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Assessment of human-wildlife conflict in Kailali district of Nepal

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Abstract

Human-wildlife conflict (HWC) is on an increasing trend and has become one of the most challenging problems for the rural communities of developing nations like Nepal. There is limited information available on HWC in Kailali district, Nepal. The objective of our study was to explore the different incidents and the perceptions of local people on HWC within four different sites in Kailali district. To collect information three different methods were used, a questionnaire survey (n= 80), key informant interviews (n= 10) and focus group discussions (n= 4); all during February and March 2018. Different records of HWC incidents were collected that occurred during the period of one year in 2017, except for information on human attacks which were collected from 2015 to 2017. Of the total of 102 HWC incidents, crop damage was the most severe problem followed by property damage (15) and livestock depredation (9). The Asian elephant (n= 54) was the most conflicting species for crop damage, followed by the Rhesus macaque (n= 23) and the wild pig (n= 14). Similarly, property damage was mostly caused by elephants (n= 10) and other animals (n= 5). Rice (43%) was the most damaged crop type by the conflicting species, followed by wheat (28%) and then maize (9%). For property damage, 19% of respondents reported suffering house damage while 11% suffered damage to stored food. Shouting and hitting drums was the most applied measure during HWC's but other measures for human-wild animals co-existence and resolution are suggested.

Key words: Wildlife conflict, crop damage, property damage, livestock depredation, conflict resolution

Introduction

Human wildlife conflict (HWC) can be defined as any interaction between humans and wildlife that results in negative impacts on the social, economic or cultural life of people, on the conservation of wildlife populations, or on the environment (Liu et al., 2011). HWC continues to be a severe worldwide issue resulting in crop damage, livestock depredation, property damage, human injuries and death, as well as retaliatory killing of wild animals (Sekhar, 1998; Nyhus and Tilson, 2000; Rao et al., 2002; Thapa, 2010; White and Ward, 2011; Acharya et al., 2016). The severe result of this impact is in the loss of human lives which cannot be compensated for and that lead to the retaliatory killings of wild animals involved in the conflict (Treves and Bruskotter, 2014). Most of the past studies regarding HWC in Nepal are focused on the buffer zones of Protected Areas (Gurung et al., 2008; Ayadi, 2011; Timalsina and Ranjitkar, 2014; Pandey et al., 2016), while limited studies have been conducted outside of these (Neupane et al., 2018; Dhakal and Thapa, 2019; Kafle et al., 2020). It is more meaningful to study the wildlife conflicts outside of these Protected Areas where the threat is much more on human lives. Our study was therefore designed to explore one of these situations of HWC outside the Protected Areas of the Kailali district in Nepal.

HWC occurs when humans and wild animals share, and compete for, the same limited resources (Treves, 2007). The conflict becomes more severe when the wildlife habitat becomes compromised and results in financial losses from crop and property damage, livestock depredation and threats to human lives in the vicinity of the Protected Areas (Vedeld et al., 2012). People exploit the wildlife habitat for various purposes including agriculture expansion, logging, animal husbandry and this consequently results in HWC (Fernando et al., 2005). Studies around the world show that HWC is more intense in developing countries where livestock holdings and agriculture are an important part of rural livelihoods (Distefano, 2005). In Nepal, most of the rural people depend on forest resources for agriculture and livestock husbandry for their subsistence livelihood (Neupane, 2014) and thus have greater chances of encountering wild animals. Major natural resources used by the local people, particularly in the inner areas of Kailali district are firewood, grasses, timber for construction and fodder for livestock (Baral and Heinen, 2007). In these regions, competition between the local communities and the wild animals, for the use of natural resources is particularly intense and the resident human populations are very vulnerable (Distefano, 2005).

Previous studies regarding "Man-Wildlife Conflict" are suggested to be site-specific and so with appropriate strategies can reduce HWC, mitigate crop and livestock depredation and improve local livelihoods (Thapa, 2014).

Formulation of an intensive mechanism in impacted regions that would help to develop positive attitudes towards wildlife conservation is essential (Parker et al., 2007). Realizing the need to document HWC information in the Kailali district, the present study has gathered baseline information and any relatively appropriate measures to mitigate the conflict. The current study also provides information which might help governments, wildlife managers, scientists, and local communities to ensure a positive co-existence between humans and wildlife.

The major aim of this study was to document different incidents of HWC, existing mitigation measures practiced by local people and their perceptions of HWC in the Kailali district of Nepal. The output of this study is expected to help the authorities, including Division Forest Office, Kailali, to formulate better management strategies for the coexistence of humans and wildlife in the study area.

