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Research paper

Willingness to pay for mitigating human-elephant conflict by residents of Nepal

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ABSTRACT

Human-elephant Conflict (HEC) is a significant problem in Nepal, with approximately two-thirds of households being impacted by elephants (*Elephas maximus*), particularly during the winter. In addition to elephant casualties, more than 10% of the households surveyed have had human casualties (injury or death) during the past 5 years. This study evaluates the economic viability of elephant conservation in Nepal within the context of current and proposed HEC mitigation scenarios. Face-to-face interviews were carried out using a structured questionnaire to elicit the residents' willingness to pay (WTP) for elephant conservation and HEC mitigation programs using seemingly unrelated regression (SUR). Residents' WTP was found to be positively related to income and education, and negatively related to damage-related programs. Local stakeholders were willing to pay about 42% more to programs that were economically transparent and improved upon existing management. Residents' WTP were also greater if they have had previous HEC-related injuries or deaths.

1. Introduction

Forest degradation and habitat destruction associated with increases in human populations have been accelerating at an alarming rate in South Asia over the past several decades. This is particularly problematic for Nepal, which is one of the most densely populated countries in South Asia. In the lowland Terai of southern Nepal, there has been a three-fold increase in the human population over the past 50 years (GoN/MoHP, 2011), resulting in the replacement of native forests and grasslands by farmland.

Large mammals, such as the Greater One-horned Rhinoceros (*Rhinoceros unicornis*), Bengal Tiger (*Panthera tigris*), Leopards (*Panthera* spp.) and Asian Elephant (*Elephas maximus*), interact with local inhabitants as they roam among remaining forests and into farmland in search of food, and ultimately contribute to human-wildlife conflict in the Terai of Nepal (Neupane, Johnson, & Risch, 2014). The Asian Elephant is the most problematic species of the large mammals, responsible for more than 40% of the wildlife-human conflict and 70% of the wildlife-caused human casualties in Nepal (Bajimaya, 2012). People in many villages of the Terai live in fear of being attacked by wild elephants (Yadav, 2004; Shrestha, Bajracharya, & Pradhan, 2007; Neupane et al., 2014). Human-elephant conflict (HEC) in Nepal has intensified in recent years (Neupane et al., 2014), and annual crop production in Nepal is reduced by about 25% in the Terai due to damage by elephants (Shrestha et al., 2007). The numbers of Asian Elephants throughout their range have declined by about half in the 20th century (CITES, 2004).

It is intuitive that people's attitudes towards environmental conservation efforts would take a 'back-seat' to the meeting of basic human needs such as food, shelter, and safety (Kaimowitz & Sheil, 2007). Both socio-economic and environmental variables interact in the development of attitudes toward elephant conservation, and understanding these variables is essential to formulating a long-term management plan to reduce HEC. Nonetheless, the government has been slow in protecting critical habitat and local inhabitants to reduce HEC. Mechanisms to reduce HEC and ultimately elephant deaths are thus vital.

Various techniques such as the hedonic pricing approach, the travel cost method, and the contingent valuation method (CVM), exist for the monetary evaluation of environmental and natural resource-related goods. However, the hedonic pricing and the

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travel cost methods have been criticized, primarily because they fail to effectively measure non-use values (Stevens, Benin, & Larson, 1995), such as in the case for elephant conservation. Non-use values do not involve market purchases and may not involve direct participation. Some examples of non-use values include elephant conservation, the valuing of natural wonders, birdwatching, protection of biodiversity, and wilderness experience, etc. On the other hand, use value is associated with observable activity from the consumer, such as travel to a recreation site. The CVM can estimate the total value, which includes both use and non-use values, of a good and rely on survey questions to elicit people's stated preferences (Pate & Loomis, 1997). Revealed preference techniques like the hedonic pricing and travel cost methods can adequately measure only the direct use value since these methods are based on observed behavior. The CVM, on the other hand, has been widely used since the 1970s to estimate the economic value of goods and services that are not traded in the market and for which there exists no market price (Arrow et al., 1993).

Within the CVM, hypothetical questions are asked to respondents about the monetary value of one's willingness to pay (WTP) or willingness to accept (WTA), given the existence of a stated opportunity (Bishop, Heberlein, & Kealy, 1983; Kahneman & Knetsch, 1992; Hanemann, 1994). However, the fact that CVM is based on asking hypothetical questions as opposed to observing actual behavior has led to a number of criticisms, which can be categorized into six claims (Shavell, 1993): individuals do not understand the scenario they are being asked to evaluate; respondents have motives to misrepresent their opinions; there are poor incentives to give truthful answers; respondents' answers may not reflect their valuation; respondents' answers may vary depending on the wording of questions; and the estimates from CVM may vary greatly. Nevertheless, the potential biases occurring through the use of the CVM can be addressed with stringent survey and statistical methodologies (Hadker, Sharma, David, & Muraleedharan, 1997).

The CVM has been widely applied to various conservation programs. For example, CVM was used to elicit respondents' WTP for broad concepts such as ecosystem protection (tropical rain forests; Kramer & Mercer, 1997), national park protection in India (Hadker et al., 1997), and regional endangered species conservation in Wisconsin (Boyle & Bishop, 1987). Similarly, CVM has been used for species-specific conservation programs such as for Giant Panda (*Ailuropoda melanoleuca*) (Kontoleon & Swanson, 2003), Pacific salmon (*Oncorhynchus* spp.) (Pate & Loomis, 1997), sea turtle (*Caretta caretta*) (Whitehead, 1992), wolf (*Canis* spp.) (Williams, Ericsson, & Heberlein, 2002), wolverine (*Gulo gulo*) (Ericsson, Kindberg, & Bostedt, 2007), and elephant (*Elephas maximus*) conservation (Bandara & Tisdell, 2004). The above CVM studies identified associations between the social profiles of respondents and their WTP.

While CVM studies use different eliciting formats (dichotomous choice, open-ended, payment cards, etc.), the use of the payment card approach is considered as an effective approach in the CVM for a small sample size, as it identifies the upper and lower bounds on WTP (Cameron & Huppert, 1989). The payment card approach is based on a range of WTP values for the public good, from which individuals have to choose their maximum WTP values among an ordered set (Mitchell & Carson, 1986; Kramer & Mercer, 1997). The payment card approach is efficient if the number of divisions for any given range of values is increased, since it narrows down the range within which each individual's WTP falls (Kerr, 2001).

