Options and Determinants of Livelihood Diversification under Environmental Change in Coastal Communities of Bangladesh

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Abstract

The study aims to investigate the options and determinants of livelihood diversification strategies adopted by the climate-vulnerable coastal communities in Bangladesh. In order to peruse the research objective, a set of statistical tools such as mean, standard deviation, Simpson Index (SI), Herfindahl Index (HI), Priority Index (P.I), and multiple linear regression model have been applied. Simple random sampling has been used to select the sample, and multistage sampling has been applied to select the study area. The descriptive statistics show that most household heads are middle-aged and have completed the secondary education level. A total of 12 diversified economic activities adopted by the respondents have been identified. Fish cultivation, rice production, domestic bird rearing and working as agricultural labour are commonly adopted activities. The annual return from the above economic activities varies widely. The estimated results from the SI and HI show that the overall diversification level is not satisfactory among the respondents. There is still scope for increasing diversification levels. In addition, the estimated regression result indicates that age, education, earning family member, social organisation, government donation positively influences the decision to take diversified economic activities. Besides, natural disasters, risk, poor roads, lack of money and access to institutional credit have been identified as barriers to livelihood diversification activities. The research findings provide a deep understating of the existing livelihood diversification strategies in the context of the coastal region of Bangladesh.

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Introduction

The livelihood diversification (LD) strategy is expected to promote economic growth and reduce rural poverty in developing countries [1]. Livelihood diversification often refers to the process of combining both agricultural and non-agricultural activities to survive and improve the standard of living [2-5]. Households across the developing countries are trying to diversify their livelihood activities to secure from risks and cope with economic and environmental shocks[2, 6, 7]. By providing alternative non-farm job opportunities, livelihood diversification is crucial in sustainable environmental development and rural poverty reduction[8].

Climate change has emerged as a threat to natural life and livelihood systems[9]. In order to cope with the changing situation, smallholder farmers in the coastal regions are adopting both on-farm and off-farm adaptive strategies such as selling household assets, migration of the entire households and decreasing food consumption/changing diets, planting drought-tolerant crops. These diversified activities are taken to manage risk and improve the lives of the farming households[6, 10]. Several factors such as education level, the number of livestock, and farming experience affect the adoption of diversified activities[11]. Most importantly, the household head's age, cropland possession, and distance from markets are essential determinants of livelihood diversification strategy [12-14].

Despite having a negligible contribution to global emission, Bangladesh is experiencing the adverse impact of global warming in changing climate [15]. Farmers are being forced to alter or diversify their agricultural activities to cope with climate-driven water availability[16]. Besides, several natural disasters such as cyclones, floods, tidal surges, droughts, salinity intrusion, and waterlogging are posing severe threats to the life and livelihoods of the coastal communities of the country [17, 18]. In addition, the rural riverine households in Bangladesh are confronted with many climate-driven hazards, including riverbank erosion, resulting in the loss of productive land and other natural resources of the riverine households, thus threatening their livelihoods and food security [19, 20].

In order to tackle these events, the household in the community considers taking multiple economic activities to reduce the loss. Taking these activities into their portfolio has successfully increased their capacity to prevent significant

threats and losses. However, there is very little research on the issue from the context of the country. In order to increase the understanding of the issue, the current research employs rigorous and in-depth effort to bring light to the factors affecting livelihood diversification strategies and available effective diversification strategies in the context of the coastal region of Bangladesh.

Methodology

Study area selection

A multistage sampling technique has been applied to select the study area. In the preliminary stage, Satkhira District, one of the south-west coastal districts of Bangladesh[21], has been chosen as the primary sampling unit (PSU). After that, Shyamnagar Upazila (sub-district) under Satkhira District has been selected as a secondary sampling unit (SSU) (Figure 1). The Upazila is situated between 21°36′ and 22°24′ north latitudes and between 89°00′ and 89°19′ east longitudes covering an area of 1968.24 square kilometres [22].The reason for choosing Upazila as the study area is that this area is located near the coastal belt [23] and is highly vulnerable to natural disasters such as cyclones, flood, salinity intrusion [24].

Selection of sample

Smallholder farmers from Burigoalini, Munshiganj, and Atulia unions of Shyamnagar Upazila have been chosen as the research sample. A total of 60 samples has been selected by applying a simple random sampling technique. A pilot survey has been conducted in the study area to test the questionnaire's validity and reliability before collecting the final data. After the pilot survey, a pre-tested structured questionnaire collected final data using the face-to-face interview method between February and March 2019. In addition, focused group discussion, key informants and observation methods have been used to supplement the data collection procedures.

