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Nonmarket valuation in developing countries: incorporating labour contributions in environmental benefits estimates*

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There are limitations associated with the application of nonmarket valuation techniques, including choice experiments, in subsistence economies. In part, this is due to the concern that using money as a mode of contribution may not capture the potential contribution of low-income households. To address this limitation, respondents in this study were provided with the option of contributing towards the management of invasive plants in labour terms if they were unwilling to contribute in monetary terms. The results show that the existing practice of using dollar values to estimate willingness to contribute may disproportionately exclude the concerns of some groups within the community. The analysis also indicates that allowing respondents to express their willingness to contribute in labour increases their participation in environmental decision-making processes and hence increases the estimated value of forest ecosystem services. This study contributes to the limited empirical literature on the development of nonmarket valuation surveys, particularly choice experiments, in low-income countries in general and rural areas in particular.

Key words: choice experiment, low-income communities, mode of contribution, willingness to contribute.

1. Introduction

With a strong theoretical background, choice experiments (CEs) are increasingly being used for the purpose of nonmarket valuation of ecosystem goods and services (Ben-Akiva and Lerman 1985; Alpizar *et al.* 2001; Lehtonen *et al.* 2003; Wang *et al.* 2007; Birol and Das 2010). A *monetary* attribute is usually included in a choice set as a cost of a hypothetical policy alternative and is the basis of willingness-to-pay (WTP) estimates. Despite the possible task complexity due to socio-economic conditions, including low income and low education, the use of CEs in developing countries has received considerable attention from applied environmental economists (Wang *et al.* 2007; Do and Bennett 2009; Birol and Das 2010; Rai and

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Scarborough 2013). These studies have suggested several strategies to address the cognitive and communication challenges inherent in eliciting stated preferences in developing countries. The strategies for framing questionnaires and designing and implementing surveys are discussed in Bennett and Birol (2010).

This study adds to the limited literature on nonmarket valuation in developing countries by addressing the limitation of using money as the payment vehicle in cash-constrained communities. The research question addresses the estimation of the environmental benefits of mitigation of the invasive vine, *Mikania micrantha* (hereafter *Mikania*), in Chitwan National Park, in Nepal.

A positive relationship between WTP for nonmarket forest benefits and income of respondents (Lehtonen *et al*. 2003; Wang *et al*. 2007), indicates income-poor households have a relatively lower WTP or prefer to free ride in their use of forest services. However, the success stories of community-based natural resource management programs signify their contribution to and benefits received from forest management (Ostrom 1990). In addition, it is widely observed that respondents, particularly forest users and rural inhabitants, have higher WTP for forest ecosystem services compared with nonusers and urban residents (Hanley *et al*. 1998; Brey *et al*. 2007; Christie *et al*. 2007). The challenge is determining how to incorporate the potential contribution and concerns of members of subsistence communities into a nonmarket valuation framework.

Valuation studies using the contingent valuation method have occasionally used nonmonetary numéraire, including time and in-kind goods such as rice and beehives, to address the cash constraint problem in developing countries (Shyamsundar and Kramer 1996; Mekonnen 2000; Alam 2006; Asquith *et al*. 2008; Saxena *et al*. 2008; Shiappacasse *et al*. 2010; Tilahun *et al*. 2011). Previous CEs have also indicated that communities in developing countries are willing to work towards environmental outcomes (Abramson *et al*. 2011; Casiwan-Launio *et al*. 2011).

This study adds to this previous literature by focussing on the management of invasive plants in a forest-dependent community. Usually, in an agrarian community, labour contributions have a social acceptance and farm-households allocate labour for different purposes such as forestry, farming, work for wages and self-employment to optimise their benefits (Jacoby 1993; Abdulai and Delgado 1999; Alam 2006). The elicited willingness to contribute (WTC) in labour terms can be monetised to estimate the dollar value of nonmarket services (Hung *et al*. 2007; O'Garra 2009).

Using labour as a cost attribute in a CE survey faces a theoretical challenge as aggregation of the monetary value of the number of labour days declared by respondents is sensitive to the value of labour, which is situation dependent (Ahlheim *et al*. 2010). There are several strategies in practice to estimate the money value of labour. For instance, O'Garra (2009) proposed

the rate of conversion by assessing the nature of the trade-off, whether the individual makes a trade-off of labour spent contributing towards the environmental program with work time or leisure time, while eliciting WTP. The shadow value of labour has also been estimated by Eom and Larson (2006), using the contingent valuation method, and by Rai and Scarborough (2013) using a CE.

In addition, using nonmonetary numéraire, including labour, adds to the complexity of incentive compatibility associated with CEs (Carson and Groves 2007). In this case, forest resources are managed by local communities and members voluntarily participate in forest management activities according to their annual community forest management plan. Hence, it is possible that the survey's results may be seen by respondents as potentially influencing forest management decisions (Carson and Groves 2007).

