HUMAN-ELEPHANT CONFLICT IN THE ADJOINING AREAS OF KOSHI TAPPU WILDLIFE RESERVE, EASTERN NEPAL

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Submitted to:

Central Department of Zoology

Institute of Science and Technology

Tribhuvan University

Kirtipur, Kathmandu, Nepal

August, 2021

DECLARATION

I hereby declare that the work presented in this thesis entitled **"Human-Elephant conflict in the adjoining areas of Koshi Tappu Wildlife Reserve, Eastern Nepal"** is the result of genuine work and research, except as cited in references. The thesis work has not been submitted, published, or accepted elsewhere for any other degree.

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RECOMMENDATION

This is to recommend that the thesis entitled "**Human-Elephant conflict in the adjoining areas of Koshi Tappu Wildlife Reserve, Eastern Nepal"** has been carried out by Ambika Tiwari for the partial fulfillment of the requirements for the Degree of Master of Science in Zoology with a special paper 'Ecology and Environment'. This is her original work and has been carried out under my supervision. To the best of my knowledge, this thesis work has not been submitted for any other degree in any institution.

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LETTER OF APPROVAL

On the recommendation of the supervisor Assistant Professor Dr. Bishnu Prasad Bhattarai, this thesis submitted by Ambika Tiwari entitled **"Human-Elephant conflict in the adjoining areas of Koshi Tappu Wildlife Reserve, Eastern Nepal"** is approved for the examination in partial fulfillment of the requirement for the Master's Degree of Science in Zoology with special paper "Ecology and Environment".

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CERTIFICATE OF ACCEPTANCE

This thesis entitled **"Human-Elephant conflict in the adjoining areas of Koshi Tappu Wildlife Reserve, Eastern Nepal"** submitted by Mrs. Ambika Tiwari has been accepted for partial fulfillment for the requirement of Master's Degree of Science in Zoology with Special paper Ecology and Environment.

EVALUATION COMMITTEE

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ABBREVIATIONS AND ACRONYMS

BZUC	Buffer Zone User Committee
CNP	Chitwan National Park
DNPWC	Department of National Parks and Wildlife Conservation
GIS	Geographical Information System
GPS	Global Positioning System
HEC	Human-Elephant Conflict
IUCN	International Union for Conservation of Nature and Natural Resources
KTWR	Koshi Tappu Wildlife Reserve
SPSS	Statistical Package for the Social Sciences

ABSTRACT

Human-Elephant Conflict (HEC) has worsened in the past decade and has had its influence till now. There has been a significant increase in human-elephant conflict for land and resources, which has important implications for their respective distributions. This study aims to explore the elephant occurrence, pattern, causes, and impact of human-elephant conflict on humans and also explore the relationship of HEC with farming practice using a questionnaire and sign survey. The pattern of human-elephant conflict was analyzed using the secondary data reported to Koshi Tappu Wildlife Reserve from 2017 to 2019. During three years of study period a total of 1,119 incidents of human-elephant conflict was recorded. Overall nineteen signs of elephant were reported during the study period out of which seventeen new footprints and two fresh dung were recorded which revealed the occurrence of wild elephants near water bodies and agricultural field. Elephant behaviour and inadequacy of preventive measures were the foremost reasons for conflict. Variables such as nearest forest and water sources showed a significant association between conflicts. This study reported seventy-four incidents of crop damage, fifty-eight incidents of property damage, and only a case of human casualty during three years. Total economic loss from crop damage was US$ 80.850 per household (HH) and property damage was US$ 81.296 per household (HH) in three years. Traditional farming practice such as paddy, maize, wheat increases the higher chances of elephant attacks. This study has also shown that crop damage is most intense in November at night whereas property damage and human casualties were peak on January. Moreover, Kusaha- Lauki and Prakashpur Buffer Zone User Committees were very much affected by conflict. Hence, understanding the ecological behavior of elephants and reducing the human interference inside the reserve would be the most useful method to reduce conflict.

1. INTRODUCTION

1.1 Background

The global loss of wild habitat and increase of the human population has enlarged human-wildlife conflict (Hoare, 2000). Human-Wildlife Conflict (HWC) is considered as the condition where the need for wildlife and human negatively impact the goals and needs of one another (Madden, 2004). Human-Elephant Conflict (HEC) is described as human-elephant interaction that has a negative impact on people' economic, cultural or social lives, as well as elephant conservation and the environment (Parker *et al.,* 2007). According to IUCN red list, the Asian elephants *(Elephas maximus*) are considered as an endangered species (Choudhury *et al.*, 2008). HEC is understood as a two-sided equation where both the people and the elephant are in conflict. Due to the increase in human population, dense forest is transformed into human settlements and agricultural lands (Cordingley, 2008). When elephants roam around remaining forests and into farmland, elephant and local inhabitants get interacted resulting in conflict (Neupane *et al.*, 2013). Hence, human–elephant conflict refers to the unfavorable physical encounters that occur between elephants and humans (Mumby and Plotnik, 2018).

Nowadays, HEC has been consistently increasing in Nepal and it is the single greatest threat to the survival of Asian Elephants throughout their range (Choudhury *et al.*, 2008). The socioeconomic and political conditions, as well as the increased human population of the country have impacted on survival range of Asian elephants whereas only a few resources are accessible to address those issues (Sukumar, 2006). Wherever people and elephants coincide, HEC occurs which is an obvious challenge for elephant conservation (Hoare, 2000). Every year hundreds of elephants and people are killed through conflict. Human-elephant conflict is significant in Nepal, with an average of 10 people and two elephants killed per year (Neupane *et al.*, 2013). Seasonally, small residential herds of elephants make damage locally whereas large herds of mobile elephants create problems in trans-border human settlements (Shrestha, 2007; Neupane *et al.*, 2013). The elephant is responsible for more than 40% of the total human-wildlife conflict and 70% of wildlife-related human victims because of which elephant is one of the most problematic large mammal species in Nepal. Elephants enter settlements usually at night causing human injury and house damage (Bajimaya, 2012). HEC results in property damage, including a

significant loss in agricultural production. Serious threats of HEC are human deaths and injuries. However, in the case of elephants, they are killed for protection and for revenge. HEC is strongly linked with agriculture (Santiapillai *et al.*, 2010). Elephant crop raiding increases the food scarcity among rural people adjacent to forest areas (Barirega *et al*., 2010). Crop damage in long term generates negative attitudes toward the species, which reduce support for conservation as well as increases poaching rates for ivory (Barirega *et al*., 2010). The relief fund for elephant damage in Nepal is limited in scope and still delayed (Neupane *et al.,* 2013). However, the lack of a long-term management plan and insufficient financial resources by government agencies rigorously hamper the effectiveness of these measures. Elephants do not necessarily cause the greatest damage but they are considered as the biggest threats to the people living in close vicinity to the elephant habitats. Fear of death by wildlife is a major cause of HEC (Thirgood *et al*., 2005). When damage exceeds a level of tolerance, people's perceptions change towards wildlife (Hill, 1998). In wildlife conservation, local people's attitude is vital and the attitude may vary according to gender, age, education, and past experiences (Røskaft *et al.*, 2007). HEC harms people, elephant, environment and also create the obstacles for biodiversity conservation (Parker *et al.*, 2007).

Generally, two types of elephant herds are founded in Nepal. They are large mobile herds which frequently cross the border to and from India, and small residential herds that occupy the remaining forest fragments (Shrestha, 2007). In eastern Nepal, Koshi Tappu Wildlife Reserve is tiny area with a 4.59 km^2 forest. The movement of the transboundary herd is largely restricted to the Bahundangi area of Jhapa district and creates massive human-elephant conflict (DNPWC, 2008). Elephant damage is higher in Eastern Terai (Pant *et al.*, 2015).

1.2 Distribution

Asian elephants are distributed in 13 countries i.e., Nepal, Bangladesh, Bhutan, China, Cambodia, India, Indonesia, Malaysia, Myanmar, Sri Lanka, Thailand, Vietnam, Pakistan (Sukumar, 2006) with an estimated population of 38,000–52,000 (Blake and Hedges, 2004; Sukumar, 2006). In Nepal, they are distributed in 19 districts (17 districts in lowland Terai and two districts in the hills) and found in four isolated groups that cover 10,982 km^2 of forest habitat in the Terai lowlands (DNPWC, 2008). The population of wild elephants increased from an estimated individual of 13 to 21 between the period of

1980 to 1989 in central Nepal (Smith and Mishra, 1992). Asian elephants are indicated as flagship species (Sitati and Walpole, 2006), where in Nepal, they are protected under National Park and Wildlife Conservation Act 1973.

In Nepal, elephants were once widespread in the lowland Terai, but are now constrained to a few protected areas and occur in four isolated populations – eastern population in Koshi Tappu Wildlife Reserve and Jhapa district; central population in Chitwan National Park and Parsa National Park; western population in Bardia National Park and adjoining municipalities; and far-western population in Suklaphanta National Park and adjoining municipalities (Pradhan, 2011; Ram *et al.*, 2021). The elephant uses both forest and human-dominated portions of the Terai (Lamichhane *et al.*, 2017). Eastern Terai and western Terai of Nepal comprise trans-border mobile routes for elephants which is the main reason for the conflict. In contrast, central Terai has residential herds which is the reason behind low cases of conflict (Neupane *et al.*, 2013). Nepal has estimated 227 individuals of resident wild elephant, and with the increase in elephant number, HEC is rising significantly (Ram and Acharya, 2020). It is essential to realize that as long as the elephant and human being share the same landscape, HEC can never be removed, it can only be reduced (Cordingley, 2008). Inorder to understand the occurrence of elephant on KTWR and to explore the main cause, pattern and impact of HEC, this study is mandatory. By understanding when and which crops are consumed by elephants, the crop vulnerability and effective mitigation strategies for specific crops can be predicted. Effective mitigation of HEC around the Koshi Tappu area is an essential part of efforts to conserve elephants.