This paper uses CVM with a payment card approach to elicit the inhabitants of Terai's WTP for elephant conservation and HEC mitigation programs. Thus, the focus of this study was to ascertain if inhabitants of the Terai were supportive of a system that could be developed to effectively reduce HEC and enhance the compensation of the victims of HEC. Current HEC mitigation measures include a compensation mechanism for human death and injury, including house damage, and the establishment of protective infrastructure, such as the digging of trenches, the building of watch towers, and installing electric fences (Shrestha et al., 2007; Neupane et al., 2014). However, compensation for elephant damage in Nepal is limited in scope and is inconsistent in its application (Neupane et al., 2014). For example, compensation for property damage is set at a maximum of Rs.10,000 (US$128), for human injury a maximum of Rs.50,000 US$640), and for death Rs.300,000 (US$3846) (US$1 = Rs.78; conversion rate of 15 October 2011 used throughout). Nonetheless, the lack of a long-term management plan and insufficient financial resources by government agencies severely hamper the effectiveness of these measures. Existing HEC mitigation plans are determined by government officials without input from local residents. For programs to have a wide acceptance among constituents, there must be a strong interaction between officials and people impacted (stakeholders) by decisions implemented (Neef and Neubert, 2011). Lastly, this study investigates the willingness of local residents to financially assist in the mitigation process.

2. Hypotheses

The following predictions were tested investigating demographic variables and conservation attitudes associated with residents' WTP. First, various socioeconomic factors should impact an individual's WTP. Second, WTP to pay for mitigating HEC should differ by the intensity of personal impact of HEC. Specifically, individuals facing greater damage associated with HEC should have a higher WTP to avoid future damage or injury. Third, residents should be less willing to pay when they are dissatisfied with current governmental HEC mitigation practices. Lastly, WTP for HEC mitigation should increase with the provision of a better management team and greater economic transparency, i.e. respondents are sensitive to the scope of the goods offered. This hypothesis is based upon the rationality assumption of economic theory (Arrow et al., 1993), as people should be willing to pay more for a good they place a higher value on (scope test).

3. Study area

Nepal is bordered by China to the north and India by the east, south, and west. In a north-south direction, topographically Nepal descends from mountains, hills, to the lowland Terai, where agriculture is intense. Both the eastern and western Terai contain trans-border migratory routes for elephants (Velde, 1997; Yadav, 2004; Shrestha et al., 2007; Yonzon, 2008; Neupane et al., 2014). Eastern Terai contains one nationally protected area (Koshi Tappu Wildlife Reserve) and fragmented patches of community forests, and is facing intense seasonal HEC from trans-border migratory elephant herds (>100 elephants; Pradhan, Williams, & Dhakal, 2011; Neupane et al., 2014); few elephants are residential year-round within this region (n = 15; DNPWC, 2008; recent personal observation by Neupane). The western Terai has three larger protected areas (Banke National Park, Bardia National Park, and Shuklaphanta Wildlife Reserve), and good forest connectivity with protected areas of India. The western Terai has the country's largest residing elephant herd, located in Bardia National Park (n = 80; Pradhan, 2007), and a small group of migratory elephant herds cross seasonally into Nepal from adjacent Indian forests (n = 20–30; Velde, 1997). This study surveyed residents of villages situated within six highly populated districts of the Terai (three districts each from the eastern and western Terai; Fig. 1) which are heavily impacted by seasonal migrations of these large elephant herds (Pradhan et al., 2011; Neupane et al., 2014).

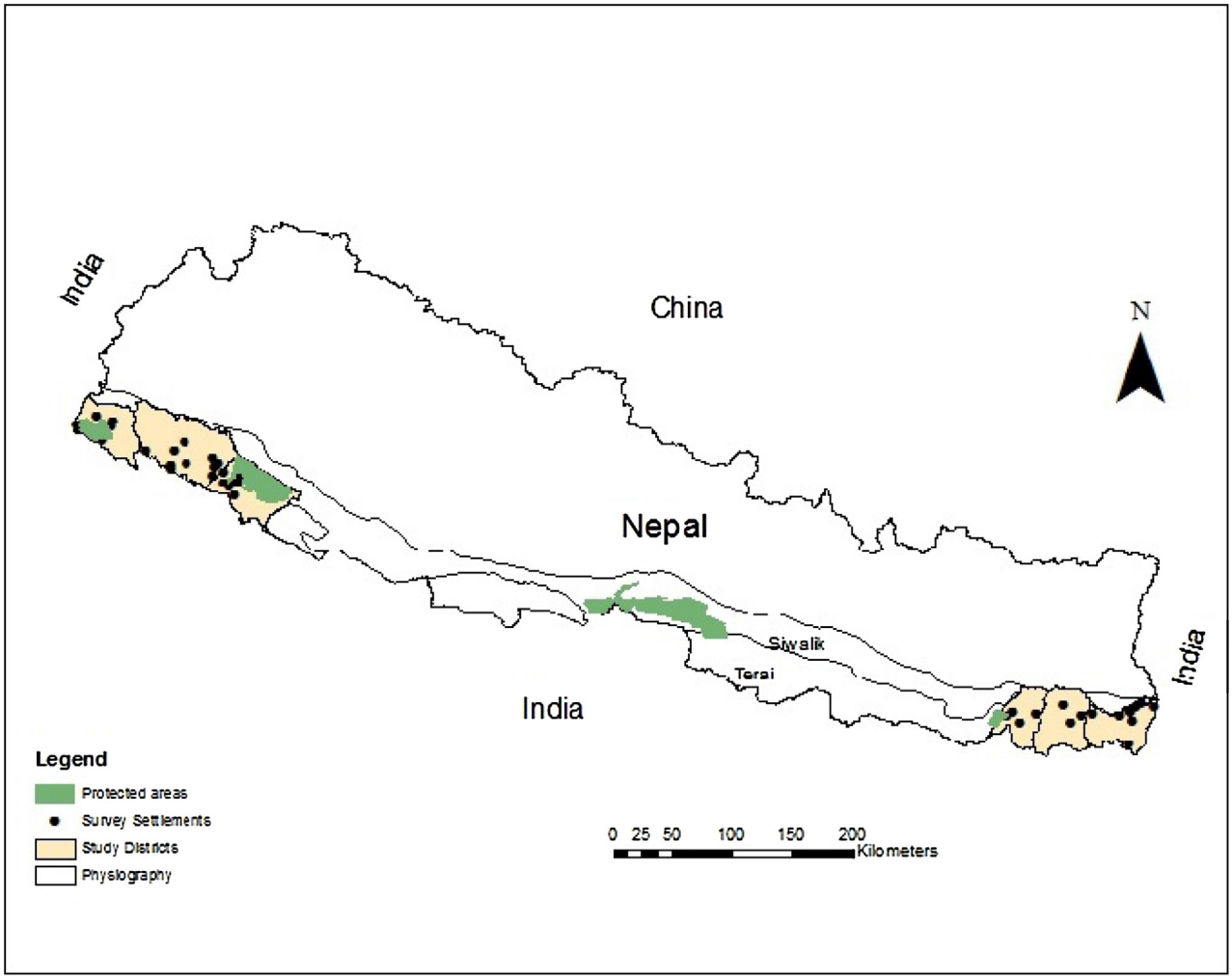

Fig. 1. Map of Nepal demonstrating eastern and western districts surveyed along the border of India (in beige). Villages sampled within each district indicated. Wildlife conservation areas indicated in green.