Theoretically, when choices are constrained by both time and money, WTP can be elicited using either numéraire (Eom and Larson 2006). The main aim of stated preference surveys is to contribute to social cost-benefit analysis of environmental projects, and in some situations, using labour as a numéraire may contribute to making CEs accessible to income-poor populations and allow them to participate in environmental decision-making (Farley and Brown 2007).

In the process of determining WTP using CEs in a subsistence community, in previous research, we used dual cost attributes, monetary and labour, together as attributes in the CE (Rai and Scarborough 2013). That study was novel as it included two cost attributes in the choice set. The results provided an estimation of the shadow value of labour spent in forest-related activities by the communities. We realised that the dual cost attributes also increased the complexity of the results analysis. Respondents considered two modes of contribution for interventions (money and labour), and we estimated the implicit prices for each mode of contribution by controlling one payment vehicle. The resulting estimates of the value of labour contributions are included in the sensitivity analysis for this study in section four.

In this study, a CE with a two-stage offering and two distinct questionnaires, each with only one mode of contribution, either monetary or labour, was conducted. The results provide valuable insights into the estimation of environmental benefits in subsistence economies and the sensitivity of the WTP to the mode of contribution. The study identifies the socio-economic determinants influencing the selection of mode of contribution and finds that the use of labour as a mode of contribution influences the estimated social benefits in subsistence economies. This study contributes to the limited empirical literature on the application of nonmarket valuation surveys, including CE, in developing countries in general and rural areas in particular.

2. Methodology

2.1. Study area

The buffer zone of Chitwan National Park covers 750 km^2 of Chitwan and Nawalparasi districts (Figure 1). It was established in 1996 to facilitate more harmonious relations between local people and Chitwan National Park. A total of 21 user committees and one subcommittee, with 44,918 households manage the buffer zone (Department of National Parks and Wildlife Conservation 2011). State-owned forest patches in the buffer zone are being managed as buffer zone community forest. These buffer zone community forests are handed over to local communities and managed by buffer zone community forest user groups (BZCFUGs).

Mikania is carpeting forest patches and grasslands in both the buffer zone and the core area of Chitwan National Park (Poudel *et al*. 2005; Sapkota 2007). *Mikania*, is listed as one of the world's worst weeds (Lowe *et al*. 2000) and is colonising in Nepalese tropical and subtropical forests (Tiwari *et al*. 2005). Two main characteristics make this vine notorious; it exhibits vigorous and rampant growth and it not only displaces native vegetation but also kills it. Currently, it has been observed in twenty districts of Nepal which have forests with high-economic value.

Buffer zone communities have indicated that the colonisation of *Mikania* has had serious effects on their livelihoods and have shown their willingness to invest in the control and management of the invasive vines (Rai *et al*. 2012). However, mitigation strategies to constrain the growth of invasive plants, including *Mikania*, have not yet been developed in Nepal. This study

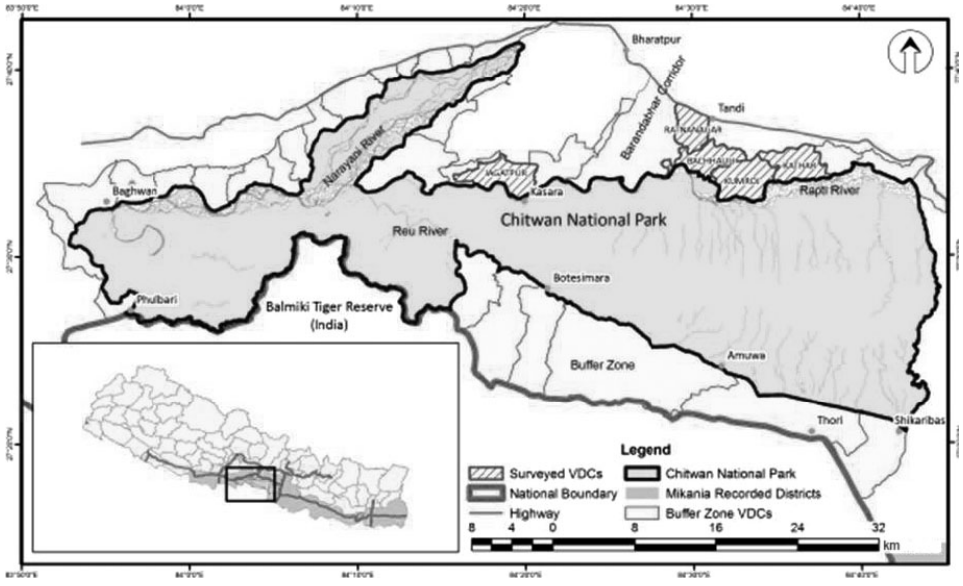

Figure 1 Study area: Chitwan National Park, Nepal.

was carried out in four village development committees (Bachhauli, Jagatpur, Kathar and Kumroj) and one municipality (Ratnanagar). Specifically, the CE method was used to estimate the WTP and WTC of forest-dependent communities towards the mitigation of this invasive plant, which is influencing the values of the forest associated with the quantity and variety of forest products.

