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Coastal Farmers' Perception of Climate Change Effects on Agriculture at Galachipa Upazila under Patuakhali District of Bangladesh

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Abstract- Bangladesh is one of the most vulnerable countries to climate change with a very high population density. The increasing risks from climate change, sea level rise, and natural and man-made hazards—such as cyclones, storm surge, flooding, land erosion, water logging, and salinity intrusion in soil and water have already adversely affected livelihoods of people living in environmentally fragile coastal areas of Bangladesh. This study identifies the relationship between the characteristics of the farmers and their perception of climate change effects on coastal agriculture at Patuakhali district of Bangladesh. To make the outcomes useful, both qualitative and quantitative approaches of field investigations were done.

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Coastal Farmers' Perception of Climate Change Effects on Agriculture at Galachipa Upazila under Patuakhali District of Bangladesh

M. G. R. Akanda [α] & M. S. Howlader [σ]

Abstract- Bangladesh is one of the most vulnerable countries to climate change with a very high population density. The increasing risks from climate change, sea level rise, and natural and man-made hazards—such as cyclones, storm surge, flooding, land erosion, water logging, and salinity intrusion in soil and water have already adversely affected livelihoods of people living in environmentally fragile coastal areas of Bangladesh. This study identifies the relationship between the characteristics of the farmers and their perception of climate change effects on coastal agriculture at Patuakhali district of Bangladesh. To make the outcomes useful, both qualitative and quantitative approaches of field investigations were done. The perception scores of the farmers ranged from 50 to 88 with a mean and standard deviation 78.03 and 5.72 respectively. Majority (80.20 percent) of the farmers has low to medium perception and 19.80 percent high perceptions were found in this area. The research showed that some respondents had a clear understanding of climate change which directly affecting their lives and livelihoods. Most respondents were also aware of to adapt to the climate change effects on coastal agriculture. However, the most respondents were less able to understand about climate change impacts on agriculture due to several factors which also characterize in this study. Among the selected personal characteristics some were positively related and some were negatively related with their perception on climate change effects on coastal agriculture. The perceived aspects according to the perceived frequency/index were increased temperature, increased disease of crop, longer summer, increased insect infestation, unexpected rainfall, during winter water shortage hinder fish production, increase in poultry disease, unavailability of fish, reduced soil fertility, Saline water intrusion due to increased tidal flow, climate change occur due to deforestation, emission of industrial CO2 cause global warming, etc.

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I. Introduction

Agriculture is the backbone of economy of Bangladesh. About 80% of the population lives in rural areas and directly or indirectly depends on agriculture. There are concerns regarding agricultural sector as Climate change effects on the same sector as Climate change effects on the same becoming prominent. 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. Agriculture, being one of the most weather-dependent of activities is highly vulnerable to climate change because of its dependence on rain fed agriculture, high levels of poverty, and low levels of human and physical capital, inequitable land distribution and poor infrastructure.

Bangladesh is located between 20̊34' to 26˚38' North latitude and 88˚01' to 92˚42' East longitude. The country occupies an area of 147,570 sq. km (BBS, 2012). Bangladesh is one of the most populated countries in the world having a coastal area of 47,211 sq. km. which is 32% of its entire land. The coast of Bangladesh is approximately 711 km. long which has a very low-laying flat land. Sixty two (62%) percent of the land has an elevation less than 3 meters and 86% have less than five meters (Mobassarul et al., 2009) [20]. The population of the coastal zone of Bangladesh was 36.8 million in 2001. Agricultural labourers, small farmers, fisherfolk and the urban poor make up 71 percent of the 6.85 million households (Ahmad, 2004) [1]. Severe floods, cyclones, tornados are hitting every year; salinity and cold spell claims human lives as well as damage crops. According to experts these are early sign of global warming effects. Sea level rise in the coming decades will create over 25 million climate refugees (Climate Change Cell, 2007) [8]. According to UNFCCC (2005) [29] Bangladesh is one of the top risked countries in terms of natural disaster in the world.

The effects of climate change in Bangladesh are still being understood, but it is likely that changes include higher temperatures throughout the year and problems with rainfall predictability leading to greater shortages in some seasons and flooding in others (Khan 2011; Rana, Rajib, and Rahman 2011; Shahid 2010a; Thurlow et al. 2012) [17][22][25][27]. Some studies predict that rainfall will increase in the wet monsoon season and decrease in the dry winter and spring months (Shahid 2010a; Thurlow et al 2012) [25][27], while other studies vary in predicting which

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months will be most affected by erratic rainfall (Thomas et al. 2013) [26]. In coastal areas, it is likely that sea level rises will lead to increased salinity of groundwater. Moreover, greater frequency of cyclones and storm surges is likely (Karim and Mimura 2008) [15]. These complex changes interact with other trends not directly caused by climate change—particularly the impact of increased agricultural water extraction and potential adverse water availability impacts from diversion of rivers upstream in India—in depleting river flow and replenishment of ground water aquifers in Bangladesh.

