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Valuing the Damage Caused by Invasive Plant Species in a Low-income Community in Nepal

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Contents

Abstract

This paper presents a choice experiment designed to estimate the willingness-to-pay (WTP) of rural farmers to mitigate damages caused by invasive plant species, particularly *Mikania micrantha*, in the buffer zone of the Chitwan National Park in Nepal. In subsistence economies, where households face cash constraints, labor contributions can be used to estimate WTP for environmental services. However, since the opportunity cost of time varies across individuals, aggregating individual willingness to contribute time to obtain social welfare is not straightforward. In this study, the social opportunity cost of time spent in invasive species management is estimated by using two cost attributes, labor contribution and membership fees. The results suggest that the estimated shadow value of time is 47% of the daily wage rate. The results also reveal that rural farmers are willing to pay NRs. 2,382 (USD 31) per year for *Mikania* management activities. Households are willing to make cash and labor contributions because they expect that invasive species management will reduce forest product collection time and increase tourism.

Key words: *Mikania micrantha*, Choice experiments, Labor contribution, Subsistence community, Shadow value of time, Buffer zone.

Valuing the Damage Caused by Invasive Plant Species in a Low-income Community in Nepal

1. Introduction

Invasive species are non-native species, which may include plants, animals and microbes that have been relocated deliberately or accidentally as a result of economic activities (Holmes et al., 2009). The recent expansion in global trade and increase in human mobility have only accelerated the spread of invasive species throughout the world (Meyerson and Mooney, 2007). Ecologists identify invasive plant species (IPS) as one of the greatest threats to native forest ecosystems and species richness (Wilcove et al., 1998; Moore, 2000; D'Antonio and Kark, 2002). Their introduction undoubtedly modifies the structure and functions of the recipient forest ecosystems, which ultimately creates a change in the supply of ecosystem services (Wilcove et al., 1998; MA, 2005). An assessment of the economic impacts of IPS on ecosystem services is fundamental for the efficacy of any invaded area management programs (Pejchar and Mooney, 2009).

This study estimates the non-market benefits of the mitigation of *Mikania micrantha* (hereafter, Mikania) in the buffer zone of Chitwan National Park , Nepal. *Mikania* is a native South and Central American climbing perennial weed that has become a significant invasive plant in many tropical and subtropical Asian countries including Nepal. In Nepal, *Mikania* was first reported in 1963 in the eastern part (Ilam district) of the country before spreading westward (Tiwari et al., 2005). By now, the plant is found in over 20 eastern, central and western Terai districts of Nepal (Rai et al., 2012a).

Nepalese farmers perceive the invasion of *Mikania* to have adverse effects on their livelihoods (Rai et al. 2012b). The species has demonstrated its hostility by covering up to 80 percent of the buffer zone community forests in Chitwan National Park and Koshi Tappu Wildlife Reserve (Sapkota, 2007; Siwakoti, 2007). The patterns of spread of *Mikania* in Nepal and its aggressiveness indicate that it may create a monoculture destroying biodiversity, particularly in the Terai region, if steps are not taken to control it immediately. The urgency of coming up with a mitigation plan arises from this fact.

In order to assess the local costs associated with the spread of Mikania, our study employs a choice experiment (CE) with personal interviews conducted in five buffer zone community forest user groups (BZCFUGs). This research highlights the challenges associated with implementing non-market valuation surveys, particularly choice experiments, in the context of a subsistence community. In addition, this research contributes to the limited understanding of the economic impacts of biological invasions in forest ecosystems (Holmes et al., 2009). To our knowledge, to date, only one recently published study (Garcia-Llorente, 2011), using the contingent valuation method, has focused on different management strategies aimed at controlling the spread of invasive plants.

In what follows, we first discuss the available literature in the area of invasive species management and their relevance to our study. In section 3, we present the study area and our reasons for selecting that particular site. Section 4 delineates the methods adopted in the study while Section 5 discusses the some of the major findings. Section 6 presents conclusion and policy recommendations.

2. Literature Review

Though the literature adopting an economic approach to biological invasion is growing, a review of this literature highlights the need of non-market valuation to comprehensively capture the impacts of IPS on forest ecosystems (Born et al., 2005; Hoagland and Jin, 2006; Holmes et al., 2009; Pejchar and Mooney, 2009). This is because most

of the available economic impact assessments overlook costs and benefits that go beyond the market system. They are generally based on an estimation of control costs, are ex-post evaluations or assessments of lost market products such as timber. Curnutt (2000), for example, has shown that many of the control strategies tend to fail or become ineffective when more effective alternatives become available, as a result of which the impacts may be overestimated. On the other hand, as Born et al. (2005) have shown, the imperfect assessment of the external effects is likely to undervalue the impacts of invasive species on the invaded habitat.

Several empirical studies provide a positive assessment of the livelihood effects of invasive exotic plants on rural livelihoods (Shackleton et al., 2007; García-Llorente et al., 2011; Rai et al., 2012b). Many multipurpose and fast-growing plant species were introduced in many countries in the past to fulfill the demands of rural populations for forest products, for production of biofuels and for the rehabilitation of degraded lands (McNeely et al., 2001; Witt, 2010). Although these species have, over time, turned invasive, they remain useful, at least to some sections of the community (Pasiecznik et al., 2001; Shackleton et al., 2007).

Since invasion of exotic plants has both positive and negative effects on local livelihoods, management of invaded forests, particularly in areas with forest-dependent communities, is complicated. In such contexts, public awareness regarding the costs and benefits of an IPS management program becomes an important tool in winning public support for the management process (Pimentel et al., 2005; Xu et al., 2006). In general, the level of social awareness positively influences the implementation of the IPS management programs (Nun˜ez and Pauchard, 2010). Accurate information on the costs and benefits of implementing the IPS management program can be very useful. Hence, empirical data that capture the full impacts of IPS on human well-being, including the magnitude of this impact on the communities affected, would enhance the effectiveness of the decision-making process regarding such programs (Pejchar and Mooney, 2009).

García-Llorente et al. (2011) consider the stated preference method as a viable tool for exploring social preferences and gauging public support related to IPS management. Several researchers have employed contingent valuation method, the most widely used stated preference method, to estimate the value of controlling invasive species (Jetter and Paine, 2004; Nunes and van Den Bergh, 2004; Nunes and Markandya, 2008; García-Llorente et al., 2011). In contrast, the CE method has received considerable attention from applied economists in recent non-market valuation studies (Hanley et al., 1998; Lehtonen et al., 2003; Wang et al., 2007; Do and Bennett, 2009; Birol and Das, 2010). Our study adopts the CE method because of the advantages it offers in terms of benefits transfer, testing for internal consistency and information elicited from each respondent relative to the contingent valuation method (Hanley et al. 1998, Do and Bennett, 2009).

3. Study Area

We carried out the study in the Buffer Zone of the Chitwan National Park, Nepal. We selected Nepal as our study site because developing countries are more susceptible than developed countries to the invasion of exotic plants because of the absence of infrastructure to prevent the introduction of exotic species. In fact, this is turning developing countries into unwitting hosts of unwanted guests (Nun˜ez and Pauchard, 2010). Moreover, as Moore (2000) points out, once introduced, these plants are more likely to establish themselves in disturbed and fragmented habitats. At the same time, the phenomenon of rapidly growing populations of both humans and livestock, coupled with the increasing fragmentation of habitats resulting from land-use changes, are pushing developing countries in general, and rural areas in particular, towards previously non-invaded habitats. As a developing country that hosts an increasingly large number of tourists annually, Nepal is more vulnerable than most other countries to the transportation of exotic species - even as it benefits economically from the increasing mobility of people globally.

