Journal of
Forest and Livelihood
Vol 11 (1) March 2013 ISBN 1684-0186

Climate Change and Adaptation: Evidence from a Forest-dependent Community in Bangladesh

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Abstract: Climate change and its effects are widely visible in all sectors, including the scarce forest resources of Bangladesh and the dependent communities. This study was undertaken in the periphery of the National Sal (*Shorea robusta*) forest under the Tangail District of Bangladesh to understand and document the trend of climate change as well as the adaptation measures for coping with adverse situations that might arise in the future. The study was accomplished through a survey of 50 households and analysis of long-term meteorological database (1961–2010). The results show that forest and forest products have been reduced drastically. The changing trend of climate, along with anthropogenic activities, might have contributed to decrease in the forest resources and livelihood options of the community. A steady increase in maximum and minimum temperatures over time was noted where increment rate per year of maximum and minimum temperatures was 0.017°C and 0.011°C respectively. The minimum temperature during the winter had been slightly decreasing in December–January. An increase of rainfall at the rate of 68.7 mm per decade was estimated. The increase was remarkable during the monsoon months (June–October), while it decreased during winter (November–March) at the rate of 1.17 mm per decade. The results of the analysis of long-term climatic data on temperature and rainfalls have strongly been supported by perceptions and opinions of the community people. They have already adopted several adaptation measures such as changing planting time and using new technologies. Similarly, the government has undertaken several adaptation measures to protect the forest and environment. In the face of challenges of climate change and livelihoods, communities have strongly suggested undertaking some new adaptation measures, such as construction of water reservoirs, strengthening afforestation programmes through community approach, development of pest and disease-resistant varieties, and supply of high quality planting materials for conservation of resources and better livelihoods.

Key words: Forest resource, climatic database, community perception, adaptation measure

INTRODUCTION

Climate change is increasingly being reported to have significant adverse impacts on almost all sectors, in varying degrees across the world. But the scale of severity of impacts is predicted to be unprecedentedly high in resource-poor countries, including Bangladesh. Bangladesh is frequently cited as one of the countries most vulnerable to climate change because of its disadvantageous geographic location; flat and low-lying topography; high population density; high levels of poverty; reliance of many livelihoods on climate-sensitive sectors, particularly agriculture, forest and fisheries; and inefficient institutional aspects (MoEF 2008). Many of the adverse effects of climate change, such as sea level rise, higher temperatures, short monsoon with high precipitation, and an increase in cyclone intensity, are placing pressure on the existing resources like agricultural and forestland. Such impacts have already impeded development in Bangladesh, particularly by reducing livelihood opportunities of the population (World Bank 2009).

Forest is historically a scarce resource in Bangladesh, where Sal (*Shorea robusta*) forest is the third largest forest ecosystem (BFD 2011). This forest is precious and important as it is the only forest in the central part of the country as well as an integral part of the country's natural heritage. It plays a significant role in fulfilling the diverse needs of the people, socioeconomic development and environmental stability. Geologically, it is a terrace from 1 to 10 metres above the adjacent floodplains. Sal forest is popularly known as *Madhupur Tract* (Special Landscape) forest in Bangladesh. As this forest is located in the central part of the country and is free from floods, thousands of people, both ethnic and non-ethnic, have been directly or indirectly dependent on this forest resource. But it has been under severe pressure over the past two decades because of illegal logging, encroachment of land for industrialisation by powerful groups of people and for livelihoods by the poor people living around the forest (BFD 2004). These pressures have already caused significant depletion (about 3% per year) of forest and associated resources. The depletion is likely to become more severe in the near future, especially as the impacts of climate change, as high temperature and prolonged drought, high precipitation in short period of time, high humidity and tornadoes have been occurring frequently (MoEF 2008). Most of the forestland does not have satisfactory tree coverage and its productivity is low (BFD 2004).

As a result, this forest ecosystem has become more vulnerable (Banglapedia 2006). While the government has taken enormous steps to protect this forest from illegal deforestation and other anthropogenic activities, it is difficult to save it from the impacts of climate change. Local communities have been trying to cope with the changing scenarios with various adaptation programmes based on experience and available knowledge. In view of the importance of climate change, it is necessary to understand how the farming/forest communities are adapting to this changing scenario and what would be the best option to cope with this situation.