Thurlow et al. (2012) [27] predict that climate change may reduce dry (winter) season (irrigated) boro production more than wet season aus and aman, and increase food insecurity in Bangladesh. Karim et al. (1996) [16] reported that the 1988 flood caused reduction of agricultural production by some 45 percent. Prolonged flood can cause death of livestock through a number of direct and indirect mechanisms (Ahmad and Mirza, 2000; Choudhury et al., 2003) [2][7]. Climate change has increased the extent of monsoon flooding and threat to culture fishes has also increased under climate change (GOB, 2005) [10]. Cyclone and storm surge have both immediate and long term consequences on coastal agriculture (Uddin, 2012) [28]. The saline water hampers the productivity of the soil for several years. In recent cyclone SIDR, among the productive sectors, damage was highest (USD 0.43 Million) in agriculture. According to the latest estimates, about 800,000 to 1300,000 MTs of paddy have been destroyed in SIDR which created severe food insecurity among the affected people (GoB, 2008) [11]. Shrimp culture in ghers both inside and outside embankments are threatened by high tides and flood (Howlader et. al., 2015) [12]. Livestock also suffer large-scale death in cyclonic storm surge (Haider et al., 1991)[13].

Droughts disturb land preparation and ploughing activities, 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 Bangladesh causing substantial reduction in food production. FAO (2008)[9] forecast that, dry season rainfall may decrease by 37 percent, which will increase the risk of droughts significantly. 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) [23].

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) [30] 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) [21]. CEGIS (2006)[6] has shown that rice suitable areas would decrease significantly due to sea level rise along the coastal 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) [3]. A World Bank (2000) [30] 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. Global Circulation Model (GCM) results predict an average temperature increase in Bangladesh due to climate change of 1.0^{o}C by 2030 and 1.4^{o}C by 2050 (IPCC,2007)[14].

Perception refers to the process concerned with the acquisition and interpretation of information from one's environment (Maddox, 1995) [19]. Maddison (2006)[18] described that adaptation to climate change requires that farmers first notice that the climate has changed, and then identify useful adaptations and implement them. Another important issue related to adaptation in agriculture pointed out by Bryant et al. (2000) [5] is how perceptions of climate change are translated into agricultural decisions. Howlader et al., (2015) [12] described that adaptation towards climate change is affected by mostly the same factors affect farmers perception in this study, thus perception is the preliminary stage to adaptation towards climate change. Maddison (2006) [18] argues that if farmers learn gradually about the change in climate, they will also learn gradually about the best adaptation options towards it. According to him, farmers learn about the best adaptation options through three ways: (1) learning by doing, (2) learning by copying, and (3) learning from instruction. So, Farmers' perception of climate change need to be documented for these are thought to influence the success of agricultural production compared to other factors. Therefore, study of farmers' perception of climate change effects on coastal agriculture should be appraised as well as identify gaps where scientists and other stakeholders including extension agents could provide vital inputs to assists farmers. Thus the need for this research to assess the farmers' perceptions of climate change effects on costal agriculture to meet the need of this important group of stakeholders in the agricultural development system.

a) Purpose and Objectives

The overall purpose of the study was to identify the perception of climate change effects on coastal agriculture among farming households of Coastal Bangladesh. Specifically, the paper sought to:

1. To determine and describe the extent of farmer's perceptions of climate change effects on coastal agriculture.
2. To explore the relationship between the dependent variables (farmers' perception) and the independent variables (farmers selected characteristics)

II. Materials and Method of the Study

a) Study location and Sampling

The study area was coastal area namely Galachipa upazila at Patuakhali district of Bangladesh. The geographic location of the study area is 22.1639°N 90.4306°E. Galachipa upazila has 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 SAAOs. 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. A reserve list of 10 percent of the sample size was also prepared in case of absence of the selected sample during data collection despite all attempts.

b) Data collection and processing

Data were collected personally by the researcher himself through face to face visit to all the selected farmers during 1st August, 2014 to 10th September, 2014. 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 relationship among variables in this study.

c) Variables of the 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.

