Paper presented at the 2012 AARES conference.

Estimating the public benefits of mitigating damages caused by invasive plant species in a subsistence economy

Rajesh Kumar Rai*, Helen Scarborough
School of Accounting, Economics and Finance
Deakin University, Australia.

This paper presents analysis of a choice experiment (CE) designed to estimate willingness-to-pay (WTP) to mitigate damages caused by invasive plant species (IPS) in a rural community of Nepal. In order to address the cash constraints problem in a subsistence economy, two payment attributes, *labor contribution* and *membership fee*, were included in the choice sets. The results reveal that rural farmers have significant WTP for forest management activities, in terms of both cash and labor contributions. The results also suggest that rural farmers value their time in this context at a different rate to the current wage rate.

*Corresponding author: rkrai@deakin.edu.au

Key words: Choice experiments, Invasive plant species, Rural communities, Developing countries.

† This research was supported by the South Asian Network for Development and Environmental Economics (SANDEE), Research Grant no. SANDEE/Dec 2010/001, as a part of the PhD study of the corresponding author entitled "Valuing damages caused by invasive plant species in a low-income economy" at School of Accounting, Economics and Finance, Deakin University, Melbourne. Any opinions, findings and conclusions expressed in this article are those of the authors and do not necessarily reflect the views of supporting agencies.

1. Introduction

The pace of the spread of invasive plant species (IPS) has increased with trade, travel, and technology (Meyerson and Mooney, 2007). As spillovers of economic globalization, invasive plants are widely heralded as one of the greatest threats to native forest ecosystems and species richness (Wilcove et al., 1998; D'Antonio and Kark 2002; Moore, 2005). Undoubtedly, their introduction brings a change in the supply of ecosystem services through the modification of structure and functions of native ecosystems (Wilcove et al.1998; MA 2005). An assessment of the economic impacts of IPS on ecosystem services is sought for the efficacy of the invaded area management programs, as ecosystem services approaches to conservation are central to environmental decision-making (Pejchar and Mooney 2009).

A review of the literature on the economic impacts of invasive species highlights the need of non-market valuation to capture a comprehensive account of the impacts of IPS (see e.g. Born et al., 2005; Holmes et al., 2009; Pejchar and Mooney, 2009). This is because most of the economic impact assessments are based on control costs, ex-post evaluation and lost market products such as timber. These methods are criticized as estimates of the impacts associated with invasive species as they overlook the costs and benefits beyond the market system (Hoagland and Jin, 2006). For instance, many control strategies tend to fail or are ineffective when more effective alternatives are available and the impacts may be overestimated (Curnutt, 2000). On the other hand, imperfect assessment of the external effects is likely to undervalue the impacts of invasive species on invaded habitat (Born et al., 2005).

Since, IPS have both positive and negative externalities, management of an invaded forest is considered a challenging task (e.g. Shackleton et al., 2007; Garcia-Llorente et al., 2011). In this context, public awareness regarding the cost of IPS management becomes an important tool in winning public support for the management process (e.g. Pimentel et al., 2005; Xu et al., 2006). There is also a risk of supporting flawed policies, if information regarding costs associated with IPS management is based on rough estimations. This is because the level of social awareness has a strong association with the management of invasive species (Nunez and Pauchard, 2009). In order to overcome such situations, empirical data is required to

capture the full impacts of IPS on human well-being including the magnitude of this impact on communities (Pejchar and Mooney, 2009).

Stated preference (SP) methods are considered viable tools for exploring social preferences and gauging public support related to IPS management (Garcia-Llorente et al., 2011). The contingent valuation method (CVM), one of the widely used SP methods, has been employed to estimate the value associated with invasive species (e.g. Jetter and Paine, 2004; Nunes and van Den Bergh, 2004; Nunes and Markandya, 2008; Gracia-Llorente et al. ,2011). In SP techniques, the choice experiment (CE) method poses several advantages relative to CVM including facilitation of benefits transfer, estimation of the marginal values of attributes, and avoidance of the "yes-saying" problem (Hanley et al., 1998; Rolfe and Bennett, 2006). In addition, the CE method has received considerable attention from applied economists in recent SP studies (e.g. Hanley et al. ,1998; Lehtonen et al. ,2003; Wang et al., 2007; Do and Bennett, 2008; Birol and Das, 2010).

The research reported in this paper estimates the non-market values associated with the mitigation of invasive plants, particularly mile-a-minute (*Mikania micrantha)* in the buffer zone of Chitwan National Park (CNP), Nepal. A choice experiment (CE) was employed with personal interviews being conducted in four village development committees and one municipality. In addition, this research contributes to the limited studies on the economic impacts of biological invasions in forest ecosystems (Holmes et al., 2009). To the authors' knowledge only one recently published study using CVM by Garcia-Llorente et al. (2011) has focused on different management strategies aimed at controlling the spread of invasive plants. In particular, no CE study has been performed to elicit public preferences for invasive plant species management in forest ecosystems.

2. Methodology

2.1 Study area

There are two reasons why this study was carried out in Nepal. Firstly, developing countries are in the frontline of the invasion of exotic plants. With economic globalization and governments' priority to promote tourism, Nepal is hosting an increasing number of tourists annually, and this is considered one of the major sources of the diffusion of exotic species. Lack of infrastructure to prevent the introduction of exotic species is resulting in developing

countries being the hosts of unwanted guests (Nunez and Pauchard, 2009). Once introduced, these plants are more likely to establish in disturbed and fragmented habitats (Moore, 2000). The phenomena of rapidly growing populations coupled with the increasing fragmentation of habitat resulting from land-use changes are pushing developing countries in general, and rural areas in particular, towards previously non-invaded habitats.

