovation of Sustainable Crop System for Drought Prone and Coastal/saline Area to Face Climate Change Impact.	0.75 Million
4	Innovation of various Crop System for Drought Prone and Coastal/saline Area to Face Climate Change Impact	0.6 Million
5	Agriculture Adaptation in Climate Risk Prone Areas	22.5 Million

Table 2 Distributions of the farmers according to their personal characteristics

Characteristics	Categories	Number	Percentage	Mean	SD
Age	Young (up to 35)	20	19.80	44.50	8.67
	Middle aged (36-50)	54	53.50		
	Old (>50)	27	26.70		
Education	Illiterate (0)	15	14.85	4.56	3.40
	Can sign only(0.5)	22	21.80		
	Primary (1-5)	30	29.75		
	Secondary (6-10)	28	27.70		
	Above secondary(>10)	6	5.90		
Farm size	Marginal (>.02-.20 ha)	8	7.90	2.16	1.67
	Small (.21-1.00 ha)	20	19.80		
	Medium (1.01-3.00 ha)	50	49.50		
	Large (above 3.01 ha)	23	22.80		
Farming experience	Short (8-19 years)	30	29.70	24.40	8.21
	Medium (20-30 years)	47	46.50		
	Long (>30 years)	24	19.80		
Annual family income ('000' tk)	Low (90-200)	73	72.30	185.64	79.58
	Medium (201-300)	20	19.80		
	High (>300)	8	7.90		
Training experience	No (0 days)	28	27.70	14.12	12.86
	Short (1-12 days)	12	11.90		
	Medium (13-20 days)	44	43.56		
	Long (>20 days)	18	17.84		

Communication exposure	Low (22-30)	14	13.87	37.21	4.84
	Medium (31-38)	62	61.38		
	High (>38)	25	24.75		
Organizational participation	No (0 days)	27	26.73	6.49	4.36
	Low (1-7 days)	30	29.70		
	Medium (8-14 days)	34	33.67		
	High (>14 days)	10	9.90		
Agricultural knowledge	Low (up to 30)	20	19.80	32.68	3.10
	Medium (31-35)	63	62.37		
	High (>36)	18	17.83		
Fatalism	Low (>41)	17	16.83	37.60	4.17
	Medium (34-40)	56	55.45		
	High (27-33)	28	27.72		

Data presented in Table 2 indicate that majority of the respondents were having low level of education (69.30 percent). Majority (72.30 percent) were aged 35 to 65 years, with farming experience ranging from 20 to 45 years (66.30 percent). Most of the farmers (79.20 percent) have medium to marginal farm size and majority of them belongs to low income (72.30 percent). About 27.70 percent of the respondents have no training experiences. Majority (56.43 percent and 73.25 percent) of respondents had low to medium organizational participation and communication exposure respectively. Majority (70.30 %) of the respondents had an unfavorable perception of climate change effects and most of the farmers (72.28 percent) are fatalistic in behavior. The farmers who are more fatalistic take less adaptive practices.

#### *Relationship between Framers' selected characteristics and their Adaptation*

To explore the relationship between the farmers selected characteristics and their adaptation to climate change on coastal agriculture Pearson's Product Moment Correlation Co-efficient (r) was used. The correlation coefficients have been given in table 3.

Table 3: Relationship between selected characteristics of the farmers and their adaptation strategies towards climate change effects on coastal agriculture

Dependent variable	Independent variable (Farmers characteristics)	Coefficient of correlation (r)
Adaptation strategies	1. Age	.204 *
	2. Education	.265**
	3. Farm size	.095
	4. Farming experience	.226 *
	5. Annual family income	.102
	6. Training experience	.020
	7. Communication exposure	.278 **
	8. Organizational participation	.094
	9. Agricultural knowledge	.365 **
	10. Fatalism	-.374 **

\*\* = Significant at .01 level, \* = Significant at .05 level.