Data analysis methods

In order to analyse the collected data, a set of statistical and econometric tools has been used. Descriptive statistics such as mean, standard deviation, minimum, and maximum have been used to examine the respondents' socioeconomic status. Simpson Index (SID) and Herfindahl Index (HI) have been used to demonstrate livelihood diversification. Multiple linear regression has been applied to identify the determinants of livelihood diversification. Priority Index (P.I) has been used to rank the constraints to adopting diversified activities.
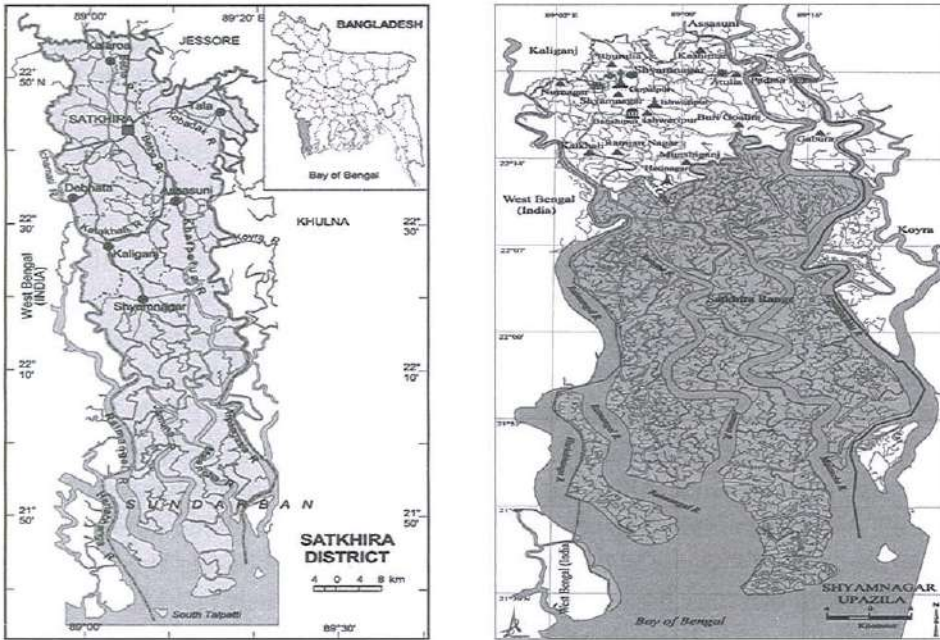
Figure 1. Location of the study area: The Shyamnagar Upazila.
Source: Author compilation based on Banglapedia [22].

Simpson Index (SI)

Several indicators and indices such as Simpson index, Herfindahl index, Ogive index, Herfindahl–Hirschman index, Entropy index, Composite Entropy index have been used to measure the household livelihood diversification. Among them, the Simpson index is widely used for its simple calculation procedure and wider acceptability. This research adopts the Simpson index from [25] formulated in Equation 1.

$$\text{HI} = \sum_{i=1}^{n} (s_i^2) \dots 2$$

Where N denotes the total number of income sources and Pi indicates the income proportion of the ith income source. The value of SI lies between 0 and 1. When there is an entire specialisation, the value of SI becomes 0, and when it moves towards 1, there is an increase in diversification level.

Herfindahl Index (HI)

Another popular and widely used index to measure economic diversity is the Herfindahl Index (HI)[26]. The Herfindahl Index can also measure the level of household diversification formulated in Equation 2 [27, 28].

$$HI = \sum_{i=1}^{n} (S_i^2) \dots 2$$

Here, Si represents the share of each livelihood activity i to the overall income of the household. The value of HI ranges from 0 (when the household has a large number of economic activities or high diversity) to 1 (when the household's income comes from a small number of economic activities or entire specialisation.

Regression Analysis

Multiple linear regression has been used to identify the determinants of livelihood diversification. The general form of the regression model is given in Equation 3[25, 29].

$$D_{ij} = \beta_0 + \beta_i X_i + \mu \dots 3$$

Here,

D is the dependent variable indicating diversification of household i measured in the number of activities j.

$\beta 0$: Constant

βi: Vector of parameters

Xi: Vector of independent variables,

i: 1,2, 3,1 households, j: Number of household economic activities

The description of the independent variables has been presented in Table 1.

Constraint Analysis

The socioeconomic and environmental factors highly influence the number of diversified activities adopted by the household. A set of constraints has been identified and ranked using the priority index given in Equation 4[30].

$$P.I = \sum Sifi/n \quad (0 \leq P.I \leq 1) \dots \dots \dots (4)$$

Here, P.I = Priority Index, Si = Scale value of ith priority, fi = frequency of ith priority, N = Total number of observations A five-point scale has been applied to construct the index, where the scale values range from 1 to 0 with the priority of 1st to 5threspectively.