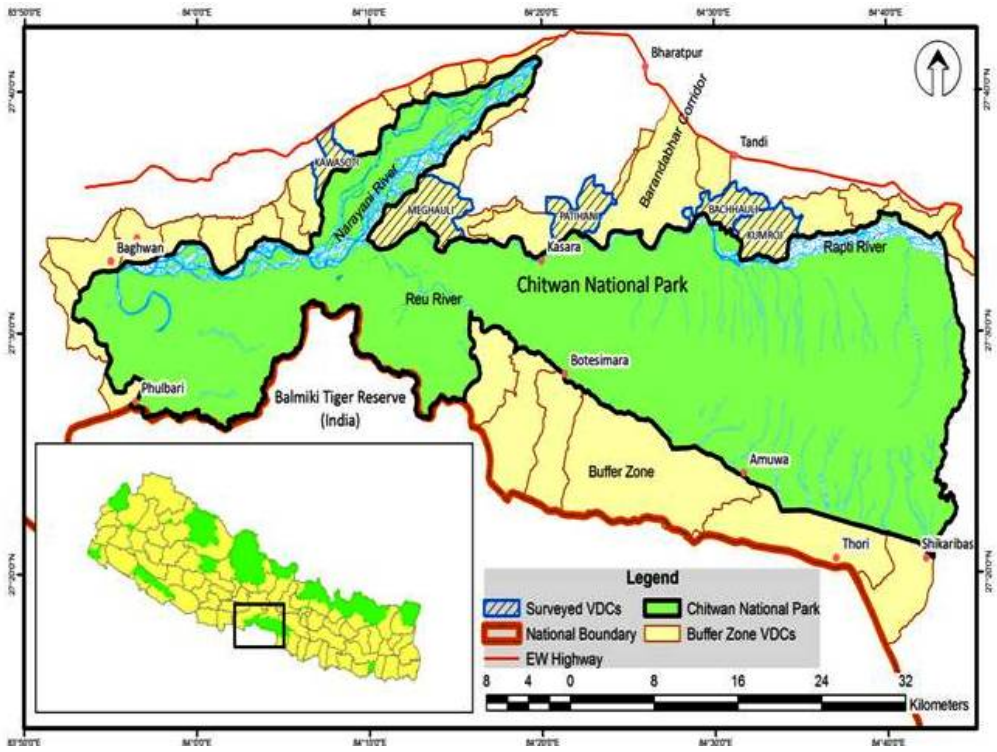
Despite the fact that developing countries are prone to the invasion of exotic species, research on bio-invasion is primarily focused on developed countries (Pysek et al., 2008). It is widely acknowledged that control of IPS could be more beneficial in developing countries because these countries tend to have highly diverse habitats and low-cost labour is available (Nunez and Pauchard, 2009). Usually, large non-market economic impacts of IPS can occur in forested landscapes close to population centres (Holmes et al., 2009). This indicates that rural populations in developing countries are the ultimate victims of IPS, as the rural landscape is attributed by scattered human settlements with forest patches and farmlands.

Second, non-market valuation has not received significant attention as a policy tool in developing countries. To the authors' knowledge a handful of CE studies in developing economies are limited to urban areas (e.g. Wang et al., 2007; Do and Bennett, 2008; Birol and Das, 2010). Rural communities, which constitute a large part of the population in developing countries, and have regular interaction with and contribution to the management of natural resources, are consistently being excluded from non-market valuation studies. In the absence of considered evaluation of the concerns and contributions of rural communities, the establishment of good environmental governance is unlikely (King, 2007). In such context, the environmental Kuznets curve can be interpreted as environmental protection is the outcome of economic development, and this may overshadow environmental conservation (see Bennett and Birol, 2010).

Our choice of the buffer zone (BZ) of Chitwan National Park (CNP) for this study was motivated by the intensity of the colonization of *Mikania* and the importance of CNP as a biodiversity hotspot and income source for the rural population. The BZ covers 750 sq km including 35 village development committees (VDCs) and two municipalities of Chitwan and Nawalparasi districts (Figure 1). A total of 21 user committees and one sub-committee with 36,193 households manage the BZ. Agriculture and tourism (off-farm) are the main sources

of income for the local inhabitants (Table 2). Forest patches in the BZ are being managed by the residents of the BZ as members of buffer zone community forest user groups (BZCFUGs).

Figure 1 Study Area



A program or policy to constrain the spread of invasive plants has not been formulated in Nepal. An *ex-ante* assessment of the possible measure for one target species can serve as an aid to decision-making for policy advice (Born et al., 2005). Since, the BZ aims to reduce the local pressure on the core area of the national park, controlling the spread of *Mikania* is essential to facilitate a conservation program inside the national park.

2.2 Choice experiment (CE)

In choice experiment (CE) surveys, respondents are asked to select an option among the available alternatives in a choice set assuming that they prefer the alternative with maximum utility subject to the resource constraint (Ben-Akiva and Lerman, 1985). The alternatives are hypothetical scenarios which constitute a set of attributes. These attributes are outcomes of the proposed policy or program in the choice set, and are distinguished by the levels of the attributes. The choice is known as a function of the attributes as CE is founded on Lancaster's

theory of characteristics stating that usefulness of goods for the consumer depends on their properties (Lancaster, 1966), and individuals implicitly make trade-offs between attributes (Alpizar et al., 2003).

The alternative *j* will be chosen over some option *g*, if expected utility for individual, *i* , (U_{ij}) exceeds the expected utility (U_{ig}) for all alternatives. This implies that the probability of selecting an option is likely to increase with utility from the option and probability (P) that individual, *i,* will choose option *j* over other options *g* in a complete choice set *R*, is given by,

$$P(j|C) = P\{(U_{ij} > U_{ig}, \text{ s.t. } \forall\, g \in R, \text{ and } j \neq g)\} \quad \text{(i)}$$

In general, the likelihood of selecting an alternative increases with the level of the desired attributes and vice-versa. A change in the level of an attribute can lead to a discrete switch from one alternative to another; therefore, CE links the Lancasters' theory with the model for consumers demand for discrete choices (Hanemann, 1984). The utility derived from the alternatives is not restricted to the presented attributes and it is considered that unobservable components unknown to the analysts lead to inconsistency (Hanemann and Kanninen, 1999). The choices made in CE are analysed based on random utility theory and the framework links the deterministic model with a statistical model of human behaviour to address those inconsistencies (McFadden, 1974; Manski,1977).

The utility of a choice is comprised of two components, a deterministic component (βx), and an error component (ε). The former component is related to the attributes, x, included in the choice sets. A random model with the utility function that individual *i*, is associated with alternative *j* (e.g., invasive plant species management program option) models the consumer choice behavior as;

$$U_{ijt} = V(x_{ijt}) + \varepsilon_{ijt} \quad \text{(ii)}$$

where, individual i (i= 1, ……N) obtains utility (U) from choosing alternative j (j= alternative I, alternative II, status-quo) in each of the choice sets t (t= 1, ….n) presented to them. Following Lancasters' theory, the utility derived from any alternative depends on its attributes, x, such as *forest products collection time.* The error terms, ε, are assumed to have identical and independent distribution (IID), and relationship between utility and attributes

are linear in the parameters and variables function. Therefore, equation (ii) is usually estimated with a conditional logit (CL) model (McFadden, 1974).

The indirect utility function for estimation is,

$V_{ijt}= ASC+ \beta_i x_{ijt}$ (iii)

where, alternative specific constant (ASC) captures the effects on utility of variables not included in choice set, and β is coefficient of attributes x (Table 1).

The conditional logit (CL) model based on IID error terms implies a number of restrictions including the property of independence of irrelevant alternatives (IIA), and limitation in modelling variation in taste among respondents. The IIA property states that the choice probability ratio for any two alternatives in any choice set is constant for an individual, which is considered too restrictive in many practical situations. To relax the IIA assumption, the CL model can be generalized into a mixed logit or random parameter logit (RPL) model (Train 1998).

In a RPL model, the observed component ($\beta_i x_{ijt}$) given in the equation (iii) is expressed as the sum of the population mean (β′) and individual deviation (ή). The coefficient vector ή, captures a random, unconditional and unobserved type of taste heterogeneity of each random parameter β′ (Grosjean and Kontoleon, 2009). The utility is;

$V_{ij} = ASC+ \beta'_i x_{ijt}+\acute{\eta}_i x_{ijt}$ (iv)

However; RPL models are considered not well-suited to explaining the sources of heterogeneity (Boxall and Adamowicz, 2002). It can be explored by introducing socio-demographic (SD) characteristics, s, in equation (iv) (Grosjean and Kontoleon, 2009). After including SD variables, the indirect utility function estimated becomes;

$V_{ij} = ASC+\beta'_i x_{ijt}+\acute{\eta}_i s_i x_{ijt}$ (v)

The respondents' characteristics do not vary over choices and captures conditional type of preference heterogeneity by interacting with given attributes. The socio-demographic variables (s) enter as interaction terms with the IPS management program attributes and ASC.

