Adaptation practices of climate change in agriculture by the farmers of Phulbari upazila of Kurigram district in Bangladesh

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Abstract

The main purpose of this study was to determine and describe some socio-demographic character of farmers, the extent of adoption of climate change adaptation practices, explore relationship between selected characteristics and climate change adaptation practices as well as determining the problem faced by the farmers for climate change adaptation. Data were collected using interview schedule from a sample of 96 farmers (exactly 30% of population) out of 320 farmers. For selection of the sample of the study simple random sampling technique was followed. Besides the usual descriptive statistical parameter, Pearson's Product Moment Correlation Coefficient (r) was used for the statistical analysis. Adoption of climate change adaptation practices was determined on 23 selected practices. For comparative analysis of adoption of climate change adaptation practices by the farmers in individual practices "Adoption of Climate Change Adaptation Practices Index (ACAPI)" was calculated. The highest proportion of the farmers adopt 'Pit crop in homestead' (ACAPI= 230.7) as climate change adaptation practice. The lowest adopted practice for climate change adaptation was observed 'Saline tolerant sugarcane variety ISWARDI-40 cultivation' with ACAPI value of 37.3. The highest proportion (82.3 percent) of the farmer had medium adoption of practices, while 11.5 percent had high and only 6.3 percent had low adoption of climate change adaptation practices. Among the nine selected characteristics of the farmer's education, annual income, organizational participation and training received showed positive relationship with adoption of climate change adaptation practices; while their age, family size, farm size aspiration and climate change awareness had no significant relationships. 'Lack of knowledge regarding modern agricultural technologies' (64.58 percent) emerged as the most important problem expressed by the farmers. The foremost suggestion cited by the farmers (54.17 percent) was 'Organizing more training program for the farmers'. Community involvement should be emergency to practice the climate change adaptation to the study area. So, it's the demand of time to establish something or some policy to take them in action.

Key words: Climate change, adaptation, agriculture, Kurigram, Banglades

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Introduction

Bangladesh is predominantly an agricultural country (BBS, 1993). Bangladesh is frequently cited as one of the most vulnerable countries to climate change (Huq and Ayers, 2007; Rahman and Alam, 2003) 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 and fisheries and inefficient institutional aspects (Cell, 2006). The major elements of climate change including temperature and precipitation has been gradually changing over the period (MOEF, 2005).

Agriculture is the single largest producing sector of the economy and it contributes about 13.41 percent of the Gross Domestic Product (GDP) (Bangladesh, 2017). This sector also accommodates around 48.1% of labor force (BBS, 1993). Although due to natural calamities loss of food and cash crop is almost regular phenomenon. Bangladesh incurs annual loss of 1.81 percent of GDP due to extreme weather events. Total losses were 2.19 billion dollars a year from 1990 to 2008. Bangladesh scores eight on risk index (Ahmad *et. al*, 2001; Anonymous, 2010).

Agriculture is already under pressure mainly due to an increase in demand for food as well as depletion of land and water resources. Climatic change possesses serious threat to our country specially on our economy through damaging agricultural resources, but the use of adaptation technologies is very few. Majority of farmers are illiterate and have small farm size. Farmers do not change agricultural practices to improve water efficiency and crop diversification. Suitable adaptation of environmental friendly agricultural technology and disaster risk management practices need to be identified, tested and integrated into national food security strategies and policies in order to improve food security under a changing climate. The research work was conducted to explore the relationship between selected characteristics of the farmers and their extent of adoption of climate change adaptation practices as well as for finding out the problems faced by the farmers in adopting adaptation practices for climate change and their probable suggestions to overcome the problems.

Materials and Methods

***Study location*:** The study was conducted in Phulbari Upazila under Kurigram district. The district is situated on the bank of Teesta River. Phulbari Upazila was selected following simple random sampling technique for the study because the agricultural features and the vulnerability of climate change. The study location map is showing in the following Figure 1.

