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Vulnerability and Adaptation to Climate Change in Western Jamuna Basin of Bangladesh

M.B.Ullah[1] and M. H. Rahman[2]

Abstract

Bangladesh, with an area of 147 thousand km^2 and population of 149.78 millions, is prone to natural hazards (PHC, 2011). The specific objectives of the study were to examine the extent of climatic variations, and to analyze farming communities' vulnerabilities and adaptations to climate change in the western Jamuna basin of Bangladesh. Assessment was made on March 2013 in Sariakandi Upazila under Bogra district. Primary data were collected through Focus Group Discussions (FGDs) and direct observation. Secondary data were collected from various publications of government agencies and NGOs. Workshop was also conducted at Upazila level to justify, validate and further improvement of the findings of village levels discussion. The major vulnerabilities were flood, river bank erosion, crisis of flood shelters, homestead erosion, shifting of housing, crisis of fodder, crisis of seedbeds, infestation to crops, riverbed siltation, lack of boats and fishing nets, and crisis of quality seeds. The major adaptation practices were construction of flood resistant housing with plinths raising, cultivation of seedlings and vegetables by using flood proofing technologies, case fish culture, rice fish culture, drilling tube wells, installation of sanitary latrines, cultivation of fodder, organized training on disaster management, arrangement of boat ambulance, establishment of tree nurseries including huge tree plantation for carbon sequestration, and arrangement of alternative livelihood activities. Farmers have poor adaptive capacities on cropping practice, livestock and fisheries including alternative livelihood aspect. To make adjustment with impacts of climate change, farmers should change their adaptive technologies.

Keywords: vulnerability, adaptation, climate change

Introduction

Bangladesh, with an area of 147 thousand km^2 and population of 149.78 millions, is prone to natural hazards (PHC, 2011). Annual average rainfall in Bangladesh is 2,300 mm, varying from 1,200 mm in the northwest to over 5,000 mm in the northeast. Too much and too little water in a hydrological cycle is the annual phenomenon of the country. It has 230 rivers including 57 trans-boundaries, among them 54 originated from India and 3 from Myanmar (BWDB, 2011). The inundation areas were increased by 12 to 16% in the Ganges and Jamuna basin. The duration of flood was also increased from 10 days to 16 days, and 3 days duration flood was prolonged to 8 days due to climate change (IWM, 2008).

Islam (2009) stated that in Bangladesh, the daily maximum temperature was shown a positive trend of increased at a rate of 0.621 ± 0.491^{0}C per 100 year. The maximum increased was occurred during November at a rate of 2.7^{0}C per 100 year. Daily minimum temperature was shown more significant trend of increase at a rate of

[1]Project Coordinator, International Rice Research Institute, Bangladesh Office and PhD Fellow, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh, Bangladesh and [2]Professor, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh, Bangladesh

1.536 ± 0.461^{0}C per 100 year. The maximum increased was occurred during February at a rate of 3.4^{0}C per 100 year. Daily mean temperature was shown positive trend of increased at a rate of 1.026 ± 0.403^{0}C per 100 year. It has been clearly found that temperature of winter season (December to February) was raised much higher rate than that of summer season (June to August). Temperature was increased predominantly over the last 30 years (1978-2007) than last 60 years (1948-2007).

About 93 disasters were occurred over the period from 1991 to 2000 and incurred the loss of US$ 5.90 billion in agriculture and infrastructure sectors. During the period from 1973 to 1987, about 2.38 million tons of rice was damaged due to flood (CCC, 2007). Affected farmers of climate change are adapting by migration to the different places for searching employment and living in unhygienic condition due to losing their homesteads and cultivated lands. In these circumstances, climate change would likely to increase the frequency and severity of various climatic events.

Bogra district has an area of 2947 km^2 including riverine area. Out of total 12 Upazilas, Sariakandi is the largest by covering an area of 409 km^2 which is about 13.88% of total district and is the most flood susceptible upazila of the district (BBS, 2008). The major hazards particularly in monsoon are flood and river bank erosion. The specific objectives of the study were to examine the extent of climatic variations, and to analyze farming communities' vulnerabilities and adaptations to climate change in the flood prone western Jamuna basin of Bangladesh.