These interaction terms examine the impacts of individual specific characteristics to participate in the invasive plant species management program.

2.3 Questionnaire Development

The CE requires two separate components to capture the preferences of respondents, a statistical design plan to create the hypothetical scenarios, and a statistical method to analyse the responses (Louviere et al., 2000). The first step is to define the attributes and their levels. In this study this was finalized after thorough discussions with the local villagers in five focus group discussions (FGDs), consultation with local experts, and reviewing CFUGs records, reports and literature. To prioritize the attributes in FGDs, we followed Bergmann et al. (2006). In addition, a draft questionnaire was tested and a payment vehicle was selected.

Table 1 Attributes and levels used in choice sets

Attributes	**Description**	**Levels**
Forest products collection time	Time require for each trip for a day requirement (hours)	4 hours* , 2 hours, 1 hour
Visitors to community forests	Number of tourists visiting community forests annually	The same number as now*, one and a half as many as now, twice as many as now
Labor contribution	Volunteer involvement of forest users in forest management activities	0*day, 3 days, 5 days, 7 days
Annual membership fee	Annual membership fee in each BZCFUG (NRs)	NRs. 0*, NRs. 1,050, NRs. 1,750, NRs. 2,450

Note: * Levels use in status-quo. Annual visitors in status quo are 20,000. NRs. is Nepalese currency, US$1~ NRs. 78.00.

The selected attributes (Table 1) are similar to the motivational factors influencing individuals to pay in a hypothetical market and support IPS management related factors such as impacts on ecosystems, native species, ecosystem services, and, tourism (Garcia-Llorente et al. , 2011). In rural areas, where subsistence exchanges are dominant, estimation of trade-offs between non-monetary attributes may be a more appropriate means of estimating the

value of non-market services (Bennett and Birol, 2010). Therefore, two payment attributes, *labour contribution* and *annual membership fee*, were included in the choice set. This may help to address the problem of cash constraints in a subsistence economy to capture the concern of low-income households (Mekonnen, 2000; Alam , 2006).

An efficient design created the unlabelled CE with three alternatives; "*Status quo*", "*Option A*" and "*Option B*". The D-efficient design strategies are considered to be efficient in the context of discrete CEs, as responses are analysed in logistic models (Ferrini and Scarpa, 2007; Scarpa and Rose, 2008; Bliemer and Rose, 2010). An efficient design was generated using Ngene (1.0.2) and the twenty-four choice situations were blocked into six versions of the questionnaire (see Figure 2 for an example of choice set). The number of attributes and choice sets in each version were determined based on the observation of piloting. The number of alternatives, their levels and choice sets are important considerations in reducing the task complexity, particularly in the context of developing countries (Bennett and Birol, 2010). In addition, visualization of the choice cards enhances the efficacy of the choice task in low-literate communities (Jae and Delvecchio, 2004; Brouwer et al., 2010).

Figure 2 Example of a choice set

छनौट अवस्था १.२

	विकल्प १	विकल्प २	हालको अवस्था
वन पैदावार उपलब्धता 	४ घण्टा	१ घण्टा	४ घण्टा
वार्षिक पर्यटक संख्या 	४०,००० हालको भन्दा दोब्बर	हालको जति २०,०००	हालको जति २०,०००
श्रमदान (वार्षिक) 	०	७ दिन	०
वार्षिक सदस्यता शुल्क 	रु. १,७५०	रु. ०	रु. ०
मेरो रोजाईको विकल्प			

The questionnaire included the following three sections. Firstly, it introduced IPS and the existing situation in the buffer zone. In addition, this section described the proposed plan to mitigate the damages incurred from the infestation of *Mikania*, the need to raise funds to implement mitigation policies, and asked respondents to select their preferred option from policy alternatives presented in the choice sets. Each option presented two policy attributes with *labor contribution* and *cost* in the form of an annual membership fee in each BZCFUG for the next five years. To understand how individuals become aware of the need to make the decision, search information on alternatives and attributes, construct choice sets and make decisions follow up questions were asked (Do and Bennett, 2008). Secondly, the questionnaire asked respondents what changes they are experiencing following the colonization of *Mikania*. Finally, the questionnaire also collected information about the socio-demographic characteristics of respondents.

2.4 Survey implementation

A face-to-face survey and appropriate training to enumerators are crucial in ensuring the success of a CE in developing settings (Bennett and Birol, 2010). Recruitment of local enumerators was beneficial as approaching female respondents by outsiders is not socially acceptable and the local ethnic community has their own dialects. The team of enumerators were given intensive training and monitored by the research team. In addition, each enumerator was given a folder containing choice sets on coloured sheets so that they could show them while describing the scenarios. A plain language statement was read before the respondent was asked whether s/he would like to participate in research.

Considering the relationships between households' dependency on forest products and distance to the forest (Sapkota and Oden, 2008), the households was stratified into three strata based on their proximity to the forest; less than 1 km, 1 to 2 km, and more than 2 km. A systematic random sampling was employed to select households and every 10^{th} household was interviewed. To establish a consensus about the species going to be discussed, a photograph and specimen of the vines were shown to the respondents before the interview. The household heads of either gender were interviewed because they hold decision-making power in household expenditure. The interviews were conducted in *Nepali* and *Tharu* (local dialect) as per the interest of respondents.

3. Results

3.1 Sample characteristics

Table-2 reports the characteristics of the sampled households. Of the total (325) households interviewed two-thirds were farmers. This indicates that the study area is agro-based and rural households are diversifying their livelihood strategies due to tourism, a trend to go abroad for employment, and access to education. The average education level of the interviewed household heads was not above the primary level. Respondents having agriculture as their main income source have higher average *land-holdings* and *age* compare to their neighbours who depend on off-farm income. As expected, *farmers* have lower average education level and annual income.

Table 2 Socio-demographic characteristics of the sampled households

Variables	Agriculture	Agri. +Off-farm	Off-farm	Total
Respondents	214	10	101	325
Male	101	5	77	183
Female	113	5	24	142
Native	105	3	51	159
Education* (Years)	3.00	5.40	7.86	4.59
Landholding size* (Katha)	11.83	9.40	9.91	11.16
Age* (Years)	48.22	45.30	42.71	46.42
Households using *Mikania*	13	1	8	22
Prefer to contribute in labor	140	7	61	208

* Average of the variables.

Unlike the focus group participants, a small fraction of respondents (~7%) were using *Mikania,* particularly for goat fodder during the dry season, when other grass and fodder are not available. To compensate a reduction in forest products availability, the households were executing different strategies whether they were using *Mikania* or not. Such compensating strategies included; plantation in private land, exploring more areas, particularly core areas of the national park, to collect forest products, using alternative energy such as bio-gas, liquefied petroleum gas, and purchasing firewood and fodder from the local market.

