Rajshahi University journal of social science and business studies **ISSN 2309-0944 (Print)**
Vol. 30 (2022), pp 115-128 **ISSN 2408-8811 (Online)**
DOI: https://doi.org/10.64102/rujssbs.0490

Contingent Valuation Study of Groundwater Recharge Service of *Chalan Beel* Wetland, Bangladesh

Md. Rozi Uddin[1*], Md. Elias Hossain[2], Md. Redwanur Rahman[3]

Abstract

Chalan Beel, the largest wetland in northern Bangladesh, offers various ecosystem services that support human well-being and sustain the ecological balance of the region. Among these services groundwater recharge is critically important for maintaining the underground water levels of the aquifers. However, because of the non-market nature of groundwater recharge service, scant attention has been given by the researchers to valuing this important ecosystem service. This study aims to estimate the economic value of groundwater recharge service provided by *Chalan Beel* using the Contingent Valuation Method (CVM). To achieve the objective, primary data are collected from 204 randomly selected households across three upazilas of Natore district. A double-bounded dichotomous choice (DBDC) framework is employed to estimate households' willingness to pay (WTP) for continuation of groundwater recharge service. Estimation results show that 64.71% of the respondents are willing to pay the proposed bids for continuation of groundwater recharge service of *Chalan Beel*, while 35.29% rejected them. The regression results reveal that households' income, education, knowledge of ecosystem services, and environmental awareness have a positive and significant influence on WTP, whereas distance from the wetland negatively affects their WTP. Using the regression results, the mean WTP is estimated at BDT 17.04 per household per month and based on the total number of households in Natore district, the aggregate annual economic value of groundwater recharge service provided by *Chalan Beel* is estimated at approximately BDT 102.64 million (equivalent to 0.855 million USD). The findings provide significant implication for policy formulation and sustainable management strategies to protect the ecosystem of *Chalan Beel* amid increasing anthropogenic and environmental pressures.

***Keywords**: Chalan Beel* ecosystem, Contingent valuation method, Double bounded dichotomous choice, Groundwater recharge, Willingness to pay.

1. Introduction

Wetlands are among the most diverse and valuable ecosystems that provide numerous ecosystem services essential to human societies (Balwan & Kour, 2021). It includes rivers, lakes, *haors, baors, beels,* and floodplains, which support various types of flora and fauna, all of which are crucial for maintaining environmental sustainability and supporting human well-being (Nayak & Bhushan, 2022; Mitsch & Gosselink, 2015). The multitude of services a wetland provides is flood control, biological and genetic diversity, carbon sequestration,

[1] Ph.D. Fellow, Institute of Environmental Science, University of Rajshahi, Rajshahi 6205, Bangladesh; E-mail: rose2028@gmail.com * Corresponding author

[2] Professor, Department of Economics, University of Rajshahi, Rajshahi 6205, Bangladesh; E-mail: eliaseco@ru.ac.bd

[3] Professor, Institute of Environmental Science, University of Rajshahi, Rajshahi 6205, Bangladesh; E-mail: redwan_rahman@ru.ac.bd

water purification, soil erosion prevention, groundwater recharge and other life-support functions (Assefa et al., 2015; Sharma & Naik, 2024). Among these, groundwater recharge is particularly vital because it helps to maintain hydrological cycle and to secure freshwater resources (Gebreslassie et al., 2025). Groundwater recharge occurs when water from rain, rivers, and other surface sources is absorbed by soil and gradually infiltrates into the ground to refill aquifers (Mitsch & Gosselink, 2007; Tundisi & Tundisi, 2016). Groundwater provides drinking water to about half of the global population and accounts for 20 to 70 percent of total global irrigation (Hammer & Bastian, 2020). Despite this critical contribution provided by wetlands, the groundwater recharge function does not receive significant attention of the policymakers in the developing counties like Bangladesh.

Chalan Beel is the largest and the most ecologically significant wetland in the northern region of Bangladesh. It plays a crucial role in sustaining regional biodiversity by providing habitat for a variety of species (Ali & Yousuf, 2019, Uddin et al., 2025). Furthermore, *Chalan Beel* maintains the regional hydrological cycle by reducing flood, purifying water, recharging groundwater and augmenting low flows (Bullock & Acreman, 2003; Salam et al., 2021). Groundwater is the primary source of freshwater for irrigation, drinking water, and fish production in the *Chalan Beel* region (Hossain et al., 2009; Nurullah, 2023; Rahman et al., 2022). By providing groundwater recharge function, *Chalan Beel* ensures continuous supply of freshwater for the surrounding communities.