2.2. Questionnaire development

The CE questionnaire was developed based on five focus group discussions with local communities. A total of 74 local forest users, including general users and members of the BZCGUG executive committee of both genders, participated in the focus groups. The focus groups were aimed at determining attributes related to *Mikania* colonisation, defining the payment vehicle and mode of contribution, delineating appropriate levels for each of the attributes and piloting the draft questionnaire. Following the focus groups, four attributes and their levels were selected in consultation with local experts, a review of the literature and discussions with BZCFUGs (Table 1). The attributes were treated as continuous variables in the model estimation.

D-efficient designs have increasingly been used for environmental problems as the ability to 'inform' the design with the anticipated outcome makes them preferable to an orthogonal design due to the efficiency gains (Scarpa and Rose 2008; Bliemer *et al*. 2009). Cost-effectiveness can be achieved by reducing the sample size required by the use of a D-efficient design. Hence, an efficient design was constructed using Ngene 1.02 software (Rose *et al*. 2008).

D-efficient designs require assumptions of parameter values. The assumptions are generally based on prior information from different sources, such as previous studies, piloting and 'best guess'. Some researchers apply zero priors while others assume priors based on knowledge of the parameters (Bliemer and Rose 2010). In this study, it was assumed that '*forest products collection*

Table 1 Attributes and their levels

Attributes	Description
Forest products (FP) collection time	Time required for each trip in hours for a day requirement excluding travel time between house and community forest. There are three levels: 4†, 2 and 1 hour(s)
Plant species present	Number of plant species in the community forests. There are three levels: 102†, 115 and 126
Visitors to forest	The number of tourists visiting community forests annually. There are three levels : 20,000†, 27,000 and 35,000
Contribution	Annual contribution for five years. There are four levels: In cash: An annual membership fee. NRs‡ 0†, 1,050, 1,750 and 2,450 or In labour: 0†, 3, 5 and 7 labour day(s)

Notes †Denotes levels used in status quo.
‡Nepalese currency (NRs). 1 US$~NRs 71 (2010 US$ exchange rate).

time' is a favourable attribute compared with the other attributes, followed by '*visitors to forest*' and '*plant species present*'. Twenty-four choice sets were grouped into six blocks each containing four choice sets. Each choice set presented to respondents included three hypothetical policy alternatives including a status quo option.

Two versions of the questionnaire were developed which were the same apart from the one change of the cost attribute being in terms of money or labour. The cost attribute in the choice cards was given as the monetary amount and the labour equivalent based on the market wage rate. The questionnaire included three sections. Firstly, the introductory information stated background information about the spread of *Mikania* in Chitwan National Park. Respondents were told that the alternatives contained hypothetical outcomes which could be accomplished with management intervention in community forests. The payment vehicle, either an annual membership fee or labour contribution, was to be collected for 5 years because this is the time frame of the operational plan of the BZCFUG.

In the choice sets, attributes were visualised using drawings and levels were presented using vertical bars and numbers (Adhikari *et al*. 2005; Brouwer *et al*. 2010; Figure 2). In order to minimise the risk of random responses, respondents were asked follow-up questions (Bennett and Birol 2010).

The second section of the questionnaire asked respondents about changes in household activities after the infestation of *Mikania*. The respondents were asked about the situation 5 years ago as well as the current situation as the invasion of *Mikania* came to public notice in 2005 (Poudel *et al*. 2005). The third section of the questionnaire collected information about the socio-demographic characteristics of respondents.

2.3. Survey implementation

The study focused on residents of the buffer zone as the selected payment vehicle (annual membership fee or labour contribution) was not relevant for the population beyond the buffer zone. A total of 500 households were interviewed by local enumerators, who were trained and supervised by the research team. All approached households participated in the interview. In household surveys in developing countries, a 100 per cent response rate is not unusual when local enumerators are employed to conduct interviews (Hung *et al*. 2007; O'Garra 2009). In rural areas, farmers are not fully employed and most of them, particularly women, stay at home. This makes household surveys an efficient method of data collection in agrarian communities. In addition, as the problem under investigation is relevant to respondents' daily life, this also motivates them to participate in the research. A team of local enumerators was formed considering cultural diversity and gender issues. The interviews were conducted in different languages including Nepali (official language) and *Tharu* (a local dialect) to accommodate the language preferences of respondents.

