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Willingness to Pay for Environmental Quality Improvement Programs and Its Determinants: Empirical Analysis in Western Nepal

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Abstract: Environmental conditions in western Nepal are experiencing a possible threat to economic losses and sustainability, especially due to decreased productivity and increased health risks. This research investigates the maximum willingness to pay (WTP) of the local community for environmental quality improvement programs by using the contingent valuation technique. It also explores socio-economic and behavioral determinants that influence the maximum WTP for environmental quality improvement. A cross-sectional analytical design is employed using primary data obtained through in-depth face-to-face interviews with people in the community, interviews with key informants, focus group discussions and direct observations. Of the total of 420 households sampled, 72% were willing to pay for the environmental improvement program. The average WTP of households per annum for environmental protection at the community level is given as Nepalese rupees (NPR) 1909 (confidence interval—CI: 1796–2022). Environmental factors (prolonged drought, sporadic rains and drying sprout), socio-economic factors (family size, occupation, regular saving habits in microfinance, distance to the nearest health facility, health insurance enrollment, owning a home and owning arable land) and behavioral factors (cleanliness of the toilet) are the major factors influencing the household's WTP decision. The findings of this study provide an important guideline and basis for the implementation of cost sharing in environmental quality improvement programs among the community, governments and other stakeholders in this sector.

Keywords: willingness to pay; environment protection; logistic regression; western Nepal

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1. Introduction

The importance of environmental protection, especially from a public health perspective, has been increasingly recognized over the years due to the high burden of diseases caused by environmental risk factors. Comparing the data from the World Value Surveys (WVS5 and WVS6), governments in developing countries and some less developed countries have placed higher priority on environmental protection than economic growth [1]. However, these countries' environmental values are not keeping pace with their economic development. Environmental quality is critical to human life because it has the potential to drive economic growth and poverty reduction, particularly in low- and middle-income countries [2,3]. The consequences of environmental degradation increase the magnitude and rate of disease and death from extreme weather and climatic events [4], resulting in economic losses regardless of whether the country is developing or developed [5,6]. Environmental hazards are thought to impact or be accountable for around a quarter of the global burden of diseases [7]. Nepal is one of the countries on this list with a diverse spectrum of natural systems, from subtropical to alpine climates, as well as high levels of physical and biological diversity. Rapid population growth, rural poverty, unsustainable use of natural resources, damaged forests and unsustainable farming methods have all contributed to the depletion and degradation of ecosystems and natural resources [8]. The

economic loss resulting from these adverse environmental changes has multiple negative implications in different sectors of the economy, particularly in health and agriculture [9]. Given the situation between a degrading endowment of environmental assets (such as forests, water and air) and a growing demand for ecosystem services, which is primarily driven by human population growth and socioeconomic development, the Government of Nepal has taken steps to protect the country's natural resources through various legal frameworks: for example, the enactment of the Environment Protection Act 2019 [10]; the National Forest Policy 2019 [11]; the Forest Regulation 2022 [12]; the Water Resources Act 1992 [13] and the National Biodiversity Strategy and Action Plan 2014–2020 [14], among others. However, the government's legal framework is not very effective in its role of managing the country's resources, and it ignores the importance of promoting public engagement in the management of environmental components [15]. Although a considerable number of studies in Africa, Europe, the Americas and some parts of Asia have used the contingent valuation (CV) method to gauge people's engagement in environmental quality improvement programs [16,17], such studies are scarce in Nepal. Some studies conducted in Nepal [18,19] applied the CV approach to estimate costs of environmental losses and derive benefits from wildlife conservation. These studies are confined to the maximum willingness to pay (WTP) method recommendations and the relationship between the WTP and socio-economic characteristics.

In absence of market data, the economic valuation of changes in environmental quality in natural ecosystems relies solely on CV techniques. Environmental economists have conventionally managed to address environment quality changes in the natural ecosystems by adopting approaches that rely upon WTP survey responses [20,21]. Martínez-Paza et al. (2014) argued that the WTP survey has been proven to be an indispensable tool for decision–making [22]. In countries such as Nepal, where severe environmental degradation persists with spatial and temporal variability, the national environmental restoration policies demanded by the public are ineffective, and as there is social and political resistance to funding for environmental protection [23–25], the WTP survey is required. A comprehensive review of the literature on the WTP and its environmental, socio-economic and behavioral determinants concluded that water pollution [26], climate change [27] and biodiversity loss [28] are key influencing factors in developing countries.

One study explored the strong relationship of environmental and social factors with the WTP of households in low-income countries [29]. Some other studies explored the effects of environmental regulation on residents' WTP for environmental protection [30] as well as the effects of social interactions and information bias on the WTP for trans-boundary basin ecosystem services [31]. Another study explored the determinants of the WTP for public sector health care services empirically in Nigeria [32]. Nonetheless, no single study incorporating all of the environmental, social and behavioral aspects affecting the WTP for environmental improvement was found that could help policymakers to develop the environmental quality improvement programs across western Nepal. Therefore, this paper primarily aimed to empirically elicit the maximum WTP of households in western Nepal for environmental quality improvement, where environmental damage and variability are prominent. The WTP for a better environment is believed to help to identify and design policies for cost-effectiveness and long-term sustainability of public resources in western Nepal. The second objective of this study was to empirically conceptualize the potential environmental determinants of the WTP within communities.

The next section explains the methods employed, and the third section presents the results. The fourth section discusses the results in relation to the broader literature and, finally, the fifth section concludes the study based on the findings.

2. Methods and Materials

2.1. Study Design

A cross-sectional analytical economic evaluation design was employed using primary data. Based on the objectives of the study, primary data collected from household survey

were analyzed, incorporating all environmental variables, including socioeconomic and behavioral variables. Record reviews, focus group discussions (FGDs), in-depth interviews and key informant interviews (KIIs) with different stakeholders were the fundamental techniques employed for data collection. Data collection was conducted using a semi-structured questionnaire containing both qualitative and quantitative aspects. FGDs and KIIs were conducted to validate the results of the household survey. Record reviews, local experts' suggestions and cross-checks were the major data validation tools, following the procedure of Ali and Audi (2016) [33]. For the analysis, the data were entered into SPSS version 20 and subsequently transferred to STATA version 12. This research employed a well-known econometric technique that is linked to the usage of a Bernoulli regression model derived from conditional Bernoulli distributions. The WTP was estimated using a descriptive statistical analysis, and the factors impacting the WTP were investigated using a logistic regression model.