However, increasing anthropogenic activities like unplanned urban development, agricultural encroachment, human settlements, and pollution reduced the groundwater recharge function of *Chalan Beel* (Rahman, 2015; Sayeed et al., 2014; Nurullah, 2023). These activities, along with the over extraction of groundwater, resulted in a continuous decline of the underground water table in the aquifers. According to a report (The Daily Star, 2024), there are 7,000 deep tube wells (DTWs), 100,000 shallow tube wells (STWs), and thousands of submersible pumps, all of which extract underground water for irrigation and other purposes leading to adverse effects on the *Chalan Beel* ecosystem and the surrounding communities. Moreover, climate change and extreme weather events added additional challenges to continue the ability of groundwater recharge function of *Chalan Beel* (Zhang & Li, 2021). As a result, the long-term sustainability of *Chalan Beel* and its critical ecosystem services, particularly the groundwater recharge, is increasingly threatened.

Although *Chalan Beel* bears enormous ecological importance, the groundwater recharge service it provides has not been recognized sufficiently by researchers and policy makers. The reason for the neglect is the difficulty associated with valuing the service of *Chalan Beel* as it cannot be captured though market transactions due to its non-market nature (Barbier et al., 1997). Therefore, policy makers, users and other stakeholders generally find less incentive to invest in the conservation and restoration of *Chalan Beel* ecosystem.

In situations where valuation challenges arise due to non-market nature of a good or service, economists generally suggest three valuation methods- Travel Cost Method (TCM), Hedonic Pricing Method (HPM) and Contingent Valuation Method (CVM), all of which are based on measuring WTP of the users (Perman et al., 2007). Among these three methods, CVM is the popular and the most widely used approach for assessing the economic value of non-market environmental services like groundwater recharge. CVM is a stated preference method that involves asking individuals to state their willingness to pay for sustaining this particular ecosystem service through hypothetical scenario (Ramsar Convention, 2018; Perman et al., 2007). By using CVM, we can estimate the economic value that individuals place on the conservation of ecosystem services, even without market transactions. This method is applicable for both the use and non-use values of ecosystem services of a wetland *like Chalan Beel* (Carson, 2004; Carson & Hanemann, 2005; Carson & Czajkowski, 2014).

Despite its popularity and widespread use, the application of CVM to estimate the economic value of groundwater recharge services provided by wetlands in developing countries, such as Bangladesh, remains limited. This study addresses this gap by applying the CVM to estimate the monetary value that local communities place on sustaining the groundwater recharge service provided by *Chalan Beel*. Accordingly, the main objective of this study is to estimate the economic value of groundwater recharge services of *Chalan Beel* and to investigate the factors that influence WTP of the respondents using the Contingent Valuation Method. Thus, this research will contribute to the growing body of knowledge on the economic value of wetlands, offering insights into the role of ecosystem services in sustaining human livelihoods and fostering long-term environmental sustainability.

2. Research Methodology

This study is based on primary data collected from the households of three *upazilas* in Natore district. Contingent Valuation Method is employed to assess the economic value of groundwater recharge service provided by *Chalan Beel* ecosystem. The Double-Bounded Dichotomous Choice format is employed to gather data on households' willingness to pay for the conservation of groundwater recharge service provided by the wetland.

2.1 Contingent Valuation Method

The Contingent Valuation Method is a widely used and direct approach among all stated preference methods towards WTP (Titenberg and Lewis, 2012). This Method presents a hypothetical scenario for the respondents to buy public goods and services and then asks to state their willingness to pay for these goods and services (Carson and Mitchell, 1993; Hanemann, 1994). CVM is a survey-based tool that allows us to assess non-market goods and services like pollution impacts and ecosystem services preservation (Carson, 2005, Jahan & Hossain, 2025). Furthermore, CVM has been applied across various sectors, including conservation of groundwater recharge, water quality improvement, public health, and tourism (Bateman et al., 2002; Loomis, 2000). Although CVM has some limitations, it is a broadly applied and popular method of valuing non-market goods and services (Orlowski & Wicker, 2019). Moreover, CVM is the only valuation method capable of estimating both use and non-use values of a natural resource (Venkatachalam, 2004). Given the non-market and public goods characteristics of groundwater recharge service, this study applies CVM to estimate the average WTP for the conservation of groundwater recharge services by *Chalan Beel*.

2.2 Elicitation Technique

There are several types of elicitation techniques used in the Contingent Valuation Method such as payment cards, bidding games, open-ended questions, and both single-bounded dichotomous choice (SBDC) and double-bounded dichotomous choice (DBDC) questions (Smith, 1997). This study used the DBDC format, as described by Hanemann et al. (1991), and Cameron and Quiggin (1994). In this format, respondents are presented with two bids, each followed by a "yes" or "no" response to determine if their WTP meets or exceeds the offered bid. The second bid is contingent upon the answer to the first: it is reduced if the first response is "no" and increased if it is "yes" (Yoo & Yang, 2001).

