



# Tourists' willingness to pay for restoration of Sundarbans Mangrove forest ecosystems: a contingent valuation modeling study

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## Abstract

The decaying trend of the Sundarbans due to loss of habitat, lack of provision of entrance fee, absence of tourism tax, and destruction of the resource base may restrict restoration of the Sundarbans mangrove forest ecosystems. We measure tourists' willingness to pay (WTP) and revenue stream in response to the policy change of restoration schemes on a sample of ( $n = 607$ ) observations. Following the random sampling technique, well-designed dichotomous choice questions were employed to elicit stated preference (SP) data toward restoration schemes of the Sundarbans mangrove forest ecosystems in selected tourist spots in the Sundarbans. It is found that age, monthly income, and years of schooling are influential factors in determining tourists' WTP for the restoration schemes of the Sundarbans ecosystems. The estimated WTP for the restoration schemes is Bangladeshi Taka (BDT) 64.54. Investment in restoration schemes creates a guarantee to earn BDT 11.81 billion per annum. It ensures scope to collect revenue from tourists and mobilize it for the restoration schemes. This finding is robust to various alternative data, sample, and model specifications.

**Keywords** Contingent valuation · Dichotomous choice · Willingness to pay · Mangrove restoration · Non-market valuation · Stated preference

## 1 Introduction

Mangrove forest ecosystems around the world received more attenuation to international concerns because of their vulnerability and importance. Parties from various countries argued at the 21st meeting of the conference of parties to the Blue Carbon (BC) and Nationally Determined Contributions (NDCs), held in December 2015 in Paris, that "mangrove forest ecosystems offer significant mitigation and adaptation value, as a carbon sink and as a coastline protection and food security, respectively" (Herr & Landis, 2016, p.6).

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Considering the importance of the ecosystems of the mangrove forest, the United Nations General Assembly declared 2021–2030 the decade of ecosystem restoration. Such a declaration of ecosystem restoration may be hampered by natural causes and man-made activities. For instance, environmental inconsistency, as well as complex biotic controls, species redundancy, and anthropogenic disturbances are potential contributors to instability of the mangrove forest ecosystems (Iqbal, 2020a). Climate change, unplanned urbanization, industrialization, and deforestation have received much attention for destroying the mangrove forest ecosystems. Empirical studies show that mangrove deforestation is recorded at 1.2% every year, which means more destruction of the ecosystems in the near future (Bernardino et al., 2021).

Like other mangrove forests, the Sundarbans is also affected by deforestation and is exposed to destruction of its ecosystems. Despite high rates of disappearance, the ecosystem restoration of the Sundarbans mangrove forest plays significant role by offering important functions such as protection against storms, tides, cyclones, sediment, salinity, coastal erosion, and storm surges. The ecosystem restoration of this forest is a process of reversing the degradation of prevailing ecosystems where landscapes, forests, oceans, and lakes regain their ecological functionality, essential for wildlife and people. Such ecosystems work as “filters” against the introduction of pets and exotic insects and provide shore protection (Sage, 2020) and nursery grounds and breeding sites for fish, birds, crustaceans, reptiles, mammals, and terrestrial and estuarine organisms (Gurjar et al., 2019). Animal and plant productivity, nutrient bowls for substrate stabilization, sources of food, fuel, and timber products, traditional medicines, diversified livelihood options, and tourists’ recreation are also associated with the Sundarbans mangrove forest ecosystems (Iqbal, 2020a). However, there was no consensus on what constitutes “other effective area-based conservation measures (OECMs)” (Dudley et al., 2018, p.1), which comprise fundamental changes in protected area planning, human rights, and social safeguards for the ecosystems of the Sundarbans mangrove forest. Having no government spending, inefficient supporting services, inappropriate provisioning and regulating services, unplanned livelihood options, fewer recreational facilities, and no provision of willingness to pay (WTP) for the ecosystems may reduce the restoration capacity of the Sundarbans mangrove forest (Iqbal, 2020a; Pham et al., 2018; Sardana, 2018). While these measures would certainly improve the restoration options for the Sundarbans mangrove forest, such options require strong empirically tested support. Therefore, the following pertinent questions can be raised from the tourists’ viewpoint as they play a significant role in developing the ecosystems of the Sundarbans mangrove forest through the provision of WTP: how should restoration schemes of ecosystems be designed to meet the preferences of tourists to the Sundarbans mangrove forest? What is tourists’ marginal, average, and total willingness to pay (WTP) for such restoration schemes? Based on these questions, the objective of our study is to measure the tourists’ WTP for restoration of the Sundarbans mangrove forest and to estimate the present value (PV) of the total revenue that will come through tourists’ payments.

The study estimates non-market WTP for the ecosystem restoration of the Sundarbans mangrove forest because of its contribution to well-being through the marketization process. The findings of the study will be useful for the sustainable ecosystem restoration of the Sundarbans, livelihood options, revenue generation, well-being, and decent tourism. Tourists’ perception of the ecosystems of the Sundarbans and their WTP for the ecosystems will certainly play a role in designing, developing, and implementing intervention policies in future. In this paper the ecosystem of the Sundarbans has been selected for two reasons. First, it is essential for reserve management, better recreation, decent livelihood

options, and well-being (Getzner & Islam, 2013). Second, it promotes conservation practice in forests and sustainable landscape restoration (Temperton et al., 2019).

The remainder of this paper is organized as follows: Sect. 2 provides the literature review. Section 3 includes a detailed description of materials and methods. The results and discussion are provided in Section 4. Section 5 concludes by offering policy implications and recommendations.

## 2 Literature review

The pertinent literature on the research topic are reviewed in this study which are obtained from the databases of Scopus and Google Scholar. The significance of the mangrove forest ecosystems, the necessity of valuation, the necessity of stated preference (SP) data, WTP, compensating surplus (CS), policy nexus, and the gap in the existing literature are covered in this section.

Mangrove forests are vital to millions of people in the tropics and subtropics (Maina et al., 2021). Based on marketable and non-marketable mangrove-derived commodities and services, the overall economic value of mangroves is estimated to be US\$10 million/ha/year (Barbier, 2000), the highest among all productive ecosystems (Malik et al., 2015). Mangroves are becoming more widely recognized for their role in carbon sequestration and storage, as well as their ability to mitigate climate change, as they store three to five times more carbon per unit of area than any other forest ecosystem (Kelleway et al., 2016). Tourism, fishing, trading, biodiversity, and environmental services are all examples of tangible and intangible socioeconomic development potentials from mangrove forests (Iqbal, 2020a).