1.3 Significance of the study

For a long time, the challenges of the coexistence between humans and elephants have been a matter of concern for people around the globe. Due to encroachment, deforestation, habitat fragmentation, and loss of connectivity between the elephant habitats, human-elephant conflict (HEC) have become a burgeoning issue. Also, there is a relationship between HEC and land use practice. Because of forest degradation, lack of proper cultivation, and deficiency of scientific mitigation measures, crop-raiding by elephants and human causalities are increasing at an alarming rate. By incorporating land use practice with human-elephant conflict, a new hypothesis for the sustainable conservation measure can be built up. In eastern Nepal, KTWR is considered as the

stepping stone for the elephant population (Ram *et al*., 2021). In this cases, human-elephant conflict is increasing, especially in the eastern corridor of Nepal. However, the relief fund for elephant damage is limited in scope in these areas and is inconsistent in its application even though many practices and programs have been in action. In addition to this, the relation between HEC patterns with land-use practices is rarely studied. To overcome and be aware of all these incidents and to discover the occurrence of elephants scientifically, this study is essential. Also, this study aims to aid knowledge on the pattern, cause, and impact of human-elephant conflict along with the relation of farming practice with human-elephant conflict around Koshi Tappu Wildlife Reserve.

1.4 Objectives of the study

1.4.1 General objective

The main aim of this study was to explore the occurrence of elephants, the cause and impact of human-elephant conflict (HEC) in the eastern area of Koshi Tappu Wildlife Reserve, Sunsari district, Eastern Nepal.

1.4.2 Specific objectives

1. To explore the occurrence of elephants around Koshi Tappu Wildlife Reserve.
2. To understand the temporal and spatial pattern of HEC, cause, and impact of elephants on the people living near the adjoining areas of Koshi Tappu Wildlife Reserve.
3. To explore the relationship between farming practices and human-elephant conflict.

2. LITERATURE REVIEW

2.1 Occurrence of elephant

Elephants were distributed across all protected areas in southern Karnataka, India (Madhusudan *et al*., 2015). A total of 91 human death by elephants and 101 elephants death occurred in retaliatory killings in Karnataka (Gubbi *et al.*, 2014). It also cited no correlation between conflict incidences/unit area and elephant density, forest cover, forest perimeter of protected areas, and presence of physical barriers. 5×5 km grid-based questionnaire survey in Sri Lanka revealed elephant occurrence over 59.9 % of the country (Fernando *et al.,* 2019). Elephants were spreaded in 23 districts of the lowland Terai and Churia range of Nepal (Ram and Acharya, 2020). Similarly, in Jhapa, presence of resident wild elephants has increased the vulnerability of local people living around the forest (Neupane *et al.,* 2018). The occurrence of crop damage was connected with the presence of fruit trees, field topography along with the type of deterrent, season, and type of cropping activity (Ngama *et al.,* 2019).

Asian Elephants inhabit the mixed forest, riverine forest, grassland, tropical evergreen forest, semi-evergreen forest, moist deciduous forest, dry deciduous forest, and cultivated or scrublands (Neupane *et al.*, 2019). Similarly, elephants were associated with higher diversity of vegetation (Neupane *et al.,* 2020). They actively select the habitats (e.g. riverine) which comprises water, forage, and shade (Shannon *et al.*, 2006). Due to similar ecological requirements of humans and elephants, when both species occupy the same area, the conflict between them is unavoidable.

2.2 Pattern, cause, and impact of HEC

Average crop-raiding incidents by elephants occurred within 1.54 km of areas of natural habitat where elephants can hide and feel undisturbed by human activities. Also, small-scale farms (settlement densities below approximately 20 dwellings per km^2) are especially in danger to crop-raiding and above these settlement values, crop-raiding declines (Graham *et al.*, 2010). Conflict was expanding significantly southward trend in Assam India and suggests that a critical threshold for conflict may exist between 30 to 40% forest cover. Below this level, conflict expanded across the landscape. Maintenance of remaining forest areas, reforestation, and the creation of habitat corridors were

strategies that could help to prevent further expansion of the conflict. Similarly, 98.8% of the conflict incidences were occurred in villages that lie within 6 km of the national park boundary in the south Indian reserve (Gubbi *et al.*, 2012). Out of the 26 crop types affected by elephants, finger millet, maize, cotton, paddy, and sugarcane formed 86.34% of the total crop losses. Conflict frequencies were highest during August–November, a period when there was a decrease in rainfall and important crops such as finger millet, maize and paddy were ripening.

When the needs of humans clash directly with the requirements of threatened species,the situation become tough . In Paschim Kusaha, crop depredation and human harassment has been caused by wild animals, with the villagers adjacent to KTWR (Limbu and Karki, 2003). According to Yadav (2007), Chitwan National Park and Parsa National Park have faced 50 house losses, 15 human and 5 wild elephants death indicating increasing HEC. The tangible losses of human-wildlife conflicts were well documented, however, hidden health consequences remain under-researched. Jadhav and Barua, (2012) studied the negative mental impact of HEC among local people such as worsening pre-existing mental illness of people, fear of elephant, disturbed sleep, tiredness, anxiety and also children are refusing to attend school.

HEC has caused 100 human deaths along with 47 serious injuries and 615 cases of extensive property damage (Neupane *et al.,* 2013). In Kenya, the average number of HEC incidents was 594 annually (Munyao *et al.,* 2020) showing a moderate increase in HEC.

Asian elephants and common leopards were most commonly involved in conflict with people in terms of attack frequency and fatalities. Attacks by elephants were peak in winter and human settlements were increasing as a conflict hotspot (Acharya *et al.*, 2016). 290 incidents of damage, 21 human casualties and four serious injuries were found on the buffer zones of Chitwan National Park and Parsa National Park (Pant *et al.*, 2015). In addition to this, three human deaths and two human injuries along with frequent crop damage revealed that HEC was fluctuating (Dangol *et al.,* 2020). It was found that the Willingness to pay (WTP) of residents was also greater if people have had previous human-elephant conflict-related injuries or deaths and local stakeholders were willing to pay to the programs that were economically transparent and improved upon existing management (Neupane *et al.*, 2017)

In Srilanka, 70 people and 250 elephants lost their lives annually as a result of human-elephant conflict (Fernando *et al.*, 2011). Elephants lost 16.1% of their range since 1990, but their current distribution remains still largely connected. Human-elephant coexistence model could be only sustainable option for effectively mitigating human-elephant conflict and conserving elephants in Srilanka (Fernando *et al.*, 2019). However, the highest number of annual elephant deaths were still exceeding with 300 in 2018 and 400 in 2019 indicating an increasing HEC along with economic and psychological effects (Prakash *et al.*, 2020).

Mixed forest landscape and grassland heterogeneity has positively influenced elephant's habitat, whereas elevation and slope have their negative influence (Neupane *et al.*, 2019). So, the Asian elephant avoid steep and rugged terrain (slope) area (de la Torre *et al.*, 2020). Elephants prefer core areas having adequate availability of food resources whereas the corridor area was associated with encounters with human conflict. Likewise, distance to the road, water, elevation, and slope were important variables to determine the habitat suitability of elephants (Sharma, 2020). Besides this, Thapa (2019) explored that, elephants were broadly scattered along Churia range and attracted towards the bamboo habitat. During hot hours, elephants search for shades from the sun close to the forest which results in more clumped distribution in summer as compared to winter. 67% of the eastern part of the habitat was displayed by the elephant in both seasons whereas about 24% of the western region was used in summer (Thapa *et al.*, 2019).

2.3 Relationship of human-elephant conflict with farming practise

Human-elephant conflict has strong association with agriculture which predicts higher HEC incidents during cultivation periods (Santiapillai, 2010). The test crops (ginger, onion, garlic, and lemongrass) were only slightly damaged by elephants meanwhile the maize was completely eaten. The selection of appropriate, less attractive or even unpalatable crops is an important step to tackle these conflicts mostly through trampling (Gross *et al.*, 2015). Elephant prefers monoculture plantations (Krishnan *et al.*, 2019). Koirala (2016) explained that 57 species of plants are preferred by an elephant. *Saccharum spontaneum, Shorea robusta, Acacia catechu, Spatholobus parviflorus, Mallotus philippensis, Saccharum bengalensis, Garuga pinnata, Litsea monopetala, Cymbopogan spp, and Phoenix humilis* were highly consumed ones (Ram and Acharya, 2020).

Gardening practices such as bananas, mango, bamboo, huge maize fields and alcohol-based production at home has caused conflict (Neupane *et al.*, 2017). HEC was greatest during the winter period when rice grows and the second peak in summer during the maize harvesting period. Moreover, Medicinal and Aromatic Plants (MAPs) were less consumed by an elephant. They could be repellent but not a deterrent to the elephant (Gross *et al.*, 2017). Paddy, coconut, and banana are highly preferred food (Santiapillai and Read, 2010) whereas citrus trees are mostly avoided. Fixed sequential mode of farming has shift HEC interaction from harmonious ones to unsure ones (Anuradha *et al.*, 2019). Although it is unlikely that the human-elephant conflict can be eliminated, yet every effort must be taken to reduce it to tolerable levels (Santiapillai *et al.*, 2010).

