*Asian Journal of Conservation Biology*, December 2020. Vol. 9 No. 2, pp. 196-206 AJCB: FP0136
ISSN 2278-7666 ©TCRP Foundation 2020

# Status of Human-Wildlife conflict and Assessment of Crop Damage by Wild Animals in Buffer Zone Area of Banke National Park, Nepal

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(Received: November 11, 2020; Revised: November 22, 2020; Accepted: November 24, 2020)

## ABSTRACT

This study was carried out to investigate human-wildlife conflict in and around buffer zone of Banke National Park (BNP), Nepal. It is aimed to assess major causes of human-wildlife conflict (HWC) such as the extent of crop damage, livestock depredation, human casualties, etc. and to identify local people's attitude towards wild-life conservation and management. Primary data was collected through preliminary field observation, focus group discussion, key informant survey and a questionnaire survey of households. Agricultural crop damage was the major problem faced by the local respondents. Wild boar followed by deer and common leopard were found as major culprit for crop-raiding and livestock depredation with Index of Relative Ranking (IRR) value 0.96, 0.8 and 0.77 respectively. High level of conflict was observed during the mid-night and the peak time like morning and night where livestock go to the field and return to their home. Communities living in close proximity to the park seemed to be more prone to damages. As the distance from the park boundary is decreased by 100 m then the total loss is increased by NRs. 3885 as revealed by the linear regression ($R^2$= 0.8086). More positively, re-garding the measures such as regular patrolling, net fencing, electric fencing, and compensation for crop damage have been recommended to reduce HWC. Further, it is also suggested that the active participation of local people in conservation and awareness program can play a vital role to reduce and mitigate the HWC at the community level.

**Key words:** Buffer zone, Crop raiding, Compensation, Livestock depredation, Property damage

## INTRODUCTION

Human-Wildlife Conflict (HWC) is a common phenom-enon for long past and has become a serious threat to the survival of many endangered and rare species in the world (Ghimire, 2019; Redpath *et al*., 2015). The lack of access to forest resources for the local community resid-ing in buffer zones of protected areas has created human -wildlife conflict between the people residing in these areas and wildlife (Dowie, 2011). Human-Wildlife Con-flict (HWC) is regarded as any negative interaction be-tween people and wildlife that results in negative im-pacts on human's social, economic or cultural life, on the conservation of wildlife populations, or on the envi-ronment (WWF, 2005; Bhatta *et al*., 2020). It affects the economy of both wild-life and human beings. Humans lose their crops, livestock, property and sometimes their lives whereas animals, which are already endangered or threatened, are often killed by the people (Bhatta, 2003; Banikoi *et al*., 2017). Human-wildlife conflict is a glob-al problem that varies according to geography, land use patterns, human behavior, and the habitat and the behav-ior of wildlife species or individual animals within the species (WWF, 2007). The nature of HWC in the buffer zone area and corridors of the Terai Arc Landscape (TAL) is both historical and recent which seems inevita-ble that HWC incidences will continue to occur in the present context of wildlife habitat instability and grow-ing human population's activity in and around the pro-tected areas (PAs) (Shrestha, 2006). However, the wide expansion of PAs has come into direct conflict with traditional linkages and immediate needs of local liveli-hoods that depend upon forest resources for their sur-vival (Silwal *et al*., 2013).

HWCs arise primarily because of competition between humans and wildlife for shared, limited re-sources (Treves, 2007; Distefano, 2005). The conflicts can be particularly controversial when the resources concerned have economic value and the wildlife in-volved is legally protected. The frequency of conflicts has grown in recent decades, largely because of the ex-ponential increase in human populations and the result-ant expansion of human activities (Graham, 2005). HWC is a serious challenge to conservation worldwide and is spreading as the human population and develop-ment increase (Lamarque *et al*., 2009). Damages by wildlife can have disastrous economic demerits for vul-nerable households. The major sources of HWC include crop and property damage, livestock toll, harassment to the people, sometimes even death (Banikoi *et al*., 2017).

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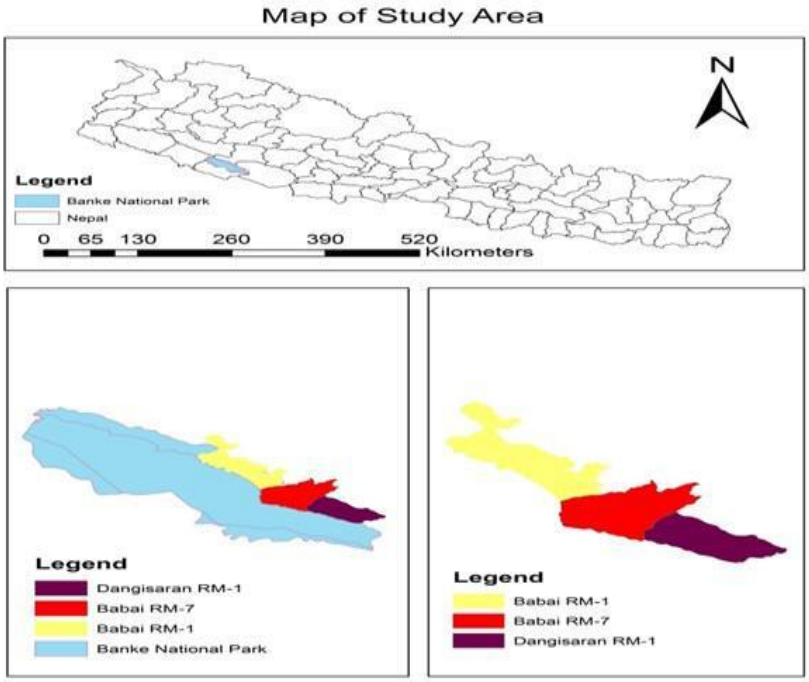


**Figure 1.** Map of the study area

The consequences of the human-wildlife conflict are found more serious in the sub-optimal tropics and in developing countries (Lamarque *et al*., 2009; Acharya *et al*., 2016). Wildlife populations that came into severe conflict with humans' interests may have to be directly managed to keep their levels below tolerable limits (Sukumar, 1994; Bhatta *et al*., 2020).

To reduce the negative impacts of wildlife on people, different types of social security schemes should be proposed as a part of conservation plans because poor communities are found to be relatively more dependent on forest resources, which helps to increase the complex-ity of protected area management for human as well as wildlife needs (Budhathoki, 2004; Rayamajhi, 2009). Such type of research about HWC can provide essential guidance and can motivate local communities towards biodiversity conservation, management, and research priorities in Nepal (Primack *et al*., 2013).