3.2 Model selection

The choice data set was analysed using LIMDEP 9.0 NLOGIT 4.0. Socio-demographic variables used in these models and their coding are specified in Table 3. These variables are introduced to investigate the source of preferences heterogeneity by interacting with the ASC.

Table 3 Definition of variables

Variables	Description
Age	Age of the respondents (years).
Sex	Gender of the respondents, male (0) and female (1)
Education	Number of years attended school.
Income source	Income source of respondents, agriculture (1) and off-farm (0).

Annual income	Annual family income from off-farm activities including business, job, foreign employment, and cottage industry in NRs.
Land	Landholdings by households in Katha[1]
Native	Native to Buffer zone of Chitwan National Park, native (1) and migrated (0).
Distance	Distance between respondent's house and their respective community forest.
ASC	Alternative specific constant (ASC), 0 for status-quo, and 1 for alternatives.

Individual specific characteristics including age, gender, income, and occupation of respondents have significant influence on selecting alternatives for forest management programs (e.g. Lehtonen et al. 2003, Wang et al. 2007). In addition, household characteristics including proximity to forests, landholding size, education, and wealth status are crucial determinants for forest products collection in rural parts of Nepal (Adhikari et al., 2004; Sapkota and Oden, 2008). The terai[2] of Nepal has heterogeneous communities as an extensive migration from the hills is occurring due to more productive agricultural land and increasing availability of modern facilities. Therefore, the origin of respondents is likely to be one of the important variables in estimating community preferences over forest resources in the study area.

3.2.1 Conditional logit (CL) model

Two different CL models were estimated (Table 4). The first is a basic model (Model I) with the attributes related to IPS management program included in a choice set and ASC as explanatory variables. In this model, attributes included in choice sets are the main determinants of the expected utility and it shows the importance of the attributes in explaining respondents' choices across the three options included in a choice set. The second model (Model II) includes the socio-demographic (SD) variables interacting with the ASC[3].

As expected, *a priori,* the respondents have, in general, a preference for less *forest products collection time,* more *visitors* in their community forests, lower *annual membership.* The

[1] Katha is unit of area approximately equal to 67 square meters.

[2] Southern part of the Siwalik Hills, the lowest outer foothills of the Himalaya. Chitwan National Park is situated in the terai region.

[3] Other interaction terms with specific attribute could be included but their interpretation could less informative in this context.

labour contribution attribute is more complex and has a positive sign in Model I. This is probably due to the trade-offs between *labour contribution* and *annual membership fee* as respondents majority of the respondents have preference to contribute in labour over cash payment in term of an *annual membership fee.* In addition, this model does not consider the role of the characteristics of individuals in the expected utility. This is clearly reflected in model II, where *labour contribution* has also negative coefficients.

Both models were estimated twice: the first time including all respondents and the second time excluding those who objected to the choice scenarios. This was detected by asking follow-up questions. The following respondents were considered as protest respondents. Those who:

- expressed their preference to make labour contribution instead of paying annual membership fee;
- believed that the government should pay for invasive plant management program, not citizens[4].

Total protest respondents that is those who preferred not to pay in monetary terms, if alternative payment is available, account for 64% of the total respondents. This result is consistent to Alam (2006) who found that in Bangladesh only a quarter of the total respondents, who supported restoration of a vulnerable river were willing to pay in monetary terms. This is not unexpected in a developing economy where subsistence exchange is dominant. Of the estimated Models those without protest respondents were found to have a higher adjusted R^2 but have two insignificant attributes. Therefore, the models including all respondents were used for further analyses.

Table 4 Results of conditional logit model for two scenarios

	All respondents included		Protest respondents excluded	
Variables	Model I	Model II	Model I	Model II
ASC	-0.3703***	-0.289***	-0.197	-0.152

[4]This category of protest respondents consists of less than 1% or only three respondents. Respondents would like to pay in monetary term and contribute in labor are 117 and 205 respectively.

	(0.0732)	(0.072)	(0.133)	(0.131)
Forest products collection time	-0.7947*** (0.0491)	-0.566*** (0.058)	-0.570*** (0.080	-0.406*** (0.096)
Visitors to forests	0.0001*** (0.00001)	0.0001*** (0.87D-05)	0.0001*** (0.14D-04)	0.0001*** (0.15D-04)
Labor contribution	0.0615*** (0.0225)	-0.066** (0.032)	0.055 (0.040)	-0.055 (0.060)
Annual membership fee (Cost)	-0.0002*** (0.00007)	-0.0006*** (0.0001)	0.22D-04 (0.0001)	-0.0003* (0.085)
Age ×ASC	-	0.044*** (0 .016)	-	0.015 (0.041)
Income source (Agriculture) ×ASC	-	1.56** (0 .647)	-	-
Education × ASC	-	0.089 (0.056)	-	-0.233** (0.117)
Annual income × ASC	-	-0.009 (0 .006)	-	0.087 (0.057)
Landholdings × ASC	-	-0.038 (0 .035)	-	0.147 (0.127)
Observation	1300	1300	468	468
Log-likelihood	-686.23	-666.61	-213.51	-205.99
Adjusted R^2	0.258	0.278	0.349	0.369

Notes: *, ** & *** denote statistical significance at 10%, 5% and 1% level respectively. Standard errors (SE) are in parentheses.

3.2.2. Random Parameter Logit (RPL) Model

The Hausman test was performed to confirm IIA/IID condition. It was found that the data did not support the test, as the difference matrix was not positive definite. Further analysis was conducted to address the limitations of the CL model including IID assumption and absence of preference heterogeneity. To this end, the random parameter logit (RPL) model was estimated to relax the IID assumption and investigate heterogeneity in respondents' preferences. The socio-demographic (SD) variables were introduced by interacting with the ASC to examine the variations in effects of IPS management program.

In RPL models, taste parameters are considered to have statistical distributions arising from potentially different parameters for each individual (Hensher *et al.,* 2005). Usually, random

parameters are assumed to have log-normal and normal distributions, and these distributes are used for estimation (Carlsson et al., 2003). Following Hensher *et al.* (2005), first, all attributes except payment attributes were estimated as random parameters. Then, random parameters having insignificant standard deviations were re-estimated as non-random parameters. Different distributions were used to estimate the model and resulted in minimal differences. The results reported in Table-5 are estimated with a normal distribution for each of the random parameters as the normal distribution sets no constraints on the signs of the parameters (Train, 2003).

The model is statistically significant overall with Chi-square statistics of 1549.15 with 14 degrees of freedom and *p*-value equal to zero. The overall model fits with *pseudo* R^2 of 0.3, and Hensher and Johnson (1981) comment that values of *pseudo* R^2 between 0.2 and 0.4 are considered extremely good fits. The RPL model with 50 random draws and random parameters with normal distributions shows that respondents have heterogeneous preferences over the *forest products collection time* and *visitors to forest* attributes, significant at the one per cent level (Table 5).