3. MATERIALS AND METHODS

3.1 Study area

Koshi Tappu Wildlife Reserve (KTWR) (86^0 55' to 87^0 05'E longitude and 26^0 34'-26^0 45'N latitude) lies in the sedimentary flood plains of the Saptakoshi River bordering Saptari and Sunsari of eastern Terai of Nepal (Limbu and Karki, 2003). It is the only remaining wildlife reserve of Nepal covering an area of 175 km^2 of Sunsari, Saptari, and Udayapur Districts. The reserve has a sub-tropical climate (Khatri *et al*., 2010). It consists of reed beds, extensive mudflats and freshwater marshes in the Sapta Koshi River's floodplain, with elevations ranging arround 75 to 81 meters (246 to 266 ft). It was established in 1976 and in December 1987 designated as a Ramsar site (KTWR, 2018).

The buffer zone is the area to sustain ecological integrity and participate in the community for biodiversity conservation (Lamichhane *et al.*, 2019). This study was conducted in the eastern buffer zone of KTWR consisting of four buffer zone user committees (BZUCs) including- Haripur- Shreepur, Kusaha- Lauki, Madhuban, Prakashpur. This study was mainly focused on the four BZUC of Sunsari district due to the lack of sufficient scientific study over there.

3.1.1 Flora and fauna

It is covered in a combination of deciduous riverine woodland, marshy vegetation, and grassland.Grasslands cover 68 percent of the area, compared to only around 6% of the forest, which is dominated by Indian rosewood. The forests are mostly dominated by one or more of the three species, Khair (*Acacia catechu*), Simal *(Bombax ceiba*), and Sissoo (*Dalbergia sissoo*). Catechu forests are more widespread in the northwestern part. The grasslands near the running water bodies are maintained by the annual flooding and grazing by wildlife. The Sapta Koshi River, a tributary of the Ganges, causes rapid and intense flooding during the rainy season. In the extensive wetlands, various plant species are found including kapok, sugarcane, reed, cattail, *Imperata cylindrica,* eelgrass, and species of *Eichhornia*, *Hydrilla*, *Azolla,* and lotus (KTWR, 2018). 31 species of mammals are recorded include the *Elephas maximus*, *Axix axis*, *Bubalus arnee*, *Sus scorfa*, *Lutrogale perspicillata*, and *Canis aureus*. The Ganges river dolphin has been sighted in

the Koshi River. KTWR is bordered by settlements with a low-income human population who rely directly or indirectly on forest resources (Khatri *et al.*, 2010).

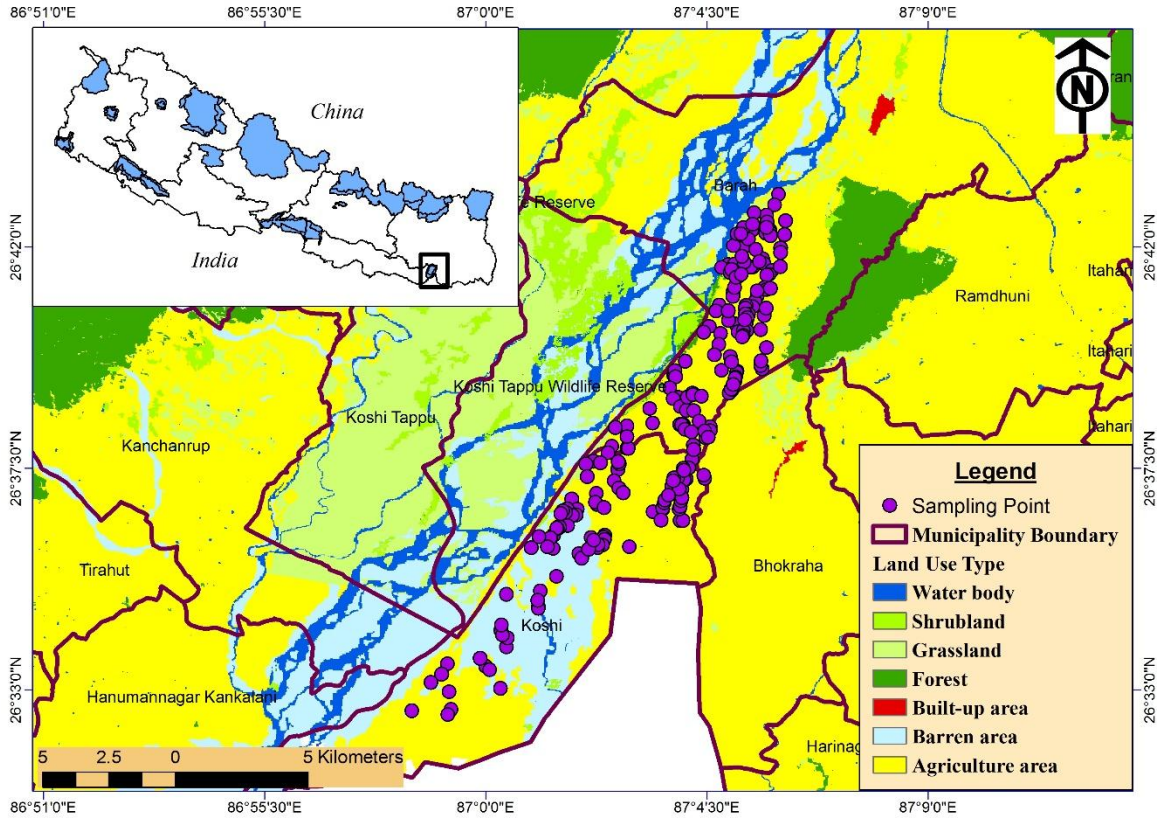


Figure 1. Map of the study area with sampling points for questionnaire survey.

3.2 Methods

3.2.1 Preliminary survey

A preliminary survey was carried out in December 2019. The survey was conducted to know the high conflict site in the study area. After field observation, four BZUCs were selected. So these BZUCs were selected to study the conflict between humans and elephants.

3.2.2 Data collection

Both primary and secondary data were collected. Primary data were collected through a household questionnaire survey and sign survey of the elephant.

3.2.2.1 Primary data collection

Household questionnaire survey

The household survey was conducted from January – February 2020 through a semi-structured interview to know about the causes of HEC and to find out the impact of HEC on people residing there. 250 questionnaire survey was conducted for interviews with household heads of the local population. Similarly, GPS points of elephant occurrence, human casualties, and injuries were also recorded.

Sampling

The sample size of this study was determined based on the number of households in the study area. The household number was available from Koshi Tappu Wildlife Reserve office. Altogether, there are 7,701 households in four BZUCs. Stratified random sampling was done. To cover all study areas, the survey has been stratified in four BZUCs in Sunsari district, eastern Nepal. Hence, altogether 250 households were selected from four BZUCs. Random points were generated in ArcGIS 10.4 within in the boundries of each BZUCs excluding the forest area. The nearest household of the random point was selected for the survey. Mainly questionnaire was asked with the head of the family but in the absence, another house member above 20 years was interviewed. The interview was focused on the cause of conflict in that area and on economic loss due to conflict issues like crop loss, property loss, and human casualties.

Sign survey

Sign survey (footprint, dung) was searched, observed, and recorded with the help of questionnaire respondents. During questionnaire survey, with the help of respondents, sign found around that settlements or between the house and protected area was observed and recorded. The sign survey has been carried out in the four buffer zone user committees (BZUCs) of Koshi Tappu wildlife reserve viz. Prakashpur BZUC, Madhuban BZUC, Kusaha- Lauki BZUC and Shreepur-Haripur BZUC. After identification, GPS points have been recorded and pictures of signs were taken (Sony 12 megapixel). The GPS point, crop damage, property damage, walking point of the elephant were also recorded.

Focus group discussion

The discussion was carried out with the staff of Koshi Tappu Wildlife Reserve and 2 representatives of each 4-BZUCs to get general information about the cause of conflict, impact of conflict on humans.

3.2.2.2 Secondary data collection

Secondary data were collected from the official records of the Koshi Tappu Wildlife Reserve. Data on human-elephant conflict incidents were collected for temporal pattern analysis .

3.3 Data analysis

The data analysis involved the tabulation of all information collected through primary and secondary sources. All the information has been collected in the form of semi-structured, and photographs. Collected data were organized into various types of loss such as crop loss, property damage, human death, and injury. The economic values of crop loss from the study area were calculated by using the local market price of the crop at that time, for instance, the value of estimated loss of different years was calculated separately using year-wise rates for different crops provide by own local farmers. The collected data were entered into the MS Excel program to analyze and generate tables and figures. Simple statistics such as frequency and percentage were used to analyze gathered data from the household survey.

Later, the data was analyzed using SPSS (version 20) and interpreted for the preparation of the final report of the study. Distance to nearest forest, road, water sources, village and agricultural field from questionnaired household was calculated by using google earth pro. Pearson Chi-Square tests were performed to compare the association between conflicts with area and municipalities. An independent t-test was used to show the statistically significant association between conflicts with selected variables. Binary logistic regressions were employed for statistically significant variables such as area, municipality inorder to measure their risk. Results were presented as, figures, graphs, and text in a descriptive way. The ArcGIS software was used to prepare the map of the study area as well as to show the occurrence of elephants in the study area.

4. RESULTS

4.1 Occurrence of elephant

The occurence map was formed from ArcGIS (https://www.esri.com/en-us/arcgis) through the GPS point based on the sign survey comprises of elephant dung, crop damage, and footprints. Overall nineteen incidents of crop or property damage were reported during the study period out of which seventeen new footprints and two fresh dung were recorded which revealed the occurrence of wild elephants (Figure 2). Most of these signs were found near the wildlife reserve. Footprints were mostly sighted in areas near to the agricultural fields, and water resources.