METHODOLOGY

The study was conducted in two villages, namely Matonginagar and Joloy under Madhupur Upazila of Tangail District in the vicinity of Sal forest. Out of the total 202 households from two villages, 50 respondents were interviewed through pre-tested schedules in September 2011. Several Focus Group Discussions (FGDs) were held to verify the information and to discuss the important issues. The major parameters included in the study were socio-economic and livelihood parameters, benefits from forest and their changing patterns, perception on climate change and its impacts. These issues were examined through a formal questionnaire survey and close interactions with respondents. The collected information was then verified and updated through FGDs. Elderly and experienced persons of the localities were also consulted. The present changing pattern of resources and the respondents' perceptions on climate change were compared with those drawn at least 10 years ago. Major adaptation measures undertaken by the local community and possible steps to be undertaken to sustain the livelihood were also studied. The long-term meteorological data (1961–2010) were collected from the nearby Meteorology Station and then analysed to identify the climate variability and extreme events and to verify the climate variability and events with farmers' experience and perceptions.

The Standardized Precipitation Index (SPI) calculation for a location based on the long-term precipitation records for a desired time period was carried out. This long-term record was fitted to probability distribution, which was then transformed into a normal distribution (Edwards and McKee 1997). It reflected the number of standard deviations that an observed value deviates from the long-term mean.

$$SPI = (X_i - \overline{X})/б$$

Where, SPI is Standardized Precipitation Index; X_i, $\overline{X}$ and б are i^{th} year precipitation, long-term mean of precipitation and standard deviation of mean respectively.

OVERVIEW OF STUDY SITE

Demographic and Socio-economic Profiles of the Respondents

Age: The average age of the respondents was 46.76 years (Table 1); however, the highest proportion of the respondents (40%) belonged to the old age group (> 50 years), closely followed by the middle age group (35–50 years). Majority of the respondents were well experienced as the highest proportion was from the old age group.

Education: The majority of the respondents (74%) had some level of education, while the least number of respondents had no education at all (26%) (Table 1). Among the educated, most had passed the primary level (5 years of schooling), while very small proportion had higher level of education (upto Masters level).

Family size: The average family size of the respondents was 5.86, and ranged from 4 to 15, with a standard deviation of 2.18 (Table 1). The findings also indicated that about half (54%) of the respondents had medium-sized family (5–8 members), whereas 34 percent and 12 percent of the respondents had small (< 5 members) and large size (> 8 members) families respectively. The overall findings indicated that the family size in the study area was higher than the national average family size of 4.50 (BBS 2011). This might be due to the joint family system in the community visited for the study purpose.

Farm size: The majority of the respondents were small farm holders (landless to small land holders). They represented 60 percent of the respondents, while the medium and large holders together accounted for 40 percent. The average farm size was 0.56 ha per family, which is lower than the national average of 0.67 ha (Krishi Dairy 2012).

Table 1 : Socio-economic and demographic profile of the respondents

Character (unit)	Category	Respondents' Opinion			
		Frequency	Percent	Mean	Standard Deviation
Age (Actual year)	Young aged (up to 35)	11	22	46.76	0.76
	Middle aged (35-50)	19	38		
	Old (>50)	20	40		
Education (Year of schooling)	Illiterate (No schooling)	13	26	-	1.71
	Primary (1-5)	28	56		
	Secondary (6-10)	7	14		
	Higher (>10)	2	4		
Family size (Number)	Small family (<5)	17	34	5.86	2.18
	Medium family (5-8)	27	54		
	Large family (>8)	6	12		
Farm size(ha)	Landless (<0.02 ha)	3	6	0.56	0.22
	Marginal (0.02-0.2 ha)	4	8		
	Small (0.2-1.0 ha)	23	46		
	Medium (1.0-3.0 ha)	15	30		
	Large (>3.0 ha)	5	10		

Income level of the respondents: The income level of the respondents was categorized into four groups based on their monthly income (expressed in Bangladesh Taka) (Table 2). The majority of the respondents were extreme poor (10.75%) and poor (79.10%), while fewer respondents had medium income (5.65%) to high income (4.50%).

Table 2. Monthly income of respondents in the study area

Income level (BDT Tk)	Income group	Respondents' opinion (%)
≤1,999	Extreme poor	10.75
2,000-4,999	Poor	79.10
5,000-7,999	Medium	5.65
≥8,000	Rich	4.50

BDT Tk = Bangladesh Taka

Primary occupation of the respondents: The majority of the respondents were dependent on natural forest (55%), followed by farming (16%) and working as daily wage labour (9%). The other minor occupations were business and government and non-government services (Figure 1).