For policymakers and service managers to plan, monitor, and alter the ecosystems of any forest, economic assessment is required (Thompson et al., 2017). It provides systematic information on the costs and benefits of different options, as well as support tools, which are critical for determining priorities and making decisions about ecosystems (Khan et al., 2019). It is also beneficial to natural resource conservation by providing information on the amounts of payments for environmental services or admission fees for any protected areas (Iqbal, 2020a). There is a widespread belief that a valuation exercise can assist researchers and policymakers to estimate the economic value of loss and the social benefit of restoring or conserving lost resources (Mukherjee et al., 2014), because it compares costs to alternative ways of obtaining ecosystem benefits (Iqbal, 2020b).

The ecological services provided by mangrove forests may be improved by establishing a resource base through restoration practices. The mismatch between supply and demand for ecosystems generated by the local communities, and the monetary valuation of ecosystems are critical in restoring ecosystems (Iqbal, 2020b). It is crucial because local communities have conflicting interests, priorities and, therefore, they perceive ecosystems differently (Zoderer et al., 2019). The contingent valuation method (CVM) is a strong tool for understanding the gaps between supply and demand for ecosystem restoration. The CVM has been used to address a variety of issues, including community forest management (Wollenberg et al., 2000), natural park management (Daconto & Sherpa, 2010), future ecological changes (Odada et al., 2009), deforestation (Soler et al., 2012), and funding policy (Bayfield et al., 2008).

While existing studies have documented the history, utilization, conservation strategies, causes of degradation, ecosystems and dependent livelihoods, and sustainable management options of the Sundarbans mangrove forest, very few studies have quantified the ecosystem restoration through the provision of WTP by tourists. This study reduces such a gap by designing a guideline for restoration of the Sundarbans ecosystems and estimating the WTP for ecosystem restoration.

### 3 Materials and methods

#### 3.1 Study area

The Sundarbans (Fig. 1) is the largest mangrove forest in the world, spreading between Bangladesh and India. About 5955 km<sup>2</sup> (58.3%) of this forest is located in Bangladesh



**Fig. 1** Map of Sundarbans of Bangladesh. Source: Prepared by the authors based on the satellite image, 2021

(Sen & Ghorai, 2019). This forest has sound ecological significance in terms of its diverse flora and fauna, a deluge of ecological services, tourism, and functions for recreation and well-being. It is an independent biome and very rich in biodiversity. Over 1186 species of living flora and fauna are found in this biome (Rahman & Begum, 2011). It is the breeding ground for several globally threatened species, such as the endangered Ganges River Dolphins, Irrawaddy Dolphins, the masked finfoot, the water birds, the Bengal Tigers, crocodiles, monkeys, olive ridley turtles, and other species of reptiles (Iqbal, 2020a). A large number of tourists visit this forest every year, which was recorded at 183,000 in 2016 (Chakraborty & Eagle, 2017). They enjoy the natural beauty of this forest without having to pay an entrance fee or tourism tax.

Uncontrolled tourism, oil spillage, coastal pollution, indiscriminate use of this forest's resources, climate change and natural hazards, changes in coastal agricultural patterns and land use, fires, poor planning and management, unplanned industrialization, and improper commercialization make the Sundarbans mangrove forest ecosystems more vulnerable (Islam & Bhuiyan, 2018). The ecosystems of the Sundarbans suffer from climate change-induced natural hazards, unplanned tourism practices, and more human intervention every year. The density of the *Goran* (*Ceriops*), *Sundari* (*Heritiera*), *Passur* (*Xylocarpus*), *Baen* (*Avicennia*) and other wildlife populations like reptiles, birds, crustaceans, and mammals has been drastically decreasing in this forest over the years. This finding is consistent with the findings of Mukhopadhyay et al. (2015) and Islam et al. (2018).

### 3.2 Focus group design

Customization is an issue in the selection of the pecuniary attribute of any good or service in the provision of non-market valuation (Iqbal, 2020a). Under this provision, there should be an attempt to make the preference more realistic by relating pecuniary attributes to proposed goods and services. Debriefing focus group discussions (FGDs) were organized prior to the main survey, because these FGDs helped us to determine hypothetical baselines, attributes and variables selection, and questionnaire design (Rahaman & Iqbal, 2021). The hypothetical baseline is essential to initiate tourists' interviews about WTP to support restoration efforts. Each respondent expresses a wish to visit the Sundarbans if an entrance fee is imposed under this provision.

**Table 1** Composition of FGD participation (%)

Participant	Karamjol	Hiron point	Katka beach	Total
Researcher	2 (8%)	1 (4%)	1 (4%)	4 (16%)
Businessman	1 (4%)	1 (4%)	2 (8%)	4 (16%)
Service holder	1 (4%)	1 (4%)	1 (4%)	3 (12%)
Farmers	1 (4%)	1 (4%)	0	2 (8%)
NGO worker	1 (4%)	2 (8%)	1 (4%)	4 (16%)
Local government representative	0	1 (4%)	0	1 (4%)
Student	3 (12%)	2 (8%)	2 (8%)	7 (28%)
Total	9 (36%)	9 (36%)	7 (28%)	25 (100%)

Percentage (%) in parentheses

We organized three FGDs. Each FG consisted of seven to nine participants (tourists) selected at random from all groups of tourists (i.e., tourists over 18 years old, researchers, businessmen, service holders, farmers, NGO workers, and local government representatives) to maintain the representativeness of all tourists (see Table 1 for more details). Such FGDs were organized at three tourist sites (Karamjol, Hiron Point, and Katka Beach) during May 11–17, 2019 to determine the initial and subsequent bid levels for the restoration of the Sundarbans mangrove forest ecosystems. During the FGDs, a major portion of respondents said that every tourist can contribute to the restoration of the Sundarbans mangrove ecosystems through the provision of WTP. They also argued that the collected funds should be utilized transparently toward the restoration of ecosystems in the Sundarbans through the proper coordination of the Bangladesh Tourism Board, the Forest Department of Bangladesh and the National Board of Revenue (NBR). A few of the respondents argued that the Sundarbans mangrove forest is public property and that they will visit this forest under the provision of a free rider strategy where payment provision should not be mandatory.