The government of Nepal has recently notified the Banke National park (BNK) as the youngest national park in Nepal without considering the impact on the livelihood of local people's possibilities of human-wildlife conflict. Though this national park is established just a few years ago in 2010, the cases of human-wildlife con-flict occurred in this area can be observed since earlier. BNP is considered to be an important part of Terai Arc Landscape (TAL) as it provides habitat for the conserva-tion of tigers, an endangered wildlife species reflects the commitment of the Government for landscape level bio-diversity conservation. Many studies have been conduct-ed in different protected areas of Nepal on HWC; but very limited studies related to such conflict issues have been undertaken in the vicinity of Banke National Park. Therefore, it is urgent to assess the HWC in Banke Na-tional Park for better understanding about the local peo-ple's role and their perception towards wildlife conserva-tion and management. This article is designed to assess the existing scenario of human wildlife conflicts in Banke National Park and suggests conservation and management strategies to mitigate human wildlife con-flict. The aim of this study is to predict and identify the degree of HWC such as crop damage, property damage, livestock depredation, and human loss, and to identify and understand the perceptions and attitude of local communities towards wildlife conservation and management.

## MATERIALS AND METHODS

### *Study area*

The study was carried out in the buffer zone of Banke National Park (BNP) which lies in Babai rural municipality (ward no. 1 & 7) and Dangisaran rural municipality (ward no. 1) of Dang district in the Lumbini Province of Nepal (Figure 1). BNP (550 square kilometers) was established as Nepal's $10^{th}$ National Park in July 2010 for biodiversity conservation at the landscape level after its recognition as a "Gift to the Earth. The buffer zone with an area of 343 $km^2$ covers parts of Banke, Bardia, Dang, and Salyan districts of Lumbini Province. The buffer zone with an area of 343 $km^2$ covers parts of Banke, Bardia, and Dang districts of Lumbini Province and Salyan district is from Karnali province. Buffer zone area of Banke National Park is extended in five rural municipalities (RM) and one municipality. Among them three are from Banke district (Rapti-Sonari RM, Baija-nath RM and Kohalpur municipality), two from Dang district (Babai RM and Dangisaran RM), and one from Salyan district (Kalimati RM). There are eight buffer zone user committees in Banke National Park consisting of six from Banke, one from Dang and one from Salyan district. There are seventy buffer zone user groups. The park is located between $81^0$ 39'29" to $82^0$ 12'19" east longitude and $27^0$58'13" to $28^0$ 21'26" north latitude. BNP is adjoining to Kamdi corridor that joins Suhelwa Wildlife Sanctuary in India through national and commu-nity forests towards the south. It is joined with Bardiya National Park (BNP) towards the west whereas national forests, community forests, and Khata corridor links the park with Katerniaghat Wildlife sanctuary of India.

The core area of the BNP is delineated by the Chisapani-Obary section of east-west highway and cultivated land in the south, the Churia ridge in the north,

**Table 1.** Total number of households and sampled households (HHs)

| S.N. | Rural Municipality/Ward | Area ($Km^2$) | Total HHs | Sampled HHs | Sampling intensity (%) |
|---|---|---|---|---|---|
| 1 | Babai/1 | 74.58 | 860 | 86 | 10 |
| 2 | Babai/7 | 63.94 | 830 | 83 | 10 |
| 3 | Dangisaran/1 | 47.82 | 537 | 54 | 10 |
| | **Total** | **186.3** | **2227** | **223** | **10** |

Shiva khola in the east and Kohalpur-Surket road in the west. The core area of the park (61.5%) totally lies in the Banke district. The main objective of the establish-ment of this national park is to conserve endangered species of wild flora and fauna and their habitat, for the promotion of ecotourism and, to strengthen trans-boundary biological corridor.

Banke National Park comprises an array of eight ecosystem types such as Sal (*Shorea robusta*) for-est, deciduous riverine forest, savannahs and grasslands, mixed hardwood forest, flood plain community, Bhabar, and foothills of Chure range. It is home to 124 types of vegetation, 34 species of mammals, more than 300 spe-cies of birds, 24 species of reptiles, 9 species of amphibi-ans, and 58 fish species. 90% natural forest coverage composed of mainly Sal (*Shorea robusta*), Karma (*Adina cordifolia*), Khair (*Acacia catechu*), and Sissoo (*Dalbergia sissoo*). The habitat of the flood plain, foot-hill, and Churia hill is of prime concern to conserve ma-jor focus species such as the Royal Bengal tiger (*Panthera tigris tigris*), asiatic wild elephant (*Elephas maximus*) and four-horned antelope (*Tetracerus quadri-cornis*). In addition, the Rapti river on the south and Ba-bai river on the north which are flowing from east to west are the major support of the Park for lifeline. Ac-cording to the National Parks and Wildlife Conservation Act 1973, three species of mammals i.e. tiger (*Panthera tigris*), striped hyaena (*Hyaena hyaena*), four-horned antelope (*Tetracerus quadricornis*), four species of birds i.e. giant hornbill (*Buceros bicornis*), black stork (*Ciconia nigra*), Bengal florican (*Houbaropsis bengalensis*), and lesser florican (*Sypheotides indicus*), and two species of reptiles i.e. gharial crocodile (*Gavialis gangeticus*) and python (*Pythonidae*) residing in the park are found kept under the protected list.

### *Sampling design*

The research was accomplished based on primary and secondary information. Based on the information regarding crop damage, property damage, and livestock depredation cases registered in BZUC and park office, allied previous findings and community perceptions on human wildlife conflict particularly wildlife damages and adaptation strategies were collected through participatory tools of assessment such as focus group discussion, key informant survey (DFO, BNP officials, BZMC, and local leaders and teachers) and a questionnaire survey of households.

After taking information about the wards of Babai and Dangisaran rural municipality (RM) within the buffer zone of Banke National Park, depending upon the most conflict-prone areas three wards selected randomly, i.e. ward number 1 (Babai RM), 7 (Babai RM), and 1(Dangisaran RM). Purposive sampling with a sampling intensity of 10% was used for this study. A systematic and integrated methodology was followed to extract reliable data.

### *Sample size*

The following formula given by Arkin and Colton (1963) was applied to determine the sample size (n) for the questionnaire survey of households (HHs) at 95% confidence interval.

$$\text{Sample size (n)} = \frac{N \times Z^2 \times P\,(1-P)}{N \times d^2 + Z^2 \times P\,(1-P)}$$

Where,

N = Total number of households
Z = value of standard variant at 95% confidence level (1.96)
P = estimated population proportion (0.05)
d = error limit of 5% (0.05)

### *Data collection*

Primary data were collected from the study site by employing combination of social survey methods involving participatory techniques such as focus group discussions, key informant interview, formal and informal interviews, semi-structured questionnaire survey of households and on-site observations. The methods were used to dig out the information related to socio-economic condition, major conflicting animal, crop loss, major season and time of conflict, local techniques to mitigate the HWC and attitude of local people towards park and conservation.