***Sampling and socio-economic information*:** An interview schedule was prepared for collection of data from the respondents keeping the objectives of the study in mind. Data for the study were collected through personal interview. During the collection of data, both primary and secondary sources were considered. Primary data were collected from respondents. An up-to-date list of 320 farmers was prepared with the help of the Upazila Agriculture Office, Upazila Agriculture Extension Officer and Sub-Assistant Agriculture Officer of the DAE. From these farmers, 96 (exactly 30.0 percent) were selected as the sample by using simple random sampling technique. A reserve list of 10 farmers (about 10 percent of sample size) was prepared so that these farmers could be used for interview in case any farmer included in the original sampled farmer was not available in spite of utmost effort during collection of data. All of the data were collected considering on the respondents' age, educational qualification, occupation, their farm size and equal in gender.
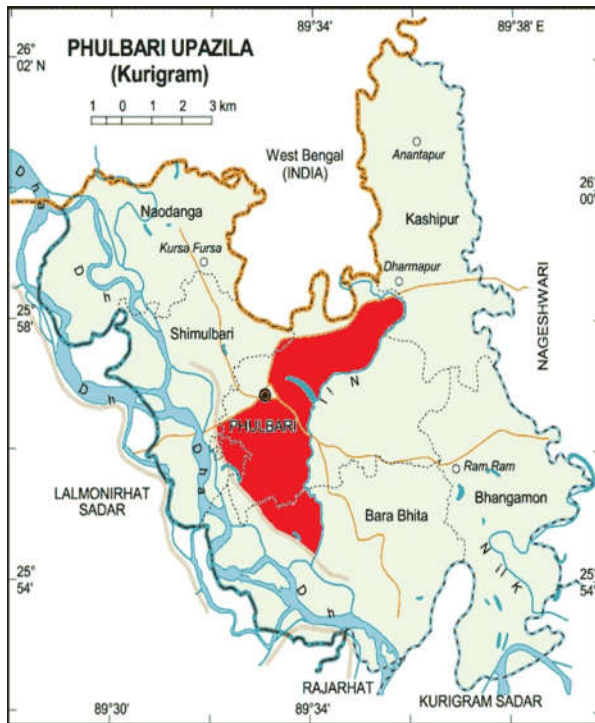

254
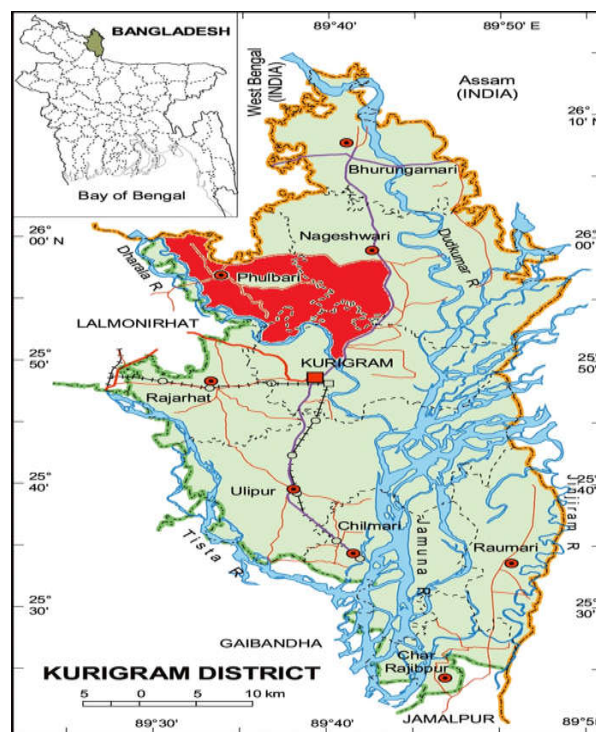
Figure 1. Map of study area including district and upazila.

Formulation techniques

***Development of* indices:** For comparative analysis of adoption of climate change adaptation practices by the farmers in individual practices "Adoption of Climate Change Adaptation Practices Index (ACAPI)" was calculated by using the following formula:

ACAPI= 3 x Prea + 2 x Poa + 1 x Praa + 0 x Pna

Where,

ACAPI = Adoption of climate change adaptation practices index

Prea = Percentage of farmers with 'regularly' adoption of adaptation practices

Poa = Percentage of farmers with 'occasionally' adoption of adaptation practices

Praa = Percentage of farmers with 'rarely' adoption of adaptation practices

Pna = Percentage of farmers with 'not at all' adoption of adaptation practices

In respect of any practices adoption the "Adoption of Climate Change Adaptation Practices Index" could range from 0 to 300, where 0 indicating no adoption and 300 indicating high adoption.

