Are farmers willing to accept compensation from tourism revenue for elephant crop damage and coexistence support? Evidence from Sri Lanka

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Abstract

In many regions of the world the incidence of human-wildlife conflict is increasing. This problem is made more complex in countries where wildlife are a key tourist attraction. For example, while subsistence farmers' crops can be destroyed by elephants, they are at the same time an important tourist drawcard. This study of human-wildlife conflict in Sri Lanka explores this issue and proposes as a solution a compensation scheme for farmers funded from revenue raised from tourism revenue and/or a tourism levy such as an embarkation tax. To ascertain the viability of this proposal we investigate affected farmers' willingness to accept compensation for elephant-related crop damage thereby providing an economic means for coexistence. The scheme proposed was tested by undertaking a discrete choice experiment involving 439 affected farm households. The modelling results show that farmers perceive an increased disutility from elephants visiting their farmland. However, they are willing to accept an average compensation of US$295 per acre when the entire crop is destroyed. The modelling exhibits preference heterogeneity: farmers' education, gender, tourism opportunities and membership in environmental clubs significantly influence their preference to coexist with human-elephant conflict (HEC). In particular, the interactions between 'crop switching and education' and 'crop switching and gender' reveal that better educated and male farmers are more inclined to adapt by changing crops on their farmlands compared to their less educated and female counterparts. Furthermore, farmers who prioritize tourism opportunities and those affiliated with environmental clubs are more open to coexistence, as they are willing to accommodate a greater number of elephants visiting their farmland compared to their counterparts. The key outcome of this study is that tourism has the potential to contribute to and form the basis for resolving HEC.

Keywords: human-elephant conflict; farmers; compensation; nature-based tourism; conservation; human wildlife conflict

1. Introduction

HEC is one of Asia's and Africa's most pressing conservation concerns regarding wildlife management (Hoare, 2000; Karanth & DeFries, 2011; Brouwer et al., 2010; Neupane et al., 2017). HEC in Sri Lanka has escalated in recent years due to habitat loss coupled with the rapid growth of the human population (Bandara & Tisdell, 2004; Dharmarathne et al., 2020). Nevertheless, despite its relatively small size (65,610 km^2) and large population size (> 21 million), Sri Lanka is a refuge for nearly 10 per cent of the global wild elephant population, accounting for approximately 4,400 elephants (Kemf & Santiapillai, 2000). It is one of only three such island elephant populations (*elephant maximus*) and is the home of a recognised Asian elephant subgenus catalogued as threatened by the International Union for Nature Conservation (IUCN) (Choudhury, 2008). According to the Global Wildlife Fund (WWF, 2018), over the past three decades, the total Asian elephants' habitats has decreased by more than 50%, while the population of Sri Lankan elephants has fallen by almost 65% since the 19th century (Santiapillai et al., 1999). This is due to a combination of the destruction of natural habitat and repeated HEC (Barbier et al., 1990; Kremer & Morcom, 2000). Moreover, of concern is that approximately 70% of Asian and African elephants' habitats are outside national parks and reserves (Choudhury, 1999; Hoare, 2000).

Subsistence farmers are the most vulnerable group in respect of HEC in developing countries (Hoare, 2000; Pant et al., 2015; Santiapillai et al., 1993) and is a continuing problem in most Sri Lankan districts where crop raiding by elephants is a crucial issue (Fernando et al., 2005; Santiapillai et al., 1993; Dharmarathne et al., 2020). For example, a survey conducted of adjoining villages in the Yala National Park in Sri Lanka found that 93% of farmers had lost their crops due to elephant crop raiding in 2004 (Fernando et al., 2005). Another study found that 69% of Sri Lankan farm households suffered crop damage (paddy) from elephants (Santiapillai et al., 1993). Crop losses due to HEC in the Mahaweli region in Sri Lanka is estimated to total between Rs.10,000 (US$106.40) and Rs.30,000 (US$319.10) per farmer per annum (Jayewardene, 1998). Bandara & Tisdell (2002) estimated that the cost of crop damage from HEC in Sri Lanka averaged Rs.12,049 (US$128) per farmer and that 70% spent a considerable portion of their income on crop protection activities. In most of the cases, compensation to farmers covered less than 10% of their crop losses due to elephant damage (Bandara & Tisdell, 2004). A large majority (89%) of these farming families were those which could least afford these losses given that, on average, they earned less than Rs.120,000

(US$1,200) per annum. Hence, individual farmers in Sri Lanka commonly perceive elephants as an agricultural pest.

A number of studies have investigated various aspects of HEC and wildlife conservation in Asia and Africa particularly in South Asia (Dharmarathne et al., 2020; Sukumar, 1989; Gubbi, 2012; Brouwer et al., 2010; Wilson et al., 2015). These studies examine local community perceptions towards HEC (Fernando et al., 2005; Bandara & Tisdell, 2004), spatial analysis of HEC (Wilson et al., 2015; Brouwer et al., 2010) and human spatial integration with elephant populations (Hoare, 2000). Such studies have examined HEC damage attributes and conflict mitigation, local behavioural patterns concerning wildlife and various demographic attributes such as spiritual affiliations and growing anthropogenic threats. However, studies on mitigating HEC through compensation using tourism receipts have not yet been examined. Understanding whether compensation raised from tourism revenue and/or a tourism levy can address this problem may offer a solution. We therefore examine a new means of sustaining the elephant population as an economic asset for nature-based tourism (NBT). In doing so, this study utilizes a discrete choice experiment to measure whether tourism revenue could be used as a suitable form of compensation for farmers to mitigate HEC.

This paper explores a potential symbiosis between NBT and nature conservation by investigating local farmers' views on elephant conservation using a hypothetical conservation fund financed from tourism revenue. More specifically, the aim is to assess the extent to which revenue generated from tourism can be used to compensate farmers whose crops are affected by wildlife (particularly elephants) which, in most cases, wander from neighbouring Sri Lankan national parks. The need for such a study is based on the fact that the long-term future of elephants outside protected areas critically depends on the willingness of local farmers to embrace wildlife conservation. Failure to accept the need to resolve the HEC would have a particularly detrimental effect on the long-term tourism potential of Sri Lanka as the majority of international tourists visiting Sri Lanka come to see these elephants.

The tourism sector is classified as one of the world's rapidly expanding industries (other than during the Covid 19 pandemic[1]) with an annual growth before COVID-19 being around 3.9% and which contributes to around 10% of global GDP. In addition, the sector contributes to one

[1] For an excellent article on economic, social and political issues raised by the Covid19 pandemic, see Tisdell (2020).

in ten jobs created and accounts for 30% of service exports globally (WTTC, 2019). However, tourism is now being increasingly promoted as a means of protecting and preserving environmental resources (WTTC 2019; Nickerson et al., 2016). This reflects the fact that NBT can provide tangible economic benefits and can therefore attract political support for the conservation of wildlife (Chidakel et al., 2021; Karanth & DeFries, 2011; Tisdell & Wilson, 2012). Kenya's wildlife-related tourism income has been estimated at around US$ 350 million a year, contributing around 12% of its GDP (Akama, 1996). A similar contribution can be found in many other African countries (e.g. Tanzania, Namibia and Tanzania).

Tourism is the third largest income earner for the Sri Lankan economy and contributes to around 5.3% of GDP. Around half a million people (12% of total employment) depend on tourism directly and around 2 million people are indirectly employed in the sector (Central Bank of Sri Lanka, 2018). International tourist arrivals reached 1.9 million in 2019. The strategic location, size (65,610 km^2), wildlife and landscape - such as coastal beaches, mountain ranges, forests and wild elephants - are the key attractions for tourists coming to Sri Lanka. Moreover, elephants are the flagship species with cultural, religious and political[2] significance. Given Sri Lanka's tourism sector depends so heavily on nature-based resources it is of paramount importance to protect them especially key 'showcase' species such as elephants. Beyond tourism, Sri Lanka, coupled with the Western Ghats, is recognised as one of the world's 34 'biodiversity hotspots' for NBT and as a means of livelihood for locals (Hanson et al., 2009).

A wide range of literature has examined NBT and nature conservation (Tisdell & Wilson, 2012; Burns & Howard 2003; Kruger, 2005) including the range of sustainability and HEC problems. Yet there remains a need for improved mitigation measures and initiatives that include farmers' views on promoting elephant conservation. The use of tourism receipts as compensation has been under-researched. In particular, to what extent does tourism have the potential to be a tool for mitigating HEC? Hence, this study investigates the nature of HEC and to what extent farmers' attitudes toward elephants can be changed through compensation. Fostering the conservation of natural resources typically leads to an increase in the competitiveness of a tourist destination. This in turn can raise awareness of the price of preserving natural resources and lead to a rise in land protection and biodiversity enhancement. In other words, the health

[2] United National Party (UNP) is the first political group formed in Sri Lanka to use the symbol of the elephant.

of ecosystems and the health of NBT are interrelated. However, NBT is subject to high demand and is a competitive market. If the needs of the tourism sector and conservation of nature-based resources are not equally fulfilled, then tourism dollars are likely to decline and revenue available for the protection of natural resources will be restricted.

Public-funded policies to manage HEC are not new and several studies have investigated the magnitude of the issue's impact (Kahler & Gore, 2015; Neupane et al., 2017). Human-wildlife conflict mitigation initiatives have been undertaken through the use of economic enticements to minimise disputes and assist the establishment of fences and other protection measures (Dharmarathne et al., 2020; Bandara & Tisdell, 2002). Evidence has shown that from an economic perspective, the major benefits attributed to compensation programs for wildlife damage would be increased tolerance of wildlife, the encouragement of more sympathetic attitudes and support for protection among its participants (Wagner et al., 1997). However, lack of government support due to a limited financial capacity to absorb wildlife-related losses remains a key problem (Bandara & Tisdell, 2003; Bulte & Rondeau, 2005). Moreover, government compensation schemes for mitigation of HEC have proven to be hard to manage and too often subject to administrative shortcomings for generating adequate finance. Indeed, many compensation initiatives have been found to be ineffectual (Bell, 1984; Hoare, 2000). Further issues encompass the following: firstly, funding agencies and wildlife management authorities often face difficulties in prioritizing the delivery of funding needs of affected parties. Secondly, there are seemingly complex technological systems with which rural communities have little contact with. Thirdly there is a lack of understanding of the compensation schemes among local communities (Thouless & Sakwa, 1995). Hence, it is vital to understand the local community's perceptions towards HEC mitigation and wildlife conservation and following this, assess farmers' preferences for HEC mitigation through tourism receipts.