### *Household survey*

Altogether 223 households from all three wards of two rural municipalities were selected for the survey. A semi-structured questionnaire was used to elicit information from the respondents. Mainly senior members of the family were considered eligible as respondents but in absence of senior members, other members of the family were also considered eligible respondents. The HHs questionnaire survey began by explaining to them the purpose of the study and their willingness to contribute. The interview was done only with the persons who had expressed their willingness to contribute. Each interview lasted for about 15-20 minutes.

### *Focus group discussion*

Focus group discussion was organized with local people in each village to extract various opinions through research questions and also help to check the reliability of the answers obtained from other methods. Facilitative discussion with the initiation of open-ended questions provided the members of the groups to explain the issues in detail. It comprised 10-15 people together to engage in a guided discussion.

### *Key informant survey*

A key informant survey was done aiming to address overall issues. The warden, BNP office, DFO, school teachers, office bearers of BZMC, innovative farmers, local leader's, activists, etc. were included in the survey with a semi-structured checklist.

***Direct observation***

During the field research period covert and overt observation was done. Photographs and simple notes were taken during meetings and during the walking tours. Observations became the primary source of information in some questions and used in the triangulation of infor-mation in others to make sure if the information gathered from other sources are reliable.

The secondary data and information were collected and collated from the relevant reports, newsletter, research papers, published and unpublished articles, books, journals, IOF library, annual report of different organizations, and websites. Literature was reviewed in two phases, before and after field visits.

***Data analysis***

Qualitative and quantitative analysis methods were applied to analyze the data in this research. Data collected were checked, refined, and scrutinized as per the objectives. Finally, data were analyzed using Microsoft Excel program and later exported to Statistical Package for Social Sciences (SPSS) for further analysis. All the qual-itative and quantitative results were presented graphical-ly in the form of tables, figures, and texts in a descriptive way using tools as mean, rank, frequency, range, and Index of Relative Ranking (IRR).

***Calculation of IRR***

IRR= $(R_1S_1+R_2S_2+\ldots..+R_nS_n)/nr$ (Miller, 1986), where, $R_1$= rank of the first order, $S_1$= score of the first order, $R_n$= rank of last order, $S_n$= score of last order, n= number of observations and r= total rank given to particular at-tribute.

***The economic loss of crop per year per household was determined by the following method (Bhatta and Joshi, 2020):***

Economic value of crops per year per HHs= Average damage per year per HHs in Kg × Local market value of each crops per kg

$$\text{Average damage per year per HHs (Kg)} = \frac{\text{Total damage of crops of sampled HHs}}{\text{Number of sampled HHs}}$$

Total damage of crops of sampled HHs (in Kg) = Sum of the total damage of crop of each sampled HHs.

## RESULT AND DISCUSSION

***Socio-economic Characteristics of Respondents***

***Education status of the respondent***

In the present study, the education level of respondents was categorized into two groups- literate and illiterate (Figure 2). The literate group includes those who can read and write. The literate group includes all those hav-ing education up to School Leaving Certificate (SLC) or the people having higher degrees after SLC. Similarly, the illiterate group includes those who cannot read and write. Among the total respondents, about 43 percent of the respondents were literate and 57 percent of the re-spondents were illiterate, which is different than the study conducted by Bhatta and Joshi (2020) in Shuklap-hanta National Park, Poudel *et al.* (2020) in Annapurna Conservation Area and Lamichhane *et al* . (2020) in Chit-wan National Park. The education level of the respond-ents cannot be taken as human-wildlife conflict effect but it can somehow reflect the respondent's insight towards the subject matter. The literacy rate of the respondents was found less compare to the national literacy rate of the population of Nepal (65.9 percent) (CBS, 2012).

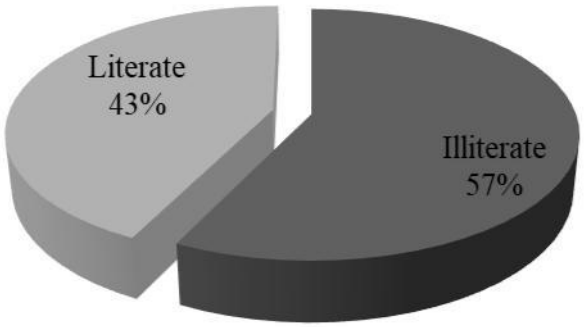


**Figure 2.** Education status of the respondent

***Major income source of respondent***

As the study area lies in the Terai region of Nepal, the majority of the households in the study area were involved in agriculture-related occupation (64%) which is higher than the study of Lamichhane *et al*., 2020 (50.47%); Poudel *et al*., 2020 (5%), and lower than the study of Ghimire (2019) in Chitwan National Park (69.5%). Similarly, 31 percent of the households found involved in foreign employment, 5 percent had private/ government services and 4 percent of the respondents were engaged in labor work (daily wages). Very fewer households were involved in the business sector (3%), which is very less than the study of Poudel *et al*., 2020 (79%); Lamichhane *et al*., 2020 (18.69%) and Ghimire, 2019 (17%). The results of the present study indicate that the people in the study area depend directly on agricul-ture and other occupations for sustaining their livelihood (Figure 3).

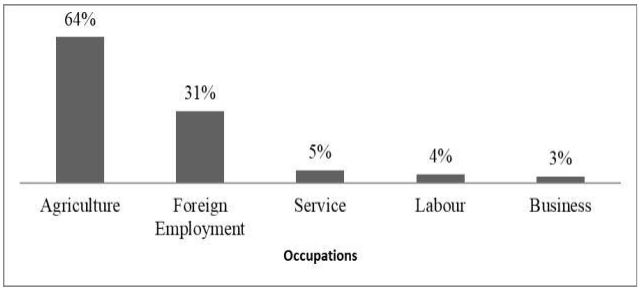


**Figure 3.** Major source of income of the respondent

***Forest condition***

The majority of the respondent perceived that the forest is becoming dense after the establishment of National Park in 2010. When the respondents were asked about the forest condition and its management practices, the majority (86 percent) of the respondents said that the condition has been improved, 9% of the people agreed on the condition of forests the same as before and thought that after establishment of parks the condition of forests can be improved. Only a few (5%) respondents said that the condition of the forest has been degraded (Figure 4).

**Nature and extent of crop, livestock, and poultry damage**

Altogether 223 respondents, 10 percent of total HHs from each ward, were surveyed to understand their views regarding the awareness level, and also to measure their perceptions towards wildlife conservation. Almost all (95%) respondent were found suffering from crop dam-age, and livestock as well as poultry loss by a wild ani-mal whereas minor respondent (5%) are safe from wild

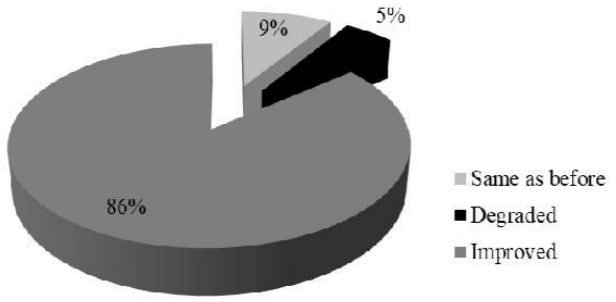


**Figure 4.** Respondent view on forest condition

animals (Figure 5). People are utilizing their land to grow different crops as the productive capacity of the land is high and they are also herding livestock as well as poultry. The tendency of immigration from neighboring districts with the aim of agro-based business is increas-ing in this low land. Annually, wild animals damage massive amounts of agricultural crops.

