**HAOR AREA PEOPLES’ ADAPTATION STRATEGIES TO CLIMATE CHANGE INDUCED EVENTS IN KISHOREGANJ, BANGLADESH**

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**ABSTRACT**

**Background**: Bangladesh is a vulnerable country with respect to climate change especially in Haor areas because of its geographic location, lateral of flood plains, high population density, overhead level of poverty and irresistible dependency on nature. An extreme weather events due to climate change pose a risk to future food security. **Objectives**: This study analyzed the haor area people’s adaptation ability and significant factors influencing their adaptation towards climate change. **Methods/Approach**: Various descriptive statistical analysis and frequency distribution were used to examine the status of various adaptation strategies and village-wise binary logistic regression analysis was performed to determine the factors that significantly affects haor area people’s adaptation to climate change. **Results**: The people of Khoishore, Dalargaon and Hasimpur villages adopted different adaptation strategies like take loan, seasonal migration, job switching, and changing crop calendar etc. taken because of climate change induce events such as flash flood, riverbed fill up and riverbank erosion. Education level, possession of own farming land, yearly family income, perception level of people about climate change impact are found most significant factors that motivated people to take various adaptation strategies. **Conclusions**: Government and NGO’s should come forward to arrange alternative income opportunities for the people and to build up sustainable flood control embankments to prevent the damage of flash flood in haor area due to climate change induce events.

**Keywords:** Climate change, Adaptation, Logit regression, Haor Area, Bangladesh

# Introduction

Bangladesh is the most vulnerable area to several natural disasters and calamities related to climate change that are the occurrences of flood, cyclone and storm surge, flash flood, drought, tornado, riverbank erosion and land slide (Disaster Report, 2015). Haors (basin like structure) with the unique hydro-ecological characteristics are located in the north-eastern region of Bangladesh covering about 1.99 million ha of area. There are many haors in Bangladesh because of its unique geographic location, dominance of flood plains, high population density, elevated level of poverty and overwhelming dependency on nature and its resources and services and where water remains either stagnant or in flash flooding condition. *Haor* in Kishoreganj district is very much important in geo-physical, economic, social and cultural point of view (Kishoreganj Zilla, 1993; District Statistics, 2014). People of the Itna and Mithamoin upazilla of the Kishoreganj district is mainly farmer and is fully dependent on their agricultural land. Haors are important areas for Boro rice cultivation but early flash floods often wash away standing crops and people lose their harvest (Ahmed, 2017). Early flood, hailstorm and drought are the main constraints to grow modern boro rice (Mirza, 1997; Alam et al., 2010). Though flood is the common phenomenon in the *haor* areas, people have had an experience about the seasonal and flash flood with its frequency and magnitude. But now a days they are unable to predict about the flood due to different development activities in the upstream, embankment and river filling as well as change of river flow.

Flash floods are a common incident in the Haor region in the pre-monsoon period, but poor management of the rivers and embankments and the decline in the navigability of the rivers have worsened the situation over the years. Early flash floods in Haor areas is the result of climate change which is having a bad impact on agricultural productivity, natural fish breeding, land use practice, lifestyles and livelihoods (Seraj, 2017). In April 2017 flood attack unpredictably and severely in the Haor areas and damage agricultural crop with a large amount. Last several years after liberation in 1974, 1988, 1998, 2004, 2010, and recently 2017 flood attacks severely in this Haor area of Mithamoin Upazilla under Kishoreganj district and damage huge amount of rice production. There are a few empirical works have been conducted to know the land use pattern, farmers’ perception, adaptation strategies of climate change and impact of flood on rice production (Milliman et al., 1989; Haq et al., 1996; Ahmed, 2006; Basak et al., 2009; GoB and UNDP, 2009; Islam et al., 2011; Sarker et al., 2012; 2014; Khan et al., 2012; Asaduzzaman et al., 2010; Monjur-Ul-Haider and Zakaria, 2015; Amin et al., 2015; Uddin, 2012, 2014; Uddin et el., 2017) but no studies are focused yet to examine the adaptation strategies adopted by the people living in the Haor area of Mithamoin Upazilla. Therefore, this study attempts to determine the factors that significantly affect Haor area people’s adaptation towards climate change induced events.

1. **Methodology**

2.1 Survey Area and Sample Size

The structured questionnaire has been used in the interview of survey data on the haor area people’s adaptation strategies to climate change, and factors associated with the adaptation strategies in Khatkhal union, Mithamoin Upazilla in Kishoreganj District, Bangladesh. A total of 230 respondents collected covering 80 individuals from Khoishore village, 60 individuals from Dalargaon village and 90 individuals from Hasimpur village. Mithamoin Upazilla is located 24013/ north to 24031/ north latitude and 90056/ east to 91016/ east longitude with an area of 222.92 sq. km to area 200.52 sq. km, is located in between 24°22' and 24°32' north latitudes and in between 90°48' and 91°01' east longitudes. It is bounded by [Tarail](http://en.banglapedia.org/index.php?title=Tarail_Upazila) and I[tna](http://en.banglapedia.org/index.php?title=Itna_Upazila) Upazillas on the north, N[ikli](http://en.banglapedia.org/index.php?title=Nikli_Upazila), K[atiadi](http://en.banglapedia.org/index.php?title=Katiadi_Upazila) and [Kishoreganj sadar](http://en.banglapedia.org/index.php?title=Kishoreganj_Sadar_Upazila) Upazillas on the south, Austagram Upazilla on the east, Nikli and Karimganj Upazillas on the west.

