HUMAN-ELEPHANT CONFLICT AND ITS MITIGATION MEASURES IN MECHINAGAR MUNICIPALITY, JHAPA, NEPAL

Puskal Khanal
T.U. Registration No: 5-2-37-181-2009
T.U. Examination Roll No: 40/070
BATCH: 2070/71

A thesis submitted in partial fulfilment of the
requirements for the award of the degree of Master of Science in Zoology
with special paper Ecology

Submitted to:
Central Department of Zoology
Institute of Science and Technology
Tribhuvan University
Kirtipur, Kathmandu
Nepal

October, 2020

DECLARATION

I hereby declare that the work presented in this thesis has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the authors.

Date: 18/09/2020

.....
Puskal Khanal

TRIBHUVAN UNIVERSITY
01-4331896
CENTRAL DEPARTMENT OF ZOOLOGY
Kirtipur, Kathmandu, Nepal.

Ref.No.:

Central Department of Zoology T.U., Kirtipur

RECOMMENDATIONS

This is to recommend that the thesis entitled **"HUMAN-ELEPHANT CONFLICT AND ITS MITIGATION MEASURES IN MECHINAGAR MUNICIPALITY, JHAPA, NEPAL"** has been carried out by Mr. Puskal Khanal for partial fulfillment of Master's Degree of science in Zoology with special paper Ecology. This is his original work and has been carried out under my supervision. To the best of my knowledge, this work has not been submitted for any other degree in any institutions.

18/09/2020
.....
Date

.....
Supervisor
Prof. Dr. Tej Bahadur Thapa
Head of the Department
Central Department of Zoology
Tribhuvan University
Kirtipur, Kathmandu, Nepal

TRIBHUVAN UNIVERSITY
01-4331896
CENTRAL DEPARTMENT OF ZOOLOGY
Kirtipur, Kathmandu, Nepal.

Ref.No.:

Central Department of Zoology T.U., Kirtipur

LETTER OF APPROVAL

On the recommendation of supervisor Dr. Tej Bahadur Thapa; Professor, Central Department of Zoology, Tribhuvan University, the thesis entitled **"HUMAN-ELEPHANT CONFLICT AND ITS MITIGATION MEASURES IN MECHINAGAR MUNICIPALITY, JHAPA, 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.

Date: 18/09/2020

.....

Prof. Dr. Tej Bahadur Thapa
Head of Department
Central Department of Zoology
Tribhuvan University
Kirtipur, Kathmandu, Nepal

TRIBHUVAN UNIVERSITY
01-4331896
CENTRAL DEPARTMENT OF ZOOLOGY
Kirtipur, Kathmandu, Nepal.

Ref.No.:

Central Department of Zoology T.U., Kirtipur

CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Mr. Puskal Khanal entitled **"HUMAN-ELEPHANT CONFLICT AND ITS MITIGATION MEASURES IN MECHINAGAR MUNICIPALITY, JHAPA, NEPAL"** has been accepted as a partial fulfillment for the requirement of Master's Degree of Science in Zoology with special paper Ecology.

EVALUATION COMMITTEE

.....

(Supervisor)
Dr. Tej Bahadur Thapa
Professor
Central Department of Zoology
Tribhuvan University
Kirtipur, Kathmandu, Nepal

.....

(Head of the Department)
Dr. Tej Bahadur Thapa
Professor
Central Department of Zoology
Tribhuvan University
Kirtipur, Kathmandu, Nepal

.....

External Examiner
Dr. Jhamak Bahadur Karki

.....

Internal Examiner
Dr. Laxman Khanal

Date of Examination: 09/10/2020

ACKOWLEDGEMENTS

First of all, I would like to express my deep gratitude to my respected supervisor and Head of the Department Prof. Dr. Tej Bahadur Thapa, Central Department of Zoology, Tribhuvan University for his valuable suggestions, incisive guidance and co-operation. I would also like to thank both the teaching and administrative staffs of Central Department of Zoology, Tribhuvan University for all their help during my study in all the semesters.

My sincere thanks go to my brothers Mr. Paras Neupane and Mr. Rajan Dhital for their enthusiastic support and diligence to my work. I am debt to my field guide Mr. Shanker Luitel and president of Human-Elephant Conflict Management and Environment Conservation Forum, Mr. Hari Upreti for their immense support and guidance during my field work. My special thanks go to my friends Mr. Peshal Neupane and Mr. Bikash Bastola and all my friends of Ecology group CDZ, TU for their valuable help and suggestions. I am thankful to Mr. Hira Prasad Pokhrel, Mr. Bishwadeep Choudhary and Mr. Devendra Upreti of Division Forest Office Jhapa for their cooperation and support to obtain data required for my thesis.

I highly appreciate the co-operation of local people extended during the field survey. I sincerely sympathize with those who suffered damage, those who were injured and lost their family members due to HEC.

I would also like to express my gratitude from the core of my heart to my parents for all their blessings, love and support and for being my strength and inspiration. I also express my sincere appreciation and thanks to my dear wife Ms. Sujata Pathak for all her support and co-operation during my research work.

Finally, I would like to thank all my friends, relatives and other people who are directly or indirectly related to my dissertation work.

- Puskal Khanal
jhapalipk5@gmail.com

CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHS

LIST OF ABBREVIATIONS

Abbreviated Form	Detail of Abbreviations
AC	Alternating Current
A.D.	Anno Domini
APF	Armed Police Force
B.S.	Bikram Sambat
CBS	Central Bureau of Statistics
CD	Compact Disc
CDZ	Central Department of Zoology
CNP	Chitwan National Park
DC	Direct Current
DDC	District Development Committee
DFO	Division Forest Office
DHM	Department of Hydrology and Metrology
DNPWC	Department of National Parks and Wildlife Conservation
Etc.	Et cetera
FAO	Food and Agriculture Organization
Fig.	Figure
GoN	Government of Nepal
Ha	Hectare
HEC	Human-Elephant Conflict
HECMECF	Human-Elephant Conflict Management and Environment Conservation Forum
HH	Household
HWC	Human-Wildlife Conflict
IUCN	International Union for Conservation of Nature
Kg	Kilogram
Km	Kilometer
m	meter
MoFSC	Ministry of Forest and Soil Conservation
NTNC	National Trust for Nature Conservation
PAs	Protected Areas
PWR	Parsa Wildlife Reserve
Rs.	Rupees
TU	Tribhuvan University
USD	United States Dollar
VDC	Village Development Committee
Viz.	Videlicet
WWF	Worldwide Fund for Nature

LIST OF APPENDICES

ABSTRACT

The eastern lowland of Jhapa district has higher number of incidents of HEC due to the seasonal migration of elephants from India and the presence of local solitary elephants. So, the research was conducted with the aim to explore the present status of elephant-human conflict and its mitigation measures being applied recently in Mechinagar Municipality, Jhapa. Mechinagar Municipality ward number one and four were selected as the study area as they had frequent incidents of HEC. Questionnaire surveys, group discussions and interviews were conducted and data was collected during November-December 2018. Ten percent of households were selected from the research area by simple random technique for questionnaire survey. People who were residing in the research area since five to ten years were selected for the interview. Twelve villagers who were directly and indirectly involved in the management of HEC in research area were selected for focus group discussion. The areas susceptible to HEC were visited with the help of field guide. Data analysis and data representation was done by using appropriate statistical tools of Microsoft excel 2013.