Data processing and statistical analysis: Data were systematically recorded, edited, compiled, arranged, tabulated and computerized for statistical analysis. The software SPSS were used for data management and analysis. Descriptive statistical measures such as frequency, range, mean, co-efficient of variation, rank and percentage were used to categorize the farmers. Pearson's product moment correlation co-efficient (r) was used to examine the relationships of characteristics of the respondents (independent variables) with technology adoption on climate change adaptation (dependent variable). At least 5 percent (P= 0.05) level of probability was used as a basis for rejection of the null hypothesis throughout the study.

Results and Discussion

Socio-demographic characteristics of the farmers: A variety of attributes that aggregate in human life influenced on their activity directly and indirectly. For this reason, it can be assumed that different characteristics of farmers may influence the adoption of climate change adaptation practices and hence nine (9) selected characteristics (i.e. age, education, family size, farm size, annual income, organizational participation, training received, aspiration and climate change awareness) were considered as independent variables in this regard. The characteristics of the farmers were classified into suitable categories for description and interpretation in relation to adoption of climate change adaptation practice (Table 1).

Extent of adoption of climate change adaptation practices: The Climate Change Adaptation Practices Index (ACAPI) of the farmers ranged from 37.3 to 230.7 against the possible range 0 to 300. The rank order of each of the practices was made on the basis of ACAPI value (Table 2).

255

Table 1. Salient features of the selected characteristics of the farmers (n=96).

Characteristics	Scoring Method	Range Observed (Possible)	Categories	Respondents No.	Respondents Percent	Mean	SD
Age	No. of year	27-56 (Unknown)	Young aged (≤35)	49	51.0	37.01	9.31
			Middle aged (36-50)	23	24.0		
			Old aged (>50)	24	25.0		
Education	Year of schooling	0-10 (Unknown)	Illiterate (0)	10	10.4	3.23	4.94
			Can sign only (0.5)	31	32.3		
			Primary level (1-5)	32	33.3		
			Secondary level (6-10)	23	24.0		
Family size	No. of members	3-10 (Unknown)	Small (≤4)	12	12.5	5.70	1.88
			Medium (5-6)	60	62.5		
			Large (>6)	24	25.0		
Farm size	Hectare	0.11-1.81 (Unknown)	Marginal (0.02-0.2)	40	41.7	0.48	0.50
			Small (0.21-1.0)	44	45.8		
			Medium (1.01-3.0)	12	12.5		
Annual income	('000' Tk.)	37-286 (Unknown)	Low income (≤45)	13	13.5	115.35	69.80
			Medium income (45-185)	71	74.0		
			High income (>185)	12	12.5		
Organizational participation	Score	0-14 (0-18)	No(0)	18	18.8	3.97	3.76
			Low (≤6)	36	37.5		
			Medium (7-12)	30	31.3		
			High (>12)	12	12.5		
Training received	Score	0-9 (Unknown)	No (0)	37	38.5	2.12	2.42
			Short (≤2)	29	30.2		
			Medium (3-6)	28	29.2		
			Long (>6)	2	2.1		
Aspiration	Score	10-27 (6-30)	Low (≤ 10)	18	18.8	19.80	4.29
			Medium (11-20)	60	62.5		
			High (>20)	18	18.8		
Climate change awareness	Score	4-10 (0-10)	Low (≤6)	18	18.8	7.88	1.54
			Medium (7-9)	66	68.8		
			High (>9)	12	12.5		

Table 2. Distribution of the farmers according to their adoption of climate change adaptation practices.