***Human wildlife encounter***

Most of the respondents encountered more than one wild animal. All of them, most frequently encountered with tiger, wild boar, monkey, porcupine, and deer. About 79% of the respondents encountered wild animals during the night-time which is lower than the study conducted by Ghimire (2019) in the buffer zone area of Chitwan National Park. The respondents expressed their opinion that crop-raiding was more destructive during nighttime because of the detection difficulty. 65% of the respond-ents mentioned that the wild animals visited the cropland and/or houses on daily basis (Figure 6). Respondents stated that the occurrence and attempts of the visit of wildlife were found high during the growing and harvest-ing period of the crop.

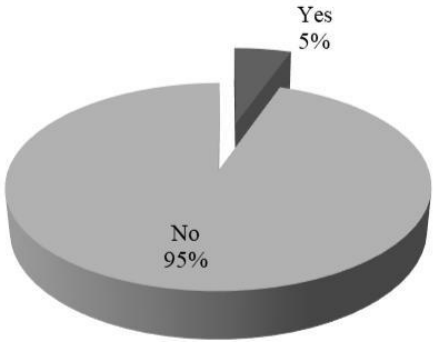


**Figure 5.** Respondents suffering from crop damage, livestock, and poultry loss

***The Trend of human-wildlife conflict***

Most of the respondents believed that extent of HWC is increasing. While very few respondents said that degree of HWC is decreasing (Figure 7). The main reason for wild animals to visit outside their habitat area may be due to the food scarcity in their habitat (Bhatta and Joshi, 2020).

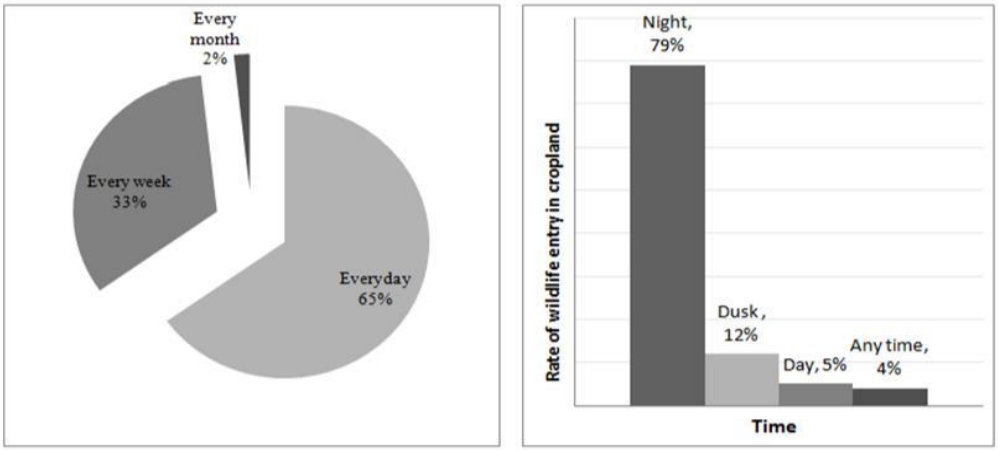


**Figure 6.** Intensity and time of wildlife entry in cropland and settlement

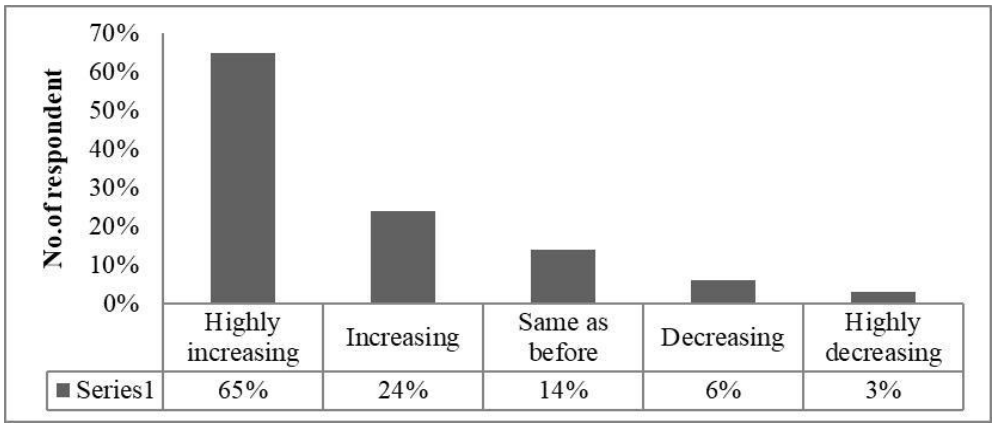


**Figure 7.** Trend of human-wildlife conflict

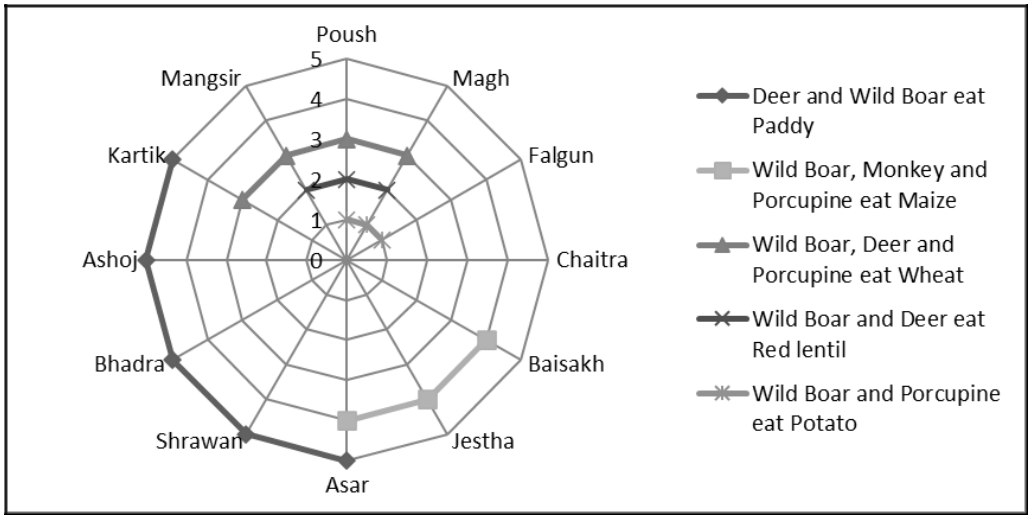


**Figure 8.** Chronology of wild animals raiding crop in study area

***Chronology of wild animals raiding crop in the study area***

Huge damage to several agricultural crops by wild animals was found as the most prominent effect of HWC in the study area. Paddy and maize were the most severely damaged agricultural crops in the study area. The maximum number of respondents faced the crop damage problem by the wild animals. The crop raiding by the wild animals was continued almost throughout the year. Wild boar, porcupine, deer, monkey, etc. were the problematic animals in the study area which involve in crop damage (Figure 8).