The areas near the bank of Mechi River ward number one and four located near the Mechi River had more impacts of HEC. Crop damage by elephant was higher in compared to physical damage, livestock damage and human casualties. Months of June, July, November and December had high intensity of crop damage and human casualties. Lack of habitat and corridor in the border area, lack of sufficient vegetation in forest and migratory behaviour of elephants were the major causes of HEC. The survey of 180 households showed that, there was a total economic loss of Rs. 3,526,525 annually due to HEC. In average, each household were bearing the annual loss of Rs. 23,592.29 due to crop damage by elephant. Maize damage accounted the highest among the crops. In spite of several mitigation measures being adopted, the incidents of HEC was still prevailing in the Mechinagar area. However, solar fencing along the bank of Mechi river was found to be the most effective measure to reduce the HEC in the research area.

1. INTRODUCTION

1.1 Background

Asian elephant *Elephas maximus* Linnaeus, 1758 is the only living species of the genus *Elephas* and is distributed in Southeast Asia from India and Nepal in the west to Borneo in the east (Shoshani 2005). Currently, Asian elephants are distributed in only 5.4% of their historical range of Asian countries including southern Nepal (Choudhary et al. 2008). The occurrence of these elephants has been recorded within Indian sub-continent (India, Nepal, Bhutan and Bangladesh), continental south-east Asia (China, Thailand, Kampuchea, Laos, Vietnam and Malaysia) and island Asia (Andaman island of India, Sri Lanka, Sumatra of Indonesia and Borneo) (Sukumar 1989). The estimated number of Asian elephants in the world is between 41,410–52,345 (Sukumar 2003). The number of Asian elephants in Nepal is estimated to be 109-142 (DNPWC 2008).

The Asian elephant is the largest living land animal in Asia (Shoshani and Eisenberg 1982). However, it is smaller than African bush elephant (*Loxodonta africana*) but larger than African forest elephant (*Loxodonta cyclotis*). It has the characters like dark grey or brown coloration with pink patches on forehead, ears and base of trunk, small ears with dorsal borders folded laterally, presence of single lip, four nails on each hind foot and five nails on each fore foot. Its height is about 2.75 m (male) and 2.4 m (female) (Kurt and Kumarasinghe 1998).

Elephants range over large areas and home ranges in excess of 600 km² have been recorded for females in south India (Baskaran et al. 1995). In north India, female home ranges of 184–326 km² and male home ranges of 188–407 km² have been recorded (Williams 2002). Smaller home range sizes, 30–160 km² for females and 53–345 km² for males, have been recorded in Sri Lanka (Fernando et al. 2005). Asian elephants inhabit grasslands, tropical evergreen forests, semi-evergreen forests, moist deciduous forests, dry deciduous forests and dry thorn forests, in addition to cultivated and secondary forests and scrublands. Over this range of habitat types elephants occur from sea level to over 3,000 m (9,800 feet) (Haynes 1993). The life span of Asian elephant is 60 to 70 years, and males reach sexual maturity at between 10–15 years of age; females usually first give birth in 15 or 16 years (Shoshani and Eisenberg 1982).

The Asian elephant is one of the last few mega-herbivores still extant on earth and need to consume large quantities of food per day (Owen-Smith 1988). They are generalists and browse and graze on a variety of plants. The proportions of the different plant types in their diet vary depending upon the habitat and season. During dry season in southern India, Sukumar (1992) observed that 70% of the elephant's diet was browse, while in wet season, grasses make up about 55%. However, in an adjoining area, Baskaran (2002) observed that browse formed only 15% of the diet in dry deciduous forest and 47% of the diet in the thorn forest in the dry season, while the annual diet was dominated by grass

(84%). In Sri Lanka, elephants may feed on more than 60 species of plants belonging to 30 families (McKay 1973). In southern India, Baskaran (2002) recorded that elephants fed on 82 species of plants (59 woody plant species and 23 grass species). Elephants may spend up to 14–19 hours a day feeding, during which they may consume up to 150 kg of wet weight (Vancuylenberg 1977). An adult elephant can consume between 250 to 350 kg of solid food per day (Sukumar 1992).

Given their requirements for large areas, elephants are regarded as an "umbrella species" because their conservation will also protect a large number of other species occupying the same area (Fernando et al. *200*5). They are also a premier "flagship species" and are sometimes regarded as a "keystone species" because of their important ecological role and impact on the environment.

Since 1986, the Asian elephant has been listed as Endangered on the IUCN Red List as its population has declined by at least 50 percent over the last three generations, estimated to be 60–75 years. The Asian elephant is primarily threatened by loss of habitat, habitat degradation, fragmentation and poaching (Choudhary et al. 2008).

1.2 Human-Elephant Conflict (HEC)

The case of conflict between humans and Asian elephants is one of the serious issues in South Asia and has resulted in challenges towards achieving effective conservation outcomes (Sitati et al. 2003). The Asian elephants of the northern districts in the Indian state of West Bengal is an issue of discontent between India and Nepal (Mallick 2013). The elephant habitat in the state extending from the Sankosh river in the east, to the Mechi river in the west, houses a great assemblage of biological resources in the protected and reserve forests lying very close to the Himalayan foothills (Mitra 2013).

Nepal is not an exception to HEC, where cases of elephant attacks have been reported in the recent years (Neupane et al. 2014). Elephant- human conflict has become the foremost, widely debatable issue in biodiversity conservation in Nepal (GoN 2009). Among other areas of Nepal, the eastern lowland of Jhapa district has higher number of incidents of HEC (Pradhan et al. 2011, Ram 2014). Habitat suitability modeling showed that approximately 20% of the total area in Bardia National Park was highly suitable for elephants (Neupane 2017). These habitats alone may not be sufficient to maintain the existing elephant population in Nepal, which may have exacerbated HEC. Despite the rise in HEC cases in the past few years, effective strategies and guidelines to address the issue are lacking in Nepal (Neupane et al. 2018).

An average household in Jhapa district lost USD 430 (NRs. 30,000) to elephants. In a period of five years (2003-2007) 20 people have died due to elephant attacks and in retaliation 12 elephants were killed in 2006 (DNPWC 2008).

1.2.1 Causes of HEC

The human-wildlife conflict is particularly due to the conversion of forest into agricultural field, shifting cultivation, overgrazing, forest cutting and encroachment in the home range which reduce the availability of natural food to the wild animals (Bajracharya 2009). Biophysical processes and livelihood practices intersect with species population dynamics to generate the conditions of HEC (Goswami et al. 2014). Elephant herd sizes, densities, growth rates and regular movements directly impact conflict locations, timing and intensity (Chen et al. 2016). Conflict between wild elephants and the people occur to a varying extent throughout the elephant range (Seidenstiker 1984, Sukumar 1989).

Elephant population sub-units (clans and solitary bulls) have different strategies for habitat utilization with well-defined home ranges; this includes the use of seasonal ranges within home ranges, and regular routes or migration paths within these seasonal ranges (Desai and Baskaran 1996). Elephants elicit the greatest fear for the rural communities because they have the potential to damage large area of crops, destroy property and cause human injury and death (Parker et al. 2007). Studies in South India by Balasubramanian et al. (1995) show that only some female family units and some adult males raid crops; but not all elephants are crop raiders. However, in cases where elephant populations are severely compressed into small habitat fragments, the resulting high densities and/or the significant levels of habitat fragmentation affect all elephants in that area, and then all elephants may be likely to raid crops.