The Table 3 shows that out of 10 independent variables, the correlation coefficients of 6 variables were significant. Age, education, farming experience, communication

exposure, agricultural knowledge show positive and fatalism show negative correlation with adaptation towards climate change.

#### *Problems faced by the farmers in adaptation to climate change*

Farmers of coastal area face many problems in adaptation towards climate change effects on agriculture. The problemscores of the farmers ranged from 17 to 27 against the possible range of 0 to 30. The mean and standard deviation were 23.12 and 2.05 respectively. On the basis of adaptation scores of the farmers were classified into three groups viz. "low problem", "medium problem", high problem". The distribution of the farmers based on their problem score is shown in figure 4.

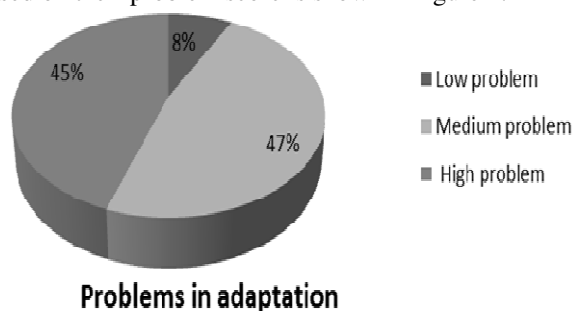


Fig.4. Distribution of the farmers according to their problems faced in adaptation

Slightly less than half (47.50 percent) of the farmers had medium problem compared to 7.90 percent of them having low and 44.60 percent high problem were found in this area. Thus majority (92.1 percent) of the farmers has medium to high problem in adaptation. The problems farmers faced are unpredicted weather, scarcity of farm input, lack of information, poor access to market, lack of irrigation, no access to crop insurance, poor fertile land, lack of credit etc.

#### **IV. CONCLUSION**

The impact of climate change in Bangladesh is dire and they are already taking place. Based on the above findings it can be concluded that there is a continuing need to accelerate activities in connection with increasing education, communication exposure, and agricultural knowledge and reduce fatalism of coastal farmers which directly influence the adaptation to climate change effects

on coastal agriculture. Relevant training programmes should be conducted for the farmers to upgrade their understanding of the knowledge about climate change and its effects on coastal agriculture and how to cope up with new climatic condition for agricultural situation. The study also established that farmers' in coastal area of Bangladesh are experiencing various overwhelming effects of climate change on agriculture, directly and indirectly. Coastal farmers were able to put up various adaptation strategies that enable them to cope with the various adverse effects of the climate on coastal agriculture. But adaptation strategies taken by farmers to reduce climate change effects were limited and take some adaptation measures within their economic reach, while those requiring some levels of financial commitments were scarcely employed, and this is a major constraint to adapting to climate change. In order to increase adaptation of farming practices in response to climate change, a number of measures need to be taken both by major intervening agencies, such as governmental organizations (GOs), non-governmental organizations (NGOs) and the community-based organizations (CBOs).