Given the limitations of current mitigation schemes in Africa and Asia, farm households must largely not only defend their farms from elephant threats themselves but also bear the costs of damage from wild elephants. Intuitively, farmers in HEC-affected areas employ numerous low-cost, primitive methods and non-lethal mitigation strategies to protect their livelihoods (Bell, 1984; Hoare, 2000). For example, there are inactive blockade methods (such as digging ditches, erecting walls, and growing plants) and active blockade methods (banging tins and drums, lighting fires). This may be successful when farmers well know a particular method and

therefore provide a successful outcome. Giving farmers responsibility to act in minimising HEC and encouraging coexistence is vital because the methods they use may be the best suited to the situation and most sustainable (Osborn & Parker, 2003). However, there is little scientific evidence about which methods are the best for mitigating HEC (Nyhus et al., 2000). Moreover, studies on the effectiveness of such methods are limited, particularly in the case of Sri Lanka. Identifying which mitigation methods, perform best in different locations and countries is important given that the findings can support farmers and local communities subject to HEC. Indeed, such evidence-based conservation can help to encourage HEC mitigation and wildlife protection holistically for locals.

However, conservation efforts typically do not achieve their desired outcomes unless there is an understanding of local community needs and the community's willingness to be involved in resolving the issues (Adhikari et al., 2005). In any effort to promote nature conservation, then, the understanding and involvement of key stakeholders and actors are vital to achieve future sustainability and viability (Bandara & Tisdell, 2003; Sims et al., 2020). Tourism development has long been established as an economically rational activity for governments; sponsored landscape and wildlife conservation has been a feature since modern protected areas were first established in North America and Africa (Reed, 1997; Tisdell & Wilson, 2012). In practice, NBT provides tangible economic benefits for wildlife which can offset the cost of protection and coexistence with locals (Wakamatsu et al., 2018). That is, it provides revenue for the local community which is sufficient for them to value and safeguard their natural environment, given it can be a valuable source of income (Goodwin, 1996). If tourism is to act as an economic incentive for the tolerance of wildlife, then it should generate positive returns sufficient to offset the direct and indirect cost of living with wildlife. However, the integration of tourism and mitigation of wildlife conflict remain inadequately studied.

Tourism development typically produces contested issues such as resource utilization and profit sharing with the local inhabitants. Benefits from the trickle-down process of the tourism sector is a critical outcome especially given farmers are likely to perceive elephants as an agricultural pest due to losses to their agricultural output. On the other hand, if tourism revenue does flow to farming communities within the revenue-generating regions, farmers may well be willing to switch to tourism activities as an alternative income source - possibly a win-win situation. When tourism revenue is greater than the cost incurred by farmers due to wildlife crop damage, then the compensation could be operationalized using tourism revenue. Farmers'

loss of livelihoods can be offset in the short run by adequate compensation and in the long run this could be achieved by generating income on their own from various tourism activities. But unless the economic significance of wild elephants and nature-based resources in general is established, the aim of sustainable nature conservation will remain in doubt. Hence, our paper sets out to examine under what circumstances NBT can be used as an alternative tool for underpinning elephant conservation and wildlife stewardship. It is argued that evidence-based, well-designed nature conservation and benefit-sharing policies are critical to the implementation of sustainable nature conservation.

In this study, we employ a discrete choice experiment (DCE) to explore the preference heterogeneity of farmers for nature conservation and willingness to accept (WTA) compensation through tourism receipts. Research shows people living in regions adjoining areas of national parks typically prefer to have elephants removed or fenced in because they perceive no benefits from wildlife, and which are seen as being owned by the state (Sitati & Walpole, 2006). Consequently, farmers are not aware that the NBT sector (particularly elephants) could generate much-needed revenue for the economy as a whole. The outcome of this study, therefore, offers potential value in terms of benefits to nature and/or to species. For example, through tourism, greater enthusiasm and cooperation can be expected from both decision-makers and the public in their support for conservation. In such a case, the level of support for conservation by decision-makers is not only likely to be high but also provides them with the validation needed to take appropriate actions in support of both conservation and tourism. Such conservation actions might include the creation of new national parks, enlarging of existing parks and connecting wildlife corridors to enhance tourism and economic values.

The main research question this study seeks to answer is whether farmers are willing to accept compensation from tourism revenue for elephant crop damage. Thus, the statistical null hypothesis is that farmers are not willing to accept compensation for the loss due to elephant encroachment. The study tests this hypothesis by estimating farmers' WTA compensation utilizing a discrete choice experiment. Hence, this study examines a potential solution for HEC mitigation and coexistence with wildlife and makes a two-fold contribution to the extant literature. Firstly, we seek to better describe the poorly explained relationship between receipts from tourism and support for nature conservation. Secondly, we extend the understanding of balancing of forgone farming revenues and compensation from tourism receipts by examining

local farmers' WTA compensation for nature conservation and coexistence with wildlife (elephants).

2. Empirical context

Data was collected in the adjoining villages of the Wasgamuwa National Park in Sri Lanka. The Park is known for an abundance of endangered species (23 species of animals, 143 species of birds, 35 species of reptiles, 15 species of amphibians, 17 species of fish and 25 species of butterflies). Sri Lankan elephants (numbering over 200) can be seen in herds in the Wasgamuwa National Park as can occasional viewings of sloth bears. The Park covers 39,322 hectares and adjoins the Polonnaruwa and Matale districts of Sri Lanka and was declared a nature reserve to protect and provide refuge for displaced wild animals during the Mahaweli development project[3] in 1984. The Park is dominated by the dry zone: which means the annual temperature is around 27^{C} and annual rainfall between 1750mm to 2,250mm making it attractive weather for tourists. The Park is surrounded by the Amban, Mahaweli and Kalu Ganga rivers.

The Wasgamuwa region has been a hotspot for HEC over the past three decades. From Figure 1 it can be seen that the spatial pattern of crop raiding by wild elephants is not uniform among the Divisional Secretariat (DS) divisions of Matale and Polanaruwa districts surrounding the Wasgamuwa National Park. It is also evident that the severity of the damage has increased over time in the Dimbulaga and Wilgamuwa DS divisions. Hence, we selected these two DS divisions as our sample study area based on the severity of HEC-affected farm households during the years between 2006 and 2018. The study sites are shown in Figure 2.

[3] The accelerated Mahaweli development project was initiated in 1978 as a multi-purpose project with the intention of increasing the acreage of irrigated rice farming, hydropower generation and animal husbandry.

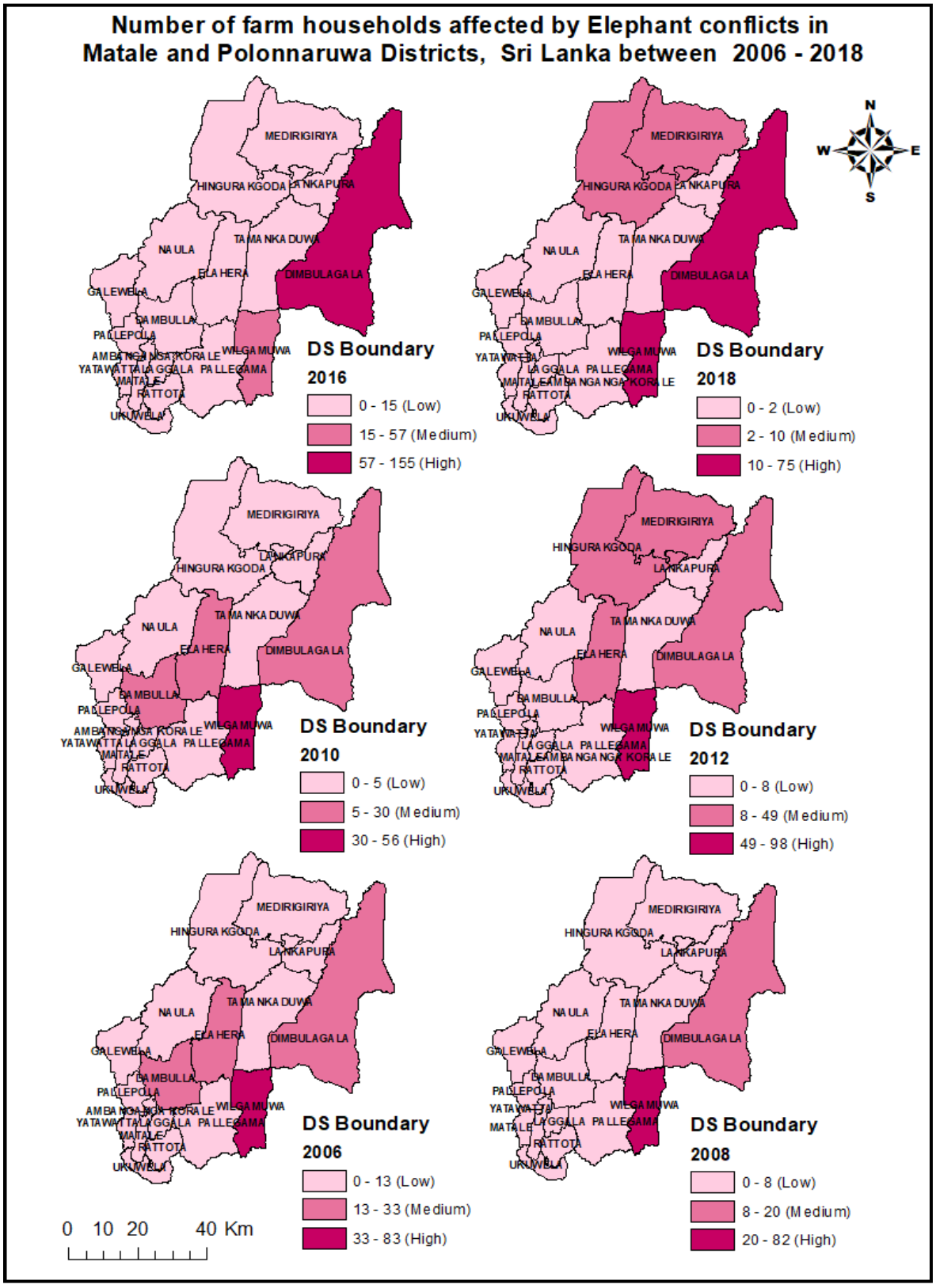


Figure 1. Number of farm households affected by HEC in Dimbulagala DS division in the Polonnaruwa district and Wilgamuwa DS division in the Matale district, Sri Lanka.

Note: Scale was created based on the natural breaks system in Arc GIS 10.4

The prolonged occurrence of HEC in the Wasgamuwa region is due firstly, to major development projects acquiring an increasing amount of land thus escalating disputes over land formerly reserved for animals. For example, the Mahaweli project absorbed approximately 165,000 hectares of land in the Wasgamuwa nature reserve for agricultural settlements involving around one million people (Amerasinghe & Ariyasena, 1990). Secondly, the functioning of wildlife corridors has been hampered due to the many development projects (and in particular the Moragahakanda reservoir) and the increasingly intensive agricultural activities (for example, chena cultivation[4]). This area is known for HEC due to Wasgamuwa National Park being located close to other nature reserves such as Somawathiya, Minneriya, Kadulla and Maduru Oya. Consequently, wild elephants have been migrating for generations between these parks. Thus, if elephants are affected in one of these parks there is a flow-on effect due to the likelihood of a detrimental effect on potential tourists' visits to other national parks resulting in elevated financial losses of tourist revenue. Finally, cattle grazing has been increasing in recent years in the Wasgamuwa region due to the loss of grasslands in Sri Lanka's Southern province resulting from development projects (e.g., Mattala airport and the Hambantota port).