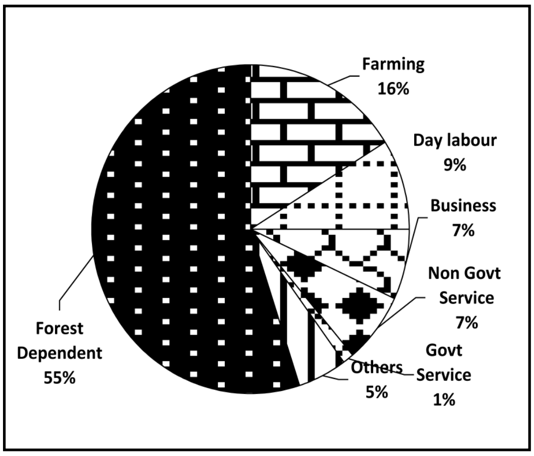

Fig. 1 : Primary occupations of the households in the study area

Micro-credit facility: A good number of micro-credit facilities were found in the study area. Among them, non-government organizations (NGOs) were observed to be more active than government organizations. Different NGOs provided micro-credit to the local people for small businesses, farming, livestock rearing, fish culture, poultry and other alternative income-generating activities. But interest rate was high. Government entities, such as banks, also provided loans. However access of poor households to those institution was limited. Similarly some NGOs also provided loans to resource-poor women.

CLIMATE CHANGE: TRENDS AND PERCEPTIONS

Climate change, particularly in terms of temperature and rainfall, in the study area was examined through analysis of long-term meteorological database and perceptions of local respondents.

Evidence from database: The evidence of climate change over time was documented through analysis of long-term (1961–2010) climatic data of monthly temperature and rainfall to find out the trend in the changes.

Trend of temperature: The long-term temperature data showed a steady increase of both maximum and minimum temperatures over time (Fig. 2 and 3). The increase in maximum temperature was more distinct than minimum temperature, while increment rate of maximum and minimum temperatures per year was 0.017 and 0.011°C respectively. It was observed that the minimum temperature during winter season had been slightly decreasing (December–January), while it exhibited an increasing trend in the remaining months of the year. These changes in temperature indicated that the study location was gradually becoming warmer in all seasons. These changes might have influenced the pest and disease infestation, as well as productivity of vegetation, both trees and crops, of the locality (Ahmed 2011).