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### REFERENCES

- [1] Adger, N., Huq, S., Brown, K., Conway, D., Hulme, M. 2003. Adaptation to climate change in the developing world, *Progress in Development Studies* 3(3): 179–195.
- [2] Ahmad, Q.K. (Ed.), 2000, *Bangladesh Water Vision 2025: Towards a Sustainable Water World*, Bangladesh Water Partnership (BWP), Dhaka, 73 p.
- [3] Ahmed, A.U. and Mirza, M.M.Q. 2000, 'Review of Causes and Dimensions of Floods with Particular Reference to Flood '98: National Perspectives'. In Q.K. Ahmad, A. K. A. Chowdhury, S.H. Imam, M. Sarker, (Eds.)
- [4] Ahmed, A.U., 2005. 'Adaptation Options for Managing Water Related Extreme Events Under Climate Change Regime: Bangladesh Perspectives', in M.M.Q. Mirza and Q.K. Ahmad (eds.), *Climate Change and water Resources in South Asia*, Balkema Press, Leiden, pp. 255-278.
- [5] Ali, A., 2000. Vulnerability of Bangladesh Coastal Region to Climate Change with Adaptation Option. Bangladesh Space Research and Remote Sensing Organization (SPARRSO), Dhaka.
- [6] Asaduzzman, M., Ahmed, A.U., Haq, E. and Chowdhury, S.M.Z.I., 2005. *Climate Change and Bangladesh: Livelihoods Issues for Adaptation*. Bangladesh Institute for Development Studies (BIDS), Dhaka.
- [7] CEGIS, 2006. Impacts of Sea Level Rise on Land use Suitability and Adaptation Options, Draft Final Report. Submitted to the Ministry of Environment and Forest, Government of Bangladesh and United Nations Development Programme (UNDP) by Centre for Environmental Geographic Information Services (CEGIS), Dhaka.
- [8] Choudhury, A.M., Neelormi, S., Quadir, D.A., Mallick, S. and Ahmed, A.U., 2005. Socio-economic and Physical Perspectives of Water related Vulnerability to Climate Change: results of Field Study in Bangladesh, *Science and Culture* (Special Issue), 71(7-8): 225-238.
- [9] Choudhury, A.M., Quadir, D.A., Neelormi, S., and Ahmed, A.U., 2003. Climate Change and Its Impacts on Water Resources of Bangladesh, in A. Muhammed (ed.), *Climate Change and water Resources in South Asia*, AsianicsAgroDev International, Islamabad, pp. 21-60.
- [10] Climate Change Cell (2007). Climate Change and Bangladesh, published with support from Comprehensive Disaster management programme of the Government of the People's Republic of Bangladesh and its development partners, UNDP and DFID.
- [11] Ericksen, N.J., Ahmad, Q.K. and Chowdhury, A.R., 1996. Socio-economic Implications of Climate Change for Bangladesh, in R.A. Warrick and Q.K. Ahmad (eds), *The Implications of Climate and Sea-level Change for Bangladesh*, Kluwer Academic Publishers, Dordrecht, pp. 205-287.
- [12] FAO, 2008. Community Based Adaptation in Action: A case study from Bangladesh. Project Summary Report (Phase I), Improved Adaptive Capacity to Climate Change for Sustainable Livelihoods in the Agriculture Sector, Food and Agriculture Organization of the United Nations, Rome.
- [13] GOB, 2005. National Adaptation Programme of Action (NAPA), Final report: November 2005, Ministry of Environment and Forest, Government of the People's Republic of Bangladesh (GOB), Dhaka, 48 p.
- [14] GoB, 2008. Cyclone Sidr in Bangladesh: Damage, Loss, and Needs Assessment for Disaster Recovery and Reconstruction. A Report Prepared by the Government of the People's Republic Bangladesh Assisted by the International Development Community with Financial Support from the European Commission, April 2008, Dhaka, Bangladesh.
- [15] Haider, R., A.A. Rahman and S. Huq (eds.), 1991, "Cyclone '91: An Environmental and Perceptual Study", Bangladesh Centre for Advanced Studies, Dhaka, 91 pp.
- [16] IPCC. 2007. Glossary of Terms. In *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Parry ML, Canziani OF, Palutik of JP, van der Linden PJ, and Hanson CE (eds.), Cambridge University press, Cambridge, UK.
- [17] Karim, Z., Hussain, S.G. and Ahmed, M., 1996, "Assessing Impacts of Climate Variations on Foodgrains Production in Bangladesh", *Journal of Water, Air and Soil Pollution*, 92, 53-62.
- [18] Leary, N. 1999. A framework for benefit-cost analysis of adaptation to climate change and climate variability. *Mitigation and Adaptation Strategies for Global Change* 4: 307–318.
- [19] Mohal, N., & Hossain, M.M.A. 2007. Investigating the impact of relative sea level rise on coastal communities and their livelihoods in Bangladesh. Draft Final Report. Dhaka: Institute of Water Modelling (IWM) and Center for Environmental and Geographic Information Services (CEGIS). Submitted to UK Department for Environment Food and Rural Affairs in May 2007.
- [20] RVCC, 2003. Report of a Community Level Vulnerability Assessment Conducted in Southwest Bangladesh. A report prepared by the Reducing Vulnerability to Climate Change (RVCC) Project, CARE Bangladesh, Dhaka.
- [21] Stern, N. 2006. *The Economics of Climate Change: The Stern Review*. Cambridge University Press, Cambridge, UK.
- [22] Uddin, M. E. 2012. Household Food Security Status of Marginal Farmers in Selected Storm Surge Prone Coastal Area of Bangladesh. *The Agriculturist*, 10(1):98-103.
- [23] Warrick, R.A. and Ahmad, Q.K. (Eds.), 1996, "The Implications of Climate and Sea-Level Change for Bangladesh", Kluwer Academic Publishers, Dordrecht, Boston, London. 415 pp.