The CL and RPL models show that respondents preferred having less forest *products collection time*, more number of *visitors to community forests* and less *labor contribution* and *annual membership fee* in forestry activities. Regarding socio-economic variables older respondents with more education chose invasive species management program more frequently than younger respondents with less education. The likelihood of selecting alternative IPS management program increases even more if respondents are female and their major source of income is agriculture. The negative sign of ASC indicates that there are still some respondents having preference towards the current situation. This might be a consequence of having provision of annual contribution in IPS management program, which need further investigation.

Table 5 Results of conditional logit and random parameter logit models

Variables	CL	RPL
ASC	-0.282***(0.072)	-0.341***(0.128)
Forest products collection time	-0.556***(0.057)	-1.015***(0.184)

Visitors to forests	0.0001***(0.8D-05)	0.0002***(0.4D-04)
Labor contribution	-0.071**(0.0322)	-0.117**(0.057)
Annual membership fee	-0.0006***(0.0001)	-0.001***(0.0001)
Landholdings ×ASC	-0.016(0.025)	-0.030(0.035)
Age ×ASC	0.043*(0.024)	0.056(0.037)
Education ×ASC	0.4D-05 (0.3D-04)	0.1D-04(0.9D-04)
Income source (Agriculture) ×ASC	1.148*(0.653)	1.784**(0.850)
Sex ×ASC	0.538***(0.146)	0.684***(0.199)
Annual income ×ASC	-0.2D-04**(0.9D-05)	-0.3D-04**(0.1D-04)
Distance ×ASC	-0.019 (0.023)	-0.022(0.032)
Standard deviations of random parameters		
Forest products collection time		0.674***(0.207)
Visitors to forests		0.0001***(0.4D-04)
Adjusted R^2	0.282	0.300
Log likelihood	-660.18	-643.73

Notes: *, ** & *** denote statistical significance at 10%, 5% and 1% level respectively. Standard errors (SE) are in parentheses.

On the contrary, respondents having more private land and off-farm income are less likely to select alternative IPS management programs. The likelihood of selecting alternative forest improvement programs becomes less frequent with increasing distance between community forests and the respondents' house. Of the socio-demographic variables only, off-farm annual income, sex and income source of respondents were significant in both models and age of the respondents only in the CL model.

The CL and RPL models were compared to determine the superiority between these two. A Swait-Louviere log-likelihood ratio test was carried out following Rolfe *et al*. (2000) for the test of the significance of log-likelihood values and adjusted R^2 change. The log-likelihood (LL) decreased from -660.18 in CL model (LL_1) to -643.73 in the RPL model (LL_2). The calculated statistics $\chi^2 = -2(LL_1-LL_2) = 32.90$, was greater than a statistic χ^2 of 5.99 at two

degrees of freedom. The degrees of freedom are given by the difference in the numbers of parameters estimated in the two models. This indicates that the RPL model provides a significant improvement in model fit over the CL model. Hence, this model was used for further analysis and discussion.

3.2.3 Estimation of Willingness-to-pay (WTP)

The marginal value of a change in an invasive species management attribute can be estimated as a ratio of coefficients between IPS management attribute in choice set and *annual membership fee.* This is also known as marginal willingness-to-pay (MWTP) for a change in that attribute. MWTP for each attribute was calculated from both CL (Model II) and RPL models using Krinsky and Robb (1986) bootstrapping procedure. A vector of 1,000 sets of parameters is drawn for each model to re-estimate the welfare changes. These results are reported in Table 6.

Table 6 Estimated implicit price (IP) from different techniques (in NRs/year)

Attributes	Implicit price CL (NRs)	Implicit price RPL (NRs)
Forest products Collection time	827.13 (634.70-1,019.56)	983.05 (712.64-1,253.46)
Visitors to community forests	0.19 (0.16-0.22)	0.25 (0.19-0.31)
Labour contribution	106.74 (70.01-143.47)	113.69 (71.05-156.33)

* Confidence intervals at 95% in brackets.

The RPL model (table IV) shows that across the whole sample, an average willingness to pay for an hour decrease in forest products collection time was NRs. 983.05 (US$12.60) and for increase in one thousand tourists was NRs. 250 (US$ 3.20). However, the trade off between the cost and labour contribution attributes is estimated to be NRs. 113.69 (US$1.45) for every man-day involved in IPS management activities. The estimated value of labour contribution is about one-third of the local agriculture labour wage, which was NRs. 350 per labour-day during the interview period.

Welfare measures for changes in invasive plant species management attributes can be calculated by using the following formula (Hanemann, 1984),

$CS = (V_1 - V_0)/\beta_c$ (vi)

where CS is compensating surplus welfare measure, V_1 is the utility of the change scenario, V_0 is the utility from the *status-quo*, and β_c is the coefficient of *annual membership fee.*

The status-quo is indicated in Table 1 and the change scenario for this estimation was based on the operational plan and record of BZCFUGs. The change scenario for this estimation was considered as the average time for forest product collection will be reduced to two hours, the number of tourist increases to 30,000 and there is no labor contribution for IPS management. The annual household WTP for the expected outcome is NRs. 4,557.09 (US $ 58.42). The estimated annual household WTP is six percent of the average annual household income estimated by Chakrabarty *et al* (2010).

Table 7 Estimates of WTP (NRs)

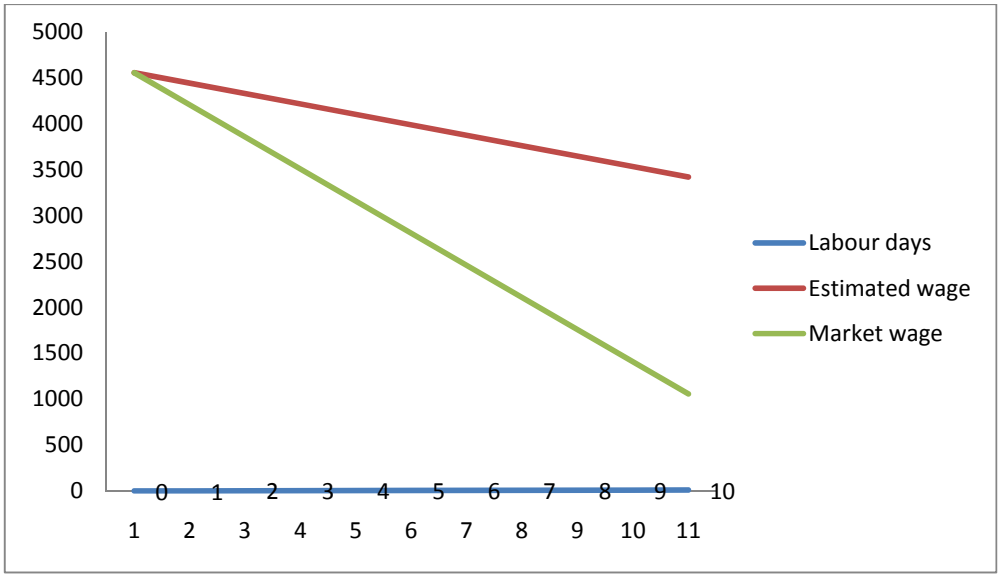
		Household mean and confidence intervals at 95%	Aggregated for BZ community	
			Lower Bound	Upper Bound
WTP per annum		4,557 (3,471-5,643)	59,376,513	163,412,283
Discounted household WTP for 5 years	3%	21,496 (16,373-26,619)	280,084,854	770,831,822
	5%	20,716 (15,778-25,653)	269,922,689	742,864,153
	7%	19,992 (15,228-24,757)	260,497,306	716,924,210

The present values of the CS calculated using a range of discount rates at three, five and seven percent are reported in Table 7. In 2011, the present value of the average WTP per buffer-zone household for the specified forest improvement was 21,496 (US $ 275.59) at three percent discount rate.