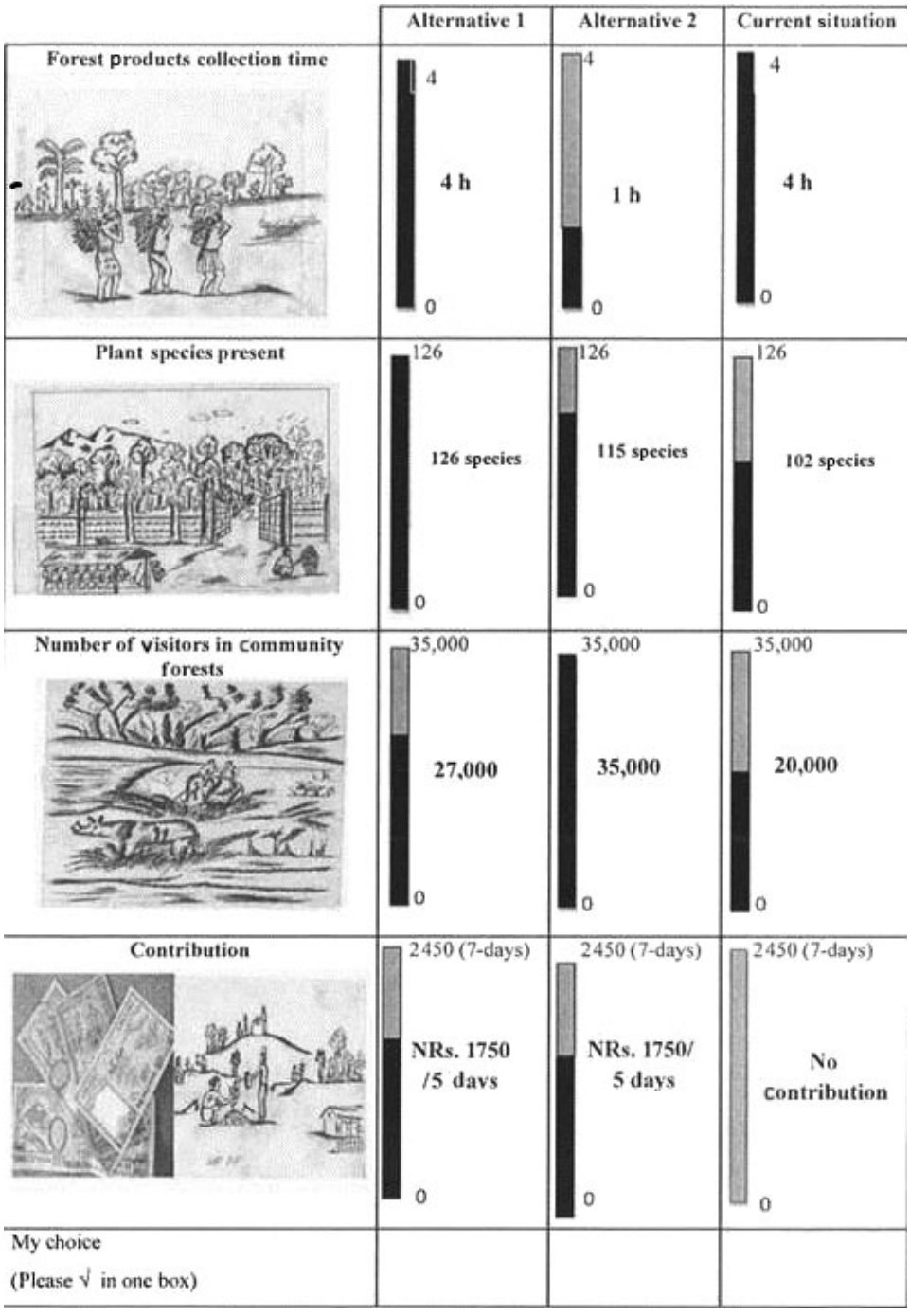

Figure 2 An example of a choice set.

Before presenting the choice scenarios, respondents were asked whether they were willing to contribute towards the mitigation of invasive plants in the forest in monetary terms. If their response was negative, they were provided with the

option of contributing in labour. It is likely that the findings of the study have been influenced by this design, and further research with variations in the design is required. The approach, of offering the WTP initially and then the labour options to those unwilling to contribute in money, was chosen as the aim of this study was to assess the potential exclusion of preferences with the conventional monetary estimation of WTP for ecosystem services. Based on their responses, the version of the questionnaire with the most appropriate mode of contribution was presented to respondents.

2.4. Econometric framework

Choices made in CEs are analysed by using random utility theory considering that the utility of a choice comprises an observed component and an error (unobservable) component (Manski 1977; Hensher *et al*. 2005). The utility level (U) of individual (i), associated with alternative (j), can be described by an indirect utility function, which can be expressed as;

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{1}$$

where V_{ij} is the deterministic component, and ε is the random or unobservable portion.

The probability that individual i will select alternative j over other alternative n is given by:

$$\text{Prob}(j/C) = \text{Prob}\{(V_j + \varepsilon_j) > (V_n + \varepsilon_n),\ \text{all } n \in C\} \tag{2}$$

where C is the complete choice set. To estimate equation (2), the latter component (ε) is assumed to be independently and identically distributed (IID), with a Gumbel's distribution and scale parameter μ having a value equal to 1 implying constant error variance.