Artificially maintained water sources attract elephants during drought (Sukumar 1990). Similarly, traditional migration routes can be severed by human intervention which leads to aggressive behaviour in elephants and thus increase conflict (Kangwana 1995).

1.2.2 Effects of HEC

1.2.2.1 Crop depredation

Elephants are one of the least tolerated crop raiding wildlife species as the intensity of damage per conflict incident is much higher than with any other species (Naughton-Treves 1998). An elephant herd may destroy as much vegetation as it consumes (Sukumar 1992). It is recognized that although superficially conservation conflicts involve adverse human–wildlife relations, at a deeper level they usually reflect adverse human–human relation, where the views of conservationist conflict with those of others with apparently incompatible goals. In both cases, one party is perceived to assert its interests at the expense of another's (Draheim et al. 2015, Redpath et al. 2015).

Elephants as generalist pests destroy different parts of the plant and parts of crops, including herbs, trees, nuts, fruits, roots, barks, branches and seeds. They are also responsible for pre-harvest and post-harvest damage (Lamarque et al. 2009). Cultivated crops are richer in protein and carbohydrates as well as some mineral nutrients than most

of the wild. Unlike forest plant species, many of which grow in isolated stands or scattered throughout the forest, agriculture crops occur in relatively large, concentrated stands (Osborn 2004). The mostly raided crops by elephants include Paddy, Maize, Millet, Sorghum, Green Gram, Soya Bean, Mustard, Beans, Banana, Coconut and variety of local vegetables (Ramakrishnan et al. 1997).

Depredation of crops by elephants occurs to varying extents throughout their present range in Asia and Africa, wherever cultivation abuts elephant's habitat (Sukumar 1990). Raiding of agricultural fields by elephants can be explained in terms of proximate factors such as contact with cultivation, especially in fragmented habitats, in the course of their movements for foraging or drinking. However, in ultimate terms crop raiding can be thought of as an extension of their natural optimal foraging strategy (Sukumar 1992). Local people believe elephants as the most destructive agricultural pest because of lengthy interactions and disturbances (Mambeleo et al. 2017). In areas where there is intense culling or hunting, elephants form larger group which can give rise to greater damage to vegetation and crops (Southwood 1997).

1.2.2.2 Property damage

Properties damaged by wild elephants includes houses, cattle sheds and fences. According to Neupane et al. (2018), the fences constructed from bamboo or wood are severely damaged. Moreover, in most of the cases, partial damages to houses are made from the attacks. Cattle sheds and/or fences are both completely and partially damaged by the attacks. Beside these, damages on water pipes and furniture can also be seen.

1.2.2.3 Human Casualties

Annually there is death of 30-50 people due to elephant attack in southern India (Sukumar 1989). In Northern regions of West Bengal human deaths caused by elephant ranges from 28-59 annually (Dey 1991). Datye and Bhagwat (1995) documented a total of 208 human deaths between 1980-1991 A.D. from south Bihar (134) and south West Bengal (74) through pocketed elephants on a fragmented landscape. Balasundaram and Shivaraj (2018) recorded 96 human deaths caused by elephants within 1994-2014 in Tamil Nadu, India. Their study revealed that most of the deaths were occurred outside the forest areas (67%) and considerable human deaths were recorded inside the forest areas (33%).

Every year about 40 percent of the total human-wildlife conflict and 70 percent of wildlife-related human casualties in Nepal have taken place due to elephant attacks (Neupane et al. 2017). Asian wild elephants killed about 100 people and more than 30 wild elephants have been killed by human in six districts of eastern Nepal within 1992-2007 (Yadav 2007). Between 2008-2012, 21 people lost their life and four people were seriously injured in elephant attacks in CNP and PWR and their buffer zones (Pant 2013). Out of 25 victims 19 were male and six were female. Ages of victims ranged from 8 years to 71 years. Of 25 attacked by wild elephants, 11 were trampled in their own home, 10 in

the forest either in the core area of the park or buffer zone, two in the crop fields, and two on the trails on their way home.

1.2.3 Management of HEC

The main strategies for mitigation of HEC include establishment of PAs and corridors, development of infrastructure for guarding and protecting crops (training of villagers, erecting watch towers and electric fencing), deterrent measures (sirens, search lights and shotguns) and planting alternate crops such as tea (Yadav 2004).

Corridors that account for the ecological needs and ethological characteristics of both humans and elephants help to prevent human-elephant conflict by providing elephants additional routes for seasonal migration and assisting ranging behaviour for resources and water (Adams et al. 2017). Physical exclusion methods such as electric fences and trenches are commonly used to deter elephants from farmland and human settlement (Perera 2009). Farmers may light bonfires and use flaming torches or flashlights to guard ripening crops and deter raiding elephants (Shafer 1999). Another agriculture-based deterrent involves the spatial strategy of interspersing commonly raided crops with the crops that are less attractive or palatable to elephants (Gross et al. 2016). Domestication practices in Asia have long served to remove or reduce human-elephant conflict pressures. Although Asian elephant can breed in captivity, it is preferred to capture and train wild females (Clutton-Brock 2012). The culling of crop raiding elephants or those that kill humans has been regularly practiced in Africa to manage elephant populations and HEC (Sukumar 1991). Another method to reduce HEC is drugging, immobilization and transportation of problematic elephants from human settlements or farms to PAs for release (Saaban et al. 2011).

Most of the measures for HEC mitigation in Nepal are reactive and implemented to control the crisis situation that develops after a major conflict incident (Pradhan et al. 2011). Technological advancements have made it possible for the use of electric fencing to mitigate HWC since the 1960s (Kassilly et al. 2008); thus, in 2002, a large investment was made by the Government of Nepal to establish electric fencing in CNP to mitigate human-wildlife conflicts (Sapkota et al. 2014). The measures employed by local communities around CNP range from crop switching to electric fencing (Bailey 2011). The mitigation measures adopted by the local people in different regions of eastern Nepal have been inefficient due to behaviour flexibilities of Elephants against the measures (Pradhan et al. 2011).

1.3 Objectives of the study:

1.3.1. General objective:

To explore the status of human-elephant conflict and its mitigation measures in Mechinagar Municipality, Jhapa, Nepal.

1.3.2. Specific Objectives:

1. To explore the status and impacts of HEC in Mechinagar Municipality area.
2. To assess the mitigation measures used by local people for the management of HEC and their effectiveness.

1.4 Significance of study:

HEC is increasing in the eastern Nepal because the number of elephants visiting Jhapa has been increasing at recent years (Ram 2014). Various techniques have been applied to reduce HEC in this area but still elephant threats are prevailing. Despite the several researches, the best way for mitigating HEC could not be identified. Along the application of new technique there is a need of frequent researches and surveys to monitor and evaluate its effectiveness. There is a need for detailed assessment of the HEC in Nepal including the nature and extent of damage caused by elephants as a basis for developing measures towards its mitigation (Bhatta 2006). There is a necessity to find out effective and permanent measure for managing HEC in Mechinagar area. This research will be helpful to generate latest data regarding the status of HEC in the research site. Data obtained from this study will be helpful to compare the status of HEC on local community in past and present. Moreover, it will help to assess the effectiveness of the mitigation measures which are currently being applied. In contrast, this research will be helpful to explore the trend of HEC in the research area and will suggest the most appropriate mitigation measure for managing HEC.