Methodology

Assessment was made on March 2013 in Sariakandi upazila under Bogra district. The study was conducted by applying both primary and secondary qualitative and quantitative data. Primary data were collected through 19 Focus Group Discussions (FGDs) of 19 flood and river bank erosion affected villages under Sarikandi sadar and Narchi unions of Sariakandi upazila of Bogra district. Fifteen (15) participants were participated in each FGD session. Farmers, fishermen, share croppers, small traders, teachers, religious leaders, day labors, and van pullers were participated in the discussion. Women participants numbering 30% were also participated for collection of relevant data to make gender sensitivity. Prior the conduction of focus group discussions, related templates such as vulnerabilities and its reasons with impacts and adaptation strategies were prepared for collection of real information from the participants. One workshop was also conducted at Upazila level at Sariakandi ensuring the participation of respective Upazila Nirbahi Officer and members of Upazila Disaster Management Committee (UzDMC). These discussions were conducted to justify, validate and improve the findings of village level's discussion. Secondary data were collected from various publications of Government agencies i.e. Bangladesh Agricultural Research Council (BARC), Bangladesh Water Development Board (BWDB), Bangladesh Meteorological Department (BMD), Bangladesh Bureau of Statistics (BBS), Institute of Water Modeling (IWM), Bangladesh University of Engineering and Technology etc.

Findings and Discussion

Overall temperature and change

Sixty six (66) years' data of temperature, and 64 years' data of rainfall were collected from the nearest meteorological stations at Bogra. These data were used for assessing changing pattern of climatic factors mainly temperature and rainfall.

Maximum temperature: The data of Figure 1 show that the annual average maximum temperature was 30.69°C during 1948 -2013 at Bogra. The highest maximum temperature was recorded as 31.92°C in 1958, while the lowest was 29.89°C in 1974 (BARC, 2014). The positive slope of the maximum temperature trend line shows that maximum temperature has increased over the last six decades but this increase is not statistically significant. This means that there is no significant change of maximum temperature in Bogra station.

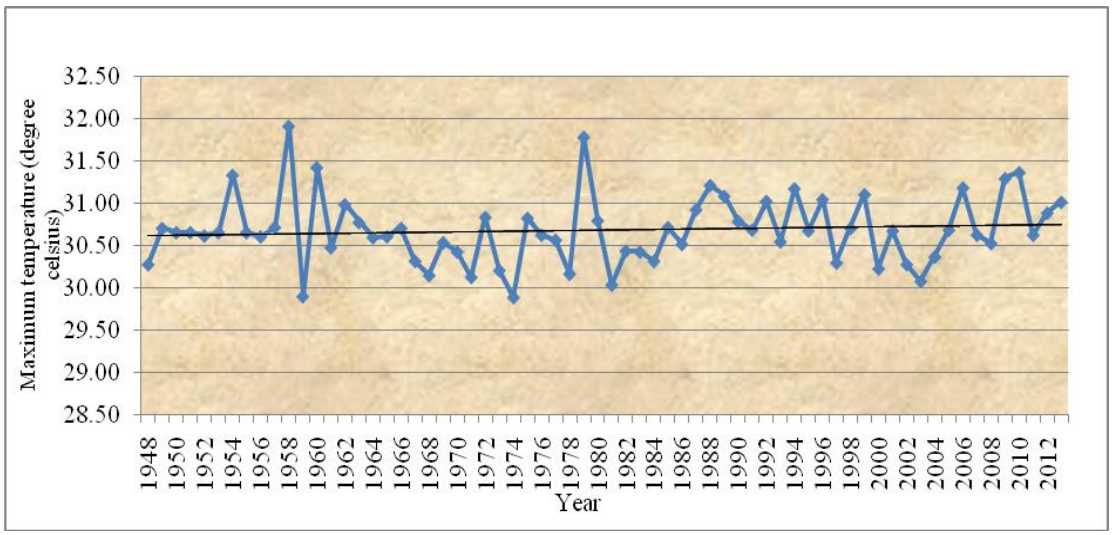

Figure 1: Annual maximum average temperature (Degree Celsius) of Bogra Station

Minimum temperature: The data Figure 2 show that the annual average minimum temperature at Bogra station was 19.66°C during 1948 -2013. The highest minimum temperature was recorded as 20.4°C in 1999, while the lowest was 18.55°C in 1967 (BARC, 2014). The positive slope of the minimum temperature trend line shows that minimum temperature has increased over the last six decades but this increase is not statistically significant. This means that there is no significant change of minimum temperature at Bogra station.