**Types of losses**

There is more crop loss (81%) than livestock and poultry loss. Neither any property damage nor human casualty found among the respondent (Figure 9).

***Crop production and its loss in the study area***

Almost 57% of the total respondents were dependent on subsistence agriculture for their basic livelihood. Maize, wheat, mustard, red lentil, cotton, and paddy were major crops and were grown once a year. Paddy was grown in July and harvested in November, while Maize was grown in April and harvested in June. (Table 2) The result is similar to the findings of WWF (2007). The study conducted in Shuklaphanta, Chitwan, and Bardiya National Park shows paddy as the highly affected and damaged agricultural crops by wild animals that accounted nearly for 60-70% of total economic loss (WWF, 2007; Ghimire, 2019).

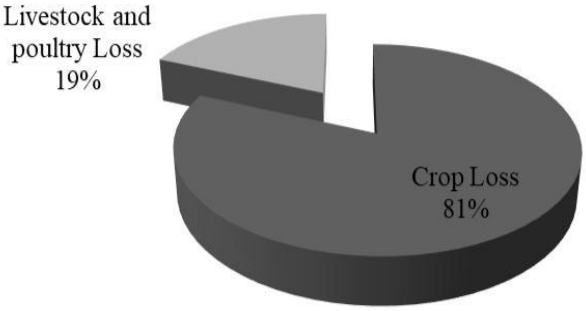


**Figure 9.** Types of losses

Most of the people were dependent on a subsistence type of agriculture. The major crops grown were paddy, maize, wheat, Red lentil, cotton, and mustard. The damage per HHs per year of paddy was highest than of maize and of wheat. The average damage each HHs per year of paddy was 116 kg and that of maize was 83 kg.

**Table 2.** Average, maximum and minimum annual production and loss of crops in kg

| S.N | Production | | | | | Loss | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Major Crops | Average (Kg) | Max. (Kg) | Min. (Kg) | Average (NRs.) | Average (Kg) | Max. (Kg) | Min. (Kg) | Average (NRs.) | Average loss (%) |
| 1 | Paddy | 673 | 1933 | 0 | 26920 | 127 | 294 | 0 | 5080 | 19% |
| 2 | Red lentil | 90 | 365 | 0 | 6300 | 12 | 62 | 0 | 840 | 13% |
| 3 | Mustard | 109 | 423 | 0 | 7630 | 17 | 84 | 0 | 1190 | 16% |
| 4 | Maize | 416 | 1452 | 0 | 9984 | 86 | 295 | 0 | 2064 | 21% |
| 5 | Wheat | 312 | 3356 | 0 | 6240 | 52 | 264 | 0 | 1040 | 17% |
| 6 | Potato | 237 | 1497 | 0 | 4740 | 38 | 181 | 0 | 760 | 16% |
| 7 | Cotton | 79 | 4305 | 0 | 5530 | 3 | 557 | 0 | 210 | 4% |

**Note**: Local market price (per kg) for different crops are: Paddy= NRs. 40/-, Maize= NRs. 24/-, Wheat= NRs. 20/-, Potato= NRs. 20/-, Mustard= NRs. 70/-, Cotton= NRs. 70/-, Red Lentil= NRs. 70/-

**Table 3.** Depredation status of per household in three wards of both rural municipalities

| S.N. | Livestock and Poultry | Average Loss (NRs.) | Maximum Loss (NRs.) | Minimum Loss (NRs.) |
|---|---|---|---|---|
| 1 | Goat | 969 | 36000 | 0 |
| 2 | Hen | 657 | 9200 | 0 |
| 3 | Cow | 589 | 16000 | 0 |
| 4 | Buffalo | 357 | 40000 | 0 |

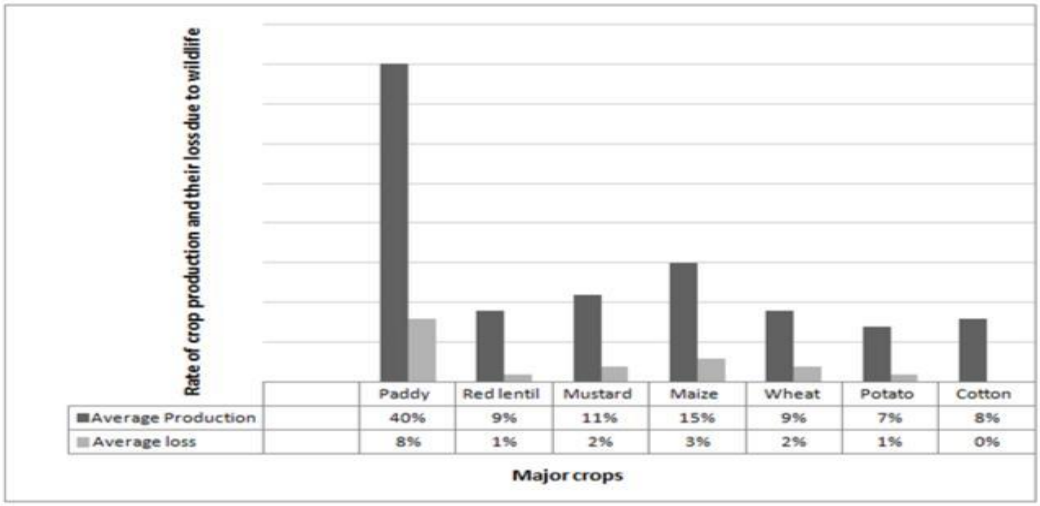


**Figure 10.** Rate of crop production and their loss due to wildlife per year in monetary terms

***Crop production and damage by Wildlife***

The main agricultural product of the study area is paddy which covers 40% of the total crop production per year (in monetary value) followed by red lentil, mustard maize wheat potato and cotton. Similarly, the major loss due to a wild animal is in paddy (7%) of the total produc-tion followed by maize, mustard, red lentil, wheat, and potato whereas there is a negligible loss in cotton, thus local people are replacing other crops with cotton (Figure 10).

***Livestock and poultry depredation***

In the study area, the extreme loss was found in goat followed by hen, cow, and buffalo respectively. Most of the people in the buffer zone area keep livestock and poultry as an integral component for agricultural produc-tion and meat. Generally, they keep cow and buffalo for milk and manure, goat, poultry, etc. for meat and ox and bull for agricultural support (Table 3).