Sl. No.	Name of the Practices	Percentage of Farmers				ACAPI	Rank Order
		Not at all	Rarely	Occasionally	Regularly		
1.	Cultivation of saline tolerant rice varieties (BRRI Dhan-47, BINA-8)	62.8	19.1	0.0	18.1	73.4	20th
2.	Cropping in the fallow land (sand bar) (Pumpkin, squash, water melon, onion, ground nut)	6.4	24.5	31.9	37.2	199.9	5th
3.	Short duration rice variety (BINA-7) cultivation	12.8	31.9	24.5	30.8	173.3	9th
4.	Floating agricultural practices	70.2	11.7	11.7	6.4	54.3	22nd
5.	Vegetable production on pond embankment	44.7	31.9	5.3	18.1	96.8	19th
6.	Mini pond excavation for supplementary irrigation	18.1	6.4	31.9	43.6	201	4th
7.	Saline tolerant sugarcane variety ISWARDI-40 cultivation	75.5	18.1	0.0	6.4	37.3	23rd
8.	Pit crop in homestead	12.8	6.4	18.1	62.7	230.7	1st
9.	Alternative wet and dry method of Irrigation	56.4	25.5	18.1	0.0	61.7	21st
10.	Introduction of capsular is CVL-1varieties	19.1	19.1	24.5	37.3	180	8th
11.	Zero tillage potato cultivation using straw as mulch	43.6	25.5	12.8	18.1	105.4	18th
12.	Maize cultivation in char areas	12.8	6.4	19.1	61.7	229.7	2nd
13.	Flood tolerant rice BRRI Dhan 51, BRRI Dhan 52 cultivation	18.1	19.1	25.5	37.3	182	7th
14.	Drought tolerant rice varieties like BRRI Dhan 56, BRRI Dhan 57	25.5	38.3	24.5	11.7	122.4	17th
15.	Drought tolerant wheat varieties like BARI Gom 26	31.9	12.8	25.5	29.8	153.2	14th
16.	Organic agricultural practices	37.2	12.8	31.9	18.1	130.9	15th
17.	Cattle rearing	38.3	6.4	12.8	42.5	159.5	13th
18.	Crops Cultivation on embankment	19.1	19.1	38.3	23.5	166.2	11th
19.	Goat/Sheep rearing with Slatted housing	12.8	31.9	0.0	55.3	197.8	6th
20.	Integrated fish culture in case and rice field	12.8	25.5	43.6	18.1	167	10th
21.	Fish culture in fallow water body (Khal)	25.5	19.1	24.5	30.9	160.8	12th
22.	Vermin Compost culture	19.1	44.7	24.5	11.7	128.8	16th
23.	Off-farm IGA (small business) for alternative livelihood	6.4	18.1	25.5	50	219.1	3rd

ACAPI = Adoption of Climate Change Adaptation Practices Index.

Data in Table 2 revealed that the highest proportion of the farmers adopt 'Pit crop in homestead' (ACAPI= 230.7) as climate change adaptation practice in the study area. The result might be due to that the pit crop cultivation is easier in homestead and it can do by any member of the family.

The second highest adopted practice for climate change adaptation was found 'Maize cultivation in char areas' (ACAPI= 229.7). The findings might be due to that maize is a year round crop and can easily adapt in any area. It is more profitable than other crops so, farmers may have high interest to cultivate maize in their fields especially in the char lands.

The lowest adopted practice for climate change adaptation was observed 'Saline tolerant sugarcane variety ISWARDI-40 cultivation' with ACAPI value of 37.3. This finding might be due to that there has a lowest salinity problem in Tista riverine areas in Bangladesh. So, farmers are not so much interested to cultivate ISWARDI-40 sugarcane. The lowest adopted practice for climate change adaptation was found 'Floating agricultural practices' with ACAPI value of 54.3. This might be due to that only vegetable can be cultivated through floating agricultural technology and it's very laborious and costly job. So, farmers are less interested to adopt this practice. Therefore, it obtained the second lowest position in the rank table.

Relationships between the selected characteristics of the farmers and adoption of climate change adaptation practices

Relationships of the 9 independent variables with the adoption of climate change adaptation practices as found by correlation test are described in this section. The computed co-efficient of correlation (r) between the independent and dependent variable (Table 3).

***Age and adoption of climate change adaptation practices*:** The computed value of coefficients of correlation between age and adoption of climate change adaptation practices was found -0.079 as shown in Table 3. This led to the following conclusions

regarding the relationship between the concerned variables.

The relationship showed a negative trend. Based on the above findings, the null hypothesis could not be rejected and hence, the researcher concluded that age had no significant relationship with the adoption of climate change adaptation practices. Similar findings were also observed by Karim, 2011.

Table 3. Relationship between the dependent and independent variables.

Dependent Variable	Independent Variables	Computed Values of 'r' with 94 d.f.
Adoption of Climate Change Adaptation Practices	Age	-0.079
	Education	0.246[*]
	Family size	0.088
	Farm size	0.078
	Annual income	0.245[*]
	Organizational participation	0.307[**]
	Training received	0.230[*]
	Aspiration	-0.077
	Climate change awareness	0.116

*, significant at 5 percent level of significance,
**, significant at 1 percent level of significance.