Table 1: Description of variables

Sl.	Variable Name	Unit of Measurement	Definition
1	Age (X_1)	In year	The age of the household head.
2	Education (X_2)	In the year of schooling	The education status of the household head.
3	Family Member (X_3)	In number	A total family member of a household.
4	Earning Member (X_4)	In number	Total earning member of a household.
5	Educated Family Member (X_5)	In number	A family member who completed ten years of schooling
6	Distance (X_6)	In Kilometre	The distance from home to the nearest town.
7	Loan (X_7)	Dummy (1= yes, 0 = otherwise)	Whether loan/credit taken by the household in the last three years.
8	Training (X_8)	Dummy (1= yes, 0 = otherwise)	Whether the household head has taken any professional training.
9	Social Work Participation (X_9)	Dummy (1= yes, 0 = otherwise)	Whether the household head has participated in any social works.
10	Health/Financial Problem (X_{10})	Dummy (1= yes, 0 = otherwise)	Whether a household head has any financial or health-related problems.
11	Forest Resource Use (X_{11})	Dummy (1= yes, 0 = otherwise)	Whether the household uses resources from the adjacent forest.
12	Govt. Donation (X_{12})	Dummy (1= yes, 0 = otherwise)	Whether the household has got any government donation.

Source: Author compilation.

Results and Discussion

Socio-demographic characteristics

Table 2 shows the general characteristics of the respondents. It has been found that the average age of the respondents is around 46 years old, with a minimum of 27 years to a maximum of 70 years. More than fifty per cent of the respondents belong to the age group 36 years to 50 years. The size of the family varies from household to household. Survey data revealed that nearly 60% of the household has a family member of 4 to 6 people.

The educational status of the household head is found to be below secondary level, on average six years of schooling completed. It has been found that the majority of the respondents (53%) have completed secondary level education. On the other, 33%respondents have completed primary school. It has also been noted that 75% of households have at least 1-3 members who have completed at least ten years of schooling. In general, the household head is the main earning person

Table 2: General profile of the respondents

Characteristics	Frequency	Per cent (%)
Age		
15-35	8	13
36-50	32	53
51-64	17	29
64+	3	5
Mean	46.52	
Education (household head)		
Illiterate	1	2
Primary	20	33
Secondary	31	53
Higher Secondary	3	5
Graduate	4	7
Mean	6.93	
Education (family member)		
0	12	20
1-3	45	75
4-6	3	5
Mean		
Family size		
0-3	12	20
4-6	38	63
6+	10	17
Mean	4.95	
Earning member (except the household head)		
0-2	47	78
3-4	13	22
Mean	1.8	
Household landholding (acre)		
0-2	41	69
3-4	9	15
5-7	8	13
7+	2	3
Mean	2.19	

Source: Author's compilation.

of the family. The surveyed data reveal that 77 per cent of households have at least 1-2 earning people along with the household head. However, the amount of cultivatable land holding possessed by the households is minimal. A majority of

the respondents (69%) own only 0 to 2 acres of land, whereas the average possession of land remains 2.19 acres per household.

Figure 2: Economic activities of the household
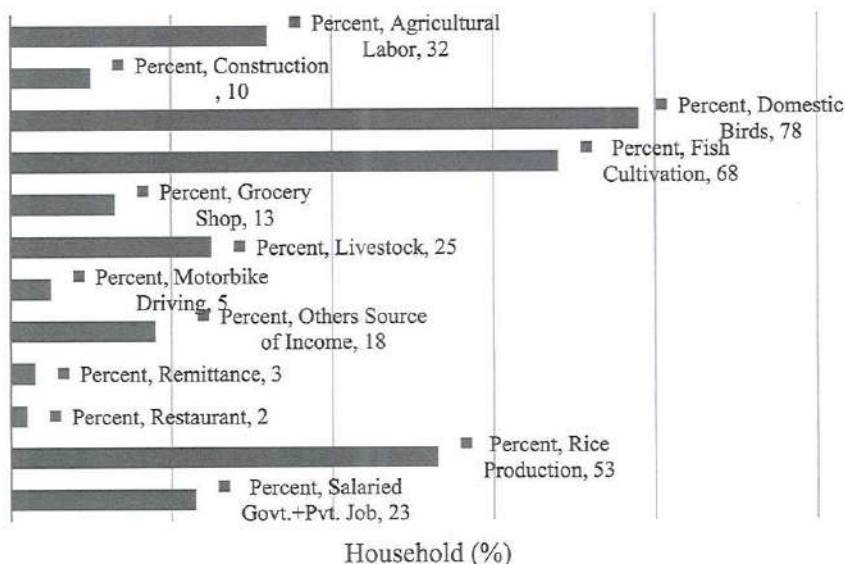
Household (%)

Source: Author compilation.