### 3.3 Payment vehicle and bid values

We relied on the findings from FGDs to estimate a conceivable bid range. For better bidding practice, enumerators showed a few images and gave descriptions of vulnerable ecosystem services to the respondents, minimizing the *indignation effect* and *guilt effect* and motivating them to take part in the bidding game and survey process. This strategy helped to raise their interest in WTP for the restoration of the Sundarbans mangrove forest, recreational value of the Sundarbans, revenue generation and awareness about protection of the ecosystems of the Sundarbans. For this drive, a coercive payment was presented in the form of an entrance fee to restore the ecosystems of the Sundarbans, which would be imposed on all respondents except those under the age of 18.

A lower number of tax instruments and a lower rate of collection of property tax, sales, and income make an appropriate payment vehicle difficult in developing countries (Slemrod, 2019). According to Whittington (2010), using a surcharge, voluntary donation, and increased entrance fees are the potential contributors to payment vehicles. This statement motivated us to consider making a desirable payment vehicle for all tourists. Prior to selecting bidding price for restoration schemes, a majority of the rules were explained in the bidding game where subjunctive native language was used, like “would you like to participate in the initial round of bidding at BDT 75 for the restoration of the Sundarbans mangrove ecosystems? Would you like to participate in the next round of bidding, etc.?” The enumerators of our study gave direction to each respondent that bids would be continued until a “no” response was obtained. *Yea*-sayers were the respondents to bidding who said “yes” to any stage of the bidding amount. There is an increasing probability of bid acceptance at all bid amounts, but relatively less at higher stages of bid amounts. According to empirical studies, *yea*-saying has a greater effect in the bid-increasing path (Bateman et al., 2001). On the other hand, non-utility maximizing behavior prefers to say “no” at any given level of bid because of the free-riding strategy. The five bids, such as BDT 30, BDT 50, BDT 75, BDT 80, BDT 100 (BDT 84: US\$ 1 prevailed in May 2019) comprise the bidding path for the restoration of Sundarbans mangrove ecosystems (Fig. 2).

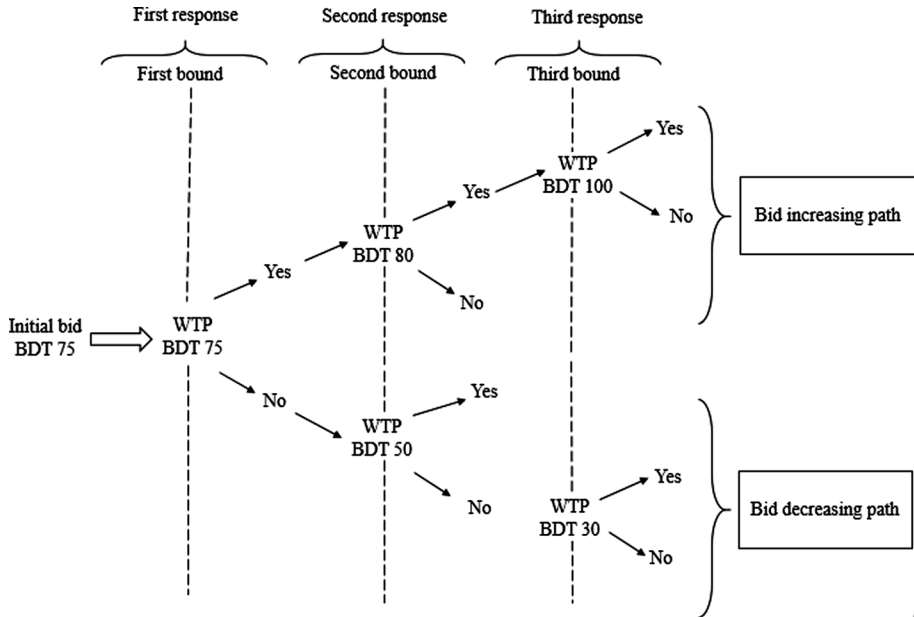


Fig. 2 Bidding path for the restoration of Sundarbans mangrove ecosystems. Source: Prepared by the authors based on Bateman et al. (2001)

### 3.4 Survey method, sample selection and questionnaire design

Our study is based on on-site surveys of randomly selected 607 tourists from Hiron Point (Nilkomol), Katka Beach, Karamjol, Kochikhali (Tiger Point), Jamtola Beach, Mandarbaria, and Dublarchar Island in the Sundarbans. All tourists were asked to answer the structured and closed-ended questionnaire in face-to-face interviews. As much as possible, the selection of tourists was random, but there is a possibility of the occurrence of sampling error. To overcome the sampling error, the survey was conducted by the authors and other four paid enumerators. All visitors were informed about the aim, rationale, and objectives of this study. After successful completion of these activities, they were introduced to a payment vehicle for initiating their WTP for restoration of the ecosystems of the Sundarbans and the surveys.

The scope test was used to check the embedding effects and judge the internal consistency of CV estimates in the presence of variation in the degree of WTP for proper empirical assessment. Hypothetical bias is a common problem for conducting SP data-assisted surveys. Every respondent generally has a *yea*-saying tendency in this survey technique. There are two reasons for this *yea*-saying tendency: social interaction between the respondent and the data collector, and respondents' lack of desire to pay the offered bid amount. According to Whittington (2010), cheap-talk scripts, ballot boxes to simulate voting behavior, recalibration of SP results with data from real- experiment time-to-think (TTT), and drop-off protocols are the potential ways to reduce the hypothetical bias and ensure the empirical accuracy. Whittington (2010) further argued that among all these protocols, the TTT requires more time (usually overnight) and the drop-off protocol is applicable in knowledge-based societies and urban areas where people are literate enough to execute a SP data-assisted survey. Sardana (2018) suggests that a cheap talk script is a convenient

way to eradicate the hypothetical bias, which warns respondents against the propensity to inflate the hypothetical WTP values. Thus, we considered the cheap talk script in our survey and showed it prior to the question of WTP.

Out of 633 tourists, 607 (95.89%) agreed to take part in the survey, and the remaining 26 (4.11%) declined the request to join in the survey. Agreed tourists were asked whether they would like to participate in the bidding game and pay for desirable ecosystems in the Sundarbans. Due to time constraint and engagement with other works, 87 of these tourists said “no” to participate in the bidding game. As all the tourists appreciated the proposed restoration schemes of the Sundarbans ecosystems, 54 tourists out of 87 who said “no” replied that restoration schemes were not their concern, and financial and other support should come from the government level. These 54 tourists were treated as protest bidders. We, therefore, considered the responses of 54 out of 87 respondents as valid zeros.