4. Methods

4.1. Sampling design and implementation

To administer the surveys in 2011–2012, field researchers were trained to conduct face-to-face interviews. The interview process of the 242 respondents was adopted based on White et al. (2001) and Alberini and Cooper (2000) guidelines.

The questionnaire was structured based on previous surveys regarding HEC in Sri Lanka (Bandara and Tisdell, 2004; Bandara and Tisdell, 2005). There were three categories of questions: interviewee socioeconomic characteristics, their knowledge regarding elephant conservation and HEC, and WTP for HEC mitigation programs which ultimately help to protect elephants (Appendix A). Prior to each section, the survey instrument included a brief description of the status of the local elephant population and HEC scenarios to provide a framework for the interview; setting the context of the issue to respondents prior to administering the survey increases the reliability of WTP estimates (Mitchell and Carson, 1986; Bergstrom, Stoll, & Randall, 1990). Specifically, likeability of species and WTP are influenced by the information provided prior to survey (Tisdell, Nantha, & Wilson, 2007).

Variables included within the socioeconomic section were district, age and gender of participant, education level, profession, household size, land holding, and income. Bardia was used as the baseline for the 'District' variable, because Bardia was identified as intermediate for levels of HEC (Neupane et al., 2014). During the survey, attempts were made to interview the person in the family unit responsible for financial decisions in the household, and thus all participants surveyed were >18 years of age. 'Gender' is a dummy variable that takes a value of 0 for female, and 1, if the respondent is a male.

Education level, profession, household size, land holding, and income each have financial implications associated with them. Education level was created as a dummy variable with 0 representing 12 years or less of education, whereas 1 represented participants with greater than 12 years of education. The school systems of Nepal include 10 years of basic schooling followed by 2 years of high school. 'Professions' were categorized into seven activities: farming, non-farming, volunteers, social activities, service, student, wage labor, and retired. Farm size is the total amount of land owned by the respondents and was measured in 'kattha', a unit of measurement for land in Nepal (1 kattha = 0.034 ha). Personal income is the annual personal income of the respondent and was reported in thousands of rupees.

There were six conservation-related variables included in the survey which were recorded in a binary manner (1 = Yes, 0 = No). These variables include villager interest in the protection of elephants within Nepal, their conservation awareness, their association with a conservation society, and their interest in visiting

natural areas; each was compared to with resident WTP. The two variables 'villager support of elephant conservation in their local forests' and 'attitude towards existing compensation scheme' were different measures that deal with participant attitudes towards HEC mitigation approaches. Participants were also asked if they had personally experienced any human or property damage from elephants. Only responses where there was human casualty (human injury or death) were assigned a value of 1 for WTP modelling, as almost all residents had experienced relative degrees of property damage. This designation allowed for comparisons to be made when there were severe incidents resulting from HEC.

There were two WTP scenarios (WTP1 and WTP2). WTP1 involved villager responses to a hypothetical situation (White, Bennett, & Hayes, 2001), where trust funds could be established to mitigate HEC. By establishing a 'Trust Fund", local residents can be directly involved in the decision-making process locally, whereby that fund can be used for infrastructure projects to reduce HEC, in addition to enhancing compensation from elephant damage and injury. For those respondents stating they were willing to pay into a monthly trust fund, a range of values from Rs.5–Rs.500 (US$0.06–6.4) was included as a follow-up question. WTP2 measured if villagers were willing to pay additional funds if there was better management of and greater economic transparency in the payments towards HEC damage. To clarify "better management" to respondents, options were provided such as elephants being kept inside protected areas by the establishing of new wildlife areas, by better managing existing protected areas, and extending present compensation schemes. The specific questions for WTP1 and WTP2 are as follows:

WTP1: For the next '3′ years, how much would you be willing to contribute for the program per month, i.e. '12X' per year starting from January 2012 towards the establishment of the proposed "TRUST FUND" for HEC mitigation?

WTP2: If the elephants are kept inside the protected areas (either by establishing new area or practicing with better management on existing protected areas), would you change your WTP? If your value of WTP increased or decreased, by what percentage would you be willing to change?

Lastly, participants were asked which payment vehicle was most preferable for their payments; options included those payments being associated with schooling, taxes, utility bills or direct payment.

Readability, reliability and the determination of appropriate value limits to place on WTP was determined for the survey instrument by conducting a pilot survey prior to sampling with 15 Nepalese students studying in the U.S.

4.2. Economic and econometric theory

The Hicksian welfare approach (Hicks, 1943), which is static in nature, forms the basis for the welfare analysis. According to the Hicksian approach, the change in welfare can be measured either by compensating variation or equivalent variation. Equivalent variation is the amount of income that must be given to, or may be taken from the consumer, in place of an economic change to make him/her as better off as with the price change (Haab & McConnell, 2002). Similarly, compensating variation is the amount of income that must be taken away from the consumer after economic changes to restore him to the original level of welfare (Hassan, 1995). In compensating variation, changes in price would make him or her better off and the individual should be willing to give up some amount of money (i.e., WTP). The theoretical foundation of the financial component of the survey is based on welfare analysis derived by Hanemann et al. (1991) and Hassan (1995), and is described in greater detail in Appendix B.

4.3. Statistical approach

For the econometric estimation of WTP for the conservation of elephants, seemingly unrelated regression (SUR) was preferred to the ordinary least squares (OLS) method as SUR has an advantage over OLS when there are simultaneous equations with correlated errors since the regression coefficient estimators obtained from SUR are at least asymptotically more efficient than those of OLS (Zellner, 1962). If the disturbance terms in different equations are highly correlated and the independent variables are not highly correlated, then the gain in efficiency is even larger from SUR than with OLS (Zellner, 1962). While both OLS and SUR methods gave similar results, we used SUR for our modeling due to greater predictive power.