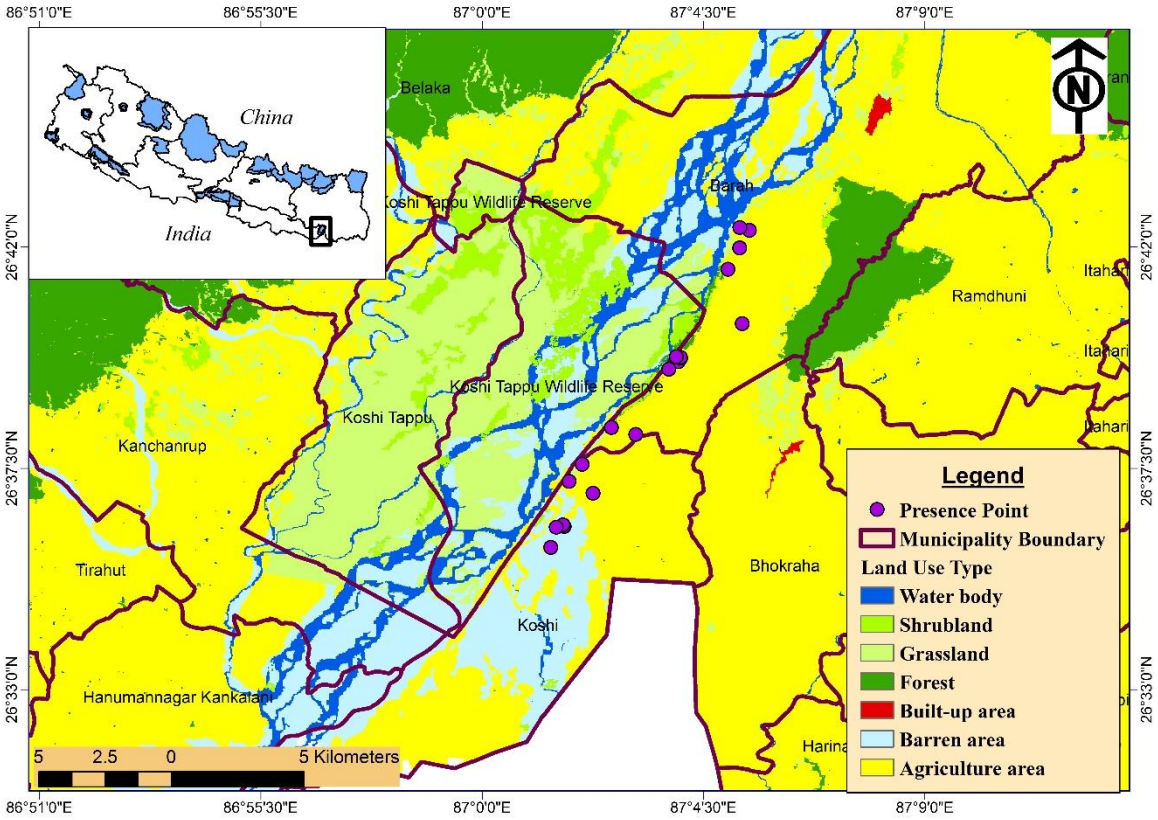


Figure 2. Presence of signs of elephants around Koshi Tappu Wildlife Reserve

4.2 Pattern of human-elephant conflict

4.2.1 Temporal pattern analysis

In 2017, HEC incidents was over 450, but in 2018, it was more than 100 and in 2019, HEC had increased up to 566 (Figure 3). This study reveals that the number of human-elephant conflict incident is not uniform.

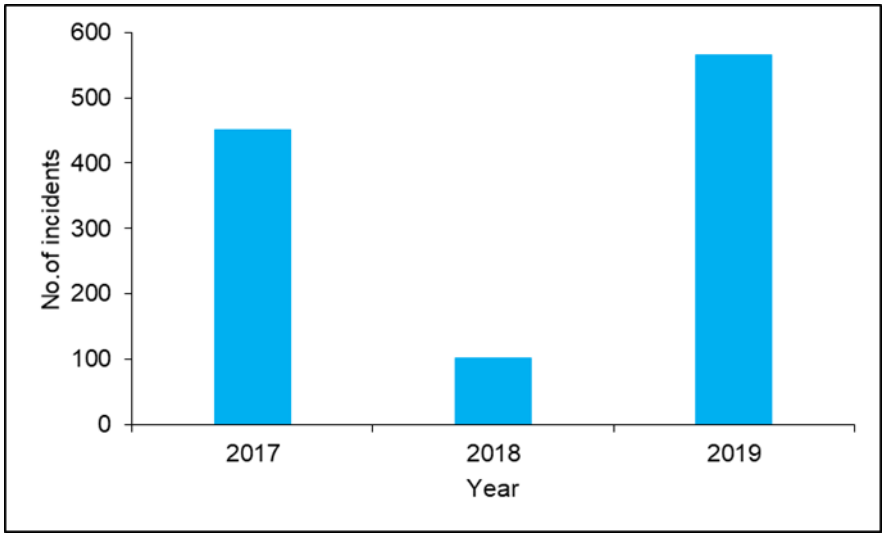


Figure 3. Pattern of HEC incidents (official records of KTWR)

The number of human casualties was increased, with a total of 13 incidents in these three years. In 2019, the number of human casualities was seven whereas 2017 and 2018 had three incidents in each year (Figure 4).

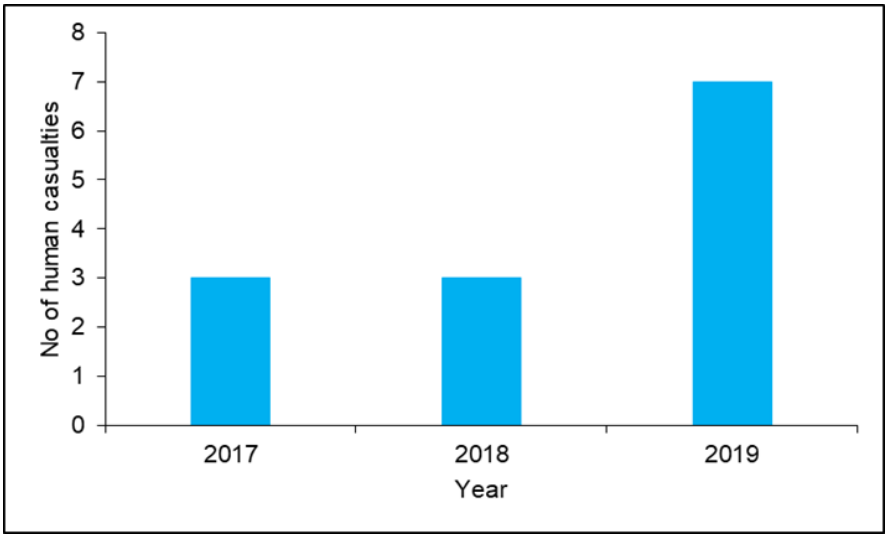


Figure 4. Human casualties during 2017-2019 (official record of KTWR)

4.2.2 The month-wise intensity of crop damage, property damage & human casualties

Higher incidents of crop-raiding occurred in November (48.4 %) and fewer incidents in January (18.4) and May (18.4%). Similarly, in the case of property damage, higher incidents were occurred in January (53.2%) and fewer incidents in July (17.6%). In the case of human casualties, higher causalities were occurred in January (59.6%) and fewer incidents were recorded in July (28.4%) (Figure 5).

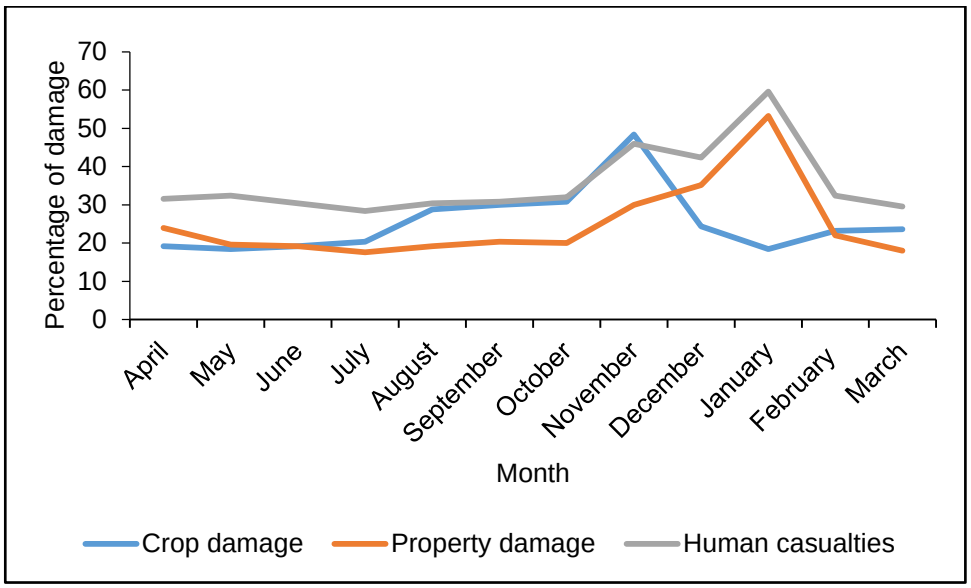


Figure 5. The month-wise intensity of human-elephant conflict

4.2.3 Time of crop damage, property damage, human causalities

The majority of crop damage was occured at night (98.4%). It shows that 2.8% of crop damage was occurred at dawn, 1.6% at midday, 5.2% at dusk. Similarly, no record of damage was observed in the morning or afternoon . In case of property damage, most of the property was damaged during the night time (98.4%), with no damage occurring in the morning or afternoon. In addition to this, 1.2% of property was damaged at dawn, 1.6% at midday, and 5.2% at dusk respectively. Similar type of result was obtained in case of human casualties where maximun number of casualties (98.4%) were recored during night time. It also shows that 5.2% of casualities were occurred at dusk followed by 1.2 % at dawm and 1.6% at midday whereas no harm in the morning or afternoontime. (Figure 6).

