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Poverty and its Risk Factors for the Northeastern Wetland Region of Bangladesh

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ABSTRACT

One of the main challenges facing developing countries is poverty, which is more complicated in rural areas like the wetland part of Bangladesh. That is why development policies based on national-level research occasionally fall short of resolving poverty in rural areas. So, the current study's objectives are to estimate poverty and determine its risk factors for the northeastern wetland region of Bangladesh. This study used data from 2340 households collected by a research project sponsored by the GARE Program, Ministry of Education, GoB. The Cost of Basic Needs (CBN) method and logistic regression were applied to estimate poverty and to extract the potential risk factors, respectively. This study has also performed a bivariate analysis to identify the covariates for the multivariate model. According to the CBN method, 25% of the households lie below the lower poverty line (LPL) and 55% below the upper poverty line (UPL). The findings of the Binary Multiple Logistic Regression (BMLR) model show that geographical region, household size, religion, occupation, micro-credit status, NGO membership, per capita income, agricultural land, electricity connection in the household, and livestock ownership are the significant (p<0.05) risk factors of poverty based on LPL. On the other hand, geographical regions, household size, age, religion, micro-credit status, per capita income, agricultural land, and electricity connection in the household are the significant (p<0.05) risk factors of poverty based on UPL. The factors found in this study may be helpful in the development of strategies and policies aimed at reducing poverty among Bangladesh's wetland populations.

Keywords: Bangladesh, CBN method, logistic regression, poverty, risk factors

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INTRODUCTION

Poverty is a socio-economic issue that persistently exists in society. For the past few decades, it has been a global concern. Poverty is typically defined as a person's consumption or income level falling below

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a particular threshold required to meet basic needs (Bhuiya et al., 2007). People, families, and groups are considered in poverty when they lack the means to follow customs, engage in customary activities, or have the amenities and living arrangements generally accepted or encouraged in the societies to which they belong (Townsend, 1979). The World Bank (2000) stated that "poverty is pronounced deprivation in well-being" (as cited by Haughton & Khandker, 2009). There is much debate regarding what contributes to human well-being. A person's ability to obtain a particular type of goods or services, such as adequate food, shelter, health care, and educational opportunities, indicates their level of well-being. Sen (1987) provided a thorough framework for conceptualizing human well-being and poverty. He contends that a person's participation in social activities determines their welfare and that a lack of skills leads to poverty. In general, poverty occurs when people do not have the resources necessary to maintain a minimum quality of life that society accepts. There are several approaches to measuring poverty, including the income method, Multidimensional Poverty Index (MPI), Direct Calorie Intake (DCI), and Cost of Basic Needs (CBN) methods. The income approach measures poverty by calculating the percentage of the population that incomes less than what is required as a minimum to purchase the set of goods and services that serve as a threshold for poverty (Foster et al., 2013).

The Multidimensional Poverty Index (MPI) measures poverty by calculating an individual's overlapping deprivation scores across ten indicators in three equally weighted dimensions: standard of living, education, and health. Six indicators form the basis of the standard of living dimension, while two indicators each form the basis of the health and education dimensions (United Nations Development Program, 2023). The Bangladesh Bureau of Statistics (BBS) has used various methodologies since 1973–1974 for poverty measurement, including DCI, Food Energy Intake (FEI), and CBN (Hossain, 2020). The BBS has used both DCI and CBN methods in the Household Income and Expenditure Survey (HIES 2000; Hossain, 2020). The BBS has used only the CBN method for poverty estimation in the HIES 2010 and HIES 2016 (Bangladesh Bureau of Statistics [BBS], 2017). Bangladesh has made significant progress in lessening poverty during 2000-2022. HIES 2022 reported that the incidence of poverty was 34.3% concerning the lower poverty line and 48.9% concerning the upper poverty line in 2000 (BBS, 2023). By 2022, it had decreased to 5.6% concerning the lower poverty line and 18.7% concerning the upper poverty line. Other indices, like the poverty and squared poverty gaps, also decrease nationally. Moreover, the MPI of Bangladesh decreased from 0.237 in 2007 to 0.188 in 2016 (United Nations Development Program, 2017). Despite all these advances in poverty reduction, a substantial portion of the wetland peoples of Bangladesh still live below the poverty line.

A wetland is a place or region where water stays at or close to the surface of the

soil due to periodic or perennial flooding with shallow water (Ministry of Law, 2013). Bangladesh has several types of wetlands, and *haor* is one of them (Ministry of Water Resources, 2016). *Haor,* also called the seasonal water body, is a sizeable geological lowness with a bowl-shaped appearance and gathers surface runoff water during monsoon. The *haor* districts of Bangladesh occupy 19,998 square kilometers of land or 13.56% of the country's total area (Centre for Environmental and Geographic Information Services [CEGIS], 2012). About 43% (8585 sq. km.) of the *haor* district's total area is made up of wetlands, comprising 373 *haors* (CEGIS, 2012). Historically, the *haor* regions have not developed as quickly as the rest of the country because of their geographical location. Even if the *haor* regions are skilled in growing *boro-rice* and fishing in freshwater, the primary means of subsistence are mainly lacking. Due to floods and other natural calamities, the individuals involved in farming and labor selling are frequently unemployed, which causes poverty in these places and occasionally leads to famine-type situations. Long-term seasonality in the monsoon season is another factor contributing to people's unemployment (Hasan & Hossain, 2024). So, the *haor* people are significantly behind the country's general population in per capita income, consumption, electricity facilities, and roads, leading to a high poverty rate (Khondker & Mahzab, 2015).

According to Kazal et al. (2017), about 29.6% of *haor* people live below the lower poverty line, and 43.0% live below the upper poverty line. As a result, a considerable portion of the *haor* people is grappling with food insecurity and lack of basic needs. The household-level poverty and food insecurity are distressingly common scenarios for the *haor* people (Amin & Farid, 2005). Many studies (Food and Agriculture Organization of the United Nations, 2017; H. M. T. Rahman et al., 2015; Shaw, 2006) have shown that flash floods have a detrimental effect on most of the *haor* population, who rely on agriculture for their livelihoods and are therefore vulnerable to food insecurity. Thus, poverty condition is a crucial issue for the population residing in the wetland region of Bangladesh. Special care is necessary for the vulnerable pockets where poverty is high, and the wetland region of Bangladesh is one of the vast areas where about 20 million people are living to achieve sustainable development goals (SDGs). A comprehensive study is essential to have the stakeholder's understanding of the poverty situation of the wetland population, encompassing both poverty conditions and risk factors. The existing studies on wetland people did not focus on both issues simultaneously with a strong statistical footing. The review revealed that selection bias and insufficient sample size are two other drawbacks of most current research on the wetland population of Bangladesh.

Hence, this study's objectives are (a) to estimate the poverty conditions of the people living in Bangladesh's northeastern wetland region and (b) to identify several risk factors linked to poverty. This study's main contribution is its comprehensive

nature, with an extensive sample size that includes all six districts of Bangladesh's northeastern wetland region, where most *haors* are located. This study's findings will help to understand the poverty scenario of Bangladesh's wetland region and take necessary actions to reduce poverty in that region.