2.2 Logistic Regression Analysis

Village wise individual logistic regression analysis was performed to determine the factors that significantly affects haor area people’s adaptation to climate change.

2.3 Data Description and the Variables

**Dependent variables:** There are in total of 17 adaptation strategies practiced by the people of Khatkhal union, Mithamoin upazilla under Kishoreganj district. Each of the adaptation strategy is created as a dummy variable and it is determined by assigning a value of ‘1’ for farmers who indicated that they have taken adaptive measures in response to negative effects of climate change and a value of ‘0’ for farmers who indicated they have not been engaged in any adaptive measures at all in response to negative effects of climate change. Each of this dummy variable i.e. adaptation strategy has been considered as a dependent variable in the binary Logit model. After decoding of the adaptation strategies there were in total of 9 dummy variables which were considered for 9 independent binary Logit models. These dependent variables include taking loan, job switching, modern effective seed, changing crop calendar, homestead gardening, preventing and avoiding climate events, duck rearing, fishing and buffalo rearing.

**Explanatory Variables:** The explanatory variables include possession of own farming land to the farmers, family members (size), age, income, education level, climate change perception, consequence of climate change perception, climate change impact on crop production and climate change impact on fertility of the cultivated land.

1. **Results and Discussion**

3.1 Results on the Adaptation Strategies to Cope up with the Climate Events

To cope up with the climate events, farmers, fishermen and people in other occupation took different adaptation strategies are shown in (table 1).

**Table 1: Adaptation Strategies to cope up with the Climate Events**

|  |  |  |  |
| --- | --- | --- | --- |
| **Characteristics** | **Categories** | **Count** | **Percentage (%)** |
| Adaptation Practices in Agriculture | Taking loan from Bank | 53 | 23.0 |
| Taking loan from Local Money Lenders | 131 | 57.0 |
| Taking loan from NGO | 64 | 27.8 |
| Migration | 42 | 18.3 |
| Job switching | 110 | 47.8 |
| Submergence / flood tolerant crop varieties | 23 | 10.0 |
| Introducing short duration crop varieties | 56 | 24.3 |
| Changing crop calendar | 58 | 25.2 |
| Upland house | 37 | 16.1 |
| Homestead vegetable gardening | 38 | 16.5 |
| Tree plantation | 79 | 34.5 |
| Follow weather forecast | 17 | 7.4 |
| Aman Rice Cultivation | 30 | 13.1 |
| Adaptation Practices in Livelihoods and Fishing | Duck rearing | 110 | 48.5 |
| Fishing with nets on flooded lands | 85 | 37.6 |
| Fishing from the land and ‘bill’ after the water dried out | 32 | 14.1 |
| Buffalo rearing | 53 | 23.3 |
| Adaptation Practices for Riverbank Erosion | Tree plantation | 76 | 33.6 |
| Distribute ***Khas*** lands among eroded people | 40 | 17.7 |
| Introduce alternative income opportunities | 122 | 54.0 |
| Erosion tolerant embankment | 39 | 17.3 |
| Adaptation Practices for Infrastructure | Construct flood friendly infrastructure | 100 | 43.7 |
| Repair or reconstruction of houses | 81 | 35.4 |
| Bamboo and Chailia (raised flood-proof houses) | 36 | 15.7 |
| Disaster endurable house | 62 | 27.2 |
| Institutional grounds (flood/cyclone shelter) | 12 | 5.2 |
| Raising plinths (above the flood level) | 24 | 10.5 |
| Low-height submersible embankments | 7 | 3.1 |
| Adaptation Practices In Health | Long lasting insecticide treated nets | 28 | 12.5 |
| Bed nets | 185 | 82.6 |
| Distributed stickers, poster and installed billboards | 9 | 4.0 |
| Boil water and Potash alum | 18 | 8.0 |

Source: Author’s Computation

Among them, most of them take loan from local money lenders (57%) or switch their job (47.8%). Other noticeable practices take loan from NGO (27.8%) and Bank (23%), introducing short duration crop varieties (24.3%), tree plantation (34.5%), seasonal migration (18.3%), homestead vegetable gardening (16.5%), upland house (16.1%) and ‘Amon’ rice cultivation (13.1%). Fishermen and people in other occupation practice four different adaptation strategies. Duck rearing (48.5%) is the most important of them. Other practices are- fishing with nets on flooded lands (37.6%), buffalo rearing (23.3%) and fishing from land and ‘bill’ after the water dried out (14.1%). The popular adaptation practices are- alternative income opportunities (54%), tree plantation (33.6%), distributing ‘*khas*’ lands among eroded people (17.7%) to cope up with the damage of riverbank erosion. Adaptation strategies in terms of infrastructure are: constructing flood friendly infrastructure (43.7%), repairing or reconstruction of houses (35.4%), disaster endurable house (27.2%). Similarly, some adaptation strategies are followed in health. They are bed nets (82.6%), long lasting insecticides treated nets (12.5%), using boil water and potash alum (8%) and distributing stickers, poster and install billboards to aware people (4%).