2.2. Description of the Study Areas

The study was conducted in the Jajarkot and Banke districts of western Nepal, located between 28°37′22″ to 29°07′32″ N and 81°49′22″ to 82°34′46″ E, including higher mountain and lowland terai regions. Western Nepal is also considered as an environment-sensitive part of the country, with large varieties of climatic zones and harsh weather conditions. The altitude of the Jajarkot Hill district ranges from 610 m to the highest altitude of Darim Lek (5440 m). Banke, within the terai region, has an altitude ranging from 109 m to 1950 m. The climate of the districts ranges from subtropical to alpine conditions. The socioeconomic statuses of the district's residents vary with transportation access and the complex lives of the local people in terms of geographical difficulties (high hills and mountains) and the lack of public facilities. Water shortage, out-migration to India for seasonal employment and sudden outbreaks of contagious diseases (including diarrhea, jaundice, malaria, etc.) are common characteristics of the study areas (Figure 1).

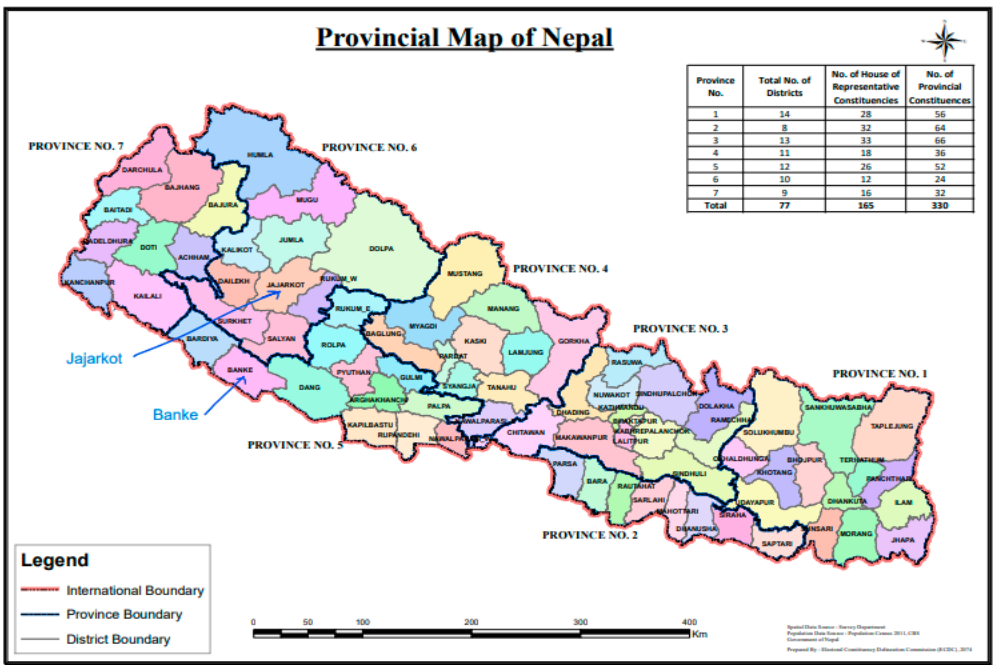

Figure 1. Map of the study area.

(Source: https://www.election.gov.np/uploads/Pages/1564381682_np.pdf, accessed on 17 November 2018). Based on information acquired from the forest and environment offices of the districts, one municipality and one rural municipality were chosen from each district. Bheri Municipality and Junichande Rural Municipality were selected from

Jajarkot District; and Nepalgunj Municipality and Janaki Rural Municipality from Banke District. As per district health officials and the environment department, these four municipalities were part of the list for environmental impact assessment by means of district level investigations. This was the major rationale for selecting these municipalities as the study areas.

2.3. Sampling Technique and Sample Size

The list of households was obtained from the municipal offices, and a random sampling technique was employed to select a sample of 420 households for in-depth interviews. The sample size was estimated by using EPI-Info software (statistical software by Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia (USA) at a 95% level of significance and a targeted population of 463,000. The random sampling method was applied by leaving at least 5 households in between two sample households, at least 500 m apart, to cover heterogeneity in the population characteristics, following the methods suggested by Vasileiou et al. (2018) [34].

2.4. Preparation of Questionnaire and Data Collection

Prior to finalizing the questionnaire, a rapid assessment study within the study area was conducted to ensure the appropriateness and coherence of the questions. In order to balance the flow of questions, both qualitative and quantitative response-related questions were included in the questionnaire. A pretest was conducted with 20 rural households in the Kavrepalanchok district of Nepal to check internal validity and reliability. The questionnaire was organized according to the survey order of the Government of Nepal [8]: first, social-demographic information; followed by knowledge of environmental changes; then a scenario of environmental conditions with WTP questions and explanations for positive or zero WTP. The questionnaire was then double-checked to ensure that the flow of questions was maintained.

(a) Household survey

Enumerators with backgrounds in environmental study were chosen and trained to collect high-quality data. They conducted in-depth interviews with the heads of the households included in the sample. Every day in the field, the field supervisor checked all the data-filled questionnaires for missing and incomplete information or irrelevant responses. In order to make the data more precise, the supervisor also checked the collected data as much as possible by sharing data via email. The method used for eliciting households' willingness to pay is discussed in Section 2.5 below.

(b) Focus Group Discussion

The primary goal of the FGDs was to gain a thorough understanding of the past and current state of environmental deterioration in the study area. With the support of local school principals, four focus group discussions were conducted, with an average of 10 to 15 participants. Furthermore, each participant was carefully selected based on gender and age to ensure the highest levels of involvement and expertise for each participant. The FGDs were carried out using a guideline consisting of the same questions taken from the questionnaire. During the process, topics related to the overall environmental situation in their community and possible WTP of the households for environmental improvement programs were discussed. The questions were roughly given as guidelines, including two broad techniques—resource mapping and institutional analysis [35]. Limited but carefully selected questions from the set of questions included in the in-depth interview tool were used for FGD implementation.

(c) Key Informant Interviews and Direct Observations

The key informants for this study were 16 local community leaders, 16 school principals or environment subject teachers, 16 local activists (people at social services) and 16 local senior citizens who were asked to share their experience regarding the environment

situation in the study area. To identify them, a snowball sampling technique was employed in such a way that new key informants were identified from each informant interviewed, and the sample size increased continuously with subsequent interviews until saturation was reached [35].

Direct observation in the household and around the community was conducted mainly to obtain sufficient data and to ensure or validate the situation of the environment, as well as to observe participants' livelihoods, activities, social networks and governance issues. Direct observation was mainly used for the purpose of understanding the current behavioral approaches at the household level [35]. A separate checklist with the most important key questions was used to check the accuracy of the household responses.