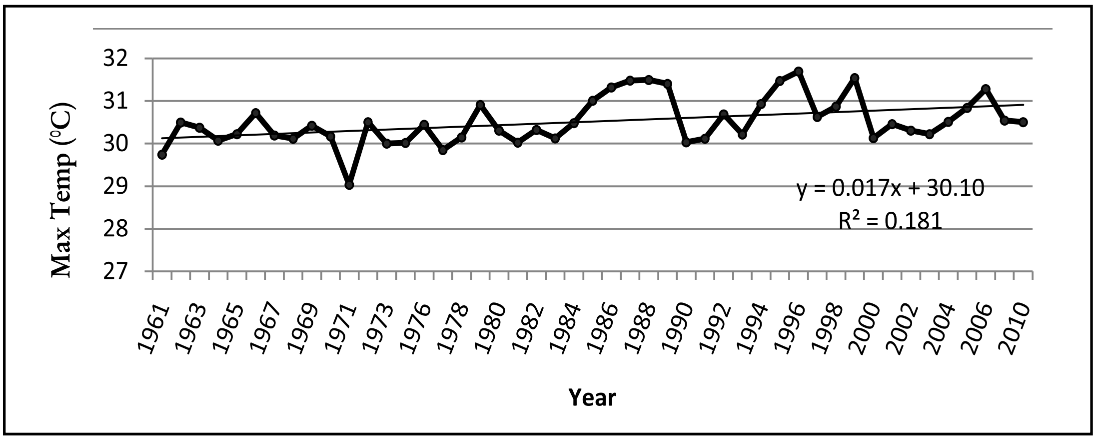

Fig. 2 : Long-term (1961-2010) trend of maximum temperature in the study area

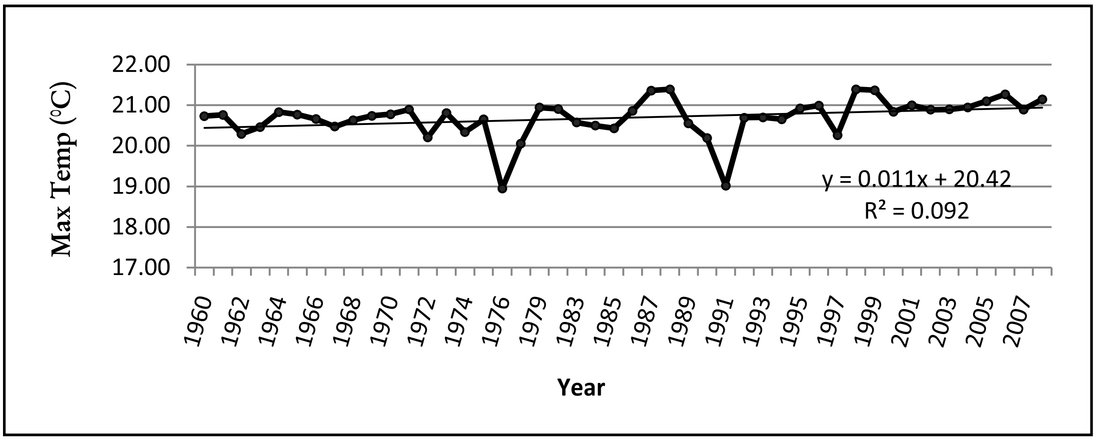

Fig. 3 : Long-term (1961-2010) trend of minimum temperature in the study area

Trend of rainfall and frequency of SPI: The analysis of long-term rainfall database reflected that the change of rainfall pattern was not definite over seasons. The trend of annual rainfall indicated an increasing pattern in the study area (Fig. 4), and the increment rate was 68.7 mm per decade. However, it also showed that the increase of mean monthly rainfall was remarkable during monsoon months (June–October) in the recent decade (2001–2010) compared to first ten years (1961–1970), while a decreasing trend during winter (dry) season (November–March) was observed (Fig. 5). The monsoon rainfall increased by 56.4 mm in the recent decade compared to the base decade, while it decreased by 1.17 mm during dry season. Decreasing trend of winter season rainfall is associated with higher rate of increase in minimum temperature (Wang *et al.* 2009), which might have hampered the growth of vegetation.