LITERATURE REVIEW

The review of literature has been made based on several studies focusing on estimating poverty conditions and associated risk factors in Bangladesh and abroad. These studies, conducted with thoroughness and precision, provide valuable insights into the poverty situation. Several studies at home and abroad were found to deal with the estimation of poverty (Alam, 2004; Kazal et al., 2017; Negash et al., 2019) and its risk factors (Acharya et al., 2022; Achia et al., 2010; Farah, 2015; Imam et al., 2018; Korankye, 2014). To investigate whether the choice of methods matters in determining the level of poverty, Hossain (2020) employed the CBN, the DCI, and the FEI methods based on the primary data collected from rural areas of the Sylhet division of Bangladesh. After thorough analyses, the study concluded that the choice of method affects the estimation of the incidence of poverty. The study also suggested using the modified approach of the direct calorie intake method (households took less amount of food than required considering the age and sex of the members) to estimate the poverty incidence by the DCI method as this method over-estimated the poverty condition (Hossain, 2020). In the context of the wetland region, Alam (2004) conducted a study using the CBN and the DCI method to estimate the poverty situation of fishermen in the Sunamganj district of Bangladesh. The study found that 37.2% of the fishermen live below the lower and 54.7% live below the upper poverty line. The study's findings showed that the DCI method underestimated the poverty condition as 15.1% of the fishermen lie below the hardcore, and 47.7% lie below the absolute poverty. However, the study focused on a particular community, so generalizing results for the wetland regions is impossible. Kazal et al. (2017) estimated the poverty conditions in Bangladesh's northeastern *haor* districts using both CBN and the DCI method based on data collected from a comprehensive sample of 4200 households from *haor* areas in 2009. The study found that 29.6% of households lie below the LPL, and 43.0% lie below the UPL by the CBN method. However, the study did not focus on the risk of poverty. Negash et al. (2019) applied the CBN method to estimate the poverty lines in three districts of the Tigray region in northern Ethiopia. According to the findings, the absolute total poverty line was estimated as ETB 5112.0 per adult per annum, and over half of the households were found to be poor.

An extensive corpus of literature in almost every country addresses key components of poverty. For example, Imam et al. (2018) used data from the nationally representative Household Income

and Expenditure Survey (HIES)-2010 to determine rural Bangladesh's poverty determinants. The study found that several factors contribute to poverty, including the age and education of the household head, division, household size, house type, per capita income, ownership of land, access to electricity, amount of cultivable land, involvement with livestock and farm forestry, possession of non-agricultural assets, and the proportion of male and female wage earners in the family. Farah (2015) conducted a study identifying factors significantly affecting household poverty. The study used data from the Bangladesh Demographic and Health Survey (BDHS 2011). A logistic regression was estimated using a set of demographic factors as the explanatory variables and socio-economic status (SES) as the dependent variable. The result suggested that the factors that affect the likelihood of a household being poor are the age, sex, and religion of the household head, household size, housing condition, land ownership, and child-woman ratio. Acharya et al. (2022) used the binary logistic regression model to determine the factors responsible for poverty in Nepal. The study found that the household head's illiteracy status, remittance status, landholding status, access to the nearest market, and number of literate persons of working age are the potential risk factors for poverty. Achia et al. (2010) researched the key factors contributing to poverty in Kenya using a logistic regression model. The study identified that age, educational level of household head, household size, type of residence, religion, and ethnicity are the significant risk factors for poverty. A study by Korankye (2014) found that the prevalence of diseases, lack of education, corruption, and inefficient government are the leading causes of poverty in Ghana. The review of existing literature revealed that no studies cover a broad geographic region in the context of poverty and its risk factors. So, there is an urgent need to estimate the poverty level and its risk factors for the wetland region of Bangladesh.

It is documented that the *haor* region of Bangladesh faces significant poverty and food insecurity among its residents, with 37.3% and 77.3% being food insecure based on calorie and protein consumption (Chowdhury, 2014), despite being productive for *boro-rice* farming and biodiversity. Floods and other natural calamities often lead to unemployment, poverty, and famine-like situations. The literature review suggests that an in-depth study on the risk factors of poverty is lacking in the existing literature.

METHODS

Study Area

This study was conducted in Bangladesh's northeastern wetland region, covering six *haor*-prone districts: Sunamganj, Sylhet, Habiganj, Maulvibazar, Netrokona, and Kishoreganj. *Haors* are mainly found in Sunamganj, Sylhet, Netrokona, and Kishoreganj districts. There are 366 *haors* in the six districts above, although only seven are in the Brahmanbaria district (CEGIS, 2012).

The Data

The required data for this study was taken from the data collected through a household survey by a research project titled "Vicious Cycle of Poverty in *Haor* Region of Bangladesh: Impact of Formal and Informal Credits" funded by the Grants for Advanced Research in Education (GARE) Program, Ministry of Education, Government of Bangladesh (GoB). Since the data was collected from several individuals at a single time point hence, it is cross-sectional. The household survey for required data collection was conducted from February–December 2019. This study took several steps to check the validity and reliability of the data. Among them, cross-checks of several filled-up interview schedules by supervisors and examination of the validity of the variables by data exploration were performed.

Sample Design

A cluster-sampling design was used in the survey from which the data was extracted, and *haor* attached unions were considered clusters. The survey covers a total of 30 clusters. The sample size for the survey was 2340 according to the standard sample size determination formula[1]. The survey used the following procedures to select clusters as well as households:

(i) The number of *haors* in each of the six districts is defined and determined.

(ii) A stratified random sampling with proportional allocation was employed to estimate the number of *haors* in each district. A systematic probability proportional to size (PPS) sampling was then used to select *haor* from six districts.

(iii) A cluster was chosen randomly from each of the chosen *haor*s.

(iv) The households within the cluster were chosen at random using the UNICEF pencil-spin method.

(v) Finally, 2340 households (78 from each cluster) were chosen from 30 clusters for interview.

Analytical Techniques

This study estimated household poverty using the Cost of Basic Needs (CBN) method. The poverty estimation through the CBN method is based on FGT (Foster, Greer, Thorbecke) family of poverty measures (Foster et al., 1984, 2010). It is argued that the CBN method provides better estimates of poverty than other methods like DCI and FEI. The association between poverty status and the background characteristics of the individuals and households in Bangladesh's wetland region was studied using the chi-square test of independence. A significant factor with a p-value (<0.10) in bivariate analysis was considered to identify the potential predictors for multivariate analysis. Finally, the Binary Multiple Logistic Regression (BMLR) model has been employed to determine the essential risk factors contributing to the poverty status

[1] $n = \frac{p(1-p)Z^2}{(0.04p)^2} \times Deff$; Where, p = percentage indicator, Z = normal variate value with 95% CI, $0.04p$ = relative error margin, and *Deff* = design effect.

of the wetland population of Bangladesh. The analyses were performed using SPSS (Windows version 25.0).

The Cost of Basic Needs (CBN) Method

The CBN method calculates the area-specific poverty threshold (S. Rahman, 1999; Ravallion & Sen, 1996). This method estimates two poverty lines, (1) the lower and (2) the upper poverty line, in three steps.

Step One: Calculation of food poverty line:

The first step involved calculating the cost of a bundle of specific food items. The bundle comprises eleven items: coarse rice, wheat, pulses, fruits, potatoes, vegetables, milk, oil, meats, fish, and sugar, as recommended by Ravallion and Sen (1996) based on Alamgir (1974). It covers 2,122 kcal per day per person, the minimum nutrition requirement.

Step Two: Calculation of two non-food allowances for non-food consumption:

- The "non-food lower allowance" was obtained by taking the median amount utilized for non-food goods by households whose per capita total expenditure is near the food poverty line.
- The "non-food upper allowance" was obtained by taking the median amount utilized for non-food goods by households whose per capita food expenditure is near the food poverty line.

Step Three: Calculation of two poverty lines:

- Lower Poverty Line (LPL): food poverty line + non-food lower allowance
- Upper Poverty Line (UPL): food poverty line + non-food upper allowance

The Head Count, Poverty Gap, and Squared Poverty Gap Indices of the CBN Method

Let, $Y_i = (Y_1, Y_2, ... , Y_N)$ be a vector of the household's per capita consumption expenditure; N = number of sampled households; N_p = number of sampled poor households; Z_L = per capita lower poverty line; Z_U = per capita upper poverty line; $I_1(.)$ = indicator function that holds 1 if $Y_i < Z_L$ and 0 otherwise; and $I_2(.)$ = indicator function that holds 1 if $Y_i < Z_U$, and 0 otherwise. Then, the indices can be defined as follows:

Headcount in terms of LPL:

$$P_{01} = \frac{1}{N}\sum_{i=1}^{N_p} I_1(Y_i < Z_L)$$

Headcount in terms of UPL:

$$P_{02} = \frac{1}{N}\sum_{i=1}^{N_p} I_2(Y_i < Z_U)$$

Poverty gap in terms of LPL:

$$P_{11} = \frac{1}{N}\sum_{i=1}^{N_p} \frac{G_i}{Z_L}$$

Where, $G_i = (Z_L - Y_i).I(Y_i < Z_L)$ is the poverty gap score in terms of LPL.