2. LITERATURE REVIEW

2.1 Human-Wildlife Conflict (HWC)

Human-Wildlife Conflict (HWC) or negative interaction between the people and wildlife has become the fundamental aspect of wildlife management as it represents the most widespread and complex challenge currently faced by conservationists all over the world (WWF 2007). In Asia, large predators such as Royal Bengal Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Lion (*Panthera leo persica*) and Snow Leopard (*Uncia uncia*) and Elephant (*Elephas maximus*) are the major initiators of conflicts (Lamarque et al. 2009). There is increasing likelihood of conflict as populations of wildlife, humans and livestock are increasing and wildlife habitats are shrinking (Ripple et al. 2017). HWC usually starts when wild animals consume resources meant for human consumption: crop by herbivore and livestock by carnivores (Kissui 2008). Intensity of HWC is evidently increasing (Perera 2009) in the context of growing habitat loss and fragmentation over the last century. HWC occurs when growing human populations overlap with established wildlife territory, creating reduction of resources or life to some people and/or wild animals. The conflict takes many forms ranging from loss of life or injury to humans, and animals both wild and domesticated, to competition for scarce resources to loss and degradation of habitat (Madden 2004). Conflict generally arises from economic losses to agriculture, including loss of cattle through predation and destruction of crops (Ayyapan et al. 2016). A wide range of species are responsible for conflict, with the principal culprits being primates, rodents, ungulates, Antelope, Hippo, Buffalo, Zebra, Elephant, Lion, Leopard, Tiger and Hyaena (Naughton-Treves 1998, Hill 2000).

Park-People conflicts are prevalent in all the protected areas of Nepal, although the extent of conflicts varies due to separate legislation (Heinin 1993). In Nepal, people are attacked by large mammal species such as Tigers, Common Leopards, Rhinoceros, Elephants and Bears, but there is little discussion about the patterns of fatalities and injuries caused by wildlife or their underlying temporal dynamics (Woodroffe 2000). Attacks by wildlife are life-threatening and thus are not acceptable to society, so people often retaliate by killing the animals involved in the conflict (Treves and Bruskotter 2014). Large mammals are generally involved in the conflicts, and most of these species are threatened with extinction, so the retaliatory killings of threatened mammals further increase their extinction risk (Madhusudan 2003, Paudel and Heinen 2015). The penalties for illegally killing endangered animals may further escalate hostile attitudes towards conservation efforts (Sillero-Zubiri et al. 2007).

In Nepal, HWC is a major problem in most protected areas and often results from the inability of local communities to access the local natural resources they were using from time immemorial before being legally barred from their use after the post–World War II legalization of protected areas (Lamsal 2012, Timalsina and Ranjitkar 2014). According to Lamsal (2012), One-horned rhinoceros (*Rhinoceros unicornis*), Elephant (*Elephas*

maximus), Wildboar (*Sus scrofa*) and Chital (*Axis axis*) are troublesome in Chitwan National Park. Similarly, Bhandari (2011) reported that, Elephant, Chital, Wild boar and Blue bull are troublesome to the villagers of Shuklaphanta Wildlife Reserve. Tiger and Leopard were identified as livestock depredators in Chitwan National Park (CNP) (Mishra and Margaret 1991, Sharma 1991) and Bardia National Park (Jnawali 2002). Jackal, Indian fox, Common mongoose and Jungle cat have been reported as livestock lifter around the CNP (Uperety 1995). Similarly, Leopard, Jackal, Wild dog and Grey wolf were identified as livestock depredators in Makalu-Barun Conservation Area (Jackson 1990).

HWC is more complicated when it is a transboundary issue that involves one or more countries and their protected areas (Busch 2008). The mobility of wildlife within a transboundary setting has largely been facilitated with the creation of natural corridors which mitigates conflict, but also creates conservation challenges (Bennett and Mulongoy 2006). Despite various mitigation measures, HWC has not subsided, but increased and expanded from rural communities to urban and suburban regions (Baruch-Mordo et al. 2013).

2.2 Human-Elephant Conflict (HEC)

Elephants capture the affection of people worldwide, but in some cases bring animosity and fear among those sharing their land with them (Okello et al. 2014). Expansion of human settlements and agricultural fields across Asia and Africa has resulted in widespread loss of elephant habitat, degraded forage, reduced landscape connectivity, and a significant decline in elephant populations relative to their historical size and overall range (Thouless et al. 2016, Calabrese et al. 2017). According to Williams et al. (2001), growing human pressure on areas supporting elephants has resulted in fragmentation and loss of their habitat, and elephants frequently find themselves in competition with people for space and resources. Bajracharya (2009) reported that conflict is caused due to shifting cultivation, deforestation, encroachment in the home range reducing the food resources of wild animals. Artificial water resources can attract elephants during drought (Sukumar 1990). Sometimes, traditional migratory routes of elephants are interrupted by human which may lead to aggressive behaviour in elephants thus causing conflict (Kangwana 1995). In India, elephants are known to kill 150 to 200 people every year and damage crops worth up to USD one million (Bist 2002). Ultimate causes of human-elephant conflict include growing human populations, large-scale development projects (Santiapillai and Jackson 1990), and to a lesser extent, poor top-down governance in elephant-bearing countries (Jepson and Canney 2003).

The distance at which villages were located from the park also influenced HEC intensity, with decreasing conflict incidents as the distance from the forest boundary increases (Lahkar et al. 2007). Yadav and Chalise (2012) reported that, the growing human population collect the edible foodstuffs like wild bananas, wild bamboos, climbers and wild cassava from the habitat of elephants which further increases the risk of HEC.

Elephant is the most pervasive species causing more than 40% of the conflicts and responsible for 70% of human casualties in Nepal (Bajimaya 2012). The resultant effects are interaction of wild elephants with human in the form of human casualties and injuries, crop losses, property damages, social fear and retaliatory killings of elephants (Acharya et al. 2016). Parker et al. (2007) stated that, elephants elicit the greatest fear for the rural communities because they have the potential to damage large area of crops, destroy property and cause human injury and death.

Elephants are one of the least tolerated crop raiding wildlife species as the intensity of damage per conflict incident is much higher than with any other species (Naughton-Treves 1998). Wild elephants generally feed on Debre lahara (*Spatholobus parviflorus*), Sugarcane (*Saccharum* spp.), Junelo (*Sorghum* spp.), Sindure (*Mallotus philippensis*), Dabdabe (*Garuga pinnata*), Bamboo (*Bambusa* spp.), Millet (*Panicum* spp.), Kutmiro (*Listea monopetala*), Lemon grass (*Cymbopogan* spp.), Thaakal (*Phoenix humilis*), Succulent plants, tree barks, shrubs, climbers and creepers (Koirala et al. 2016). An elephant herd may destroy as much vegetation as it consumes. An adult elephant can consume between 250 to 350 kg of solid food per day (Sukumar 1992). Males are twice as likely to raid at their reproductive peak and younger males are more likely to raid if they were following older role models (Archie and Chiyo 2012). The tendency to raid crops in the reproductive phase is generally higher when compared to the vegetative phase (Easa and Sankar 2001). Some males raid crops, damage houses for stored grain and may become very aggressive if confronted in the process. These types of individual are problem-elephant and responsible for the majority of HEC incidents (Sukumar 2006).