The individuals' indirect utility function (V_j) can be estimated using a random parameters logit (RPL) model. The utility function is:

$$V_{ij} = \text{ASC} + \beta'_{ij}\mathbf{x}_{ijk} + \acute{\eta}_i\mathbf{x}_{ijk} + \gamma s_i * (\text{ASC or } \mathbf{x}) \tag{3}$$

where ASC is the alternative specific constant, which captures the unobservable influences beyond attributes present in the choice sets, $\mathbf{x}$ is a vector of k attributes, β' is the sum of the population mean, and $\acute{\eta}$ is the individual deviation (Hensher *et al*. 2005). A panel specification was used to incorporate the possibility of correlations over the multiple choice observations by an individual respondent (Bliemer and Rose 2008). The socio-economic characteristics (s) with coefficient vectors (γ) are interacted with attributes and/or the ASC. In this study, ASC is 1 for alternatives and 0 for status quo or current situation. The description of the socio-economic variables is presented in Table 2.

Table 2 Household socio-economic characteristics and description

Variables	Male	Female	Description and coding in analysis
Gender	199	301	Gender of respondents: female (0) and male (1)
Livestock	2.17 (1.71)	2.20 (1.79)	Average livestock unit per household
Age	44.96 (12.62)	42.30 (12.30)	Age of the respondent (years)
Education	4.86 (5.32)	2.20 (3.55)	Number of years attended school.
Landholding	12.77 (12.73)	11.40 (12.83)	Area of arable land as property of the household members (in Katha†)
Family size	6.33 (2.81)	6.20 (2.56)	Number of members living in the same house
Native	115	104	Respondents native to the area (0), and migrant (1)
Agriculture only	58	89	Households' income source: agriculture only (1), otherwise (0)
Both agriculture and off-farm	138	198	—
Off-farm only	3	14	—

Notes: Standard deviation in parentheses. †Katha is unit of area approximately equal to 67 m^2.

3. Results

3.1. Sample description

Table 2 presents summary socio-economic characteristic data for the interviewed households. The sample was 60 per cent female with an average age of 42.3 years. As expected, the average education level was primary school. A very small per cent of the sample population (4 per cent) had attended and/or completed university level education. Of the total, 40 per cent of respondents were illiterate and three-quarters of this group were female.

3.2. Effects of *Mikania* on household activities

All respondents indicated that the colonisation of *Mikania* has had negative impacts on their livelihoods and expressed a desire to control the spread of the vines (Rai *et al*. 2012). The effects of *Mikania* on household activities are expected to influence respondents' WTP and WTC to manage the invaded area. The results in Table 3 depict that the number of households visiting community forests to collect forest products has decreased since the invasion of *Mikania*, with a decrease in both frequency of visits and quantity of forest products collected per visit. Additionally, the time taken to collect forest products has increased and the number of livestock owned by households has substantially decreased.

Households were practicing different strategies to compensate for the reduction of forest products, such as exploring more areas (particularly collecting from the national park), planting trees in farmlands, buying

Table 3 Effects of *Mikania* infestation on household activities

Variables	5 years ago	Current situation	Description
Households Enter the forest	491	231	Number of households that rely on community forests for forest products
FP collection time (Hours/trip)	1.49 (0.66)	3.64 (1.04)	Forest products collection time for a day requirement in hours per trip
Enter the forest to collect forest products (day/week)	6.0 (1.94)	1.6 (2.12)	Average number of days in a week that household enter forest to collect forest products
Fodder (Bhari/trip)	1.13 (0.56)	0.55 (0.52)	Average amount of fodder collected from community forest per trip
Fuelwood (Bhari/trip)	1.29 (1.02)	0.40 (0.54)	Average amount of fuelwood collected from community forest per trip
Livestock unit per household	4.75 (.21)	2.18 (.07)	Average livestock unit per household

Note: Standard deviation in parentheses.

fuelwood and fodder from local markets, and using alternative energy sources such as biogas, sawdust stoves and liquefied petroleum gas.

3.3. Selecting the mode of contribution

Approximately 35 per cent (176) of respondents elected to complete the choice task in monetary terms, and the remaining 65 per cent (324) indicated their inability to participate in monetary terms but elected to complete the choice task in labour contribution. To understand the factors influencing the selection of the mode of contribution, a binary logistic model was used and the data were analysed using STATA/SE-12. The dependent variable was 'mode of contribution' with a value of 1 if a household selected a monetary value as a mode of contribution and 0 if labour contribution. The results of the binary logistic model are reported in Table 4 with *pseudo* R^2 value 0.209.

These results show that *male migrants* with higher *education* were more likely to elect to complete the choice exercise in monetary terms. Likewise, the likelihood of electing a monetary contribution increased with the size of *landholdings*. On the contrary, *distant* households or those with larger *family size*, or who *visited the community forest* to collect forest products were more likely to elect labour as a means of contribution. In addition, households with higher off-farm income were more likely to elect the monetary form of contribution than those who rely on income from agriculture. The differential in the selection of mode of contribution could reflect differences in the opportunity cost of time between responses with male migrants with higher education placing a higher value on time. As will be discussed further in

Table 4 Variables that influence the selection of mode of contribution

Variables	Coefficient
Constant	−1.039 (0.666)
Male	0.680 (0.247)**
Education	0.082 (0.031)***
Landholding size	0.091 (0.012)***
Family size	−0.120 (0.048)**
Distance	−0.012 (0.005)**
Forest entry	−0.448 (0.230)**
Native	0.463 (0.245)*
Agriculture only	−0.914 (0.262)
Age	0.001 (0.011)

Notes: Standard error (SE) in parentheses. *, **, and *** indicate significant at 10%, 5% and 1%, respectively.