Leopard is the most problematic animal for livestock depredation. Jackal/fox and birds were also depredating animals as hens and duck. It has found that about 83% of the total amount loss is only due to leop-ard. Goats were most killed by the leopard (Figure 11).

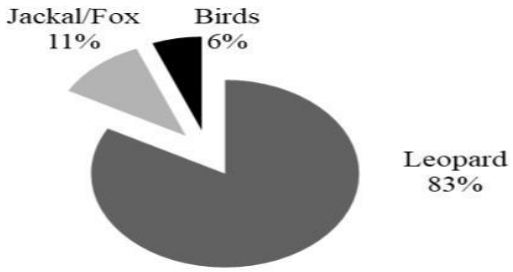


**Figure 11.** Contribution of different wildlife for livestock depredation

***Relationship between loss and distance***

There is a strong linkage between damage and distance. Both frequency and loss were indirectly proportional to the distance from the park boundary. The nearer commu-nities have pronounced effects than farther communi-ties.There is a strong negative relation between distance from park boundary and total loss. As given by regres-sion equation when the distance is decreased by 100 me-ters then the total loss is increased by 3885 rupees (Figure 12).

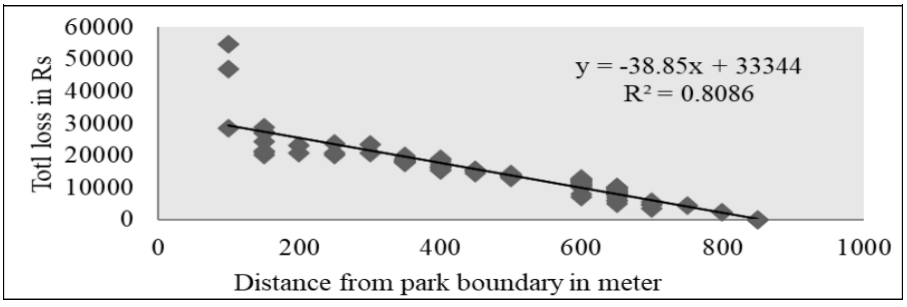


**Figure 12.** Relationship between total loss and distance

| Wildlife | IRR values | Rank |
|---|---|---|
| Wild Boar | 0.96 | 1 |
| Deer | 0.8 | 2 |
| Leopard | 0.77 | 3 |
| Others | 0.71 | 4 |
| Jackal/Fox | 0.66 | 5 |
| Porcupine | 0.64 | 6 |

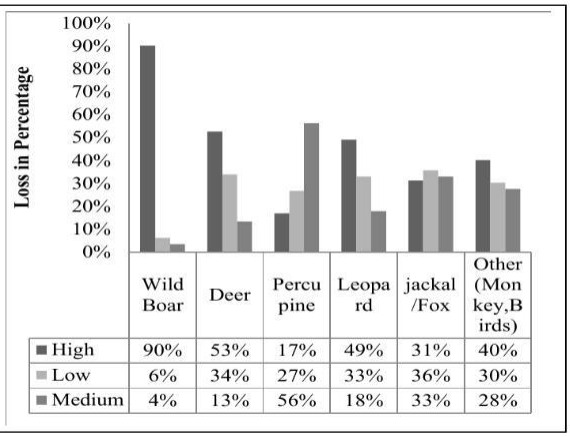


**Figure 13.** IRR value and rank for problematic wild animal

***Problematic wild animal***

Wild boars and leopards were the most conflicting animal. Wild boar damages the crops whereas leopard kills the livestock as well as poultry (Figure 13) which is similar to the finding of Sukumar (1994). The damage by wild boar is probably the most widespread because of its availability in almost all forested habitats including highly degraded and fragmented ones.

***Drivers of damage***

In general, an increase in wildlife population, settlements closer to the forest, inadequate prevention and control measures, dependency on forest resources, degradation and destruction of habitat, lack of awareness, and inadequate prevention and control measures are considered the driving factors of creating an environment for human wildlife conflict (HWC) in the BNP (Figure 14). This contrasts with the finding of Ayadi (2010) which men-tions that deficiency in food is a major cause of conflict, this is because the number of wildlife increases after the establishment of the National park in 2010.

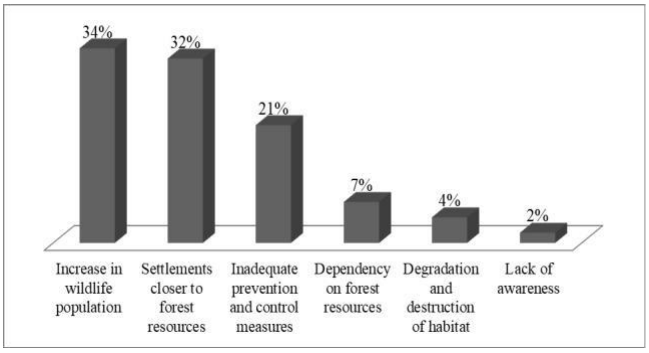


**Figure 14.** Major causes of conflict

***Measures undertaken to mitigate HWC***

Majority of the people practices one or more measures to deal with human wildlife conflict. One common feature observed in the cultivated area was following, shouting, and throwing the stone. Other methods were noise making, chasing with fire, scaring by hitting tin boxes, stone and dust throwing, watching wild animals through high point and dog releasing during the encounter with wild animals. During a certain periods of high crop vulnerability, farm HH members would take the turns to guard the field crops. They used different methods to cope with HWC (Figure 15).

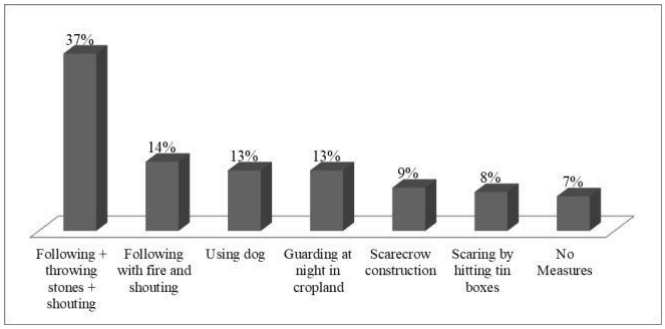


**Figure 15**.Adaptation techniques

***People's perceptions towards conservation and management of the Park***

Expanding human demands on land, vegetation, and fresh water, along with the impacts of climate change, have made the conservation and management of wild areas and wild animals a top priority. Almost all the re-spondents are aware of conserving the park as well it's components as they have a sense of importance to the forest and its associates. The relationship between people and the park is of utmost importance for their existence. In the research site, most of the people are not satisfied with the management aspects such as provision for the compensation, provision of using park resources, conser-vation strategies, etc. (Figure 16).