We selected the buffer zone of Chitwan National Park for this study for two main reasons: the importance of Chitwan National Park as a biodiversity hotspot and as one of the most popular tourist destinations in the country, and the intensity of the colonization of Mikania. The buffer zone is the area peripheral to the Chitwan National Park and includes villages, settlements or hamlets declared to be within the buffer zone by the Government of Nepal

(Government of Nepal, 1996). The buffer zone covers 750 sq km including 35 village development committees[1] and two municipalities of Chitwan and Nawalparasi districts (see Figure 1). A total of 21 forestry user committees and one sub-committee, i.e. approximately 44,918 households, manage the buffer zone (DNPWC, 2011). These committees are formed in coordination with the local authorities to assist community development and forest conservation. The user committee may be made up of more than one BZCFUG, with each group having their own work plans for managing their patch of forests.

The buffer zone was established in 1996 to facilitate more harmonious relations between the local people and Chitwan National Park (Straede and Helles, 2000). The concept of buffer zone management aims to develop alternatives to the use of the protected areas, including national park and wildlife reserve, by forest fringe villagers. This was in part to compensate the local community for their exclusion from protected area resources and to create incentives for local populations to change their practices in the protected areas (Agrawal and Ostrom, 2001). The provision of buffer zone community forest helps to minimize pressure on the protected areas by redistributing benefits to local communities and involving them in park management (Adhikari et al., 2004b). Buffer zone communities receive 30-50 percent of the park's total annual income for community development. In addition, development of eco-tourism in the buffer zone generates income for households (Mehta and Kellert, 1998). In brief, degradation of forests in the buffer zone increases pressure in the core area of the national park. Hence, controlling the spread of *Mikania* in the buffer zone also contributes to conservation inside the national park.

4. Choice Experiment

4.1 Theoretical Background

The Choice Experiment (CE) method is based on a questionnaire survey where respondents are presented with a number of alternative policy options and asked to select a set of options within a choice set. It is assumed that respondents will prefer the alternative that provides them with the highest utility, subject to resource constraints (Ben-Akiva and Lerman, 1985).

The alternatives included in choice sets are hypothetical scenarios indicating a (hypothetical) change in environmental goods and services. These alternatives constitute a set of attributes and are distinguished by the levels of the attributes. The attributes are generally outcomes of a proposed policy or program in the choice set. Such choice experiments build on Lancaster's theory of characteristics, which states that the usefulness of goods for the consumer depends on the attributes of the concerned goods (Lancaster, 1966). It is also assumed that individuals can implicitly make trade-offs between attributes while selecting the alternative of their choice (Alpizar et al., 2001). The CE method assumes that a change in the level of an attribute can lead to a discrete switch from one alternative to another, thus linking Lancaster's theory with consumer demand models regarding discrete choices (Hanemann, 1984).

The choices made in CE are analysed based on the random utility model, which links a deterministic model with a statistical model of human behaviour (McFadden, 1974; Manski, 1977). The assumption is that utility over a choice comprises of two components: a deterministic component (βx) and an error component (ε). While the former component is related to the attributes, x, included in the choice sets, the latter may be due to attributes not included in the experiment, such as measurement error and/or taste variations (Hanemann and Kanninen, 1999).

Thus, a random utility function of i^{th} individual that is associated with alternative *j* (e.g., the IPS management program option) can be expressed as:

$$U_{ijt}=V(x_{ijt}) + \varepsilon_{ijt} \quad (1)$$

where individual *i* (i= 1, ...N) obtains utility (*U*) from choosing alternative *j* (in our study, *j*= alternative I, alternative II, and the status-quo) in each of the choice sets *t* (t= 1, ...n) presented to them. Following Lancaster's theory, the utility derived from any alternative depends on its attributes *x*.

[1] Nepal has a two-tier system of local governance, with village development committees and municipalities. While the village development committees are rural focused, the latter is an urban-focused body for local governance.

As respondents are rational and try to maximize their utility selecting the best option, alternative *j* will be chosen over some option, *g*, if the 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. The probability (P) that individual, *i*, will choose option *j* over other options, *g*, in a complete choice set *C*, is given by,

$$P(j|C) = P\{(U_{ij} > U_{ig}, s.t. \forall g \in C, and\ j \neq g) \quad (2)$$

The error term ε is assumed to have identical and independently distribution (IID), and the relationship between utility and attributes is linear in parameters and variables. Therefore, equation (2) is estimated with a conditional Logit model (McFadden, 1974). The indirect utility function for the estimation is,

$$V_{ijt} = ASC + \beta_i x_{ijt} \quad (3)$$

where the alternative specific constant (ASC) captures the effects on utility of variables not included in the choice set and β is vectors of coefficients associated with *x*, a vector of attributes included in choice sets. In empirical estimations, the ASC is a dummy variable and is coded with 0 for the status-quo, and 1 for all alternatives.

The conditional Logit model based on IID error terms implies a number of restrictions including on the property of independence of irrelevant alternatives (IIA). There are also limitations 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 (Ben-Akiva and Lerman, 1985). To relax the IIA assumption, the conditional Logit model can be generalized into a mixed Logit or random parameters Logit (RPL) model (Train, 1998).

In the RPL model, the observed component ($\beta_i x_{ijt}$) given in equation (3) is expressed as the sum of the population mean (β') and individual deviation (η). The coefficient vector, η, captures a random, unconditional and unobserved type of taste heterogeneity of each random parameter β' (Grosjean and Kontoleon, 2009). In order to capture the source of heterogeneity, we can include socio-economic variables (s) in the utility function. Hence, the indirect utility function becomes

$$V_{ij} = ASC + \beta' {}_i x_{ijt} + \eta' x_{it} + \gamma S_i \quad (4)$$

The respondents' characteristics do not vary over choices. In this form of estimation, we capture the conditional type of preference heterogeneity by interacting socio-economic characteristics with given attributes. The socio-economic variables, *S*, with coefficient vector (γ) enter as interaction terms with the management program attributes and ASC. These interaction terms examine the impacts of individual-specific characteristics on selected alternatives.

Table 2 specifies the socio-economic variables used in this study and their coding. Individual-specific characteristics such as age, gender, income, and occupation of respondents, are expected to have a significant influence on the selection of alternatives for forest management programs (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 of forest products collection in rural Nepal (Adhikari et al., 2004a; Sapkota and Oden, 2008). The Terai of Nepal has heterogeneous communities because of extensive migration from the hills due to more productive agricultural land and increasing availability of modern facilities in the Terai. This feature makes the origin of respondents also an important variable in estimating community preferences over forest resources in the study area.

4.2 Experimental Design

A choice experiment requires two separate components to capture the preferences of respondents: a statistical design to create the hypothetical scenarios and a statistical method to analyse responses (Louviere et al., 2000). The first step is to define the attributes and their levels. This step was undertaken and finalized based on a thorough discussion with local villagers in five focus groups; consultation with local experts; and a review of BZCFUGs records, reports and literature. Following Bergmann et al. (2006), we asked the focus group participants to prepare

a list of changes as a result of the *Mikania* colonization. Participants then ranked the effects based on a majority voting system. Their ranked attributes were: forest products collection time, visitors to community forests, plant species richness, forest density, natural regeneration, number of livestock, and increased wild animals raiding. We then selected the top two attributes to reduce the complexity of the task and combined them with two payment attributes to form the choice sets for the study (see Table 1). The two attributes selected are similar to motivational factors (such as tourism, ecosystem services, and local economy) identified by García-Llorente et al. (2011) as factors that typically influence individual's willingness to pay to support IPS management in a hypothetical market.

The second step is to create several choice sets to which local households could respond. Each of our choice sets included the two identified attributes – forest product collection time, which is expected to decrease with improved *Mikania* management and tourism or 'visitors to community forests', which is expected to increase with better management. The choice sets varied in terms of levels of these two attributes i.e. how much change would occur with forest product collection and increased tourism.

The level of the attribute 'visitors to the community forest' is primarily based on the visitors' record maintained at the BZCFUGs. The upper limit on the number provided by the participants describes their target with regard to increasing the number of visitors to the community forests. For the purpose of determining the number of visitors to the forests, we added and averaged the number given in the records of the studied BZCFUGs. We found that BZCFUGs host approximately 20,000 visitors annually, though this was on average as high as 30,000 five years ago. Focus group participants attributed the decrease in visitor numbers in their BZCFUGs mainly to the *Mikania* colonization since it reduces the likelihood of seeing wild animals due to habitat shifting while the trails for jungle walks are also obstructed. At a meeting with executive members of the concerned BZCFUGs which was held after focus group meetings, they affirmed that they have plans to double the number of visitors to their forests. Based on these discussions, we identified 3 levels (current numbers, 1.5 times as many as current and twice as many as current) for the 'visitors to community forests' attribute (see Table 1).