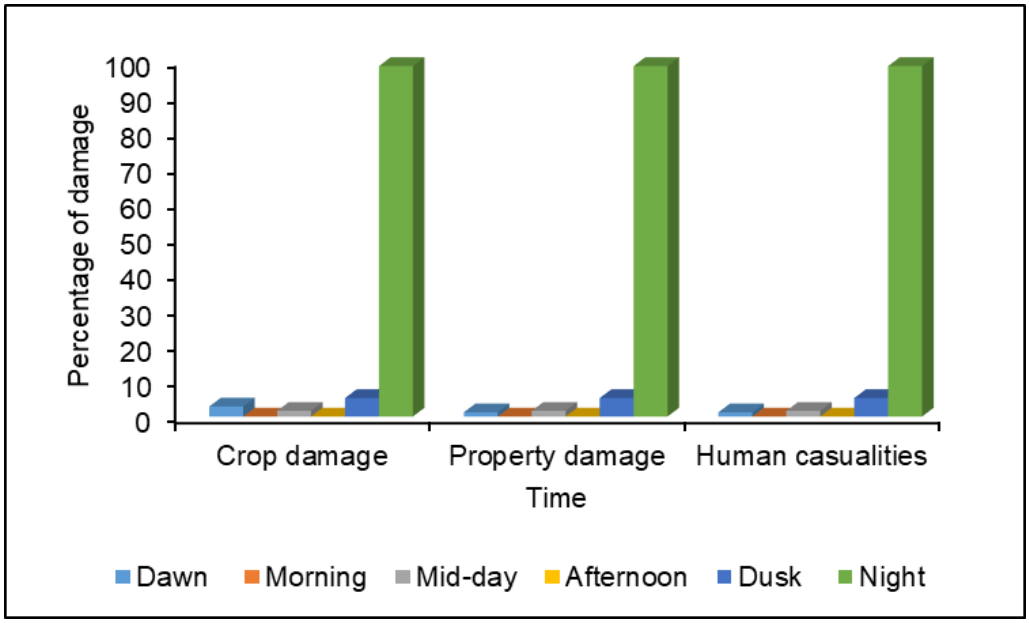


Figure 6. Time of crop damage, property damage, and human causalities

4.2.4 Human-elephant conflict in different buffer zone user committees

The elephant is highly responsible for damage (66.4%) than other species. All the buffer zone user committees (BZUCs) were not equally affected by wild elephants (Figure 7). The highest percentage of conflict was found in Prakashpur BZUC (34%) and Kusaha - Lauki BZUC (34%), whereas Madhuban (18.8%), Shreepur- Haripur (13.2 %) of conflict.

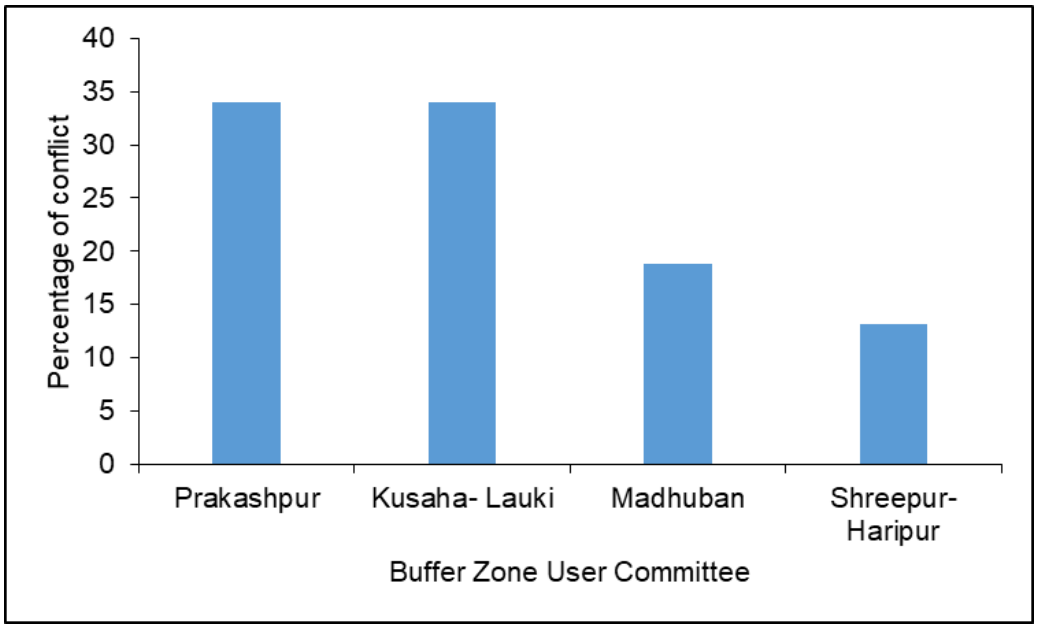


Figure 7. Human-elephant conflict in different BZUC

4.2.5 Types of elephant involve in damage

Elephant herd was responsible for (65.6 %) of crop damage whereas (34.4%) was caused by single one. In case of property damage elephant herd has caused (63.6%) of damage while single elephant has caused (36.4%) damage (Figure 8). Data showed that single elephant was responsible for (55.6%) of human casualty and (44.4%) of casualty was caused by elephant herd.

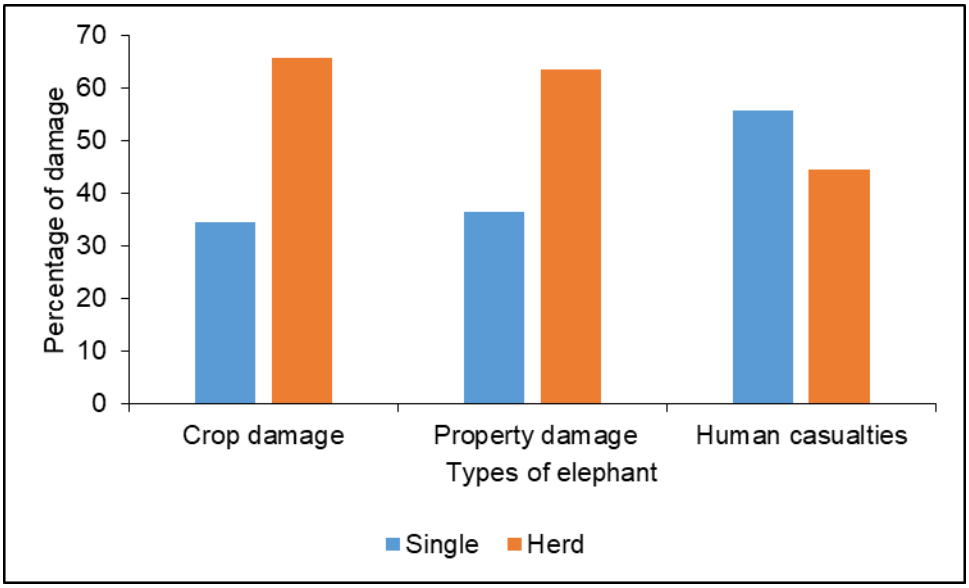


Figure 8. Types of elephant involved in damage

4.3 Causes of human-elephant conflict

The causes of human-elephant conflict were elephant behaviour (34.8%), and inadequacy of preventive measures (33.2%). Increases in elephant population (22.4 %), people and their activities (4 %), and others (5.6%) were also responsible for the conflicts (Figure 9).

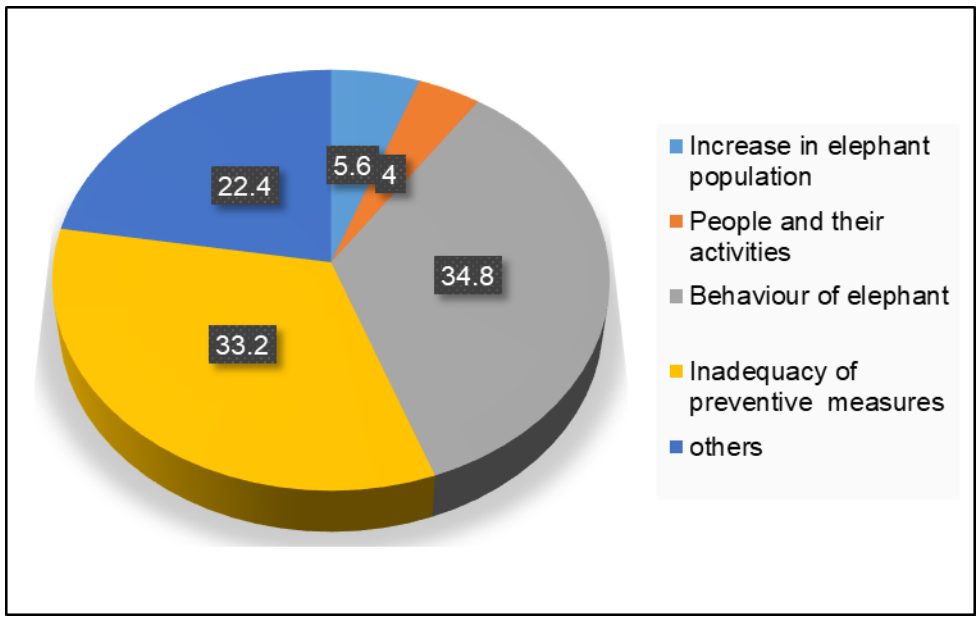


Figure 9. Causes of human-elephant conflict

To determine other possible causes of human-elephant conflict, the chi-square test was performed which showed the association between conflicts with area and municipality. The conflict is significantly associated with area and municipality. Binary logistic regressions were used for statistically significant variables.