4.4. The SUR model

The essence of SUR is using the reduced form equation and performing the generalized least squares method. In order to estimate the WTP by the SUR model, we can write our model as:

$$LNWTP_1 = X'\beta_1 + U_1$$

$$LNWTP_2 = X'\beta_2 + U_2,$$

where, X' are the vectors of the independent variables for estimating the pre- and post-WTP. An N X 2 matrix of residuals is obtained from the estimation of the two independent equations, given by the stacked vector, U = (U1U2) and the variance-covariance matrix Ω:

$$\Omega = \hat{\Sigma} \otimes I = \begin{pmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{pmatrix} \otimes I_n$$

In the case of independence of error terms between the equations, the variance-covariance matrix Ω should have an asymptotically similar diagonal element. The Breusch-Pagan test was used to test the assumption that the errors across equations are contemporaneously correlated and the null hypothesis of no correlation was rejected at $p < 0.001$.

The initial choices of variables selected were based upon previous empirical CVM studies that found to have an influence on the estimated WTP (Hanemann, Loomis, & Kanninen, 1991; Herriges & Shogren, 1996). Certain variables such as age of respondent, member of conservation society, occupation and awareness on wildlife conservation, etc., were not significant in our regression results and were thus removed from the final model. Similarly, different studies (e.g., Loomis & Larson, 1994; Bandara & Tisdell, 2004) highlighted the importance of positive attitudes towards wildlife conservation in influencing WTP and so the variable 'protection of elephant in their locality' was included in the analysis as a control variable.

As a result, WTP was set up as a function of the following independent variables in our final model: location of the household as to district, education, human damage, personal income, elephant conservation, protection of elephant in locality, and compensation. The dependent variable was the logarithm of WTP, which was chosen based on the Box-Cox analysis (Appendix C).

5. Results

5.1. Socioeconomic profile of sample group

The median age of the respondents was 38 years with a range of 18–73 (Table 1); however, a high proportion of participants were less than 30 years of age (29.1%; Fig. 2). The average family size of the household was 7, with larger families occurring in western Terai

Table 1
District-wise socio-economic and value characteristics of the individuals surveyed of the Terai of Nepal (standard errors are in parentheses). Annual personal income is reported in Rupees (Rs.). For lnWTP1 and lnWTP2, Bardia is used as the reference for other district comparisons.

Variable	Bardia Mean	Jhapa Mean	Kailali Mean	Kanchanpur Mean	Morang Mean	Sunsari Mean
Family size	7.2 (0.85)	6.0 (0.3)	7.8 (0.53)	7.3 (0.53)	5.3 (0.45)	5.3 (0.34)
Personal income	74,417 (14,643.4)	120,316 (12,751.2)	55,111 (8,338.9)	46,306 (9,199.5)	156,250 (28,639.6)	76,786 (19,255.4)
Education (yr.)	9.2 (0.7)	9.4 (0.38)	6.1 (0.74)	9.2 (0.78)	10.9 (0.7)	7.6 (0.83)
Membership in conservation society	0.14 (0.06)	0.09 (0.04)	0.08 (0.04)	0.44 (0.07)	0.06 (0.06)	0.06 (0.06)
HEC awareness	0.28 (0.07)	0.7 (0.06)	0.11 (0.04)	0.91 (0.04)	0.31 (0.12)	0.17 (0.09)
WTP amount (Rs.)	34.1 (4.2)	51.2 (13.88)	51.9 (2.51)	126 (6.27)	56.7 (30.66)	19.2 (1.68)
lnWTP1	NA	−0.09 (0.23)	0.77 (0.22)*	−0.09 (0.21)	0.29 (0.30)	−0.39 (0.32)
lnWTP2	NA	0.17 (0.24)	0.84 (0.23)*	0.17 (0.23)	0.18 (0.32)	0.40 (0.34)

*Significant at $p < 0.01$.