The attribute 'forest product collection time' was ascribed 3 different levels (4 hours, 2 hours and 1 hour). These levels were based on the experience of focus group participants. Before *Mikania* was introduced, according to the participants of our focus groups, an hour was adequate to collect their daily requirement of fodder and fuel-wood (this does not include the walking time to the forest and back). After the colonization of Mikania, however, approximately four hours on average is required for the same purpose. Thus, local households see *Mikania* has having had a significant effect on their forest product collection time.

The choice sets also included two payment attributes, i.e. ways in which local communities could express their willingness to pay for reducing *Mikania* and thereby achieve improvements in the two previously identified attributes Our two payment attributes for this choice experiment were 'annual membership fee', as an indicator of monetary willingness to pay and 'labor contribution' as a forest management activity to reduce Mikania.

A *Mikania* management program generally involves the periodic cuttings of vines. We, therefore, informed respondents that a periodic cutting was the proposed forest management activity. Since community forest users are often involved in weeding, pruning and thinning activities in local forests, they understand these to be forest management activities. We clarified to them that involvement in a *Mikania* management program would be similar to their regular forest management activities, but would have an additional contribution in the form of labor for cutting vines and/or annual membership fee to have the task undertaken. In community forestry practices, forest users generally pay a fixed amount of annual fee while also participating in forest management activities. Hence, we expect them to be familiar with these two types of contribution and able to decide on a trade-off between them while selecting the utility maximizing alternative in the choice sets.

An important issue in designing monetary payments is the mechanism through which the payment could be made. We first discussed a buffer zone level fund for the *Mikania* management program as a payment vehicle. However, like many other rural people who often entertain serious doubts regarding the proper use of public funds, the focus group participants were not confident about the proper utilization of funds if the fund was centralized at the buffer zone level. Instead, they proposed that the fund be managed at the BZCFUG level. They were confident that households would be willing to contribute a mandatory 'annual membership fee' at the user group level. The

collected fees could then be allocated for *Mikania* management activities since users have the right to both monitor and determine the utilization of user group funds. This fee would be for a period of five years since the operational plan, which describes the planned operations for the buffer zone community forests, is usually for a period of five years. The funds thus collected would be exclusively devoted to improving the condition of their community forests through the implementation of a *Mikania* management program. Four levels 0, NRs. 1,050, NRs. 1,750, NRs. 2,450) were ascribed to this household-level payment attribute based on focus group discussions,

Because we were undertaking a choice experiment in a subsistence economy, we identified a second payment attribute. WTP is usually determined as a function of the respondents' income. However, estimating WTP for any change in a subsistence economy, where most of the economic transactions are non-monetized, can pose problems. The concern is that a low WTP may mislead those in charge of policy development. In such scenarios, some contingent valuation surveys have used labor contribution as a measure of utility (Mekonnen, 2000; Alam, 2006; Hung et al., 2007; O'Garra, 2009). We followed the same strategy in using labor contribution as one payment vehicle. In order to determine the levels of the labor payment attribute, we asked focus group participants how much their household could contribute annually to mitigate the damages caused by Mikania. They proposed a realistic range that was either a labor contribution between one- to seven-days annually or an equivalent financial contribution at the average wage rate of NRs. 350/day. As identified in Table 1, the household labor levels ascribed to this payment attribute were 0 days, 3 days, 5 days and 7 days.

The next step in the choice experiment, once we identified the four attributes and their levels, was to create the choice sets that households to which households would respond. Since each of the four attributes had several levels, combining these into a limited number of choice sets (combinations of alternatives) that make sense is not easy. For this purpose, we used asoftware (Ngene (1.0.2) that is often used for generating experimental designs for CEs.

Choice experiments always have design restrictions that need to be imposed – these reflect reality and are necessary so we do not have an over-whelming array of choices. It is particularly important to give due consideration to the complexity of the task in the context of developing countries (Bennett and Birol, 2010). In our case, a restriction was place on the software to ensure that respondents always had the opportunity to choose one positive payment attribute in any choice set. Thus if a choice set included a labor contribution level equal to 0 days, it also included a positive annual membership. Similarly 0 membership fee was coupled with different positive levels of labor contribution. However, it was possible for households to choose an alternative that combined both labor and monetary payments, i.e. households could choose to provide some labor and some money.

Another issue to consider in designing the choice sets is 'efficiency'. Efficiency is a statistical measure of how good the design of the experiment is. Generally, the higher the efficiency the lower the standard errors in the parameter estimate. There are several design strategies in choice experiments and we considered what is referred to as 'D-efficient design'. This design is considered to be more appropriate relative to the widely used orthogonal design when responses are analysed in logistic models (Ferrini and Scarpa, 2007; Scarpa and Rose, 2008; Bliemer and Rose, 2010). A D-efficient design requires prior parameter information to create hypothetical scenarios. There are many ways of estimating the priors. While some consider the null hypothesis (zero priors), others assume some prior knowledge about the parameters (Bliemer and Rose, 2010). These values can be obtained from different sources such as previous studies, piloting, and assumptions based on available information. In the case of our study, we estimated the priori information about parameters from the pilot study.

Once all this information is fed into the computer, using the Ngene software, we were able to generate 24 choice sets. Each choice set had three alternatives – Alternative I and Alternative II offered new policy changes. Alternative III represented the status quo. These alternatives are distinguished by different levels of the 4 attributes. Thus each Alternative offered the household a picture of the benefits (improvements in tourism and forest product collection time) and costs (payment attributes) from better managing Mikania. Alternative I and II differed across each choice set while Alterative III stayed un-changed across all choice sets. Household respondents were asked to pick one alternative out of the three for each choice set that they were offered.

The 24 identified choice sets were divided into six versions of the survey questionnaire (see Annex 1). In other words, each version of the questionnaire has four choice sets. Thus, each household had to choose Alternative I, II or III four times.

We provided visual images of the choice sets using pictographs for attributes and vertical bars for levels in order to make scenarios respondent friendly (see Figure 2 for an examples of a choice set). Visualization of the choice cards seems to enhance the efficacy of the choice task in communities with low literacy levels (Jae and Delvecchio, 2004; Brouwer et al., 2010).

4.3 Household Survey

The questionnaire included three sections (see Annex 2). The first section introduced IPS and the existing situation in the buffer zone. In addition, this section described the proposed plan to mitigate the damages caused by the infestation of *Mikania* and the need to raise funds to implement the mitigation policies. It also requested respondents to select their preferred option from the policy alternatives presented in the choice sets. Each option presented two payment attributes for the next five years. Follow-up questions were asked to help the researcher understand the decision-making strategies of respondents (Do and Bennett, 2009). These questions were about their preferred mode of payment, whether money or labor, and who they thought was responsible for carrying out a *Mikania* management program.

The second section in the questionnaire focused on current problems related to Mikania. It asked what changes respondents are experiencing following the infestation of Mikania. The third section in questionnaire gathered household information.

We selected a team of local enumerators to conduct the household survey of our study. Since the enumerators were not familiar with CE exercises, the research team first trained them and then supervised them regularly throughout the interview process. We considered various social and cultural issues when selecting the enumerators as recommended by Puetz (1992). Recruitment of local enumerators was beneficial because it is not socially acceptable for outsiders to approach female respondents and the local ethnic community has their own dialect. In addition, we gave each enumerator a folder containing choice sets on colored sheets so that they could show the sets to the respondents while describing the scenarios. We also gave the respondents a plain language statement (Annex 3) to read. This statement describes the research, the researchers and our study objectives. The enumerators would read the statement to the participants as per their request and need before asking them whether they were willing to participate in the research.