Before the surveys, a pre-test was conducted on May 25–27, 2019, in Karamjol tourist point, which covered 15 tourists for the interview to test and amend the questionnaire and get appropriate, required, and essential information about WTP and other data. These 15 tourists were not included in the final surveys. After ensuring the appropriateness of the proposed survey questionnaire, the survey was conducted on July 3–November 21, 2019.

The National Oceanic and Atmospheric Administration (NOAA) guidelines were followed for the layout of the questionnaire for our study. The questionnaire has four segments. In the first segment, tourists were asked for general information on their socio-economic characteristics. The second segment highlighted travel-related information for tourists. The third segment was constructed by the current vulnerable scenario of the Sundarbans due to climate change-induced natural hazards, illegal human intervention, and proposed restoration schemes for the ecosystems of this forest. The fourth segment explored the tourists’ WTP for restoration of the ecosystems of the Sundarbans mangrove forest. The summary statistics of major socioeconomic characteristics are shown in Table 2.

### 3.5 Nature of valuation method, collected data and model specification

In general, WTP can be measured by revealed preference (RP) data (observable behavior in response to an existing policy) and SP data (hypothetical behavior in response to an imaginary policy) (Iqbal, 2020a). The SP data is more reliable for the study of potential policies for further improvement. The contingent valuation method (CVM), discrete choice experiment method (DCEM), and travel cost method (TCM) are used to collect such data through surveys. All of these methods require the SP data for better empirical assessment.

**Table 2** Summary statistics of major socioeconomic characteristics of all sample tourists. Source: Authors’ calculation based on survey data, 2019

Variables	Maximum	Minimum	Mean	Standard deviation
Age (years)	71	15	32.38	13.13
Monthly income (BDT)	500,000	0	13,000.09	192.94
Trip expenditure (BDT)	5700	100	609	241.07
Educational status (years of schooling)	23	0	11.52	4.02
Distance (km.) (make a column)	525	4	50.71	27.34
WTP Bid (BDT)	100	30	78.82	34.33



Respondents are requested to elicit their WTP for a hypothetical policy under the provision of SP data through these models.

TCM, according to Kolstad (2016), is more realistic for valuing the natural environments that people visit to appreciate (Kolstad, 2016). This oldest method is more realistic for measuring user values (Whittington, 2010). Estimating the value of time spent traveling, opportunity cost of travel time and wage rate, and computing travel costs are the potential difficulties in implementing the TCM (Mulwa et al., 2018). The TCM does not include associated extra costs such as some depreciation, expenditure on essential travel kits, insurance and tourism tax (Kolstad 2016). In addition, the heterogeneity of visitors influences travel expenditure, which may hamper the estimation process of aggregate and average zonal TCM (Zambrano-Monserrate et al., 2018).

By contrast, the DCEM is an attribute-driven experimental method where imaginary situations are explained by a group of attributes and their associated levels, including monetary attributes (Iqbal, 2020a). From this viewpoint, DCEM is applied perfectly to estimate the value of attributes and provide significant findings essential for policy formation and intervention (Sydavong et al., 2019). However, the DCEM is not free from certain limitations. For instance, the DCEM-assisted policy interventions require more funds, which may hamper the intervention activities within the budget constraint conditions (Agarwal et al., 2019). In addition, this method cannot effectively identify the causal effect of each proposed attribute on the choice outcome unless a complete set of interventions is conducted (Sydavong et al., 2019).

To address the above limitations of TCM and DCEM, we applied the CVM in our study for proper empirical assessment of our proposed attributes and variables. The CVM creates a bridge between the valuation of ecosystems and the WTP. This is a method of recovering essential information about preferences or WTP for changes in the quantity or quality of goods or services and the effect of covariates on WTP (Needham & Hanley, 2019). The CVM is successfully applied to measuring user, nonuser, altruistic, and non-market hypothetical values (Whittington, 2010). CVM has been broadly applied in the fields of environmental and resource economics, ecological economics, and forestry economics (Barrio & Loureiro, 2010; Iqbal, 2020a). The literature related to the application of the CVM to estimate WTP for mangrove restoration in the context of climate change in Vietnam revealed that the average WTP for mangrove restoration is US\$ 8.64 (Pham et al., 2018). A similar study was also conducted in the context of the restoration of social forestry in India by Sardana (2018) and Kohlin (2001).

Forest ecosystems are a major concern for policy makers in the forestry sector. Policymakers need to consider such determinants that influence the tourists' WTP for restoration of forest ecosystems. The evidence from observational studies of the essential attributes and variables of mangrove forest ecosystems can be summarized as follows: entrance fees, new plantation, agroforestry, land management, great green wall, forest landscape restoration (Flr), riverside planting, reforestation, management of natural forest succession (Mnfs), development wetlands, nurturing mangroves and other native tree species (Nmonts), developing regeneration practices, soil enhancement measures, and supporting monitoring flagship tools including the red list of ecosystems and the barometer (Bernal et al., 2018; Chen et al., 2018; Iqbal, 2020b; Nelms et al., 2021; O'Connor et al., 2020; Pham et al., 2018; Sardana, 2018; Valasiuk et al., 2018). To avoid the multicollinearity problem, we consider Flr, nurturing mangroves and other native tree species in the Sundarbans (Nmontss), Mnfs, and mangrove plant-supported green walls on the seaside and riverside (Mpsgwsr) are included in our regression model. Payment or WTP bid for the ecosystem is gaining worldwide recognition as a promising approach to achieve sustainable

development as restoration schemes require economic incentives from tourists for the restoration of ecosystems (Razzaque, 2017). Thus, we consider the WTP bid in our regression model. We also include some covariates, such as tourists' age, educational status, and monthly income to reduce the problem of heterogeneous preferences. These attributes and variables are used as explanatory variables, and WTP-based restoration schemes for Sundarbans mangrove ecosystems are used as an outcome variable in our regression model.

The WTP bid was figured out by categorical and dichotomous dummies. More specifically, all the tourists were asked the extent to which they agreed to pay for the restoration of the Sundarbans mangrove forest ecosystems from BDT 30, BDT 50, BDT 75, BDT 80, and BDT 100; while Flr, Nmontss, Mnfs, and Mpsgwsr were figured out by a dichotomous dummy, i.e., Yes = 1 and Otherwise = 0. While age, educational status, and monthly income were figured out by continuous data. To avoid data entry errors and get good estimated results in the descriptive statistics and the regression model, the data entry was completed manually and cross-checked after the surveys. Because the data was categorical and dichotomous in nature, transformations were required to facilitate analysis using the Software-Statistical Package for Social Sciences (SPSS).