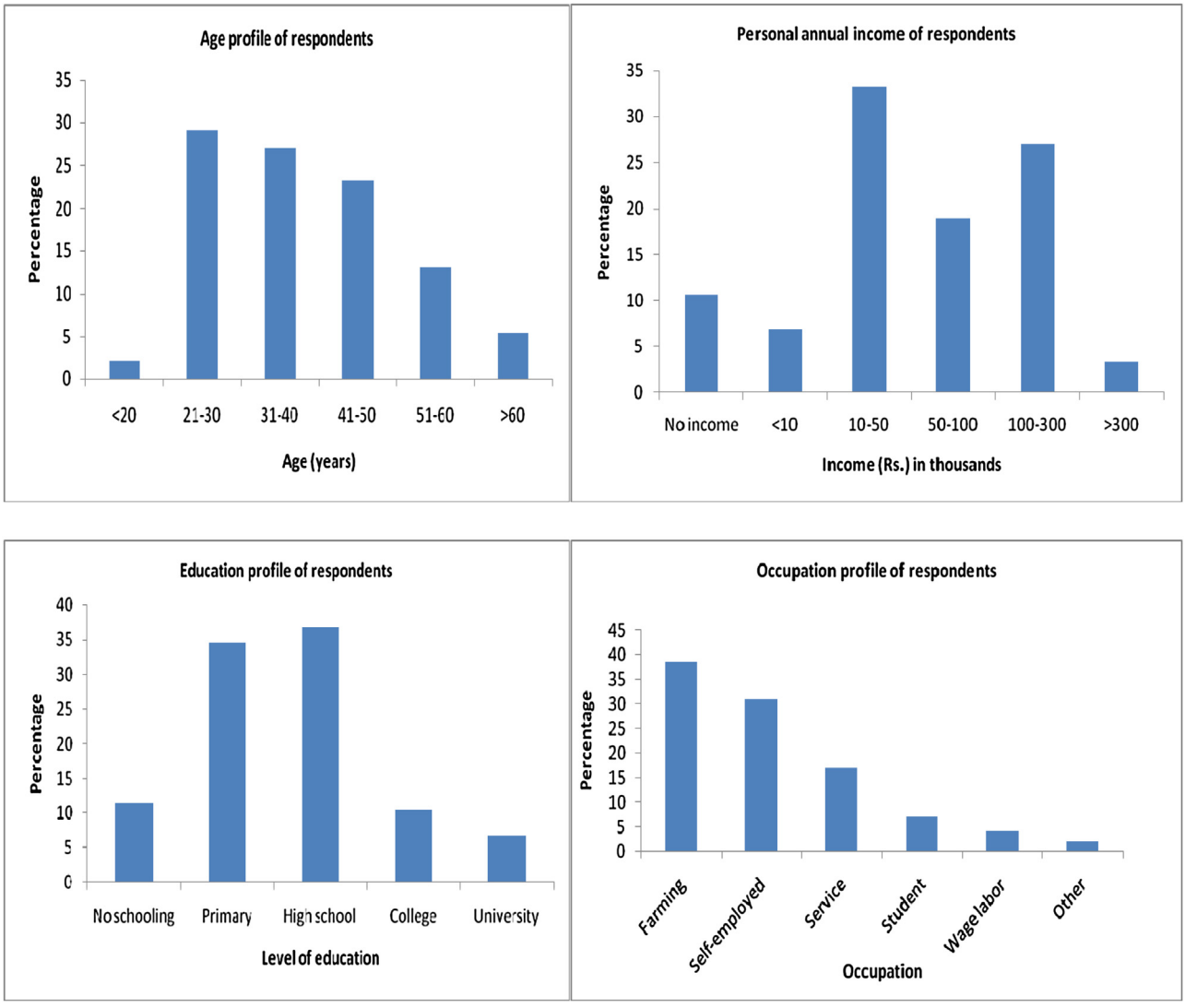

Fig. 2. Socioeconomic profile by age, education and personal annual income of the respondents of the six districts of Terai of Nepal sampled in 2011–2012 (n = 242).

(Table 1). The average annual income was Rs.82,000 (US$1051), and people of the western Terai had half the income of those in the east. Half of the respondents had the annual income below Rs.50,000 (US$ 641), and a quarter of them had annual income between Rs.100,000–300,000 (US$1282–3846) (Fig. 2). Most respondents were the head of the household (64%) and were male (78%). They had an average education of 8+ years, with a third of the respondents (34.6%) educated only to primary levels (1–8 years of schooling) and another 11.4% never attending school (Fig. 2). The primary occupations of participants were farming (38.6%), self-employment (31.1%), then followed by the service sector (16.6%) (Fig. 2).

Only 17% of the respondents were involved in a conservation-related society, with a greater frequency from western Terai, where the districts of Bardia and Kanchanpur occur within protected areas. More than 90% of respondents were conservation-focused,

Table 2
Regional comparisons of percentages of households damaged over the past 5 years by elephants in the Terai of Nepal 2011–2012 as noted by respondents.

District	No damage	Crop	Property	Human	Total
Western Terai					
Bardia	31.0	19.1	23.8	26.2	42
Kailali	37.3	27.5	33.3	2.0	51
Kanchanpur	46.0	24.0	28.0	2.0	50
Sub-total	38.5	23.8	28.7	9.1	143
Eastern Terai					
Jhapa	21.5	23.1	35.4	20.0	65
Morang	75.0	6.2	18.8	0.0	16
Sunsari	0.0	50.0	44.4	5.6	18
Sub-total	26.3	25.3	34.3	14.1	99
Totals	33.5	24.4	31.0	11.1	242

with interest in visiting national parks and wildlife reserves, and conserving wildlife, including elephants (Table 1).

5.2. Intensity of damage related to elephants

Among the 242 households surveyed, two-thirds had encountered some damage from elephants within the past five years including that to crops, property and human casualties (Table 2). More households suffered damage in the eastern districts versus the western districts. Half of that damage impacted property, and over 10% of individuals had family members or themselves sustaining injury or death from elephants. Among the six districts surveyed, Bardia (26.2%) had the highest percentage of individuals suffering injury, followed by households of Jhapa (20.0%) (Table 2). All residents surveyed of the district Sunsari experienced damage, whereas residents of Morang suffered the lowest damage from elephants (25%).

5.3. Willingness to pay (WTP)

This study passes the scope test, i.e., respondents were willing to pay more for a good they place a higher value on. Fig. 3 provides a distribution of the amount respondents were willing to pay for the conservation of elephants in their locality under the two scenarios presented. Most individuals (99%) were willing to contribute on a monthly basis for elephant conservation and HEC mitigation programs. Under WTP1, most individuals (74.3%) preferred to pay between Rs.25-100 (US$0.32–1.28) per month to support elephant conservation. When participants were provided the option of contributing to the second scenario resulting in greater government efficiency and transparency in the management of elephants (WTP2), most respondents (89.2%) responded positively to the idea of increasing their WTP (Fig. 3). The results from the SUR analysis show a 42% increase in WTP between scenarios 1 (lnWTP1, median Rs.42.6 (US$0.55) and mean Rs.63.1 (US$0.81); 95% CI 55.4–70.7) and 2 (lnWTP2, median Rs.59.9 (US$0.77) and mean Rs.93.4 (US$1.20); 95% CI 81.4–105.4). The confidence intervals of the SUR analysis show a significant positive range of valuation for scenario one (WTP1) and scenario two (WTP2) values. The confidence intervals around the median do not overlap for WTP1 and WTP2 estimates, indicating a different value range for each bundle.

For comparison among districts as a variable, only residents of Kailali had significantly greater WTP, with both WTP1 and WTP2 higher by 77% and 84% respectively, compared to respondents surveyed in Bardia (Table 1). Residents of Kailali were strongly positive for both WTP1 and WTP2 despite social variables which indicated individuals of Kailali having annual incomes half that of the mean, being less educated, having a larger family size, and lower HEC awareness (Table 1).

Table 3
Seemingly unrelated regression (SUR) for study variables of lnWTP of respondents of the Terai of Nepal (Standard errors are in parentheses.).

Variables	lnwtp1	lnwtp2
Human Damage	0.513** (0.230)	0.459* (0.244)
Annual income (Rs. in thousands)	0.002** (0.001)	0.002** (0.001)
Education	0.273** (0.135)	0.299** (0.143)
Protection of elephant in locality	0.399 (0.282)	0.483 (0.300)
Wildlife conservation	−0.474*** (0.165)	0.435** (0.176)
Compensation	−0.418** (0.184)	0.500** (0.196)
Constant	3.665*** (0.386)	0.934*** (0.411)
Observations	210	210
R-squared	0.192	0.208

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Each of the variables other than respondents' agreement in their locally protecting elephants was significant for both WTP1 and WTP2 (Table 3). Income, education and frequency of human damage (injuries or deaths) from elephants were positively related to WTP. The variable 'human damage' indicates that people's WTP to mitigate HEC is 51% higher when human injuries and deaths have occurred as compared to other individuals (Table 3). In contrast, under current wildlife conservation and compensation practices, individuals were not willing to pay additional money to mitigate HEC (WTP1). Nonetheless, individuals were willing to pay more if current conservation and compensation practices were improved (WTP2).