Taking into consideration the known correlation between household dependency on forest products and distance to the forest (Sapkota and Oden, 2008), we stratified the households into three groups based on their proximity to the forest: i.e., less than 1 km, 1 to 2 km, and more than 2 km. We selected households systematically for the purposes of the research, i.e., while the first household was selected randomly, every 10th household thereafter was interviewed. Moreover, with regard to questionnaire distribution, while the first household received the first version of the questionnaire, the second selected household received the second version, with this pattern of distribution continuing for the entire survey. This meant that every seventh household obtained the same version of the questionnaire.

In order to ensure that all respondents were clear about the species to be discussed, we showed the respondents a photograph and a specimen of the *Mikania* vines before the interview. We interviewed household heads, irrespective of gender, because they hold decision-making power with regard to household expenditure. We conducted the interviews in *Nepali* and *Tharu* (local dialect) as appropriate. All the households that we approached participated in the research.

5. Results and Discussion

5.1 *Mikania* and Rural Livelihoods

Table 2 reports the sample household characteristics. Of the total (325) heads of households interviewed, the majority (56 percent) were male. The high number of female respondents was not surprising given that, in many households, the men were absent as they were working away from home. Of the total interviewed households, two-thirds were farmers while the remainder had off-farm activities as their main source of household income. In addition, households diversify their livelihood strategies by involving themselves in tourism and going abroad for employment. Ninety nine percent of the respondents felt that the spread of *Mikania* has been increasing over the last five years.

Sixty one percent of respondents said there had been a decrease in forest products, including fodder and firewood availability, in their community forests over the last five years. In addition, 73 percent of total respondents said the condition of their community forests was comparatively worse than it was five years ago. However, BZCFUGs were regularizing the collection of forest products and had imposed a ban on cattle grazing in order to arrest rapid resource depletion. This was forcing some rural farmers to use the *Mikania* vines for fodder even though it is not a preferred species (Siwakoti, 2007; Rai et al., 2012b). A small number of respondents (~7 percent) were using Mikania, particularly as goat fodder, during the dry season when other fodder is not adequate. The number of *Mikania* users is expected to increase given its abundant growth.

In order to compensate for the reduction in forest product availability, households were executing different coping strategies, whether they were using *Mikania* or not. The coping strategies practiced by the buffer zone households were: plantations on private land (85%), collecting forest products from the core areas of the national park (35%), using alternative energy sources such as bio-gas and liquefied petroleum gas (56%), and purchasing firewood and fodder from the local market (72%). Most households were using more than one strategy. This makes it evident that buffer zone households were already bearing the costs of the invasion of Mikania, which would make them willing to invest in the management of the *Mikania* infestation.

5.2 Choice Experiment Analysis

We analysed the choice data set using LIMDEP 9.0 (NLOGIT 4.0). We found the follow-up questions helpful for understanding the respondents' decision-making strategies and heuristics (Carlsson et al., 2010). Only three respondents (~1 percent of total respondents) selected the option that the government, *not citizens*, should pay for the IPS management program. We considered these respondents as protest respondents and excluded them from the analysis.

Out of the remaining respondents, 36 percent (117) showed their preference to participate in monetary terms while 63 percent (205) preferred to participate in labor contribution terms. This result is consistent with previous contingent valuation studies that provide an option to respondents to select their mode of contribution, whether monetary or non-monetary (Alam, 2006; Hung et al., 2007; O'Garra, 2009). This suggests that the estimated social benefits of IPS management programs depend not only on the outcomes of IPS management activities but also on whether or not respondents are allowed to express their WTP in non-monetary terms. If low-income households are asked to express their WTP only in monetary terms, it would underestimate their WTP.

We use the conditional logit model to examine variations in effects of the IPS management program (see Table 3). In this regression, the dependent variable is 'choice'—the chosen alternative was coded as 1, whereas the remaining alternatives were coded as 0.

We interacted socio-economic variables with the ASC and attributes and then performed a Hausman test to confirm the IIA/IID condition in the conditional logit model, which revealed that the data did not support the test as the difference matrix was not positive definite. Hence, we estimated a RPL model, which relaxes the IIA assumptions. We included only significant socio-economic variables in the RPL model.

In order to determine the model with the best fit, we compared the conditional logit and RPL model using a Swait-Louviere log-likelihood ratio test (Rolfe et al., 2000). The calculated statistics[2] ($\chi 2$) 22.32 was greater than a critical $\chi 2$ of 3.84 at one degree of freedom. The degrees of freedom are given by the difference in the number of parameters estimated in the two models. This indicates that the RPL model provides a significant improvement in model fit over the conditional logit model. In addition, the value of *pseudo* R^2 increases from 0.301 in the conditional logit model to 0.315 in the RPL model. Hence, we used the latter model for further analysis and discussion.

It is common to assume that random parameters have a log-normal and normal distributions; hence these distributions are used for estimation (Carlsson et al., 2003). To identify the distributions of the random parameters, we followed Hensher et al. (2005). First, we estimated two attributes: 'visitors to community forests' and 'forest products collection time', as random parameters, while estimating the two payment attributes as non-random. We then re-estimated the random parameters with insignificant standard deviations as non-random parameters, while we used different distributions to estimate the model.

We estimated the results of the RPL model with a 1,000 random draws (see Table 3 and treated only the attribute 'visitors to community forest' as a random parameter with a normal distribution significant at the one percentage level. The random parameter indicates that the buffer zone community shows heterogeneous preferences regarding the attribute and that the normal distribution does not set any constraints on the sign of the parameter (Train, 2003). The model is statistically significant overall with Chi-square statistics of 1459.69 with 12 degrees of freedom while the *p*-value is practically zero. The value of *pseudo* R^2 of this model (r2 = 0.31) indicates that the model is a good fit (Hensher and Johnson, 1981).

The results of both the conditional logit and RPL models indicate that respondents have a preference towards less 'forest products collection time', more 'visitors to community forests', and less 'labor contribution' and a lower 'annual membership fee'. The likelihood of selecting alternatives I or II against the status quo increases with an increase in number of visitors to community forests, and decreases with an increase in forest products collection time, labor contribution and annual membership fee. The negative sign of the ASC, which is coded with 0 for the *status-quo* and 1 for Alternatives I and II, indicates that there are some respondents who prefer the current situation.

The results show that the selected socio-economic variables influence the probability of selecting an alternative choice set. This suggests that the impact of the *Mikania* infestation differs from one socio-economic group to another. One variable positively associated with selecting alternatives is family size. In the buffer zone of CChitwan National Park, members of the indigenous *Tharu* community live in joint families. Typically, family size is positively associated with the contribution to public activities as large families have strong social networks (Beard, 2007).

Farm households select alternatives that promote IPS management more frequently than their neighbors whose primary income source is off-farm activities. This finding is reasonable considering that the infestation of *Mikania* has adverse effects on farm-based livelihoods, including livestock-keeping and fuelwood consumption (Rai et al., 2012b), making farmers more desirous of improved forest conditions than others. However, farm households preferred to contribute in labor terms in comparison with their neighbors whose main income source was off-farm activities.

Households with large livestock herds mostly preferred choice sets that included lower forest products collection time because they spend much of their time on collecting fodder. Gender too brought about a variation in the selection of options. Women preferred options with less forest products collection time since women in general are responsible for collecting basic forest products in rural areas (Fish et al., 2010). Households with larger parcels of land did not go for the options with less collection time as they are less dependent on community forests than other groups. Since they can collect the required forest products from their own land (Sapkota and Oden, 2008), a change in forest products collection time may not be in the interest of wealthier households.

[2] Calculated (χ^2) =-2(LL_1-LL_2), where LL_1 and LL_2 are the value of log-likelihood in conditional logit and RPL models respectively. Here, the value of LL_1 was -598.54 and LL_2 was -587.38.

5.3 Estimation of Willingness-to-pay (WTP)

The estimation of social benefits from the IPS management program is usually carried out in three steps. The first step is to estimate the marginal value of each attribute. Next, individual household's WTP for different proposed scenarios is estimated. Finally, the aggregate of individual WTP is estimated in order to estimate the social benefits.