**3.2 Results on Reasons for Taking Different Adaptation Strategies in Different Sectors**

*3.2.1* *Agriculture and Livelihood Sector*

The reasons for adaptation practices in Agriculture and Livelihoods are shown in (table 2a). Flash flood is found the main reason behind choosing most of the adaptation strategies. According to the 69.1% of the people, flash flood is the main reason behind seasonal migration and riverbed fill up (36.5%) is the second main reason behind migration. Flash flood (73.9%) is the main reason behind job switching, riverbed fill up (39.5%) and riverbank erosion (23.9%) are the second and third main reason respectively behind job switching. It could be said that flash flood (86.1%) is the only reason behind changing crop calendar. For community-based seed preservation, 92.1% respondents identified flash flood as the main reason and 21% identified the riverbank fill up. For using flood tolerant rice varieties, 89.1% of the people identified flash flood as the main reason behind it. 97.2% of the people believe that flash flood is the main reason behind introducing short duration crop varieties. The people of 84.3% think that flash flood is the reason to do homestead vegetable gardening and 21.3% think that it’s because of riverbank erosion. For tree plantation adaption strategy, 72.5% believe that flash flood is the main reason and 22.7% think that riverbank erosion is the second main reason.

**Table 2a:** Reasons for Adaptation Practice in Agriculture and Livelihoods

|  |  |  |  |
| --- | --- | --- | --- |
| **Adaption Strategies** | **Categories** | **Count** | **Percentage (%)** |
| Migration | Flash Flood | 159 | 69.1 |
| Heavy Rainfall | 8 | 3.5 |
| Seasonal Storm | 1 | 0.4 |
| Riverbank Erosion | 63 | 27.4 |
| Sheela Brishty | 8 | 3.5 |
| Riverbed Fill up | 84 | 36.5 |
| Job Switching | Flash Flood | 170 | 73.9 |
| Heavy Rainfall | 2 | 0.9 |
| Seasonal Storm | - | - |
| Riverbank Erosion | 55 | 23.9 |
| Sheela Brishty | 13 | 5.7 |
| Riverbed Fill up | 91 | 39.5 |
| Changing Crop Calendar | Flash Flood | 198 | 86.1 |
| Heavy Rainfall | 5 | 2.2 |
| Seasonal Storm | 1 | 0.4 |
| Riverbank Erosion | 37 | 16.1 |
| Sheela Brishty | 10 | 4.3 |
| Riverbed Fill up | 77 | 33.4 |
| Community Based Seed Preservation | Flash Flood | 211 | 92.1 |
| Heavy Rainfall | 4 | 1.7 |
| Seasonal Storm | 2 | 0.9 |
| Riverbank Erosion | 37 | 16.2 |
| Sheela Brishty | 13 | 5.7 |
| Riverbed Fill up | 48 | 21.0 |
| Flood Tolerant Rice Varieties | Flash Flood | 204 | 89.1 |
| Heavy Rainfall | 5 | 2.2 |
| Seasonal Storm | 3 | 1.3 |
| Riverbank Erosion | 30 | 13.1 |
| Sheela Brishty | 9 | 3.9 |
| Riverbed Fill up | 37 | 16.2 |
| Introducing Short duration Crop Varieties | Flash Flood | 225 | 97.2 |
| Heavy Rainfall | 7 | 3.0 |
| Seasonal Storm | - | - |
| Riverbank Erosion | 25 | 10.9 |
| Sheela Brishty | 11 | 4.8 |
| Riverbed Fill up | 29 | 12.6 |
| Homestead Vegetable Gardening | Flash Flood | 194 | 84.3 |
| Heavy Rainfall | 6 | 2.6 |
| Seasonal Storm | 1 | 0.4 |
| Riverbank Erosion | 49 | 21.3 |
| Sheela Brishty | 15 | 6.5 |
| Riverbed Fill up | 30 | 13.0 |
| Tree Plantation | Flash Flood | 166 | 72.5 |
| Heavy Rainfall | 4 | 1.7 |
| Seasonal Storm | 28 | 12.2 |
| Riverbank Erosion | 52 | 22.7 |
| Sheela Brishty | 10 | 4.4 |
| Riverbed Fill up | 42 | 18.3 |

**Table 2b:** Reasons for Adaptation Practice in Agriculture and Livelihoods

|  |  |  |  |
| --- | --- | --- | --- |
| **Adaption Strategies** | **Categories** | **Count** | **Percentage (%)** |
| Following Weather Forecast | Flash Flood | 168 | 73.4 |
| Heavy Rainfall | 4 | 1.7 |
| Seasonal Storm | 47 | 20.5 |
| Riverbank Erosion | 18 | 7.9 |
| Sheela Brishty | 9 | 3.9 |
| Riverbed Fill up | 34 | 14.8 |
| Take Loan | Yes | 180 | 78.3 |
| No | 50 | 21.7 |
| Reason for taking Loan | Flash Flood | 160 | 88.9 |
| Heavy Rainfall | 11 | 6.1 |
| Seasonal Storm | - | - |
| Riverbank Erosion | 16 | 8.9 |
| Sheela Brishty | 8 | 4.4 |
| Riverbed Fill up | 60 | 33.3 |

 Source: Author’s Computation

The people from hoar region are not that much aware to follow weather forecasting to avoid different climate events are shown in (table 2b). The people of 73.4% believe that the occurrence of flash flood in advance is the reason to to follow weather forecasting. The affected people usually take loan from bank, NGO and local money lenders. When asked about whether they take loan or not as adaptation strategy, 78.3% responded yes. For this, 88.9% respondents think that effect of flash flood is the main reason and 33.3% think that riverbed fill up is the second main reason for taking loan.