Material and Methods

Study area

Kailali District lies in the western most Terai region of Nepal which covers an area of 3,235 km^2 of which approximately 40% is lower Terai land (southern lowland of Nepal) with less undulating terrain while the rest forms the Churehill Range. The altitude of the district ranges from 109 to 1950 m from mean sea level (msl). The climate varies from tropical to subtropical with a mean annual rainfall of 1840 mm and temperatures ranges from 24 °C to 43 °C in autumn, and 5 °C to 19 °C in winter. The population density has been recorded at 240 people/ km^2, with the majority of the people belonging to the Hindu religion and Tharu as the main spoken language (DCC Kailali, 2015) in the district. The district has seven major lakes: Ghodaghodi, Jokhar, Tilko, Liki, Koilahi, Behadababa, and Laukabhauka. Several rivers are also present in the Kailali district: Karnali Mohana, Kutiya, Patharaiya, Rora, Donda, Shivaganga, Gaurishankar, Kadra, Manahara, Godawori, Likma, and Gulara. After consultations and discussions with local stakeholders, including the staff of the Division Forest Office, Kailali, we selected four sites for our study that were near to Dudhwa National Park of India, a region known to be affected by HWC (Gyawali, 1989; Thapa, 2014). The selected sites were Kailari Rural Municipality, Basanta Community Forest (CF), Bhajani Municipality and Lamkichuwa Municipality within the Kailali district (Fig. 1; Table 1).

The major wild animal species that usually come from the nearby forest areas into the study sites are: in Basanta Community Forest - the Asian elephant, *Elephas maximus* Linnaeus, the wild boar, *Sus scrofa* Linnaeus, the Rhesus macaque, *Macaca mulatta* (Zimmermann), and the Bengal fox, *Vulpes bengalensis* (Shaw); in Kailari Rural Municipality - *E. maximus*, the Bengal tiger, *Panthera tigris* (Linnaeus), the Chital deer, *Axis axis* (Erxleben) and *M. mulatta*; in Lamkichuwa Municipality- the Nilgai, *Boselaphus tragocamelus* (Pallas), *A. axis*, *M. mulatta* and *S. scrofa*; and in Bhajani Municipality - *B. tragocamelus*, *S. scrofa*, *M. mulatta*, *V. bengalensis*, *E. maximus*, and *P. tigris tigris*.

Data collection

Questionnaire survey

In February and March 2018, a questionnaire survey was conducted at the household level, selecting 80 households randomly (10% sampling intensity), among which 30 were selected from Basanta Community Forest Users Group, 14 were from Lamkichuwa Municipality, 16 from Bhajani Municipality and 20 from Kailari Rural Municipality. This is in equal proportion based on the total number of HWC affected households at each site. However, the total numbers of households in those settlements were only considered if they were within a 3 km distance from the surrounding forest areas, assuming very few possibilities of HWC if farther away. Each household was considered a sampling unit, and interviews were restricted to 1 respondent per household with an age greater than 18 years (preferably the oldest one or the head of the family). To assist in the household survey, we trained a group of volunteers (bachelor level and above) in data

collection, including female students who helped to ensure that female respondents felt comfortable during the interviews. All the incidents of HWC documented for this study were from a year time period of 2017, except for information on human attacks which were collected from 2015 to 2017. The semi-structured questionnaire was designed to collect information on respondents' socioeconomic and demographic characteristics, crop, livestock and property damage by wild animals, their attitudes towards HWC, and existing mitigation measures practiced by them.