The four possible response combinations are: “yes-yes,” “yes-no,” “no-yes,” and “no-no,” which help refine the bounds of the respondent’s WTP. This approach improves the efficiency of the WTP estimates compared to the single-bounded dichotomous choice model by providing more data points and increasing the precision of the estimates (Haab & McConnell, 2002). The yes-yes and no-no responses are particularly valuable, as they provide clearer bounds for WTP.

2.3 Study Area and Data

Chalan Beel is a freshwater wetland in the northern Bangladesh located across three districts- Sirajganj, Natore and Pabna. It is situated between 24˚05′ and 24˚35′ north latitude and 89˚ to 89˚35′ east longitude. Due to the continuous process of siltation, the command area of *Chalan Beel* has been shrinking gradually over time. From an original extent of around 1,085 km^2 in 1909, its coverage shrank to 368 km^2 at present (Kostori, 2016). The water depth in *Chalan Beel* is about of 2 to 2.5 meters (Galib et al., 2009). The area is part of the Ganges floodplain and has low-lying depressions including *beels*, swamps, and marshes (Siddiquee & Hoque, 2007). *Chalan Beel* is the biggest body of water connected to many rivers and channels in the northern region of Bangladesh.

This study is based on primary data collected from selected households of Natore district. A total of 204 households is randomly selected from three *upazilas* (Sadar, Singra, and Gurudaspur) of Natore district. The primary data are collected from the selected respondents through face-to-face interviews using a well-structured questionnaire. Following Cooper (1993), a number of focus group discussions are conducted to gather necessary feedback, and a pilot study is carried out to pre-test the questionnaire and refine the bid values before commencing the contingent valuation survey (CVS). The pre-testing of the questionnaire facilitated to ensure clarity, reliability and respondents’ understanding of the valuation scenario. The bid values and payment vehicles in the questionnaire are obtained from focus group discussions (FGDs).

3. Model Specification

3.1 Empirical Model

This study employs the Contingent Valuation Method (CVM) using a Double Bounded Dichotomous Choice (DBDC) framework, which enhances statistical efficiency by including follow-up questions (Hanemann et al., 1991; Cameron & Quiggin, 1994; Alberini, 1995; Liu & Chen, 1996). Let us define $y_i^1 and\, y_i^2$ as the dichotomous variables for responses to the first and second closed-ended questions. Then the probability that an individual answers ‘yes’ to the first question and ‘no’ to the second can be expressed as Pr($y_i^1 = 1, y_i^2 = 0 | z_i$) = Pr(*s,n*) (For notational simplicity, we omitted from the right-hand side the explicit conditioning of the probability on the explanatory variables). Given this and under the assumption that WTP (z_i, u_i) = $z_i'\beta + u_i$ and $u_i \sim N(0, \sigma^2)$, we have the probabilities of each one of the four cases are given by:

1. $y_i^1 = 1 \, and \, y_i^2 = 0$

$$Pr(s,n) = \varphi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) - \varphi\left(\frac{t^1 - z_i'\beta}{\sigma}\right) = \varphi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right) - \varphi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) \quad ... (1)$$

Here, t^1 and t^2 is the bid value of 1st and 2nd respectively.

2. $y_i^1 = 1 \, and \, y_i^2 = 1$

$$Pr(s,s) = 1 - \varphi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) = \varphi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) \quad ... (2)$$

3. $y_i^1 = 0 \, and \, y_i^2 = 1$

$$Pr(n,s) = \varphi\left(\frac{t^1 - z_i'\beta}{\sigma}\right) - \varphi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) = \varphi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) - \varphi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right) \quad ... (3)$$

4. $y_i^1 = 0 \, and \, y_i^2 = 0$

$$Pr(n,n) = \varphi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) = 1 - \varphi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) \quad ... (4)$$

Maximum likelihood estimation method is applied to directly obtain the estimates for β and σ. The maximum likelihood estimation function is:

$$\Sigma_{i=1}^{N}\left[d_i^{sn}\ln\left(\varphi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right) - \varphi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right)\right) + d_i^{ss}\ln\left(\varphi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right)\right) + \right.$$
$$\left.\left[d_i^{ns}\ln\left(\varphi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) - \varphi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right)\right) + d_i^{nn}\ln\left(1 - \varphi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right)\right)\right]\right] \quad ... (5)$$

Indicator variables $d_i^{sn}, d_i^{ss}, d_i^{ns}, d_i^{nn}$ might have values of one or zero, depending on the particular situation for each individual. In other words, a particular individual only contributes to one of the likelihood function's four components.