Section 4.2, gender is particularly important in the estimation of WTC, with 46 per cent of males electing to contribute in terms of money compared with 28 per cent of females.

3.4. Choice experiment results

All respondents showed their WTC to a *Mikania* management program, when they were provided with the choice of mode of contribution. The responses were grouped according to the elected mode of contribution in the choice task. Hence, two data sets emerge: *Monetary group* (176 respondents) and *Labour group* (324 respondents). The choice data sets were analysed using NLOGIT 4.0 (with Limdep 9).

For each group of data, RPL models were estimated. Following Hensher *et al*. (2005), all attributes, except the cost attribute, were estimated as random parameters. Then parameters having insignificant standard deviations were considered as nonrandom parameters. In addition, different distributions and combination of distributions were used to estimate the model. The selection of the models and distributions of the parameters was based on the fit of the model. The presented models (Table 5) are the outcomes after testing several estimations with 1,000 random draws. The RPL models are statistically significant overall with chi-square statistics of 1465.71 and 813.99 for the labour and monetary groups, respectively.

Selected socio-economic variables were interacted with the ASC and attributes. Gender of respondents was interacted with attributes, as prevention and management of invasive species have gender dimensions, which modifies the impacts of invasive species (Fish *et al*. 2010). As expected *a priori*, respondents in both groups prefer lower payment and decreased forest products collection time, while they would like to have forest patches with higher numbers of plant species and visitors.

Table 5 Random parameters logit model results

Variables	Coefficient (Monetary)	Coefficient (Labour)
ASC	−8.28E-3 (0.116)	5.71E-2 (7.61E-2)
Visitors	2.32E-4 (4.04E-5)***	1.71E-4 (1.86E-5)***
FP collection time	−0.688 (0.142)***	−0.382 (6.63E-2)***
Plant species	6.38E-2 (1.35E-2)***	4.34E-2 (7.55E-3)***
Contribution	−9.89E-4 (1.41E-4)***	−0.269 (2.68E-2)***
Age × ASC	9.25E-2 (2.55E-2)***	6.28E-2 (7.37E-2)
Education × ASC	0.4238 (0.225)*	−0.277 (0.235)
Family size × ASC	−0.229 (0.123)*	1.00 (0.798)
Male × FP collection time	0.327 (0.175)*	3.30E-2 (0.111)
Male × Plant species	−3.38E-2 (1.74E-2)*	−2.86E-2 (1.23)**
Male × Contribution	6.12E-5 (4.93E-5)	3.83E-3 (4.11E-2)
Male × Visitors	−3.67E-5 (4.93E-5)	−3.25E-5 (2.86E-5)
Standard deviations of parameter distributions		
Visitors	2.04E-4 (2.82E-5)***	1.20E-4 (1.45E-5)***
Model statistics		
Log likelihood	−364.22	−680.53
Pseudo R^2	0.276	0.238

Notes: Standard error (SE) in parentheses.
*, **, and *** indicate significant at 10%, 5% and 1%, respectively.

Other than the attribute variables, only the interaction term between gender and plant species richness was significant in the *labour* group, indicating that women were more likely to select the alternative with more plant species. In the *monetary* group, all variables interacted with the ASC such as *age*, *education* and *family size* were significant. Among the interacted variables between gender and attributes, female respondents were more likely to select the attributes with *less forest production collection time* and more *plant species*.

4. Discussion

4.1. Estimation of willingness to pay/contribute

The key outcome of CEs is the *part-worth* of each attribute included in the choice set, which is the marginal utility (also known as implicit price) of forest service attributes resulting from a *Mikania* mitigation program for the average household (Table 6). The implicit price (IP) for random parameters was estimated by the following relationship;

$$\mathrm{IP}_k = -\frac{\beta_k + \sigma_k * \varphi_k}{\beta_c} \tag{4}$$

where β_k is the attribute coefficient, β_c is the coefficient of cost attribute, σ_k is an estimated standard error of the random parameter, and Φ_k is a draw from the standard normal distribution assumed for each β_k. Implicit price for nonrandom parameters are estimated by

Table 6 Mean annual implicit prices, willingness to contribute (WTC) and confidence intervals (95% level)