Table 1. Logistic regression of conflict with area and municipalities

		S.E.	Wald	P-value	OR	95% C.I.for OR	
Area	**B**					**Lower**	**Upper**
Prakashpur	1.975	0.760	6.747	0.009	7.208	1.624	31.991
Other (Ref.)							
Municipality							
Barahakshetra	1.708	1.246	1.880	0.017	5.517	1.480	63.406
Koshi Rural Municipality (Ref.)							

Regarding the area, conflict risk in Prakashpur is 7.208 times higher (Odd Ratio= 7.208) as compared to other areas (with 95% CI = 1.624 to 31.99). Regarding the municipality, conflict risk in Barahakshetra Municipality is 5.551 times high (Odd Ratio= 5.551) as compare to Koshi Rural Municipality (with 95% CI = 1.48 to 63.40).

Table 2. Association of conflict with selected variables

Variables	HEC	Mean	Std. Deviation	t-value	P-value
Distance to forest	Yes	1506.9	2259.8	-2.693	0.008
	No	9458.7	41250.4		
Distance to water	Yes	581.4	549.1	-4.22	<0.001
	No	997.7	876.1		
Distance to village	Yes	51.4	87.1	-1.953	0.052
	No	85.4	176.1		
Distance to road	Yes	37.3	45.2	-2.024	0.044
	No	54.0	75.6		
Distance to agriculture	Yes	66.0	120.4	1.551	0.122
	No	39.8	35.8		

An independent t-test shows the association between HEC with selected variables (distance measured in meter). Hence, distance to nearest forest (P=0.008), distance to nearest water sources (P<0.001) and distance to nearest roads (P=0.044) have association with conflict whereas nearest village (P=0.052) and agricultural fields (P=0.122) didn't show any association with conflict.

4.4 Impact of human-elephant conflict

Agriculture contributes a major income source for the farmers in KTWR. The major crops lost around the KTWR area were paddy, maize, and wheat (Table 3). The amount of crop loss due to elephants was converted into monetary value. Total economic loss resulted from crop damage in 2018 was NRs. 986,670 (US$ 9,052.018). Whereas in 2019, NRs. 1,261,145 (US$ 11,160.575) was lost which point towards increasing value of crop loss (Table 3).

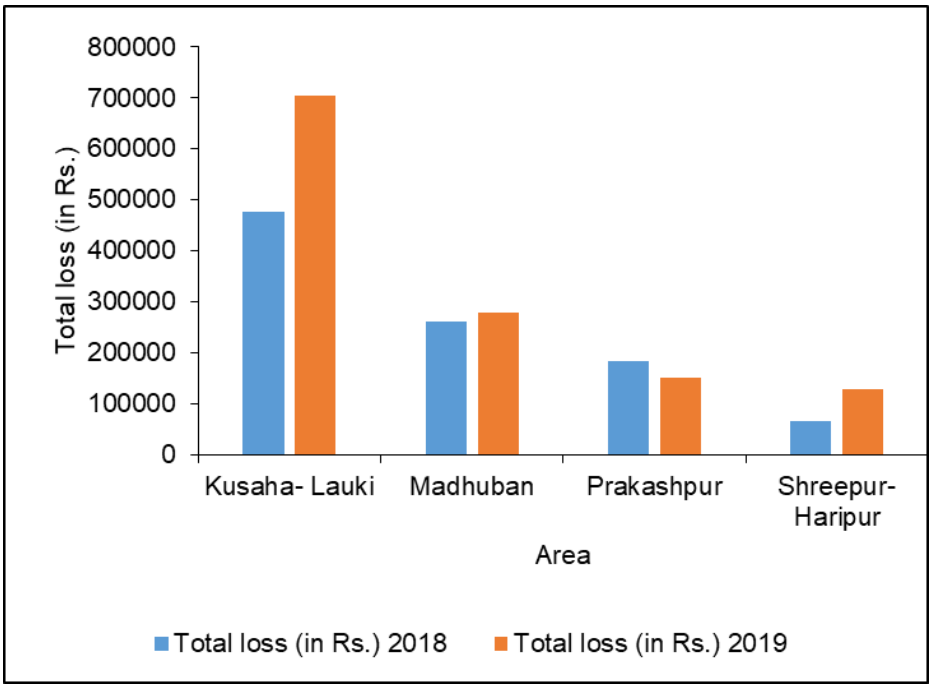
Table 3. Estimated economic loss from crop damage

Crops	2018			2019		
	Crop Loss	Per kg price	Total loss	Crop Loss	Per kg price	Total loss
Maize	14140	20	282800	9965	26	259090
Paddy	23190	27	626130	26675	29	773575
Wheat	3380	23	77740	8160	28	228480
	Total amount (Rs.)		986670	Total amount (Rs.)		1261145

The amount of crop loss and property loss in different buffer zone user committees has been shown in Figures 10(a) and 10(b) respectively. It was found that in 2018, the highest amount of crop loss was in Kusaha- Lauki with a net loss of approximately NRs. 475,600 (US$ 4,363.302) which exceeds its previous loss in 2019 with a total loss of

approximately NRs. 704,330 (US$ 6,233.008) Figure 10(a). Similarly, in the case of property loss, Kusaha- Lauki is facing a higher amount of damage approximately NRs. 975,000 (US$ 9,027.777) between three years whereas, Madhuban has NRs. 588,000 (US$ 5444.444), Shreepur- Haripur has NRs. 527,000 (US$ 4879.629) and Prakashpur has NRs. 105,000 (US$ 972.222) Figure 10 (b).

a)



b)

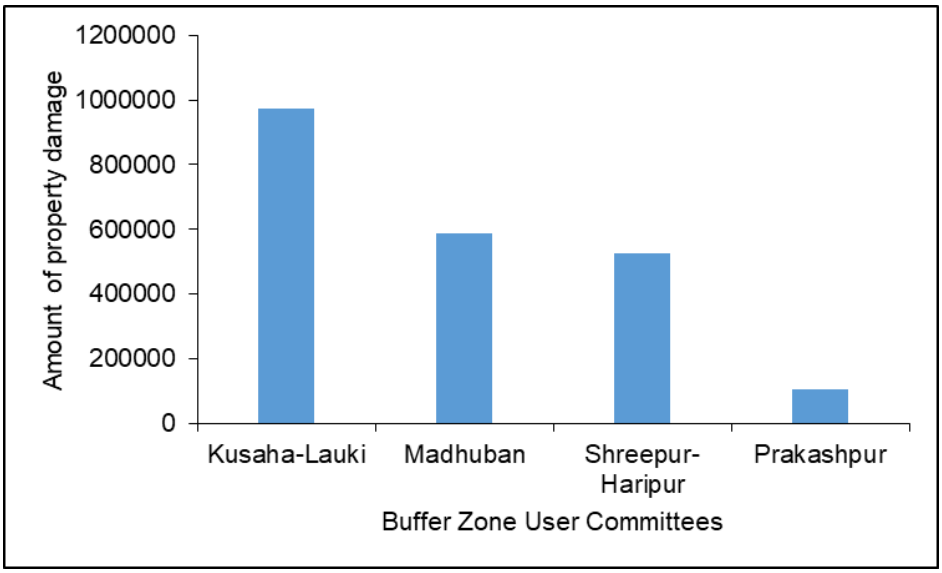


Figure 10. Impact of human-elephant conflict a) crop loss b) property loss

4.5 Human-elephant conflict in relation with farming practice

Traditional farming practice was used by majority of residents in the Koshi Tappu Wildlife Reserve area. Crops like Paddy, wheat and maize turn out to be mostly raided crops by elephants whereas potatoes, mustard, sunflower were least damaged. This shows that corp raiding pattern of elephant is crop specific.

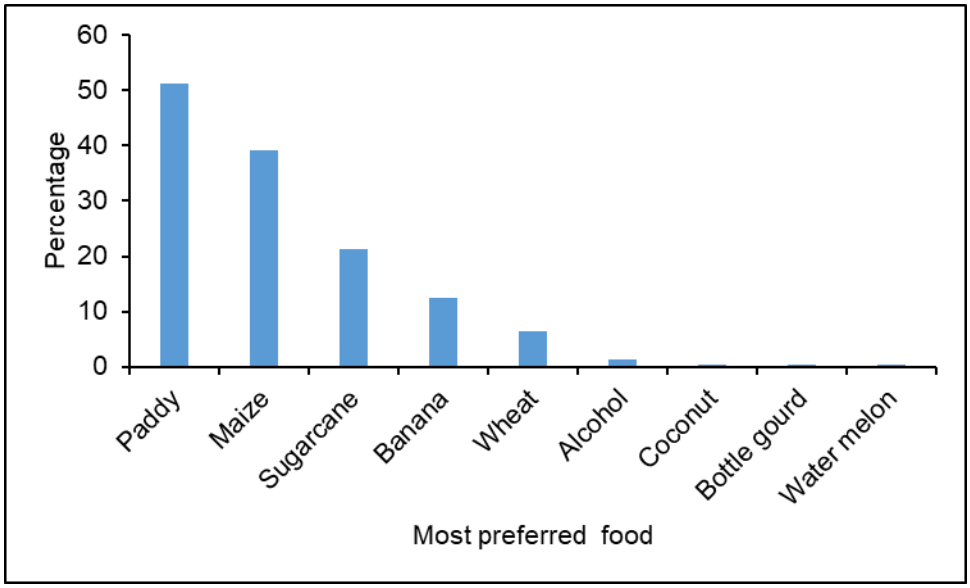


Figure 11. Preferred food by elephant

Paddy is the most preferred food for elephants (51.2%), and watermelon, bottle gourd, and coconut are the least preferred items (0.4%) Whereas maize (39.2%), sugarcane (21.2%), banana (12.4), wheat (6.4%), alcohol (1.2) are also chosen by elephants (Figure 11).