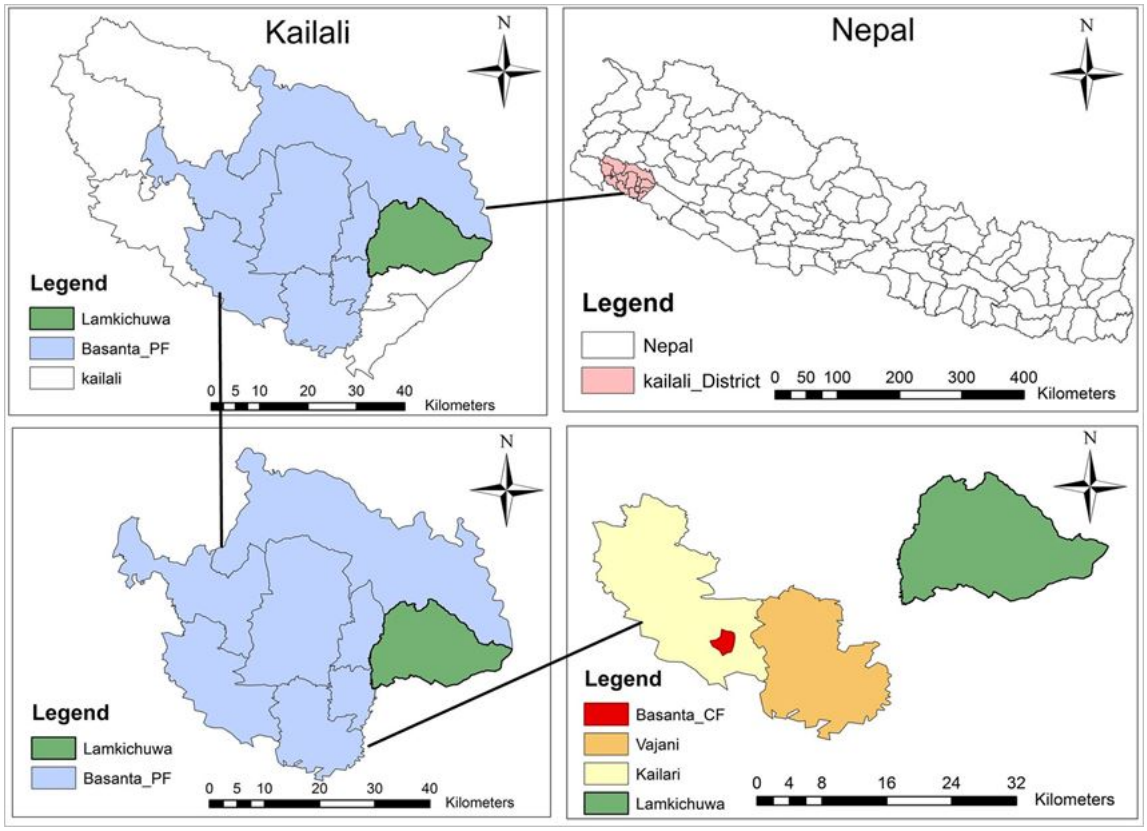

Figure 1: Map of the study area showing the four different sites (Basanta CF, Vajani, Kailari and Lamkichuwa).

Table 1: Description of the study sites (Kailali district, Nepal).

Serial Number	Study Sites	Geographic Location		Area (km^2)	Population
		Latitude	Longitude		
1	Basanta Community Forest	48°62'31"E	31°56'306"N	0.4846	365
2	Kailari Rural Municipality	47°62'16"E	31°68'299"N	233	47987
3	Lamkichuwa Municipality	51°40'15"E	31°65' 759"N	225	10,000
4	Vajani Municipality	49°81'21"E	31°53'279"N	176	52,128

Source: (DCC Kailali, 2015)

Focus group discussions

Four focus group discussions (FGDs) were conducted (one at each site) to reveal different aspects of HWC and the perceptions and attitudes of local people towards the main conflict species and locally adapted techniques to minimize the damages. As stated by the Government of Nepal, the presence of women must be at least 33% at all decision making activities (Secretariat and Durbar, 2015), therefore, we included women in the focus group discussions. Similarly, in most cases, the decisions are often dominated by elite people of the local community or institutions (McDougall et al., 2007), therefore we also included socially marginalized groups to include their perspective and encourage their participation in every community management activities, including planning and decision making. Each of our FGDs conducted in the study area consisted of around 10 people, including women and marginalized persons in the above ratio.

Key informant interviews

Among the 10 key informants (KI), two permanent residents and elites were selected from each site.

In addition, one conservation officer from the protected Basanta Community Forest (CF) who knew about the HWC situation and one chairperson from Basanta CF who had been posted for more than 5 years in the area, were chosen for the KI interviews. The key informant interviews provided information on various aspects of HWC existence in the study sites, which helped to cross check the information obtained from household surveys and FGDs.

Field based evidence and secondary sources

During the field observations of conflict sites, some photographs (Appendix) were taken as evidence and to ensure validity of the data obtained through the questionnaire surveys. In addition to the primary information obtained from the above sources, we reviewed various secondary sources and online portals (Gautam et al., 2020; Timilsina et al., 2020) including published reports, newsletters, journal articles, books, Doctoral and Master's Theses, annual reports from various sources, and the website of Division Forest Office (DFO), Kailali.

Data analysis

All the quantitative analysis was performed using MS Excel and the calculated results have been reported as mean, frequency, and percentage. The qualitative information obtained from the open-ended questionnaires were further discussed with conservation officers and locals and then the final information was summarized and interpreted in a descriptive way. The location map of the study area was prepared by using ArcGIS (ver. 10.2.2).

Results

Socio-economic characteristics

The respondents were categorized into seven easily distinguishable socio-economic groups based on gender, age, education, ethnicity, religion, land tenure and income (Table 2). We observed about 45% of all the respondents were with no formal education, while 30% completed their primary education. Almost 73% of the respondents belong to the Tharu ethnic group followed by Brahmin/Chettri and Dalit. Similarly, 66% of respondents had their Numbari while 26% had Aailani type of land. Agriculture occupied the major share (73%) of family income, followed by business and labor, while only 4% of them were involved in the service sector.

Overall situation of HWC

From the key informant interviews and secondary sources of DFO office Kailali, we found only one case of a human casualty - a 56-year old person from Bhajani Municipality ward number five killed by a tiger on 2nd May 2015. Additionally, there were three other cases of human injuries (2 cases in 2016 from Kailari Rural Municipality and one in 2017 from Bhajani Municipality) by the attack of a tiger. In comparison to human attack incidents, other incidents such as crop damage, property damage and livestock depredation were more severe in the study area. In total, 78% of respondents were affected by HWC whereas 18% of respondents were not affected by any incident of HWC in the study area. The major wild animals that came from Dudhwa National Park into the settlement areas of our study sites were *Elephas maximus*, *Panthera tigris tigris*, *Macaca mulatta*, and *Axis axis*, while the wild animals that come from Basanta Protected Forest were *E. maximus*, *P. t. tigris*, *Boselaphus tragocamelus*, *A. axis*, *M. mulatta*, and *Vulpes bengalensis*.