5.3.1 Marginal Willingness to Pay for each Attribute

The marginal value of each attribute (increased visitors and reduced time in forest product collection) represents the marginal benefit to the household from a small change in a particular attribute. It is possible to estimate the marginal value of a change in an attribute as a ratio of the coefficient of the attribute to the coefficient of the cost attribute. We can interpret this marginal rate of substitution as the marginal willingness-to-pay (MWTP) for a change in that attribute. Here, we calculated the MWTP for each attribute (k) as a negative ratio between the coefficient of the attribute (k) and the payment attribute (c). For the random parameter– visitors to community forests– we estimated the following equation with normal distributions (Hensher et al., 2005):

$$MWTP_k \quad \frac{-(\beta_k + \sigma_k * \varphi)}{\beta_c} \tag{5}$$

where, β_k is the mean of the random parameter k, σ_k is the standard deviation of the random parameter k, and φ is a standard normal deviate from a random number generator. We estimated the implicit price for each attribute twice using the two payment attributes individually. Thus, the denominator in equation (5), β_c reflects either labor contribution or monetary willingness to pay.

We obtained the estimated MWTP for each attribute in this manner as reported in Table 4, after dropping the alternative payment attribute. Thus, we estimated the MWTP either in monetary terms (NRs) assuming the labor contribution to be zero or in labour terms assuming monetary contribution is zero.

The estimated marginal values of attributes can be expressed in monetary terms or in labor terms. WTP is estimated for an hour's decrease in forest products collection time per day and an increase in one thousand tourists. In monetary terms, WTP for these two attributes is NRs. 541(USD 6.94) and NRs 240 (USD 3.07) respectively. In labor terms, households are WTP 1.43 labor days for an increase in one thousand visitors and 3.26 labor days for a decrease in collection time of forest products each day by one hour.

We found that the estimated MWTP of each attribute has the same dollar value when we use either monetary payment as the numéraire or labor time, with labor values converted to monetary values based on the estimated shadow value of time. This result suggests that households are clear about the trade-offs between their labor time and their monetary willingness to pay. In order to obtain the shadow value of time, we estimate the MWTP of labor through equation (5). Here, we treat β_k as the labor payment attribute and β_c as the monetary payment. As shown in Table 4, the estimated shadow value of time is NRs.166 (USD 2.12) per day.

The estimated MWTP for time spent in an invasive species management program (the average shadow value of time) of NRs 166 is equal to 47 percent of the market wage rate (NRs. 350/day) of agricultural labor. This suggests that existing methods of estimating the value of time spent in public work using either the market wage rate or the usual leisure rate of time at about a third of the value of wage rate (Cesario, 1976; O'Garra, 2009) may not produce reliable results.

5.3.2 Household Willingness to Pay for an Improved Scenario

The social benefits generated from any IPS management program are equivalent to the value of a change in welfare to all households. After estimating the marginal values of each attribute, we carry out the welfare estimations in two steps. The first step is to estimate the overall change in each household's welfare, which is then aggregated to compute the change in social welfare for all affected households.

It is possible to estimate average household welfare measure from better IPS management as the compensating surplus (Hanemann, 1984):

$$CS = \frac{-(V_0 - V_1)}{\beta_c} \quad (6)$$

where, V_1 is the utility of the projected scenario, V_0 is the utility from the *status-quo* (without any intervention), and β_c is the coefficient of the annual membership fee. Here, CS is estimated in monetary value terms because our analyses using either mode of payment produced the same value. Typically, CS is the mean WTP to go from the current situation (V_0) to the improved condition of community forests after the implementation of the program (V_1). The value of the projected scenario (V_1) includes improvement in forest products collection time and annual visitors to community forests as well as the ASC.

In order to estimate equation (6), we need to identify one clear policy alternative out of the many alternatives possible. Table 1 reports the current situation and alternative change scenarios. A moderate policy change scenario that seems most feasible is a reduction in the average collection time (for a day's requirement of forest products) by two hours and an increase in annual visitors by 7,000 along with no additional labor contribution to IPS management.

Hence, using this policy scenario, equation (6) is extended as;

$$CS = \frac{-\{(\beta_{fp} * 4 + \beta_v * 20,000 + \beta_L * 0) - (\beta_{asc} + \beta_{fp} + 2 + \beta_v * 27,000 + \beta_L * 0)\}}{\beta_F} \quad (7)$$

where, β is the estimated coefficient associated with variables fp, v, L, F, and ASC. These variables represented forest product collection time, visitors to community forests, labor contribution, annual membership fee and the alternative specific constant.

The annual household benefits resulting from moving from V_0 to V_1, or the household WTP (WTPhh) for the above discussed policy scenario is NRs. 2,382 (USD 30.53). Chakrabarty et al. (2011) estimate average annual household income in the study region to be NRs. 66,420. Thus, our estimated annual WTP amounts to four percent of the average annual household income in the region.

Since the IPS progam was presented to households as 5 year program, it is appropriate to estimate the net present value of welfare changes or CS over a five-year period. To do this, we have calculated the present values of the CS using three discount rates at three, five and seven percent (see Table 5). The calculations show that in 2011 the present value of the average WTP per buffer-zone household for the specified forest improvement ranged from NRs 10,450 (USD 134) to NRs 11,236 (USD 144). The lower-bound and upper-bound estimations are at three and seven percent discount rates respectively.

5.3.3 Aggregate Social Benefits

The next step is to estimate the social benefits generated from the *Mikania* management program. We estimated social benefits using two approaches, which are based on the preferred payment option of respondents in the follow-up question: (i) respondents who elected to contribute in monetary terms and (ii) all respondents, with the exception of those who believed that the government should pay for the IPS management programs. The first approach to estimating social welfare, which provides a lower bound, describes the conventional method to estimating WTP. The second approach offers a higher bound of aggregated WTP values for the buffer zone community of Chitwan National Park to mitigate the damages caused by *Mikania micrantha*.

We calculated the annual social benefit for the buffer zone community of Chitwan National Park (WTPtotal) using the following equation:

$$WTP_{total} = WTP_{hh} * HH * R_{wtp} \quad (8)$$

where WTPhh is the mean annual household WTP (NRs. 2,382), HH denotes the total number of households in the buffer zone (44,918) and R_{wtp} is the percentage of respondents' willing-to-pay/willing-to-contribute. Here, the value of R_{wtp} is 36 percent for the first approach and 99 percent for the second approach.

Table 5 presents the economic value of benefits generated from a *Mikania* management program in the buffer zone of the Chitwan National Park. The lower and upper bound for estimated annual WTP of the buffer zone community is NRs 38.51 million (USD 493,820) and NRs. 106 million (USD 1.35) million respectively. The WTP range indicates that benefits from IPS management can be substantially underestimated (by approximately 64%) if low-income households are asked to express their WTP only in dollar terms.

We estimated the present values of WTP for a five-year period at both the household and the buffer zone levels. For a five-year period, the total benefits of the *Mikania* management program range from NRs 168.98 million (USD 2.16 million) (at 7 percent discount rate and the lower-bound WTP) to NRs 500 million (USD 6.41 million) (at 3 percent discount rate and the upper-bound estimate of WTP).

It is useful to compare our estimated benefits from a *Mikania* management program to any costs associated with management. Currently, the Government's buffer zone management budget does not include any specific program for *Mikania* management. The current costs to the Government or the annual budget for Buffer Zone management in the Chitwan National Park was approximately USD 1.02 million (or NRs. 80 million)[3] in fiscal year 2011/2012. Our upper-bound estimates suggest that households are willing to spend at least as much (USD 1.35 million) annually for *Mikania* management. The gap between the estimated social benefits and the annual budget indicates that there is potential to improve the social welfare of the buffer zone community through an IPS management program. If the program is properly implemented, local households are likely to be willing to pay for it.