5. DISCUSSION

5.1 Occurrence of Elephant

The occurrence of elephants varie in four BZUC of the eastern buffer zone (n=4) of the Koshi Tappu Wildlife Reserve. i.e. Prakashpur, Madhuban, Kusaha-Lauki and Shreepur-Haripur. This study lights the high frequency of elephants in Kusaha-Lauki. The presence of stable (hattisar) might be the main reason for elephant attraction. Presence of fruit tree, the distance of the field from the park border, season, and type of cropping activity are also associated with conflict (Ngama *et al.,* 2019). HEC incidents mostly occurred within the distance of 5 km (Pant *et al.,* 2015). Elephants prefer a habitat that is away from roads and near water bodies (Sharma *et al.,* 2020). Additionally, the cultivation pattern of the village is also an essential reason for the elephant's visit to the village. The smell of paddy fields during the harvesting time attracts the elephants which could be the reason for irregular visits (Santiapillai and Read, 2010).

5.2 Pattern, cause, and impact of human-elephant conflict

This study reveals that the total number of human-elephant conflict incidents was 1,119 between three years in four buffer zones of KTWR. Temporal pattern analysis showed the fluctuating pattern of human-elephant conflict incidents. A similar outcome of an uneven pattern of human-elephant conflict was mentioned by (Dangol *et al.,* 2020). Human-elephant conflict is high in Kusaha- Lauki in comparison with other BZUCs. It might be due to traditional farming practice of farmers and due to presence of stable (hattisar) in that area. Similar latter explanation was cited by (Pant *et al.,* 2015). These days, local farmers are interested in fish aquaculture (Mishra *et al.*, 2021) to reduce possible loss from elephant however, it could be the mainsource of attraction for elephants during the dry period. The crop damage by wild elephants in Nepal follows a seasonal pattern with two peak seasons during maize and wheat maturing period (June-July), and rice maturing time (September-November) (Pradhan *et al.,* 2011). This study shows that the highest amount of crop damage was in October-December. HEC has become a year-round phenomenon. Additionally, the study also demonstrates that HEC was peak in some season of the year. Nearly more than half of the people around KTWR states that incidences of crop and property damage were on the increasing trend. However, fewer

human casualties have been occurred. Only a few respondents accept that people and their activities are responsible for increasing HEC.

The behaviour of elephants, the inadequacy of preventive measures, and the lack of food inside the protected areas are the reasons for conflict, which also coincides with the previous study (Gubbi, 2012; Yadav, 2014). Due to the narrow protected area, the elephants might have come out of the reserve in search of food or possibly in search of a female partner. Overgrazing of forest by feral cattle/livestock, invasion of exotic species like *Lantana camara*, *Mikania micrantha*, *Parthenium spp* are also responsible for growing conflicts **(**KTWR, 2018). Similarly, numerous reasons like habitat fragmentation, degradation of habitat quality, deforestation, loss of connectivity between elephant habitats, negligence in the management of physical barriers, and extra causes have been mentioned for the human-elephant conflict (Sukumar, 1991). Additionally, the inititing factors and sustaining factors for HEC are elephant behaviour, elephant population and human activities.When requirements of wildlife overlap with human populations, conflict takes place (Ogada, 2011). Human elephant conflict is associated with the area in this study. Statistical analysis showed the highest conflict in Prakashpur in comparison with other BZUCs which might be due to the reason of availability of an adequate amount of crop in Prakashpur. Moreover, the presence of higher number of water bodies in that area during droughts, artificially maintained water sources might attract elephants (Sukumar, 1990). This study shows the distance to forest is responsible variable for HEC which has same result as expressed by (Neupane *et al.*, 2018; Pant *et al.*, 2015; Dangol *et al.*, 2020).

In Nepal, HEC was increasing from 1999- 2007 (Shrestha, 2007). The death of 5 wild elephants were reported from 2005-2010 (Yadav 2014). Similarly, 224 frequencies of HEC and 147 human casualties were recorded from 2003-2017 beecuse of which many villagers of the Terai lived in fear of being attacked by wild elephants (Neupane *et al.*, 2013) . Between 2008-2012, 290 incidents of damage done by elephants were reported along with 21 human casualties and four severe injuries (Pant *et al.*, 2015). The official record of District Forest Office, Jhapa, reported 31 casualties and 30 serious human injuries between 2012- 2017 (Neupane *et al.*, 2018)**.**

HEC mainly impacts the productivity of crop, property loss and rarely causes human casualties (Neupane *et al.*, 2017). In this research, overall estimated amount of crop

damage was found to be NRs. 2,247,815 (US$ 20212.593) whereas the amount of economic loss due to property damage was NRs.2,195,000 (US$ 20,324.074). Total economic loss from crop damage was US$ 80.850 per household (HH) and property damage was US$ 81.296 per household (HH) in three years.

People living near the protected area are also facing many psychological impacts like fear and anger. According to focus group discussion, local people were also unsatisfied with the relief fund they received from the government and demanded higher relief fund as well as faster delivery. HEC mostly occurs during the dry season of winter which corresponds with the previous study of Nepal (Shrestha, 2007; Dangol *et al.*, 2020). The considerable amount of destruction done by elephants during the night or early morning was may be due to the fewer activities of humans at that time, similar to that founded by (Shrestha, 2007). The damage is generally greatest when the crops are matured (Sukumar, 1990). This study explores the pattern of HEC in the BZUCs of the KTWR and shows that crop damage is the most frequent form of conflict caused by elephants in this study area followed by property damage and human casualty.

Unscientific exploitation like habitat encroachment for human settlement and agricultural aspect has created a scarcity of forage for the wild elephants.The remaining habitat has been also used by the local people for their cattle grazing and collection of fodder and grasses. Insufficient forage in the forest compels the elephants towards crop-raiding in settlements surrounding the habitat. These activities done by local people creates conflict. Hence, the government should manage the palatable crops like sugarcane, bananas, maize, and plenty of fodder trees inside the habitat of elephants (Yadav *et al.*, 2014) to minimize the conflict.

5.5 Relationship of HEC with farming practice

Agriculture is Nepal's most important economic sector. Traditional farming practices like paddy, maize, wheat, sugarcane, potato, mustard, sunflower and vegetables are cultivated by most of the residents in the Koshi Tappu Wildlife Reserve area. However, in practice, many people haven’t grown sugarcane in that area in last 4-5 years because of high preference for elephants. To maintain their livelihood, they have continued to produce paddy, maize, and wheat which has also increased the chances of elephant attacks. Paddy was the most damaged crop by the elephants in this study which correlates with the

finding of (Neupane *et al.*, 2018)**.** In this study; potatoes, mustard, sunflowers were not raided by the elephants which may be due to the lower nutritional value of these food items. Similarly, (Sukumar, 1990) stated that crops like rice, wheat, sugarcane, etc contain great nutritive value to the elephants and also added that cultivated crops as palatable and contain higher proteins and minerals in comparison with wild foods (Sukumar, 1989), which may be the driving factor for some elephants to raid crops (Rode *et al.*, 2006) and that might be the reason behind 25% local crop loss in Nepal. Although, farmers have the risk of conflict, they still depend on the crops that would get them higher returns (Gubbi, 2012). In this case, the decision to substitute rice and other crops with alternative crops can be a cost-benefit approach (Neupane *et al.*, 2013). Nowadays, the majority of farmers have shifted to integrated farming with agriculture, aquaculture and animal husbandry (Mishra *et al.*, 2021). To some extent, the agricultural area in this region is converting into fish ponds. Local people are still struggling to adjust with elephant causing threats.

6. CONCLUSION AND RECOMMENDATION

Regarding the nature of HEC, crop-raiding was the most common and reported problem followed by property damage and threats to people**.** Although elephants were not uniformly distributed across the four BZUCs, Kusaha – Lauki BZUC had the highest number of elephant occurrence and highest amount of economic loss. Nearest forest, water bodies and road are responsible variables for HEC. In summary, increasing HEC has been identified over some years but the conflict trend is not uniform. HEC was at peak during paddy ripening and harvesting period. HEC mostly happened during the night time while human activity was lowest. It seems that people only agreed to protect elephants just because of the governmental law alone. For elephant conservation, a detailed behaviour and study of ecology is needed. Electric fencing along the periphery of the wildlife reserve must be maintained properly It is also essential to be aware of the importance of forests and elephants among people living proximate to protected areas. If people's activities inside the protected areas can be controlled and adequate amount of food crops can be planted inside the forest, conflict can be reduced to some extent.