2.5. Method for Eliciting Household Willingness to Pay

A hypothetical scenario was created explaining the scenario below and including a question for their response (benefit), so they were free to respond in any way they wanted to. As we intended to give the participants freedom to respond with the combined voice of family, focus group discussion among local key persons and management of local experts' suggestions were carried out to ensure that the estimation was free from starting bid bias and range bias, but criterion validity was employed to avoid biases in this methodological issue. Furthermore, households in western Nepal may contribute small amounts at shorter intervals due to severe resource constraints. However, residents preferred annual payments, as these would allow them enough time to manage the payment amount. Households that refused to pay in cash but preferred to pay in labor terms were also documented. The agreed-upon days for labor were converted into monetary values by multiplying days by NPR 517 [36] (the government's daily wage rate for unskilled workers). The following is a summary of the hypothetical background (Box 1) and the questions.

Box 1. Contingent market for environmental goods.

Suppose the Nepal Government or other organization wants to improve environment quality in Western Nepal to reduce the risk of your household being affected by extreme weather, climate, air, water quality and biodiversity loss, and to ensure that everyone in the community benefits from various services rendered by the improved environment quality across western Nepal. Unfortunately, the government faces budget deficits and would like to ask you to contribute towards the implementation of integrated environmental protection program. Q1. Would you be willing to pay to improve environment quality in western Nepal? Yes/No If Yes, how much? NPR (If no, go to question 3) Q2. Can you explain why you are willing to pay if you are? Q3. What might be the reasons for your unwillingness to pay?

If there was a positive WTP response for Q1, the proposed bids were (NPR 500, 750, 1000, ... , 5000), and these were pretested first before being used in the survey. Based on the first response, either Yes or No, the respondents were further asked for their WTP for a follow up bid, to which they, again, were able to answer (Yes/No). If the participant denied answering the first bid, s/he was encouraged to choose either lower or higher bids. Following the Double Bounded Dichotomous Choice (DBDC) format [35,37], the participants were asked a second follow up WTP question after answering the first WTP questions.

Thus, the steps in the equation are formed, beginning for first bid, as:

$$WTP_i = \alpha X_i + u_i$$

where X_i represents factors affecting the ith individual's WTP, including starting bid α; and u_i is an error term (nonparametric for logistic regression model).

The second follow-up question is represented by

$$WTP_i^2 = (1-\lambda)WTP_i + \lambda\alpha + \delta$$

where λ is the parameter referring to the starting bid α_i, and δ is the shift parameter. The participants were asked two questions for double intervals in DBDC method [38]. Mathematically, the WTP up to the second bid can be expressed as
WTP = α^2, accept both starting bid (α^1) and follow-up bid (α^2);
$\alpha^2 \leq$ WTP < 1, reject the starting bid (α^1) and accept the follow-up bid (α^2);
WTP < α^2, reject both bids (α^1) and follow-up (α^2)

Following a modified version of Makwinja et al. (2019) [39] to derive the probability for each possible choice j, the jth role to the likelihood function was indicated as:

$$L_{1j}\left(\frac{WTP_1}{\alpha_1}\right) = P_r(WTP_1 + u_{ij} > \alpha_i WTP_2 + u_{ij} \geq \alpha^2)^{yy}$$

$$P_r(WTP_1 + u_{1j} > \alpha^1 WTP_2 + u_{2j} \geq \alpha^2)^{yn}$$

$$P_r(WTP_1 + u_{1j} > \alpha^1 WTP_2 + u_{2j} \geq \alpha^2)^{ny}$$

$$P_r(WTP_1 + u_{1j} > \alpha^1 WTP_2 + u_{2j} \geq \alpha^2)^{nn}$$

Here, WTP_1 and WTP_2 represent means for the first and second bid responses, respectively; and yy = yes–yes answer, yn = yes–no answer, ny = no–yes answer, and nn = no–no answer. This likelihood function is suitable for developing a logit model with a cumulative distribution function with zero mean (WTP). The logit likelihood function is given in an equation in [38].

$$L_{1j}\left(\frac{WTP_1}{\alpha_{\alpha_1}}\right) = \chi_{\frac{\alpha}{\alpha_2}}\left(d_{1j}\left(\frac{\alpha_1 - WTP}{\sigma^1}\right)d_{2j}\left(\frac{\alpha_2 - WTP}{\sigma^2}\right), d_{1j}d_{2j}\varphi\right)$$

Here, WTP_{1j} = 1 if the response to the first question is yes or otherwise; WTP_{1j} = 1 if the response to the second question is yes or otherwise; and WTP_{2j} = 1 if the response to the follow-up question is yes or otherwise.

The mean and median WTP were derived as follows:

Mean WTP = $EXP\left(\frac{\overline{X}\hat{\alpha}}{\hat{\alpha}_0} + 0.5\hat{\sigma}^2\right)$

Median WTP = $EXP\left(\frac{\overline{X}\hat{\alpha}}{\hat{\alpha}_0}\right)$

Here, $\overline{X}$ is a row vector of the mean value of the explanatory variable, $\hat{\alpha}$ is column vector of estimated coefficient and $\hat{\sigma}$ is the estimated variance [40]. STATA version 12 was used to calculate the specified confidence intervals around the mean and median. Similarly, respondents were also requested to specify the reasons for their payment decision as a post-elicitation check performed by Burchardi et al. [41].

2.6. Aggregate Hypothesized Variables Measured

This study explores the effects of environmental change on human welfare through the use of cross-sectional data. Therefore, the variables in use for finding associations between environment and welfare are given as follows:

Outcome (dependent) variable: WTP

The dependent variable is dichotomous in nature. A positive WTP is coded by 1 and a negative by 0.

Covariates: environmental determinants, community characteristics, socioeconomic variables and household behavioral indicators.

Environmental variables include knowledge and perception of environmental change, natural disasters due to environmental change (drought, forest fire, flood, windstorm, thunderstorm, heavy rain, sporadic rain, landslide, snowstorm, erosion, heat waves, cold

waves, biodiversity change, air pollution, water pollution, solid waste, etc.) [8] and change in water resources (amount of water, quality, level, drying up of spring spouts, flow in piped water, etc.).

Household socioeconomic and behavioral indicators include sex, age, education, marital status, income, current occupation, ownership of residence, source of drinking water, main source of energy for cooking and lighting, main types of toilets, hand washing habits, disposal of waste, food preferences, access to health facilities, distance to motorways, saving habits in microfinance and involvement in awareness programs [7]. Among these variables, Table 1 includes some variables available in the literature and some variables of interest.

Table 1. Description of hypothesized variables with expected sign.