Crop damage is the major negative impact of HEC in Sri-Lanka (Campos-Arceiz et al. 2009). Crop raiding is more frequent during the months of June-July and October-November in India (Lakhar et al. 2007). The crop damage by wild elephant in Nepal also follows a similar seasonal pattern with two peak seasons of crop raiding are June-July, during maize or wheat maturing period and September-November, during Paddy maturing time (Pradhan et al. 2011). The study conducted by Yadav et al. (2012) documented that, Paddy was the most preferable crop to wild elephant in CNP and PWR. One bull elephant was responsible for most of the human casualties in central Nepal. The same elephant was known to have killed at least nine people in and around CNP over the last four years (CNP 2012). Bahundangi, Jhapa is the main entry point of the migrating elephant herds (Baidya 2010). According to Nepal (2011), within 156 sample households, the total paddy loss was 93,341 kg (43.87%), maize 110,326 kg (51.80%) and millet 9,289 kg (4.36%) in Bahundangi VDC, Jhapa. Bahundangi has lost 24 inhabitants to the unruly giants in the past 15 years. According to the Kuldip Giri, the village secretary 19 people have been injured, 13 houses demolished and nearly 10 million worth's of crop have been destroyed (Ram 2014). The household survey assessed the major crops, paddy, maize, millets, mustard, ginger, banana, bamboo, broom grass and wheat, kitchen gardens and beetle nuts in Bahundangi VDC (Yadav 2001). An estimated amount of about NRs. 2,000,000 (US$ 25,165) was found as the economic loss due to crop raiding by elephants

in Parsa District for the year 2009; whereas it was slightly less to a level of about NRs. 1,600,000 (US$ 20,289) in the year 2010 (Yadav et al. 2012).

The number of deaths of both humans and elephants is much lower in Nepal than that of both India and Sri Lanka (Perera 2009), yet over a much smaller area. Despite these lower total numbers of deaths for Nepal elephants, the levels we report are still alarming.

According to Smith and Kasiki (2014) these human-wildlife incidents involve crop raiding animals that consume or destroy food crops and injure or kill those people trying to protect their farms. In Kerala, losses due to crop damage and human casualty are still low when compared to the national average (Sinu and Nagarajan 2015). Modification of farming practices such as planting crops less palatable or appealing to raiders, or planting heavily raided crops beyond a buffer of unappealing crops or unsuitable habitat, may present a more effective and sustainable solution to crop raiding than the construction and maintenance of fences or reliance on guards (Hockings and Humle 2009).

Indigenous Knowledge has been effective in human-wildlife conflict management since local people have managed the land on which they live and the natural resources which surround them (Roe et al. 2009). Solid physical barriers to prevent HEC generally consist of metal or rail fences or walls (stone, cement, brick, etc.). These types of barriers can be very expensive if they are built properly to stop elephants; they can be used in special situations or to overcome weak spots in other systems (Nelson et al. 2003, Osborn and Anstey 2007). Yadav (2004) suggested that, the main strategies for mitigation of HEC include establishment of more PAs and corridors, development of infrastructure for guarding and protecting crops (training of villagers, erecting watch towers and electric fencing), deterrent measures (sirens, search lights and shotguns) and planting alternate crops such as tea.

In Northeast India, chasing elephants by producing loud sound, using foggy lights, fire and fire crackers are most common techniques applied by villagers to deter elephants (Choudhary 2004). The use of acrid smell, for example chilli smoke, has been tested in Africa (Osborn and Rasmussen 1995) and Asia (Baishya et al. 2012) and reported as being successful to deter elephants from raiding crops. According to Barua (1995), short-term measures aimed at providing immediate relief to the people from HEC are: driving away elephants physically with the help of wildlife officials, use of trained elephants (*koonkie*) to chase away wild elephants, use of barriers (Elephant - proof trench and watch towers). Long term measures aim at removing the factors responsible for the elephant depredation and at creating ideal living conditions for elephants within the forests, viz, habitat development works, eco-development works, establish elephant corridors, promotes conservation education and public awareness. As conflict shows geographically specific patterns, understanding underlying causes will help in establishing appropriate mitigation methods (Sitati et al. 2005) that are site specific. Patrolling on elephant back is also used as a guarding strategy; the main difference is that this is a daytime activity whereby the patrols attempt to locate wild elephant herds that

may be moving towards crop land (Riddle 2007). Agave has been suggested as being suitable for bio-fencing against elephants (Perera 2009). Shiny objects such as metal foil strips, old CDs, white cloth, etc. (Chelliah et al. 2010) or minor sound making devices such as pairs of glass bottles or metal objects which clink against each other whenever wind moves them, or lamps which rotate based on wind direction are strung or placed along fences (Fernando et al. 2008). These add-ons make fences more visible to elephants and add value to the deterrence effect.

A study conducted by Sapkota et al. (2014) around the CNP found the electric fencing has not only been effective in reducing conflicts relating to crop and property damage, but has also generated socio-economic and ecological benefits to the local people and wildlife respectively. Kioko et al. (2008) have reported that the success of electric fences depends upon the location of fences in relation to landscape factors, regular maintenance and proximity of fences to areas of high elephant concentration.

Translocation of problematic elephant can be one of the ways to reduce HEC (Fernando et al. 2012). However, the long efficacy and long-term feedbacks of elephant translocation have not been extensively tested, initial results suggest that translocated elephants often return to their original territory and tend to propagate conflict around the release area while returning towards their original home range (Pinter-Wollman 2009). Moreover, translocation often undermines conservation goals because of increased elephant mortality during capture and transportation, and sometimes deliberate killing in the release area (Pinter-Wollman 2009, Fernando and Pastorini 2011, Fernando et al. 2012). A vaccine prepared using glycoproteins of the Zona Pellucida (ZP) of pig oocytes, when injected in many species including horses and elephants, results in the production of antibodies that disrupt the normal functions of the ZP, preventing conception (Fayrer-Hosken 2008).

Compensation is a complex, time consuming and not always effective (Ogra 2008). The lack of standardized assessment guidelines and compensation approaches create opportunity for conflict and corruption (Ogra and Badola 2008). It is recognized that although superficially conservation conflicts involve adverse human–wildlife relations, at a deeper level they usually reflect adverse human–human relation, where the views of conservationist conflict with those of others with apparently incompatible goals. In both cases, one party is perceived to assert its interests at the expense of another's (Draheim et al. 2015, Redpath et al. 2015). The perceptions and attitudes of people who inhabit conflict-prone areas are crusial to the management of HEC (Treves and Bruskotter 2014), and offsetting economic losses plays a major role in building positive attitudes towards wildlife and fostering tolerance towards elephants (Brooks et al. 2013, Synman 2014). But, in elephant range countries, compensatory programmes face often severe criticism due to insufficient compensation, logistical challenges, ineffective governance, lack of transparency, reduced local understanding of programme scope and limitations and fraudulent claims (Nyhus et al. 2005, Nath et al. 2009). Mature and older people have negative attitude towards wildlife than young and educated people (Røskaft et al. 2007).

In CNP and PWR, 63% of respondents had negative attitude towards elephant conservation (Pant et al. 2016).