Attributes	WTC (labour day)	WTC Money (NRs)
Per one hour decrease in forest products collection time	1.41 (1.17 to 1.65)	695.61 (570.77 to 820.45)
Per visitor to the community forest per year	6.36E-4 (5.64E-4 to 7.08E-4)	0.23 (0.19 to 0.26)
Per one unit increase in plant species richness	0.16 (0.13 to 0.19)	64.5 (51.39 to 77.61)
Household WTC for the operational plan scenario	9.38 (8.18 to 10.58)	3,871 (3,279 to 4,463)

$$\mathrm{IP}_k = -\frac{\beta_k}{\beta_c}. \tag{5}$$

The implicit prices and their confidence intervals for per hour decrease in collection time, increase in one plant species and one visitor per year are reported in Table 6. The implicit price is highest for the '*forest product collection time*' attribute with a mean annual contribution of 1.4 labour days for the labour group, or 696 NR for the monetary group. The local labour wage rate at the time of data collection was NRs, 350 per day. If the labour days are valued at the local labour wage rate, the estimated implicit prices suggest that the respondents electing to contribute in monetary terms consistently have a higher WTP than their neighbours who prefer to contribute in labour terms. This supports the findings of Casiwan-Launio *et al*. (2011). As indicated in Section 3.3, the socio-economic determinants of selecting the mode of contribution suggest that respondents with higher levels of education and larger landholdings have WTP in monetary terms. Hence, this finding is probably in line with previous CE surveys, suggesting that WTP for nonmarket services has a positive association with respondents' income (Lehtonen *et al*. 2003; Wang *et al*. 2007).

Based on the estimates derived from the RPL models, different combinations of the attributes (as outcomes of the management program) can be evaluated as a change in utility of individual households. The compensating surplus (CS) for each household as a household WTP and WTC for a change from the current situation has been calculated (Table 6). The current situation for this study is indicated in Table 1, and the change to the operational plan scenario for this estimation was considered as the *average time to collect forest products* for a day requirement will be reduced to two hours, the *number of plant species* increased to 115 and *annual visitors* increased by 7,000. The operational plan scenario was based on the BZCFUG operational plan, the BZCFUG records and focus group discussions.

Households' WTP and WTC for the operational plan scenario was calculated using the following equation:

$$\mathrm{CS} = \frac{V_1 - V_0}{\beta c} \tag{6}$$

where V_1 is the utility of the operational plan scenario, V_0 is the utility from the status quo, and β_c is the coefficient of the cost.

The estimated CS for households intending to contribute in monetary terms for the given scenario has an average WTP of 3,871 NR (US$ 53.51) as an annual BZCFUG membership fee for 5 years. For those electing to contribute in labour, the estimated labour contribution is 9.38 days annually for 5 years.

4.2. Estimations of the social benefits

Aggregation of the household WTC to the mitigation of *Mikania* is particularly sensitive to assumptions regarding the per cent of female respondents and the shadow value of labour time. Table 7 presents estimated total annual WTC and WTP, with sensitivity analysis for these two variables. The household WTP/WTC was aggregated to estimate the social benefits of managing *Mikania*. The total WTC and WTP for all buffer zone households for the predicted operational plan scenario was expressed as;

$$\begin{aligned}\text{Total WTC and WTP} = {} & \text{Household WTC (labour)} \times (1 - P) \\ & \times \text{Total buffer zone households} \\ & + \text{Household WTP (money)} \times (P) \\ & \times \text{Total buffer zone households}\end{aligned} \tag{7}$$

where P is the per cent of respondents choosing the monetary mode of contribution.

Generally, all members of the BZCFUGs tend to participate in forestry activities planned by their forest user group and absentees have to pay fines according to the BZCFUG's constitution. The fines are usually equal to the market wage rate. Hence, it can reasonably be expected that all households would participate in a *Mikania* management program.

Gender differences influence forest management in different ways (Fish *et al.* 2010). Total annual WTC and WTP for buffer zone households was estimated assuming different proportions of female respondents (Table 7). The Master Plan for Forestry Sector, Nepal (MPFS 1988), has acknowledged women as primary users of the forest and made a recommendation that at least one-third of executive committee members of forest user groups should be women (MPFS 1988). Hence, the aggregate WTP has been estimated with sensitivity analysis assuming 33 per cent of respondents are female as a minimum, and 50 per cent as an alternate assumption. In the second column of Table 7, if 50 per cent of the population is female and it is assumed that

Table 7 Estimated total annual willingness to contribute (WTC) of buffer zone community for the operational plan scenario in NRs and US$ (in '000)

Gender composition	Respondents WTC in monetary terms (%)	Shadow value of time (% of market wage rate)				WTC in monetary terms†
		100	33	50	70	
Current sample	35	95,557 (1,345)	31,534 (444)	47,778 (678)	66,890 (942)	61,204 (862)
If (Female = 50%)	37	92,903 (1,308)	30,658 (431)	46,451 (654)	65,032 (915)	64,334 (906)
If (Female = 33%)	40	88,479 (1,246)	29,198 (411)	44,239 (623)	61,935 (872)	69,551 (979)

Notes: Figures in brackets in US$. †Willingness-to-pay purely in monetary terms with labour contribution not included.

28 per cent of these choose to contribute in monetary terms (based on findings in Section 3.3), then 14 per cent of those willing to contribute in terms of money will be female. Conversely, of the remaining 50 per cent of the population that is male, 46 per cent are likely to choose to contribute in terms of money. This means that of the total 37 per cent contributing in terms of money, 23 per cent would be male and 14 per cent female. Hence, the proportion of the population likely to contribute in terms of labour or money is sensitive to assumptions regarding the per cent of females in the population.