Overall rainfall pattern and change: The information presented in Figure 3 shows that the annual average rainfall in Bogra station 142.85 mm during 1950 -2013. The highest rainfall was recorded as 216.75 mm in 1998, while the lowest was 88.17 mm in 1953 (BARC, 2014). The positive slope of the rainfall trend line shows that rainfall in Bogra station increased in the past six decades but this increase is very small and it is not statistically significant.

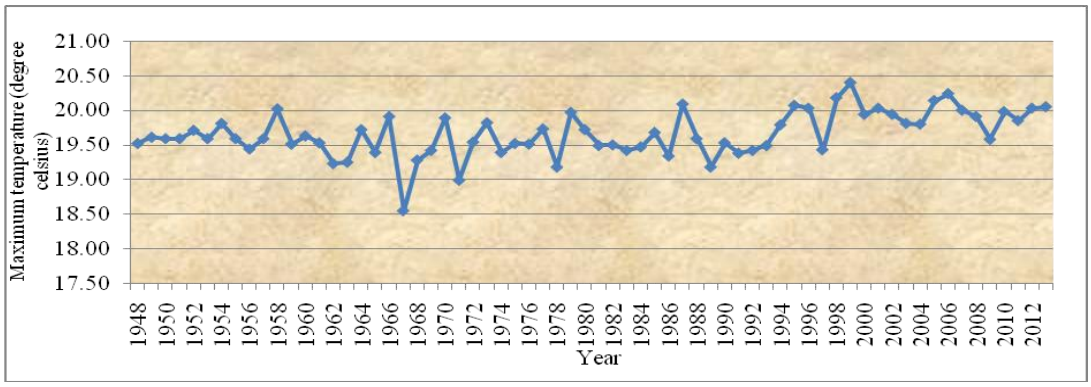

Figure 2: Annual minimum average temperature (Degree Celsius) of Bogra Station

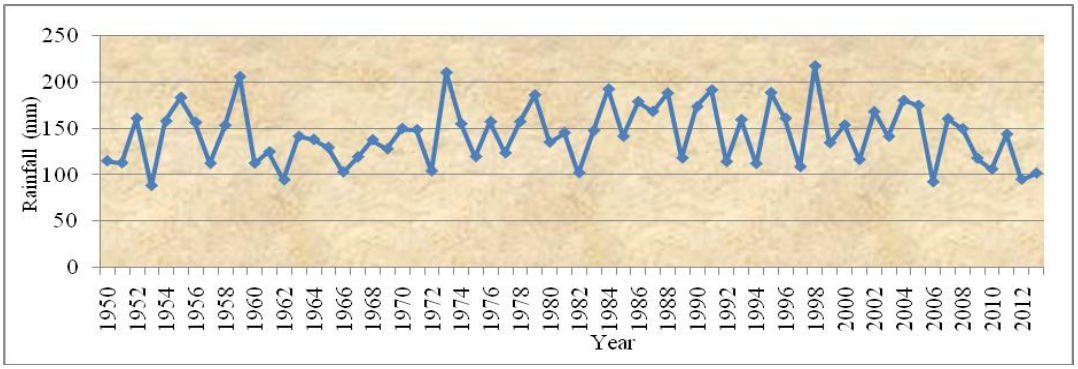

Figure 3: Annual average rainfall (mm) of Bogra Station

Findings from the Villages Level Discussion on Vulnerability, Reasons and its Impacts

The vulnerabilities to the farmers were assessed and presented in Table1.

Findings from the Upazila Level Workshop on Vulnerability to the farmers

After completed the assessment on vulnerability to the farmers, the findings were shared with the members of Upazila Disaster Management Committee (UzDMC) where the head of departments, chairman of all local elected bodies and NGO representatives were attended and provided their valuable opinions. All participants were provided the same opinion of village level findings. Moreover, they were contributed as some suggestions which were emphasis on early warning system; repair the disorder tube wells and ground raising of livestock shelter along with arrangement of boat ambulance for quick communication from the villages to hospital.