Descriptive analysis was conducted to characterize our sample and evaluate the feasibility of WTP for restoration of the Sundarbans mangrove forest ecosystems. Tourists' perceptions about WTP for restoration schemes and its related attributes and variables were calculated based on survey responses. We also assess the impacts of our proposed restoration schemes of the Sundarbans mangrove ecosystems by the regression model. The following explanations are essential for better understanding of the estimation process of the regression model.

When we have two choices or alternatives in the CV case, we can write the indirect utility for respondent  $j$  as follows:

$$u_{ij} = u_i(y_j, Z_j, \varepsilon_{ij}) \quad (1)$$

where,  $i$  can take the values of 1 and 0. The value 1 indicates the condition of the final state under the CVM, and 0 indicates the existing condition. The contributors to this utility are  $y_j$  (the  $j$ th tourist's discretionary income),  $Z_j$  (the  $k$ -dimensional vector of tourists' characteristics), and  $\varepsilon_{ij}$  (a set of preferences known to every tourist but unknown to the investigator). Under this condition, it is possible to measure five proposed pecuniary values for restoration schemes of Sundarbans mangrove forest ecosystem, e.g., the quality of restoration schemes  $x$  could be changed from  $x^0$  to  $x^1$  where  $u_{0j} = u(y_j, Z_j, x^0, \varepsilon_{0j})$  is associated with present conditions and  $u_{1j} = u(y_j, Z_j, x^1, \varepsilon_{1j})$  is associated with improved conditions. Under consideration of both conditions (present and improved), it is possible to write the following equation when respondent  $j$  answers "yes" to restoration schemes and wants to pay  $t_j$  amount of money for this restoration.

$$u_1(y_j - t_j, Z_j, \varepsilon_{1j}) > u_0(y_j, Z_j, \varepsilon_{0j}); u_1 > u_0 \quad (2)$$

Probability statement about "yes" or "no" becomes more effective when there is less scope of prediction about the random part of preference. For tourist  $j$ , the probability can be written as:

$$\Pr(\text{yes}_j) = \Pr[(y_j - t_j, Z_j, \varepsilon_j) > u_0(y_j, Z_j, \varepsilon_{0j})] \quad (3)$$

Under the condition presented in Eq. (3), the functional form of  $u(y_j, Z_j, \varepsilon_{ij})$  must be chosen first. After this step, the distribution of  $\varepsilon_{ij}$  must be specified. The first step is known

as deterministic, or non-stochastic, and the last step is known as stochastic performance. The deterministic and stochastic performances of the utility function are additively separable. The indirect utility is the sum of the deterministic component and the stochastic component under this condition and can be written as:

$$u_i(y_j, Z_j, \varepsilon_{ij}) = u_i(y_j, Z_j) + \varepsilon_{ij} \quad (4)$$

Combination of the additive specification and the probability statement for respondent  $j$  becomes:

$$\Pr(\text{yes}_j) = \Pr[\tau_1(y_i - t_j, Z_j) + \varepsilon_{ij} > \tau_0(y_j, Z_j) + \varepsilon_{0j}] \quad (5)$$

Equation (5) does not ensure estimation. To overcome this situation, we consider the linear utility function arises from the linearity in income and covariates of the deterministic preference function. The linear utility function can be written as:

$$\tau_{ij}(y_j) = \alpha_i Z_j + \beta_i(y_j) \quad (6)$$

where,  $y_j$  indicates the discretionary income,  $Z_j$  represents  $m$ -dimensional vector of attributes and variables related to tourists  $j$  and  $\alpha_i$  represents the  $m$ -dimensional vector of parameters. Both the  $\alpha_i$  and  $Z_j$  satisfied the condition of  $\alpha_i$  and  $Z_j = \sum_{k=1}^m \alpha_{ik} Z_{jk}$ . The NOAA guided CV questions induce each tourist to select between the proposed pecuniary attribute for restoration schemes at a certain amount of payment ( $t$ ), the current state (Haab & McConnell, 2002). The deterministic preference based utility for the proposed pecuniary attribute in the CV and the current utility scenario of tourists can be written as:

$$\tau_{1j}(y_j - t_j) = \alpha_1 Z_j + \beta_1(y_j - t_j) \quad (7)$$

$$\tau_{0j}(y_j) = \alpha_0 Z_j + \beta_0 y_j \quad (8)$$

The change in deterministic preference based utility can be written as:

$$\tau_{1j} - \tau_{0j} = (\alpha_1 - \alpha_0) Z_j + \beta_1(y_j - t_j) - \beta_0 y_j \quad (9)$$

Our collected data has many zero values. The Double-hurdle model, also known as the Cragg model, is effectively used to handle zero values and two-step decisions such as participation in any particular event and payment decision (Jones, 2000). This model assumes that factors affecting participation in restoration schemes have a different impact on payment (Humphreys, 2013). It is also suitable for covariates to be different for two processes (Chopra & Das, 2019). Generating Double-hurdle model estimators  $\alpha_0$  and  $\beta_1$  consists of estimating a Probit regression model for the probability that  $\Pr(\text{yes}_j) > 0$  and a truncated regression model (Green, 1993). The Double-hurdle model has enjoyed widespread use in determining the implicit value of different aspects of restoration of ecosystems since its structural formation and theoretical explanation were developed by Cragg in 1971 (Orlowski & Wicker, 2016). After that, many studies have applied the Double-hurdle model to estimate the value of restoration amenities (Armel, 2020; Cenamo & Carrero, 2012; Chen et al., 2020; Kontogeorgopoulos, 2003; Okoffo et al., 2016; Sharma et al., 2020). This model has two stages: the first stage is concerned with a decision about a certain action, and the two-tier stage offers an improvement over the traditional dichotomous choice. The basic model for analyzing dichotomous CV

responses is the random utility model, which is estimated by the Probit model and truncated Ordinary Least Square (OLS) method (Ndebele & Forgie, 2017). In the first step, a Probit regression model is run for the willingness to participate in the CV is regressed on independent variables (Jones, 2000). The second step is a truncated Ordinary Least Square (OLS) regression to model the payment decision (Chopra & Das, 2019). The following regression model is associated with the Probit model and the truncated OLS.