Variables	Description of Variables	Expected Sign	Mean	Standard Deviation
Sex of household head	Male = 1, 0 otherwise.	−ve	0.55	0.49
Family size	Number	+ve [42]	6.55	3.49
Living duration	Number of years	−ve [42]	52.21	23.21
Occupation	Business = 1, 0 otherwise	−ve	0.31	0.15
Owning house	Yes = 1, 0 otherwise	+ve [39]	0.88	0.10
Drinking water source	Pipe = 1, 0 otherwise	+ve	0.52	0.43
Receiving remittance	Yes = 1, 0 otherwise	+ve	0.29	0.45
Owning land	Yes = 1, 0 otherwise	+ve [39]	0.80	0.39
Income level	High = 1, 0 otherwise	+ve	0.21	0.40
Regular saving habits	Yes = 1, 0 otherwise	+ve	0.49	0.51
Membership in microfinance	Yes = 1, 0 otherwise	+ve	0.24	0.43
Distance to health facilities	Number of KM	−ve	2.77	1.98
Drought	Increased = 1, 0 otherwise	+ve [43]	0.87	0.32
Rain patterns	Timely = 1, 0 otherwise	−ve [44]	0.23	0.42
Cold waves	Increased = 1, 0 otherwise	+ve	0.57	0.49
Dried sprout	Yes = 1, 0 otherwise	+ve [44]	0.76	0.42
Health insurance	Registered = 1, 0 otherwise	−ve	0.56	0.49
Toilet cleaning devices	Yes = 1, 0 otherwise	−ve [45]	0.45	0.57

2.7. Econometric Dealing for Determinants of Willingness to Pay

Estimates of public benefit or welfare, based on compensating and comparable variation, are at the core of economic policy analysis. However, because the quality/quantity change in the consumption level for environmental services is outside the individual's control, the shift in environmental services is primarily concerned with compensation surplus (CS) and equivalent surplus (ES). The ES is the amount that would make the local community apathetic about the environment's natural position in a situation in which they are forced to live in a degraded environment. However, if the community were forced to use a certain amount of environmental services, CS is the sum that would make the community indifferent between the degraded status of the environment and the original unaltered environmental situation.

If deterioration of the environment (E) is evaluated, and CS and ES are examined for that situation, CS is the readiness to accept compensation for a lower E, while ES is the willingness to pay to avoid it. CS may be quantified using the minimum willingness to accept (WTA), whereas ES can be calculated using the maximum willingness to pay (WTP), as the amount of ecosystem services declines owing to environmental deterioration [46]. Now, based on the hypothetical statement, this study has recorded the maximum WTP of individuals for the restoration of environmental services; thus, the concern is linked with the equivalent surplus (ES). The model formulation includes a detailed derivation of the equivalent surplus. The following model is based on the theories proposed by Kristrom (1990) [37], Lopez-Feldman (2010) [47] and Bateman and Wills (1999) [48].

Model Formulation

Let us consider an individual that attains random utility u from the use of monetary income (y) under a degrading environment scenario for the improvement of environmental

quality from q_0 to q_1, where $q_1 > q_0$. This individual, who has also felt a need for environmental improvement or to avoid the hazards cost, would either be willing to pay (h = 1) or unwilling to pay (h = 0). If s/he wants to pay, the individual utility is $u_1 = u(1, q^1, y; s)$, and if s/he does not, his/her utility is $u_0 = u(0, q^0, y; s)$, where s is the vector of explanatory observable variables. Therefore, utility function $u(h, q, y; s)$ now helps us to generate the stochastic structure of the statistical binary response model.

If u_0 and u_1 are random variables with means $v(0, y; s)$ and $v(1, y; s)$, the utility equation takes the form:

$$u(h, q_j, y; s) = v(h, q_j y; s) + \varepsilon_j, h = 0, 1 \tag{1}$$

where ε_0 and ε_1 are random variables with zero mean.

From this sense, the individual will accept the offer of environmental improvement if

$$v(0, y - A; s) + \varepsilon_0 \geq v(1, y; s) + \varepsilon_j, J = 0, 1 \tag{2}$$

They will reject if otherwise. In the above equation, A represents the adaptation mechanisms (cost).

Now, a rational consumer of environmental services tries to maximize his utility by responding to a random variable with probability distribution, given by

$$P_0 = \Pr(YesWTP)$$

$$P_0 = \Pr\left\{v(1, q^1 y - A; s) + \varepsilon_1 \geq v(0, q^0 y; s) + \varepsilon_0\right\} \tag{3}$$

$$P_1 = \Pr(NoWTP) = 1 - P_0$$

Consider, $\eta = \varepsilon_1 - \varepsilon_0 \& F_\eta(.)$ is a conditional function of η. Then the WTP probability function becomes

$$P_0 = F_\eta(\Delta v) \tag{4}$$

where

$$\Delta v = v(1, q^1, y - A; s) - v(0, q^0, y; s) \tag{5}$$

and Δv is the change in mean random utility or the individual equivalent surplus from the environmental improvement.

Furthermore, the probability function following Bateman and Wills (1999) [48] in Equation (4) can be written in a Logit model, and takes the following form:

$$P_0 = F_\eta(\Delta v) = \left(1 + e^{-\Delta v}\right)^{-1} \tag{6}$$

Again, the utility difference Δv can be another avenue to explain the binary response model as the outcome of a utility-maximizing choice. It displays the criteria for the utility maximization model as a binary response.

If we suppose

$$v(j, q, y; s) = \alpha_j + \beta y, \beta > 0, \tag{7}$$

with suppressing s, then Δv becomes

$$\Delta v = (\alpha_0 - \alpha_1) + \beta A \tag{8}$$

and the discrete choice model becomes

$$P_0 = F_\eta(\alpha + \beta A) \tag{9}$$

Similarly, in semi-log form,

$$v(j, q, y; s) = \alpha_j + \beta \ln y, \beta > 0, j = 0, 1 \tag{10}$$

and finally,

$$\Delta v = (\alpha_0 - \alpha_1) + \beta \ln(y - A) - \beta \ln y \tag{11}$$

which is equivalent to

$$\Delta v = (\alpha_0 - \alpha_1) + \beta \frac{A}{y} \tag{12}$$

To measure the welfare-fitting binary response model if individual utility is lost in the present environment quantity E_0, we must satisfy

$$P_1 = \Pr(E_0 > A) = 1 - G_E(A) \tag{13}$$

where E_0 is the individuals' maximum WTP, which satisfies

$$u(0, q^0, y; s) = v(1, q^1, y - E_0; s)$$

or

$$E_0 = y - m[v(1, y; s) - \eta, 1; s] \tag{14}$$

and $G_E(.)$ is a conditional function of E_0, with welfare measurement in terms of means.

$$E^* = \int_0^\infty [1 - G_E(A)] dA \tag{15}$$

where E^* is the improved environment quality or original quality of environment.