***Education and adoption of climate change adaptation practices*:** The computed value of coefficients of correlation between education and adoption of climate change adaptation practices was found to be 0.246[*] as shown in Table 3. This led to the following conclusions regarding the relationship between the variables.

The relationship showed a positive trend. On the basis of the above findings, the null hypothesis was rejected and therefore it was concluded that education of the farmers had a significant positive relationship with the technology adoption for climate change adaptation. The relationship between the variable indicate that the more the education of the farmers the more the

adoption of climate change adaptation practices. A similar finding was experienced by Hossain, 2003; Jewel and Khan, 2007; Karim, 2011.

Family size and adoption of climate change adaptation practices: The computed value of coefficients of correlation between family size and adoption of climate change adaptation practices was found to be 0.088 as shown in Table 3. The relationship showed a positive trend between the concerned variables. Based on the above findings, the null hypothesis cannot be rejected and hence, the researcher concluded that family size had no significant relationship with adoption of climate change adaptation practices. A similar finding was found by Jewel and Khan, 2007; Karim, 2011; Islam, 2005.

Farm size and adoption of climate change adaptation practices: The computed value of coefficients of correlation between farm size and adoption of climate change adaptation practices was found 0.078 (Table 3). In respect of relationship between these two variables the following observations were made.

Firstly, relationship showed a tendency in the positive direction between the concerned variables. On the basis of above findings, the null hypothesis may not be rejected and hence it was concluded that farm size had no significant relationship with adoption of climate change adaptation practices. The finding has conformity with the findings of Aurangozeb (2019).

Annual income and adoption of climate change adaptation practices: The computed value of coefficients of correlation between the annual income and adoption of climate change adaptation practices was found 0.245[*] (Table 3). The following observations were recorded in respect of relationship between these two variables on the basis of coefficients of correlation.

The relationship showed a tendency in the positive direction between the two variables. The relationship was statistically significant. Based on the above findings, the null hypothesis was rejected and hence the

researcher concluded that annual income had a positive significant relationship with technology adoption for climate change adaptation. The findings are quite logical, because respondents are influenced to adopt improved farming practices, which in turn, increases farm output and eventually improves financial condition of their family. A similar result also reported by Jewel and Khan, 2007; Karim, 2011; Hussen, 2001; Islam *et al.*, 2017a,b; Islam, 2013.

Organizational participation and adoption of climate change adaptation practices: The computed value of coefficients of correlation between organizational participation and adoption of climate change adaptation practices was found to be 0.307[**] (Table 3). This led to the following conclusion regarding the relationship between the variables.

The relationship showed a positive trend. The relationship was statistically significant at 1 percent level of significance. On the basis of the above findings, the null hypothesis was rejected and therefore it may be concluded that organizational participation of the farmers had a significant positive relationship with the adoption of climate change adaptation practices. The relationship between the variable indicate that the more the organizational participation of the farmers the more the adoption of climate change adaptation practices. Similar result was found by Chowdhury, 1997; Jewel and Khan, 2007; Mostafa, 1999.

Training received and adoption of climate change adaptation practices: The computed value of coefficients of correlation between training received and adoption of climate change adaptation practices was found to be 0.230[*] (Table 3). This led to the following conclusion regarding the relationship between the variables.

The relationship showed a positive trend. The relationship was statistically significant at 5 percent level of significance. On the basis of the above findings, the null hypothesis was rejected and therefore it may be concluded that training received of the farmers had a significant positive relationship with the

adoption of climate change adaptation practices. The relationship between the variable indicate that the more the training received of the farmers the more the adoption of climate change adaptation practices. Similar result was experienced by Karim, 2011.

Aspiration and adoption of climate change adaptation practices: The computed value of coefficients of correlation between aspiration and adoption of climate change adaptation practices was found to be -0.077 (Table 3). The following conclusions are made regarding the relationship between the concerned variables under consideration on the basis of correlation coefficient.