3.2 Variables Used in the Model

Households’ WTP for groundwater recharge service of *Chalan Beel* ecosystem is considered as dependent variable in the regression analysis. Socioeconomic variables such as age, family size, education, income etc., along with distance, knowledge of ecosystem services, and environmental awareness are taken as independent variables. The summary of variables and their descriptions are shown below in Table 1:

Table 1. Variables Used in the Regression Analysis

Variables	Definition of variables	Nature of variables
AGE	Age of household head in years	Continuous
EDU	Education level in years	Continuous
HS	Household size in number of persons	Continuous
LS	Size of land holding by household (*bigha**)	Continuous
HHI	Household income in Bangladeshi Taka (BDT)	Continuous
DIST	Distance of house from the *Beel* in km	Continuous
KES	Knowledge about ecosystem services (ES) of *Chalan Beel*	Dummy variable, 1 if the respondent has knowledge about ES of *Chalan Beel*, and 0 otherwise
EVAWS	Environmental awareness status	Dummy variable, 1 if the HH has satisfactory awareness about environment, and 0 otherwise

* 1 *bigha* = 33 decimal

4. Results

4.1 Descriptive Analysis

The descriptive analysis of the independent variables used in the regression analysis is shown in Table 2. The average age of the individuals in the sample is 42.33 years, with a standard deviation of 11.60 years, indicating a wide age range from 22 to 78 years. Education attainment in the region is highly varied with an average of 8.09 years of formal education. This result exhibits a significant range in schooling levels—from zero to 17 years. The mean household size is 3.47 members, with a range from 2 to 7. Landholding size, measured in *bigha*, shows substantial variability, with an average of 3.52 *bighas*, but a maximum landholding of 28 *bighas* and a minimum of zero *bighas*. The average distance from the *beel* is 5.17 kilometers. This figure, however, masks a high degree of variability, as distances range from nearly 0 kilometer to 20 kilometers. Household income (HHI) varies greatly, with an average of BDT 264,361.80, a minimum of BDT 84,000.00, and a maximum of BDT 960,000.00, reflecting significant income disparity within the sample. Two dummy variables, KES and EVAWS, indicate that 56.37% and 38.73% of the respondents exhibit these characteristics, respectively. Overall, the variability in these variables highlights the diverse socioeconomic and demographic profile of the sample population, which is expected to offer rich insights into the factors influencing the regression outcomes.

Table-2: Descriptive Analysis of Independent Variables used in Regression Analysis

Continuous variables (Sample size, N= 204)				
Variables	**Mean**	**Std. Dev.**	**Min**	**Max**
AGE (in years)	42.33	11.601	22	78
EDU (class)	8.09	6.019	0	17
FS (in number)	3.47	1.317	2	7
LS (in *bigha*)	3.52	5.65	0.091	28
DIST (in kilometers)	5.17	6.06	0	20
HHI (in Taka)	264361.8	192899.6	84000	960000
Dummy variables (Sample size, N= 204)				
Variables	Yes	%	No	%
KES	115	56.37	89	43.63
EVAWS	79	38.73	125	61.27

Source: Field survey, 2024

4.2 Analysis of Dichotomous Responses

The DBDC survey results for groundwater recharge service in *Chalan Beel* is consistent with the law of demand hypothesis. The percentage of no-no responses increases with the higher initial bid price faced by the respondents. Among total 204 respondents 132 say "yes" and 72 says "no". The highest (50%) respondents say no-no for initial bid of BDT 30 and the lowest (22%) no-no for initial bid of BDT 10. As expected, the proportion of positive answers goes down as the bid amount goes up. Table 3 provides the detail answers of the respondents under the DBDC approach.

Table 3: DBDC Answers of Respondents for Groundwater Recharge Service

ES Service	**Initial Bid**	**Yes-Yes**	**Yes-No**	**No-Yes**	**No-No**	**Observations**
Ground water Recharge	10	14	21	18	15 (22%)	68
	20	13	15	17	23 (34%)	68
	30	09	12	13	34 (50%)	68
Total		36	48	48	72 (35.29%)	204

Source: Field survey, 2024

It is found in the survey that a significant number of respondents have expressed their unwillingness to pay for groundwater recharge service provided by *Chalan Beel* as shown in Table 3. It is found in the table that a total of 35.29% respondents showed unwillingness to pay for groundwater recharge service. The primary reason for their unwillingness to proposed bids is lack of financial capacity which is 41.67% (Table 4). The second most common reason, at 20.83%, is the belief that wetland conservation is the government's responsibility, indicating a gap about perceived duty between public and institutional actors. Additional concerns revolve around fairness, with 12.5% thinking that they should not be responsible for the degradation of *Chalan Beel* ecosystem and 8.33% lacking confidence in proper budget allocation, pointing to issues of transparency and trust. Furthermore, a notable portion of respondents is either satisfied with the *Chalan Beel's* current state (9.72%). The remaining 6.94% cited unspecified other reasons. Collectively, these findings suggest that for a wetland funding bid to succeed, it must be designed to be financially accessible, clearly communicate why change is needed, fairly allocate costs, and build trust through accountable financial management.