Equation (15) refers to the total value of the consumer's surplus from the improvement of environmental services. To identify the actual equivalent surplus of the consumer, let us consider another measure of environmental quantity, E^{**}, which satisfies

$$E^* \left\{ u(0, q^0, y; s) \right\} = E_0 \left\{ u(1, q^1, y - E^{**}; s \right\}] \tag{16}$$

Again, a third measure is represented by E^+, which is the median of the distribution $G_E(.)$. Then, E^+ can be written as

$$\Pr \left\{ (u(1, q^1, y - E^+; s) \geq u(0, q^0, y; s) \right\} \tag{17}$$

Now, the quantities E^+ and E^* can be expressed as

$$E^* = y - y e^{(\alpha_0 - \alpha_1)/\beta} E \left\{ e^{\eta/\beta} \right\} \tag{18}$$

$$E^+ = y - y e^{(\alpha_0 - \alpha_1)/\beta} \tag{19}$$

This calculation model helps us to identify the total equivalent surplus from environmental improvement, thus satisfying $q_1 > q_0$, which allow for the formulation of actual welfare:

$$E^* = ES = \int_0^\infty \left[1 + E_0^{-\delta_0 - \delta} \ln A \right]^{-1} dA = -e^{-\delta_0/\delta_1} \frac{\Pi/\delta_1}{Sin(-\Pi/\delta_1)}, 0 > \frac{1}{\delta} > -1 \tag{20}$$

The above Equations (12) and (20) allow us to generalize, evaluate and analyze public welfare from non-tradable environmental services by the use of the logit and logistic regression model, as suggested by Bateman and Wills (1999) [48], for the binary response of an individual, with several resulting effects. Bateman and Wills (1999) [48] and Mc Fadden (1986) [42] have strongly suggested that the logit model is essentially the best option for analyzing the environmental improvement in household-level studies. Therefore, the logit model was used to analyze determinants of the maximum WTP.

Now, as a binary dependent variable, let P_x be the probability of changing the maximum WTP agreement due to the possible change in explanatory (exposure) variable x. Let it take a value of 1, with a given probability of change. The probability of increasing or decreasing the chance of change can be expressed as

$$P_x = P(D|_{X=x}) = \frac{1}{1 + e^{(-a+bx)}} \tag{21}$$

Then, the linear form of Equations (21) and (22) is represented as

$$y_{ij} = \beta_0 + \beta_i X_{ij} + \varepsilon_{ij} \tag{22}$$

where y_{ij} is a household's willingness to pay, with j = 1 (willing to pay) and 0 (not willing to pay). The response of the ith household can also be expressed as 1 = Yes, and 0 = No. X_{ij} represents a vector of explanatory variables, including individual, environmental, demographic and household characteristics; and ε_{ij} represents a random component following a normal distribution with a mean of zero and constant standard deviation.

Therefore, the general form of the binary logistic regression equations is:

$y_{ij} = \beta_0 + \beta_i X_{ij} + \varepsilon_{ij}$, where X_{ij} is the vector of socioeconomic, behavioral and environmental (climatic and non-climatic) variables.

The specific form of the model (variables and their types are explained in Table 1) is given below:

$$\begin{aligned} WTP_{ij} = \beta_0 + \beta_1(Sex) + \beta_2(FamilySize) + \beta_3(Liv\_Dur) + \beta_4(Occupation) + \beta_5(HomeOwnership) \\ +\beta_6(Dri\_Water) + \beta_7(\text{Remit tan}\,ce) + \beta_8(Own\_Land) + \beta_9(Income\_Cate) + \beta_{10}(\text{Re}gularSaving) \\ +\beta_{11}(Mem\_Micro\_finance) + \beta_{12}(Dist\_healthpost) + \beta_{13}(Drought) + \beta_{14}(Sporadic\_Rain) \\ +\beta_{15}(ColdWave) + \beta_{16}(DriedSpout) + \beta_{17}(HealthInsurance) + \beta_{18}(ToiletDevice) + \varepsilon_{ij} \end{aligned}$$

The above model was validated with an iterative process to have the best fit at the highest R-squared value, in order to define the goodness of fit. Similarly, the model was also tested with the variable omission test to ensure its robustness in the maximum likelihood estimation.

2.8. Ethics Approval and Informed Consent

Ethical approval was given by the Ethical Review Board of Nepal Health Research Council, Government of Nepal, as explained in the methodology section. Written and oral informed consent was also given to collect the data from the community. The data are from the research of the first author, supervised by the second and third authors. The data are secured in the storage of Tribhuwan University, Kathmandu.

3. Results

3.1. Estimation of Willingness to Pay

Of the total sample size of 420 households, all the questionnaires were administered and obtained positive or negative responses, with a 100% valid response rate after the recheck of all responses. The actual distribution of households' WTP responses was first categorized into negative (zero) and positive (greater than zero), as shown in Table 2.

Table 2. Distribution of the WTP responses.

WTP	Number of HH	Percentage
Positive	302	72
Negative	118	28

Almost 28% of the participants denied the idea of paying to improve environmental quality in western Nepal. Some denied paying, and some responded that they were unable to pay in cash but wanted to pay in labor, because of their low income level and

under-employment. As expected, a large fraction of households, (72% of the participants) responded positively to the notion of paying for the environment improvement program. Table 3 shows the results of the analysis of the WTP households.

Table 3. Descriptive analysis of the WTP.

Parameter	Number	Mean	Median	Mode	Min–Max	S.D.
Amount per year (NPR) *	302	1909(CI:1796–2022)	1850	2000	500–8000	977.41

* 1 USD = NPR 110.

A total of 302 participants (72%) were willing to pay toward environmental quality improvement programs in western Nepal (Table 3). Likewise, a study in Turkey found a 92% response rate regarding paying for water quality program [49] and another Chinese study found that 53% of respondents were WTP for improved air quality [50]. This might be due to the importance of water for household use and the community use of other environmental services.

The average annual maximum WTP of households of the study area was calculated as NPR 1909 (CI: 1796–2022) (USD 17.35) among those who were willing to pay for the mitigation of environmental degradation. This WTP amount is also close to the average drawn from FGD and KIIs as NPR 2043 (USD 18.57). This amount is slightly lower than the WTP of households for land conservation (USD 24 per annum) in western Nepal [19]. In contrast, this amount is higher than the WTP for biodiversity conservation [51]. The maximum WTP for those who wanted to pay in terms of labor is estimated separately as NPR 1312 (CI: 993–1555).