Types of diversified economic activities

Figure 2 presents the diversified economic activities adopted by the household to secure their income flow. Twelve diversified economic activities have been identified and categorised as primary, secondary, and tertiary activities. Primary economic activities generally are agricultural-based, such as rice and fish cultivation, rearing livestock and domestic birds, and working as agricultural labour.The secondary activity includes working in the construction sector. Lastly, some economic activities have been identified as tertiary level activities such as running grocery shops, restaurants, driving motorbike, working in government and non-government organisations, and receipts money as a remittance. It has been seen from Figure 2 that a large share of the annual income of the respondents come from primary activities. The survey results indicate that more than half the respondents get income from rice production (53%), domestic bird rearing (78%), and fish cultivation (68%). On the other hand, a negligible portion of the respondents (10%) secure income from the construction sector. Grocery shop business is run by 13% of the respondents, and 23% are engaged in salaried government and non-government organisations.

Household yearly income share from diversified economic activities

Table 3 represents an annual average income share from various economic activities of the households. The analysed data show that among the broad economic activities, a small number of them provide high returns to the households. The annual average earning from domestic bird rearing becomes BDT3,734 which is adopted by 78% of the respondents. From fish cultivation, 68% of respondents earn on average BDT1.34 lakhs per year. On the other hand, 53% of them get BDT24,000 per year by cultivating rice. In addition, by working

Table 3: Share of annual income from various economic activities

Type of Activities	Average Earning (BDT)	Frequency	Per cent
Domestic Birds	3,734	47.00	78.33
Fish Cultivation	1,34,619	41.00	68.00
Rice Production	24,575	31.00	53.00
Agricultural Labor	48,105	19.00	32.00
Livestock	37,062	15.00	25.00
Salaried Govt.+Pvt. Job	1,46,357	14.00	23.00
Others Source of Income	2,33,545	11.00	18.33
Grocery Shop	1,72,500	8.00	13.33
Construction	42,666	6.00	10.00
Motorbike Driving	80,000	3.00	5.00
Remittances	75,000	2.00	3.33
Restaurant	50,000	1.00	1.67
Overall	2,47,358	60	100

Source: Author's compilation.

Table 4: Distribution of respondents on the extent of diversification

Range	Simpson Index (SI)		Herfindahl Index (HI)	
	Frequency	Percentage	Frequency	Percentage
0	1	2	0	0
0.01-0.10	10	17	0	0
0.11-0.20	6	10	1	2
0.21-0.30	4	7	3	5
0.31-0.40	9	15	8	13
0.41-0.50	9	15	11	18
0.51-0.60	8	13	6	10
0.61-0.70	8	13	11	18
0.71-0.80	4	7	2	3
0.81-0.90	1	2	8	13
0.91-1.00	0	0	10	17
Total	60	100	60	100
	Mean = 0.39; SD = 0.24		Mean = 0.62; SD = 0.23	

Source: Author compilation.

as agricultural labour, some of the respondents (32%) also receive on average BDT48,000 per year. Though the annual return of livestock rearing is nearly BDT37,000 per year, only 26% of the respondents are engaged in this occupation. The annual earnings from the salaried job and grocery business are higher than the other occupations (construction, motorbike driving, restaurant and remittance), although very few of the respondents are involved therein.

Extent of diversification

Table 4 demonstrates the estimated results from the Simpson Index (SI) and Herfindahl Index (HI) to measure the extent of household livelihood diversification. It has been found that the mean value of SI is 0.39 indicating low levels of diversification among the respondents. In addition, it has also been seen that 27% of respondents have indexed values below 0.20. Only 30% of them reach indexed value ranges from 0.30 to 0.50, meaning almost half of the respondents have a lower level of diversification activities.On the other hand, 9% of the respondents are found to be highly diversified. The estimated results from Herfindahl Index have confirmed the same result.