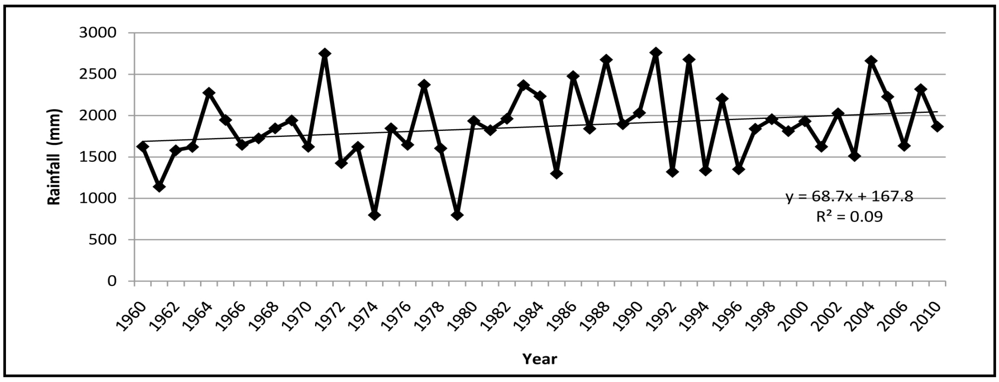

Fig 4 : Long-term (1961–2010) trend of rainfall in the study area

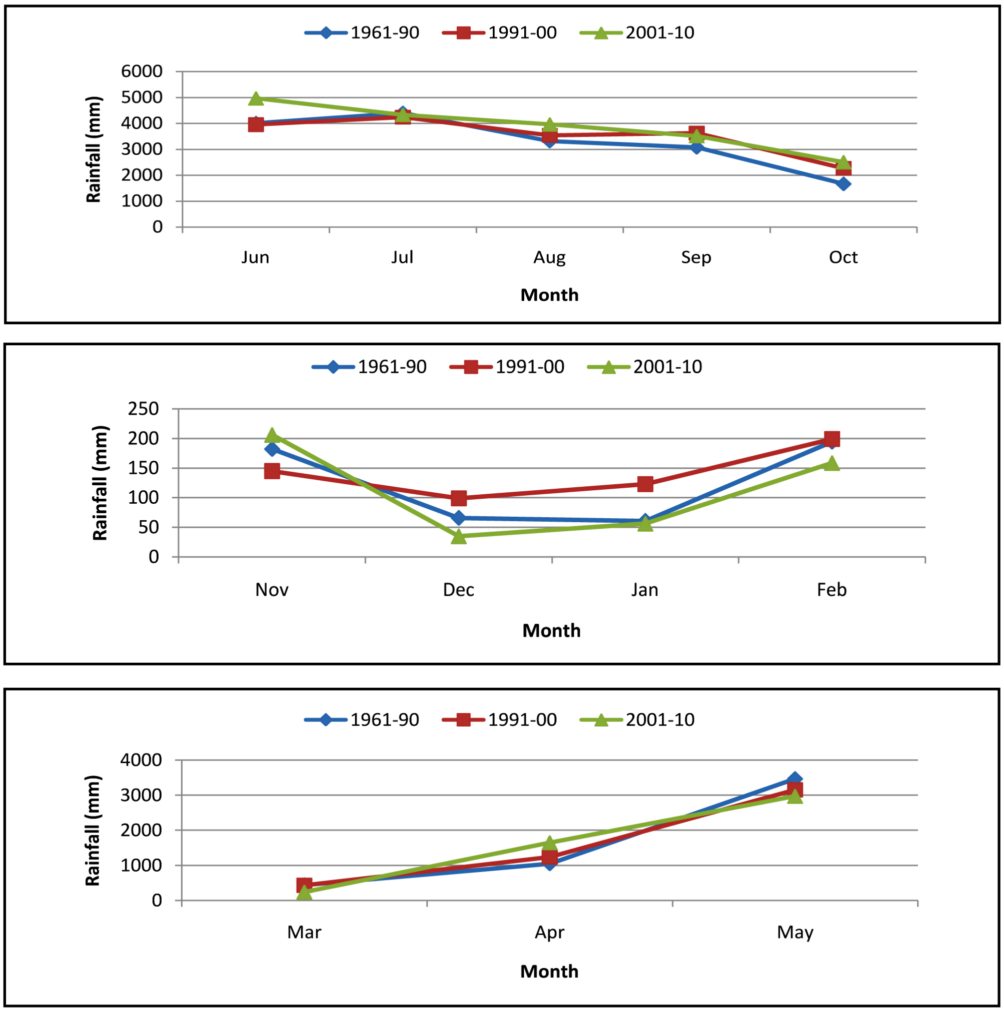

Fig. 5 : Seasonal variations of rainfall in the study area over time

The annual drought and wet frequency corresponding to SPI in the study area is shown in Fig. 6. The results showed that the drought frequency was dominant in recent years and the SPI values crossed the normal level (-0.5 to +0.5) in most of the years. Subash and Mohan (2011) reports wide year-to-year variation in the monthly distribution of rainfall in the Indo-Gangetic region.

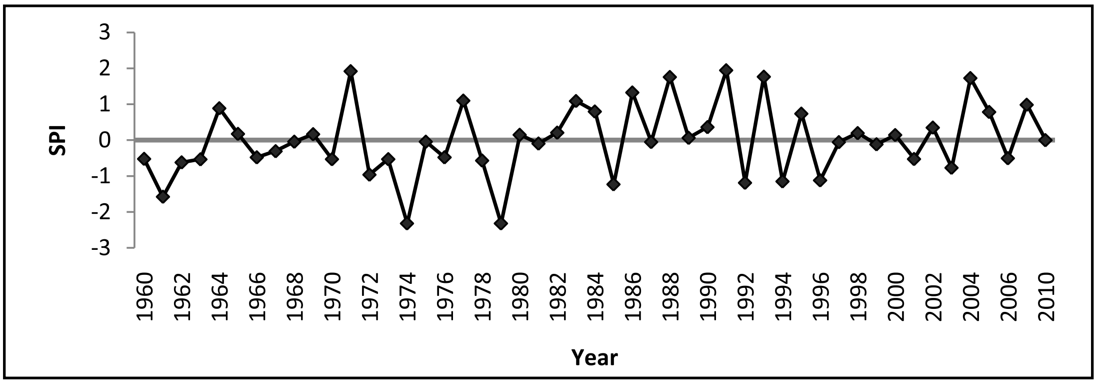

Fig. 6 : Long-term (1960-2009) annual (SPI) in the study area, indicating frequency of dry and wet conditions

Increase in monsoon rainfall was thought to be responsible for flash flood, resulting in the loss of vegetation, while decrease in winter rainfall might result in prolonged droughts, which consequently might cause stunted growth of vegetation and obstruct sowing of winter crops. Deforestation might have accelerated the processes. Moreover, seasonal variations in weather parameters might have also increased the disease, insect and pest incidence in trees and crops as well as other vegetation (Ahmed 2011). A warmer climate with uncertain winter rainfall is likely to affect not only agricultural crops or forests but also other sectors, such as health and water.

Evidence from community perception: The community's perceptions on the change of local climate and their impacts over time (10–15 years ago) indicated that (Table 3), they were almost similar to the evidence of climate change recorded from the meteorological database. Regarding the change of summer temperature over time, majority of the respondents (98%) expressed their opinion that summer temperature had increased, which was very consistent with the change of maximum temperature of meteorological database. Forty-four percent of the respondents said that the change of winter temperature over time had decreased. This statement was consistent with the change of minimum temperature of long-term database. But the overall trend of minimum temperature had increased, whereas it decreased during December–January. The majority of the respondents (64%) stated that rainfall intensity had increased over time, which was consistent with the meteorological evidence, while, in the opinion of 72 percent of the respondents, rainfall frequency had decreased. Though there was no evidence on frequency of rainfall, this was confirmed by the community during FGDs. A majority of the respondents expressed that drought length and severity (54%) and drought frequency (56%) had increased over time, which were consistent with the current climatic events.