Table 4. Reasons for Rejecting the Proposed Bids

Reasons	Frequency	%
I do not have financial capability to pay	30	41.67
I am satisfied with the present status of *Chalan Beel*	7	9.72
I do not think that I should be responsible for the programs	9	12.5
It is the government's responsibility	15	20.83
I am not confident on proper budget allocation	6	8.33
Others (no explanation of reasons)	5	6.94

Source: Field survey, 2024

4.4 Econometric Analysis

4.4.1 WTP without Control Variables

This study used double-bounded contingent valuation model to estimate the willingness to pay for sustaining groundwater recharge service of *Chalan Beel*. The estimation of the collected data is performed at two stages as per the provision of DBDC framework. At the first stage, the estimation is done excluding the control variables (socioeconomic, demographic and perception-based variables), which could influence people's willingness to pay. This indicate that in the estimation, the WTP is assumed constant for every respondent in the sample, irrespective of their personal characteristics. Thus, the model only considered the bid value presented to each respondent without any background factors.

The model is estimated using the *doubleb* command in *Stata* to assess respondents' willingness to pay, and the command *doubleb* (Lopez-Feldman, 2012) allows the direct estimation of regression coefficient (β) and standard deviation (σ). As shown in Table 5, the mean WTP is estimated to be around BDT 16.91 per month at the individual level, and the coefficient is significant at 1% level. The table also shows substantial heterogeneity in respondents' willingness to the pay indicated by estimated standard deviation of BDT 26.72, which is also significant at 1% level.

Table 5. Estimated WTP without Control Variables

Variables	Coefficient	Standard Error	*p*-Value
Beta _constant	16.91	2.09	0.000
Sigma _constant	26.72	2.32	0.000
N	204		
LL	-293.433		
i.e. n = No. of respondents; LL= log likelihood			

Source: Field survey, 2024

4.4.2 WTP Including Control Variables

At the second stage, estimation of the double bounded dichotomous choice contingent valuation model is extended by incorporating socioeconomic, demographic and perception-based variables. These variables help explain variations in WTP across respondents and improve the interpretability of the estimated results. The double bounded WTP model is as follow:

$$WTP_i = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \hat{\beta}_3 x_3 + \hat{\beta}_4 x_4 + \hat{\beta}_5 x_5 + \hat{\beta}_6 x_6 + \hat{\beta}_7 x_7 + \hat{\beta}_8 x_8 + \varepsilon$$

Where WTP_i indicates the WTP of respondent i, x_1 represents age, x_2 represents household income, x_3 represents the education level of the respondent, x_4 represents respondents' family size, x_5 represents land size, x_6 represents household distance from the Beel, x_7 represents respondents' knowledge of ecosystem service of *Chalan Beel*, x_8 represents respondents' environmental awareness, and ε represents error term. The WTP is calculated by the simple formula $\tilde{z}'\hat{\beta}$.

Table 6: Estimation Results of the WTP Model with Control Variables

Attributes	Coefficient	Standard error	*p*-value
AGE	-0.002	0.124	0.985
HHI	0.001***	0.000	0.000
EDU	1.073***	0.319	0.001
FS	-0.003	1.012	0.998
LS	0.249	0.234	0.286
DIST	-0.338**	0.145	0.020
KES	7.986***	2.957	0.007
EVAWS	7.195**	2.994	0.016
Constant	-13.508*	7.309	0.065
No. of observations	204		
Log likelihood	-200.829		

Source: Field survey, 2024

Table 6 presents the estimated coefficients of the double bounded dichotomous choice contingent valuation model with socioeconomic, demographic and perception-based variables explaining the respondents' WTP for sustaining groundwater recharge service provided by *Chalan Beel*. It is found that the variables- income, education, and knowledge about ecosystem services of *Chalan Beel* and environmental awareness have positive and significant influence on WTP of the respondents, whereas the variable distance from the *beel* has negative significant effect on the WTP of the respondents for sustaining groundwater recharge service of *Chalan Beel*. The findings are consistent with the findings of Sersinghe (2018) and Bandyopadhyay (2006) and Patwary et al. (2020). Both Sersinghe (2018) and Patwary et al. (2020) found household income and education to have significant impact on WTP of the respondents, while Bandyopadhyay (2006) found only education to have significant effect on WTP. The study also indicated that knowledge about ecosystem services of *Chalan Beel* and environmental awareness improved WTP. This emphasizes the necessity of education and awareness in encouraging the conservation of groundwater recharge services provided by *Chalan Beel*. This is consistent with Li et al. (2025), who found that Chinese wetland ecological understanding increased bird conservation spending. In addition, Mamboleo and Adem (2022) and Chenje et al. (2017) found that understanding ecosystem services' worth increases the likelihood of their preservation.

This study found that age, family size, and land size did not significantly affect WTP. It is not uncommon in environmental economics research for certain demographic factors, particularly age and family size, to fail to exert a statistically significant effect on respondents' WTP (Li et al., 2025; Sengkhamyong et al., 2022; Thuy et al., 2024). While these variables may influence willingness to pay for groundwater recharge services in other contexts, they do not appear to have an impact in the case of Chalan Beel.