Most respondents felt that cash (57%) was their payment vehicle of choice, followed by personal deposits directly into an HEC bank account (36%). Respondents were not interested in payments associated with insurance premiums, electric bills, schooling costs or taxes (each < 4%).

6. Discussion

6.1. Regional differences in WTP

Approximately two-thirds of the households surveyed in the study areas experienced damage from elephants, whereas 10% of surveyed households have had human casualties from elephant attacks. Neupane et al. (2014) found similar results compiling news reports of HEC in Nepal from 2003 to 2012 where they identified 10 human deaths and more than 60 incidences of housing damage reported annually. The current survey found the two districts of Bardia and Jhapa had the highest damage from elephants and Neupane et al. (2014) identified that Jhapa had the greatest number of reported human casualties. Jhapa lies in the eastern trans-border migratory route for elephants entering from India (Yadav, 2004; Shrestha et al., 2007; Pradhan et al., 2011; Neupane et al., 2014). In contrast, Bardia holds the largest numbers of residential elephants in the western Terai (Pradhan, 2007; Pradhan et al., 2011).

Among district comparisons, only residents from Kailali were willing to pay significantly more than the baseline despite their low education levels and per capita income (CBS, 2014; this study). The district of Kailali lies in the far-western Terai with dense forests and good connectivity among those forests, which contain primary seasonal migration routes for elephants between Nepal and India. Neupane et al. (2014) previously identified that Kailali has moderate HEC with the fewest human casualties among these six districts studied. Residents of Kailali with higher WTP have a high dependence on subsistence farming in their district and are dependent on these forests for other natural resources such as fodder and firewood. Their direct connection to forest ecosystems may promote their greater WTP.

Jhapa had the highest HEC among all the districts and mostly from migratory herds rather than residential (Neupane et al., 2014;

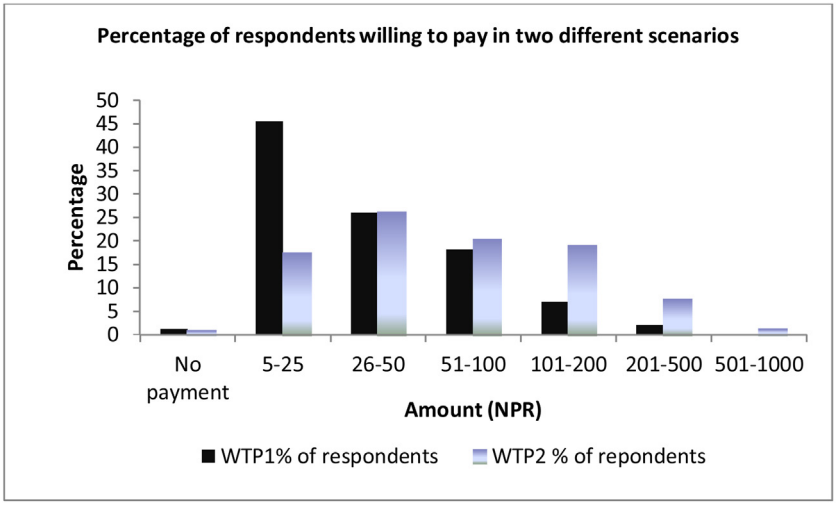

Fig. 3. Amount of money by percentage that respondents are willing to pay for elephant conservation and a HEC mitigation program in two different scenarios. (n = 242, 6 districts surveyed in 2011–2012).

this study), but did not have significantly higher WTP. Specifically, individuals were willing to take responsibility for the few elephants within local forests as compared to a higher number associated with migratory herds. It is intuitive that people were willing to pay less for the goods if they did not have a sense of ownership of those goods (Reb & Connolly, 2007). Local elephants are more predictable than migratory elephants and that predictability can be used within an industry of tourism.

6.2. Demographic differences in WTP

Residents were positive towards the establishing of a trust fund and were willing to contribute for elephant conservation and mitigation. Residents' positive perceptions towards elephant conservation in the Terai of Nepal are consistent with and financially comparable to residents of Sri Lanka (Bandara & Tisdell, 2004). Despite the similar WTP value of the two countries, there are several demographic differences between them. As an agrarian society with little mechanization, people of the Terai are impoverished, with a per capita income about one fifth that of Sri Lankans (World Bank, 2015). Further, Bandara and Tisdell (2004) conducted their study in an urban setting, the capital city (Colombo) of Sri Lanka, unaffected by elephants, whereas our study surveyed residents from rural areas with a greater impact from elephants. Relative to their incomes, residents of the Terai, Nepal, have a greater WTP than residents of Colombo, Sri Lanka, consistent with differing impacts of their lives by elephants.

Respondents' levels of education and income were correlated to WTP for elephant conservation. Educated people can grasp the importance of wildlife conservation and better comprehend the scope of problems and potential solutions to those problems. Further, education level was positively related to stakeholders' WTP in several previous contingent valuation studies of varying conservation issues (Whitehead, 1992; Hadker et al., 1997; Pate & Loomis, 1997). Similarly, Boyle and Bishop (1987) studying WTP for endangered species in Wisconsin, and Bandara and Tisdell (2004) studying WTP for elephant conservation in Sri Lanka have shown through different contingent valuation studies that high income earners have a higher ability and WTP for public and environmental goods. Williams et al. (2002) reviewed research over a 28 year period on wolf conservation across several continents, and found that both increasing income and education have positive influences on peoples' WTP.

Consistent with our prediction, people were willing to pay more for HEC mitigation if they have had human injury in their family. It is intuitive that individuals would place a greater value on human damage than to property damage (Tversky & Kahneman, 1981). However, Ericsson et al. (2007) in their research on wolverine (*Gulo gulo*) conservation found a negative relationship between WTP and personal experience with wolverines.

People's WTP for HEC mitigation declined if the government already had in place a program for reducing HEC regardless of the quality of that program. This lack of WTP may be a response to current HEC mitigation programs where local residents are not treated as stakeholders within a decision-making process. Wildlife conservation parks in Nepal are usually established and supervised by the government. Under a public perception of government responsibility to mitigate damage and conserve wildlife, that wildlife becomes a public good, consistent with economic theory (Reb & Connolly, 2007).

Elephants often damage and destroy electric fences designed to restrict their movements. Thus, these electric fences are in need of regular maintenance and repair; much of the fencing in the Terai suffers from poor maintenance (Shrestha et al., 2007; Neupane et al., 2014). Such inadequacy of protection measures has created a high level of frustration in local residents regarding wildlife conservation in general, and particularly elephants. There is, therefore, a lack of coordination between governmental agencies and impacted residents in the balancing of human and conservation needs. Further evidence of a lack of trust of government-sponsored mechanisms was demonstrated by the overwhelming choice selection of a payment vehicle not associated with government entities (e.g., taxes, utilities, and schooling).