Poverty gap in terms of UPL:

$$P_{12} = \frac{1}{N}\sum_{i=1}^{N_p} \frac{G_i}{Z_U}$$

Where, $G_i = (Z_U - Y_i).I(Y_i < Z_U)$ is the poverty gap score in terms of UPL.

Squared poverty gap in terms of LPL:

$$P_{21} = \frac{1}{N}\sum_{i=1}^{N_p}\left(\frac{G_i}{Z_L}\right)^2$$

Squared poverty gap in terms of UPL:

$$P_{22} = \frac{1}{N}\sum_{i=1}^{N_p}\left(\frac{G_i}{Z_U}\right)^2$$

Association Between the Outcome Variable and Covariates

The chi-square test of independence has been used to explore the association between the outcome variable (poverty conditions) and several explanatory variables (background characteristics of individuals and households). In this case, the hypotheses are as follows:

H_0: There is no association between the household's poverty conditions and their background characteristics.

H_1: There is an association between the household's poverty conditions and their background characteristics.

The test statistic is:

$$\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{c}\frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

With $(r-1)(c-1)$ degrees of freedom. Where O_{ij} = Observed cell frequency, E_{ij} = Expected cell frequency, r = No. of categories of one variable, c = No. of categories of another variable.

Binary Multiple Logistic Regression (BMLR) Model

This study developed two BMLR models to extract potential risk factors associated with household poverty levels. The models are stated below:

Let, $X = (X_1, X_2, \ldots, X_n)$ (n = 1, 2, ..., 13) is a vector of the collection of household predictors and $Y_i(LPL)$ is a binary outcome variable that indicates the household's poverty condition based on LPL. Where,

$$\mathrm{Y_i}(LPL) = \begin{cases} 1 & \text{if the i-th household lies below the LPL} \\ 0 & \text{otherwise} \end{cases}$$

The conditional probability of the i-th household lies below LPL given X be written as

$$\pi_i(LPL) = \mathrm{Prob}\left[\mathrm{Y_i}(LPL) = 1 \mid X\right] = \frac{\exp\left(\beta_0 + \sum_{i=1}^{13}\beta_i X_i\right)}{1 + \exp\left(\beta_0 + \sum_{i=1}^{13}\beta_i X_i\right)}$$

Here, $\beta = (\beta_1, \beta_2, \ldots, \beta_n)$ (n = 1, 2, ..., 13) is a vector of unknown parameters ordinarily estimated by the method of maximum likelihood.

The logit of $\pi_i(LPL)$ with predictors is given by

$$\log_e\left(\frac{\pi_i(LPL)}{1-\pi_i(LPL)}\right) = \beta_0 + \sum_{i=1}^{13}\beta_i X_i \quad [1]$$

Similarly, the logit of $\pi_i(UPL)$ with predictors is given by

$$\log_e\left(\frac{\pi_i(UPL)}{1-\pi_i(UPL)}\right) = \beta_0 + \sum_{i=1}^{12}\beta_i X_i \quad [2]$$

Where, $\pi_i(UPL)$ is the conditional probability of the i-th household lies below UPL given X. Models (1) and (2) are the BMLR models.

Study Variables

This study considered several individual-level and household-level characteristics as explanatory variables from previous research (Borko, 2017; Hossain et al., 2013; Imam et al., 2018; Kazal et al., 2017). The two poverty lines served as the outcome variables. Table 1 shows the list of study variables and their descriptions.

RESULTS AND DISCUSSION

Poverty Measures Using the CBN Method

An adult in Bangladesh is estimated to need at least 832 grams of food, or 2,122 kcal per day (Bangladesh Institute of Development Studies, 1997). The Bangladesh Institute of Development Studies (BIDS) suggested 397 grams of rice, 40 grams of wheat, 40 grams

Table 1
Study variables with description

Study Variables	Description	Type	Class level
Explanatory variables			
Geographical region	District of households	Categorical	Sunamganj, Sylhet, Kishoreganj, Habiganj, Netrokona
Household size	Number of household members	Categorical	<4, 4 or more
Age	Age of the respondents	Categorical	≤30, 31–50, 51–60, 60+
Religion	Religion of the respondents	Categorical	Muslim, Non-Muslim
Gender	Gender of household head	Categorical	Male, Female
Educational status	Year of schooling of household head	Categorical	Below primary, Primary or above
Occupation	Occupation of household head	Categorical	Farming, Day laborer, Off-farm activities, Service/Business, Household work, Others
Marital status	Marital status of the respondents	Categorical	Married, Unmarried, Widowed/ Divorced
Micro-credit status	Households' micro-credit status	Categorical	Non-borrower, Borrower
NGO membership	Households' NGO membership	Categorical	No, Yes
Per capita income	Households' per capita income (in BDT) per year	Categorical	≤10000, 10000–20000, 20000–30000, 30000 or more
Agricultural land	Households' amount of agricultural land (in decimal)	Categorical	No Land, 1–15 decimal, 16–50 decimal, 50+ decimal
Electricity connection	Access to electricity in households	Categorical	No, Yes
Livestock	Households' livestock ownership	Categorical	No, Yes
Outcome variables			
Poverty conditions (based on LPL)	Households' poverty conditions based on LPL	Categorical	Below LPL, Otherwise
Poverty conditions (based on UPL)	Households' poverty conditions based on UPL	Categorical	Below UPL, Otherwise

of pulses, 20 grams of fruits, 27 grams of potatoes, 150 grams of vegetables, 58 grams of milk, 20 grams of oil, 12 grams of meat, 48 grams of fish, and 20 grams of sugar as a food combination. Generally, the rural people of Bangladesh rely more on rice than other foods. Hence, a higher combination of food and a daily intake of 455 grams of rice per person was used by BBS (2000). The food combinations suggested by BIDS (1997) and BBS (2000) were considered for this study when determining the daily food combinations per capita. The average cost of each item in food combinations was determined using data from BBS (2020a, 2020b). To estimate poverty, the food intake, price, and calorie contents for the population under study are shown in Table 2.

The headcount index, poverty gap index, and squared poverty gap index are members of the FGT (Foster, Greer, Thorbecke) family of poverty measures (Foster et al., 1984, 2010). Table 2 shows that the per capita lower and upper poverty lines are BDT 16296.5 and BDT 21638.2, respectively. According to these poverty line thresholds, about 55% and 25% of households were 'poor' and 'very poor,' respectively, based on LPL and UPL (Table 3). The incidence of poverty measured by the headcount index is easy to estimate and understand. However, the headcount index has weaknesses in that it does not consider the intensity of poverty, it does not change if people below the poverty line become poorer, and it is designed for the poverty estimates of individuals and not households (Haughton & Khandker, 2009). Considering the headcount index's limitations, this study employed the poverty gap and squared poverty gap proposed by Foster et al. (1984, 2010). The poverty gap index is a widely used measure of the degree of poverty in a country or a population. It is expressed as a percentage of the poverty line and is defined as the average number of people living

Table 2
Estimation of poverty lines by the CBN method

Food items	Food intake per capita per day (in gm)	Calorie content per gm	Total calorie	Average price per kg	Average price (in BDT) of required quantity
Cereals					
Rice	448.00	3.52	1576.96	33.50	15.008
Wheat	36.56	3.4206	125.06	23.44	0.8570
Pulses					
Masur	7.53	3.4316	25.84	82.81	0.6236
Mash Kalai	1.94	3.3608	6.52	74.30	0.1441
Khesari	6.00	3.4517	20.71	44.58	0.2675
Fruits	20.00	0.9291	18.58	63.51	1.2702
Potato	61.19	0.9701	59.36	18.11	1.1082
Vegetables					
Leafy Vegetables	72.37	0.6496	47.01	15.09	1.0921