***3.2.2 Fishing and Livelihoods Sector:***

The reasons for adaptation practices in Fishing and Livelihoods are shown in (table 3). To take fishing as an adaptation strategy, 66.1% respondents think flash flood is the main reason and 44.8% think riverbed fill up is the second main reason. For duck rearing, 68.7% think flash flood is the main reason and 39.1% think riverbed fill up is the second main reason. For introducing alternative income opportunities, 71.6% respondents believe that flash flood is the main reason and 38.9% believe that riverbed fill up is the second main reason, as well as 28.8% believe that riverbank erosion is the third main reason. For construction and maintenance of infrastructure, 69% think that flash flood is the main reason, 34.1% think that riverbed fill up is the second main reason and 24.5% think that riverbank erosion is the third main reason.

**Table 3:** Reasons for Adaptation Practice in Fishing and Livelihoods

|  |  |  |  |
| --- | --- | --- | --- |
| **Adaption Strategies** | **Categories** | **Count** | **Percentage (%)** |
| Fishing | Flash Flood | 152 | 66.1 |
| Heavy Rainfall | 9 | 3.9 |
| Seasonal Storm | 2 | 0.9 |
| Riverbank Erosion | 51 | 22.2 |
| Sheela Brishty | 10 | 4.3 |
| Riverbed Fill up | 103 | 44.8 |
| Duck Rearing | Flash Flood | 158 | 68.7 |
| Heavy Rainfall | 5 | 2.2 |
| Seasonal Storm | - | - |
| Riverbank Erosion | 50 | 21.7 |
| Sheela Brishty | 11 | 4.8 |
| Riverbed Fill up | 90 | 39.1 |
| Construction and Maintenance of Infrastructure | Flash Flood | 158 | 69.0 |
| Heavy Rainfall | 2 | 0.9 |
| Seasonal Storm | 7 | 3.1 |
| Riverbank Erosion | 56 | 24.5 |
| Sheela Brishty | 11 | 4.8 |
| Riverbed Fill up | 78 | 34.1 |
| Distribution of ***Khas*** Lands among Eroded People | Flash Flood | 124 | 54.1 |
| Heavy Rainfall | 9 | 3.9 |
| Seasonal Storm | 4 | 1.7 |
| Riverbank Erosion | 66 | 28.8 |
| Sheela Brishty | 6 | 2.6 |
| Riverbed Fill up | 89 | 38.9 |
| Introduce alternative Income Opportunities | Flash Flood | 164 | 71.6 |
| Heavy Rainfall | 5 | 2.2 |
| Seasonal Storm | 3 | 1.3 |
| Riverbank Erosion | 59 | 25.8 |
| Sheela Brishty | 12 | 5.2 |
| Riverbed Fill up | 85 | 37.1 |

 Source: Author’s Computation

For the distribution of khas lands among eroded people, 54.1% respondents consider flash flood as the main reason, 38.9% consider riverbed fill up is the second main reason and 28.8% respondents consider riverbank erosion is the third main reason.

***3.2.3 Water and Sanitation Sector:***

The reasons for adaptation practice in Water and Sanitation are shown in (table 4). In case of flood proof raised tube wells implantation, 50.2% respondents consider flash flood is the main reason and 49.8% respondents consider flood as the second main reason. For flood proof sanitary latrine implantation, 43.4% respondents consider flash flood is the main reason and 56.6% respondents consider flood as the second main reason. Behind the reason of using boil and potash alum mixed water, 48.9% respondents consider this for potable water crisis, 15.9% consider this for daily needs and 35.2% consider this for drinking purpose.

**Table 4:** Reason for Adaptation Practice in Water and Sanitation

|  |  |  |  |
| --- | --- | --- | --- |
| **Adaption Strategies** | **Categories** | **Count** | **Percentage (%)** |
| Flood Proof Raised Tube Wells | Flash Flood | 115 | 50.2 |
| Flood | 114 | 49.8 |
| Heavy Rainfall | - | - |
| Flood Proof Sanitary Latrines | Flash Flood | 99 | 43.4 |
| Flood | 129 | 56.6 |
| Heavy Rainfall | - | - |
| Using Boil Water and Potash Alum | Potable Water Crisis | 111 | 48.9 |
| Daily Needs | 36 | 15.9 |
| Drinking Purposes | 80 | 35.2 |