In support of our predictions, people have a higher WTP, up to 2% of their mean annual income (World Bank, 2015), for a good having a higher quality (trust fund with better management). This situation is analogous to creating a new good with a higher value to see if people would be willing to pay more for a product that provides them higher utility (Arrow et al., 1993). This higher payment for better management and efficient conservation program suggests that residents of the Terai are willing to pay to reduce HEC. A higher WTP also reflects the greater urgency by a populace (Tisdell & Wilson, 2006), which is consistent with the findings of our study (WTP2 relative to WTP1).

In defining the quality of the 'good', the product to the people of the Terai may be greater than simply serving the conservation of large mammals. In contrast to much of the HEC present

in Africa (see historical reviews of Barnes, 1996; Parker, Osborn, Hoare, & Niskanen, 2007) and even in India (Choudhury, 1999; Datta-Roy, Ved, & Williams, 2009; Parera, 2009), where poaching of elephants for their tusks has become severe, most elephant deaths in Nepal are due to retaliation of damage caused by elephants (Neupane et al., 2014). Low levels of poaching of elephants in Nepal have been attributed to a historically strong cultural and religious foundation for revering elephants (Sukumar, 1989; Kharel, 2002) and a strong military presence in areas where poaching of large mammals was historically problematic (Martin & Vigne, 1996; Heinen & Shrestha, 2006). Additionally, people are receiving a benefit from wildlife-based ecotourism in Nepal and the local economies are improved from that ecotourism, as 30–50% of the ecotourism monies are re-directed towards local development in wildlife buffer zones (Neupane, 2007). Thus, ecotourism helps to improve public perception towards wildlife conservation and thus WTP. However, recently escalating HEC (Neupane et al., 2014) has potentially undermined many of these cultural ties to elephants.

The results of the scope test are consistent with the recommendation by Arrow et al. (1993), who recommended that improvements in programs should result in greater participant WTP. The results from WTP1 and WTP2 demonstrate that people correctly understood the survey questions regarding WTP, and people in the sample behaved rationally, consistent with economic theory (Heberlein, Wilson, Bishop, & Schaeffer, 2005). Kahneman and Knetsch (1992) argue that one of the problems with contingent valuation studies is an embedding or scope effect, and as such, our results support the validity of the data collection methodology.

6.3. Extrapolating WTP to identify economic viability

Extrapolating a WTP of individuals surveyed to a greater geographic base has been performed in various environmental studies. For example; Kramer and Mercer (1997) studied US residents' WTP for tropical rain forest protection and estimated that a couple of billion US dollars could potentially be generated as a revolving fund. Similarly, Hadker et al. (1997) extrapolated a WTP by residents of India for the preservation of Borivli National Park of over a billion rupees (US$33 million, US$1 = Indian Rs.31.37; May 1994). Kontoleon and Swanson (2003) identified that tourists' WTP for the conservation of the Giant Panda (*Ailuropoda melanoleuca*) amounted to $ 50 million annually in China.

We surveyed villagers of eastern and western Terai suffering from the worst elephant damage within southern Nepal. Of the approximately 171,000 households in these highly impacted areas we surveyed 242 households. With an average monthly WTP of Rs. 63 (US$0.81) and 93 (US$1.20) for households under WTP1 and WTP2, respectively, this could result in an estimated annual payment of ~Rs.130 million (WTP1; $1.7 million) and Rs.200 million (WTP2; $2.6 million) regionally available for HEC mitigation. Additional monies could be made available with the inclusion of lesser HEC impacted areas of southern Nepal. Monies contributed under this scenario could be augmented with matching funds from governments or NGOs such as World Wide Fund for Nature (WWF) or the International Elephant Foundation (IEF). Thus, over a three year period, as stated within the survey, almost $16 million could be generated locally and through matching funds to finance HEC mitigation and compensation programs. Similar to our findings, Bandara and Tisdell (2004) identified a total WTP (Rs.2 billion; $22.5 million; US$1 = Sri Lankan Rs.89.3; December 2001) of Sri Lankan urban residents sufficient to compensate farmers for their damages from elephants.

As both education levels and income are positively associated with WTP, improvements in the local economies could further spur mitigation-focused monies. It must be noted, however, that the basic weakness of WTP studies in general is the lack of the next step, which is of utmost importance; that is, for WTP to truly have an effect there must be an implementation of that proposal with the identified outcome.

Examples of government-coordinated usage of monies generated by the trust fund to enhance development of better management mechanisms to mitigate HEC could include: introduction of an early warning system to inform the residents of elephant encroachment; improved fencing and regular maintenance of that fencing; expanding protected forests to both improve their connectivity and to establish corridors among existing forests; and enhancing compensation amounts to residents for damage and injury. Long term goals to reduce HEC include the promoting of alternative cropping with a specific focus on crops undesirable to elephants, investing in infrastructure to promote ecotourism, and providing HEC mitigation training to local residents.

7. Conclusions

Understanding conservation issues and the development of positive attitudes by the public towards wildlife are crucial both for stakeholder WTP and for effective management programs. Further efforts must be made to educate residents of the Terai as to the magnitude of the HEC, find ways to enhance financial opportunities associated with ecotourism, and make residents aware of appropriate programs needed to enhance mitigation efforts.

The results of this study provide strong policy implications towards the mitigation of HEC, as residents were not satisfied with existing mitigation mechanisms, and were willing to pay more for new interventions to reduce human-elephant interaction. Further, residents were supportive of a government-established trust fund to compensate a greater proportion of the elephant-caused damage to individuals suffering loss; however, economic transparency of that trust fund is critical in the distribution process. Local residents of Terai were seeking a greater involvement in the decision-making processes for HEC mitigation plans. Shared policy changes by the government would enhance people's perception towards and an ownership of those elephants being conserved.

The validity of the scope test (i.e., WTP2 > WTP1) in our survey highlights the importance of asking the proper questions to best understand the values people place on the quality of a good. This can be especially important in a country like Nepal, where illiteracy is high and economic resources are low; thus it is imperative that residents understand a problem clearly for the government to derive locally effective solutions. Further study is required to investigate people's WTP for elephant conservation through the use of their time as compared to the payment of money. In an impoverished area such as the Terai of Nepal where unemployment is high, the time provided by local residents may prove to be a greater asset to the conservation of elephants than using the few financial resources available by those residents. Improving the local involvement of stakeholders should be the focal point of future management plans.