In case of other studied climatic events, the respondents could not place responsive opinion, except on cloudy weather, which had increased over time, as indicated by majority of the respondents.

However, both meteorological database and community perception strongly supported the change of climate over time and increasing trend of its impacts. This location-specific information is also consistent with the national database (MoEF 2008).

Table 3 : Respondents' perception on climate change over time in the study area

Climatic parameter	Respondents' perception (Respondent opinion expressed as percentage)				
	Increased	Decreased	No change	No idea	Total
Temperature (Summer season)	98	0	0	2	100
Temperature (Winter season)	34	44	14	8	100
Rainfall intensity	64	24	2	10	100
Rainfall frequency	18	72	2	8	100
Drought length and severity	54	8	14	24	100
Drought frequency	56	4	16	24	100
Hailstorm amount and severity	0	28	18	54	100
Frost/ dew intensity and severity	14	26	26	34	100
Cold spell-intensity and severity (March-April)	24	10	24	42	100
Cold spell-intensity and severity (September-October)	14	16	22	48	100
Cloudy weather	44	26	12	18	100

CHANGES IN FOREST RESOURCES STATUS

Forest resource: Historically, the respondents have been highly dependent on forest resources. The dominant forest species in this forest ecosystem was Sal *(Shorea robusta)*, followed by Bohera *(Terminalia bellerica)*, Horitioki *(Terminalia chebula)* and Amloki *(Emblica officinalis)*. These abundance of species has decreased severely as reported by 100 percent of the respondents. Over-exploitation of resources, along with illegal felling and climate change, was reported as the main reasons for decrease in indigenous forest species. On the contrary, some exotic forest species, such as Akasmoni *(Acacia auriculiformis)*, Eucalyptus *(Eucalyptus camaldulensis)*, Mahogony *(Swietenia macrophylla)*, were reported to have increased by 40 to 76 percent of the respondents (Table 4). The increased trend of exotic species plantation was due to their quick growth and relatively high adaptive capacity even during the extreme climate events.

Table 4 : Changes in distribution of tree species in the study area

Type of change forest species	Vegetation	Respondents' opinion	
		Frequency	Percent
Decrease in indigenous spp.	Sal *(Shorea robusta)*	50	100
	Bohera *(Terminalia bellerica)*	50	100
	Horitoki *(Terminalia chebula)*	50	100
	Amloki *(Emblica officinalis)*	50	100
Increase in exogenous spp.	Akashmoni *(Acacia auriculiformis)*	38	76
	Eucalyptus *(Eucalyptus camaldulensis)*	25	50
	Mahogony *(Swietenia macrophylla)*	20	40
	Other species	10	20

Changes in the availability of forest products over time: Different types of forest products were collected and used by the respondents as a part of their livelihood activities, but the availability of those products was decreasing over time. Irrespective of forest products, availability and collection was decreasing (Table 5). Among the different products, the highest reduction was in non-timber forest products (60%), followed by fruit (58.33%), bamboo (56.25%), fodder (50%) and timber (42.50%). The decrease in those forest products has created a negative impact on the livelihoods of the forest-dependent community.

Table 5 : Respondent's exception on the types of forest products available/collected

Forest product	Availability of forest products as opined by respondent (%)		
	10 years back	Current year	Change (%)
Leaf and branch	100	84	-16.00
Fuel wood	100	74	-26.00
Timber	80	46	-42.50
NTFP (Non-Timber Forest Product)	50	20	-60.00
Bamboo	32	14	-56.25
Fodder	20	10	-50.00
Fruit	25	10	-58.33

Alternative resources for adapting to the reduced availability of forest products: The preceding section showed that availability of forest products was decreasing over time. As a result, the respondents were exploring alternative resources to overcome their needs, especially for energy. The respondents were already using a number of alternative resources to cope with the lessening availability of forest resources. Among the alternative resources, cow dung stick (70%) was found as the most prevalent, followed by rice husk and bamboo (52%), plant part/material of homestead plantation (40%) (Table 6).

Table 6 : Alternative resources against decreasing availability of forest products

Alternative resource	Respondents' opinion	
	Frequency	Percent
Cow dung stick	35	70
Rice husk and bamboo	26	52
Plant part/material of homestead plantation	20	40
Crop stubble	7	14
Kerosene	4	8
Stove/ biogas	2	4

Changes in cropping intensity over time: It was learned during FGDs that farming was not the dominant livelihood activity in the earlier periods, but it became an important one due to the decreasing availability of forest products. Cultivation of different crops increased remarkably and it varied from 10 to 40 percent, except for wheat (Table 7). Interms of increase in the growth rate, turmeric ranked the top (40%), followed by banana (30%), aroid (25%), pineapple (22%), ginger (18%), potato (14%) and rice (10%), while the growth of wheat was almost nil. Furthermore, the cultivation of cereal crops was very low because of upland ecosystem of the study area.