Because the northern hill region of the study area has been severely impacted by climate-related natural disasters/events such as drought, delayed summer rains, the spread of unknown diseases and the extinction of flora and fauna in the last decade, participants expressed their willingness to pay after hearing about a hypothetical improved environmental situation under a contingent market; however, the WTP appears low for these participants due to their poverty. The median was also determined for the purpose of finding a solution to the problem of excessive WTP values, and in this skewed scenario, the median was more informative than the mean. In the same way, the mode was also recorded to determine the most common number in the dataset, to which data heaping also contributes. An exponential trend line was fitted to the likelihood of responses in Figure 2. According to the exponential regression model $y = 15.248^{1\times10^{-4}x}$ ($R^2 = 0.7118$), the rate of respondents decreases by 0.15 percent for every rupee increase in the WTP amount.

Some of the households agreed to pay through a labor contribution instead of a direct cash payment. As a result, eliciting willingness to pay in labor appeared to be a useful and perhaps unbiased benefit measurement approach for rural households. The willingness to pay of households in rural and urban hillside areas appeared to be nearly equal on average. However, in the Terai lowland region, a significant number of residents refused to pay for any environmental improvement activities. These households seemed to be wealthier than those in the hillsides, but the average WTP was not significantly higher.

Table 4 exhibits the summary status of the reasons for positive and negative WTP responses. Almost 43% of the deniers cited reasons related to a lack of money for the program according to their income level, and 22% expressed disbelief regarding the government's ability and readiness to implement an effective environment protection program. In contrast to this, 67% of the respondents who agreed to pay were aware of the environmental benefits of such a program for their area, and 24% responded in favor of biodiversity conservation. This is an important message to the policymakers to make decisions in line with people's understanding of the environmental improvement programs. This also explains why local governments should organize an environmental management coordination council whose main objective can be to design relevant development policies and strategic plans for the environment and ecosystem services. To improve environmental quality, the authority must further empower communities in western Nepal to take charge of the management. Now

is the time to raise a household's WTP and make a good contribution to the conservation of western Nepal's natural resources. This result is nearly identical to the average of FGD and KII results. During the focus groups, participants agreed that community members' payment decisions should be influenced by their monetary payment capabilities in rural areas. This observation indicated that their home structures and individual abilities to pay were weak, with most earning barely enough to support their families on a daily basis.

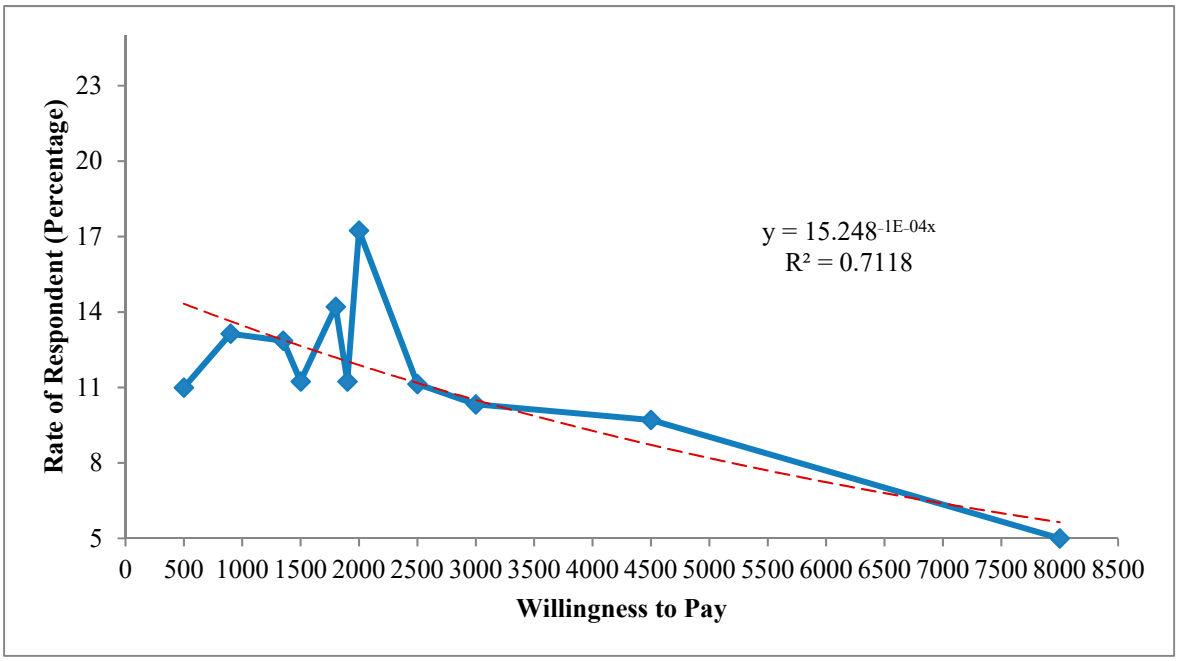

Figure 2. Analysis of WTP amount.

Table 4. Summary of reasons for positive and negative responses on WTP.

Factors	Information Category	Value	Percent	Mean ± Std. Dev.	Min-Max
WTP	Positive	302	78	0.63 ± 0.33	0–1
	Negative	118	28		
Reasons for positive WTP	Improves household economy	18	6	3.21 ± 0.01	1–5
	Biodiversity gains	74	24		
	Improves environmental quality	201	67		
	Reduces impact of climate change	16	5		
	Other reasons	6	2		
Reasons for negative WTP	No money to pay	51	43	3.98 ± 0.16	1–5
	Disagree with the program	26	22		
	Government should pay	22	18		
	No impact of environment	11	9		
	Other reasons	7	6		

3.2. Results of Logit/Logistic Regression Model

Table 5 reveals the logit regression results (odds ratio) of the demographic and socioeconomic factors influencing the decisions of households regarding the maximum WTP for the improvement of the environmental situation in western Nepal, where people are afflicted by many diseases induced by climatic and non-climatic factors. After checking the correlation coefficients, it was clear that there was no co-linearity between the hypothesized variables. The multiple logit regression was run heuristically and explored all of the possible variables that may have influenced the households' decisions about whether or not to pay for any environmental improvement programs, which may reduce environmental

and health hazards. In addition, logistic regression was also run, and more precise results were obtained.

Table 5. Factors affecting household WTP.

Variables	Coefficients (Std. Error)	Odd Ratios
Male household head	−0.105 (0.380)	0.900
Family size	0.232 *** (0.079)	1.261
Living duration	−0.018 ** (0.008)	0.981
Business occupation	−1.254 *** (0.531)	0.285
Owning house	2.126 * (1.245)	8.385
Piped drinking water	0.497 (0.573)	1.644
Receiving remittance	0.833 (0.543)	2.301
Owning land	0.819 ** (0.399)	2.268
Higher income category	0.887 (0.573)	2.430
Regular saving habits	0.843 **(0.445)	2.324
Membership in microfinance	0.990 (0.715)	2.691
Distance to health facilities	−0.187 ** (0.084)	0.828
Drought	1.153 ** (0.564)	3.168
Timely rain	−1.111 * (0.609)	0.328
Cold waves	0.300 (0.412)	1.350
Dried sprout	0.664 * (0.396)	1.943
Health insurance	0.776 ** (0.394)	2.173
Toilet cleaning devices	−0.656 * (0.382)	0.518
R^2 = 0.3248.		
Log likelihood = −113.84		
LR chi-squared (18) = 109.55		
Prob > chi-squared = 0.000		

Number of observations = 420, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Source: Field Survey, 2018.