[24] World Bank, 2000, "Bangladesh: Climate Change and Sustainable Development. Report No. 21104-BD", Rural Development Unit, South Asia Region, The World Bank, Dhaka, pp. 95.

## AUTHORS PROFILE



### Md. Sumon Howlader

Date of Birth and Place: 25-08-1991, Patuakhali, Bangladesh  
 Department of Agricultural Extension and Rural Development, Faculty of Agriculture, Patuakhali Science and Technology University, Bangladesh.  
 Email: sumonpstu10@gmail.com  
 Phone: +8801744989355

Educational Qualification:

Degree	Field	Passing year	Board/University	Division /CGPA
MS	Agricultural Extension and Rural Development	2014	Patuakhali Science & Technology University	3.922 (Out of 4)
B.Sc. Ag. (Hons.)	Agriculture	2013	Patuakhali Science & Technology University	3.738 (Out of 4)
H.S.C	Science group	2008	Barisal Board	4.70 (Out of 5)
S.S.C	Science group	2006	Barisal Board	5.0 (Out of 5)



### Prof. Dr. Md. Golam Rabbani Akanda

Place of Birth: Mymensingh, Bangladesh  
 Department of Agricultural Extension and Rural Development, Faculty of Agriculture, Patuakhali Science and Technology University, Bangladesh.  
 Email: rabbanipstu@yahoo.com;  
 Phone: 01716950727

Educational Qualification:

Degree	Board/ University	Passing year
Ph.D.**	Dept. Agricultural Extension Education Bangladesh Agricultural University, Mymensingh	2006
M.Sc. in Agricultural Extension Education*	Dept. Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh	1988
B.Sc.Ag.(Hons)	Bangladesh Agricultural University, Mymensingh	1985
HSC (Science)	Dhaka Board	1981
SSC (Science)	Dhaka Board	1978

List of 3 research publications :

1. Akanda, M.G.R. (2008). Farmers' Attitude towards Recommended Technology in Transplanted Modern Aman Rice. Journal of Subtropical Agricultural Research and Development. 6(1, 2 & 3): 454-459.
2. Akanda, M.G.R.(2008). Contribution of Factors Knowledge Gap of the Farmers in Transplanted Modern Aman Rice Production. Journal of Subtropical Agricultural Research and Development. 6(1, 2 & 3): 460-465.
3. Hasan, I., S.I. Afrad, M.G.R. Akanda and M.E. Haque. 2010. Coping strategies practiced by displacees for river erosion. Bangladesh Journal of Extension Education. 22(1&2).

### Prof. A K M Mostafa Zaman

Place of Birth: Barguna, Bangladesh.  
 Department of Geo-Information Science and Earth Observation, Faculty of Disaster Management, Patuakhali Science and Technology University, Bangladesh.