Table 7: Mean WTP for Groundwater Recharge Service

	Coefficient	*p*-value	Sig
WTP	17.04	0.000	***

By applying the WTP calculation formula mentioned earlier, the estimated mean willingness to pay for the continuation of the groundwater recharge service provided by *Chalan Beel* is approximately BDT 17.04, after accounting for socioeconomic, demographic, and perception-based variables. This mean WTP is statistically significant at the 1% level. The estimated mean WTP for groundwater recharge services of *Chalan Beel* is compared with the findings of Patwary et al (2020), who found that households were willing to pay an average of BDT 53.3 per month for *Beel Dakatia* conservation. The value differs from that of our study because they considered WTP of the respondents for all aspects of ecosystem services provided by *Beel Dakatia* while in our study only groundwater recharge service is considered. If the services were considered separately in Patwary et al. (2020), then the estimated WTP of our study could have been similar to theirs. It should also be noted that WTP across different wetlands can vary depending on socioeconomic and geographical contexts.

The negative effect of households' distance from *Chalan Beel* and WTP is an important finding as well. Households staying farther from the wetland contributed less monetarily, suggesting that ecological proximity can impact people's value perception. This finding is supported by Asmare et al. (2022) who observed that distance to the wetland has negative influence on households' WTP in the case of Gudera wetland of Ethiopia.

Table 8: Total estimated WTP for Groundwater Recharge of *Chalan Beel*

Category of characteristics	**Value**
Total number of households in Natore district	501,957
Household's mean WTP per month (BDT)	17.04
Household's total WTP per year (Million BDT)	102.64

Table 8 presents the aggregation of the individual level WTP to estimate the total economic value of ecosystem service in terms of groundwater recharge provided by *Chalan Beel*. Natore district has a total of 501,957 households (BBS, 2022) and using the estimated mean WTP value per month (BDT 17.04), the total willingness to pay is BDT 102.64 million per year. This indicate that the annual economic benefit placed by the households of Natore district on the continuation of groundwater recharge service is BDT 102.64 million per year.

5. Conclusion

Groundwater recharge is one of the key ecosystem services provided by *Chalan Beel*, and this study provides empirical evidence that local communities express their positive willingness to pay for sustaining the service underscoring the perceived importance of this service despite its non-market nature. Based on their willingness to pay, households of *Natore* district, in particular, impute an estimated approximate value of BDT 102.64 million per year for this service. This signifies that the households living in the *Chalan Beel* region demonstrate their interest in and support for the conservation of groundwater recharge service provided by *Chalan Beel*. This study also confirms that households' decision on the probability and intensity of WTP are dependent on different demographic, socioeconomic and attitudinal factors. Specifically, the probability of WTP is influenced by education, income, knowledge of ecosystem services, environmental awareness, and households' distance from the *beel.* However, heterogeneity in WTP is observed which is due to the differences in socioeconomic and cognitive factors and levels of interaction with the wetland. The findings of this study have significant policy and practical implications for the sustainable management of *Chalan Beel* and continuation of its ecosystem services. Raising environmental awareness, strengthening education programs and improving local knowledge about ecosystem services can increase public participation for conservation efforts. Government and non-government organizations can promote awareness programs on the sustainable use of water, tree plantation and the benefits of using surface water for various purposes. Finally, integrating community- based payment system with targeted policy interventions will help mobilize resources for restoration and protection of this ecologically important wetland.

References

Ali, A., & Yousuf, M. (2019). Groundwater recharge and its impact on agricultural sustainability in wetlands. *Water Resources Management*, 33(6), 1855-1865.

Asmare, E., Bekele, K., & Fentaw, S. (2022). Households' willingness to pay for the rehabilitation of wetlands: evidence from Gudera wetland, Northwest Ethiopia. *Heliyon*, *8*(1).

Balwan, W. K., & Kour, S. (2021). Wetland-an ecological boon for the environment. *East African Scholars Journal of Agriculture and Life Sciences*, 4(3), 38-48.

Bandyopadhyay, S., Narayanan, K., & Ramanathan, A. (2006). Determinants of willingness to pay for wetland conservation: A study of Kolkata Wetlands. *Ecological Economics*, 56(2), 172-179. https://doi.org/10.1016/j.ecolecon.2005.03.004

Barbier, E. B., Acreman, M. C., & Knowler, D. (1997). Economic valuation of wetlands: A guide for policymakers and planners. IUCN, Gland, Switzerland.

Bateman, I. J., Carson, R. T., Day, B. H., Hanemann, W. M., Hanley, N., Hett, T., & Jones-Lee, M. (2002). Economic valuation with stated preference techniques: A manual. Edward Elgar.

Bullock, A., & Acreman, M. (2003). The role of wetlands in the hydrological cycle. *Hydrology and Earth System Sciences*, *7*(3), 358-389.