Table 2 *(continue)*

Food items	Food intake per capita per day (in gm)	Calorie content per gm	Total calorie	Average price per kg	Average price (in BDT) of required quantity
Others	57.26	0.3309	18.95	28.21	1.6153
Milk	29.70	0.7471	22.19	73.04	2.1693
Edible Oils	8.63	9.0073	77.73	83.65	0.7219
Meat					
Mutton	0.69	1.1884	0.82	655.16	0.4521
Beef	4.98	1.1386	5.67	418.84	2.0858
Chicken/Duck	3.96	1.1995	4.75	118.56	0.4695
Fishes	29.09	1.1447	33.3	168.61	4.9049
Eggs	3.20	1.7438	5.58	167.05	0.5346
Spices					
Onion	19.74	0.5	9.87	36.77	0.7258
Chilies	7.55	2.4291	18.34	44.39	0.3351
Others	6.61	2.6082	17.24	86.81	0.5738
Sugar and Molasses	7.00	3.982	27.87	50.73	0.3551
Total	824.45		2122.35		35.3138
Estimated values of food poverty line and allowances					BDT
Food poverty line per capita					12888.15
Lower allowance per capita					3408.33
Upper allowance per capita					8750.00
Lower poverty line (LPL) per capita					16296.48
Upper poverty line (UPL) per capita					21638.15

Note. Rate of Exchange: 1.00 USD = 84.90 BDT in December 2019 (Bangladesh Bank, 2023); *Source:* Computed from survey data, 2019; BBS (2000, 2020a, 2020b); BIDS (1997)

Table 3
Headcount index, poverty gap, and squared poverty gap index

Indices	Estimated value	HIES-2016 (BBS, 2017)
Headcount index		
Based on LPL	25.0%	14.9%
Based on UPL	55.1%	26.4%
Poverty gap index (overall)		
Based on LPL	4.7%	2.6%
Based on UPL	13.5%	5.4%
Squared poverty gap index (overall)		
Based on LPL	1.3%	0.7%
Based on UPL	4.6%	1.7%

below the line. This index, in actuality, measures the depth of poverty by taking into account the average distance between the impoverished and the poverty line.

The overall poverty gaps were estimated at 4.7% and 13.5% in terms of LPL and UPL, respectively, which shows the depth of poverty of the wetland population of Bangladesh. The results indicate that for those who lie under the lower poverty line, the average distance of their expenditure was 4.7% less than the poverty line. Similarly, the average distance of their expenditure was 13.5% less than the poverty line for households below the upper poverty line.

The squared poverty gap index assigns more weight to those who belong far below the poverty line than those who are closer to it by squaring the poverty gap for each household or individual. Therefore, it is considered the poverty severity index. The overall squared poverty gaps were estimated at 1.3% and 4.6% in terms of LPL and UPL, respectively, which measures the severity of poverty of the wetland population by the two poverty lines. The findings indicate that the incidence, depth, and severity of poverty among the wetland population were higher than the national average for rural areas, as HIES 2016 of BBS (2017) exposed. The incidence, depth, and severity of poverty among the wetland population are higher because of the skewed ownership pattern of land, mono-crop cultivation pattern, seasonal unemployment due to the lack of work opportunities in the lean season, absence of required income generating activities (IGAs) like cage fishing, floating gardens, and rearing of ducks. Therefore, stakeholders' attention is necessary not only to reduce the incidence of poverty of the wetland population but also to the depth and severity of the poverty.

Poverty Conditions by Background Characteristics of the Households

The association of poverty conditions with several background characteristics of the households and household heads has been carried out to study the differentials of poverty as well as to explore the potential covariates for the BMLR models. The significance of the variables has been examined through the values of chi-squares and their *p*-values (Table 4).

The incidence of poverty among wetland households varies across the background characteristics of households and household heads. Almost all the covariates except educational status were highly significantly ($p<0.01$) associated with the household's poverty conditions based on LPL. The marital status and ownership of livestock were found significant, with a *p*-value of 0.004 and 0.070, respectively. Regarding UPL, all factors except marital status and ownership of livestock were found to be significantly ($p<0.05$) associated with the household's poverty conditions. Access to electricity was found significant with a *p*-value = 0.085.

According to findings, the highest percentage of households (34.0%) in the Kishoreganj district lies below the lower poverty line, followed by the Habiganj (26.3%) and Sunamganj (25.2%) districts.

Table 4
Association of covariates with response variables (poverty conditions based on LPL and UPL)

Background characteristics	Overall, n(%)	Poverty conditions (based on LPL)		p-value	Poverty conditions (based on UPL)		p-value
		HHs below LPL, n(%)	Otherwise, n(%)		HHs below UPL, n(%)	Otherwise, n(%)	
Total	**2340(100)**	**578(24.7)**	**1762(75.3)**		**1290(55.1)**	**1050(44.9)**	
Geographical region							
Sunamganj	1256(53.7)	316(25.2)	940(74.8)		714(56.8)	542(43.2)	
Sylhet	78(3.3)	4(5.1)	74(94.9)		23(29.5)	55(70.5)	
Kishoreganj	315(13.5)	107(34.0)	208(66.0)	<0.001	169(53.7)	146(46.3)	<0.001
Habiganj	312(13.3)	82(26.3)	230(73.7)		201(64.4)	111(35.6)	
Netrokona	379(16.2)	69(18.2)	310(81.8)		183(48.3)	196(51.7)	
Household size (person)							
<4	306(13.1)	13(4.2)	293(95.8)	<0.001	88(28.8)	218(71.2)	<0.001
4 or more	2034(86.9)	565(27.8)	1469(72.2)		1202(59.1)	832(40.9)	
Age of respondents							
≤30	394(16.8)	81(20.6)	313(79.4)		217(55.1)	177(44.9)	
31–50	1453(62.1)	400(27.5)	1053(72.5)	<0.001	853(58.7)	600(41.3)	<0.001
51–60	332(14.2)	75(22.6)	257(77.4)		162(48.8)	170(51.2)	
60+	161(6.9)	22(13.7)	139(86.3)		58(36.0)	103(64.0)	
Religion of respondents							
Muslim	1425(60.9)	411(28.8)	1014(71.2)	<0.001	841(59.0)	584(41.0)	<0.001
Non-Muslim	915(39.1)	167(18.3)	748(81.7)		449(49.1)	466(50.9)	
Gender of household head							
Male	1796(78.6)	482(26.8)	1314(73.2)	<0.001	1020(56.8)	776(43.2)	0.003
Female	544(23.2)	96(17.6)	448(82.4)		270(49.6)	274(50.4)	
Educational status of household head							
Below primary	1872(80.0)	458(24.5)	1414(75.5)	0.598	1054(56.3)	818(43.7)	0.022
Primary or above	468(20.0)	120(25.6)	348(74.4)		236(50.4)	232(49.6)	
Occupation of household head							
Farming	461(19.7)	92(20.0)	369(80.0)		233(50.5)	228(49.5)	
Day laborer	532(22.7)	168(31.6)	364(68.4)		329(61.8)	203(38.2)	
Off-farm activities	308(13.2)	116(37.7)	192(62.3)	<0.001	221(71.8)	87(28.2)	<0.001