The relationship showed a negative trend. The relationship was not statistically significant. On the basis of the above findings, the null hypothesis may not be rejected and therefore it may be concluded that aspiration of the farmers had no significant relationship with adoption of climate change adaptation practices. The relationship between the variable indicate that the more the aspiration of the farmers less the adoption of climate change adaptation practices.

Climate change awareness and adoption of climate change adaptation practices: The computed value of coefficients of correlation between climate change awareness and adoption of climate change adaptation practices was found to be 0.116 as shown in Table 3.

This led to the following conclusions regarding the relationship between the variables.

The relationship showed a positive trend between the concerned variables. Based on the above findings, the null hypothesis cannot be rejected and hence, the researcher concluded that family size had no significant relationship with the adoption of climate change adaptation practices.

Problems and Suggestions

Farmers may face several problems that hinder smooth adoption of climate change adaptation practices. For easy understanding of the problems faced by the farmers and the suggestions to overcome the problems given by them are listed in this section with their number of citation, percent and rank order.

Problems faced by the farmers in adoption for climate change adaptation practices: The researcher made an attempt to identify the various problems in adoption for climate change adaptation practices which are presented below (Table 4).

It is evident from the results contained in the Table 4 that 'Lack of knowledge regarding modern agricultural technologies' (64.58 percent) emerged as the most important problem expressed by the farmers. The result may be due to that the relevant organization may not arrange sufficient training for the farmers.

Table 4. Rank orders of problems faced by the farmers in adoption of climate change adaptation practices.

Problems	No. of citation	Percent	Rank order
Lack of knowledge regarding modern agricultural technologies	62	64.58	1st
Lack of knowledge on climate change adaptation	46	47.92	2nd
Shortage of proper training about updated technology	28	29.17	3rd
Lack of proper knowledge about service providing institution	23	23.96	4th
Unconsciousness about using local resources	19	19.79	5th

Although some short duration trainings are arranged they may not fulfill farmer's information need. 'Lack of knowledge on climate change adaptation' (47.92 percent) was the second most problem perceived by the farmers. It is due to that farmers may not aware about climate change adaptation. Afrin *et al.* (2017) also reported that the deficiency of knowledge on climate change adaptation is one major problem in Bangladesh. The last problem in the rank table mentioned by the farmer (19.79 percent) was 'Unconsciousness about

using local resources'. This might be due to that the all farmers are not sincere using local resources.

Suggestions offered by the farmers to overcome the problems: Many suggestions were offered by the farmers to overcome the problems in adoption of climate change adaptation practices. These are given in Table 5.

Table 5. Rank order of suggestions offered by the farmers to overcome the problems in adoption of climate change adaptation practices.

Suggestions	No. of Citation	Percent	Rank Order
Organizing more training program for the farmers	52	54.17	1st
Involvement of the farmers in different community programs	47	48.96	2nd
Proper utilization of local resources	31	32.29	3rd
Development of value chain program	22	22.92	4th
Increasing awareness among farmers about agricultural technology	13	13.54	5th

It is noted from the result in the Table 5 that the foremost suggestion cited by the farmers (54.17 percent) was 'Organizing more training program for the farmers'. This implies that more will be the training more will be information gathered by the farmers. Training programs are more helpful in enhancing farm knowledge to them. 'Involvement of the farmers in different community programs' offered by the farmers (50.0 percent) as second ranked suggestion in the rank table. This is due to that more the involvement more will be sincere about technology. 'Increasing awareness among farmers about agricultural technology' was suggested by the farmers (13.54 percent) as the last suggestion. Similar reports observed by Afrin *et al.* (2017). The result might be due to that more awareness will create more opportunity of technology adoption.

Conclusion

The inclusive study concluded that the climate of the study area is changing latterly as all the climatic factors indicated a changing trend. Furthermore, the changing trend triggered great impact or vulnerability or effects alike increase impact on food, dead river, effect on agricultural land, low land, water reservoir, urban areas, ground water recharge, surface water quality and so many belongings of this area. The adoption of the climate change adaptation practices by the farmer are quite difficult due to their traditional aspects and lack of knowledge. The technological improvement and awareness program will be enough to practice them about the phenomena. Socio-demographic aspects will be developed by the influence of the higher authority and it will be most important strength to them for fighting against the climatic change. Community involvement should be emergency to practice the climate change adaptation to the study area. So, it's the demand of time to establish something or some policy to take them in action.

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