Source: Author’s Computation

*3.2.4 Infrastructure Sector*

The reasons for adaptation practice in infrastructure are shown in (table 5). The people of 61.3% consider flash flood is the main reason behind construction of flood friendly infrastructure and 41.7% consider flood. Behind the reconstruction of houses, 65.5% people consider flash flood is the main reason and 38.9% consider flood, as well as 10% consider riverbank erosion. In case of bamboo and chailia (raised flood-proof houses), 58.5% people consider flash flood is the main reason and 48.9% consider flood is the reason. For building disaster endurable house, 61.3% people consider flash flood behind the reason, 39.1% consider seasonal flood and 7% consider seasonal storm. Behind taking shelter in institutional grounds, flash flood is the main reason according to 61.1% people and seasonal flood is the reason according to 46.7%. When the people were asked about the reason behind raising plinths (above the flood level), 53.9% people believe that flash flood is the main reason and 47.8% think that seasonal flood is the reason. The people of 63.5% take loan to reconstruct the damage. The people of 27.4% take loan from bank, 39% from NGO and 39.7% from local money lenders.

**Table 5:** Reasons for Adaptation Practice in Infrastructure

|  |  |  |  |
| --- | --- | --- | --- |
| **Adaption Strategies** | **Categories** | **Count** | **Percentage (%)** |
| Construction of Flood Friendly Infrastructure | Flash Flood | 141 | 61.3 |
| Flood | 96 | 41.7 |
| Heavy Rainfall | 3 | 1.3 |
| Riverbank Erosion | 19 | 8.3 |
| Seasonal Storm | 3 | 1.3 |
| Repair or Reconstruction of Houses | Flash Flood | 150 | 65.5 |
| Flood | 89 | 38.9 |
| Heavy Rainfall | 3 | 1.3 |
| Riverbank Erosion | 23 | 10.0 |
| Seasonal Storm | 6 | 2.6 |
| Bamboo and Chailia (raised flood-proof houses) | Flash Flood | 134 | 58.5 |
| Flood | 112 | 48.9 |
| Heavy Rainfall | 3 | 1.3 |
| Riverbank Erosion | 14 | 6.1 |
| Seasonal Storm | 2 | 0.9 |
| Disaster Endurable House | Flash Flood | 141 | 61.3 |
| Flood | 90 | 39.1 |
| Heavy Rainfall | 3 | 1.3 |
| Riverbank Erosion | 20 | 8.7 |
| Seasonal Storm | 16 | 7.0 |
| Institutional Grounds  | Flash Flood | 140 | 61.1 |
| Flood | 107 | 46.7 |
| Heavy Rainfall | 6 | 2.6 |
| Riverbank Erosion | 7 | 3.1 |
| Seasonal Storm | 7 | 3.1 |
| Raising Plinths (above the flood level) | Flash Flood | 123 | 53.9 |
| Flood | 109 | 47.8 |
| Heavy Rainfall | 17 | 7.5 |
| Riverbank Erosion | 11 | 4.8 |
| Seasonal Storm | 1 | 0.4 |
| Taking Loan to Reconstruct the damage | Yes | 146 | 63.5 |
| No | 84 | 36.5 |
| Taken Loan from Where | Bank | 40 | 27.4 |
| NGO | 57 | 39.0 |
| Local Money Lenders | 58 | 39.7 |

Source: Author’s Computation

*3.2.5 Health Sector*

The reasons for adaptation practice in health are shown in (table 6). According to 32.9% people use long lasting insecticide treated nets for dengue, 38.7% think it’s for malaria, 28.4% think it’s for chikunguniya. 55.1% consider using bed nets for malaria, 31.6% for chikunguniya and 13.3% for dengue. When people were asked about if there were any awareness building strategy taken prior to the disasters, only 32.8% responded yes. The people of 68% believe that distribution of stickers, poster and installed billboards to raise awareness for preventing diarrhea and another 20% think that it had been for preventing malaria.

**Table 6:** Reasons for Adaptation Practice in Health

|  |  |  |  |
| --- | --- | --- | --- |
| **Adaption Strategies** | **Categories** | **Count** | **Percentage (%)** |
| Long lasting Insecticide Treated Nets | Dengue | 51 | 32.9 |
| Malaria | 60 | 38.7 |
| Chikunguniya | 44 | 28.4 |
| Snake Bite | - | - |
| Bed Nets | Dengue | 21 | 13.3 |
| Malaria | 87 | 55.1 |
| Chikunguniya | 50 | 31.6 |
| Snake Bite | - | - |
| Poster, Sticker or Installed billboards Strategy | Yes | 75 | 32.8 |
| No | 154 | 67.2 |
| Distribution of stickers, poster and installed billboards to Raise Awareness | Allergy | 1 | 1.3 |
| Malaria | 15 | 20.0 |
| Dengue | 5 | 6.7 |
| Diarrhea | 51 | 68.0 |
| Dysentery | 1 | 1.3 |
| Chikunguniya | 2 | 2.7 |

Source: Author’s Computation

1. **Results on Village-Wise Logistic Regression Analysis**

The output of Khoishore village for 9 individual binary Logit models with 9 adaptation strategies are shown in (table 7). Possession of own farming land is statistically significant for practicing homestead gardening and preventing and avoiding climate events. It’s because- people who have own farming land can do homestead vegetable gardening when other crops are affected by climate change as well as they try to prevent climate change by planting more trees in their own land. In education level, who are class VIII pass or more, significantly practice the adaptation strategy of changing crop calendar than others. It’s because- people with higher education are more aware about the consequences of climate change. The people who believe that there is severe negative impact of climate change on crop production, are significantly motivated to duck rearing, tree plantation and following weather forecast. It’s because- crop production is severely affected by climate change; they are driven to adopt new income opportunities and take steps to prevent climate change induced events.