Table 4 *(continue)*

Background characteristics	Overall, n(%)	Poverty conditions (based on LPL)		p-value	Poverty conditions (based on UPL)		p-value
		HHs below LPL, n(%)	Otherwise, n(%)		HHs below UPL, n(%)	Otherwise, n(%)	
Service/Business	441(18.8)	85(19.3)	356(80.7)		204(46.3)	237(53.7)	
Household work	442(18.9)	74(16.7)	368(83.3)		214(48.4)	228(51.6)	
Others	156(6.7)	43(27.6)	113(72.4)		89(57.1)	67(42.9)	
Marital status of respondents							
Married	2158(92.2)	549(25.4)	1609(74.6)		1192(55.2)	966(44.8)	
Unmarried	60(2.6)	5(8.3)	55(91.7)	0.004	28(46.7)	32(53.3)	0.369
Widowed/Divorced	122(5.2)	24(19.7)	98(80.3)		70(57.4)	52(42.6)	
Micro-credit status of household							
Non-Borrower	733(31.3)	230(31.4)	503(68.6)	<0.001	468(63.8)	265(36.2)	<0.001
Borrower	1607(68.7)	348(21.7)	1259(78.3)		822(51.2)	785(48.8)	
NGO membership of household							
No	1143(48.8)	359(31.4)	784(68.6)	<0.001	701(61.3)	442(38.7)	<0.001
Yes	1197(51.2)	219(18.3)	978(81.7)		589(49.2)	608(50.8)	
Per capita income (in BDT) per year of household							
≤10000	197(8.4)	148(75.1)	49(24.9)		178(90.4)	19(9.6)	
10000–20000	1190(50.9)	413(34.7)	777(65.3)	<0.001	948(79.7)	242(20.3)	<0.001
20000–30000	617(26.4)	13(2.1)	604(97.9)		138(22.4)	479(77.6)	
30000 or more	336(14.4)	4(1.2)	332(98.8)		26(7.7)	310(92.3)	
Agricultural land of household							
No land	1589(67.9)	452(28.4)	1137(71.6)		951(59.8)	638(40.2)	
1–15 decimal	157(6.7)	47(29.9)	110(70.1)	<0.001	99(63.1)	58(36.9)	<0.001
16–50 decimal	191(8.2)	37(19.4)	154(80.6)		99(51.8)	92(48.2)	
50+ decimal	403(17.2)	42(10.4)	361(89.6)		141(35.0)	262(65.0)	
Electricity connection in household							
No	451(19.3)	151(33.5)	300(66.5)	<0.001	265(58.8)	186(41.2)	0.085
Yes	1889(80.7)	427(22.6)	1462(77.4)		1025(54.3)	864(45.7)	
Livestock ownership of household							
No	1359(58.1)	317(23.3)	1042(76.7)	0.070	738(54.3)	621(45.7)	0.346
Yes	981(41.9)	261(26.6)	720(73.4)		552(56.3)	429(43.7)	

Based on UPL, the highest percentage of households (64.4%) in the Habiganj district lies below the poverty line, followed by the Sunamganj (56.8%) and Kishoreganj (53.7%) districts. The poverty level of *haor* areas is much higher than the national level (Table 3). The variation of the poverty level across districts is found to be statistically significant ($p<0.01$), and the variation is due to the variation of facilities in the district.

A larger portion of households with four or more members lie below the poverty line (27.8% below LPL and 59.1% below UPL). The percentage of respondents below the poverty line was highest among male respondents (26.8% below LPL and 56.8% below UPL) compared to female respondents (17.6% below LPL and 49.6% below UPL). The variation in poverty was not remarkable for the education of the respondents. The incidence of poverty was found to be higher (37.7% below LPL and 71.8% below UPL) for the households whose heads were engaged in off-farm activities. A study conducted by Kazal et al. (2017) in the *haor* region of Bangladesh found the highest incidence of poverty among non-agri laborers.

The proportion of households below the poverty level was lower among borrowers (21.7% below LPL and 51.2% below UPL) compared to non-borrower households (31.4% below LPL and 63.8% below UPL), which implies that receiving micro-credit may reduce poverty in borrower households.

About 28% and 60% of the landless households lie below the lower and upper poverty lines, respectively. However, most households lie below the two poverty lines (about 30% for LPL and 63% for UPL), with 1–15 decimal agricultural land. Only about 10% and 35% of the households lie below the lower and upper poverty lines, respectively, with agricultural land of 50+ decimal.

Risk Factors of Poverty Using the BMLR Models

Table 5 shows the results of the BMLR models to determine the risk factors of poverty conditions. The p-value of the Hosmer-Lemeshow test suggests that both BMLR models fit the data well. The estimated BMLR model based on LPL identified ten significant risk factors (geographical region, household size, religion, occupation, micro-credit status, NGO membership, per capita income, agricultural land, electricity connection in the household, and livestock ownership) of poverty out of thirteen. Similarly, eight significant risk factors (geographical region, household size, age, religion, micro-credit status, per capita income, agricultural land, and electricity connection in the household) out of twelve were identified by the BMLR model based on UPL. The geographical region is regarded as an important predictor of poverty based on both LPL and UPL, and the risk of poverty was found to vary significantly across districts.

The likelihood of poverty based on LPL was found remarkably higher for the Kishoreganj district (OR: 1.15; 95% CI: 0.80–1.66) and lower for the Sylhet district (OR: 0.28; 95% CI: 0.09-0.82) in comparison

Table 5
Estimated coefficients and odds ratios of the BMLR models to determine the risk factors of poverty conditions

Factors	Results of BMLR model based on LPL			Results of BMLR model based on UPL		
	β	OR (95% CI)	p-value	β	OR (95% CI)	p-value
Geographical region						
Sunamganj: Ref.		1.00			1.00	
Sylhet	-1.29	0.28 (0.09–0.82)	0.021**	-0.99	0.37 (0.19–0.71)	0.003***
Kishoreganj	0.14	1.15 (0.80–1.66)	0.446	-0.61	0.54 (0.38–0.78)	0.001***
Habiganj	-0.12	0.89 (0.62–1.27)	0.508	-0.13	0.88 (0.61–1.25)	0.468
Netrokona	-0.29	0.75 (0.49–1.14)	0.174	-0.13	0.88 (0.61–1.26)	0.473
Household size (person)						
<4: Ref.		1.00			1.00	
4 and more	2.17	8.74 (4.48–17.08)	<0.001***	1.24	3.44 (2.38-4.99)	<0.001***
Age of respondents						
≤30: Ref.		1.00			1.00	
31–50	-0.12	0.89 (0.62–1.27)	0.520	-0.29	0.75 (0.54–1.03)	0.072*
51–60	-0.29	0.75 (0.47–1.19)	0.223	-0.73	0.49 (0.32–0.74)	0.001***
60+	-0.59	0.56 (0.29–1.09)	0.086*	-0.99	0.37 (0.22–0.64)	<0.001***
Religion of respondents						
Muslim: Ref.		1.00			1.00	
Non-Muslim	-0.40	0.67 (0.50–0.89)	0.006**	-0.27	0.76 (0.59–0.99)	0.041**
Gender of household head						
Male: Ref.		1.00			1.00	
Female	0.01	1.01 (0.53–1.95)	0.974	0.29	1.33 (0.76–2.34)	0.322
Educational status of household head						
Below primary: Ref.					1.00	
Primary or above				-0.16	0.86 (0.63-1.17)	0.324
Occupation of household head						
Farming: Ref.		1.00			1.00	
Day laborer	0.44	1.55 (1.06–2.28)	0.025**	0.28	1.33 (0.92–1.92)	0.131
Off-farm activities	0.33	1.39 (0.91–2.15)	0.130	0.27	1.31 (0.84-2.03)	0.233
Service/Business	0.06	1.06 (0.69–1.62)	0.791	-0.27	0.77 (0.52–1.12)	0.172
Household work	-0.42	0.66 (0.31–1.37)	0.263	-0.65	0.52 (0.27–1.02)	0.056*
Others	0.39	1.48 (0.82–2.65)	0.191	0.30	1.35 (0.76–2.39)	0.302
Marital status of respondents						
Married: Ref.		1.00				
Unmarried	-0.89	0.41 (0.14–1.20)	0.104			
Widowed/Divorced	0.33	1.39 (0.72–2.69)	0.323			
Micro-credit status of household						
Non-Borrower: Ref.		1.00			1.00	
Borrower	-0.63	0.53 (0.39–0.72)	<0.001***	-1.10	0.33 (0.24–0.46)	<0.001***
NGO membership of household						
No: Ref.		1.00			1.00	
Yes	-0.49	0.61 (0.46–0.81)	0.001***	-0.26	0.77 (0.59–1.01)	0.061*