The IUCN proposes that indigenous communities' effective participation in wildlife conservation programmes just like experts could result into more comprehensive and effective conservation and management worldwide (IUCN 2010). Fencing reserves may affect the dynamics of wildlife populations and hinder their natural migratory and dispersal behaviour, especially in the case of highly territorial species such as lions (Lamarque et al. 2009). Wildlife conservation issues are least addressed in areas outside PAs (Macura et al. 2011). This is one of the biggest challenges to the countries like Nepal having significant role in conservation, as 23% of its total geographical area is under protected area system (DNPWC 2013), and provide one of the important habitats for Asian elephant. In eastern Nepal particularly, where levels of HEC are at their greatest, people's attitudes are becoming negative towards elephant conservation despite long cultural ties to the elephants (Shrestha et al. 2007).

3. MATERIALS AND METHODS

3.1 Study Area

Mechinagar Municipality of Jhapa district was selected as the study area. Jhapa district is located in eastern part of Province number one, Nepal. Mechinagar municipality lies west to the Mechi River within the geographical coordinates 26°40' to 26°66' North latitude and 88°07' to 88°12' East longitude. The city has Arjundhara Municipality and Birtamod in the Western Part, Buddha Shanti Gaupalika and Ilam District in the North, Bhadrapur Municipality in the South and West Bengal, India in the East. The altitude of Mechinagar municipality ranges from 100-381 m. Mechinagar municipality covers an area of 192 km^2 and is divided into 15 wards. The population of Mechinagar municipality is 111,737 with total households of 25,531.

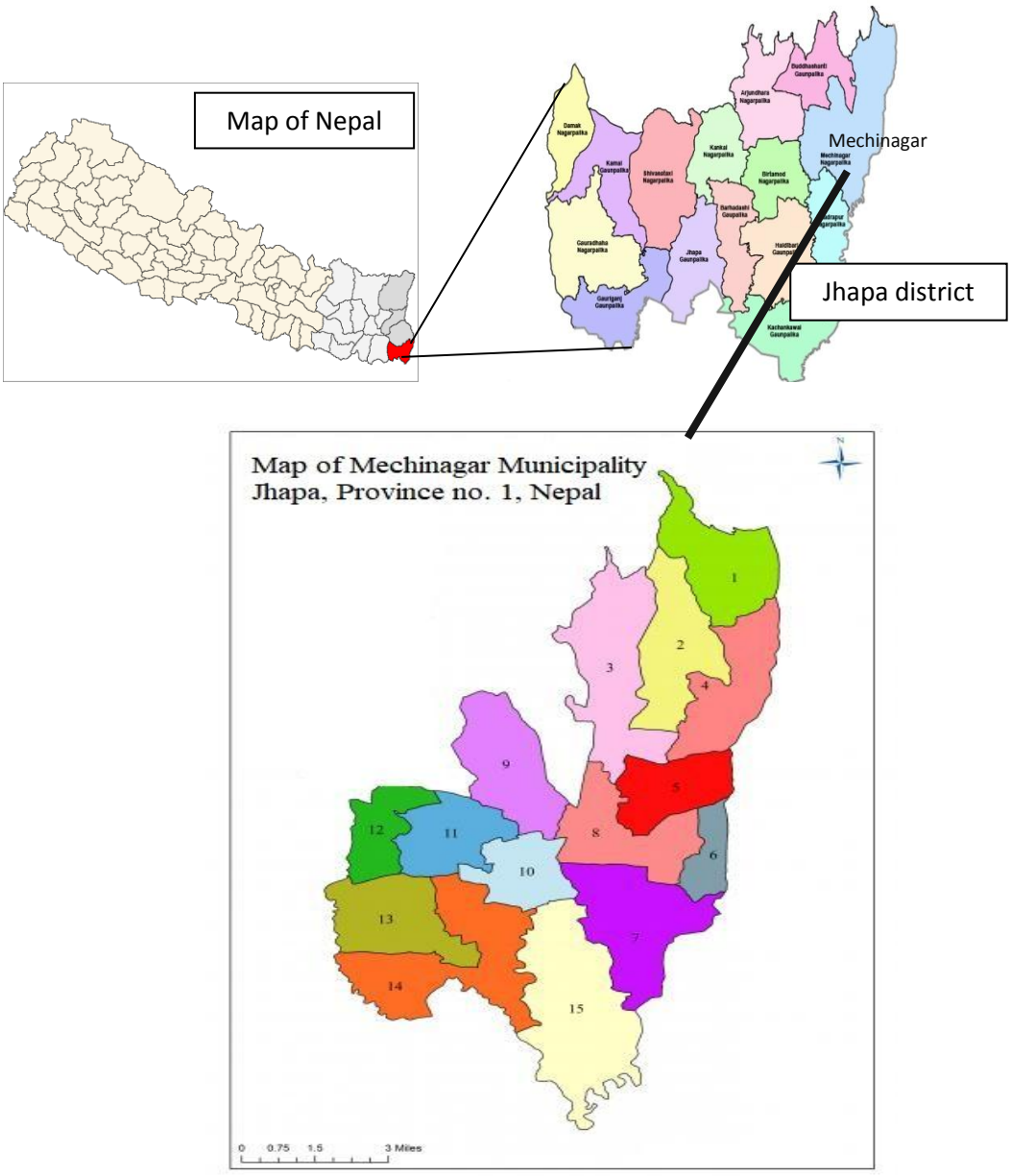

Fig 1. Location Map of the Study Area

Elephants are frequently recorded in Mechinagar Municipality ward numbers one and four (former Bahundangi VDC ward numbers one, two, eight and nine) as these areas lie along the bank of Mechi River (Yadav 2002). So, these wards were chosen for study of conflict between human and elephant in Mechinagar Municipality.

3.1.1 Geology and Soil

Most part of the study area lies in the Terai (Lowland) and a small part of it lies in the Siwalik foothills. The physical relief is mostly leveled with occasional ridges and River valleys. The geological formation of the study area is Siwaliks in the north and alluvial plain in the south. Siwaliks are composed of Tertiary Sandstones, Siltstone, Shale and Conglomerate (Joshi 1986).

3.1.2 Climate

The climate here is subtropical with March, April and May as the warmest period and January as the coolest period. Average rainfall in Jhapa district is 2700 mm per annum (Fig 2). The average annual maximum temperature is around 34°C while the average minimum temperature is nearly 10°C (Fig 3).