Human and elephant deaths are reported each year from HEC (Fernando et al., 2011; Santiapillai et al., 2010). Available statistics show that approximately 80 humans and 200 elephants (see, Appendix A and B) have died annually due to HEC in Sri Lanka between 2010 and 2018. Among these, almost one-third of the deaths have occurred in the Wasgamuwa region (Department of Wildlife Conservation, 2017). In addition, human injuries from elephants in this region average 93 people per year. The greatest number of elephant deaths have also occurred in this region (Department of Wildlife Conservation, 2017). However, the Wasgamuwa National Park attracted 28,756 tourists and generated Rs.260 million (US$1.5 million) in revenue before COVID-19. The national park is unique as a major recreational spot for watching elephants and birdwatching. Night stays and camping is open year-round for tourists.

[4] Chena cultivation is a primitive cultivation custom of Sri Lankan agriculture that involves clear felling forest patches and cultivating food crops using rain-fed agriculture.

3. Methodology

3.1 Survey design and implementation

A total of 439 farmers affected by HEC were randomly selected from the two most affected districts (Fig.2) in Sri Lanka, namely Matale and Polonnaruwa. From these districts, we then selected the two most affected DS divisions based on statistics from the Department of Wildlife Conservation (DWC), Sri Lanka. These are the Wilgamuwa DS division within the Matale district (224 respondents) and the Dimbulagala DS division within the Polonnaruwa district (215 respondents). We received a total of 2,634 observations for our choice experiment (439*6). A face-to-face survey was conducted with farm households during the months of January to March 2019 (see Appendix C). Each interview lasted on average 30 minutes and the questionnaire was translated into the local language, Sinhala.

The survey instrument was developed through a pilot study using the target populations (HEC area farmers) and was complemented with in-depth interviews and focus groups. We used in-depth interviews in order to reduce the bias of the dominant players in the focus group discussions. The study used an orthogonal factorial experimental design to generate thirty-six choice tasks which were grouped into six blocks (6*6). We assigned each respondent six choice tasks to minimize the cognitive strain on the survey participants. The pilot study was pre-tested with 62 randomly selected farmers in the Dimbulagala DS division of the Wasgamuwa park range in December 2018. The results of the orthogonal parameters of the pilot study were used to generate a Bayesian D-efficient design thereby achieving the least D-error. The D-efficient designs are statistically efficient in terms of the standard errors predicted (Hensher et al., 2015; Bliemer et al., 2008). We used the Ngene software (Ngene, 2018) to generate orthogonal and D-efficient choice designs and NLOGIT6 software (Green, 2012) for the data analysis.

The field survey was undertaken in two stages using eight well-trained enumerators (Sri Lankan University undergraduate students). In the first phase, we conducted interviews with farmers who experienced HEC in the Wilgamuwa DS division. We ensured the relevance of questions by asking supplementary questions about their HEC experiences and crop damage before undertaking the formal survey. In the second phase, we applied the same procedures in the Dimbulagala DS division to identify HEC-affected farmers. We used a semi-structured questionnaire consisting of four sections (see Appendix C).

Section one covered background information and section two contained attitudinal questions concerning HEC mitigation. Section three included the choice preferences for the presence of wild elephants visiting farmland and WTA compensation for elephant crop damage. The final section covered the socio-demographic characteristics of the respondents.

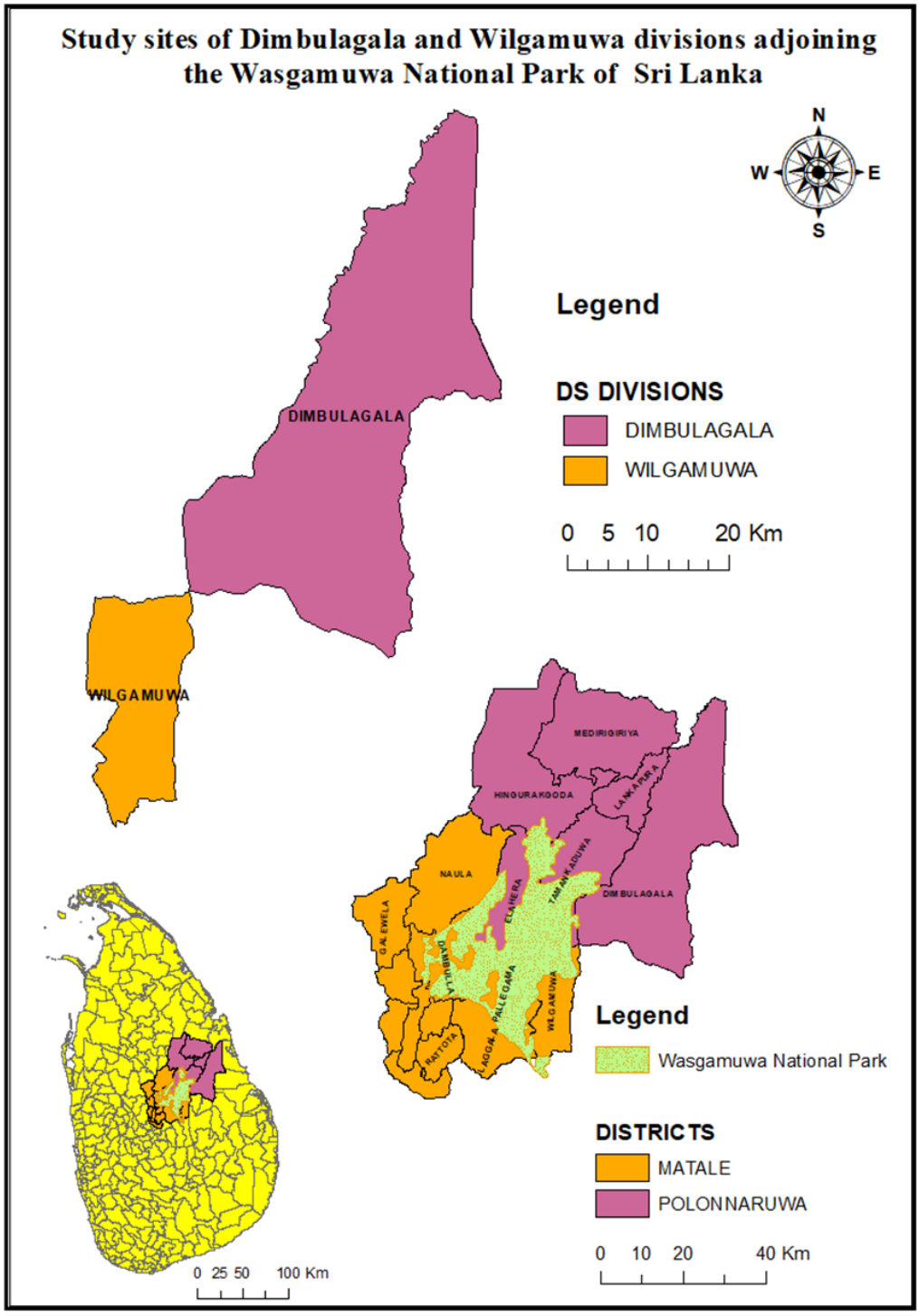


Figure 2. Survey area map.

As mentioned in the introduction we sought to answer the overarching question of how and in what circumstances, tourism revenue could be employed as HEC compensation and as a conservation tool to help overcome HEC. That is, we measured the extent to which farmers would embrace nature conservation through compensation funding from tourism revenue for crop damage caused by elephants thereby providing farmers with an alternative source of income.

3.2 Choice task

Table 1 depicts the attributes and levels of elephant conservation. The overall outcome of the study was to explore the preferences for elephant conservation. The response variable is the utility that respondents derive from choosing the most preferred alternative given a number of alternatives in a choice set. In each choice set, there are three alternatives and a status quo option. Hence, the respondent could make a trade-off among the alternatives in the choice sets and choose the most preferred alternative among them which yields the highest utility. Moreover, this study used independent variables such as 'Number of elephants visiting your farm' (NOEV); 'Extent of damage as a percentage of total cultivated land' (EXTD); 'Crop switching as a percentage of total cultivatable land' (CS); 'Preferred compensation agency for crop damage'(CA) and 'Payment received by farmers in Sri Lankan rupees per acre crop damage' (Pay). These attributes were selected using three steps. First, the researchers conducted a relevant literature review to identify potential attributes. Second, the attributes were discussed with experts including economists, ecologists, and national park officers at the Dimbulagala DS and Wilgamuwa DS divisions. The most relevant attributes were further refined via pre-testing in the Dimbulagala division. Pretesting was conducted with 62 respondents in the study area and obtained 372 observations. Each attribute included three levels, for example, for the attribute the 'number of elephants visiting your farmland', the levels were 10 elephants, 20 elephants, and 30 elephants, meaning that the more elephants that visited the farmland, they increased the difficulty for farmers to protect their crop. We also formed these levels based on an extensive review of the literature and from farmer focus group discussions. We allocated four alternatives for each choice situation where the fourth alternative was a null choice. The null choice is crucial for environmental policy making without which a biased parameter estimate in WTA can occur (Hensher et al., 2015). Moreover, the null choice in discrete choice modelling enhances the validity of the analysis by capturing true preferences, and understanding trade-offs, thus avoiding biases, increasing

model flexibility and providing valuable insights for decision-makers. Details of the modelling can be seen in Appendix D.

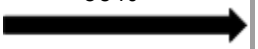
Table 1. Choice modelling attributes, their descriptions and levels

Attributes	Description	Attribute levels
NOEV	Number of elephants visiting your farm	10 elephants 20 elephants 30 elephants
EXTD	Extent of damage as a percentage of total cultivated land	20 % 40 % 60 %
CS	Crop switching as a percentage of total cultivable land	25 % 50 % 75 %
CA	Preferred compensation agency for crop damage	Government Local authority Non-governmental organization
Pay	Payment received by farmers in Sri Lankan rupees per acre crop damage (Rs.)	Rs. 70,000 Rs. 100,000 Rs. 130,000

[a] The exchange rate used to convert Rs. to US$ is the average January 2020 exchange rate of Rs.181 to US$ (www.cbsl.gov.lk 2020).

Figure 3 reports the sample choice task which is generated from Ngene software using a Bayesian D-optimal design. As mentioned earlier, a pilot study was conducted before the actual surveys took place. Thirty-six choice sets were allocated to six blocks of six choice sets. This choice design was selected in order to minimize the cognitive burden of the respondents. Blocking into six groups involves introducing another orthogonal column to the design, the attribute levels of which are used to segment the design (Hensher et al., 2015). Each respondent answered 6 choice sets and was free to select option A or B or C or 'None of the above'. Figure 3 shows an example of one sample choice task.