Table 5 *(continue)*

Factors	Results of BMLR model based on LPL			Results of BMLR model based on UPL		
	β	OR (95% CI)	p-value	β	OR (95% CI)	p-value
Per capita income (in BDT) per year of household						
≤10000: Ref.		1.00			1.00	
10000-20000	-1.75	0.17 (0.12–0.25)	<0.001***	-0.75	0.47 (0.28–0.79)	0.004***
20000-30000	-4.96	0.01 (0.00–0.01)	<0.001***	-3.55	0.03 (0.02–0.05)	<0.001***
30000 or more	-5.28	0.01 (0.00–0.02)	<0.001***	-4.68	0.01 (0.01–0.02)	<0.001***
Agricultural land of household						
No land: Ref.		1.00			1.00	
1-15	0.12	1.13 (0.72–1.77)	0.597	0.22	1.24 (0.79–1.95)	0.346
16-50	-0.19	0.82 (0.51–1.32)	0.419	0.21	1.23 (0.80–1.89)	0.340
50+	-0.93	0.39 (0.26–0.61)	<0.001***	-0.72	0.49 (0.35–0.68)	<0.001***
Electricity connection in household						
No: Ref.		1.00			1.00	
Yes	-0.73	0.48 (0.35–0.67)	<0.001***	-0.39	0.68 (0.49–0.93)	0.016**
Livestock ownership of household						
No: Ref.		1.00				
Yes	0.45	1.56 (1.20–2.03)	0.001***			
Constant	0.48	1.62	0.295	3.07	21.503	<0.001
	Hosmer and Lemeshow Chi-square = 12.989; p-value = 0.112			Hosmer and Lemeshow Chi-square = 6.448; p-value = 0.597		

Note. OR = odds ratio, CI = confidence interval, *p<0.10, **p<0.05, *** p<0.01

to that of the Sunamganj district. On the other hand, the risk of poverty based on UPL was lower for all other districts (Sylhet, Kishoreganj, Habiganj, and Netrokona) than the Sunamganj district. The poverty risk was lowest for the Sylhet district (OR: 0.37; 95% CI: 0.19-0.71). The regional variation of the poverty risk is due to the variation of facilities in the districts. For instance, Sunamganj is one of the most degraded regions of Bangladesh due to geographical and environmental factors, and crop cultivation is the primary source of income for the people living in this area (Mia, 2021). Many farmers go fishing when they have spare time after harvesting *boro* crops. The people in this area have no other sources of income during natural disasters like floods. In the lean season, some wetland residents adopted seasonal migration to other areas like Sylhet and Dhaka for their livelihood. On the other hand, Sylhet has many advantages among wetland districts, such as communication facilities (rail, road, and air), work opportunities, and a strong international *diaspora* network. That is why the poverty rate in the Sylhet district is lower than that of the other wetland districts. About this reality, our study found that households in the Sylhet district had a 72% and 63% lower risk of poverty according to the LPL and UPL, respectively, than those in the Sunamganj district.

Household size is regarded as an important risk factor for poverty based on LPL and UPL. The risk of poverty based on LPL and UPL was found to be 8.7 and 3.4 times higher, respectively, for households with four or more members in comparison to that of less than 4 members. The study conducted in Ethiopian rural areas by Bogale et al. (2005) supports this result. The literature found dissimilar results regarding the nexus between poverty and household size. Based on data from all over Bangladesh, Hossain et al. (2013) documented that the likelihood of food insecurity decreased with the increase in household size. On the other hand, Borko (2017) has argued that family members become unemployed due to the high fertility rate in rural areas and the lack of work opportunities. Moreover, households with larger members also need to make larger financial contributions for food, clothing, healthcare, and education, which will lead to a rise in household poverty. Meyer and Nishimwe-Niyimbanira (2016) conducted a study in South Africa and came to the same conclusion. In the case of the *haor* region, large families suffer from poverty primarily because of a lack of work opportunities.

This study included the respondents' age as a potential risk factor in the model. According to our findings, respondents with an age of more than 60 years were significantly 63% less likely to lie below the UPL than those with an age ≤30 years. R. I. Rahman et al. (2012) noticed a similar result in rural Bangladesh using HIES-2005. The risk of lying below the LPL and UPL was 33% and 24% lower for non-Muslim (Hindu, Christian) respondents than their Muslim counterparts. The gender of the household head was found insignificant in both the models based on LPL and UPL, though the study found that female-headed households are more prone to poverty than male-headed households.

The education of household heads is regarded as a powerful tool in fighting against poverty in Bangladesh (Imam et al., 2018). However, this potential indicator was insignificant in our study's BMLR model based on UPL. One plausible explanation is that most people in the wetland region are illiterate or poorly educated. The variation of education of the respondents (household heads) of the study population is less; hence, there is no contribution as a poverty determinant.

Household head's occupations substantially affect the income of the household, which also affects their poverty. The study's findings indicate that the probability of lying below the LPL was 1.6 times higher for day-laborer households than for farmer households. According to Mia (2021), the primary source of income for the people in wetland areas is crop cultivation. Flash floods sometimes damage the *boro* crop of the wetland region, and their poverty condition becomes more vulnerable. The earnings of day laborers become difficult throughout the year due to the lack of work opportunities.

Several studies have documented that people in wetland areas rely on high-interest

loans from local moneylenders and micro-credit organizations to meet their basic needs while unemployed (Amin & Farid, 2005; Islam et al., 2024; Kazal et al., 2017). The micro-credit program is considered an effective anti-poverty tool for the people of Bangladesh (United Nations Educational, Scientific and Cultural Organization, 1997). In this context, this study found that borrower households had a 47% and 67% lower risk of lying below the LPL and UPL, respectively, in comparison to non-borrower households. Borko (2017) reported similar results from his study in rural Ethiopia. Our findings support the efficacy of micro-credit in eradicating poverty in the short run.

According to Ara et al. (2020), along with several local NGOs like Grameen Bank, ASA (Association for Social Advancement), TMSS (Thengamara Mohila Sabuj Sangha), RDRS (Rangpur Dinajpur Rural Service), Shakti Foundation, POPI (People's Oriented Program Implementation), CNRS (Center for Natural Resource Studies), FIVDB (Friends in Village Development Bangladesh), and ASD (Assistance for Slum Dwellers), several international NGOs like Care Bangladesh, Concern Bangladesh, and Oxfam have been working for the long-term well-being of the wetland region population. With this context, our study found a positive impact of NGO membership on the household's poverty condition. For instance, the risk of lying below the LPL and UPL was 39% and 23% lower for NGO member households than their non-member counterparts. One possible explanation may be that an NGO member can easily get micro-credit facilities to invest in income-generating activities.

Income is the most crucial economic indicator for impoverished households, as it stimulates their local economic activity and raises their standard of living (Hamoh & Harun, 2021). Hence, the per capita income of wetland people may appear to have a highly significant influence on their poverty condition. The risk of lying below the LPL and UPL was 83% and 53% lower, respectively, for a household with an income of Tk. 10,000-Tk. 20,000 in comparison to a household with an income of ≤Tk. 10,000 (Table 5). Thus, the risk of poverty decreases as wetland people's income increases. A similar finding was reported by Imam et al. (2018) in their study conducted in a rural area of Bangladesh.

The availability and accessibility of agricultural land are regarded as crucial factors in poverty reduction in rural Bangladesh (Hossain et al., 2013; Kazal et al., 2010). Our study's findings indicate that households with marginally cultivable land (more than 50 decimals) had a 61% lower risk of falling below the LPL and a 51% lower risk of falling below the UPL than absolutely landless households. Similar results were found in the context of rural Mexico (Finan, 2005).

The potential of electricity access for poverty reduction in any region, especially wetland areas, is significant and inspiring. The fact is that having access to electricity allows a variety of activities due to its direct or indirect links to employment and high-return industries. Our findings indicate that

the prevalence of poverty among households is more likely to decline with the availability of electricity. More specifically, households with access to electricity had a 52% and 32% lower probability of lying below the LPL and UPL, respectively, than households without electricity. These outcomes agreed with the conclusion of a study carried out in Bangladesh by Khandker et al. (2009).