Table 7 : Change of cropping intensity over time

Crop	Change of cropping intensity as viewed by the respondents (%)		
	10 years Back	Current year	Change
Turmeric	23	63	40
Banana	15	45	30
Aroid	12	37	25
Pineapple	10	32	22
Ginger	6	24	18
Potato	0	14	14
Rice	12	22	10
Wheat	6	0	-6

Water availability: Water availability was reported as an important resource by 100 percent of the respondents in the study site (Table 8). Rainfall during July–September was the main source of water. Water was a very scarce resource, except during monsoon, and its unavailability peaked during winter months. Rover pump was the main source of water for domestic purpose, while shallow tubewell (44%) was used for irrigation, which was introduced very recently.

Table 8. Water availability and source for essential purposes

Water source	Respondents' opinion	
	Frequency	Percent
Availability of water over time		
Increase	-	-
Decrease	50	100
Purpose: Domestic		
Rover pump	50	100
Purpose: Irrigation		
Shallow tube well	22	44
Water from other machines	6	12
Total	50	100

ADAPTATION PRACTICES

The preceding sections stated that there were distinct changes in local climate, especially in temperature and rainfall, which might have a combined effect on the productivity of farm crop and forest. Against this backdrop, the government, as well as local community, has undertaken some adaptation measures. The measures taken for forest and agricultural production are discussed below:

Adaptation measures undertaken by the government agencies: The government of Bangladesh, through the Department of

Forestry and Agricultural Extension, has adopted a number of adaptation measures (Table 9) to protect and promote forest against the impacts of climate change and increasing pressure from other anthropogenic activities. Among them, plantation of exotic species with participatory approach (80%) has been found to be the most prevalent measure, followed by restriction on harvesting of forest products (54%). This restriction has been imposed by the government through the Department of Forestry. The other important measures are social forestry activities (42%) for management of forests, construction of water reservoirs inside the forest to supply water (32%) during the drought, restriction on free grazing (24%), and distribution of improved seeds of grasses or fodder trees (22%) to make them available outside the forestland and also to reduce pressure from livestock grazing. The other important measures were, introduction of new efficient fuel technology like improved cooking stove and biogas (20%) to reduce the dependency on forest products and control of pests and diseases (16%) by spraying insecticides and fungicides. Similar opinions were expressed during the FGDs. These findings indicated that both local community and government are concerned and pro-active to protect and promote natural forests from the impacts of climate change events and other natural and human activities.

Table 9. Adaptation measures undertaken by the government agencies in relation to forest management in the study area

Adaptation measures	Respondents' opinion (%)
Plantation with participatory approach	80
Restriction on harvesting of forest products (imposed by the Department of Forestry)	54
Promotion of social forestry activities	42
Construction of small water reservoirs inside the forestland	32
Control on grazing (imposed by the Department of Forestry)	24
Distribution of improved seeds of grass or fodder trees	22
Introduction of new fuel use technology (i.e. improved cooking stove, biogas)	20
Control of pests and diseases	16

Adaptation measures undertaken by the community: A number of adaptation measures were being undertaken by the community for sustaining their production systems. Among them, changed in plantation time was mostly, followed by the use of new technologies (Table 10). On new technologies, majority of the respondents (55.93%) adopted new varieties, micro-irrigation and plant protection measures. During the FGDs, the respondents also said that they had been practising those adaptation measures because of late onset of rain, scarcity of water for irrigation, and emergence of new pests and diseases.

Table 10. Type of adaptation measures undertaken by the community in relation of agricultural/crop production in the study area

Adaptation measure		Respondents' opinion (%)
Changing planting date/time		100.00
Using new technologies	Variety	12.87
	Micro- irrigation	19.25
	Plant protection measure	11.95
	Variety, micro irrigation and plant protection measure	55.93
	Total	100.00