In addition, people were not very aware of the non-timber forest products (NTFPs) available nearby in their forests. Only a few people went inside the forests for the collection of NTFPs like firewood, fodder, and forage because they feared losing their lives due to the possible encounter with the wild animals such as *E. maximus* and *P. tigris tigris*. So, there were very few incidents of HWC, particularly the human attacks that occurred inside the forest area. Photos of HWC incidents are given in Appendix.

Possible sources of wild animals responsible for HWC in the study area

While asking respondents about the possible sources of wild animals causing HWC, 51% of the respondents claimed that the wild animals came from Dudhwa National Park (India) as well as Basanta Protected Forest, while 26% said the source was their own Community Forests - which refers to Basanta Community Forest where the respondents live nearby (Fig. 2). Other respondents (14%) mentioned that possible sources of wild animals in the vicinity were from the adjacent Shuklaphata National Park, Bardia National Park, and Laljhadi Protected forest. The remaining 9% of the respondents claim the source was elsewhere, refering to some other possible forest sources rather than the above-mentioned ones.

Different incidents of HWC

Among the different incidents of HWC, crop damage was the most severe problem in the study area with a total of 102 incidents, followed by property damage with 15 incidents (Fig. 3). There were only nine incidents of livestock depredation. Crop damage incidents were mostly caused by wild elephants *Elephas maximus* (n= 54) followed by the Rhesus macaque *Macaca mulatta* (n= 23) and wild boar *Sus scrofa* (n= 14). Property damage incidents were mostly caused by *E. maximus* (n= 10) and other animals (n= 5), like the Indian Rhinoceros *Rhinoceros unicornis* Linnaeus, the Blackbuck *Antilope cervicapra* (Linnaeus), *B. tragocamelus*, and *V. bengalensis*. One incidence of an elephant killing two livestock was recorded but it was done accidentally while roaming around the settlement.

Table 2: Socio-economic characteristics of the respondents in Kailali district of Nepal.

Serial Number	Socio- economic characteristics	Sub-categories	Percentage (%)
1	Gender	Male	49
		Female	51
2	Age	Between 19 to 40 years	63
		Above 40 years	37
3	Education	No formal education	45
		Primary level	30
		Up to grade 8	16
		Higher than grade 8	9
4	Ethnicity	Tharu	73
		Brahmin/Chettri	25
		Dalit	2
5	Religion	Hindu	96
		Muslim	1
		Christian	3
6	Land Tenure	No Land	5
		Own (Numbari)[a]	66
		Own (Aailani)[b]	26
		Adhiya[c]	3
7	Income	Agriculture	73
		Business	11
		Labor	12
		Job	4

[a] Land registered under the norms of the Government of Nepal having a private ownership certificate for the land.
[b] Land owned by the Government of Nepal, but the land is used by the local people without having the owning certificate; and also called "Parti Jagga".
[c] A cultivation system in which the farmer (crop cultivators) have to share half of the total production with the land owners.

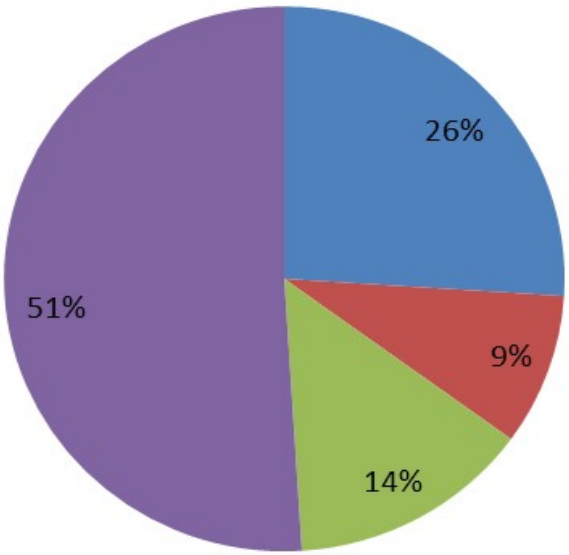

Figure 2: Possible sources of wild animals causing HWC in the Kailali district of Nepal. Purple = Dudhwa National Park (India) and Basanta Protected Forest; Blue = Basanta Community Forest; Green = Shuklaphata National Park, Bardia National Park, and Laljhadi Protected forest; Red = elsewhere.

Crop damage

From the sampled households, we found that rice was the highest damaged crop by wild animals in the study area followed by wheat and maize (Fig. 4; Table 3). According to the respondents, about 0.11 km^2 (32% of total rice cultivated area) was damaged during the period of one year (2017) followed by 0.08 km^2 (23% of total wheat cultivated area) and 0.07 km^2 (17% of total maize cultivated area) (Table 3). Similarly, with regard to the percentage of crop damage incidents, rice shared the highest (43%) of crop damage incidents, followed by wheat (28%) and then maize (9%) (Fig. 4). Sugarcane, mustard seed, yellow and black lentils make up the remaining 20% of damage incidence.