The effect of varying labour contribution on WTP for IPS management program is investigated by substituting different labour days and different wage rates (Figure 3). According to focus group participants, they want to participate in IPS management operations

for maximum ten days in a year. Average WTP per household would decrease with their labour contribution, if respondents are asked to participate with an annual membership fee. The figure clearly indicates that households' WTP based on estimated wage rate is higher than the estimated WTP based on market wage rate.

Figure 3 Households' annual WTP based on labour contribution with different wage rates (in NRs)



4. Discussion

4.1 Invasive species management

The abundance of *Mikania* is likely to reduce the availability of indigenous plant species. In this context the opportunity cost to use *Mikania* increases the number of *Mikania* users (Shackleton et al., 2007). However, *Mikania* is not a preferred resource, as the vines used during the dry season and suitable only for goats. In order to maintain daily livelihoods respondents of the buffer zone of CNP are implementing different compensating strategies. The situation clearly indicates that colonization of *Mikania* is imposing costs to the residents of the buffer zone. Therefore, respondents were willing to pay for improved forest conditions resulting from an invasive species management program.

The majority of the respondents were subsistence farmers and have willingness to contribute in non-monetary terms of labour so that they can minimize any cash payment. Their

estimated value for IPS management programs, therefore, depended not only on outcomes of forestry operations but also on the number of days they were willing to be involve personally in the implementation phase (Figure 3). This result corroborates Mekonnen (2000) and Alam (2006) that respondents in developing economies should be provided with an option to express their WTP in non-monetary terms. If they are asked to put price tag only in monetary-term, it can overlook the concern of a large portion of rural populations, which undervalue the benefits resulted from environmental program including invasive plant species management.

The estimated value of the labor contribution of respondents indicates that farm households would have a shadow value of family labor that is less than their opportunity cost. This could be because farm households may enjoy farm activities as a life style, and they make trade-offs between leisure and other benefits received from being involving in forestry activities (Ahearn et al., 2009). In addition, in agricultural households leisure is valued by its marginal worth to the household rather than as an opportunity cost derived from a market wage rate (Edmeandes et al., 2006). Therefore, the marginal rate of labor involving in forestry activities can be used to pragmatically estimate the cost and benefits of forestry programs in the context of rural economy of developing countries.

There are other factors including age, households' income source and annual income that have significant influence on the environmental payment. In this study, older respondents have higher WTP for IPS management programs. In contrast, Lehtonen *et al.* (2003), and Wang *et al.* (2007) have reported that older respondents have lower WTP for forest services in Finnish and Chinese contexts respectively. This might be because in rural areas elderly people have good knowledge of natural resources including forests and their utilization (Rao and Ramana, 2007), and respondents having knowledge about resources have more WTP for the improvement of the resources (Do and Bennett, 2008).

In addition, farmers have a higher WTP for IPS management. The number of farm households using *Mikania,* however not preferred, indicates their dependency on forest products. In this context, higher WTP is expected. This result is consistent with the findings of Hanley *et al.* (1998) that users of forest ecosystem services have higher valuations for forest ecosystem services than non-users. On the contrary, WTP for IPS management has a

negative association with off-farm income. This might be because those households can afford alternatives to forest products. In addition, they might not realize the impacts of the colonization of *Mikania* on their daily life, as this group of respondents has less dependency on forest products but this need further investigation to understand it better.

In addition, the likelihood of selecting alternative forest improvement programs is higher by female respondents. This is in line with existing studies related to gender and forest resources in developing countries like Nepal where women are primary users and managers of forests and they disproportionately bear the cost of forest management (Agrawal, 2001). Usually, colonization of invasive species has a greater impact on women because they tend to have more responsibility for household chores including fuelwood collection and responsibility for small livestock production, which are more affected by reduced forage availability (Fish et al., 2010).

In order to aggregate overall WTP from the survey results for the BZ community, two approaches were used. The first, included only respondents having WTP in monetary terms excluding protest respondent as defined in this study, and the second excluding only respondents believed that the government should pay for IPS management program and considering respondents willing to contribute in labour have same WTP. The aggregate WTP was calculated using the following equation:

$$WTP_{total} = \Sigma WTP*H*R \quad \text{(vii)}$$

Where, WTP is the aggregate WTP, WTP is the mean household WTP, H is households in buffer zone and R is proportion of respondents willing-to-pay.

The first approach provides a lower bound and latter approach to produce a higher bound of aggregated WTP values of the BZ community of Chitwan National Park to mitigate damages caused by invasive plant species, particularly *Mikania micrantha*. The lower and higher bound estimated WTP for BZ community was NRs. 59.37 million (US$0.76 million) and NRs. 163.41 million (US$ 2.09 million) respectively. This is the annual benefits for the BZ community of CNP. The present value of total WTP for a five-year period, as respondents were asked to select the alternative IPS management outcomes that would happen in five years, is reported in Table 7.

In comparison, the annual budget for Buffer Zone management in Chitwan National Park was NRs. 80 million[5] in the fiscal year 2011/2012. However, the allocated budget amount does not include any specific program for *Mikania* management. Hence, the gap between estimated social benefits and the annual budget indicates that there is potential to improve social welfare of BZ community through the IPS management program The social benefits could be higher if global WTP for IPS management is also taken into account; this is because Chitwan National Park is listed as a World Heritage Site (Do and Bennett, 2008). The estimated WTP suggests that government should respond to the problem associated with invasive plants, particularly *M. micrantha*, as soon as possible. If not the cost associated with invasive plant species increases over time (Shackleton et al., 2007). The current scenario of an absence of IPS management activities may have compounding effects and is likely to exert social costs.

4.2 Choice experiment in low-income community

The implementation of choice experiments in the rural communities of developing countries, particularly to elicit willingness-to-pay for environmental services, is almost new. This study is a milestone for further implementation of non-market valuation studies, particularly CE, in subsistence economies. Other than the suggestions made by Bennett and Birol (2010) regarding the implement of CE in the developing country context, two main issues are drawn from this study to further the development of CE in rural communities. These are the recruitment of local enumerators and the inclusion of a non-monetary contribution.