Farmers' perception of climate change effects on coastal agriculture was the dependent variable. The procedure followed in measuring the dependent variable is presented below.

d) Measurement of Farmers' perceptions on effects of climate change on coastal agriculture

A-five point rating scale ranging from ''strongly agree'' to ''strongly disagree'' was developed to measure the extent of perception of climate change effect in affected areas. Strongly agree, agree, undecided, disagree and strongly disagree was assigned as 4,3,2,1 and 0. The extent of perception of climate change found by the farmers was computed by adding all scores obtained from 25 aspects of perception on climate change observed by respondents. The perception of climate change score of the respondents ranged from 0 to 100 where 0 indicating no perception of climate change and 100 indicating extreme perception.

To find out the relationship between the farmers' perception of climate change effects on coastal agriculture and the selected characteristics of the farmers, the Pearson's Product Correlation was computed. To determine the interrelationships among the variables Correlation matrix was also computed. Five percent (0.5) levels of significance were used as the basis of statistical significance.

III. Result and Discussion

The perception scores of the farmers ranged from 50 to 88. The mean and standard deviation were 78.03 and 5.72 respectively. On the basis of perception scores of the farmers were classified into three groups viz. "low perception ", "medium perception", ''high perception" The distribution of the farmers based on their perception score shown in Figure 1.

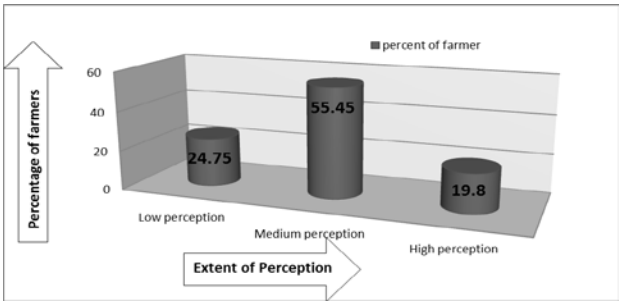

Figure 1 : Distribution of farmers according to their perception

Slightly less than three-fifth (55.45 percent) of the farmers had medium perception compared to 24.75 percent of them having low and 19.80 percent high perception were found in this area. Thus majority (80.20 percent) of the farmers has low to medium perception.

a) Rank order of Farmers perceived aspects of climate change effects on coastal agriculture

It was necessary to have an understanding about the comparative perception of the farmers on the 25 selected aspects. A perception Index (PI) for selected 25 aspects was computed to serve the purpose by using the formula.

Perception Index (PI)= PI×1+Pm×2+ Ph×3

Where,

PI = Percentage of farmers having low perception.

Pm = Percentage of farmers having medium perception.

Ph= Percentage of farmers having high perception.

Perception Index (PI) for any of the selected aspects could range from 0 to 404, where 0 indicating minimum perception and 404 indicating maximum

perception. However, computed perception index ranged from 222- 382.

Table 1 : Rank order of farmer's perceived aspect of climate change effects on coastal agriculture

Statements	Perception index	Rank
Increased Temperature	386	1st
Increased disease of crop	384	2nd
Longer Summer	382	3rd
Increased insect infestation	381	4th
Unexpected rainfall	378	5th
During winter water shortage hinder fish production	375	6th
Increased poultry disease	371	7th
Unavailability of fish	370	8th
Reduced Biodiversity	358	9th
Reduced Soil fertility	357	10th
Increased soil salinity	348	11th
Crop failure increased due to seasonal change	339	12th
Decreased yield	326	13th
Scarcity of irrigation water in Drought season	311	14th
River erosion decreases Agricultural land	303	15th
Frequency of flood/cyclone increased	291	16th
Lower production of cattle due to scarcity of grazing land at drought season	283	17th
Increased Food shortage	275	18th
Intensified winter	270	19th
Increased water logging condition	266	20th
Shorter winter	265	21st
Saline water intrusion due to increased tidal flow	260	22nd
Deforestation cause climate change	243	23rd
Emission of industrial CO2 cause Global warming	242	24th
Greenhouse gas cause climate change	222	25th

i. *Measurement of independent variables*

In this study 10 selected characteristics of the farmers were selected for investigation. The characteristics were age, education, farm size, farming experience, annual family income, training experience, communication exposure, organizational participation, agricultural knowledge and fatalism. The salient features of the different characteristics have been presented below-

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) Low (1-7) Medium (8-14) High (>14)	27 30 34 10	26.73 29.70 33.67 9.90	6.49	4.36
Agricultural knowledge	Low (up to 30) Medium (31-35) High (>36)	20 63 18	19.80 62.37 17.83	32.68	3.10
Fatalism	High (>41) Medium (34-40) Low (27-33)	17 56 28	16.83 55.45 27.72	37.60	4.17

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 (66.3%). 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 % and 73.25%) of respondents had low to medium organizational participation and communication exposure respectively. Majority of the farmers (72.28 percent) are fatalistic in behavior.

b) Relationship between selected characteristics of the farmers and their perception of climate change effects on coastal agriculture

Farmers' perception and adaptation strategies towards climate change effects on coastal agriculture studied in the study. The relationship of 10 selected characteristics of the farmers to their problem confrontation in the selected area was determined. In order to know the relationship of the selected 10 characteristics (independent variables) of the farmers with their perception (dependent variable), correlation analysis was done between the variables. The results of correlation analysis are shown in Table 3.