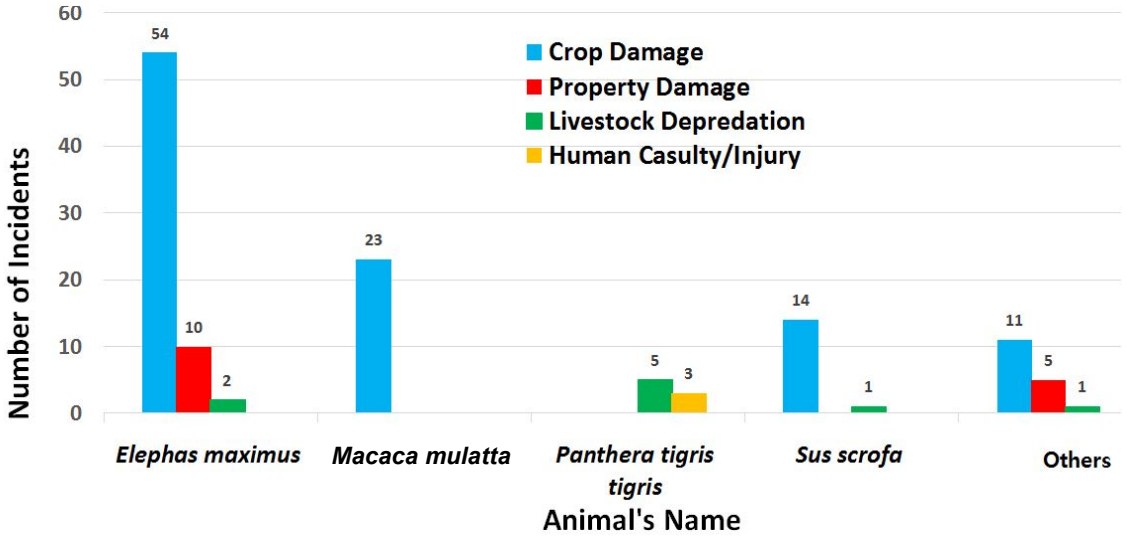

Figure 3: Different incidents of HWC in Kailali district of Nepal.

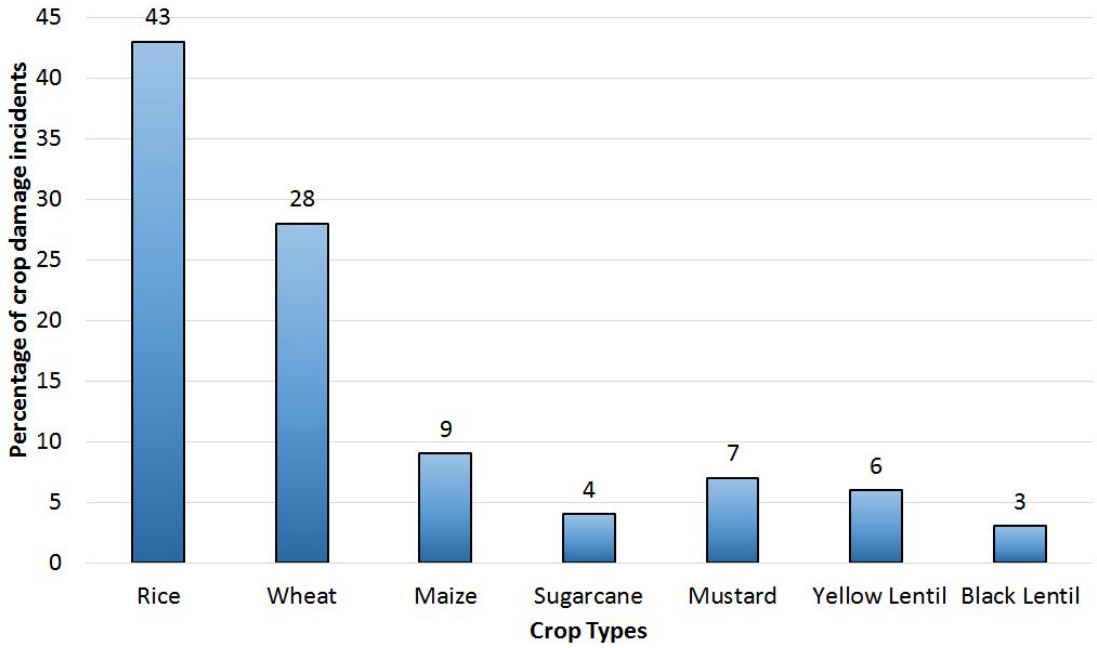

Figure 4: Major crop types damaged by wild mammals in Kailali the district of Nepal.

Table 3: Crop damage information from the Kailali district of Nepal.