In choice experiments, personal interviews are considered an appropriate mode of survey in developing countries (Bennett and Birol, 2010). In order to improve the quality of data in household surveys in developing countries several strategies including involvement of entering and verifying data in the field, enumerators training, and recruitment of local interview teams consisting of male and female enumerators were employed (Puetz 1992). In addition, ethnicity was also considered when recruiting enumerators because the study area has diverse ethnicity with their own dialects and talking to people in their native language can help to reduce task complexity in low literacy communities. Presence of the researcher during household survey was found effective to answer issues related to the research raised by

[5]This information received from Department of National Park and Wildlife Conservation, Nepal.

respondents including the implementation of research findings and also possibilities to control the spread of *Mikania.*

In a choice set, inclusion of a non-monetary payment attribute along with a monetary attribute was effective in eliciting rural farmers' WTP for IPS management activities. Providing only a monetary attribute as a cost of the bundle of outcomes may increase the chance of respondents selecting status-quo. Using a non-monetary term can address the cash constraints problem in a subsistence economy which potentially impacts the valuation of non-market benefits (Mekonnen, 2000; Alam, 2006). If not, the high protest rate is likely as respondents have limited ability to pay due to budget constraints (Bennett and Birol, 2010). In addition the estimated value of time can be very helpful to estimate social costs and benefits of environmental programs in a rural economy, as farmers value their time in this context at a different rate to the current wage rate.

4.3 Conclusion

The benefits from the management of BZ of CNP can be increased by implementing an invasive plant (*M. Micrantha*) management program. The benefits resulting from an invasive species management program in the buffer zone of Chitwan National Park were estimated between US$ 3.33 million and US$9.88 million[6]. The estimated WTP indicates that the buffer zone community is suffering from the colonization of *Mikania micrantha,* as they are experiencing a shortage of forest products and fewer visitors to their community forests. This suggests that if more resources were allocated to an IPS management program in buffer zone of CNP, social welfare would improve by up to 2.67[7] percent of the current benefits from CNP in terms of royalty.

Development progresses in the BZ may have mixed results, as commercialization of farming activities can increase the value of IPS management while it can be decreased with increasing off-farm activities. However, this can be balanced with organizing conservation education programs along with IPS management. The value of IPS management can be expected to

[6] Net present value at three percent of upper bound aggregate WTP and at seven percent of lower bound aggregate WTP.

[7] Revenue from CNP in the fiscal year 2009/2010 was NRs. 61.01 million (Department of national Park and Wildlife Reserve, Annual Report 2009-2010).

increase with awareness raising programs as women can be empowered to be involved in decision-making processes and they tended to have a greater WTP than men. This clearly indicates that the IPS management program should follow an integrated approach, where trade-off between environmental services and economic development should be taken into account during the decision-making process and awareness programs are included to foster public support.

This study shades light on the implementation of CE surveys in developing countries, particularly in rural area. The estimated value of the invasive plant management program not only focuses on the overall value of the forest ecosystem but also the on the WTP for each attribute. This informs policy in allocating available resources in forest improvement by controlling the growth of *M. micrantha* in the buffer zone of CNP. The results of the CE survey have also demonstrated the impact of socio-economic factors on the IPS management program. This can help to minimize controversy surrounding the IPS management program, particularly as the impacts of IPS on rural livelihoods are ambiguous (Shackleton et al. 2007).

In addition, provisioning of contribution to IPS management program in non-monetary terms of labour contribution can increase the socio-economic benefits. This also includes the concerns of approximately two-thirds of the rural population, whose values may otherwise be overlooked, in forest management. The inclusions of a non-monetary payment attribute with a monetary attribute not only reduces the task complexity but also estimates the marginal value of time in a subsistence economy. This is helpful in carrying out social benefit-cost analysis in low-income areas. The existing practice of including only a market wage of labour can mislead policy in rural areas.

In conclusion, for the first time, the non-market values of the IPS management program have been quantified and can be used to justify the IPS management program in Nepal. This study shows that CE can be applied in a low-income community to estimate the non-market values of the forest ecosystem. The application of CE in rural areas of developing economies may have a significant contribution to sustainable development. The use of CE to estimate the value associated with invasive species not only focuses on ecosystem services but also informs policy about the impacts on rural livelihoods.

References

Agrawal, B., 2001. Participatory exclusions, community forestry and gender: an analysis for South Asia and a conceptual framework. *World Development* 29(10),1623-1648.

Adhikari, B., Di Falco, S., and Lovett, J.C. 2004. Household characteristics and forest dependency, evidence from common property forest management in Nepal. *Ecological Economics* 48,245-257.

Ahearn, M.C., Korb, P., and, Yee, J. 2009. Produce dynamics in agriculture empirical evidence. In, Dunne, T., Jensen, J.B., and, Roberts, M.J. (eds), Producer dynamics: new evidence from micro data. The University of Chicago press.

Alam, K. 2006. Valuing the environment in developing countries, Problems and Potentials. *Asia Pacific Journal on Environment and Development,* 13 (1and2), 27-44.

Alpizar, F., Carlsson, F., and, Martinsson, P. 2003. Using choice experiments for non-market valuation. *Economic Issues* 8(1), 83-110.

Ben-Akiva, M., Lerman, S., 1985. Discrete choice analysis: theory and application to travel demand. Cambridge, MA, MIT Press, 416 pp.

Bennett, J., and, Birol, E. (eds). 2010. Choice experiments in developing countries, implementation, challenges and policy implications. Edward Elgar.

Bergmann, A., Hanley, N., and Wright, R. 2006. Valuing the attributes of renewable energy investments. *Energy Policy,* 34, 1004-1014.

Birol, E., Das, S., 2010. Estimating the value of improved wastewater treatment: the case of River Ganga, India. Journal of Environmental Management 91: 2163-2171.

Bliemer, M.C.J., and, Rose, J.M. 2006. Designing stated choice experiment: state-of-the-art. In: Paper presented at the 11th International Conferecen on Trael Proceedings of the 87th Annual Meeting of the Transportation Research Board, Washington, DC, USA.

Born, W., Rauschmayer, F., and, Brauer, I. 2005. Economic valuation of biological invasions-a survey. *Ecological Economics,* 55,321-336.

Boxall, P., and, Adamowicz, W., 2002. Understanding heterogeneous preferences in random utilitymodels: a latent class approach. Environmental and Resource Economics 23(4), 421-446.

Carlsson, F., Frykblom, P., Liljenstolpe, C., 2003. Valuing wetland attributes: an application of choice experiments. Ecological Economics 47, 95–103.

Chakrabarty, S., Grote, U., Luchters, G., 2010. Does social labelling encourage child schooling and discourage child labour in Nepal? International Journal of Educational Development 31, 489-495.

Curnutt, J.L. 2000. Host area specific climatic matching, similarity breeds exotics. *Biological Conservation,* 94, 341-351.

Do, T.N., and, Bennett, J. 2008. Estimating wetland biodiversity value, a choice modeling application in Vietnam's Mekong River Delta. *Environment and Development Economics,* 14,163-186.

D'Antonio, C.M., and, Kark, S. 2002. Impacts and extent of biotic invasions in terrestrial ecosystems. *Trends in Ecology and Evolution,* 17,202-204.

Edmeades, S., Smale, M., and Karamura, D. 2006. Demand for cultivar attributes and the biodiversity of bananas on Farms in Uganda. In, Smale, M. (eds), Valuing crop biodiversity on-farm genetic resources and economic change. CABI Publishing, Oxfordshire, UK.

Ferrini, S., and, Scarpa, R. 2007. Designs with a priori information for nonmarket valuation with choice experiments: A Monte Carlo study. *Journal of Environmental Economics and Management,* 53:342-363.