Chitwan National Park earned an income, in terms of royalty, of NRs. 61 million (USD 782 thousands) in fiscal year 2009/2010 (DNPWC, 2011). The estimated WTP of an IPS management program is 1.73 times this annual income (considering the upper bound WTP amount of NRs.106 million (USD 1.35 million) per year). Thus, if *Mikania* is properly managed, there is the possibility of the Park increasing its revenues. This will of course depend on the actual implementation of any management program.

Social benefits would be even higher if we take into account the global WTP for IPS management since Chitwan National Park is listed as a World Heritage Site (Do and Bennett, 2009). The estimated WTP therefore makes it imperative that the Government of Nepal respond to the problem associated with invasive plants, particularly M. micrantha, as soon as possible since the cost associated with managing invasive plant species increases with time due to the speed at which they spread (Shackleton et al., 2007).

6. Conclusions and Policy Recommendations

This study contributes to the existing literature on management of biological invasion. Choice experiments are now a commonly used methodology for assessing household preferences. This study sheds light on how CE surveys can be used to elicit the preferences of low-income households.

The choice experiment we undertook allowed us to estimate the social benefits of a *Mikania* management program. Our study estimates that households in the buffer zone area of Chitwan National Park are willing to make an annual payment of NRs. 2,382 (USD 30.5) for a management program that increases tourists from the current level of 20,000 to 27,000 and reduces forest product collection time from the current level of 4 hours to 2 hours per day.

Since implementing a *Mikania* management program would take about 5 years, annual household benefits are re-calculated in present value terms. The per household benefits from a five-year management program are in the range of NRs. 10,450 (US$ 134) to NRs. 11,236 (US$ 144). If we aggregate these benefits over the entire buffer zone community, the net present value of benefits are in the range of NRs. 168.98 million (US$ 2.16 million) to NRs. 500 million (USD6.41 million). Thus, if more resources were allocated to managing the infestation of *Mikania* in the buffer zone of Chitwan National Park, social welfare would improve. Households would themselves be willing to contribute towards any such program, particularly with their own labor, if the program is properly implemented.

[3] We received this information from the Department of National Park and Wildlife Conservation, Nepal.

Choice experiments allows us to evaluate the marginal benefit households obtain from different strategies to manage invasive species. Our analyses suggest that households have different preferences over whether the *Mikania* management program helps bring in more tourists or reduce their own forest product collection time. The preferences over these attributes depend on the characteristics of households. For example, large landholding households are not interested in a change in forest products collection time, while female and households with larger livestock herds strongly prefer less forest production time. Hence, policy-makers will need to design strategies based on targeted beneficiaries. The results further show that agricultural households chose forest improvement alternatives most frequently over the status quo. Thus, agricultural households should be in the frontline in developing any IPS management strategy.

In our experiment, we a solicited household willingness to pay by including two payment attributes – monetary and labour costs – in our choice set. There are two major advantages to including two separate payment attributes in choice scenarios. First, we are able to estimate the social opportunity cost of time spent in an IPS management program. This addresses the theoretical complexity associated with using time as a numéraire and opens the door to implementing stated preference surveys in a subsistence economy. Second, it enhances the participation of low-income households in environmental decision-making processes. In our experiment, 64% of households were willing to contribute to a *Mikania* management time with their labor while only 36% were willing to make a monetary payment. The inclusion of two cost attributes, however, may create some complexity in estimating WTP as the respondents of the present study considered both payments while selecting the alternatives of their interest. This aspect could do with further analysis in order to explore the relationship between the two payment attributes.

The study concludes that choice experiments can be applied in subsistence communities to estimate the non-market value of natural resources. However, those adopting this method will need to consider several factors in the designing and implementing phases such as employment of local enumerators and their intensive training, use of visualized choice sets, optimization of the number of attributes and choice scenarios per each version of questionnaire, and inclusion of non-monetary payment attributes.

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Tables

Table 1: Attributes and Their Levels Used in Choice Sets

Attributes	Description	Levels	Current Situation
Forest products collection time	Time needed to collect forest products, mainly fodder and firewood, for daily requirements after arriving at forest excluding travel time to and from forest	4 hours , 2 hours, 1 hour	4 hours
Visitors to community forests	The 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	20,000
Labor contribution	Annual volunteer involvement of forest users in forest management activities	0, 3 days, 5 days, 7 days	No contribution
Annual membership fee	Annual household membership fee in each BZCFUG (NRs)	0, NRs. 1,050, NRs. 1,750, NRs. 2,450	No contribution

Note: NRs. is Nepalese currency, USD1~ NRs. 78.00.

Table 2: Socio-economic Characteristics of the Sampled Households

	Male	Female	Description
Respondents (by gender)	183	142	Gender of the respondents, male (0) and female (1)
Age	49.79 (12.80)[a]	42.08 (11.53)	Age of the respondents (years)
Education	5.02 (4.89)	4.03 (3.94)	Number of years attended school
Landholdings	11.90 (8.02)	10.21 (5.73)	Land holdings by households in Katha.*
Native	93 (50.8%)	66 (46.5%t)	Native to buffer zone of Chitwan National Park, native (1) and migrated (0)
Mikania users	14 (7.7%)	8 (5.6%)	Household using *Mikania* as fodder.
Income_agr	101 (55.2%)	113 (79.6 %)	Income source of respondents, agriculture (1) and off-farm (0)
Monetary contribution	57 (31%)	60 (42.3 %)	Number of respondents willing-to-pay in monetary terms.

[a] standard error in parentheses not followed by percentage

* Katha is a unit of area approximately equal to 67 square meters

Table 3: Results of Conditional Logit and Random Parameters Logit Models

Variables	CL	RPL
ASC	-0.305***	-0.320***
	(0.077)	(0.113)
Visitors to forests	1.38E-4***	2.16E-4***
	(9.28E-5)	(2.60E-5)
Forest products collection time	-0.398***	-0.496***
	(0.088)	(0.135)
Labor contribution	-0.091**	-0.152***
	(0.039)	(0.058)
Annual membership fee	-6.43E-4***	-9.17E-4***
	(1.10E-4)	(1.62E-4)
Family size ×ASC	0.468***	0.559***
	(0.138)	(0.176)
Income_agr ×ASC	1.090*	1.330*
	(0.630)	(0.706)
Livestock × FP collection time	-0.156***	-0.254***
	(0.028)	(0.053)
Income_agr × Labor contribution	0.060*	0.087*
	(0.031)	(0.048)
Landholdings × FP collection time	0.011**	0.022***
	(0.004)	(0.008)
Female × FP collection time	-0.140**	-0.268**
	(0.066)	(0.112)
Standard deviations of random parameters		
Visitors to forests		1.57E-4***
		(0.3E-05)

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

Table 4: Estimated MWTP (Controlling for the alterative payment attribute)

Attributes	Monetary (NRs)	Labor (Days)
Visitors (per thousand)	240 (3.07)	1.43
Forest products collection time	541.43 (6.94)	3.26
Labor contribution (per day)	165.72 (2.12)	-

* Value in parentheses in USD

Table 5: Estimates of WTP in NRs (USD in parentheses)

		Household Mean WTP (NRs)	Aggregated for the buffer zone Community (in'000)	
			Monetary Terms Only	Excluding Protests
WTP per annum		2,382 (30.5)	38,518 (494)	106,007 (1,359)
Discounted Household WTP for 5 years	3%	11,236 (144)	181,693(2,329)	500,045 (6,410)
	5%	10,828 (139)	175,101 (2,245)	481,902 (6,178)
	7%	10,450 (134)	168,987 (2,166)	465,075 (5,962)