$$E(\text{yes}_{ij}) = \alpha_0 + \beta_1 x_i + u_i \quad (10)$$

where,  $E(\text{yes}_i)$  is the expected binary choice of respondent  $i$  for CV alternative attribute  $j$ ,  $\alpha_0$  indicates the vector of unknown parameters, and  $x_i$  denotes the vector of the exogenous values for the observation. If  $u_i \sim$  standard normal cumulative distribution function then the equation is treated as the Probit model. We define for each respondent  $i$  a dummy variable  $\gamma_i=1$  indicates the each tourist is willing to participate in the hypothetical CVM-assisted restoration schemes of the Sundarbans mangrove forest ecosystems, and  $\gamma_i=0$  indicates otherwise. This equation is also applicable to a truncated regression model and further proceeds for parameter estimation after getting the payment decision. Under this viewpoint, it is possible to write Eq. (10) as follows:

$$\Pr(\text{yes} = 0/x) - 1 - \Phi(x\gamma); \log \text{yes}/(x, y) > 0 \sim \text{Normal distribution}(x\beta, \sigma^2) \quad (11)$$

where,  $\Phi$  denotes the standardized normal cumulative distribution,  $x$  denotes a  $(k \times 1)$  vector of the exogenous values for observation, “yes” in the first tier of the Double-hurdle or Cragg model is decision to participate in the hypothetical CVM-assisted restoration schemes of Sundarbans mangrove forest ecosystems, and “yes” in the second or third tier is how much to pay for the restoration schemes. Therefore, the mean WTP is calculated using Eq. (10):

$$E_e(\text{WTP}_j/\alpha, \beta, Z_j) = \alpha Z_j/\beta \quad (12)$$

## 4 Results and discussion

### 4.1 Descriptive statistics

A total of 607 tourists from seven tourist spots in the Sundarbans mangrove forest participated in the survey. Of the tourists surveyed, 37.3% were females. About 37% of urban tourists with an income above average shown WTP for the restoration schemes of the Sundarbans, compared to 21% of rural tourists with an income below average. More than 52% of respondents come from educational institutions, and the rest is covered by the business and service sectors. About 72% of the tourists believe that proper utilization of collected funds can develop the capacity of WTP for restoration schemes in the Sundarbans. The average age of the respondents is 32 years old, and they played a significant role in making tour plans. On average, the survey found that tourists have a monthly income of BDT 13,000 per month. About 19.8% of the respondents possessed an undergraduate degree, 21% were post-graduates, including MPhil and Ph.D., 23.5% had higher secondary level education, and the rest, or 9.4% surveyed tourists stated the secondary level as their highest educational qualification. The mean travel cost and

distance from the respondents' residence to the Sundarbans were estimated at BDT 609 and 51 km, respectively. The range of the maximum and minimum values for recreation was recorded at BDT 100 and BDT 30, where the mean bid value was estimated at BDT 78.82.

## 4.2 Regression results

Table 3 presents the estimated double-hurdle model using two specifications. Specification 1 presents the results from the Probit regression model for saying "yes" to restoration schemes with proposed attributes and socioeconomic variables. Specification 2 also presents the results from the Probit regression model for different WTP bids and all WTP bids with socioeconomic variables.

Estimated results of the standard error of our regression model make guarantee that all of our proposed attributes and variables are normally distributed. Measured values of Log-likelihood (LL) and Pseudo R-square ensure the overall appropriateness of our model. A value of LL closer to zero presents a model fit for the CVM and a value of Pseudo R-square higher than 0.2 presents a well fitted model (Rahaman & Iqbal, 2021). This study perfectly follows the coding of attributes and variables, the inclusion of interaction of socioeconomic-demographic (SED) characteristics with proposed attributes, and the inclusion of intercept in the model. Interaction of SED characteristics with proposed attributes is essential for controlling heterogeneity in preferences toward any improved schemes. We allowed this strategy in our regression model to get significant results.

Results of the Probit model under the different WTP scenarios reveal that WTP bid for restoration schemes of the Sundarbans mangrove forest, Flr, Nmontss, management of natural forest succession Mnfs, Mpsgwsr, and WTP bid are essential for restoration of the Sundarbans mangrove forest ecosystem because of their level of significance at conventional levels (Boyd & Krupnick, 2013). These findings are consistent with the findings from López-Portillo et al. (2017) and Chen et al. (2018). The positive signs of the first four attributes guarantee that proper implementation and monitoring activities of these attributes can develop the restoration of the Sundarbans ecosystem services. The implication of a negative sign of payment supports the law of demand.

Estimated results make the guarantee that age, monthly income, and educational status are found to be significant determinants of WTP, with the value of restoration varying positively with monthly income and educational status in all models and inversely with age. These findings are consistent with the findings from Ekka and Pandit (2012). They argue that educated people are more conscientious about conservation, restoration, sustainable ecosystems, and travel. They further argue that tourists' income has a positive impact on WTP for restoration schemes of mangrove forests because of its influential and motivational capacity on WTP. The negative sign of the coefficient of respondents' age implies that aged tourists have less income-generating capacity and walking or moving ability to visit forest-centric tourist spots. Such a capacity of aged tourists restricts their WTP for restoration schemes of mangrove forests (Reynisdottir et al., 2008).

The estimated values of the log-likelihood test suggest that all variables are accepted. The explanatory powers of these models are estimated at 0.333 in Probit coefficient of the Cragg model designated for participation (Yes = 1 and 0 = Otherwise) in restoration schemes, 0.256 for bid 30, 0.245 for bid 50, 0.398 for bid 75, 0.279 for

**Table 3** Regression results for the determinants of WTP for Sundarbans mangrove ecosystems. Source: Authors' calculation based on survey data, 2019