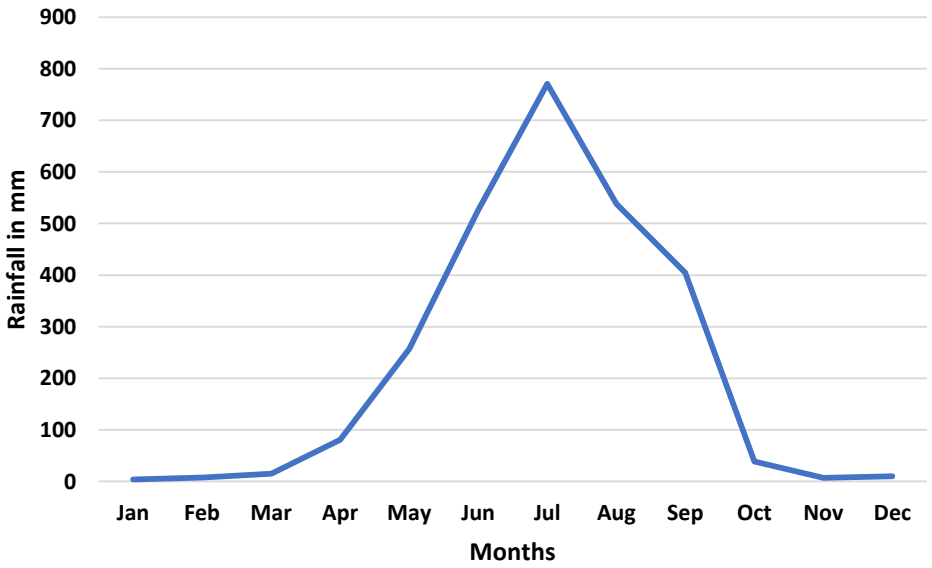

Fig 2. Mean monthly average rainfall of Jhapa district (2010-2018) (DHM 2018)

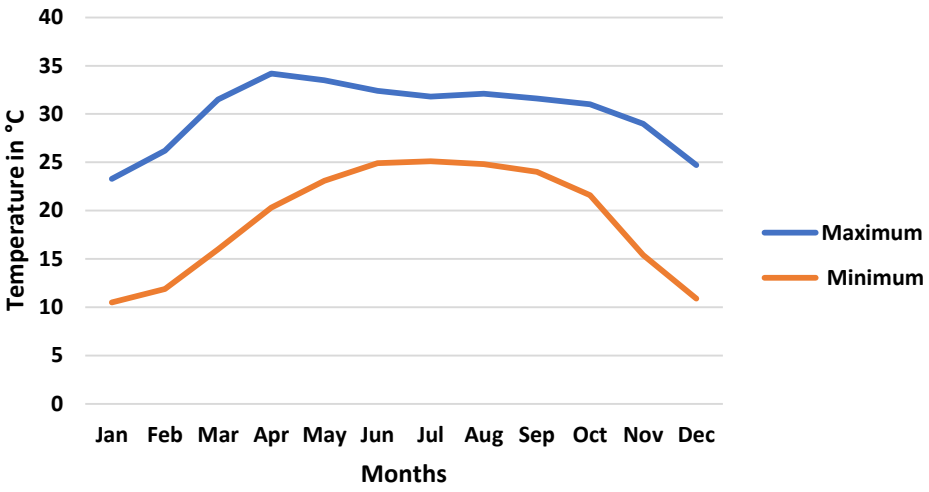

Fig 3. Mean monthly maximum and minimum average temperature of Jhapa (2010-2018) (DHM 2018)

3.1.3 Land use pattern

About 86% of land in Jhapa district is covered by agricultural field and grassland (Table 1). Nearly, 8% of total land is covered by forest and about 4% land is barren.

Table 1. Land use pattern of Jhapa district

Land use	**Area (ha)**
Forest	13,239
Shrubs	1,863
Agriculture and Grassland	141,795
Water bodies	778
Barren land	6,517
Total	164,192

(CBS 2012)

3.1.4 Flora

The main trees are Sal (*Shorea robusta*) and Sisso (*Dalbergia sisso*). Beside these, trees such as Kadam (*Adina cardifolia*), Harro (*Terminalia chebula*), Barro (*Terminalia blerica*), Bot dhaiyanro (*Lagerstromia parviflora*) and Pine (*Pinus roxburghii*) are abundant. The main grasses include Napier (*Pennisetum purpureum*), Dubo (*Cynodon*), Kans (*Saccharum spontaneum*), Amliso (*Thysonolena maxima*) etc. (DFO Jhapa 2018).

3.1.5 Fauna

The major fauna inhabiting the study area include Rhesus monkey (*Macaca mulata*), Asiatic jackal (*Canis aureus*), Indian fox (*Vulpes bengalensis*), Squirrel (*Ratufa* spp.).

Indian flying fox (*Pteropus giganteus*) among mammals, Woodpecker (*Dandrocopus spp*.), Great tit (*Alauda arvemsis*), Parakeet (*Psittacula* spp.), Crane (*Grus* spp.), Cattle egret (*Babulcus ibis*) among birds, Python (*Python morulas*), Cobra (*Naja naja*), Garden lizard (*Calotes versicolar*), Monitor lizard (*Varanus bengalensis*) among reptiles and Frog (*Rana trigrina*) and Toad (*Bufo melanostictus*) among amphibians (DFO Jhapa 2018).

3.1.6 Economy and Social life

Major inhabitants of Mechinagar Municipality are Brahmin, Chhetri, Dhimal, Rajbanshi, Marwari and Bishwakarma. The majority of the people are farmers, mostly cultivating rice, tea, betel nuts, ginger, mushroom etc. Because of its open border most of the people have free access to India where they go for tradning goods, shopping and medication to the adjoining Indian market Panitanki, Naxalbari and Siliguri. Some people are involved in business. Many people here are working in several Government and Private sectors and more than 2% of people are working as an Indian and British Army (DDC Jhapa 2018)

3.2 METHODS

3.2.1 Data Collection

3.2.1.1 Primary data collection

Field visit was done within November-December 2018. The reconnaissance survey of the study areas was carried out in first week of November 2018. During this time conflict prone areas and land use pattern of study area was identified. The survey included field observation and interaction with local people. Primary data was collected by the following ways:

i. Key informant interview: Five representatives from local forest user group, local police, school teachers, active members of Human Elephant Conflict Management and Nature Conservation Forum were selected as key persons. People who were residing in the study area since at least five years were selected for the interview. These key informants were then consulted during the survey. The areas which are susceptible to the elephant invasion and destruction of crops were visited intensively with the help of field guide. Major impacts of HEC and mitigation measures being applied currently were discussed.

ii. Group discussion: Opportunistic and focal group discussion was performed in the study area to be familiar with the potential respondents. For focal group discussion, 12 individuals with the direct or indirect involvement in HEC supervision and maintenance and residing in the study area since at least 10 years were selected. Opportunistic group discussion was conducted among two major groups. One with the age group between 15-

45 years and another group with the age above 45. The status and trend of HEC in the research area and major mitigation techniques which are being applied to control HEC were discussed. Compensation strategy applied for the relief of victims and their family was also discussed. The concerned organizations which are involved in providing fund for compensation were consulted later for the required information.

iii. House hold survey: Out of 1823 households within the research area, 180 households were selected based upon the simple random sampling using random number method, which was nearly 10% of total households in ward number one and four. Ninety households in each from ward number one and four were surveyed. Semi-structured questionnaires (*Annex I*) were filled on the basis of interview. During household survey, individuals with different age groups were interviewed so as to find out different perspectives towards HEC among different age groups. Details about the crops they grow, estimated yield of each crops, amount of crop loss and nature of property damage they faced within this year due to HEC were documented. Seasonal intensity of elephants and their nature of damages were also documented. The status and efficiency of compensation and relief distribution for victims and the perception of local people towards them were noted during interview.

Similarly, the price rate of different crops was obtained from Kakarbhitta market.

3.2.1.2 Secondary data collection

Data obtained from DFO of Jhapa district related to HEC was referred as major secondary source of data. Similarly, secondary data on human-wildlife conflict, electric fencing and other mitigation strategies was obtained from Municipal records, published journals, articles and research reports.