Figures

Figure 1: Study Area

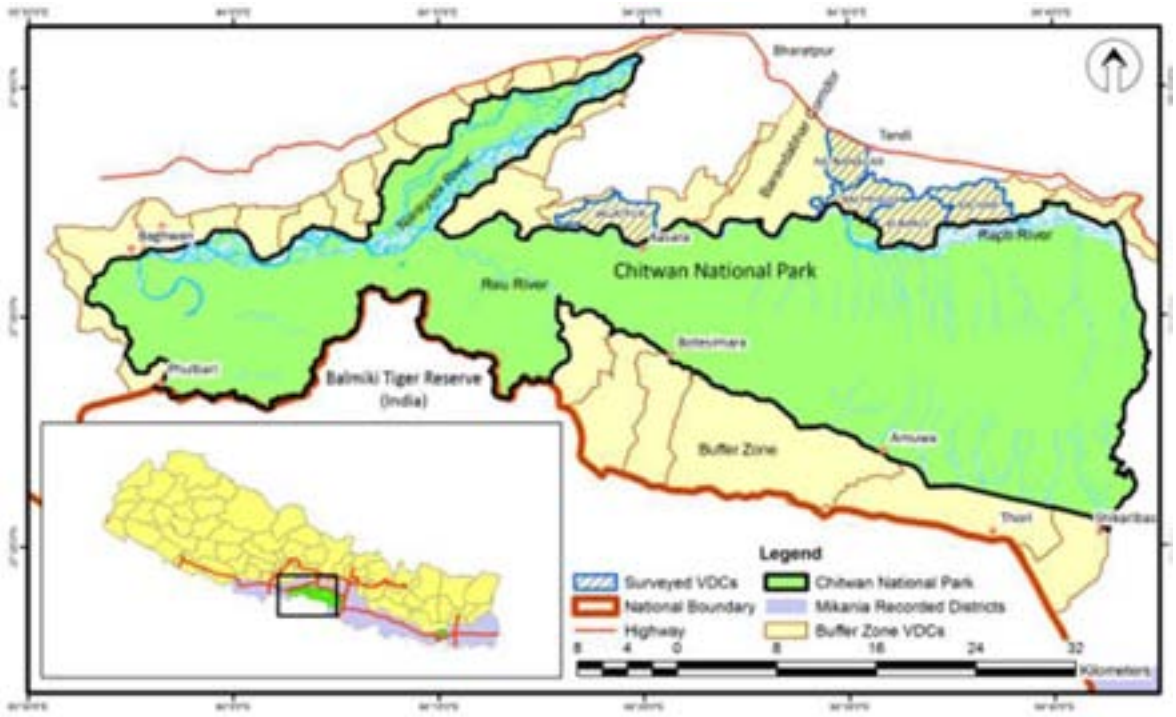


Figure 2: Example of a Choice Card

Choice Situation 1.1	Alternative 1	Alternative 2	Current Situation
Forest Products Availability 	1 hour	4 hours	4 hours
Visitors to Forests 	The same number as now	Twice as many tourists as now	The same number as now
Labor Contribution 	3 days	3 days	0
Annual Membership 	NRs. 1,050	NRs. 2,450	0
Select one (√)			

Annexes

Annex 1: The Design Matrix

Version	Choice Task	Forest Products Collection Time	Number of Annual Visitors	Labor Contri-bution	Cost (NRs)	Version	Choice Task	Forest Products Collection Time	Number of Annual Visitors	Labor Contri-bution	Cost (NRs)
1	1.1	1	20,000	3	1,050	4	4.1	2	30,000	3	2,450
		4	40,000	3	2,450			2	30,000	7	1,050
		4	20,000	0	0			4	20,000	0	0
	1.2	4	40,000	0	1,750		4.2	4	40,000	7	0
		1	30,000	7	0			2	20,000	0	1,750
		4	20,000	0	0			4	20,000	0	0
	1.3	4	40,000	7	0		4.3	2	20,000	3	1,750
		1	30,000	3	1,050			2	30,000	7	1,050
		4	20,000	0	0			4	20,000	0	0
	1.4	1	30,000	5	1,750		4.4	1	30,000	3	1,750
		2	20,000	5	1,750			2	30,000	5	1,750
		4	20,000	0	0			4	20,000	0	0
2	2.1	1	40,000	0	2,450	5	5.1	1	30,000	5	1,050
		4	30,000	5	1,050			4	30,000	3	2,450
		4	20,000	0	0			4	20,000	0	0
	2.2	1	20,000	0	1,050		5.2	1	30,000	5	1,050
		4	40,000	7	0			4	30,000	3	1,750
		4	20,000	0	0			4	20,000	0	0
	2.3	2	20,000	7	1,050		5.3	2	30,000	0	2,450
		4	40,000	0	2,450			4	40,000	7	0
		4	20,000	0	0			4	20,000	0	0
	2.4	4	40,000	0	2,450		5.4	2	20,000	0	1,750
		2	20,000	7	1,050			1	40,000	5	0
		4	20,000	0	0			4	20,000	0	0
3	3.1	2	30,000	7	0	6	6.1	2	20,000	5	1,050
		2	30,000	0	2,450			4	40,000	3	2,450
		4	20,000	0	0			4	20,000	0	0
	3.2	2	30,000	5	1,750		6.2	1	40,000	3	0
		1	30,000	3	1,050			4	30,000	5	2,450
		4	20,000	0	0			4	20,000	0	0
	3.3	4	40,000	0	2,450		6.3	1	30,000	3	1,050
		1	20,000	5	0			2	20,000	5	1,750
		4	20,000	0	0			4	20,000	0	0
	3.4	4	40,000	7	0		6.4	4	40,000	0	2,450
		1	20,000	0	1,750			1	20,000	5	0
		4	20,000	0	0			4	20,000	0	0

Annex 2: Questionnaire

"Valuing the Damage Caused by Invasive Plant Species in a Low Income Community in Nepal"

Researcher:

Rajesh Kumar Rai

Deakin University, Australia

and

South Asian Network for Development and Environmental Economics (SANDEE)

Household Code:

Date of Interview:

This study is a part of the research for the researcher's doctoral dissertation. The confidentiality of the supplied information will be duly maintained and only aggregated results of the questionnaire will be published.

PART I: State of the Area

Invasive species refers to an exotic species where their distribution beyond the natural habitat influences a native ecosystem. *Mile-a-minute* (*Mikania micrantha*), a fast growing South American climber, is colonizing your community forests rapidly. This species is displacing native vegetation, as it carpets forests and grasslands.

We are interested in your opinions about *Mile-a-minute* in the forest areas that your household has used during the past 5 years. We are interested in only your household's use of the forest, not use by other households in your village or other villages.

1. When do you think it first arrived in the forest?

_____

_____

2. Where do you think it came from in the forest?

_____

_____

3. How do you think the species came to the forest?

_____

_____

4. Has the abundance of *Mile-a-minute* changed over the last 5 years?
   a) Increased b) Decreased c) Not at all d) Can't say

5. How do you describe the effects on your life of *Mile-a-minute* invasion?
   a) Positive b) Negative c) Not at all d) Can't say

6. In your opinion, what is the current condition of your community forests in general?
   a) Close to nature b) Good c) Ok d) Bad e) Very bad f) Cannot say

7. Do you prefer the current situation or the situation 5 years ago?
   a) Current b) 5 years ago c) Cannot say

8. There are many way to manage the forests in order to enhance the availability of forest products that are useful to your households and manage them in a sustainable way. The condition of your community forest is likely to depend upon which forest management activities are adopted. Since forest management activities require cost, your household may need to contribute to the forest management program for the next five years. What do you think of the idea that costs of forest management should be shared among households, with households being able to decide whether or not to contribute?

   a) Good b) Bad c) Cannot say

9. In this part, we want your opinion on the improvement of the conditions of your community forest from now until 2015. There are three alternatives in each "Choice Situation". The choice situation consists of two policy alternatives and one option where there is no change from the current policy. Alternatives will be labeled "Intervention A", "Intervention B" and "No change to intervention levels (C)".

At present, there are no specific forest management activities focusing on the colonization of *Mikania micrantha*. To implement a sustainable forest management plan in a changing environmental, your user group requires a fund. We propose an increase in the annual membership fee of the community forest to implement the specific policy for each household for a 5-year period, which is included in Intervention A and B. In 'No intervention" no additional cost is imposed on the household.