The output of Dalargaon village for 9 individual binary Logit models with 9 adaptation strategies are shown in (table 8). Possession of own farming land is statistically significant for practicing job switching, introducing modern and effective seed and changing crop calendar. Possession of own farming land is important for practicing modern and effective seed in land and changing crop calendar. In case of lease or sublease, people cannot take their decision independently which are found significant. Family members (size) significantly influences to taking loan from bank, NGO or local money lenders. Yearly income significantly influences for fishing. Adaptation practice of modern and effective seed is significantly lower among the people who have only signatory education level. Fishing adaptation is found significantly lower among the people who are class VIII pass or higher. The people who have higher level of perception about climate change, significantly change their crop calendar. People who aware about the consequences of climate change significantly adopt to duck rearing.The people who are aware about the impact of climate change on fertility of land, significantly motivated to homestead vegetable gardening.

The output of Haismpur village for 9 individual binary Logit models with 9 adaptation strategies are shown in (table 9). Yearly income significantly influences practicing modern and effective seed. The people with lower education level (signatory or less) migrate or switch their job more significantly than the people with higher education. The people with class 5 pass or higher education level significantly adopt modern and effective seed practice more than the people with lower education. The higher education level people are aware of using modern and effective seed like submergence/ flood tolerant rice variety and short duration crop variety.

**Table 7:** Binary Logistic Regression Output of Khoishore Village

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Adaptive StrategiesExplanatory Variable | Taking Loan | Job Switching | Modern Effective Seed | Changing Crop Calendar | Homestead Gardening | Preventing & Avoiding Climate Events | Duck Rearing | Fishing | Buffalo Rearing |
| Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue |
| Own Farming Land | 1.024 | .978 | .915 | .910 | 2.518 | .318 | .816 | .792 | 11.86 | **.024** | 5.984 | **.049** | 3.784 | .140 | 1.827 | .443 | .597 | .571 |
| Family Members | 1.253 | .097 | 1.048 | .688 | 1.170 | .268 | .870 | .207 | .956 | .812 | 1.024 | .849 | 1.046 | .748 | 1.113 | .358 | .843 | .173 |
| Age | 1.015 | .503 | .977 | .255 | .965 | .183 | 1.018 | .382 | .989 | .721 | 1.014 | .568 | 1.018 | .422 | .981 | .354 | 1.023 | .327 |
| Income | 1.000 | .119 | 1.000 | .197 | 1.000 | .934 | 1.000 | .491 | 1.000 | .416 | 1.000 | .063 | 1.000 | .543 | 1.000 | .584 | 1.000 | .890 |
| Education (Base- Illiterate) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Education (Signatory) | 1.523 | .540 | .841 | .772 | 2.234 | .245 | 2.969 | .075 | 2.209 | .412 | 1.240 | .753 | 3.497 | .087 | .448 | .190 | .414 | .226 |
| Education (Primary) | .914 | .954 | .235 | .325 | 1.150 | .931 | 13.09 | .091 | 5.819 | .309 | 7.266 | .202 | 1.414 | .825 | .000 | .999 | .834 | .910 |
| Education (Class VIII) | 1.3e9 | .999 | 3.102 | .500 | 23.20 | .064 | 20.13 | **.050** | .000 | .999 | 4.8e09 | .999 | .908 | .962 | 1.075 | .963 | .589 | .779 |
| Education (S.S.C.) | .000 | .999 | 3.509 | .525 | 1.4e10 | .999 | 6.2e09 | .999 | 1.1e09 | .998 | 1.9e09 | .999 | .000 | .999 | .000 | .999 | 2.9e07 | .999 |
| Climate Change Perception | .977 | .961 | .984 | .968 | .482 | .136 | .804 | .588 | .742 | .648 | 1.503 | .384 | .464 | .144 | .787 | .579 | 2.593 | .059 |
| Consequence Perception | .882 | .817 | 1.264 | .632 | 1.132 | .829 | 1.181 | .731 | .539 | .439 | .891 | .844 | 1.006 | .992 | .989 | .983 | .683 | .491 |
| Impact on Crop Production | .271 | .332 | 1.457 | .680 | 5.514 | .232 | 1.230 | .812 | 5.3e08 | .999 | .139 | **.049** | .112 | **.028** | 1.697 | .543 | 1.2e09 | .999 |
| Impact on Fertility | .000 | .998 | 14.47 | .056 | .184 | .088 | .468 | .407 | 5.9e16 | .998 | .402 | .358 | 3.07e08 | .999 | .000 | .998 | 1.4e15 | .998 |
| **Model Summary** |  |
| Base Outcome | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation |
| No. of Observation | 79 | 79 | 79 | 79 | 79 | 79 | 78 | 79 | 78 |
| Prob>H-L value | 0.465 | 0.852 | 0.183 | 0.738 | 0.775 | 0.648 | 0.372 | 0.734 | 0.683 |