Types of crop	Growing season/months	Total cultivated land area (ha)	Total damaged land area (ha)	Percentage (%) of total area damaged
Rice	Summer (July to November)	35	11	32
Wheat	Winter (November to April)	35	8	23
Maize	Spring (April to July)	42	7	17
Sugarcane	All year round	29	3	9
Mustard	Winter (December to April)	42	5	12
Yellow lentil	Winter (October to March)	22	2	10
Black lentil	Winter (October to March)	15	1	7

During the crop ripening period, nightly crop damage incidents were experienced by the highest number of respondents (59%) followed by incidents that occurred one to two times a month (24%) (Fig. 5). However, only a few respondents (3%) experienced these incidents during the day-time.

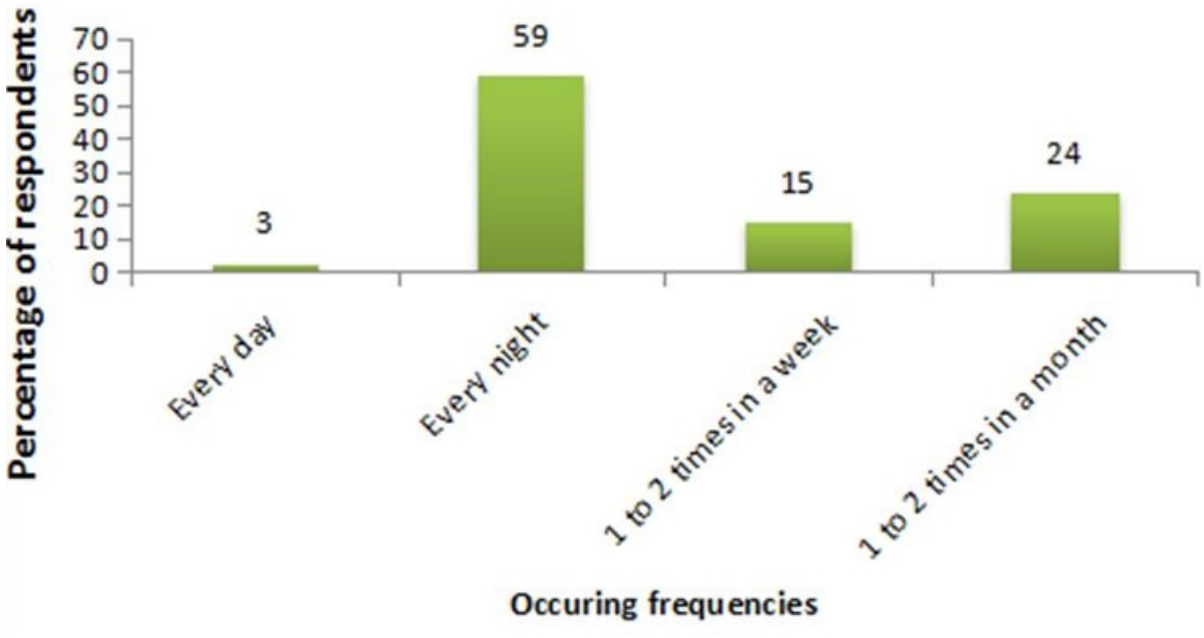

Figure 5: Occurrence of crop damage incidents in Kailali district of Nepal.

Livestock depredation

Results from the focus group discussions and key informant surveys, stated that livestock rearing has decreased due to the fear of depredation by wild animals. Most of the respondents were involved in agriculture and other alternatives for their sources of income and livelihood. So, we found only a few incidents of livestock depredation where one young cow, one adult cow, four young goats, two adult goats and one adult pig were killed by *Panthera tigris tigris* (5), *Sus scrofa* (1), *Elephas maximus* (2) and other animals (1) during the year 2017 (Fig. 3). Additionally, a young cow was killed just the day before we were in the field.

Property damage

19% of the total respondents have suffered house damage and 11% stored food damage from wild animals, while 66% reported no property damage within the study area (Fig. 6). Among the recorded conflicting wild animal species, *Elephas maximus* was the most problematic animal in terms of property damage (Fig. 3).