Table 5: Determinants of livelihood diversification

Variable	Coefficients	Standard Error	t	P>|t|
Age (X_1)	0.009	0.02	0.44	0.66
Education (X_2)	0.023	0.05	0.45	0.65
Family Member (X_3)	0.018	0.12	0.15	0.88
Earning Member (X_4)	0.451*	0.25	1.84	0.07
Educated Family Member (X_5)	0.230	0.17	1.34	0.18
Distance (X_6)	0.086	0.07	1.30	0.20
Loan (X_7)	-0.177	0.38	-0.46	0.64
Training (X_8)	-0.220	0.40	-0.55	0.58
Social Work Participation(X_9)	0.560*	0.33	1.69	0.09
Health/Financial Problem (X_{10})	0.515	0.46	1.13	0.26
Forest Resource Use (X_{11})	0.299	0.50	0.60	0.55
Govt. Donation (X_{12})	0.999**	0.38	2.66	0.01
Constant	-1.357	2.16	-0.63	0.53
R^2	0.41			
F value	2.74***			
Observation	60			
Mean VIF	1.87			

Note: * = significant at the 10 percent level, ** = significant at the 5 percent level,
     *** = significant at the 1 percent level.
Source: Author compilation.

Table 6: Ranking of barriers to adopt diversified activities

Indicator	1st (S=1)	2nd (S=.75)	3rd (S=.50)	4th (S=0.25)	5th (S=0)	Σf_i	PI	Rank
Disaster Frequency	38	9	13	0	0	60	0.85	1
Risk on New Job	5	44	6	5	0	60	0.70	2
Road Condition	2	43	14	1		60	0.69	3
Source of Job	1	15	38	3	3	60	0.53	4
Access to Bank Loan	0	9	40	7	4	60	0.48	5
Scope of New Job	2	7	38	8	5	60	0.47	6
Money for New Venture	1	2	48	4	5	60	0.46	7

Source: Author's compilation.

Determinants of livelihood diversification

A set of factors has been identified to influence the livelihood diversification activities among the respondents by using a multiple linear regression model (Table 5). It has been seen that the value of R2 is 0.41 indicating a 41 percent change in the number of diversified activities adopted by the respondents can be explained by the explanatory variables used in the model.The estimated value of the F-value is statistically significant at the 1 percent level, confirming that the model specified is statistically significant. In addition, the mean value of VIF is 1.87 suggesting no multicollinearity among the explanatory variables used in the model. Results of regression analysis show that the estimated coefficient of age, education and family member positively affect the number of livelihood activities of the respondents, although they are found to be statistically insignificant.

On the other hand, the estimated coefficient of the number of earning members is 0.451, having a positive influence on the livelihood activities, and it is statistically significant at the 10 percent level. In addition, the tendency to participate in social activities leads to affect the livelihood diversification activities. Besides, respondents' tendency to adopt diversified activities is positively influenced by donations from the government, and this relationship is statistically significant at the 5 percent level. Other factors such as the number of educated family members' distance from home to the nearest town, health/financial problems, and use of forest resources are positively associated with the number of diversified activities, although they are statistically insignificant. However, estimated coefficients of loan and training are negatively related to the adoption of livelihood activities, although they are statistically insignificant.

Constraint to adopt diversified activities

Table 6 represents some of the significant constraints to adopting diversified activities identified and ranked using the priority index (P.I). The value of P.I ranges from 0 to 1. The calculated survey data show that disaster frequency ranks first among the barriers (P. I = 0.85). Since the study area is highly prone to natural calamities, the frequency and intensity of natural disastersgreatly influence livelihood diversification activities. The respondents' perception reveals that there is a high risk in adopting new activity in the area they reside in. The respondents' much emphasis on other constraints, risk on new job ranked 2nd position. In addition, poor road conditions, everydayjob sources, limited access to the bank loan, the tiny scope of new jobs and insufficient reserve for the new venture are the other essential constraints ranked 3rd, 4th, 5th, and 6th positions, respectively.

Concluding Remarks

The research aims at investigating the options and determinants of livelihood diversification strategies in the context of the south-west coastal region of Bangladesh. The coastal communities are living under the threat of climate-induced natural disasters. In order to secure their income from natural hazards, they have been adopting several adaptation strategies for the past years. Having occupied various economic activities simultaneously is one of the identified adaptation strategies by the people living in the region. Apart from agricultural activities, both secondary and tertiary activities are adopted by the farmers. Mainly, most people's income comes from domestic bird rearing, fish cultivation, rice production, livestock rearing, and salaried government and non-government jobs. Although the community people follow several diversified economic activities, they are not highly diversified due to several socio-environmental problems. Instead, the level of diversification is low. Some influential determinants of occupying diversified activities are age, education, family member, earning member, distance from home to the nearest town, social organisation, and government help. The frequency and intensity of natural disasters are one of the main constraints to adopting diversified activities. Besides, risk on a new job, poor road conditions, and limited access to the bank also act as barriers to carrying out diversified activities. The study suggests that both government and non-government organisations should help the climate-vulnerable communities cope with an increasing number of diversified activities in the coming days.

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