Most remarkably, with drought, households were more likely to choose a payment agreement for the environmental program with the aim to reduce the negative effects of droughts. More precisely, a single-unit increase in drought level increased the chance of being willing to pay, with a high add ratio of 3.1 (95% CI: 1.048–9.564), compared to those households responding negative in terms of WTP. Similarly, households facing dried sprouts in their locality are more likely to respond positively in terms of WTP compared to those households not facing drying sprouts. Increasing every unit of drying sprouts will likely increase the WTP for the program at an odds rate of 1.9 (95% CI: 0.893–4.221). This result is parallel to that of a study by Markandya and Chiabai (2009) [52], which stated that the positive WTP of the community was due to drying sprouts.

Similarly, sporadic rain, which is strongly experienced in the study areas, seems negatively significant in the probability that households will choose to pay. All other things being equal, increasing timely rain reduces the odds of a positive WTP decision by an odds rate of 0.32 (95% CI: 0.099–1.086). Similar studies addressing the relation of sporadic rain with WTP for environmental protection have not been found to make any comparisons. Based on an interview with the local people, cold waves are rampant, but they seemed insignificant in terms of their effects on households' decisions regarding whether or not to pay for the environment protection program.

Regarding family size and living duration in the community, both were strongly significant, but different in coefficient sign. Households with larger family sizes were more likely to respond positively in terms of WTP for environmental improvement or an adaptation program compared to those with smaller families; this result is parallel to that of a study in Ethiopia [53] which stated that a larger family with more children influences households to respond positively to the question of WTP. More accurately, one extra member in the family increases the chance of choosing the positive WTP option at an odds rate of 1.26 (CI: 1.08–1.47) among those who had a smaller family and denied paying. Similarly, households remaining in the locality for a long time were less likely to respond

positively to WTP as compared to recent migrants; this might be because of the level of precaution already taken by them to adopt the future environmental situation, or because they have become habituated to the degraded environment. In the same vein, another study concluded that migration brings about more vulnerable effects of climate change [54].

Households comprising own business in the community seem less likely to respond positively to WTP (odd: 0.28 (CI: 0.10–0.80)) compared to households relying on agriculture. This may be because environmental hazards may deteriorate the primary production, rather than secondary and tertiary levels, of occupations. This result contrasts to that of the community-based study in Malawi [39], where people working in business were willing to pay more. People living in their own houses, households with their own lands for agriculture and those with regular saving habits were more likely to choose to pay (odds: 8.38, 2.26 and 2.32, with 95% CI: 0.72–9.63, 1.03–4.95 and 0.97–5.56, respectively) for the environmental improvement programs, compared to the other options. Regarding this decision, all these factors can enhance the capacity to pay for the programs. Households with their own land and houses tend to have better financial management at home, as well as better capacity to pay for an environment protection program in a community where they might be living for longer period of time, compared to those who are living at the community temporarily. As expected, regular saving at microfinance institutions also has positive influence on WTP among the households, compared to those who do not engage in regular saving at microfinance institutions. Saving at microfinance institutions also gives the households the opportunity to manage their loans. A study in Cambodia [55] stated that WTP is positively influenced by offering loans at microfinance institutions. Similarly, some studies [39,51,55] have found that income level is the major influencer in choosing positive WTP among those in the community. However, the income level remained insignificant to WTP in this study, as the income from agriculture, business and other jobs were aggregated, and businesspeople with higher income levels were not willing to pay for environmental improvements.

As distance to the nearest health facility increases, people are less likely to choose a high WTP, compared to those living near health facilities in the community. More specifically, every increase of a kilometer in the distance to a health facility leads to a decrease in the choice to pay, with an odds ratio of 0.82 (95% C.I. = 0.701–0.978). One study claimed that households distant from health facilities have low WTP [32]. This might be because they suffer a higher cost of transportation when seeking medical attention, and thus, they might have less disposable money to pay for environmental programs. Similarly, the households which already maintained clean toilets by using toilet cleaning devices were also less likely to respond positively to WTP (odds: 0.51 (95% CI: 0.245–0.098)), compared to those not maintaining clean toilet at home. By observation, evidently, the households maintaining clean toilets were aware of, but not interested in, responding positively to WTP for an environment protection program. In contrast, households with registered health insurance are more likely to have a positive WTP for the environmental protection programs. This might be because the households buying insurance services may be more aware of health risks, and would have experienced the future benefits of prepayment, compared to those who are not insured.

4. Discussion

Almost 72% of the total participants were willing to pay for an environment protection program. In comparison, a qualitative study based in New Zealand found a 26% response rate for a similar type of WTP study on environmental components [56]. Similarly, another study in China revealed a rate of positive WTP responses as 52% of total respondents [50]. Almost 92% of respondents responded positively to WTP in Turkey [49]. The average household WTP in this study was elicited as NPR 1909 (USD 17.35) per year, within the range of NPR (500–8000). In comparison, this average household WTP value is quite significantly lower than another developing country-based study, which estimated NPR 2244 [57], but higher than the average (USD 10.73) estimated by Maqwinja et al. (2019) [39]. Another

study based in India found the WTP to be INR 2097 (USD 30.50) for the Marshland improvement program, which is higher than the elicited value of this study [58]. Moreover, Loomis et al. (2000) estimated the household WTP for an ecosystem restoration-related program in the South Platte River in Denver [59], Colorado as USD 252 per annum, which is far higher than the estimation of this study.

The main public concern during the survey was identified as environmental degradation related to water scarcity, increased droughts, reducing forest land, extreme weather events, climate change and untimely rain. During the focus group discussions, participants expressed concerns about environmental degradation as a result of illicit human activities [60] and a lack of replanting [61]. According to the responses of KIIs with experienced community members, unpredictable and untimely rainfall, cold waves, rising deforestation, prolonged droughts and the extinction of plant species are all key causes of environmental deterioration. Most of the households, KIIs and participants in FGDs expressed the following experiences: a few decades ago, the environment was clean. The water was filtered; there was timely rainfall for agricultural activities, forest products were sufficient for household use and new medicinal plant species were available in the community and in forests; but currently, all of these things are breaking down at an increasing rate. Members of the community work for their own profit. Local governments and political leaders take little action to protect the environment. We know the benefits of a healthy environment, but we are unable to tackle this situation due to the lack of specific programs for environmental protection.