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

Dependent variable	Independent variable (Farmers characteristics)	Coefficient of correlation (r)
Farmers' Perception of climate change effects on coastal agriculture	1.Age	.040
	2. Education	.305**
	3. Farm size	.239*
	4. Farming experience	.037
	5. Annual family income	.229 *
	6. Training experience	.168
	7. Communication exposure	.496**
	8. Organizational participation	.166
	9. Agricultural knowledge	.663**
	10. Fatalism	-.666 **

** = Significant at .01 level,

*= Significant at .05 level

IV. Conclusion

Bangladesh's coast is the worst victim to natural disasters. Climate change impacts are already adding significant stress to physical and environmental resources of the people, their human ability, and socio-economic activities. In this paper the perception of farmers towards climate change effects on coastal agriculture in the study has been explored. Out of 10 independent variables, the correlation coefficients of 6 variables were significant. These were education, farm size, annual family income, communication exposure, agricultural knowledge, and fatalism. Fatalism was negatively significant and rests of those were positively significant. It is found that majority farmers have unfavorable perception about climate change effects on agriculture as because most of the farmers have lower access to education, low communication exposure and they are highly fatalistic in nature. Most of them are living hand to mouth with small farm size and low income. Due to low income farmers children are drop out from schools at early age and those drop out students one day become farmer by tradition and they also bear the fatalistic behavior and seldom tries to adapt with the changed climatic effects on agriculture. If someone tries to take any adaptation measures due to lack of information they can't because of the lower communication exposure and extension agents are not available to them. Thus the fate of the coastal farmers remains unchanged as they are the victim of vicious cycle of poor. So the study conclude that proper stakeholders like NGOs, Government, donor agencies etc. should take necessary steps to educate the farmers children, prevent drop out of farmers children, subsidies for coastal students education under different projects, should initiate training programme for the coastal farmers about climate change effects on coastal agriculture and adaptation measures, which will increase their perception level towards climate change effects on coastal agriculture.

V. Recommendations

Firstly, the Government and other Organizations may set up further research to detect the perception level and the causes which hinder their perception towards climate change. Secondly, to identify the aftermath of global warming and take possible steps of how to counter it so that the harmful consequences of climate change can be lessened in the coastal areas. Thirdly, the Government may set up a center/cell under the control of its relevant Ministry and take policies to deal with climate change affectations especially in the affected areas. Fourthly, measures should be taken to give protection to the coastal-belt dwellers vulnerable to often occurred natural hazards so that they may be saved from constant loss and poverty. Fifthly, a framework can be developed for constant assessment of climate change scenarios, its impacts for mitigation. Sixthly, relevant sectors (local, Govt. NGOs and other Agencies) can study climate change impacts and take possible adaptation measures for the livelihoods groups in terms of their regional basis acuteness of troubles. Seventhly, various agencies may come forward to train the people who can face challenges of climate change effects on coastal agriculture. Eighthly, it is to be ensured that all productive land in the coastal belt can be properly utilized to improve poverty situation. Ninthly, regular research, projects, field study, and subsequent evaluation are essentially required to address coastal climate change scenario. Tenthly, as the coastal areas are relatively vulnerable to different hazards on account of climate change, the physical infrastructure in such places is to be developed keeping in contemplation the effects caused by the climate change to change livelihood patterns across the coastal Bangladesh.

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List of Abbreviations

Aman= aman is transplanted at the onset of the monsoon in June-July and harvested in October-December;

Aus= Aus rice is direct-seeded or transplanted in the pre-monsoon period (April-

Boro= upland winter irrigated rice

CEGIS= Centre for Environmental Geographic Information Services

FAO= Food and Agriculture Organization

GCM = Global Circulation Model

Gher= Medium to large pond with protected mud embankment which are used to culture

GOB= Government of the People's Republic of Bangladesh

IPCC= Intergovernmental Panel on Climate Change July) and harvested in August

RVCC= Reducing Vulnerability to Climate Change

SAAO= Sub-Assistant Agricultural Officer

Union=Smallest Administrative rural geographic unit which consist of mauza and village, having institution,

Mauza =Smallest revenue geographic unit having jurisdiction list number

USD= United States Dollar