N.B.: Significant coefficients are marked in bold letters

**Table 8:** Binary Logistic Regression Output of Dalargaon Village

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Adaptive StrategiesExplanatory Variable | Taking Loan | Job Switching | Modern and Effective Seed | Changing Crop Calendar | Homestead Gardening | Preventing & Avoiding Climate Events | Duck Rearing | Fishing | Buffalo Rearing |
| Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue |
| Own Farming Land | .901 | .891 | .052 | **.013** | 36.00 | **.009** | 12.74 | **.030** | .844 | .838 | .823 | .834 | .636 | .555 | 1.629 | .656 | 3.182 | .181 |
| Family Members | 1.357 | **.047** | 1.075 | .713 | 1.595 | .095 | .928 | .760 | .906 | .501 | .999 | .995 | 1.017 | .905 | 1.127 | .604 | 1.033 | .852 |
| Age | .991 | .698 | .976 | .414 | .957 | .233 | .978 | .523 | .969 | .221 | 1.002 | .949 | .962 | .106 | 1.049 | .172 | 1.023 | .390 |
| Income | 1.000 | .747 | 1.000 | .909 | 1.000 | .100 | 1.000 | .606 | 1.00 | .766 | 1.000 | .218 | 1.000 | .771 | 1.000 | **.043** | 1.000 | .523 |
| Education (Base- Illiterate) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Education (Signatory) | .524 | .409 | .249 | .249 | .027 | **.044** | .520 | .634 | .491 | 1.723 | 1.874 | .546 | 1.413 | .673 | .126 | .116 | 1.151 | .897 |
| Education (Primary) | .247 | .235 | .816 | .816 | .550 | .674 | .727 | .804 | .343 | .274 | 6.377 | .142 | .562 | .626 | .020 | .029 | 5.081 | .221 |
| Education (Class VIII) | .195 | .316 | .855 | .855 | .255 | .531 | 1.607 | .830 | .869 | .756 | 3.0e9 | .998 | 2.106 | .647 | .001 | **.006** | .645 | .805 |
| Education (S.S.C.) | 9.9e07 | .999 | .964 | .964 | 7.8e06 | 1.00 | 5.5e07 | .999 | .999 | 5.5e9 | 1.5e9 | .999 | 7.4e09 | .999 | .000 | .999 | 1.356 | .905 |
| Climate Change Perception | 1.900 | .314 | .842 | .842 | 1.344 | .648 | 6.350 | **.022** | .567 | 1.410 | 1.061 | .927 | 1.463 | .505 | 3.397 | .096 | 1.089 | .892 |
| Consequence Perception | .917 | .868 | .673 | .673 | 2.007 | .300 | .869 | .847 | .660 | .781 | 1.869 | .300 | .284 | **.050** | 1.965 | .370 | 1.524 | .474 |
| Impact on Crop Production |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Impact on Fertility | .000 | 1.00 | .000 | 1.00 | 9.8e10 | .999 | 2.5e08 | 1.00 | 1.00 | **.000** | 3.2e8 | 1.00 | 1.7e09 | 1.000 | 0.000 | 1.000 | 4.1e08 | 1.000 |
| **Model Summary** |  |
| Base Outcome | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation |
| No. of Observation | 59 | 59 | 59 | 59 | 59 | 59 | 58 | 59 | 58 |
| Prob>H-L value | 0.084 | 0.390 | 0.863 | 0.723 | 0.395 | 0.074 | 0.439 | 0.668 | 0.579 |