Based upon this study, this study has a few recommendations and are as follows:

- Stable (hattisar) must be placed in a specific location away from the community and cropland.
- Elephant habitat must be maintained and restored.
- The study of ecology and the ranging behaviour of elephants can be supportive strategies to minimize HEC.
- Intensive awareness activities for people residing around conflict zone might be helpful to gather public support for elephant conservation.

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APPENDICES

Appendix 1: Questionnaire for the household survey

Respondent No.: ------
Date of Interview: ----------
Address:

Municipality---------- Ward No. ----------

Village Name: ----------

GPS Location: Easting ---------- Northing ----------

Have you migrated here? Yes No

If Yes, when and from where? ----------

Human-wildlife conflict

1. Is there any problem with the wild animals from the reserve in your agricultural land or any other form of property like house, cattle, etc.?
   Yes (ii) No (If yes go to question No. 3.)
2. What are the problematic wild animals in your area?

Problematic wild animals		Nature of problems
Most problematic animals	i. ii. iii.	i. ii. iii.
Moderate Problematic animal		
Animals with little or no problem		

Human-elephant conflict

3. Is there any problems from wild elephants? i. Yes ii. No
4. If yes, what are the most severe problems caused by wild elephants (in order) in your area?

5. In general which month of the year elephant damages occur?

Types of damage	Baisakh	Jestha	Asar	Shrawn	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Year round
Crop damage:													
Property damage:													
Human casualty:													

6. What is the time of day the damage by elephants most likely to occur? (Tick below)

   Crop damage: Dawn Morning Afternoon Dusk Night

   Property damage: Dawn Morning Afternoon Dusk Night

   Human casualty: Dawn Morning Afternoon Dusk Night

7. How do you see the trend of elephant damage over the last five years?

Types of damage	Highly increased	Increased	Stable	Decreased	Highly decreased
Crop damage:					
Property damage:					
Human casualty:					

‘

8. If human-elephant conflict is increased, what can be the reasons?

   i) Increase in elephant population ii) People and their activities

   iii) Behaviour of elephant iv) Inadequacy of preventive measures

v)

Others_____

9. Have wild elephants caused any damage to you and your family (people living with you in your house) over the last five years? Yes ( ) No ( ). If Yes

Types of damage	Yes/ No	If yes loss details	Estimated loss (NRs)	Compensation/relief obtained
Crop damage:				
Property damage:				
Human casualty:		Injured _____ Killled _____		

10. What is the status of crop damage from elephants this year 2075/76?

Crop Name	Season (SMW All)	Total cultivated Area (Kattha)	Est. production (Qt)	Actual production (Qt)	Damage from elephant			Crop Damage from other factors	Any compensation received? If yes mention amount in NRs.
					Area (Katthas)	%	Production loss (Qt)		

11. What is the status of crop damage from elephants last year 2074/75?

Crop Name	Season (SMW All)	Total cultivated Area (Kattha)	Est. production (Qt)	Actual production (Qt)	Damage from elephant			Crop Damage from other factors	Any compensation received? If yes mention amount in NRs.
					Area (Katthas)	%	Production loss (Qt)		

Causes of conflict

12. What do you think the major causes of human-elephant conflict?

i. ii. Iii.

13. Why do you think elephant come to human settlement?

i) Former elephant range ii) In search of better forage

iii) Agriculture next to elephant habitat iv) Problem elephant

v) In search of alcohol vi) Others _____

14. Which types of elephant/group of elephants cause damage?

Types of damage	Single bull	Herd	Remarks (Herd composition & other details)
Crop damage			
Property damage			
Human casualty			

Prevention and mitigation measures

15. How do you rate the effectiveness of the methods practiced to minimize damage by wild elephants? (Rate between 1 to 5 where 1 is not effective, 2 is sometimes effective, 3 is effective half the time (average), 4 is mostly effective & 5 is highly effective)

SN	Methods	Yes /No	Effectiveness rating for those practices				
			1	2	3	4	5
i.	Deterrents (Noise fire crackers)						
ii.	Physical barriers (Trench						

	fence)						
iii.	Power fence (electric solar)						
iv.	Awareness and training						
v.	Compensation/Relief						
vi.	Capturing problem elephants						

16. What should be done to minimize conflict between people and elephant in this area?

(i). Capture and relocate problem elephant

(ii). Kill the problem elephant

(iii). Capture and relocate all the elephants

(iv). Support to construct permanent houses

(v). Support for alternative livelihood/ crops

17. Is the compensation/relief adequate? (Please tick one)

Very Adequate	Adequate	Partially adequate	Inadequate	Completely inadequate

18. If inadequate what should be the amount?

i)Human injury _____ii)Human Death _____

iii) Crop damage _____ iv) Property damage _____

19. Are you getting compensation/relief on time? a. Yes b. No

20. If No what should be the time frame?

Human injury ---------- days/months/years

Human Death ---------- days/months/years

Crop damage ---------- days/months/years

Property damage ---------- days/months/years

Information of the respondent

Name of interviewer: ----------

Age: ---------- Sex: ---------- Education-------- Occupation----------

Contact number:

Land holding: (i) Irrigated land ----------kattha/bigha/hectare

(ii)Non-irrigated land ---------- kattha/bigha/hectare

Livestock holding: Buffalo: …. Cow/Ox: ….. Goat/Sheep: ….. Pig: …… Poultry: ……

Duck……

Fish farms (number & total area) …… …….. & Others: …..

Distance to your home from nearest forest patch: …… minutes walking

Distance to your crop field from nearest forest patch: …….. minutes walking

Appendix 2: Photographs

Photo 1. Footprint of elephant

Photo 2. Elephant dung

Photo 3. Banana destruction by elephant

Photo 4. Taking questionnaire

Photo 5. Property damaged by elephant

Photo 6. Crop damage by elephant

नेपाल सरकार
वन तथा वातावरण मन्त्रालय
राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण विभाग
(..... शाखा)

फोन नं. : ४२२०८५०
४२२०९१२
४२२७९२६
फ्याक्स नं. ४२२७६७५
पो. ब. नं. - ८६०
बबरमहल, काठमाडौं
Email: info@dnpwc.gov.np
http//:www.dnpwc.gov.np

पत्र संख्या :- ०७६/७७ इको/१२१
चलानी नं. :- १२६८

मितिः २०७६/९/१८

विषयः अध्ययन अनुमतिसम्बन्धमा ।

श्री कोशीटप्पु वन्यजन्तु आरक्ष, कुसाहा, सुनसरी ।

प्रस्तुत विषयमा तहाँ आरक्ष क्षेत्रमा निम्नानुसारको अध्ययन अनुसन्धान प्रदान गरिएको व्यहोरा आदेशानुसार अनुरोध छ।

अनुसन्धानकर्ताको नाम	अम्बिका तिवारी		
ठेगाना	रत्ननगर ३ टाडी चितवन	इमेलःambikatiwari04@gmail.com	फोन नं.९८४५७११७९८
समद्वसंस्था	Central Department of Zoology, TU, Kirtipur, Kathmandu		
अनुसन्धानको प्रकृती	व्यक्तिगत		
पद	विद्यार्थी		
अनुसन्धानको तह	स्नातकोत्तर		
अनुसन्धानको शिर्षक	1. **Human Elephant Conflict in Adjoining Areas of Koshi Tappu Wildlife Reserve, Eastern Nepal**		
अनुसन्धान विधि	Questionnaire and Sign Survey	नमुना संकलन	नमुना परिक्षण कहाँ गर्ने
		नगर्ने	नगर्ने
अनुसन्धानको अविध	३ जनवरी २०२० देखि २९ जुलाई २०२० सम्म		

शर्त :
१.अनुसन्धानकर्ताले राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण ऐन, २०२९ र नियमावली, २०३० तथा मातहतका सबै नियमावलीहरुको पूर्ण पालना गर्नु पर्नेछ ।
२. अध्ययन गर्दा सम्बन्धित संरक्षण क्षेत्र कार्यालयसंग समन्वय गरी गर्नु पर्ने पर्नेछ ।
३. अनुसन्धानकर्ताले आफ्नो अनुसन्धानको प्रस्ताव सम्बन्धित संरक्षित क्षेत्र कार्यालयमा समेत पेश गर्नु पर्नेछ ।
४.अनुसन्धानकर्ताले अनुसन्धान समाप्त भएपछि प्राप्त तथ्यांक, एक प्रति कागजी प्रतिवेदन र एक प्रति इलोक्ट्रोनिक प्रतिवेदन यस विभाग र सम्बन्धित संरक्षित क्षेत्र कार्यालयमा बुझाउनु पर्नेछ ।
५. अनुसन्धानकर्ताले नतिजाहरु प्रकाशित गर्दा अनुसन्धानमा संलग्न यस विभाग र अन्तरगतका कर्मचारीको योगदानको आधारमा सहलेखकको रुपमा समावेश गराउनु पर्नेछ ।
६. कुनैपनि नमुना संकलन गर्न पाइने छैन ।
७. तोकिएका शर्तहरुको पालना नगरेमा विभागले कुनैपनि समयमा अनुमतिपत्र रद्द गर्न सक्नेछ ।

हेम राज आचार्य
सहायक इकोलोजिष्ट

बोधार्थः
श्री अम्बिका तिवारीः सम्बन्धित संरक्षित क्षेत्र कार्यालयसंग समन्वय गरी अध्ययन अनुसन्धान गर्नु भई अध्ययन समाप्त भएपछि प्राप्त तथ्यांक र एक प्रति प्रतिवेदन यस विभाग र सम्बन्धित संरक्षित क्षेत्र कार्यालमा बुझाउनु हुन अनुरोध छ ।