Assuming that the following elephant conservation attributes and levels are available, which option would you choose?

Attributes	Option A	Option B	Option C
Number of elephants visiting your farmland	10 elephants 	30 elephants 	20 elephants 
Extent of damage as a percentage of total cultivated land	60% 	40% 	20%
Crop switching as a percentage of total cultivable land	25% 	50% 	75% 
Preferred compensation agency	Non-governmental organization 	Government 	Local authorities 
Payment (Rs.) Compensation amount per acre	Rs.130,000 	Rs.100,000 	Rs.70,000 

Option A ☐ Option B ☐ Option C ☐ None of the above ☐

Figure 3. Choice modelling sample choice task for respondents

4. Results and analysis

4.1. Demographic profiles of the respondents

Demographic information from our sample showed 77% of farmers were male and 23% female. The age categories ranged from 24–80 years with a majority (79%) over 40 years. In terms of education, 80% of respondents completed primary education. This is consistent with many studies in other developing countries where farmers with poor educational backgrounds tend to choose agriculture as their primary employment (Bandara & Tisdell, 2002; Goswami et al., 2014). Only 20% of survey respondents obtained advanced level or vocational qualifications, clearly indicating that educated youth are less likely to choose agriculture related jobs in Sri Lanka. 95% of respondents claimed agriculture was their primary source of income. Of the others 4.6% indicated agriculture was a supplementary source of income, 1.8% were

employed in the government sector, 1.8% in fishing (1.6%) and self-employment accounted for 1.1%. The monthly income of most farmers (89%) was below Rs. 36,000 (US$206).

Farmers in the sample region were cultivating different varieties of crops such as paddy, banana, coconut, mango, green beans, kowpi, corn, watermelon, chilli and pumpkin. A majority of the respondents (78%) cultivated rice as a major crop which is the staple food for 20 million Sri Lankans. Most crops cultivated in the areas are attractive to elephants. 58% of the respondents' farmland falls within 2km of the Wasgamuwa National Park. Hence, farmers frequently experienced elephant threats to their farmland. The rest of the respondents (42%) hold farmlands less than 10km distant from the park. The study revealed that 64% of the respondents were experiencing daily elephant threats, 32% once a week, 2% once a fortnight and 2% once a month. Crop raiding had been escalating over the past three years with 94% of respondents experiencing problems with elephants over the past two years.

75% of the respondents were cultivating crops on less than 2.5 acres of land reflecting the fact that small holder farmers make up the majority of Sri Lankan farmers. Moreover, our sample survey revealed that the total cultivated area averaged 1159.75 acres between 2016 and 2018 of which 467 acres (40%) had been damaged due to elephant attacks. 74% of respondents reported crop loss of more than Rs 50,000 as a result of elephant attacks. Hence, it is the most vulnerable farmers who are adversely affected by crop damage due to elephants. At present, the compensation provided in Sri Lanka is primarily for human deaths, injuries and property damage caused by wild elephants. The Government of Sri Lanka has spent Rs. 1.4 million on compensation for HEC annually. From the data collected from the Sri Lankan DWC, it can be seen that the intensity and severity of HEC has been increasing over the past three years (see, Figure 4).

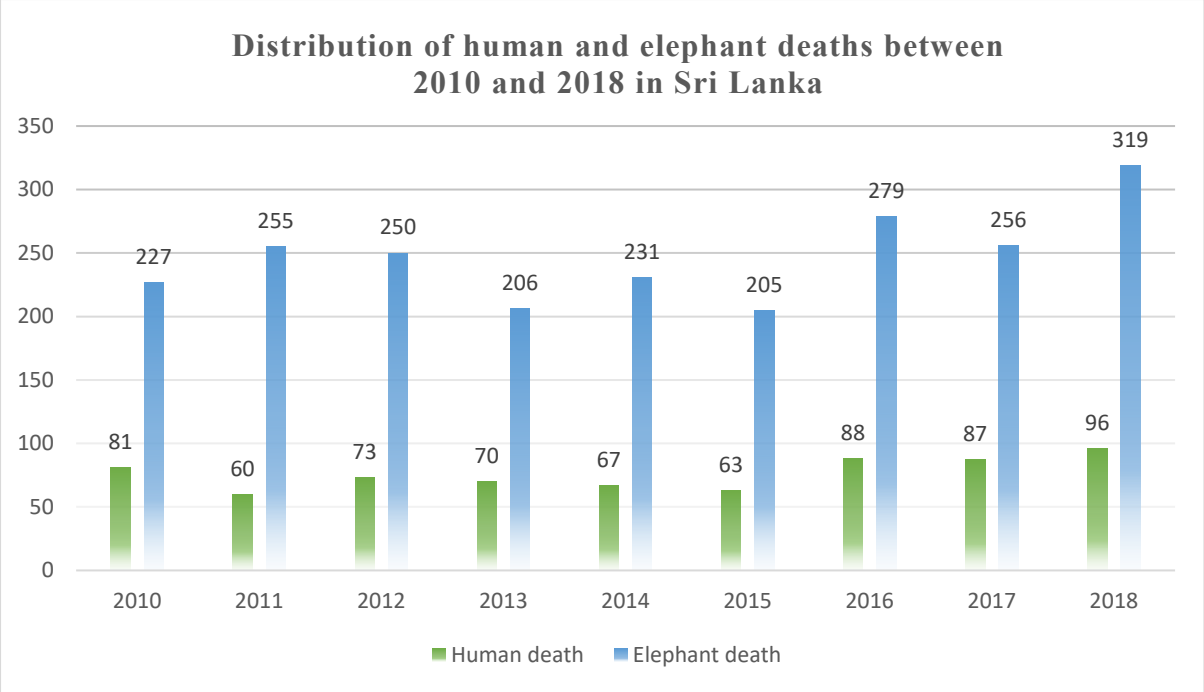


Figure 4. Number of human and elephant deaths in Sri Lanka

Most farmers (71%) from the sample region observed that there had been land use changes taking place within and near the Wasgamuwa National Park over the past 10 years. The major changes were reported as decreasing forest patches, increasing the number of cattle within the park (which reduces the food for wild elephants) and the building of houses, roads and other infrastructure which can hamper the usage of elephant corridors. These are similar to findings observed in the study by Ishwaran (1993) suggesting that less vegetation within national parks is escalating HEC. Increases in *Chena* cultivation have led to demand for more land; hence farmers have deforested adjoining areas of national parks, a further cause of escalating HEC.

Almost all respondents (95%) claimed that elephants should be protected in their locality. Moreover, farmers proposed a number of mitigation measures to minimize HEC and protect their croplands. These included constructing a permanent electric fence, assigning guards near the electric fence, cultivating crops which are less attractive to elephants (e.g., lemon trees, chilli), planting thorny crops together with electric fences, establishing wildlife officer mitigation projects, building canals around electric fences, ensuring adequate food and water for elephants inside national parks and providing adequate compensation for wildlife crop damage. Farmers spent a considerable amount of their own money on private mitigation measures such as fences, night guards and fuel to light fires. Some of the respondents had built their own electric fences surrounding their farms.

Respondents were asked about the effectiveness of the mitigation measures to combat HEC currently practiced (Fig.5). Among the eight measures, more than 50% of respondents claimed that night guards and growing crops which are less attractive to elephants seemed to be the most effective mitigation measures. On the other hand, 60% of farmers were of the view that the use of firecrackers and burning sticks was the least effective of the mitigation measures.

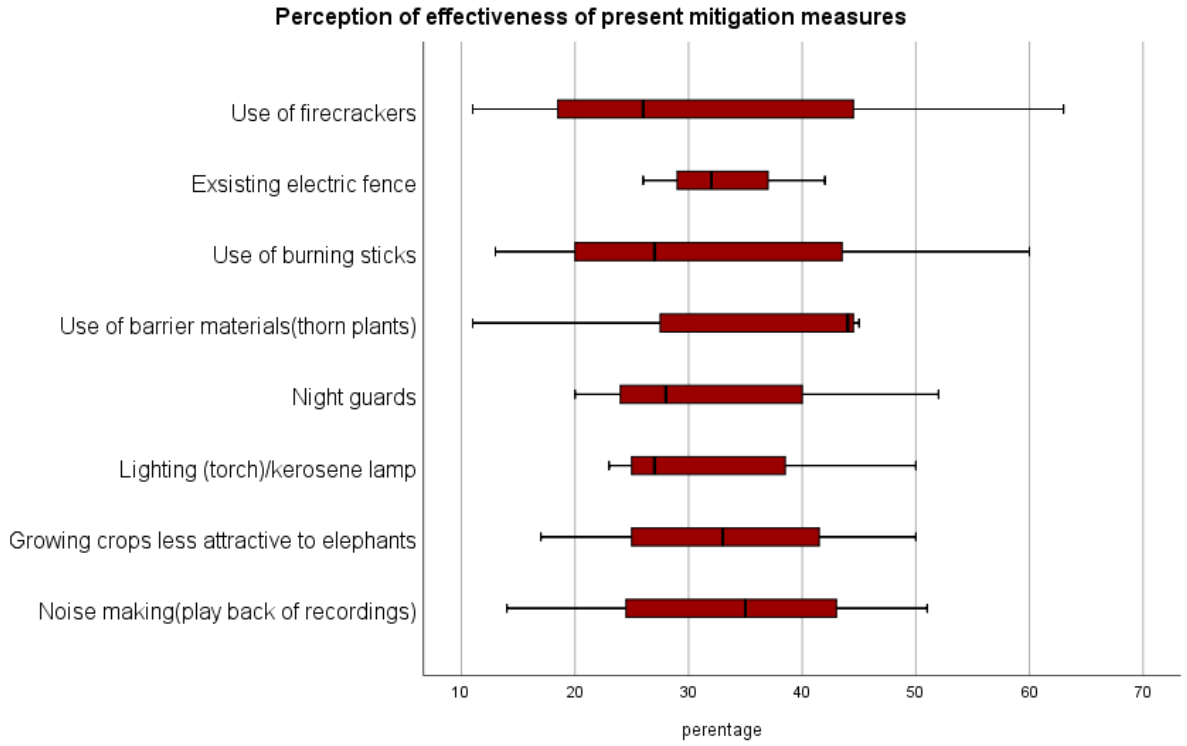


Figure 5. Farmers' perceptions of the effectiveness of present mitigation measures

We also investigated the attitudes of farmers (see, Table 2) towards the environment and nature conservation in general. Our findings clearly show that farmers have a high level of concern about nature-based resources and efforts to conserve them. However, they are shown to be less likely to make their own financial contributions to such conservation efforts.

Table 2 shows the percentage of responses to a series of attitudinal statements regarding nature conservation in Sri Lanka. Respondents were asked to express their level of agreement or disagreement with each statement, using a five-point scale. The responses were then grouped into three categories: "-" for Strongly disagree/disagree, "-/+" for Partly disagree/partly agree, and "++" for Strongly agree/agree.