Table 1: Farmers' assessment of vulnerabilities, reasons and impact of climate change

Vulnerability	Reasons	Impacts
Flood	Upstream water, excessive rainfall and construction of roads and embankments with bridges and culverts in unplanned way	Loss of life, damage crops and household's assets
River bank erosion	Riverbeds raising for siltation and unplanned constructions	Erosion of homesteads and croplands
Drought	Inadequate rainfall in winter season	Damage crops
Cold wave	Low temperature with foggy weather	Loss of life and standing crops
Communication problem	Flood and excessive rainfall	Damage standing crops with homesteads
	Insufficient roads, bridges and culverts and its maintenance	Problem of transports running, materials carrying and more cost of transportation
Crisis of flood shelters	Insufficient initiative of the government to build flood shelter	Homeless poor lives by the side of embankments and roads
Erode homestead by wave action of flood	Lack of measures to protect homesteads from wave action	Reduce homesteads and decrease vegetables productions
Crisis of safe drinking water	Submerge tube wells and insufficient tube wells	Increase water borne diseases as drinks river's water. Assets sell for treatment. Increase human mortality.
Problem of defecation	Submerge sanitary latrines	Pollute environment and increase water borne diseases
Lack of latrines	Living in low lying area as village situated on the islets. Inundate latrines. Latrines are below of highest flood level as lack of money for plinth raising	Serious problems of defecation especially for women and adolescent girls. Increase water borne diseases and treatment cost
Shifting housing	Homesteads erosion	Live in others houses or by the side of embankments and roads
Food crisis	Damage crops	Live in starvation
Fodders crisis	Damage crops and grasses	Sell livestock in advance
Death of domestic animals	Lack of raised shelters and forage including insufficient vaccination	Increase economic loss
Problem of poultry rearing	Crisis of keeping place	Poultry die and increase malnutrition

Vulnerability	Reasons	Impacts
Riverbed siltation	Deposit silt by eroding river bank	Inundate surrounding areas and damage crops
Problems of boats and fishing nets	Lake of money	Increase malnutrition
Crisis of alternative works	Submerge croplands	Increase landless
Sand deposited on crops lands	Submerge crops of flood	Crops lands are reducing and farmers are becoming landless and the landless are migrating for searching shelters and works
Unconscious on flood disaster	Lack of awareness	Loss of live and assets
Crisis of seedbeds	Low and less lands	Hamper crop production
Crisis of fish production	Less knowledge on fish culture	Low income and increase malnutrition
Deforestation	River bank and land erosion	Pollute environment
Limited treatment facility	No registered doctor, and health complex is far way with bad communication systems and limited resources.	Farmers suffer from chronic diseases and increase death
Lack of employment opportunity	Lack of work during flood	Increase migration in search of work, sell labor in advance and borrow money from money lender
Rivers dry out	Silt aggregation on the riverbed	Irrigation problem, decrease fish and weather becomes hotter
Increase social crime	No employment opportunity due to damage crops	Increase stole and robbery
Lack of transportation	Submerge roads of flood	Problems of rescue of flood affected households
Problem of irrigation	Lack of swallow pump and high price of fuel in dry season	Hamper crop production
Infestation of crops	Decrease crops friendly insects, birds and frogs due to use of pesticides	Destruct crops, and increase crops production cost
Increase human diseases	Drink unsafe waters in unhygienic condition and defecate in flood water	Break out of epidemics, increase poverty and loss of money for treatment
High price of agricultural equipments	Damage agricultural equipments	Increase production cost
Migration	Limited employment opportunity as crops are damaged by flood and river bank erosion as well as low wages in the locality	Increase social crime and insecurity especially for women and children
Lack of education facility	Close institutional due to submerge of flood and use as flood shelter. Institutions are far away.	Increase illiteracy rate

Vulnerability	Reasons	Impacts
Increased landless	Increase river erosion and population with low income and sale lands	Live at others house, *khas* lands, embankments, and roadsides in unhygienic condition.
Crisis of quality seeds	Lack of knowledge of modern technology on quality seeds preservation, shortage of storage facilities to preserve seeds during flood and corrupted seeds dealer are supplied less quality seeds	Lack of interest by the farmers as crops production cost is very high and decrease crop production
Destroy trees	Submerge and die trees	Economic loss
Malnutrition	Uptake non-nutritious food	Increase health hazards
River crossing problem	Crisis of boats	Loss of time
Homesteads in low lying areas	Crisis of high land due to river erosion	Loss of assets including livestock

Adaptation to Climate Variability and Change

The farmers were identified possible sector based adaptation strategies to climate change which are mentioned below:

Infrastructure Sector: Houses were built in safe places to avoid flood, river dredging, construction of new planned roads, reconstruction of old roads, bridges and culverts, construction of food shelter with ground raising, construction of flood resistance housing with plinths raising, raising homestead with community places, settlement of landless in chars (islets) areas by ground raising, construction of raised or flood protection embankments, establishment of evacuation system during flood, and kept the river flow in straight direction to avoid river bank erosion.