Cameron, T. A., & Quiggin, J. (1994). Estimation using contingent valuation data from a 'dichotomous choice with follow-up' questionnaire. *Journal of Environmental Economics and Management,* 27(3), 218-234. https://doi.org/10.1006/jeem.1994.1024

Carson, R. T. (2004). Contingent valuation—A comprehensive bibliography and history. Edward Elgar, Cheltenham, U.K.

Carson, R. T., & Czajkowski, M. (2014). The discrete choice experiment approach to environmental contingent valuation. In S. Hess & A. Daly (Eds.), Handbook of Choice Modelling (pp. 202–235). Edward Elgar, Cheltenham, U.K.

Carson, R. T., & Hanemann, W. M. (2005). Contingent valuation. In K. G. M€aler & J. R. Vincent (Eds.), Handbook of Environmental Economics. Valuing Environmental Changes, Vol. 2 (pp. 821–936). Elsevier, Amsterdam.

Carson, R. T., & Mitchell, R. C. (1993). The issue of scope in contingent valuation studies. *American Journal of Agricultural Economics*, *75*(5), 1263-1267.

Chenje, M., Chimba, S., & Mwanza, R. (2017). Rural households' willingness to pay for water preservation services in Zambia: A case study of wetlands. *Environmental Conservation,* 44(4), 411-419. https://doi.org/10.1017/S0376892917000077

Cooper, J. C. (1993). The use of contingent valuation to estimate the value of water quality improvements: A case study of the Lake Erie basin. *Water Resources Research, 29*(4), 1065-1073. https://doi.org/10.1029/93WR00313

Costanza, R., d'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., ... & Van Den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *nature*, *387*(6630), 253-260.

The Daily Star, 7 June 2024. (https://www.thedailystar.net/weekend-read/news/our-dying-chalan-beel-3629586)

Galib, S. M., M. A. Samad, M. M. Kamal, M. A. Haque, and M. M. Hasan. A study on fishing gears and methods in the Chalan Beel of north-west Bangladesh. *Journal of Environmental Science & Natural Resources*, no. 2 (2009): 213-218.

Gebreslassie, H., Berhane, G., Gebreyohannes, T., Hagos, M., Hussien, A., & Walraevens, K. (2025). Water harvesting and groundwater recharge: A comprehensive review and synthesis of current practices. *Water*, 17(7), 976.

Haab, T. C., & McConnell, K. E. (2002). Valuing environmental and natural resources: The econometrics of non-market valuation. Edward Elgar Publishing.

Hammer, D. A., & Bastian, R. K. (2020). Wetlands ecosystems: Natural water purifiers? In Constructed wetlands for wastewater treatment (pp. 5-19). CRC Press.

Hanemann, W. M. (1994). Valuing the environment through contingent valuation. *Journal of Economic Perspectives*, 8(4), 19-43.

Hanemann, W. M., Loomis, J., & Kanninen, B. (1991). Statistical efficiency of double-bounded dichotomous choice contingent valuation. *American Journal of Agricultural Economics,* 73(4), 1255-1263. https://doi.org/10.2307/1242831

Hossain, M. A., Nahiduzzaman, M., Sayeed, M. A., Azim, M. E., Wahab, M. A., & Olin, P. G. (2009). The Chalan beel in Bangladesh: Habitat and biodiversity degradation, and implications for future management. *Lakes & Reservoirs: Research & Management*, *14*(1), 3-19.

Jahan, M, E. and Hossain, M.E. (2025). Willingness to Pay for Solid Waste Management Service in Rajshahi City, Bangladesh: A Contingent Valuation Approach, *Environmental Quality Management*, 34 (3), 1-12.

Kostori, M. F. A. (2016). *Availability and Rational Utilization of Fisheries Resources of the Chalan Beel* (Doctoral dissertation, University of Rajshahi).

Li, Z., Zhang, J., & Zhang, T. (2025). Factors influencing the willingness to pay for wetland bird conservation: A case study in China. *Ecology and Society*, 30(2), 125-136. https://doi.org/10.5751/ES-13024-300212

Loomis, J. B. (2000). Contingent valuation: A critical assessment. In R. E. Kristofersson & K. G. Mäler (Eds.), Handbook of Environmental Economics (pp. 318-353). Elsevier.

Loomis, J. B. (2000). Environmental valuation techniques in water resource decision making. *Journal of Water Resources Planning and Management*, 126(6), 339-344.

Lopez-Feldman, A. (2012). Introduction to contingent valuation using Stata.

Mamboleo, M., & Adem, A. (2022). Estimating willingness to pay for the conservation of wetland ecosystems: The Lake Victoria case study. Journal of Environmental Economics and Policy, 17(3), 255-267. https://doi.org/10.1080/21606544.2022.1923747

Mitsch, W. J., & Gosselink, J. G. (2015). Wetlands. John Wiley & Sons.