According to field observations, many local water sprouts have already dried up. Because of the arid environment, some were observed just before drying. Due to the prolonged drought in the community, dry mud on farmland with steep slopes indicates a low level of agriculture production, leading to the conversion of agricultural land into grassland. Tree felling for timber, bushes sprouting rapidly after forest fires and traditional farming practices have all been identified as significant contributors to environmental deterioration in western Nepal. Because of these observable facts as experienced by those in the community, the locals are willing to pay for an environmental improvement program [62]. According to Loomis et al., (2000) [59], the local community's interest in the environmental improvement program is reflected as annual WTP for the program in this study.

In line with the economic theory of demand (inverse relationship between price and quantity demanded for common goods [62]), this study also revealed that the positive WTP of community people decreases as the WTP bid amount grows. Therefore, it is more reasonable to conclude that the WTP curve truly reflects the community demand curve for environmental protection programs in western Nepal. This relationship also shows that people who chose yes over no when the bid amount was low were more likely to choose yes at a higher bidding amount. While it is difficult to determine what amount is most appropriate for the entire population, it is clear that 72% of people were willing to contribute an amount in the range from NPR 500 to 8000, and only a small percentage of those who chose negative WTP responded to offer labor for environmental improvement in western Nepal. Almost a fifth of total households who denied paying showed a distrust towards the government programs, maybe due to the low transparency and accountability of past government programs. Therefore, improving the financial transparency of the government at all levels may further boost households' confidence and potentially increase the willingness to pay, as recommended by a study in China [30].

The result of the logistic regression showed that increasing drought, drying sprouts and untimely rain were the major environmental factors affecting the WTP of those in the community. This result appears to be consistent with the major information drawn from the FGDs, KIIs and direct observations conducted in the study areas. This result is also consistent with a comprehensive study by Markandya and Chiabai (2009) [52]. In terms of household socio-economic characteristics, larger family sizes have greater WTP. This result is similar to the findings of an Italian study, which stated that the WTP can mitigate the increased risk of natural catastrophe due to substantially higher exposure to environmental

factors [63]. Similarly, households owning their own house and land are more likely to opt for a positive WTP, perhaps because they have a better knowledge of the future economic value of their current investment or because they are likely to remain in that place for longer than those who have no fixed assets. Unlike migrant households, long-term resident households more effectively manage their need for home protection, resulting in a lower WTP response [64]. This could be due to the fact that households who have remained in a community for a long time are aware of the essential precautions to be taken for any naturally induced critical emergency [47], or have become accustomed to the degraded natural environment.

Households that save regularly at a financial institution are more likely to choose a positive WTP for environmental protection programs, possibly because they have a better understanding of/education on the importance of saving due to environmental hazards. Thus, they have a strong commitment to contributing a large amount of money to environmental restoration [20]. According to some studies [28,48], community members' WTP is determined by the severity of discomfort caused by environmental hazards, rather than by their income. Moreover, the WTP is found to be negatively associated with distance to the nearest health facilities, meaning that a lack of availability of health services in the community reduces the chance of a positive WTP. Thus, the management of health facilities supports community engagement in environment protection programs [32]. Households who focus on the cleanliness of their toilets by using toilet-cleaning devices may have superior health security against environmental threats; therefore, they might be less likely to indicate a positive WTP for the environment protection program.

This study also has some limitations and strengths, which will be are presented in a logical manner. This study did not take into account some key environmental factors, such as poor land uses and extreme weather occurrences, e.g., El Nino, which could have an impact on human health and, as a result, on maximum WTP. Similarly, for a cross-sectional study, this study only covered a few areas in mid-western Nepal, and cannot generalize the entirety of Nepal. This study did not look at the scenario in terms of enhanced financial transparency of government programs, and alternative payment methods were not considered among those who refused to pay or who expressed doubts in government initiatives. Future research could explore this as a different way to obtain the maximum WTP, if respondents had a high level of confidence in the transparency and accountability of the government. Furthermore, this study assumed that respondents did not free-ride, ignoring concepts such as altruism (how much a household would benefit his neighbor even if the neighbor did not pay) and spillover effects (to what degree one's contribution could have an effect even if others did not contribute). Future research can be carried out by theorizing such ideas, taking into account richer hypothetical scenarios and assuming the conditional amount committed by neighbor.

The evidence gathered in this study, on the other hand, framed community perspectives on a better future, to be achieved through clean environment quality, in western Nepal. This research takes a fresh look at such acts while taking into account the preferences and demands of the users. Additionally, this study has explored the attitude of respondents in order to determine which decisive environmental, socio-economic and behavioral factors control communities' insights towards positive or negative responses to WTP for environment improvement programs. This study can act as a major guideline in the future, with data for decision- and policymakers to use to formulate the optimal management strategy for environment protection programs, focusing on western Nepal and other similar areas.

5. Conclusions

This study proposed an economic benefit that could be achieved for an environmental improvement program. This benefit might be substantial and able to be efficiently used in an environment protection program in western Nepal. The elicited amount that the community members were willing to pay can be used as a set price for environmental conservation efforts. The reported environmental, social and behavioral aspects influencing

the general public's WTP decision present risk factors that must be addressed during the creation of an environment protection program in order to assure economic efficiency. The findings of this research have policy implications for all levels of government in federal Nepal, as they help to establish strategies for managing environmental components such as climate change, natural ecosystems and appropriate adaption mechanisms in western Nepal. A thorough understanding of the community residents and place characteristics, the WTP values, reasons for positive or negative WTP responses, the community WTP-based linear demand function and the influencing factors for the WTP decision could aid in more effectively framing environmental protection and nature conservation policies and their prospects. Future research can extend this evidence by incorporating other chemical-based environmental variables and conducting in-depth analysis on the nationally representative datasets of behavioral factors.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethical Review Board of Nepal Health Research Council (protocol code: 38/2018 and date of approval: 24 January 2018).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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Abbreviations

CBS	Central Bureau of Statistics
CDC	Center for Disease Control and Preventions
CI	Confidence Interval
CS	Compensation Surplus
CV	Contingent Valuation
DBDC	Double Bounded Dichotomous Choice
ES	Equivalent Surplus
FGD	Focus Group Discussion
INR	Indian Rupee(s)
KII	Key Informant Interview
NPR	Nepalese Rupee(s)
USD	US Dollar
WHO	World Health Organization
WTA	Willingness to Accept
WTP	Willingness to Pay
WVS	World Value Survey

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