With respect to the second issue, the shadow value of time spent on forest activities in this community, previous research by Rai and Scarborough (2013) has estimated this to be 47 per cent of the local wage rate. Sensitivity estimates of the estimated total annual WTC and WTP in Table 7 have been calculated with the shadow value of time being 33 per cent of the local wage rate (Cesario 1976), 70 per cent (Eom and Larson 2006) and 100 per cent. The estimated value of the annual labour contribution to the estimated social benefits is between NRs 29 million (US$ 411,000) and NRs 96 million (US$ 1.3 million). In the context of an estimated WTP in monetary terms, (when the value of labour contribution is excluded) of between NR 61 million (US$ 0.9 million) and NR 70 million (US$ 1 million), the WTC in terms of labour is significant.

4.3. Mode of contribution

The results of this survey show that the existing practice of determining WTP—using money as the only numéraire—is not suitable to estimate social benefits in subsistence communities as two-thirds of respondents prefer to participate in nonmonetary terms. As a result, subsistence households can be portrayed as forest free-riders. This finding is similar to existing contingent valuation studies such as Alam (2006) and Hung *et al*. (2007), who conclude that a substantial portion of respondents were found to be unwilling to commit a monetary contribution.

Our results suggest that the socio-economic attributes related to rural households are major determinants in the selection of the mode of contribution—whether monetary or labour. Primary forest users including females, farmers, indigenous community members and forest-dependent households can be excluded from decision-making processes, if they are asked to participate in monetary terms.

Typically, the sign of the landholding size variable indicates that households with a higher level of income have a positive association with monetary contributions. In rural areas, the size of land holdings is often used as a proxy for family income. Theories of human capital and endogenous growth suggest that education has substantial economic effects at both the micro and macro levels. This indicates that the more education people have the higher their income, which makes it likely that an educated person will express their preference in monetary terms. In addition, educated people are aware of the potential benefits to be derived from the forest and are more

willing to participate in economic participation than illiterate farmers (Dolisca *et al*. 2006).

Gender is signed as expected, suggesting that male respondents are more likely to choose to contribute in monetary terms. Usually, women in rural areas have less decision-making power for household expenditure (Angel-Urdinola and Wodon 2010). In general, large family size means more labour available for farming in an agrarian community. Therefore, it has been positively correlated with labour contribution in forest management (Dolisca *et al*. 2006; Tilahun *et al*. 2011).

Respondents native to the buffer zone were less likely to choose monetary contributions. This is consistent with Tilahun *et al*. (2011) who found that in forest conservation programs, respondents living in the area before resettlement programs have a positive association with a labour contribution. This highlights the role that migration can play in improving livelihoods by diversifying livelihood options (De Haan *et al*. 2002).

5. Conclusions

This study suggests that determining WTP in dollar values is a contributing factor for the relatively low use of stated preference studies in subsistence economies as a majority of respondents have shown their unwillingness to contribute in monetary terms. In support of previous studies (Shyamsundar and Kramer 1996; Mekonnen 2000; Alam 2006; Asquith *et al*. 2008; Saxena *et al*. 2008; Shiappacasse *et al*. 2010; Tilahun *et al*. 2011), the determination of WTP in dollar values substantially excludes the concerns and contribution of primary forest users. Decisions based on this information may lead to flawed policy. This is because good ecosystem governance is dependent on pragmatic information on values, incentives and options of environmental programs (King 2007).

The estimated total WTP and WTC indicates a need to extend stated preference surveys, including CE, through the appropriate design of survey tools to capture the concerns and contributions of income-poor groups. The determination of WTC in labour can improve our understanding and estimation of social benefits by including the concerns of a majority of households, and providing an option of a self-selection mode of contribution can increase the likelihood of prioritising environmental programs in subsistence communities. In developing countries like Nepal, where participatory resource management is a key strategy, providing a choice of mode of contribution in eliciting community values is appropriate. However, the expression of WTC in labour may not be suitable for all programs.

The estimation also indicates that in the long run, the determination of WTP in monetary terms would be appropriate as development occurs. This is because the average household's WTP of the monetary group is consistently higher than their neighbours who prefer to contribute labour and the number of households electing to contribute in monetary terms is also likely to

increase with education and the empowerment of women as development progresses. However, for the time being the determination of WTC in labour reflects the pragmatic value of environmental policies and programs of low-income respondents. This is likely to increase the acceptance of nonmarket valuation studies as tools for informing policy in developing economies.

In this study, we assess the effects of mode of payment on determining WTP of rural households by allowing respondents to express their WTC in labour if they choose not to pay in money terms. This may raise a question of whether the estimated social benefits between the two groups can be compared as they are two different samples. However, this study highlights the limitations of using only a monetary payment vehicle to estimate social benefits, particularly in developing countries. In order to compare the estimated benefits with different modes of payment, further research is required, which varies the experimental design and the ordering of payment options. This further research could also incorporate econometric linking of the logit model of choice of mode of contribution and the subsequent choice model.

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