Nayak, A., & Bhushan, B. (2022). Wetland ecosystems and their relevance to the environment: Importance of wetlands. In Handbook of Research on Monitoring and Evaluating the Ecological Health of Wetlands (pp. 1-16). IGI Global Scientific Publishing.

Nurullah, A. B. M. (2023). Assessment of livelihood challenges due to wetland ecological changes: A case from Chalan Beel, the largest wetland of Bangladesh. *South Asian Journal of Development Research*, 4(1), 1-23.

Orlowski, J., & Wicker, P. (2019). Monetary valuation of non-market goods and services: a review of conceptual approaches and empirical applications in sports. *European Sport Management Quarterly*, *19*(4), 456-480.

Perman, R., Ma, Y., McGilvray, J., & Common, M. (2003). Natural resource and environmental economics (3rd ed.). Pearson Education Limited.

Patwary, M. M., Al Amin, M., Ashraf, S., & Shuvo, F. K. (2020). How Much Value do People Place on Conserving the Coastal Freshwater Wetland in Bangladesh? Proceedings of the 5th International Conference on Civil Engineering for Sustainable Development (ICCESD 2020), 7~9 February 2020, KUET, Khulna, Bangladesh.

Rahman, M. H., Al-Amin, S. S. M., & Jaman, A. (2022). Biodiversity and conservation status of Chalan Beel in northern Bangladesh: A study. *International Journal of Fish Aquatic Research,* 7(2), 30-38.

Rahman, M. R. (2015). Causes of biodiversity depletion in Bangladesh and their consequences on ecosystem services. *American Journal of Environmental Protection*, 4(5), 214-236.

Ramsar Convention on Wetlands. (2018). The economic valuation of wetlands: A manual for the development and use of valuation. Ramsar Convention Secretariat.

Ramsar. (2014). Factsheet 3: Wetlands: A global disappearing act. Retrieved from https://www.ramsar.org/sites/default/files/documents/library/factsheet3_global_disappearing_act_0.pdf

Salam, M. A., Alam, M. A., Paul, S. I., Islam, F., Shaha, D. C., Rahman, M. M., ... & Islam, T. (2021). Assessment of heavy metals in the sediments of Chalan Beel Wetland area in Bangladesh. Processes, 9(3), 410.

Sayeed, M. A., Hashem, S., Salam, M. A., Hossain, M. A. R., & Wahab, M. A. (2014). Efficiency of fishing gears and their effects on fish biodiversity and production in the Chalan Beel of Bangladesh. *European Scientific Journal*, 10(30).

Serasinghe, S. (2018). Willingness to pay for wetland ecosystem services: A study in Sri Lanka. *Asian Journal of Environmental Science*, 12(1), 63-71. https://doi.org/10.1007/s13280-018-1035-5

Sengkhamyong, X., Yabar, H., & Mizunoya, T. (2022). Assessing household willingness to pay for the conservation of the Phou Chom Voy Protected Area in Lao PDR. *Sustainability*, 14(18), 11202. https://doi.org/10.3390/su141811202

Thuy, P. T., Hue, N. T., & Dat, L. Q. (2024). Households' willingness-to-pay for mangrove environmental services: Evidence from Phu Long, Northeast Vietnam. *Trees, Forests and People,* 15, 100474. https://doi.org/10.1016/j.tfp.2023.100474

Shaikh, M., & Birajdar, F. (2024). Groundwater and ecosystems: Understanding the critical interplay for sustainability and conservation. *EPRA International Journal of Multidisciplinary Research*, 10(3), 181-186.

Sharma, L. K., Naik, R., & Smith, R. D. (1997). Contingent valuation: Indiscretion in the adoption of discrete choice question formats? Centre for Health Program Evaluation.

Siddiquee, S. A., & Hoque, M. E. (2007). Wetland conservation in context of climate induced changes: Bangladesh perspective. *Journal of Economics and Sustainable Development*, *2*(3), 1-12.

Tundisi, J. G., & Tundisi, T. M. (2016). The ecology of large-scale wetlands: From water quality to biodiversity conservation. Springer.

Turner, R. K., Pearce, D., & Bateman, I. (1994). Environmental Economics: An Elementary Introduction. Harvester Wheatsheaf.

Uddin, M. R., Hossain, M. E., & Rahman, M. R. (2025). Determinants of Willingness to pay for Recreational Services of *Chalan Beel* in Bangladesh. *Journal of Economics and Development Studies,* 14(1), 26-38.

Venkatachalam, L. (2004). The Contingent Valuation Method: A Review. *Environmental Impact Assessment Review,* 24(1), 89-124.

Zhang, L., & Li, X. (2021). The impact of climate change on wetland ecosystem services: A case study of wetlands in China. *Environmental Science and Pollution Research*, 28(23), 30801-30813.