PROBLEMS AND OPPORTUNITIES

Problems: The local community used to struggle against a number of problems—both climatic and anthropogenic—in order to maintain their livelihoods. Some problems were severe and some were moderate. The biggest problem faced by the local community (Table 11) was the gradual decrease of groundwater level, resulting in scarcity of water for irrigation and drinking purposes. This was the topmost problem in the locality. The second problem was the illegal cutting of forest (86%) by some politically powerful people and the next was the decrease of grazing land (76%). The problem of decreasing grazing land had aggravated (Miah *et al.* 2010) as fallow land was gradually brought either under cultivation to feed the increasing population or construction of houses. The fourth was the restriction on harvesting forest products from the natural forestland (70%). The community members during the FGDs stated that, harvesting the forest products was an un-official right of the communities and it used to be their main source of livelihood earlier. The fifth was the infestation of insects and pests in both agricultural crops and forest (66%). They also stated that the problem had been increasingly found during the last several years. Sixth, the occurrence of sudden extreme climatic events, such as storms, heavy rainfall, water logging, high temperature, cold spell and frost (62%). This problem is becoming more dominant with time, as agreed by the respondents . The decrease in productivity of land (60%) was also found as a crucial problem, as intensive land use is accompanied by indiscriminate use of insecticides, fungicides and excessive application of inorganic fertilizers. The other problems, namely, the lack of quality of planting materials/ seeds (52%), degradation (pollution) of soil/land (40%), long dryness and drought period (38%) and change in the timing of weather (28%) were respectively graded as the 8th, 9th, 10th and 11th ranking problems. (Table 11)

Table 11. Major problems faced by the community to maintain their livelihood

Major problem	Respondents' opinion	
	Percent	Rank
Decrease of groundwater level	90	1
Illegal cutting of trees	86	2
Decrease of grazing land	76	3
Restriction by the Government in harvesting of forest products	70	4
Infestation of disease and insect/pest in both forest and agricultural crops	66	5
Sudden extreme climatic events like storms, heavy rainfall, water logging, high temperature, cold spell, frost, etc	62	6
Decrease of land productivity	60	7
Lack of quality planting material/seeds	52	8
Degradation of soil/land	40	9
Prolonged dryness and drought	38	10
Change of timing of weather parameters	28	11

Opportunities: The respondents suggested on the availability of a number of opportunities to overcome the problems prevailing in the locality (Table 12). The topmost opportunity as stated by majority of the respondents was the construction of water reservoirs (88%) for ensuring water supply to combat the impacts of climate change and to make forest and agricultural land productive. The respondents also indicated the opportunity of enhancing the afforestation programme (80%) through community approach/partnership, followed by development of pest- and disease-resistant varieties (78%), increase in grassland area for grazing (64%) and ensuring availability of high quality planting materials (56%). Other opportunities stated were, reducing the use of chemical fertilizers and pesticides (50%), increasing homestead plantation (46%) with diverse species, providing access to the communities to forest land (44%) for resource collection, improving drainage system to reduce flooding/water logging conditions (30%) and providing loans or credit to overcome the crisis.

Table 12. Opportunities to solve the problems, as suggested by the community for their better livelihood in the study area

Opportunities suggested by the respondents	Respondents' opinion	
	Percent	Rank
Construction of water reservoirs (small pond, ditches, dam) to preserve water	88	1
Afforestation through community approach/partnership	80	2
Development of pest- and disease-resistant variety	78	3
Provision of grass land for grazing livestock	64	4
Availability of high quality planting material/seeds	56	5
Reduction of use of chemical fertilizer and pesticide	50	6
Increase homestead plantation with diverse species	46	7
Provide access of resource collection from forest area	44	8
Improvement of drainage system to reduce flooding/water logging condition	30	9
Provide loan or credit to overcome the crisis	26	10

CONCLUSION

This study showed that socio-economic status of local community in the periphery of Tangail District of Bangladesh was defined by a poor resource base and by heavy dependence on the forest ecosystem for livelihoods in the past. Currently, the dependency on forest and forest products, along with other resources such as vegetation and water, has reduced noticeably. Increasing trend of climate change, particularly in temperature and erratic rainfall and anthropogenic activities like deforestation, could be the reasons for decrease in natural resources. Among the anthropogenic activities, illegal harvesting and over-exploitation of forest and forest products are the main driving forces. Because of decline in the availability of forest products and restriction of access of communities to the forest area imposed by the Department of Forest, communities have been shifting their livelihood activities to farming, especially in homestead and surrounding cropland, and other off-farm activities. They have also started migrating to other places during the non farming seasons. However, the overall quality of the lifestyle of the forest-dependent people is declining.

To conserve forest resources and maintain the environment, the government has restricted the access of people to forestland for harvesting forest products and promoted social forestry activities. The community people have fully accepted the social forestry programme and are co-operating in its execution. The community people have taken some adaptation measures, such as changing planting time and using new technologies. However, they strongly stated that the authorities concerned should take appropriate measures for adapting climate change, with specific priority on the construction of water reservoirs, afforestation through community approach/partnership, and development of pest- and disease-resistant varieties. These measures can have positive benefits for combating the impacts of climate change to a considerable extent and creating better livelihood opportunities.

ACKNOWLEDGEMENT

This research is financed by the Asia Pacific Network provided through ForestAction Nepal and the research activities are assisted by Faculty members of the Department of the Agroforestry and Environment, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh.

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