Table 2. Respondent responses to attitudinal questions for nature conservation

Attitudinal statements	Responses (%)		
	-	-/+	++
Sri Lanka should not implement programs that are designed to conserve the country's nature-based resources (particularly elephants)	87	03	10
We should not preserve our natural environment for our future generations	74	04	22
Plants and animals have no greater or lesser right to live than humans do	92	02	06
Whatever the ecological outlays today, Sri Lanka should utilize its existing natural resource base for generating income and employment opportunities.	76	11	13
Everybody in the community must bear the cost of nature conservation	11	13	76
Conservation of elephants is not essential in regard to all economic and non- economic (cultural/ religious) purposes.	87	06	07
No matter how much land I have, I should not give up any of it for national conservation development projects (park enlargement/ creation of new wildlife corridors) even though it is beneficial to the society in general.	53	21	26

4.2 Model results

In order to predict the main model outcomes, we employ a simple extended multinominal logit (MNL) model[5] which captures the core issues underlying HEC and farmers' preferences for elephant conservation via a conservation fund which is created from tourism receipts. The money raised will be used to compensate farmers who are affected by HEC and to undertake sustainable mitigation measures (e.g. park enlargement, creation of wildlife corridors and habitat improvements). Note here that the 'Preferred compensation agency' attribute shows the results for government and non-governmental organizations where we compare them to 'Local authority' as the base. Hence the extended MNL model.

Table 3 presents the estimation results for two econometric models used to analyse the choice data. Model A is an extended base Multinomial Logit (MNL) model, while Model B is a Random Parameter Logit (RPL) model. The coefficients, standard errors, and significance levels are provided for each attribute, including interactions with socio-economic characteristics. Model fit statistics are also included.

[5] For more details on the modelling process, please see Appendix D.

Table 3. Estimation results of multinomial logit (MNL) and random parameter logit (RPL) Models

	Model A Extended base MNL model (with constant)	**Model B** RPL (with constant)
	Coefficient (standard error)	Coefficient (standard error)
ASC (chooses existing HEC conditions)	4.2001*** (0.253)	8.4697*** (0.625)
Number of elephants visiting your farmland	-0.0044* (0.002)	-0.0635*** (0.014)
Extent of crop damage as a percentage of total cultivated land	-0.0048*** (0.001)	-0.0084*** (0.001)
Crop switching as a percentage of total cultivable land	-0.0241*** (0.001)	-0.1070*** (0.020)
Preferred Compensation agency		
Preferred compensation agency - government	0.0091 (0.009)	0.1260 (0.088)
Preferred compensation agency - non-governmental organization	-0.1041* (0.000)	-0.0140 (0.090)
Willingness to accept compensation amount per acre	0.9133D-05*** (0.000)	0.1118*** (0.000)
Crop switching x education		0.0052*** (0.001)
Number of elephants visiting your farmland x preferred tourism opportunities		0.0210*** (0.007)
Crop switching x gender		0.0088* (0.004)
Number of elephants visiting your farmland x membership in an environmental club		0.0159** (0.007)
Log-likelihood	-2661.7384	-2478.7219
Observations	2634	2634
AIC	5337.50	5021
BIC	5378.60	5209.40
HQIC	5352.40	5089.50
Pseudo R^2	0.111	0.321

***, **, * Significance at 1, 5, 10 % levels, respectively.

Notes: The extended MNL base model is an expanded model of the attribute, 'preferred compensation agency'.
Random parameter logit (RPL) model with the interactions of the socio-economic characteristics and model fit.
Alternative specific constant (ASC); Akaike information criterion (AIC); Bayesian information criterion (BIC); Hannan-Quinn information criterion (HQIC)

The results of the model are shown in Table 3 (Model A). All variable signs are as expected and statistically significant. Our result shows that farmers perceive an increased disutility from elephants visiting their farmland. This is because the damage caused is larger when the number of elephants visiting the farm increases. This is a finding that is consistent with other studies (Bandara & Tisdell, 2003; Hoare, 2000). A herd of elephants visiting farmland are more likely to cause greater damage to their crops. The results also suggest that some farmers are unwilling to switch their crops in order to avoid HEC even though several studies have found that there are crops that are less attractive to elephants (Sukumar, 1989; Nyhus et al., 2000). Greater educational awareness is, therefore, needed to make farmers aware of the benefits of crop switching and thereby reduce the future financial burden of farmers who are subject to HEC. However, a majority of Sri Lankan farmers have been cultivating paddy and other food crops for generations due to soil and climatic conditions. This factor motivates the continuation of current cultivation patterns rather than introducing other types of crops that are less preferred by wild elephants.

The results for the preferred compensation agency show that the government as a compensating agency is preferred by farmers over non-governmental organizations (NGO's) when compared with the local authority as the preferred compensation agency. More details on this are discussed under the effects size analysis below. It is known that farmers are more likely to receive compensation from government agencies than from NGOs. Our study reveals that government compensation for mitigating HEC is underfunded and does not include elephant crop damage. This finding is consistent with the study by Bandara & Tisdell (2002). Moreover, the current compensation scheme for death, property and injuries due to HEC is ineffective due to excessive administrative red tape. This severely hinders the achievement of conservation objectives as vulnerable farmers become highly indebted due to significant crop losses caused by elephant crop raiding.

Effects size analysis undertaken for the attribute 'Preferred compensation agency' shows that the coefficient magnitudes are different. The coefficient of base level 'Local Authority' was calculated using the estimated coefficients of the other two levels, namely government and

non-government agencies being the compensating agencies. Figure 6 graphically shows respondents' order of preferences for different levels of the compensation

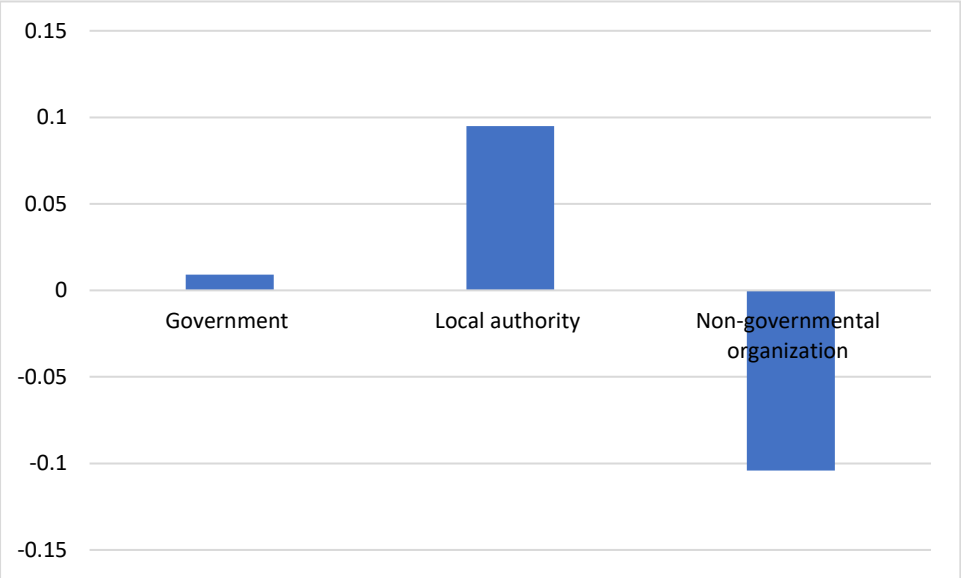


Figure 6. Respondents' preferred compensation agency

The coefficient of WTA compensation is positive and significant which suggests that even though farmers experience greater disutility from the number of elephants visiting their farmland and the extent of damage, this indicates they would be willing to receive compensation from tourism revenue. As reported by the Central Bank of Sri Lanka (CBSL, 2019 close to 2 million international tourists visit Sri Lanka annually (pre Covid 19 estimates), and total tourism receipts were around US$ 4.4 billion (Rs.712,023 million). The tourism revenue from national park entrance fees is also substantial and has been growing for all parks during the last three decades (see, Appendix E for details). According to DWC, in 2018 the total reported damage (human deaths, physical and crop and property damage) from HEC in Sri Lanka was estimated at around US$ 87 million (Rs. 478,021 million).

In addition to using the extended MNL base model, the results of which show the preferences of farmers for HEC mitigation, it is important to expand the model to capture the heterogeneity of preferences of farmers. Many influential studies recommend the use of a random parameter logit model (RPL) for this purpose as it allows for heterogeneity of preferences among individuals (McFadden & Train, 2000; Hensher et al., 2015). We employed the Swait-Louviere log likelihood ratio test and found a null hypothesis was disregarded at 5% significant level. Hence, we used the RPL model to observe the heterogeneity of farmers' preferences for nature

conservation via tourism opportunities. The RPL results are shown in Table 3 (see Model B). The single most striking observation to emerge from the interaction of variables relates to the number of elephants visiting farmland and tourism activities preferred as an alternative source of income. This was clarified through the following survey question: "*If crop damage and HEC continue at the present level would tourism provide sufficient income to compensate you and your family? If so, would you prefer tourism as an alternative source of income to current compensation schemes?* The observation is positive and significant which suggests that the farmers are most likely to prefer tourism activities as their alternative source of income for their livelihood with the flow-on effect of a greater number of elephants visiting their territory. In contrast, previous findings showed many farmers viewed elephants as agricultural pests (Bandara &Tisdell, 2003; Bulte et al., 2005). Hence, one potential solution to HEC is to promote nature-based tourism which could, to some extent, mitigate the conflict and promote coexistence between farmers and wildlife. This is important as ignoring the disutility arising from elephants entering farms and causing damage increases human-wildlife conflicts. In such a situation wildlife conservation issues will likely not be addressed.

In many countries, this is particularly the case where inadequate compensation is provided (Earnshaw & Emerton, 2000). Previous research suggests the net benefits elephants provide are largely derived outside national parks (that is, via attraction of tourists, hunting as a sport, sale of other products and by raising the awareness of the need to protect other species) and can outweigh the cost of damage caused by them (Hoare, 2000). Thus, if tourism opportunities are increasing this is more likely to increase the number of elephant viewings outside national parks thereby promoting tourism and creating revenue. The long-term sustainability of HEC mitigation depends not only on compensation for farmers but also on exploring other farm-based cost-effective, private and public mitigation strategies such as insurance, alternative livelihood opportunities and other conservation measures such as the creation of wildlife corridors.

Farmers' adoption of effective conservation strategies does not depend entirely on economic incentives: nonetheless, a farmer's socio-economic characteristics can influence the choice probabilities. Thus, those farmers with a higher education level are more likely to choose crop switching (i.e. grow crops that are less attractive to elephants). This is consistent with the existing literature demonstrating that education aids farmers in adopting modern farming

practices including those that are environmentally friendly (Goswami et al., 2014; Willy & Holm Muller, 2013). Previous studies have also highlighted that crop raiding is intensified by the presence of particular crops such as paddy, banana, sugar cane, maize and pineapple (Hoare, 2012; Sitati & Walpole, 2006). Our findings can therefore act as a trigger for policy makers to focus on the need for on-farm education which encourages cost-effective crop switching to those crops which elephants find less attractive.