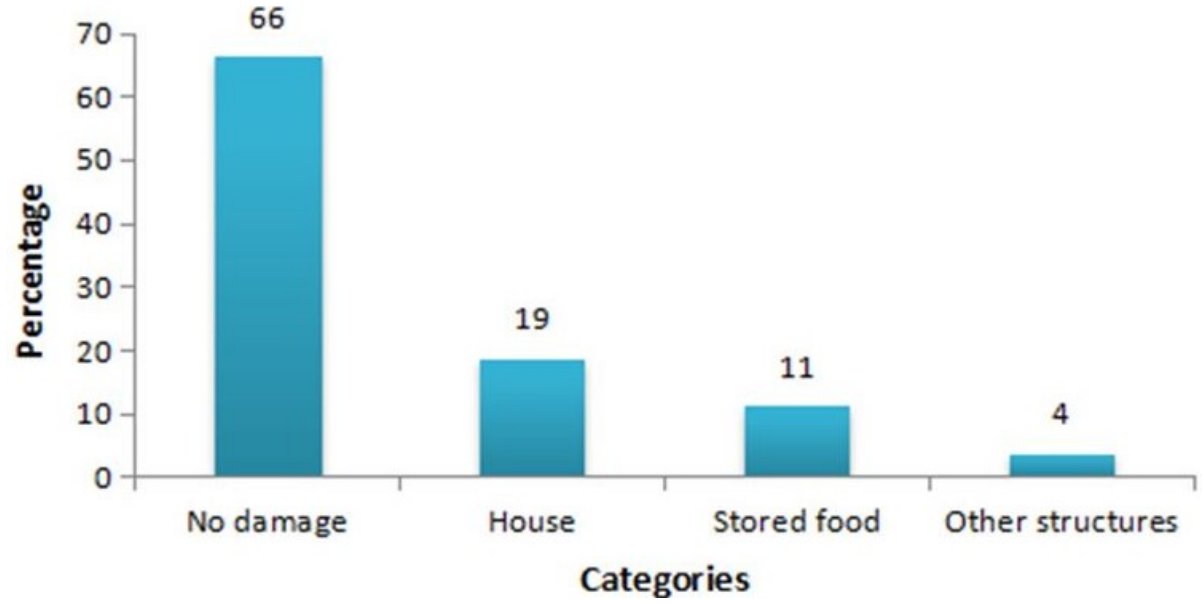

Figure 6: Property damaged by wild animals in the Kailali district of Nepal.

Locally adopted mitigation measures

The majority of the respondents (41%) used the mitigation measure of shouting and hitting drums to prevent damage from wild animals (Fig. 7). Similarly, 28% used chasing with fires and throwing stones followed by 18% who use guarding by staying in a locally constructed viewing tower and 13% by Barbed wire fencing.

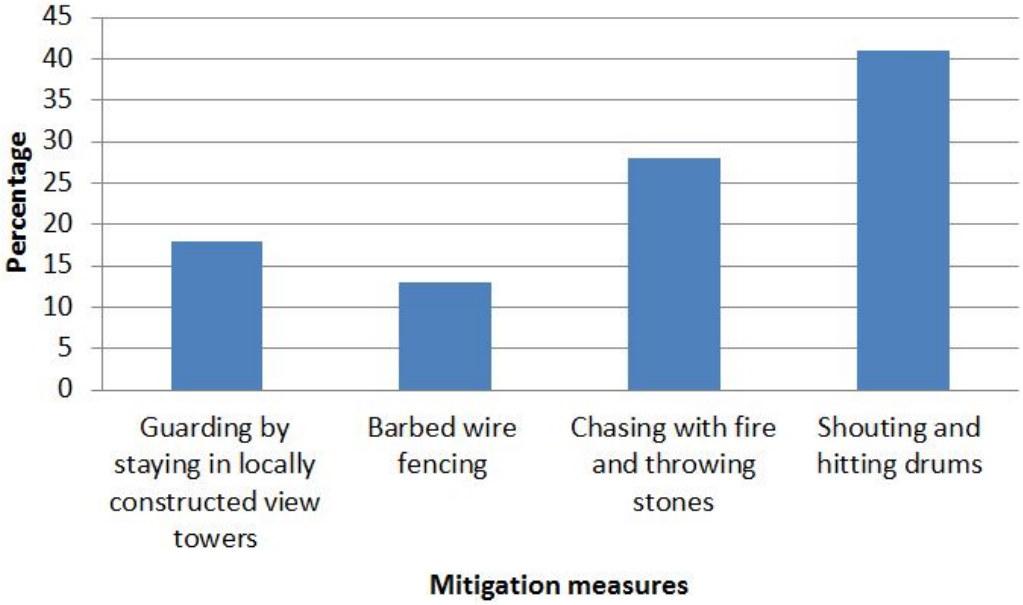

Figure 7: Mitigation measures practiced by local people against HWC in Kailali district.

Perception of local people on the causes of HWC

While measuring the perception of local people on causes of increasing HWC, we found that 24% of respondents believed that HWC was increasing due to their settlements being near (less than 200 m) to the wildlife habitat area (Table 4). Similarly, 17% believed that it was due to a lack of food resources in the wildlife habitat.

Table 4: Perception of local people on causes of HWC in Kailali district of Nepal.

Causes of increasing HWC	Percentage (%)
Lack of food resources in the habitat	17
Habitat fragmentation and isolation	9
Due to the corridor and connectivity	9
Being closer (less than 200 m) to the wildlife habitat area	24
Due to animal's behavior such as roaming	16
Increasing wild animal populations	14
Due to the strict rules and policies	6
Better conservation of local community forest	1
Lack of knowledge of controlling conflict	4

Discussion

HWC is a growing issue all over the world and involves incidents including crop damage, property damage, livestock depredation, human injury, and casualty (Parker et al., 2007). The establishment of protected areas and forests in Nepal has restricted the indigenous local communities access the forest resources which they have been using for a long time (Lamsal, 2012; Timalsina and Ranjitkar, 2014). Encroachment of people into the wildlife habitats has increased the chances of encounters (Madden, 2004).