Variable/Attribute	Double-hurdle model									
	First stage					Second stage				
	Per. for res	Bid 30	Bid 50	Bid 75	Bid 100	All bids				
Constant	-6.098*** (0.782)	-1.098 (0.020)	-3.729* (0.784)	4.032* (0.231)	-1.332 (0.003)	-2.103* (0.42)				
Flr	0.079* (0.001)	0.397* (0.003)	-0.009*** (0.194)	0.062** (0.004)	0.173* (0.163)	0.007* (0.083)				
Nmontss	0.328** (0.472)	0.021** (0.001)	0.126* (0.035)	0.027*** (0.014)	0.004* (0.017)	0.009* (0.017)				
Mnfs	0.032* (0.027)	0.001* (0.029)	0.094*** (0.003)	0.078* (0.227)	0.093** (0.783)	0.395** (0.004)				
Mpgwsr	0.139** (0.239)	0.043** (0.004)	0.004* (0.005)	0.005** (0.029)	0.008*** (0.347)	0.348*** (0.196)				
WTP bid	-0.306* (0.020)	-0.023* (0.009)	-0.010*** (0.007)	-0.135*** (0.003)	-0.044*** (0.892)	-0.130* (0.22)				
Monthly income	0.124* (0.007)	0.003* (0.017)	-0.005*** (0.243)	-0.075 (0.007)	0.225* (0.002)	0.006** (0.67)				
Education	0.281*** (0.223)	0.059 (0.241)	0.246 (0.097)	0.109* (0.009)	0.001 (0.563)	0.004*** (0.231)				
Age	-0.187* (0.022)	-0.017** (0.044)	-0.003* (0.004)	-0.233* (0.291)	-0.067* (0.285)	-0.007* (0.52)				
flr*Income	-0.003** (0.672)	0.136 (0.136)	0.132 (0.457)	0.122* (0.289)	-0.253 (0.397)	-0.242* (0.09)				
nmontss*Income	0.293* (0.007)	0.003 (0.003)	-0.004*** (0.984)	0.093 (0.023)	-0.002** (0.772)	-0.090* (0.042)				
mnfs*Income	0.347* (0.542)	0.009 (0.013)	0.078* (0.002)	0.027 (0.006)	0.008* (0.460)	0.005** (0.137)				
mpgwsr*Income	0.349** (0.371)	0.047** (0.005)	0.236*** (0.230)	0.082* (0.021)	0.064*** (0.275)	0.005** (0.287)				
flr*Education	0.064*** (0.723)	0.101 (0.005)	-0.056* (0.903)	0.081 (0.243)	0.001*** (0.528)	-0.136 (0.153)				
nmontss*Education	0.065** (0.006)	0.035 (0.236)	-0.071* (0.954)	0.087* (0.163)	-0.002* (0.752)	0.017* (0.175)				
mnfs*Education	0.003* (0.032)	-0.003* (0.004)	0.004* (0.001)	0.142 (0.178)	0.043*** (0.004)	0.023* (0.006)				
mpgwsr*Education	0.011** (0.039)	-0.003* (0.045)	0.235* (0.094)	0.132* (0.043)	0.003 (0.346)	0.007* (0.081)				
flr*Age	0.004* (0.001)	0.093** (0.008)	0.015 (0.054)	0.071 (0.066)	0.005 (0.002)	0.193** (0.033)				
nmontss*Age	0.014 (0.054)	0.099** (0.007)	0.003* (0.132)	0.043* (0.332)	0.011** (0.115)	0.119** (0.276)				
mnfs*Age	0.022*** (0.231)	0.229* (0.005)	-0.186 (0.376)	-1.094 (0.036)	0.532 (0.032)	1.327* (0.044)				
mpgwsr*Age	0.194** (0.001)	0.193*** (0.008)	0.003* (0.237)	0.013** (0.056)	0.002 (0.034)	0.028*** (0.133)				
Observation (n)	607	133	121	107	101	520				

**Table 3** (continued)

Variable/Attribute	Double-hurdle model						
	First stage			Second stage			
	Per. for res	Bid 30	Bid 50	Bid 75	Bid 80	Bid 100	All bids
Log-likelihood	- 101.660	- 202.87	- 344.021	- 279.831	- 338.052	- 344.403	- 335.033
McFaddenR <sup>2</sup>	0.333	0.256	0.245	0.398	0.279	0.371	0.342

Robust standard errors in parentheses

\*  $p \leq 0.01$

\*\*  $p \leq 0.05$

\*\*\*  $p \leq 0.1$  indicate 1%, 5% and 10% level of significance

**Table 4** Estimation of MWTP (in BDT) for different attributes

Attributes	Bid 30	Bid 50	Bid 75	Bid 80	Bid 100	All bids
Flr	17.260	0.900	0.400	3.931	0.364	0.053
Nmontss	0.913	12.600	0.200	0.090	1.094	0.069
Mnfs	0.043	9.400	0.577	2.090	0.459	3.038
Mpsgwsr	1.869	0.400	0.037	0.181	2.432	2.676

**Table 5** Estimation of average WTP and total WTP (in BDT)

Attributes	Average WTP
Flr	22.39
Nmontss	13.86
Mnfs	12.07
Mpsgwsr	16.22
WTP confidence interval (CI)	64.54 [61.36–69.04]

bid 80, 0.371 for bid 100, and 0.342 for all bids in the truncated OLS coefficient of the Cragg model that supports the addition of the covariates.

### 4.3 Marginal WTP, average WTP and total WTP

The estimated results of different bids for the second stage under the double-hurdle model are presented in Table 4. Marginal willingness to pay (MWTP) is essential for measuring additional changes in restoration schemes. Positive values of MWTP at all levels in the second stage of the double-hurdle model indicate that tourists have positive preferences toward restoration schemes of the Sundarbans mangrove forest ecosystem. The maximum WTP is recorded at BDT 100 and the minimum WTP is recorded at BDT 30 for the restoration schemes of the ecosystems of the Sundarbans.

The highest MWTP is recorded at BDT 17.260 at the bidding price of BDT 30 and the lowest MWTP is recorded at BDT 0.364 at the bidding price of BDT 100 for the Flr. The highest and lowest MWTP are measured at BDT 12.600 in the bidding price of BDT 50, and the lowest MWTP is measured at BDT 0.090 in the bidding price of BDT 80 for the Nmontss. Likewise, the highest and lowest MWTPs are recorded at BDT 2.090 in the bidding price of BDT 80 and BDT 0.043 in the bidding price of 30 for the Mnfs and BDT 2.432 in the bidding price of 100 and BDT 0.037 in the bidding price for the Mpsgwsr. Among all the improvement attributes for the restoration schemes of the ecosystem of the Sundarbans, the least MWTP is observed at mpsgwsr (0.037) and the highest MWTP is observed at Flr (BDT 17.260). The highest and lowest MWTPs are estimated at BDT 2.676 and BDT 0.053 in combination of all bidding prices for the Mpsgwsr and Flr. Under this condition, the highest value of MWTP implies that tourists prefer to pay more for additional mangrove plant-supported green walls on the seaside and riverside. Table 5 outlines the values of average WTP and total WTP of our proposed attributes for restoration schemes of the Sundarbans. The calculation of average WTP and total WTP is derived from the model for all bids. Following Habb and McConnell (2002), we applied the Turnbull estimator to measure average WTP for restoration schemes.