Agriculture Sector: Arrangement of training on seed's preservation, establishment raising seedbeds, supply quality seeds, homestead gardening, cultivation rice seedlings on floating beds, cultivation of seedlings and vegetables by using flood proofing technologies, cultivation of short duration as well as flood tolerant rice and promotion of other flood tolerant crops, cultivation of sesbania as green manure to increase soil fertility, and organized farmer exhibition field.

Fisheries Sector: Establishment of nursery for fry production, supply boats and nets, fish case culture, duck cum fish culture, raised the edged of ponds, introduction of community based fish culture in open water body and rice fish culture.

WASH Sector: Installation of tube wells and sanitary latrines of high land, and based raising of existing tube wells along with sanitary latrines.

Livestock Sector: Cultivation of fodder in regards to rear livestock, establishment of flood shelters in the islets, arrangement of vaccination campaign especially before and after flood, establishment of poultry hatchery with rearing of cows, goats and ducks. Use emergency fodder to feed the cattle i.e. jackfruit, tree leaves, sugarcane tops, banana stems, water hyacinth etc.

Disaster Management Sector: Supplied emergency food, utensils, medicines, tents and rescue boats during flood, supplied worm cloth during winter, rescued the flood

maroon people. Training arrangement on disaster management for the flood affected community. Supplied leaflets, folders, booklets, manuals, posters on disaster preparedness for massive awareness rising with arrangement of boat races, mock exercises etc.

Climate Change Mitigation Sector: Arrangement of environmental friendly improved cooking stove with proper trainings arrangement. Establishment of community based tree nurseries including huge tree plantation for carbon sequestration to mitigate adverse impacts to climate change.

Alternative Livelihood Sectors: Arrangement of alternative income generated activities such as tailoring, handicraft, small trade, bamboo materials production, and agro-processing including light engineering. In addition, sometime poor farmers were engaged in fishing, boating and cutting long grass for cattle with borrow money from local money lenders, relatives or neighbors, non-governmental organizations, banks and purchase rice on credit from large farmers. Change eating habits by reducing size of meals including frequency. Change types of food eaten i.e. eating jute leaves. Women were eaten after men and children. Sometime, days were passed by starving and eating reserved rice seeds. Sell domestic assets *i.e.,* corrugated iron sheets of houses, furniture, trees, utensils, clothing etc. Sell means of transports, livestock, jewelries and sell or mortgage land. Based on opinion of farmers, observation of the researcher and literature review the following adaptation options were suggested as appropriate in flood prone areas of Bogra district: cultivation of BRRI dhan51 and BRRI dhan52 as flood tolerant (BRKB, 2004). BR28 by broadcasting in the char (islets) areas, cultivation of rice seedlings in floating beds in hazardous period, cultivation of rice in double transplantation method with late local variety *i.e. gainzia, naizarshail, binashail*. Cultivation of flood tolerant arum *(latiraj kachu)*, *baksha* grass (flood tolerant year round) and *ipil ipil* fodder in islets areas, and fish culture in cages in open water body (Hassan 2010).

Conclusion

Affected farmers due to climate change were unknown regarding modern technologies to adapt to the vulnerability of climatic events like flood and river bank erosion. They have very poor adaptive capacities on cropping practice, livestock and fisheries including alternative livelihood aspect. To make adjustment with extreme impacts of climate change, farmers should change their adaptive technologies. At the same time, some specific programs to be launched for crops, livestock, fisheries and other aspects. Proper training should also be arranged on adaptive technologies and other issues. Various government departments including NGOs should come forward to solve these problems. It is important to note that the farmers' adaptations are mostly reactive types of responses to deal with these problems. It should be incorporated at the local level planning by various organizations, institutes and departments; and then disseminate to the national level.

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