The alternative conditions are described by means of the following attributes:

Attributes	Description	Levels	Current Situation
Forest products collection time	Time required for each trip for a day's requirement (hours)	4 hours* , 2 hours, 1 hour	4 hours
Visitors to community forests	The 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	20,000
Labor contribution	Annual volunteer involvement of forest users in forest management activities	0 day, 3 days, 5 days, 7 days	No contribution
Annual membership fee	Annual membership fee in each BZCFUG (NRs)	NRs. 0, NRs. 1,050, NRs. 1,750, NRs. 2,450	No contribution

In each situation, please choose the alternative that best describes your expectation. Please consider what you think is best. When you make the selection, please consider your income or available time after necessary expenses such as food, housing and clothing have been met.

Please check one box in each situation (This part varies in each version- see Annex 1).

(Here enumerators showed choice card as shown in Figure 2 to describe the scenarios).

Choice Scenario 1.1			
	Alternative 1	Alternative 2	Status-quo
Forest products availability	1 hour	4 hours	4 hours
Number of visitors to forests	The same number as now	Twice as many tourists as now	The same number as now
Labor contribution	3 days	3 days	0
Annual membership	NRs. 1,050	NRs. 2,450	0
Select one (√)			
Choice Scenario 1.2			
Forest products availability	4 hours	1 hour	4 hours
Number of visitors to forests	Twice as many tourists as now	The same number as now	The same number as now
Labor contribution	0 day	7 days	0
Annual membership	NRs 1,750	NRs. 0	0
Select one (√)			
Choice Scenario 1.3			
Forest products availability	4 hours	1 hour	4 hours
Number of visitors to forests	Twice as many tourists as now	The same number as now	The same number as now
Labor contribution	7 days	3 days	0
Annual membership	NRs. 0	NRs. 1,050	0
Select one (√)			
Choice Scenario 1.4			
Forest products availability	1 hour	2 hours	4 hours
Number of visitors to forests	One and a half as many tourists as now	The same number as now	The same number as now
Labor contribution	5 days	5 days	0

Annual membership	NRs. 1,750	NRs. 1,750	0
Select one (√)			

Background Information about Answering the Question

10. Which mode of payment do you prefer to pay to implement the proposed forest improvement activities?

    a) Cash b) Labor

11. While choosing the preferred alternative, did you consider every part of each alternative?

    a) Yes b) No

12. Were some characteristics more important than others?

    a) Yes b) No

    If yes,
    12.1 What are they?

    a.

    b.

    c.

If you chose alternative C (status-quo) in all choice situations, describe the reason why you prefer the current situation.

_____

_____

Part II: Impacts of *Mile-a-minute* on Livelihoods

14. Do you feel a change in forest products availability after their arrival?

    a) Yes b) No c) Cannot say

15. If yes, how do you evaluate the change in forest products availability after the introduction of *Mile-a-minute*?

Forest Products	Change (Increased/ Decreased/ No change/Cannot say)	Plant Species Collected	
		Before Invasion	Now
Fuelwood			
Fodder			
Thatch grass			
Bedding material			
Vegetables			
Fruits			
Medicine			
Other.....			

16. How do you observe the following scenarios before and after arrival of *Mile-a-minute*?

	Before	Now
Time required for a round trip to collect forest products		
Number of visits to the forest to collect forest products per week		
How much forest products do you collect per visit?	Fuelwood: Fodder:	Fuelwood: Fodder:
Number of domestic animals	Buffalo: Cattle: Goat:	Buffalo: Cattle: Goat:

17. If decreasing, how do you compensate for the reduction in forest products?

    A) Reducing consumption b) Accessing more area c) Applying agro-forestry

    d) Buying e) Others _____

18. Do you use the species (*Mile-a-minute*)?

    a) Yes b) No

    18.1 If yes, what do you use it for? (For example: fodder, compost, mulching, briquette)

    _____

    _____

    18.2 How often do you use it?

    _____ Month

    18.3 How much do you collect each time?

    _____

    18.4 Which months of the year do you collect it?

    _____

19. Are there any impacts on your household activities due to colonization by *Mile-a-minute*?

a) Positive b) Negative c) Not at all

19.1 If positives or negatives, what are they? _____

a. _____

b. _____

c. _____

PART III: Personal Information

20. Individual

20.1 Age: ..... Yrs.

20.2 Gender:

20.3 Ethnicity:

20.4 Name of the Community Forest:

20.5 Distance to Forest..... min walk

20.6 Household Information:

SN	Age (years)	Sex (M/F)	Education (No. of years)	Occupation (Code*)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

*Code

Agriculture= 1, Business= 2, Service=3, Foreign Employment= 4, Cottage Industry =5, Agriculture + Other =6, Wage Labor= 7, Other =8 (please specify)

20.7 Landholding and Tenure

Land Characteristics	Land Type and Area (Perrings et al..)		
	Own Land	Shared Crop In	Shared Crop Out
Irrigated			
Unirrigated			
Private Land			
Others			

20.8 Major Crops and Annual Income from the Crops in the Past Year

Crops	Unit	Total Production	Unit Sold	Unit Price (NRs)
Rice				
Maize				
Wheat				
Mustard				
Potato Vegetables				
Fruits				
Others				

20.9 Income from Livestock Products

Product	Unit	Total Production	Unit Sold	Unit Price (NRs)	Total Income (NRs)
Milk					
Meat					
Egg					
Other Milk Products					
Others					

20.10 How long can the field crop production meet your household food demand?

a) <3 months; b) 3 to 6 months; c) 6 to 9 months; d) 9 to 12 months; e) >12 months.

20.11 Off-farm Income

Source	No of HH Members Involved		Annual Income (NRs)	
	Male	Female	Male	Female
Business				
Service				
Cottage Industry				
Wage Labor				
Remittance				
Pension				
Others				

21. Monthly Expenditure: NRs. ..... per month

22. For how long have you been living in the area?

a) Born here b) _____ years

Thank you!!!

Annex 3: Plain Language Statement

To: Potential Participant

You are invited to take part in this research project. Please note that your participation is entirely voluntary and can be withdrawn at any time. Deciding not to participate will not affect your relationship to the researchers or to Deakin University and SANDEE. Once you have read this form and agreed to participate, you will be interviewed using a questionnaire. The interview will take approximately one hour and you may of course decide to stop the interview at any point. You may keep this copy of the statement.

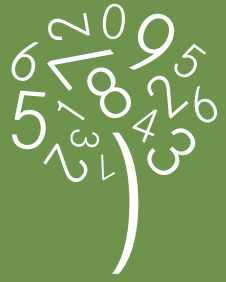
You have been selected as a member of a *Buffer Zone Community Forest User Group*, whose community forest is colonized by Mile-a-minute. The purpose of this research is to investigate the effects of Mile-a-minute infestation on the livelihoods of rural communities and to estimate the respondent's willingness-to-pay to avoid the damages caused by the infestation and improve the condition of the forest. This research aims to raise awareness about the colonization of invasive species such as mile-a minute and to provide valuable information to policy makers seeking to manage forests in a sustainable way. It also investigates the preparedness of forest dwellers to adapt to changing conditions. The questionnaire mainly contains:

- Hypothetical policy options which would have different impacts on forest conditions;
- Your household information (income sources, expenditure, dependence on forests);
- Changes in time required for forest products collection before and after the arrival of Mile-a-minute in your forests,

There are no right or wrong answers and the choices you will make are non-binding. We are interested in your opinion. We will take the handwritten notes of the interview on a questionnaire sheet. In accordance with Deakin University's ethics requirements, the following information and assurances are provided in relation to the questionnaire and its results:

- Your response to the questionnaire will be completely anonymous;
- The completed questionnaires will be secured in accordance with *Deakin Code of Good Practice in Research Procedure*. They will be stored for a minimum period of 6 years;
- Only aggregated results of the questionnaires will be published in a PhD dissertation and in referred journals, and presented at relevant academic conferences.

If you need any further information about the outcome of the project please contact: Rajesh Kumar Rai, Deakin University, Melbourne, Australia. Email- rkrai@deakin.edu.au



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