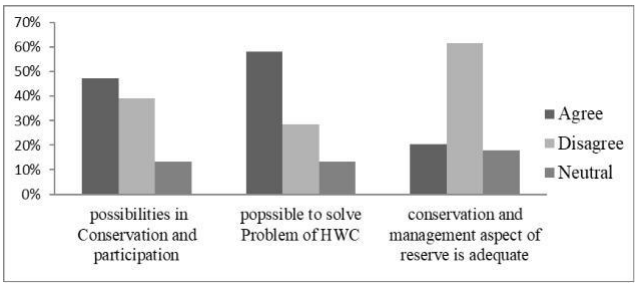


**Figure 16.** People's perception

There is no significant difference in the satisfaction of the respondent in the management approach of National park according to the education status in 5% level of signifi-cance (Table 4).

As shown in Figure 17, only a few respondents have knowledge about the compensation schemes among them negligible respondents applied for compensation whereas none of the respondents got any compensation.

**Table 4.** Chi-square test

| Variables | Category | Response in % within category | | | d.f. | $\chi^2$ value | P value |
|---|---|---|---|---|---|---|---|
| | | Satisfied | Unsatisfied | Neutral | | | |
| Education status | Illiterate | 21.9% | 62.5% | 15.6% | 2 | 0.919 | 0.17 |
| | Literate | 20.0% | 61.3% | 18.8% | | | |
| Average | | 20.95 | 61.9 | 17.2 | | | |

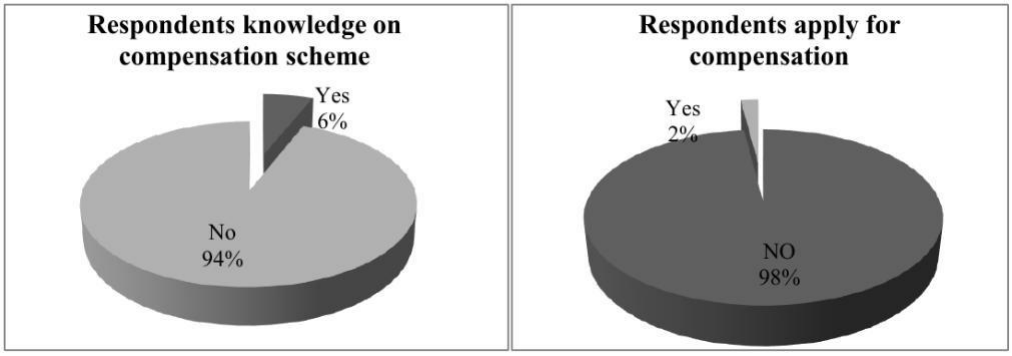


**Figure 17.** Knowledge and action of respondents on compensation scheme

Injuries and deaths caused due to wildlife attacks frequently result in people to feel violent offence and antagonism against the wildlife involved therefore, may weaken public support for conservation. Although Nepal, with rich biodiversity, is doing well in its conservation efforts, human-wildlife conflicts have been a major challenge in recent years (Bhatta and Joshi, 2020). Insufficient information on the spatial and temporal patterns of human-wildlife conflicts at the national level impedes the development of effective conflict mitigation plans (Acharya, 2016). Wild animals are in conflict with humans by causing damages (Angelici, 2016). In case of Nepal, crop damage, livestock depredation, property damage, human injury and casualties are considered to be major human-wildlife conflict (Bajimaya, 2012). Agriculture-related occupation is the main occupation of the respondents living in the vicinity of Banke National Park. The crop damage done by wild animals in the study area was very high. Paddy and maize were the most severely damaged and affected agricultural crops. The reason behind this may be due to its high palatability, huge production and its proteinous nature compare to other crops grown at the study site. The study conducted in Shuklaphanta, Chit-wan, and Bardiya National Park shows paddy as the highly affected and damaged agricultural crops by wild animals that accounted for nearly 60-70% of the total economic loss (WWF, 2007; Ghimire, 2019). According to the study conducted by Shrestha *et al*. (2006), food shortage, an increase in the number of wild animals and biotic pressure are the major causes of rising human wildlife-conflict and crop damage in Nepal. The reason behind the damage of agricultural crops also depends on the distance of the study area from the forest. More the distance from the national parks increases, the more the quantum of crop damage decreases which shows an indi-rect relationship between crop damage and distance (Mackenzie *et al*., 2012; Bhatta *et al*., 2020). The crop damage by wild animals mostly occurs during the crop harvesting period especially at the peak availability of crops (Warren *et al*., 2007).

Suitable government policies and their effective implementation, good management practices and approaches, and low-cost technologies are the basic requirement to minimize conflicts. A number of good practices such as electric/solar fencing, physical barriers, alarming system, changing cropping pattern, and sustainable compensatory or insurance system, community-based natural resource management need to be scaled up. The short-term mitigation tools should be combined with longer-term preventive strategies for resolving human-wildlife conflict. In the meantime, the long-term mitigation strategy should be directed toward the identification of impact zones around protected areas, maintaining suitable wildlife habitats and corridors, and fostering participatory management and enhancing community liveli-hoods (Bajimaya, 2012). It is obvious that human-wildlife conflicts will not be eradicated only be reduced. For this, a better understanding of conflict management options is crucial. In order to crack this conflict cycle, there is an urgent need to protect and reduce the vulnera-bility of rural livelihoods to wildlife depredation, educate the public and foster community-based conservation. The sustainable approach will be to ensure the local economic development through benefit-sharing of conservation. To make conservation more effective, management should be on sound scientific knowledge combined with practi-cal knowledge of local people and their collaboration.

## CONCLUSION

The average landholding of the study area is 0.54 hectares, and the major occupation is agriculture. Almost all (95%) people are suffering from crop and livestock as well as poultry loss damage. The trend of damage caused by wild animals is in increasing order with pronounced effect to nearer communities to park. The conflict be-tween the human and herbivore wild animal was high in the study site with crop damage in greater magnitude. The average loss from crop damage was NRs. 11243 from livestock and poultry loss was NRs. 1758 per year per HHs. With the increase of pressure in the wildlife habitat and the increase of wild animals in the park, the human-wildlife conflict may increase in the future. The major problematic animals in the study area are wild boar, deer, porcupine, birds, and monkeys which are re-sponsible for crop damage and the leopard is the most livestock and poultry killing wild animal.

Most of the techniques to reduce the HWC were

manual and human-based. The application of the techniques alone or in a combination with others depends upon the severity of the problem and the number of wild animals approaching cropland and houses. The major techniques applied were shouting and following with fire, noise making, scaring by hitting tin boxes, dog re-leasing, and regular watching of the wild animals from a higher point. The effectiveness of following fire and noise making was higher than the other techniques ap-plied. Inadequate prevention and control measures to cope with the wildlife damages further worsen the situa-tion of human-wildlife conflict. Most of the people are not satisfied with the management mechanism of the park. People are not getting any compensation for the damage. Though the local people are aware of their role in conservation, their participation in conservation is gradually reducing. Hence, promoting awareness cam-paign and enhancement of BZMC's budget allocation for human-wildlife conflict management activities and rea-sonable compensation mechanism may help to minimize the problem.