HWC incidents studied in the past have mostly reported crop damage as the major issue (Bhatta, 2003; Shrestha et al., 2007; Hedges and Gunaryadi, 2010; Neupane et al., 2018). Similar findings have been reflected in our study where crop damage was the most severe incident, followed by property damage. A study on HWC in Jhapa and Bardia districts of Nepal also reported crop damage as a serious problem where a household lost nearly a quarter of their total annual income from crop production every year (Shrestha et al., 2007). Such crop damage incidents result in economic losses, reduced food security, and insecure livelihood options for rural farmers (Shrestha et al., 2007; Bailey, 2011; Pant et al., 2016). Additionally, costs incurred from loss of crops increases the negative attitudes of local people towards wildlife and conservation policies in the area (Wang et al., 2006). It is notable that during the crop ripening period, most of the crop damage incidents in the Kailali

district occurred during night-time. About 59% of respondents faced crop damage incidents every night in our study area. The reason behind this might be the difficulty of detection of crop raiding animals during misty and cloudy nights (Limbu and Karki, 2003). In terms of crop type, Gyawali (1989) showed that the highest economic losses (27.6%) occurred in the rice crop, followed by mustard (21.9%), lentils (18.4%), maize (16.8%) and lastly, kitchen garden plants (12.5%).

Our study found rice as the most damaged crop species, followed by wheat. Many people were frequently affected because most of the respondents had their agricultural land near to the forests. The major wild animal species inhabiting the forests are *E. maximus*, *P. t. tigris*, *S. scrofa*, *M. mulatta*, and *A. axis*, which are known as frequent crop damaging species. Due to the larger body size and food requirements of elephants, they caused more damage to rice crops than other crops of our study area. In regard to property damage, we found that houses were the most damaged among different property types in our study area, which agrees with the result of Neupane et al. (2018). Other properties, such as latrines or cow sheds were not damaged by the wild animals in our study area. Our study did not calculate the monetary value of loss from wildlife damages as in other studies (Awasthi and Singh, 2015; Adhikari et al., 2018) because people were only aware of the damaged area of each crop but not about the quantity lost from each category of crop. 18% of respondents experienced no incidents of HWC in our study area and one reason for this might be that their settlements are far from the forest areas, when compared to the affected people. Some people had also fenced around their cultivated lands but only a few can afford this mitigation method.

Shouting and chasing was the most common mitigation measure practiced by the local people in our study area. Similarly, Neupane et al. (2018) mentioned that shouting and the use of fire was the most adopted mitigation measure practiced in the lowlands of Jhapa district, Nepal. People often practice such simple mitigation measures, as they are easier to adopt with their own knowledge and ideas rather than other more technical and expensive methods, like electric fencing. In contrast, a study conducted by Awasthi and Singh (2015) in the high mountainous regions of Nepal stated that crop guarding was the most common mitigation measure in Gaurishankar Conservation Area, followed by throwing stones and the use of scare-crows.

The mitigation measures adopted by the people varied for different species of wild animals. For example, people used the measures like chasing with fire, throwing stones, shouting, banging drums and following in the case of dangerous animals like *E. maximus* and *P. t. tigris*, while guarding from a viewing tower and fencing was used for less dangerous wild animals such as *S. scrofa*, *A. axis*, and *M. mulatta*. However, we found that the mitigation measures adopted by people were not considered effective due to the increasing number of wild animals in the settlements and the legal prohibition on killing the conflicting wild mammals.

Bhattarai and Basnet (2004) documented that crop damage was greatest in the settlements nearer to the forest or wildlife habitat area. A similar result was obtained in our study as most of the respondents reported that HWC was increasing due to settlements being near (less than 200 m) to wildlife habitat areas. Most of the problematic animals arrive at night and their arrival is uncertain in some circumstances. Therefore, stable watchtowers, sirens or scaring devices, and physical barriers such as electric fences should be established in these conflicting hotspots. According to the local people, wild animals mostly visit their cultivated lands due to a lack of sufficient food and water in their own habitats. Therefore, improving grasslands and water supplies, and adopting other habitat management activities, such as growing unpalatable crop species, are the preliminary suggestions from this study.

Further studies on the measurement of the carrying capacity of wildlife habitats, particularly for the common conflicting species, including food species composition and water sources are needed. Such studies may validate the perceptions of the local people and allow them to conduct the appropriate management activities. Also, our results indicate that most of the cultivated lands and settlements may have been within the regular movement paths of wild elephants in the region. Further studies on these movement patterns of elephants in the study area are another aspect that needs to be investigated.

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Conflict of interest

All the authors declare that there are no conflicting issues related to this research article.

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Appendix: Pictures related to this study including questionnaire survey, and human-wildlife conflict signs in Kailali district of Nepal.

First author collecting data with Key informants. Date: February 2018.

First author and her friend collecting data through group discussion with local people. Date: February 2018.

Incident: Calf killed by *Panthera tigris tigris* (left) and Pug mark of *Panthera tigris tigris* (right) at Vajni municipality, Ward No. 5, Purbakharauti Community Forest, March 2018.

Incident: Crop (wheat*)* damaged by wild animals - *Elephas maximus* in field near by Basanta Community Forest. Date: March 2018 (Picture taken by local people).