Results also show that the gender variable is positive and significant indicating that male farmers are more likely than females to engage in switching their crops in order to protect crops from elephant damage. One possible reason could be that men are more likely to travel to other regions and obtain significant information regarding modern farming practices. This finding is consistent with Willy & Mullar (2013) who find that male farmers are more likely to adopt conservation practices in Kenyan agriculture by receiving more farm-related information. Another study by Jacobson et al. (2003) found that male farmers are more likely to understand the detrimental effects on the environment from a range of farming practices and are therefore better prepared to change them. In addition, male farmers typically migrate to other parts of the country for seasonal agricultural jobs such as harvesting and are exposed to other forms of crop cultivation patterns.

Flagship species are particularly valued by humans for conservation purposes (Bandara & Tisdell, 2004; Tisdell & Wilson, 2012). We find that farmers who are members of an environmental society/club positively value elephants. This supports previous research findings that people who are members of an environmental society value nature and wildlife more than those who are not (Baral et al., 2008). However, a lack of knowledge of the significance of flagship species can lead to poor integration of conservation measures. From a policy perspective, the role of government and NGOs is crucial to the creation of awareness among the public and local farmers about nature conservation (particularly wildlife) and the need to ensure the sustainability of such resources.

4.3 WTA measurement

Table 4 shows the implicit prices for achieving wildlife coexistence with crop damage caused by elephants and the respective 95% confidence levels using the Wald procedure (Hensher et

al., 2015). This monetary value is expressed in Sri Lankan rupees (Rs.)[6]. Implicit prices imply that farmers have a disutility due to HEC and ask for compensation per unit of negative disutility. The marginal disutility indicates that farmers are demanding, on average, compensation of Rs.490 per additional elephant visiting their farmland and Rs.534 per the additional extent of crop damage from elephants. Famers seek the highest compensation Rs.2,645 for crop switching. The higher implicit price placed on crop switching (Rs.2,645) suggests that farmers have greater disutility and opportunity costs when moving away from the present crops being cultivated. If compensation is provided by the government, for each additional unit of damage, farmers are prepared to accept Rs.1,000 from the government and Rs.11,402 from non-governmental organization for coexistence with elephants via funds raised from the embarkation tax. Compensation payments differ between government and non-governmental organization because farmers' experience with present compensation schemes provided by the government is limited. These implicit prices provide the basis for policymakers to design effective policies which both promote nature conservation and effective HEC mitigation.

The study revealed that most of the farmers have been facing frequent elephant attacks on their farmland. Our study focussed only on crop damage whereas farmers have spent a significant amount of money and other opportunity costs on such measures as night guarding and purchasing firecrackers. We assume that whenever elephants visit their farmland, there is crop damage because regardless of the type of crops or whether they are large or small, the crop losses tend to be the same given farmers are cultivating similar crops in the region.

[6] Exchange rate of USD 1 = Rs 181. Link https://www.cbsl.gov.lk/en/rates-and-indicators/exchange-rates

Table 4. Farmers' willingness to accept compensation for choice modelling attributes related to human- elephant conflict in Sri Lanka

Attributes	WTA (Rs.)	SE	95% confidence interval	
Number of elephants visiting your farmland	490.54	277.01	52.38	1033.48
Extent of crop damage percentage of total cultivated land	534.16	146.07	247.87	820.47
Crop switching (willingness to switching the existing cultivated crops)	2645	273.25	2110.38	3181.52
Preferred compensation agency -government	1000	5830.77	621.10	12428.72
Preferred compensation agency -government- non-governmental organization	11402	6134.69	10427.50	23426.50
Wald statistics	94.45			

Note: The WTA values are expressed in Sri Lankan Rupees (Rs.) along with their standard errors (SE) and 95% confidence intervals.

We propose that the conservation fund that is generated from tourism revenue and/or a tourism levy is only used for compensation for wildlife crop damage and coexistence with elephants. This fund would be jointly managed by the local community (who live in the buffer zones) and DWC. Our study proposes that the compensation amount should be based on the expected value of the crop damage rather than the damage cost at the time. If the proposed conservation funds are sufficient, then the respective authorities can use the fund's interest for various purposes, including conservation activities. Such a conservation fund would be distributed to farmers on the basis that they allow their land to be used for the free movement of wildlife and successful coexistence with elephants.

Merits of the scheme are that it can reduce the cost of patrolling by the DWC and farmers, minimise night vigils by farmers as well as obviate the need for government expenditure on paying for preventative measures such as firecrackers. On the other hand, there is the prospect that there may be false claims for compensation. The compensation approach might foster farmers benefitting from a continuous encroachment of wildlife habitat for farming purposes

in proximity to national parks which could hinder wildlife roaming. Hence, compensation is not an absolute solution for wildlife conservation. However, effective management and law enforcement could ensure the additional measures needed to bring about effective conservation management.

4.4 Proposed conservation fund

Table 5 shows the expected compensation only for elephant crop damage per farmer per acre. It was estimated using marginal willingness to accept (MWTA) for the extent of the crop damage shown in Table 4. The *total annual crop* damage from our estimated sample was 476 acres (40% of total cultivated land) and the amount of MWTA compensation was estimated based on the amount of compensation expected by farmers per person per acre. Several studies suggest that Sri Lanka 's annual food crop losses are estimated at one-third of its total annual production, which is about 208,583 acres (Ministry of Agriculture, 2018)

Table 5. Estimation of WTA compensation for the extent of crop damage

Extent of damage	Expected annual compensation amount per farmer /per acre (Rs. & US$)
20% of the cultivated total land damaged	10,600.00 ($ 58.56)
40% of the cultivated total land damaged	21,360.00 ($118.01)
60% of the cultivated total land damaged	32,040.00 ($177.02)
80% of the cultivated total land damaged	42,720.00 ($236.02)
100% of the cultivated total land damaged	53,400.00 ($ 295.03)

Note: the above estimates are calculated per person for each season. Sri Lankan farmers have two major cultivating seasons per annum. The study has also assumed that the damage is similar each time damage occurs. However, this assumption was only for illustrative purposes. More detailed compensation modelling can be undertaken based on primary and secondary data collected.

Using the estimation, we suggest a conservation fund for the entire country based on the anticipated reimbursement amount using our sample survey of respondents (farmers). Farmers in Sri Lanka cultivate crops during two main seasons *(Yala and Maha)* and we asked the respondents about crop damage per acre caused by wild elephants. Farmers cultivate various crop varieties, and the amount of the WTA pay-out varies depending on the crop they produce. For example, the survey data show that farmers growing paddy were seeking more compensation than other crops. This is because the crop entails higher costs of production and maintenance. This is an issue that needs to be borne in mind in designing a potential conservation fund. Our survey estimates show, for example, that the average WTA

compensation amount for the elephant crop damage per farmer per acre for 100% of the cultivated crop damage was around Rs.53,400 (US$ 295). At present, the DWC's compensation scheme for an elephant-caused human death is a maximum of Rs.500,000, for human injuries it is Rs.75,000 and for property damage, the amount is Rs.100,000 (DWC, 2018). However, given there is no formal compensation scheme for elephant-crop damage in Sri Lanka the proposed conservation fund offers a valid solution for HEC mitigation and coexistence.

5. Discussion and conclusions

Human elephant conflict remains an unresolved issue for many Asian and African countries and the study results show that a resolution is possible if a conservation fund is created from tourism revenue and/or a tourism levy. While previous studies have focused on onsite or country-specific solutions for HEC, we examined a broader perspective of HEC resolution via tourism and tourism revenue. The analysis presents several findings which clearly show that farmers perceive elephants as agricultural pests, and which generate substantial disutility as a result of their visits to their farmland. We find that elephants visiting farmland do cause a significant amount of crop damage which in turn results in substantial financial burdens on subsistence farmers in developing countries such as Sri Lanka. We further report that farmers are generally unwilling to switch away from their traditional crops given the perceived greater disutility from such a solution. Fortuitously, farmers are shown to be more willing to accept compensation sourced from funds raised from tourists (e.g. tourism revenue and/or tourism levy such as from an embarkation tax) for damage to their crops caused by elephants. Moreover, farmers prefer tourism as an alternative source of income which can create sustainable livelihood activities while generating a symbiosis between farming, nature and wildlife.

The key outcome of this study is that tourism has the potential to contribute to local economic welfare while simultaneously helping to conserve nature and wildlife. Elephants are an iconic species for the tourism sector and if placed under threat, could seriously affect future tourism flows and nature conservation activities. Unfortunately, policy analysts, public officials and scholars seeking solutions for HEC have poorly understood the centrality of creating a conservation symbiosis. Building trust among farmers that nature conservation can be achieved through the assistance of tourism is essential, as is designing a compensation mechanism that

overcomes existing mistrust and provides a sustainable solution in the long term. However, for successful governance of common pooled resources, the active participation of the resource users in the management of the flows of the benefits is needed. Such empirical-based conservation research is fundamental in attaining practical solutions to existing problems (Sitati & Walpole, 2006). Our findings provide an evidence-based analysis which indicates how the nature-based tourism sector has the potential to mitigate HEC and create a symbiosis between farmers and nature conservation through the use of funds raised from tourists for compensation. We estimated that the share of the compensation from tourism receipts will be around 0.012% of the total annual government tourism receipts. One potential solution for HEC and coexistence with wildlife will be generating revenue for a conservation fund from tourism revenues and/or from a tourism levy (e.g. an embarkation tax). The compensation, for example coming from tourism revenue would not act as an additional burden to the country's economy given it accounts for only 0.013% of the country's total annual tourism revenue (Department of Wildlife Conservation, 2017; Central Bank of Sri Lanka, 2018). It should be noted that an alternative approach is a tourism levy, for example, in the form of an embarkation tax is also an option. Hence, our study proposes that there is the potential for the tourism sector to compensate farmers who are victims of HEC. Such a fund would encourage farmers to coexist with wildlife, and therefore go a long way to ensure the future sustainability of nature and wildlife.

6. Directions for future research

The strong link between nature-based tourism and nature conservation is not surprising given that tourism directly depends on the richness of the viewed nature and wildlife. However, human-wildlife interactions are complex and inadequately explained by the existing conservation and tourism literature. Future studies could investigate the weak and inadequate government response to HEC and explore how private or individual mitigation strategies could deliver productive conservation action. This is based on the view that individuals are typically the best actors in implementing environmental decisions using self-motivation and awareness of the social costs and benefits. Our findings can therefore act as a building block for the development of more detailed studies on farmer/nature conservation symbiosis which generates benefit sharing among the relevant stakeholders.