## REFERENCES


Acharya, K. P., Paudel, P. K., Neupane, P. R. and Köhl, M. 2016. Human-wildlife conflicts in Nepal: patterns of human fatalities and injuries caused by large mammals. PLOS One, 11(9). Doi: http://doi.org/10.1371/journal.pone.0161717

Angelici, F. M. 2016. Problematic wildlife at the begin-ning of the twenty-first century: introduction. In Problematic Wildlife (pp. 3-18). Springer, Cham. Doi: https://doi.org/10.1007/978-3-319-22246-2_1

Arkin, H. and Colton, R.R. 1963. Tables for Statisticians (2nd ed.). New York: Barnes and Noble Inc., pp 55.

Ayadi, D. P. 2011. Human-Wildlife Conflict in Buffer Zone Area: A Study of Banke National Park, Nepal (Doctoral dissertation, Master Thesis, Environment Science of Tribhuvan University, College of Applied Sciences, Nepal).

Bajimaya, S. 2012. Managing human-wildlife conflict in Nepal. Acharya, KP and Dhakal, M. (eds.). Biodiversity Conservation in Nepal: A Success Story. Department of National Parks and Wildlife Conservation, Nepal, pp. 21-34.

Banikoi, H., Thapa, S., Bhattarai, N., Kandel, R. C., Chaudhary, S., Timalsina, N. and Pokharel, C. P. 2017. Mitigating human-wildlife conflict in Nepal: A case study of fences around Chitwan National Park. International Centre for Integrated Mountain Development (ICIMOD).

Bhatta, M. and Joshi, R. 2020. Analysis of Human-Wildlife Conflict in Buffer Zone: A Case Study of Shuklaphanta National Park, Nepal. Grassroots Journal of Natural Resources, 3(3): 28-45. Doi: https://doi.org/10.33002/nr2581.6853.03033

Bhatta, S. 2003. Draft report on elephant- human conflict in Nepal Terai Park areas with particular emphasis to Western Terai Arc Landscape. A report submitted to Terai Arc Landscape Strategic Plan (2004-2014) . His Majesty Government of Nepal, Ministry of Forest and Soil Conservation, Kathmandu, Nepal.

Budhathoki, P. 2004. Linking communities with conservation in developing countries: buffer zone management initiatives in Nepal. Oryx, 38(3): 334-341. Doi: https://doi.org/10.1017/S0030605304000584

CBS. 2012. National population and housing census 2011. Kathmandu: Central Bureau of Statistics, 1.

Distefano, E. 2005. Human-Wildlife Conflict worldwide: collection of case studies, analysis of management strategies and good practices. Food and Agricul-tural Organization of the United Nations (FAO), Sustainable Agriculture and Rural Development Initiative (SARDI), Rome, Italy. Available from: FAO Corporate Document repository http://www.fao. org/documents.

Dowie, M. 2011. Conservation refugees: the hundred-year conflict between global conservation and native peoples. MIT press.

Ghimire, P. 2019. Analysis of Human Wildlife Conflict in Buffer Zone Area: A Study from Chitwan National Park, Nepal. International Journal of Natural Resource Ecology and Management. Special Issue: Forest and Wildlife Management, 4(6): 164-172. Doi: 10.11648/j.ijnrem.20190406.12 Graham,

K., Beckerman, A. P. and Thirgood, S. 2005. Human-predator-prey conflicts: ecological correlates, prey losses and patterns of management. Biological conservation, 122(2): 159-171. Doi: https://doi.org/10.1016/j.biocon.2004.06.006

Lamarque, F., Anderson, J., Fergusson, R., Lagrange, M., Osei-Owusu, Y. and Bakker, L. 2009. Human-wildlife conflict in Africa: causes, consequences and management strategies (No. 157). Food and Agriculture Organization of the United Nations (FAO).

Lamichhane, S., Joshi, R., Poudel, B. and Subedi, P. 2020. Role of Community in Leading Conservation: Effectiveness, Success and Challenges of Community Based Antipoaching Unit in Nepal. Grassroots Journal of Natural Resources, 3(4).

Mackenzie, C.A. and Ahabyona, P. 2012. Elephants in the garden: Financial and social costs of crop raiding. Ecological Economics, 75: 72-82. Doi: 10.1016/j.ecolecon.2011.12.018

Poudel, B. and Joshi, R. 2020. Ecotourism in Annapurna Conservation Area: Potential, Opportunities and Challenges. Grassroots Journal of Natural Resources, 3(4).

Primack, R. B., Paudel, P. K. and Bhattarai, B. P. 2013. Conservation biology: A primer for Ne-pal. Dreamland publication, Kathmandu, Nepal.

Rayamajhi, S. 2009. Forest dependency, livelihoods and conservation of high altitude forests in Ne-pal (Doctoral dissertation, Forest & Landscape, University of Copenhagen).

Redpath, S. M., Bhatia, S. and Young, J. 2015. Tilting at wildlife: reconsidering human-wildlife conflict. Oryx, 49(2): 222-225. Doi: https://doi.org/10.1017/S0030605314000799

Shrestha, R. K. and Alavalapati, J. R. 2006. Linking conservation and development: An analysis of local people's attitude towards Koshi Tappu Wildlife Reserve, Nepal. Environment, Development and Sustainability, 8(1), 69-84. Doi: https://doi.org/10.1007/s10668-005-0188-5

Silwal, T., Shrestha, B., Bhatta, B. and Devkota, B. 2013. Revenue distribution pattern and park -people conflict in Chitwan National Park, Nepal. Banko Janakari, 23(1): 35-41. Doi: https://doi.org/10.3126/banko.v23i1.9465

Sukumar, R. 1994. Wildlife -human conflict in India: an ecological and social perspective. Social ecology. Oxford University Press, New Delhi, pp. 303-317.

Treves, A. 2007. Balancing the needs of people and wild - life: when wildlife damage crops and prey on live-stock. Land Tenure Center, Nelson Institute of Environmental Studies, University of Wiscon-sin.

W.W.F. 2005. Human wildlife conflict manual 2005: Wildlife Management Series, WWF-World Wide Fund for Nature (formerly World Wildlife Fund) Southern African Regional Programme Office (SARPO).

W.W.F. 2007. A Case Study on Human-Wildlife Conflict in Nepal (With particular reference to Human-Elephant Conflict in Eastern and Western Terai regions), World Wildlife Fund, Kathmandu, Ne-pal: pp. 47-48.

Warren, Y., Buba, B. and Ross, C. 2007. Patterns of crop raiding by wild and domestic animals near Gasha-ka Gumti National Park, Nigeria. International Journal of Pest Management, 53(3): 207-216.