Fish, J., Chiche, Y., Day, R., Efa, N., Witt, A., Fesehaie, R., de Graft Johnson, K., Gumisizira, G., Nkandu, B., 2010. Mainstreaming gender into prevention and management of invasive species. Global Invasive Species Program (GISP), Washington DC, US, Nairobi, Kenya. 64 pp.

Garcia-llorente, M., Martin-Lopez, B., Nunes, P.A.L.D., Gonzalez, J.A., Alcorlo, P., Montes, C. 2011. Analyzing the social factors that influence willingness to pay for invasive alien species management under two different strategies, eradication and prevention. *Environmental Management* 48,418-435.

Grosjean, P., and, Kontoleon, A. 2009. How sustainable are sustainable development programs? The case of the sloping land conversion program in China. *World Development,* 37(1): 268-285.

Hanemann, W.M. 1984. Welfare evaluations in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics* 71 (4), 1057–1061.

Hanemann, W.M. and B. Kanninen. 1999. Statistical Analysis of Discrete-response CV data. In: Valuing Environmental Preferences. Theory and Practice of the Contingent Valuation Method in the US, EU, Developing countries, Bateman I.J. and K.G.Willis(eds.). Oxford University Press.

Hanley, N., Wright, R.E., and, Adamowicz, V. 1998. Using choice experiments to value the environment. *Environmental and Resource Economics* 11(3-4), 413-428.

Hensher, D.A., and Johnson, L.W., 1981. Applied Discrete Choice Modelling. Wiley, New York. 468pp.

Hensher, D.A., Rose, J.M., and, Greene, W.H. 2005. Applied choice analysis: a primer. Cambridge University Press, Cambridge, UK.

Hoagland, P., and Jin, D. 2006. Science and economics in the management of an invasive species. *Bioscience* 56,931-935.

Holmes, T.P., Aukema, J.E., Holle, B.V., Liebhold, A., and, Sills, E. 2009. Economic impacts of invasive species in Forests, past, present and future. *Annals of the New York Academy of Sciences,* 1162,18-38

Jae, H., and, del Vecchio, D. 2004. Decision making by low-literacy consumers in the presence of point-of-purchase information. *The Journal of Consumer Affairs*, 38(2), 342-354.

Jetter, K.,and Paine, T.D. 2004. Consumer preferences and willingness to pay for biological control in the urban landscape. *Biological Control* 30,312-322.

King, N.A. 2007. Economic valuation of environmental goods and services in the context of good ecosystem governance. Water Policy 9(2), 51-67.

Krinsky, I., and, Robb, A. 1986. On approximating the statistical properties of elasticities. *Review of Economics and Statistics* 68, 715-719.

Lancaster, K.J. 1966. A new approach to consumer theory. Journal of Political Economy 74, 132-157.

Lehtonen, E., Kuuluvainen, J., Pouta, E., Rekola, M., Li, C-Z. 2003. Non-market benefits of forest conservation in southern Finland. Environmental Science & Policy 6, 195-204.

Louviere, J.J., Hensher, D.A., and Swait, J.D. 2000. Stated choice methods: analysis and application. New York: Cambridge University Press.

Manski, C. 1977. The structure of random utility models. *Theory and Decision* 8: 229-254.

McFadden, D. 1974. Conditional logit analysis of qualitative choice behavior. In: Zarembka P. (eds), Frontiers in Econometrics, Academic Press, New York.

Mekonnen, A. 2000. Valuation of community forestry in Ethiopia, a contingent valuation study of rural livelihoods. *Environment and Development Economics* 5, 289-308.

Meyerson, L.A., and, Mooney, H.A. 2007. Invasive alien species in an era of globalization. *Frontiers in Ecology and the Environment* 5(4), 199-208.

Moore, P.D. 2000. Alien Invaders. *Nature,* 403,492-493.

Nunes, P.A.L.D., and van Den Bergh, C.J.M. 2004. Can people value protection against invasive marine species? Evidence from a joint TC-CV survey in the Netherlands. *Environmental and Resource Economics* 28,517-532.

Nunes, P.A.L.D. and Markandya, A. 2008. Economic value of damage caused by marine bio-invasions, lessons from two European case studies. *ICES Journal of Marine Science* May, 2008, 775-780.

Nunez, M.A., Pauchard, A. 2009. Biological invasions in developing and developed countries, does one model fit all? *Biological Invasions* doi,10.1007/s10530-009-9517-1.

Pimentel, D., Zuniga, R., Morrison, D. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52,273-288.

Pejchar, L., and, Mooney, H.A. 2009. Invasive species, ecosystem services and human well-being. *Trends in Ecology and Evolution,* 24(9),497-504.

Puetz, D. 1992. Improving data quality in household surveys. In, Scherr, S.J., and, Vosti, S.A. (eds), Data needs for food policy in developing countries: new directions for household survey. International Food Policy Research Institute, Washington DC.

Pysek, P., Richardson, D.M., Pergil, J., Jarosik, V., Sixtova, Z., and, Weber, E. 2008. Geographical and taxonomic biases in invasion ecology. *Trends in Ecology and Evolution* 23,237-244.

Rao, V.L.N., and, Ramana G.V. 2007. Indigenous knowledge, conservation and management of natural resources among primitive tribal groups of Andhra Pradesh. In, Bhasin, V., and, Bhasin, M.K. (eds), The Anthropologist (Special issue 3) - Anthropology Today: Trends, Scope and Applications. Kamla-Raj Enterprises, Delhi, India.

Rolfe, J., Bennett, J., and, Louviere, J. 2000. Choice modelling and its potential application to tropical rainforest preservation. *Ecological Economics,* 35:289-302.

Sapkota I, Oden PC (2008) Household characteristics and dependency on community forests in Terai of Nepal. International Journal of Social Forestry 1(2),123-144.

Scarpa, R., and Rose, J.M. 2008. Design efficiency for non-market valuation with choice modelling: how to measure it, what to report and why. *The Australia Journal of Agricultural and Resource Economics,* 52:253-282.

Shackleton, C.M., McGarry, D., Fourie, S., Gambiza, J., Shackleton, S.E., and, Fabricius, C. 2007. Assessing the effects of invasive alien species on rural livelihoods, Case examples and a framework from South Africa. *Human Ecology* 35, 113-127.

Train, K., 2003. Discrete Choice Methods with Simulation. Cambridge University Press, Cambridge, MA.

Wilcove, D.S., Rothstein, D., Dubow, J., Phillips, A., and Losos, E. 1998. Quantifying threats to imperiled species in the United States. *BioScience* 48, 607-615.

Wang, X., Bennett, J., Xie, C., Zhang, Z., and, Liang, D. 2007. Estimating non-market environmental benefits of the conversion of cropland to forest and grassland program, A choice modelling approach. *Ecological Economics* 63,114-125.

Xu, H., Ding, H., Li, M., Qiang, S., Guo, J., Han, Z., Huang, Z., Sun, H., He, S., Wu, H., and, Wan, F. 2006. The distribution and economic losses of alien species invasion to China. *Biological Invasions* 8,1495-1500.