The identified predictors of the poverty condition of the wetland region of Bangladesh would help the stakeholders develop strategies to reduce poverty and target the SDGs. Some predictors of the poverty condition of the wetland region are common with that of the rural areas of Bangladesh. However, a few predictors of the poverty condition were found unique for the wetland region only. For example, the geographical region played a dominant role in the variation of poverty conditions. The wetland region lacks infrastructure facilities for education, health, and good transportation and communication systems. The services of government and non-government organizations are always hampered due to the stiff communication system. In addition, work opportunities throughout the year make it difficult for the wetland people to survive without poverty. There is no way to reduce poverty without increasing the income of the households. In this respect, NGO membership and access to micro-credit facilities might help them to come out of poverty to some extent. The family size of the wetland region is a concern, and attention is necessary to be aware of the inhabitants regarding the demerits of large families.

CONCLUSION

This study estimated poverty and identified its risk factors for the northeastern wetland region of Bangladesh using the CBN method and BMLR models. The study's findings conclude that a significantly higher proportion of wetland households were below the poverty level, and the depth and severity of poverty were also considerably higher than national estimates for rural areas. The depth and severity of poverty thus confirm the social disadvantage of the wetland region. So, to reduce the country's overall poverty, the government should emphasize the wetland region's vulnerable groups. The findings lead to the conclusion that ten factors are associated with wetland people's lower poverty level, and eight factors are associated with the upper poverty level. Among them, geographical region, household size, ownership of agricultural land, per capita income, micro-credit facility, and NGO membership are notable. Furthermore, because the chosen factors are policy-driven, individual-level, and household-level concerns, the relevant authorities can readily execute programs to reduce poverty.

Policy Implications

The findings of this study underscore the urgent need for several policy implications to reduce poverty in Bangladesh's wetland region. This study found that the incidence of poverty in wetland areas is considerably higher than national estimates for rural areas. National poverty policies sometimes fail to meet localized challenges, so

the government and non-government organizations can implement region-specific poverty alleviation programs. For instance, the government can assist the poor in wetland areas by involving the poor households in Social Safely Net Programs (SSNPs) and offering skill development training on climate-smart agriculture, floating vegetable cultivation, and duck rearing. Besides the government, several NGOs can take the initiative to reduce poverty in the wetland areas by increasing their training programs and making easy access to micro-credit facilities. Initiatives like the Integrated Development Program (IDP) of BRAC might help to reduce poverty in the wetland areas. It is documented that the IDP initiative implanted in the selected areas of Habiganj and Sunamganj districts found positive outcomes in poverty reduction (Ara et al., 2020). Therefore, this sort of program can be extended to other parts of the wetland region of Bangladesh. A "nature-based solution" strategy can improve opportunities for IGAs in the wetland region by utilizing resources like wetlands, rich soil, and biodiversity.

With a larger household, there is a greater chance of being poor. So, the family planning program might be reinforced to maintain the ideal family size in the wetland area. NGO member households are less likely to be poor than their non-member counterparts. Thus, the involvement of various NGOs might be beneficial in facilitating training on IGAs, such as tailoring, embroidery, handicrafts, and raising poultry and livestock. Landlessness is closely associated with the likelihood of poverty. So, landless individuals living in wetland areas may be encouraged to engage in sharecropping. The availability of electricity effectively reduces poverty among households in Bangladesh's wetland region. Therefore, the government can ensure access to electricity in the wetland region due to its direct and indirect links with IGAs. Implementing these measures immediately might help reduce poverty and achieve the targets of the SDGs, Perspective Plan, and Delta Plan.

Recommendation for Future Research

A study may be conducted using recent household-level data to determine the potential IGAs for Bangladesh's wetland region and accordingly make recommendations to the government.

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REFERENCES

Acharya, K. P., Khanal, S. P., & Chhetry, D. (2022). Factors affecting poverty in Nepal- A binary logistic regression model study. *Pertanika Journal of Social Science and Humanities, 30*(2), 641-663. https://doi.org/10.47836/pjssh.30.2.12

Achia, T. N. O., Wangombe, A., & Khadioli, N. (2010). A logistic regression model to identify key determinants of poverty using demographic and health survey data. *European Journal of Social Sciences, 13*(1), 38-45.

Alam, M. J. (2004). *Income and expenditure distribution pattern of Sunamganj haor area: Implications for poverty alleviation* [Working paper series]. Department of Economics and Social Science, BRAC University, 1-25. https://dspace.bracu.ac.bd/xmlui/handle/10361/348

Alamgir, M. (1974). Some analysis of distribution of income, consumption, saving and poverty in Bangladesh. *Bangladesh Development Studies, 2*(4), 737-818.

Amin, M. R., & Farid, N. (2005, October 19-20). *Food security and access to food: Present status and future perspective* [Conference presentation]. Ministry of Food and Disaster Management, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. 17-42.

Ara, J., Shahed, S. S., Rahman, R., Ahmad, S., & Das, N. C. (2020). The 'fishnet approach' to livelihood improvement in depressed basins: Evidence from BRAC's Integrated Development Programme. *Development in Practice, 30*(4), 523-540. https://doi.org/10.1080/09614524.2020.1719978

Bangladesh Bank. (2023). *Exchange rate of Taka. Dhaka, Bangladesh.* https://www.bb.org.bd/en/index.php/econdata/exchangerate

Bangladesh Bureau of Statistics. (2000). *Rural poverty monitoring survey-1998*. Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

Bangladesh Bureau of Statistics. (2017). *Preliminary report of household income and expenditure survey-2016*. Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. https://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/b343a8b4_956b_45ca_872f_4cf9b2f1a6e0/HIES%20Preliminary%20Report%202016.pdf

Bangladesh Bureau of Statistics. (2020a). *Statistical Yearbook Bangladesh-2019* (39th ed.). Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. https://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/b2db8758_8497_412c_a9ec_6bb299f8b3ab/2020-09-17-15-30-d0e641b2e659019f2aa44cbaf628caa8.pdf

Bangladesh Bureau of Statistics. (2020b). *Yearbook of Agricultural Statistics-2019*. Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. https://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/1b1eb817_9325_4354_a756_3d18412203e2/2020-10-06-09-58-453f7e0a42348e05f0999979870ec07b.pdf

Bangladesh Bureau of Statistics. (2023). *Key findings: Household income and expenditure survey-2022*. Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. https://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/57def76a_aa3c_46e3_9f80_53732eb94a83/2023-04-13-09-35-ee41d2a35dcc47a94a595c88328458f4.pdf

Bangladesh Institute of Development Studies. (1997). *Methods of measuring poverty and trend*. In R. I. Rahman (Ed.), *Poverty and development: Bangladesh context.* BIDS.

Bhuiya, A., Mahmood, S. S., Rana, A. K. M. M., Wahed, T., Ahmed, S. M., & Chowdhury, A. M. R. (2007). A multidimensional approach to measure poverty in rural Bangladesh. *Journal of Health, Population and Nutrition, 25*(2), 134-145.

Bogale, A., Hagedorn, K., & Korf, B. (2005). Determinants of poverty in rural Ethiopia. *Quarterly Journal of International Agriculture, 44*(2), 101-120. https://doi.org/10.5167/uzh-64170

Borko, Z. P. (2017). Determinants of poverty in rural households (The case of Damot Gale district in Wolaita Zone, Ethiopia) a household level analysis. *International Journal of African and Asian Studies, 29*, 68-75.