**Table 6** Total revenue stream by PV for improved restoration schemes for 10 years

Present value (in BDT and US\$) at different discounting rate				
Discount rate	5%		10%	
	BDT (in billion)	US\$ (in million)	BDT (in billion)	US\$ (in million)
Year				
1 <sup>a</sup>				
2	26.06	310.29	39.09	465.40
3	39.18	466.41	54.81	652.55
4	52.95	630.34	72.11	858.41
5	67.41	802.46	91.13	1084.85
6	82.59	9831.85	112.05	1333.94
7	98.53	1172.95	135.07	1607.94
8	115.26	1372.20	160.38	1909.34
9	132.84	1581.42	188.23	2240.881
10	151.29	1801.09	218.87	2605.57

<sup>a</sup>In year 1, the initial annual stream of revenue is estimated BDT 11.81 billion (US\$ 140.61 million)

Estimated result of WTP suggests that tourists of the Sundarbans are very interested to pay BDT 64.54 per visit for improved restoration schemes. Estimated monthly average income BDT 13,000.09 of sampled tourists implies that WTP for improved restoration schemes is about 0.496% of their monthly income. This empirical evaluation is consistent with the study by Sardana (2018) in Karnataka, India, Pham et al. (2018) in Cat Ba biosphere reserve, Vietnam and Razzaque (2017) in the Sundarbans mangrove forest, Bangladesh.

#### 4.4 Revenue stream

Based on the regression model for all bids in Table 2, it is possible to monetize the investment prospects for restoration schemes for ecosystem services in the Sundarbans. Statements by Razzaque (2017) and Chakraborty and Eagle (2017) motivated us to assess the investment prospect for improved restoration schemes in the Sundarbans. Razzaque (2017) states that tourists should pay for mangrove ecosystems for their future, life, and recreation. Chakraborty and Eagle (2017) report that total tourists to the Sundarbans mangrove forest were recorded at 183,000 in 2016. Table 6 outlines the total revenue stream based on estimated WTP (BDT 64.54) for restoration schemes, present value (PV) for 10 years at 5% and 10% rate of discount, and recorded tourists (183,000) from Chakraborty and Eagle (2017).

An investment in restoration for ecosystems in the Sundarbans gives a guarantee of earning BDT 11.81 billion (US\$ 140.61 million) in a year. It would be BDT 67.41 billion (US\$ 802.46 million) for 5 years at a 5% discounting rate and BDT 91.13 billion (US\$ 1084.85 million) for the same years at a 10% discounting rate. Likewise, if the government or any investor invests 10 years of a project in restoration for ecosystem services of the Sundarbans, the future stream of revenue at 5% and 10% discounting rates would be BDT 151.29 billion (US\$ 1801 million) and BDT 218.87 billion (US\$ 2605.57), respectively. An investment in ecosystem restoration appears to be effective, reliable, significant and economically sustainable. The government or any investor not only gets returns from such

projects but also provides more recreational value and protects property, lives, and livelihoods from unexpected hazardous conditions.

## 5 Conclusions and policy implications

Sundarbans mangrove forest was pronounced a Ramsar site under the Ramsar Convention in 1992. What's more, UNESCO declared the Sundarbans a World Heritage Site in 1997, as a result of its 'Extraordinary Universal Value', organic variety and the diverse ecosystems the forest delivers (Sarker et al., 2016). In this situation, we explore tourists' attitudes toward reclamation plans for Sundarbans through stated preference based WTP.

Uncontrolled tourism, along with the lack of provision of entrance fees and tourism tax in the current restoration scheme of the Sundarbans, may make this scheme unsatisfactory and reduce tourists' recreational value. Therefore, to make restoration schemes more attractive, this study identifies and develops SP and WTP distribution for restoration plans based on a set of proposed attributes: forest landscape restoration, nurturing mangroves and other native tree species in the Sundarbans, management of natural forest succession, mangrove plant-supported green wall, and WTP bid in the Sundarbans. Except for the WTP bid, all of our proposed attributes are statistically significant. The first four proposed attributes are positively related to the ecosystem restoration of the Sundarbans mangrove forest in Bangladesh. For instance, forest landscape restoration is a significant contributor to the ecosystem restoration of the Sundarbans. This result is consistent with the findings of (Paudyal et al., 2017). Similarly, nurturing mangroves and other native tree species in the Sundarbans, management of natural forest succession, and mangrove plant-supported green walls are other positive contributors to the ecosystem restoration of this forest. These findings are also consistent with the findings of (Friess et al., 2020; Resende et al., 2017; Zhang et al., 2019). These three studies applied a CVM to elicit SP on ecosystem restoration in the Sundarbans. While the negative sign of the WTP bid implies that an increase in entrance fees to the Sundarbans mangrove forest may restrict tourists' willingness to visit this forest and hamper ecosystem restoration schemes in future. This empirical evidence generated by the study supports the findings (Grellier et al., 2017) in Europe's blue spaces and (Mak & Jim, 2021) in parks in Hong Kong.

For proper empirical assessment, we apply CVM to elicit SP data. The findings show that the composition of the restoration schemes has a crucial impact on tourists' probability of paying into the scheme. More specifically, tourists of the Sundarbans are very interested in paying BDT 64.54 per visit for improved restoration schemes. Investment in restoration schemes for ecosystems in the Sundarbans makes a guarantee of earning BDT 11.81 billion (US\$ 140.61 million) per annum. It would increase over the years. The government or any investor not only gets returns from such projects but also provides more recreational value and protects property, lives and livelihoods from unexpected hazardous conditions. In conclusion, a lower WTP bid in the restoration scheme in the Sundarbans does not necessarily indicate low demand by potential travelers. The study findings can serve as policy inputs not only for the Sundarbans but also to pave the way for undertaking projects like biodiversity control management to mitigate the extinction of species in red alert.

An important limitation of this study is that we fail to conduct group discussions in Indian side Sundarbans to obtain the relevant attributes of the restoration scheme. This remains an area where further research is warranted as a proper restoration scheme for

Sundarbans forest. Thus, it will be valuable to better evaluate of WTP bid. We offer our findings within these caveats.

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**Data availability** The datasets used during the current study are available from the corresponding author on reasonable ground and request.

## Declarations

**Conflict of interest** The authors announce that there is no conflict of interest.

**Ethical approval** The study was supported in accordance with rules from the ethical committee of Government Edward College, Pabna.

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