7. Limitations of the study

We acknowledge that there are limitations to our study. We have not included the socio-economic opportunity costs of HEC in our study given the difficulty in quantifying it (Hoare, 2000; Sitati et al., 200). Farmers also bear other costs (opportunity cost) due to HEC such as loss of sleep from guarding their farmland, people movement, competition with elephants for water resources, poor school attendance, poor employment opportunities and psychological stress. However, we argue that such costs could be offset by an adequate compensation programme that has the potential to create a symbiosis between humans and wildlife.

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Appendix

Appendix A: Regional distribution of human deaths (2010 to 2018)

Region	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total
North Western	34	20	18	25	7	12	6	5	11	127
Mahaweli	14	22	19	12	16	10	26	16	21	135
Eastern	14	5	14	18	22	15	20	23	17	131
Southern	9	6	7	3	9	7	10	10	5	61
Central	4	6	0	3	2	4	0	3	5	22
Yala Bundala	6	1	2	0	0	-	-	-		9
Uva	-	-	1	2	4	2	4	7	8	20
Anuradhapura	-	-	12	7	5	8	13	11	17	56
Killinocchchi	-	-	-	-	1	0	1	1	0	3
Vavniya	-	-	-	-	1	1	2	3	2	7
Trincomalee	-	-	-	-	-	4	4	5	5	13
Puttalam							2	3	5	5
Total	**81**	**60**	**73**	**70**	**67**	**63**	**88**	**87**	**96**	**589**

Source: DWC (2019).

Appendix B: Regional distribution of elephant deaths (2010 to 2018)

Region	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total
North Western	66	82	63	18	15	15	16	15	18	290
Mahaweli	74	90	72	63	57	37	54	47	76	494
Eastern	42	33	44	29	49	52	55	56	64	360
Southern	35	36	22	14	28	12	26	17	20	190
Central	2	3	5	7	8	5	5	4	11	39
Yala Bundala	8	11	4	-	-	-	-	-	-	23
Uva	-	-	14	22	16	13	14	25	22	104
Anuradhapura	-	-	19	49	32	27	42	30	53	199
ETH	-	-	7	4	12	6	8	7	6	44
Killinochchi	-	-	-	-	5	4	2	4	5	15
Vavuniya	-	-	-	-	9	12	16	13	12	50
Trincomalee						22	30	22	25	74
Puttalam							11	16	7	27

Total	**227**	**255**	**250**	**206**	**231**	**205**	**279**	**256**	**319**	**2228**

Source: DWC (2019).

Appendix C: Survey questionnaire

Are farmers willing to accept compensation from tourism revenue for elephant crop damage and coexistence support? Evidence from Sri Lanka

Interview No ☐☐

Interviewer's code ☐☐

Date: ……

Section 1: Background information

1.1 Were you involved in farming activities over the last year? ☐ Yes ☐ No

1.2 What are the major crops you cultivated last year? (list priority)

i)…….. ii)…… iii). ……

1.3 Have you experienced crop damage to your farm for last 3 years?

☐ Yes ☐ No

1.4 Were your crops affected by wild elephants over the past year?

☐ Yes → what is the value (SLR) of damage to your crops? ……..

☐ No

1.5 How far is the nearest national park from your agricultural land?

☐ Less than 2 Km ☐ 2 - < 5 Km ☐ 5- < 10Km ☐ More than 10Km

1.6 How frequently do elephants visit your farmland?

☐ Once a week ☐ Once a fortnight ☐ Once a month ☐ Daily

1.7 Please indicate the way in which wild elephants have caused damage in your locality.

Activities	**Village**	**Year/Month**	**Time of damage**	**Type of the crop/crops**	**Cultivated acres**	**Extent of damage (acre)**
Crop damage						
House damage						
Attack to livestock						
Family member death						
Family member injury						
Any other……...						

1.8 Did you receive any compensation for those losses?

☐ Yes → How much ……

☐ No

1.9 Have you seen any land use changes in areas nearby national parks over the last 10 years?

☐ Yes → what are those changes? ……..

☐ No

1.10 Should elephants be protected in your locality? ☐ Yes ☐ No

1.11 What mitigation measures are you proposing to the government? (Please list 3 most important measures)

i)…… ii)…… iii)……

1.12 What are the mitigation measures you are currently practicing minimizing elephant attack on your farmland and property and how effective has it been? (1= very effective to 5 = not effective at all)

Mitigation measures	Very effective	Effective	Neutral	Less effective	Not effective at all.
Firecrackers					
Electric fence					
Burning sticks					
Barrier materials (thorn branches)					
Night guards					
Lighting (torch)/kerosene lamps					
Crop less attracted by elephants					
Noisemakers (playback recordings)					
Others (specify)……					

1.13 What is the distance to the nearest wildlife department office from your farmland?

☐ Less than 1 Km ☐ 1 - < 5 Km ☐ 5 - < 10 Km ☐ More than 10 Km

1.14 Do you belong to an environmental society/ conservation club? ☐ Yes ☐ No

1.15 Have you been involved in any meeting/training programme regarding safety from human-elephant conflict mitigation?

☐ Yes → from whom ☐ Government ☐ NGOs ☐ Local authorities

☐ No

1.16 Do you think your suggestions and requests made to the relevant authorities regarding crop and property losses were well addressed in HEC mitigation decision-making process in the past?

☐ Fully addressed ☐ Partially ☐ Never

1.17 If crop damage and HEC continues at the present level would tourism provide sufficient income to compensate you and your family? If so, would you prefer tourism as an alternative source of income to current compensation schemes?

☐ Yes → if yes what kind of tourism opportunity you are looking for? ……

☐ No

1.18 Suppose the government decided to implement a conservation project (park enlargement/ creation of new wildlife corridors), which is beneficial to the society, that needs more lands, would you be willing to sell your land to the government with the current market price?

☐ Yes ☐ No ☐ Unsure

Section 2: Attitudinal questions – environmental conservation

I am going to read out a few statements. Please indicate your opinion on a scale of 'strongly agree' to 'strongly disagree'. There is no right or wrong answer; I only need your frank opinion. (1= Strongly agree to 5= Strongly disagree)

SN	Statements	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
2.1	Sri Lanka should not implement programs that are designed to conserve the country's nature-based resources (particularly elephants).					
2.2	We should not preserve the nature and wildlife for our future generations					
2.3	Plants and animals have no fair right to live than humans do					
2.4	Whatever the ecological outlays today, Sri Lanka should utilize its existing natural resource base for generating income and employment opportunities.					
2.5	Everybody in the community must bear the cost of nature conservation.					
2.6	Conservation of elephants is not essential regards all economic and non-economic (cultural/ religious) purposes.					
2.7	No matter how much land I have, I should not give up any of it for national conservation development projects (park enlargement/ creation of new wildlife corridors) even though it is beneficial to the society in general.					

Section 3: Preferences for elephant conservation

The wild elephant population in Sri Lanka has been declining in recent years due to habitat loss coupled with rapid growth of human population and changes in land use patterns. Nature-based tourism provides tangible economic benefits from wildlife which can offset the cost of protection and coexistence. This study proposes a hypothetical **CONSERVATION FUND** which is generated from tourism receipts and will be used to compensate farmers who are affected by HEC and for sustainable mitigation measures (park enlargements, the creation of wildlife corridors and habitat improvements). Hence, tourists would contribute to a **CONSERVATION FUND** which would be used to mitigate the negative impacts on farmland (For example, the increasing extent of damage to farmlands, switching traditional crops, and greater tolerance of elephant damage and coexistence with wildlife).

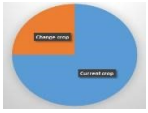
This fund is as yet, hypothetical, however, if it is successfully created and its funding implemented there is the prospect that nature-based tourism development will increase significantly. That, however, depends on whether affected farmers are willing to accept compensation and coexistence with elephants. The compensation would be most likely to be paid to your bank account over a period of ten years. If the programme is successful it will continue into the future. Note that if your household received any payment, it would mean that you would have more money to spend on other things.

Table 1: Attributes, their definition, and levels – HEC mitigation

Attributes	Definition	Levels
Number of elephants	Number of elephants visiting your farmland	Level I 10 elephants Level II 20 elephants Level III 30 elephants
Extent of crop damage	Increase in the extent of damage to crop damage (percentage of total cultivated land)	Level I 20% Level II 40% Level III 60%
Crop switching	Total extent of crop switching by less elephant attractive crops in the total cultivated land	Level I 25% Level II 50% Level III 75%
Compensation management	Farmers' preferred agency for HEC compensation payment	Government Local authorities International organizations
Payment	Willingness to accept compensation (per acre) for crop damaged by elephants (to be derived from tourism receipts)	Level I LKR 70, 000 Level II LKR 100, 000 Level III LKR 130, 000

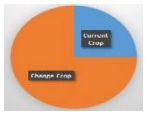
We have used five hypothetical attributes to describe the nature conservation and mitigation of HEC. If only the alternatives listed below are available, please mark only one alternative that you would prefer. You have the choice to choose "None of the above" if you don't like any of the choices enough to choose them. You should assume you are making real decisions: Now imagine as compensation for the damage caused by elephant in your farmland, farmers are entitled to get some amount of money by tourism earnings as compensation for coexistence with elephants in your region. What would you choose among the following options?

If, as mentioned below, the only choices available to you were the alternative, which one would you prefer? You should assume you are making real decisions:

Attributes	**Option A**	**Option B**	**Option C**
Number of elephants visiting your farmland	10 elephants 	30 elephants 	20 elephants 
Extent of damage as a percentage of total cultivated land	60% 	40% 	20%
Crop switching (willingness to switching the existing cultivated crops)	25% 	50% 	75% 
Preferred compensation agency	Non-Governmental organization 	Government 	Local authority 
Payment (Rs.) compensation: amount per acre.	Rs.130,000 	Rs.100,000 	Rs.70,000 

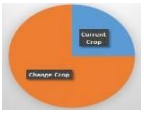
Option A ☐ Option B ☐ Option C ☐ None of the above ☐

If, as mentioned below, the only choices available to you were the alternative, which one would you prefer? You should assume you are making real decisions:

Attributes	Option A	Option B	Option C
Number of elephants visiting your farmland	20 elephants 	30 elephants 	10 elephants 
Extent of damage as a percentage of total cultivated land	40% 	20%	60% 
Crop switching (willingness to switching the existing cultivated crops)	75% 	25% 	50% 
Preferred compensation agency	Non-Governmental organization 	Government 	Local authority 
Payment (Rs.) compensation: amount per acre.	Rs.70,000 	Rs.100,000 	Rs.130,000 

Option A ☐ Option B ☐ Option C ☐ None of the above ☐

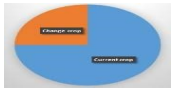
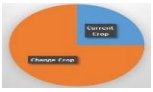
If, as mentioned below, the only choices available to you were the alternative, which one would you prefer? You should assume you are making real decisions:

Attributes	Option A	Option B	Option C
Number of elephants visiting your farmland	30 elephants 	10 elephants 	20 elephants 
Extent of damage as a percentage of total cultivated land	60% 	40% 	20%
Crop switching (willingness to switching the existing cultivated crops)	25% 	75% 	50% 

Preferred compensation agency	Local authority 	Non-Governmental organization 	Government 
Payment (Rs.) compensation: amount per acre.	Rs.70,000 	Rs.130,000 	Rs.100,000 

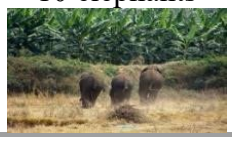
Option A ☐ Option B ☐ Option C ☐ None of the above ☐

If, as mentioned below, the only choices available to you were the alternative, which one would you prefer? You should assume you are making real decisions:

Attributes	Option A	Option B	Option C
Number of elephants visiting your farmland	10 elephants 	30 elephants 	20 elephants 
Extent of damage as a percentage of total cultivated land	20%	60% 	40% 
Crop switching (willingness to switching the existing cultivated crops)	50% 	25% 	75% 
Preferred compensation agency	Government 	Non-Governmental organization 	Local authority 
Payment (Rs.) compensation: amount per acre.	Rs.100,000 	Rs.130,000 	Rs.70,000 

Option A ☐ Option B ☐ Option C ☐ None of the above ☐

If, as mentioned below, the only choices available to you were the alternative, which one would you prefer? You should assume you are making real decisions:

Attributes	Option A	Option B	Option C
Number of elephants visiting your farmland	20 elephants 	10 elephants 	30 elephants 
Extent of damage as a percentage of total cultivated land	60% 	20% 	40% 
Crop switching (willingness to switching the existing cultivated crops)	50% 	50% 	50% 
Preferred compensation agency	Government 	Non-Governmental organization 	Local authority 
Payment (Rs.) compensation: amount per acre.	Rs.100,000 	Rs.130,000 	Rs.70,000 

Option A ☐ Option B ☐ Option C ☐ None of the above ☐

If, as mentioned below, the only choices available to you were the alternative, which one would you prefer? You should assume you are making real decisions:

Attributes	Option A	Option B	Option C
Number of elephants visiting your farmland	20 elephants 	10 elephants 	30 elephants 
Extent of damage as a percentage of total cultivated land	20%	40% 	60% 
Crop switching (willingness to switching the existing cultivated crops)	75% 	50% 	25% 
Preferred compensation agency	Local authority 	Government 	Non-Governmental  organization
Payment (Rs.) compensation: amount per acre.	Rs.130,000 	Rs.100,000 	Rs.70,000 

Option A ☐ Option B ☐ Option C ☐ None of the above ☐

3.1. For those who selected "I would choose none" please state your reason **(you may circle multiple answers)**

- ☐ I am happy with the existing status of the compensation.
- ☐ I suspect my compensation will not be distributed in a fair manner.
- ☐ I need my safety than the elephant conservation.

3.2 For those who selected the HEC mitigation alternatives. Can you kindly disclose why you are willing to pay for elephant conservation **(you may circle multiple answers)**

- ☐ I am in favour of conserving the wild elephants.
- ☐ It seems a reasonable amount of compensation.
- ☐ I wish to show my support for conserving nature in general.
- ☐ The government alone cannot solve the issue of conserving elephants.

Section 4: Socio-economic information

It is ensured that all details will be considered with the strictest confidence.

1. What is your gender? ☐ Male ☐ Female ☐ Other

2. What year were you born? . ……....

3. What is your highest educational qualification?

☐ Primary education only ☐ Advanced level (A/L)
☐ Diploma/vocational education ☐ University
☐ Postgraduate

4. What is your main occupation in relation to the following?

☐ Government employee ☐ Agriculture ☐ Fishing
☐ Retired ☐ Self-employed ☐ Other (specify) ……

5. What is your annual family income level per annum in Sri Lankan Rupees?

☐ Below Rs.16,000 ☐ Rs. 86, 001-116,000
☐ Rs.16, 001-36,000 ☐ Rs. 116, 001-136,000
☐ Rs. 36,001-56,000 ☐ Above Rs. 136,000
☐ Rs. 56,001- 86,000 ☐ I don't like to reveal income

6. Please provide any comments you many have on this survey.

……

……

Thank you for your time in completing this survey.

Appendix D: Discrete Choice Experiment

We employed a discrete choice experiment (DCE) to ascertain farmers' preference for elephant conservation and their WTA compensation via a tourism conservation fund. The DCE is a widely accepted method for stated preference (SP) studies and has the potential to create a rich data set to evaluate affected farmers' trade-offs from conservation attributes and financial benefits as compensation. The advantages of this methodology notwithstanding the higher cost involved in the large number of questionnaires outweighed other non-market valuation approaches using experimental designs (Hensher et al., 2015). The applications of DCE covers a range of disciplines including psychology, transportation, marketing, and health (Adamowicz, et al., 1998; Hensher et al., 2015). The application of DCEs in the context of non-market valuation was explored by Adamowicz et al., 1994 and Boxall et al., 1996. Since then, several studies have been undertaken using DCEs to investigate the economic significance of nature-based resources and the trade-off which can arise from their various attributes in the form of willingness to pay (WTP) and WTA (see, for example Hanley et al., 1998; Hensher, et al., 2015). However, the literature on the use of DCE for research on tourism and nature conservation is limited. Employing a DCE would provide a robust analysis of the inherent preferences of farmers towards the use of tourism revenue for nature conservation.

The DCE assumes that in each choice exercise performed by respondents a random utility maximization procedure is generated (McFadden, 1974, Louviere et al., 2010). According to the random utility theory individual I's choice is determined by his or her own utility form alternative J denoted $U_{ij.}$

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (1)$$

Utility (U) is derived from systematic elements (V) and random elements (ε). V_{ij} are the systematic elements of utility of a person i who has an alternative j and ε_{ij} represents the random elements which have an independently and identically distributed (IID) error term. As a result of leverage of the unobserved elements, individual choices are anticipated. The random elements enable the modelling of choices as probabilistic models where the expected utility of an individual is derived from the current choice situation. U_{ij} can be expressed as the maximum of the expected preference of an individual i and as the usefulness of choice j in a complete

choice task of n alternatives (Hanley et al., 1998; Hensher et al., 2015). This expected utility can be written as follows:

$$E\ (i \mid \boldsymbol{R}) = E\ [V_{ij} + \varepsilon_{ij}) > (V_{in} + \varepsilon_{in}),\ \text{all}\ n\ \boldsymbol{\epsilon}\ \boldsymbol{R}] \quad (2)$$

where *R* is the complete choice task. The ε_{ij} for the entire *j* in *Ra*re is generally presumed to be distributed independently. This gives rise to the multinomial logit (MNL) model as the starting point of discrete choice experiment which can be represented as:

$$E(ij) = \frac{\exp^{mV_{ij}}}{\sum_{n \epsilon C} \exp^{mV_{in}}} \quad (3)$$

where E_{ij} is the standard logit choice probability evaluated at the unobserved parameters β. The estimated linearity in the parameter's utility framework for the j^{th} option is frequently specified as below:

$V_{ij} = ASC_j + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots\ldots + \beta_k X_k + \gamma_p\ (S_p * ASC_j)$

In the utility function, sine *j* is an alternative, *k* represents attributes, socio-demographic variables are illustrated as *p* and the alternative specific constant is the same across the utility functions (ASC) within the utility framework.

Once a random utility model is estimated, welfare estimates of alternatives of concern can be calculated (Hensher et al., 2015). The WTA thereby reveals the marginal trade-off between farmers' wild elephants' conservation related attributes and compensation payment. Thus, the WTA for the marginal change in the k^{th} attribute (β_k) can be described as:

$$WTA_k = \frac{\beta_k}{\beta_\mu} \quad (4)$$

We used the MNL model to understand farmers' preferences for HEC mitigation (Hensher et al., 2015) followed by the employment of the random parameter logit (RPL). The RPL model focuses on the distribution of individual parameters rather than on average preference (Revelt and Train, 1998; Hensher et al., 2015). We therefore used the RPL model to identity the preference variance of farmers according to n different alternatives of elephant conservation preferences. It is this unobserved heterogeneity of farmers' preferences regarding elephant conservation and perceived compensation for crop damage which we seek to capture using a RPL model.

Appendix E: Sri Lanka tourism revenue from national park entrance fees (1988 to 2017)

Year	Yala National Park	Wilpattu National Park	Kumana Bird	Udawalawa National Park	Others*	Total revenue in Rs.'000 million
1988	226.7	-	-	11.0	49.4	287.1
1989	365.4	-	-	2.7	65.0	433.1
1990	1,151.6	-	-	3.6	-	1155.2
1991	1,511.6	-	-	9.5	214.7	1735.8
1992	2,700.9	-	-	207.3	456.2	3364.4
1993	10,803.8	-	-	829.2	1,824.9	13457.9
1994	21,613.4	-	-	5,529.1	2,224.0	29366.5
1995	21,595.8	-	-	3,905.1	13,037.8	38538.7
1996	15,196.9	-	-	2,928.7	9,776.1	27901.7
1997	12,138.8	-	-	10,642.1	11,708.5	34489.4
1998	8,918.7	-	-	13,626.4	18,681.0	41226.1
1999	20,420.1	-	-	18,098.6	17,454.1	55972.8
2000	25,417.8	-	-	15,876.9	18,857.8	60152.5
2001	25,183.4	-	-	10,940.6	18,266.0	54390
2002	25,802.4	-	-	14,813.7	17,920.4	58536.5
2003	46,480.0	230.0	-	22,780.0	32,744.0	102234
2004	48,413.9	522.3	274.6	29,647.2	34,944.0	113802
2005	23,945.8	734.9	75.9	16,205.3	21,729.9	62691.8
2006	45,411.8	366.4	82.1	23,514.4	30,176.2	99550.9
2007	30,247.9	-	-	20,316.5	35,168.9	85733.3
2008	27,707.4	-	-	18,223.5	38,488.7	84419.6
2009	50,221.2	-	-	9,864.3	43,907.5	103993
2010	123,850.1	1,503.6	445.8	22,718.5	78,731.3	227249.3
2011	154,310.8	3,881.3	906.7	33,531.2	108,378.7	301008.7
2012	222,269.9	10,032.3	2,499.9	43,252.7	146,790.1	424844.9
2013	272,581.0	91,358.9	79,078.1	1,166.4	132,274.4	576458.8
2014	360,952.8	26,182.5	4,607.9	110,828.8	325,015.9	827587.9
2015	419,311.8	37,275.2	6,307.9	172,954.7	375,735.7	1011585.3
2016	570,466.3	33,670.9	8,763.1	259,298.3	573,767.9	1445966.5
2017	623,836.9	47,975.3	10,720.4	310,071.9	738,113.8	1730718.3

Source; Department of Wildlife Conservation (2018)