Appendix A.

CVM questionnaire

Problem Statement

Elephants are listed as endangered species in the IUCN's Red Data Book. Elephants were once widespread in the lowland Terai region of Nepal, but are now restricted to just a few protected areas along the border with India. There is some movement of animals between these protected areas and the adjacent parts of India. In addition to property and crop damage, human-elephant conflict (HEC) results to death of 10–12 human lives and 2–3 elephant in Nepal each year. Due to the lack of science-based management

plans and program, HEC is increasing every year, thus necessitating urgent attention. This research will focus on the various aspects of conservation that would mitigate the escalating conflict and promote long-term conservation of the Asian elephant within the context of the currently escalating HEC situation in Nepal.

Respondent Information

Name: Age:

Gender: Profession: Years of schooling:

Respondent position in the family: Family size:

Farm size: Personal Income:

General conservation

I. Please check the activities that the wild elephants cause to your locality.

Activities	**Village**	**Year/Month**	**Details**
Crop damage			
House damage			
Attack to livestock			
Family member death			
Family member injury			
Any other……..			

II. Membership of any conservation society: 1. Yes 2. No 3. Not interested

III. Interest in visiting natural areas (National Parks/Wildlife Reserves) for recreation: 1. Yes 2. No

IV. Awareness about wildlife conservation (especially elephant): 1. Yes 2. No

V. Should elephants be protected in your locality? 1. Yes 2. No

VI. Awareness about the HEC and mitigation measures: 1. Yes 2. No

WTP questionnaire

I. Is the respondent familiar with the WTP scenario? 1. Very new 2. Slightly known 3. Very familiar

II. Has HEC been increasing in recent years?

1. Yes 2. No

III. Have cases of human death and injuries from HEC been increasing?

1. Yes 2. No

IV. Have cases of property (House rampage and crop damage) damages from HEC been increasing in your locality?

1. Yes 2. No

V. Have cases of elephant death and injuries been increasing in your locality?

1. Yes 2. No

VI. Should farmers be compensated for elephant damage to crops?

1. Yes 2. No

VII. Is existing compensation sufficient? 1. Yes 2. No

VIII. If no, do you need better compensation program? 1. Yes 2. No

IX. If a TRUST FUND is established and an appropriate program is implemented to reduce HEC, would you like to be involved in such a program?

1. Not interested 2. Depends on program 3. Very interested

X. For appropriate conservation program, finance is essential. So, if "TRUST FUND" would be established, and the account is transparent to everyone, would you like to donate some money for the program?

1. Not interested 2. Depends on program 3. Very interested

XI. For the next '3' years, how much would you be willing to contribute for the program per month, i.e. '12X' per year starting from January 2012 towards the establishment of the proposed "TRUST FUND" for HEC mitigation and elephant conservation?

a. Rs. 5 Rs. 10 Rs. 25

b. Rs. 50 Rs. 100 Rs. 200

c. Rs. 500

XII. If the elephants are kept inside the protected areas (either by establishing new area or practicing with better management on existing protected areas), would you change your WTP?

1. Decrease 2. Remain unchanged 3. Increase

XIII. If increase or decrease in Q. XII, by what percentage would you be willing to change?

a. 10% b. 25% c. 50% d. 75% e. 100%

XIV. Indicate one of the following methods that you feel would be fairest and convenient for you to make your contribution for the elephant conservation in Nepal.

a. Along with child's school fee every month

b. Along with insurance premium every month

c. Along with monthly electricity bill

d. Along with land taxes every month

e. Direct bank deposit

f. Cash

g. Others. If, indicate……

Appendix B.

Economic Theory: Utility maximizing individuals choose their consumption by solving $\underbrace{\max}_{x}$u(x, q)$subject to \Sigma P.X = m$, taking the level of q as given. The individual's consumption of q is fixed exogenously; p is the price of the good; m is the total income available and the consumption of x's can then vary. These preferences are represented by their utility function u(.). The optimization of the problem above yields both an ordinary demand function$h^i(p, q, m), i = 1, .., N$, and an indirect utility function, $v(p, q, m) = u(h(p, q, m), q)$, which has the conventional properties with respect to price and income arguments and is non-decreasing in q. A change in price from p°top1, would lead to the following equivalent variation and compensating variation outcome:

$$v\left(p^0, m^0\right) = v\left(p^1, m^0 + CV\right)$$

$$v\left(p^1, m^1\right) = v\left(p^0, m^0 + EV\right)$$

Changes in welfare can be either positive (welfare gain) or negative (welfare loss). In compensating variation, changes in price would make an individual better off and should be willing to give up some amount of money (i.e., WTP). If the price change makes that individual worse off, then the compensation has to be done and is referred to as willingness to accept (WTA).

Duality in utility maximization is expenditure maximization that yields the compensated demand functions, $x^i = g^i(p, q, u), i = 1, .., N$, and an expenditure function $m(p, q, u) = \sum p^i g^i(p, q, u)$, which has the conventional properties with respect to (p,u) and is non-increasing in q. If we suppose that q rises from $q^{\circ} toq^1\ q^{\circ}$, the WTP function is equivalent to the compensating variation, which can be written as:

WTP = $\left(p^0, q^0, u^o\right) - m\left(p^0, q^1, u^0\right)$; where u = v(p,q,m)

Appendix C.

A preliminary regression analysis was undertaken using the variables discussed previously to estimate WTP1 and WTP2 for elephant conservation. Our model used the log of WTP as the dependent variable. The use of log in the dependent variable is motivated by the Box-Cox (BC) specification. In a BC specification, both the dependent and the independent variables can be transformed using the following nonlinear transformation (Box & Cox, 1964):

$$\begin{cases} Z_i^{\lambda} = \dfrac{Z_i^{\lambda} - 1}{\lambda}; \lambda \neq 0 \\ Z_i^{\lambda} = \ln(Z_i); \lambda = 0 \end{cases}$$

The BC transformation was applied only to the dependent variable due to most of the independent variables being dummies. The BC transformation of the dependent variable as presented below is flexible because it allows the relationships between yi and the regressors to range anywhere from linear to logarithmic specifications.

$$\frac{Y_i^{\lambda} - 1}{\lambda} = X\beta + \varepsilon$$

The result from the BC transformation revealed that the use of the log linear function would be appropriate in the estimation of WTP as the Box-Cox test suggested a power of 0.173 for WTP1 and 0.154 for WTP2.

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