N.B.: Significant coefficients are marked in bold letters

**Table 9:** Binary Logistic Regression Output of Haismpur Village

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Adaptive StrategiesExplanatory Variable | Taking Loan | Job Switching | Modern and Effective Seed | Changing Crop Calendar | Homestead Gardening | Preventing & Avoiding Climate Events | Duck Rearing | Fishing | Buffalo Rearing |
| Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue | Odds Ratio | Pvalue |
| Own Farming Land | .598 | .694 | .744 | .654 | .602 | .538 | 1.189 | .794 | 2.714 | .101 | 2.161 | .232 | .807 | .704 | 1.214 | .733 | .394 | .225 |
| Family Members | 2.166 | **.027** | 1.000 | .999 | .722 | .064 | 1.049 | .705 | 1.075 | .541 | 1.082 | .561 | .962 | .715 | 1.171 | .182 | .846 | .250 |
| Age | .884 | **.040** | 1.024 | .361 | .945 | .125 | 1.038 | .140 | 1.002 | .934 | .970 | .276 | .967 | .126 | 1.001 | .957 | 1.046 | .128 |
| Income | 1.000 | .390 | 1.000 | .128 | 1.000 | **.018** | 1.000 | .112 | 1.000 | .188 | 1.000 | .698 | 1.000 | .910 | 1.000 | .158 | 1.000 | .681 |
| Education (Base- Illiterate) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Education (Signatory) | .092 | .100 | 9.850 | **.003** | .537 | .501 | 1.303 | .695 | .944 | .928 | .440 | .226 | .836 | .763 | .924 | .895 | 4.568 | .056 |
| Education (Primary) | 5.8e7 | .998 | 4.647 | .119 | 19.503 | **.006** | .899 | .915 | 3.315 | .156 | 26.210 | **.007** | .923 | .923 | .658 | .624 | .899 | .932 |
| Education (Class VIII) | 9.5e5 | .999 | 4.441 | .265 | 1.575 | .747 | 11.662 | .067 | 7.1e17 | .998 | 4.680 | .276 | 2.227 | .568 | 1.561 | .762 | .000 | .999 |
| Education (S.S.C.) | 9.2e6 | .999 | .611 | .752 | 7e09 | .999 | 5.900 | .244 | 1.1e10 | .999 | 2e09 | .999 | .297 | .399 | .547 | .680 | .000 | .999 |
| Education (H.S.C.) | 8.6e8 | 1.00 | .000 | 1.00 | 3.7e08 | 1.00 | 3.5e09 | 1.00 | 1.2e10 | 1.00 | 1.2e09 | 1.00 | 9.6e08 | 1.00 | .000 | 1.000 | .000 | 1.000 |
| Education (Graduate) | 2.1e8 | 1.00 | .000 | 1.00 | .000 | 1.00 | 1.3e09 | 1.00 | 6.8e09 | 1.00 | .000 | 1.00 | 5.2e09 | 1.00 | .000 | 1.000 | .000 | 1.000 |
| Climate Change Perception | .435 | .309 | 1.719 | .235 | 2.181 | .165 | 1.121 | .773 | .532 | .125 | 2.353 | .077 | 1.224 | .578 | 1.192 | .631 | .899 | .819 |
| Consequence Perception | 1.610 | .559 | 1.938 | .200 | .977 | .970 | 1.905 | .154 | 1.030 | .945 | .371 | .066 | .478 | .071 | 2.150 | .068 | .778 | .602 |
| Impact on Crop Production | .000 | .999 | 11.56 | **.057** | 1.867 | .710 | .280 | .229 | 2.1e08 | .999 | .194 | .142 | .312 | .350 | .864 | .899 | 3.6e08 | .999 |
| Impact on Fertility |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Model Summary** |  |
| Base Outcome | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation | No Adaptation |
| No. of Observation | 86 | 86 | 86 | 86 | 86 | 86 | 85 | 86 | 85 |
| Prob>H-L value | **0.000** | 0.940 | 0.812 | 0.149 | 0.870 | 0.533 | 0.683 | 0.356 | 0.552 |

N.B.: Significant coefficients are marked in bold letters

1. **Conclusion**

This study examined the various adaptation strategies taken to cope up with the climate change induce events in Khatkhal union of Mithamoin Upazilla, Kishoreganj and performed village-wise binary logistic regression analysis to determine the factors that significantly affect haor area people’s adaptation to climate change.

The people living in haor area practice different adaptation strategies. Seasonal migration, job switching, changing crop calendar, seed preservation, flood tolerant rice varieties, homestead vegetable gardening, tree plantation, following weather forecasting, take loan, duck rearing, alternative income opportunities, flood friendly infrastructure, flood proof raise tube wells,fishing with nets on flooded lands, buffalo rearing, fishing from land and ‘bill’ after the water dried out are found the adaptation strategies adopted by the majority of the people where flash flood is the main reason; riverbed fill up and riverbank erosion are second and third reason.

For Khoishore village, possession of own farming land was found statistically significant for practicing homestead gardening and preventing and avoiding climate events i.e. for practicing tree plantation and following weather forecast; Education level was statistically significant for people’s adaptation to changing crop calendar and people who believe that there is severe negative impact of climate change on crop production, were significantly motivated to duck rearing, tree plantation and following weather forecast. For Dalargaon village, possession of own farming land was found statistically significant for practicing job switching, introducing modern and effective seed, and changing crop calendar; family size significantly influences taking loan; yearly income significantly influences for fishing; signatory education level was found significantly lower for practicing modern and effective seed; people who have higher level of perception about climate change, significantly change their crop calendar; awareness about the consequences of climate change perception significantly influence duck rearing; and climate change negative impact on fertility significantly motivate people to homestead vegetable gardening. For Hasimpur Village, yearly income significantly influences to use modern and effective seed; people with lower education level (signatory or less) migrate or switch their job more significantly than the people with higher education; people with class 5 pass or higher education level significantly adopt modern and effective seed practice more than the people with lower education.

Climate change phenomenon has been an increasing concern around the world especially for the developing countries, like Bangladesh and Haor area is the most vulnerable area to several natural disasters especially flood and flash flood and every year this natural calamities upset people’s lives in that region. During and after the disasters, people are used to live a miserable life both socially and economically in there. Failure to do satisfactory studies on the impact of climate change on rice yield and the adaptation ability of the rice farmers to climate change may affect to investigate possible planning strategies to reduce vulnerabilities. So, this type of study should be given national priorities. Otherwise, it may create obstacle in poverty eradication and sustainable development. And government should take immediate steps to build up sustainable flood control embankments to prevent the damage of flash flood in haor area. During and after the natural disasters in haor region, government should come forward to arrange alternative income opportunities for the people and others who are severely affected by the climate change induce events.

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