Centre for Environmental and Geographic Information Services. (2012). *Master plan of Haor area* (Vol. 1, Summary report). Ministry of Water Resources, Bangladesh Haor and Wetland Development Board, Dhaka, Bangladesh. https://dbhwd.portal.gov.bd/sites/default/files/files/dbhwd.portal.gov.bd/publications/baf5341d_f248_4e19_8e6d_e7ab44f7ab65/Haor%20Master%20Plan%20Volume%201.pdf

Chowdhury, A. (2014). *Factors affecting productivity and efficiency of rice production in haor area in Bangladesh: Likely impact on food security* [Master's thesis, Bangladesh Agricultural University]. https://catalog.ihsn.org/citations/42191

Farah, N. (2015). Impact of household and demographic characteristics on poverty in Bangladesh: A logistic regression analysis. *2015 Awards for Excellence in Student Research and Creative Activity,* Documents 3. https://thekeep.eiu.edu/lib_awards_2015_docs/3

Finan, F., Sadoulet, E., & Janvry, A. D. (2005). Measuring the poverty reduction potential of land in rural Mexico. *Journal of Development Economics, 77*(1), 27-51. https://doi.org/10.1016/j.jdeveco.2004.02.004

Food and Agriculture Organization of the United Nations. (2017, October 3). *GIEWS Update Bangladesh: Severe floods in 2017 affected large numbers of people and caused damage to the agriculture sector.* Reliefweb. https://reliefweb.int/report/bangladesh/giews-update-bangladesh-severe-floods-2017-affected-large-numbers-people-and

Foster, J., Greer, J., & Thorbecke, E. (1984). A class of decomposable poverty measures. *Econometrica, 52*(3), 761-766. https://doi.org/10.2307/1913475

Foster, J., Greer, J., & Thorbecke, E. (2010). The Foster–Greer–Thorbecke (FGT) poverty measures: 25 years later. *The Journal of Economic Inequality, 8*(4), 491-524. https://doi.org/10.1007/s10888-010-9136-1

Foster, J., Seth, S., Lokshin, M., & Sajaia, Z. (2013). *A unified approach to measuring poverty and inequality: Theory and practice.* The World Bank. https://documents1.worldbank.org/curated/en/281001468323965733/pdf/A-unified-approach-to-measuring-poverty-and-inequality-theory-and-practice.pdf

Hamoh, S., & Harun, A. (2021). Factors affecting poverty reduction in Yala Community Province Thailand. *International Journal of Advanced Research in Economics and Finance, 3*(1), 56-62.

Hasan, M. R., & Hossain, M. Z. (2024). Factors affecting formal micro-credits in the wetland regions of Bangladesh: A discriminant analysis. *International Journal of Statistical Sciences*, *24*(2), 85-96. https://doi.org/10.3329/ijss.v24i2.77992

Haughton, J., & Khandker, S. R. (2009). *Handbook on poverty and inequality*. The World Bank. https://documents1.worldbank.org/curated/en/488081468157174849/pdf/483380PUB0Pove101OFFICIAL0USE0ONLY1.pdf

Hossain, M. Z. (2020). Measurement of food insecurity and poverty by different methods-Does the method matter? *International Journal of Statistical Sciences, 20*(1), 79-96.

Hossain, M. Z., Kazal, M. M. H., & Uddin, J. (2013). *Rural-urban migration and its implications for food security in Bangladesh* [National Food

Policy Capacity Strengthening Programme (NFPCSP) Project Report], FPMU-FAO, Government of Bangladesh. https://catalog.ihsn.org/citations/26021

Imam, M. F., Islam, M. A., & Hossain, M. J. (2018). Factors affecting poverty in rural Bangladesh: An analysis using multilevel modelling. *Journal of the Bangladesh Agricultural University, 16*(1), 123-130. https://doi.org/10.3329/jbau.v16i1.36493

Islam, M. N., Islam, S., & Ornob, M. S. S. (2024). Comparative impact of formal and informal microcredits on poverty alleviation in the haor region of Bangladesh: A socioeconomic analysis. *Asian Journal of Economics, Business and Accounting, 24*(6), 371-388. https://doi.org/10.9734/ajeba/2024/v24i61368

Kazal, M. M. H., Rahman, S., & Hossain, M. Z. (2017). Poverty profiles and coping strategies of the Haor (Ox-bow lake) households in Bangladesh. *Journal of Poverty Alleviation and International Development, 8*(1), 167-191.

Kazal, M. M. H., Villinueva, C. C., Hossain, M. Z., & Das, T. K. (2010). *Food security strategies of the people living in haor areas: Status and prospects* (National Food Policy Capacity Strengthening Programme Project Report). https://fpmu.mofood.gov.bd/sites/default/files/files/fpmu.mofood.gov.bd/miscellaneous_info/05b6bab2_475b_40b0_aa30_62eb109e5bdb/2024-02-12-04-29-846f17c7416a6678aaafc536e92d80e4.pdf

Khandker, S. R., Barnes, D. F., & Samad, H. A. (2009). *Welfare impacts of rural electrification: A case study from Bangladesh* (Policy research working paper no. 4859). World Bank. https://doi.org/10.1596/1813-9450-4859

Khondker, B. H., & Mahzab, M. M. (2015). *Lagging districts development: Background study paper for preparation of the seventh five-year plan.* https://www.researchgate.net/publication/332567169_Lagging_Districts_Development_Background_Study_Paper_for_Preparation_of_the_Seventh_Five-Year_Plan

Korankye, A. A. (2014). Causes of poverty in Africa: A review of literature. *American International Journal of Social Science*, *3*(7), 147-153.

Meyer, D. F., & Nishimwe-Niyimbanira, R. (2016). The impact of household size on poverty: An analysis of various low-income townships in the Northern Free State region, South Africa. *African Population Studies, 30*(2), 2283-2295. https://doi.org/10.11564/30-2-811

Mia, M. (2021). Equal access to primary education in environmentally challenged area of Bangladesh: A study into the Tanguar Haor of Sunamganj district. *Social Science Review, 38*(1), 175-202. https://doi.org/10.3329/ssr.v38i1.56530

Ministry of Law. (2013). *Bangladesh Water Act, 2013. Justice and Parliamentary Affairs, Legislative and Parliamentary Affairs Division, Government of the People's Republic of Bangladesh.* http://oldweb.lged.gov.bd/uploadeddocument/UnitPublication/1/840/Water%20Act%202013%20(English).pdf

Ministry of Water Resources. (2016). *Classification of wetlands of Bangladesh* (Vol. 1, Main Report). Department of Bangladesh Haor and Wetland Development, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. http://dbhwd.portal.gov.bd/sites/default/files/files/dbhwd.portal.gov.bd/page/7b217360_7c6b_4cf3_aa2f_909e31dce458/Volume%201%20Final%20Report.pdf

Negash, T., Etsay, H., & Aregay, M. (2019). Factors influencing households' poverty status: Evidence from selected rural districts of Tigray region, Northern Ethiopia. *Journal of the Drylands, 9*(2), 1015-1025.

Rahman, H. M. T., Hickey, G. M., & Sarker, S. K. (2015). Examining the role of social capital

in community collective action for sustainable wetland fisheries in Bangladesh. *Wetlands,* 487-499. https://doi.org/10.1007/s13157-015-0635-5

Rahman, R. I., Begum, A., & Bhuyan, H. R. (2012). *Household food insecurity in Bangladesh: Concepts, estimates and determinants* (Research monograph No. 22). Bangladesh Institute of Development Studies, Dhaka, Bangladesh. https://www.researchgate.net/publication/268334700_Household_Food_Insecurity_in_Bangladesh_Concepts_Estimates_and_Determinants

Rahman, S. (1999). The impact of technological change on income distribution and poverty in Bangladesh agriculture: An empirical analysis. *Journal of International Development, 11*(7), 935-955. https://doi.org/10.1002/(SICI)1099-1328(199911/12)11:7<935::AID-JID642>3.0.CO;2-8

Ravallion, M., & Sen, B. (1996). When methods matter: Monitoring poverty in Bangladesh. *Economic Development and Cultural Change, 44*(4), 761-792. https://doi.org/10.1086/452244

Sen, A. (1987). *On ethics and economics*. Blackwell.

Shaw, R. (2006). Critical issues of community based flood mitigation: Examples from Bangladesh and Vietnam. *Journal of Science & Culture, 72*(1-2), 1-17.

Townsend, P. (1979). *Poverty in the United Kingdom: A survey of household resources and standards of living*. Allen Lane Publisher. https://doi.org/10.1525/9780520325760

United Nations Development Program. (2017). *Human development report 2016*: *Human development for everyone*. https://doi.org/10.18356/b6186701-en

United Nations Development Program. (2023). *Unstacking global poverty: Data for high impact action: Multidimensional Poverty Index 2023*. https://doi.org/10.18356/9789210028325

United Nations Educational, Scientific and Cultural Organization. (1997). Position paper. In *Microcredit Summit* (pp. 1-8). UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000111669