3.2.2 Data Analysis

The information obtained by questionnaire was used in the statistical tool to assess the crop loss. The following formulae were used.

$$\text{Total Crop Loss (kg)} = \text{Expected yield before crop loss} - \text{Actual yield after crop loss}$$

$$\text{Crop Loss per Household (kg)} = \frac{\text{Total crop loss (kg)}}{\text{Total no. of Households Cultivating that crop}}$$

$$\text{Total Economic Loss (Rs)} = \text{Rate of crop per Kg (Rs)} \times \text{Total Amount of Crop Loss (kg)}$$

Bar graphs, line graphs, tables and pie-chart were constructed to represent the data in simplified way and Microsoft Excel 2013 was used for the analysis of data.

4. RESULTS

4.1 Status of HEC in the researh area

Among 180 respondents, 92 respondents reported that, the incidents of HEC are decresing in recent years. However, 23 respondents reported that, incidents and impacts of HEC is increasing per year. Sixty five repondents reported that, HEC in Mechinagar area is consistant since decades (fig 4).

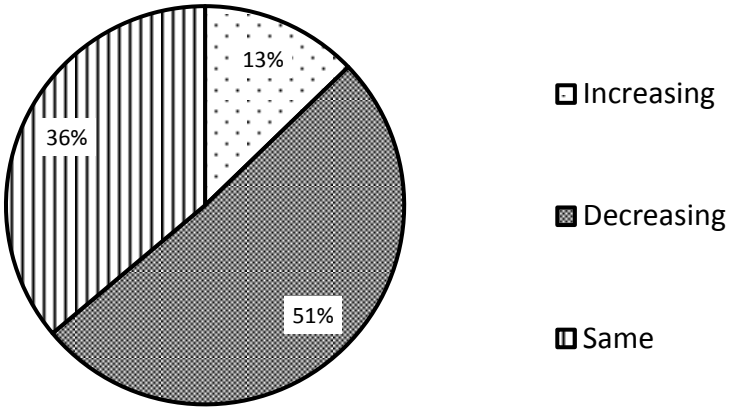

Fig 4. Respondent's perception on status of HEC in the research area

4.2 Major impacts of HEC in the researh area

Major impacts of HEC in the research area were found to be crop loss, property loss human casualty or death, threats and disturbances. Results obtained by questionnaire indicated that, crop damage was the major impact of HEC followed by property damage and disturbances (Fig 5). Other negative impacts included threats and other damages.

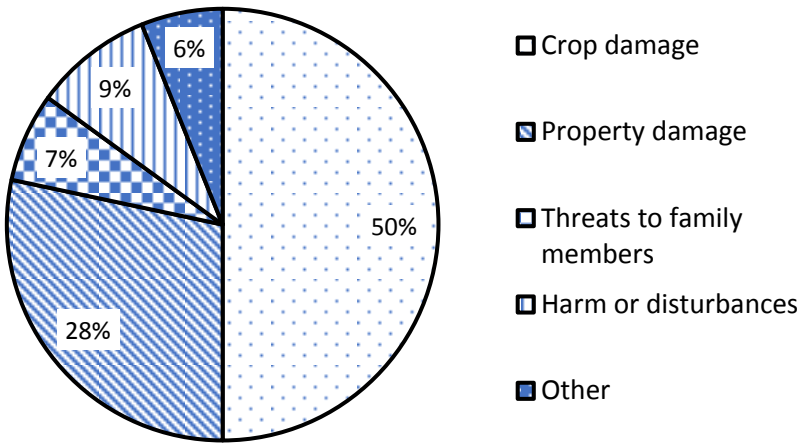

Fig 5. Major negative impacts of HEC in the research area

4.2.1 Crop loss

Major crops grown in the research area are Paddy followed by Maize and Millet. Beside these, farmers grow tea, betel nut, potato, mushroom, ginger and green vegetables. Out of 180 sample households, 146 cultivate paddy, 162 cultivate maize, 98 cultivate millet, 107 cultivate bamboo, 114 cultivate coconut and 132 cultivate beetle nut.

The expected production of major crops paddy, maize and millet along with their actual production were noted as per the details provided by the respondents to find out the amount of crop loss in the research area.

Paddy was the mostly grown crop in the research area. Farmers are facing huge loss of paddy due to elephant. Annually, the total loss of paddy was 43,787 Kg, in sample HH based on questionnaire (Table 2).

Table 2. Total annual loss of Paddy (in kg) in terms of expected production (n=146)

Ward No.	Total Expected Production (in kg)	Total Actual Production (in kg)	Total Loss (in kg)	Loss %
1	287,652	264,438	23,214	8.07
4	253,213	232,640	20,573	8.12
Total	**540,865**	**497,078**	**43,787**	

The expected production of Maize was 277,426 Kg but the farmers were able to harvest only 208,666 Kg of Maize in the research area. Nearly 26% of loss of maize was recorded from ward number one and that of ward number four was about 23% (Table 3).

Table 3. Total annual loss of Maize (in kg) in terms of expected production (n=162)

Ward No.	Total Expected Production (in kg)	Total Actual Production (in kg)	Total Loss (in kg)	%
1	148,088	109,704	38,384	25.92
4	129,338	98,962	30,376	23.49
Total	**277,426**	**208,666**	**68,760**	

Millet was the third highest grown crop in the research area. Annually, farmers are bearing 3,029 Kg loss in Millet (Table 4).

Table 4. Total annual loss of Millet (in kg) in terms of expected production (n=98)

Ward No.	Total Expected Production (in kg)	Total Actual Production (in kg)	Total Loss (in kg)	% of loss
1	6,558	4,808	1,750	26.69
4	7,019	5,740	1,279	18.22
Total	**13,577**	**10,548**	**3,029**	

4.2.1.1 Total economic loss on different crops per household

As per based on the number of sample household that grow respective crops, economic loss of crops per household was calculated for each crop (Table 5).

Table 5. Economic loss of different crops (based upon questionnaire)

S.N.	Different crops	Total crop loss	Market price	Total loss in (Rs)	Economic Loss Rs/HH
1	Paddy	43,787 Kg	25 Rs/Kg	1,094,675	7,497.77
2	Maize	68,760 Kg	31 Rs/Kg	2,131,560	13,157.78
3	Millet	3,029 Kg	60 Rs/Kg	181,740	1,854.49
4	Bamboo	1,028 trees	1 pole = Rs 80	82,240	768.60
5	Coconut	43 trees	50 fruits/tree 1 fruit = Rs 15	32,250	282.89
6	Betel nut	58 trees	1 pole = Rs 70	4,060	30.76
	Total			**3,526,525**	**23,592.29**

Annually local people from the sample households in the research area were bearing the loss of Rs 3,526,525 in crops due to elephant. The major economic loss was found in Maize (Rs 13,157.78 per HH) which was followed by Paddy (Rs 7,497.77 per HH). The minimal loss was detected in Betel Nut (Rs 30.76 per HH). In an average, each HH was bearing the annual loss of Rs 23,592.29.

4.2.1.2 Frequency and intensity of crop raiding by elephant

The frequency of crop damage by elephant in Mechinagar Municipality was found to be higher during the months of June-July and November-December. The low intensity of crop damage was recorded during February, March and April (Table 6).

Table 6. Seasonal intensity of crop damage (%) based on questionnaire (N=180)

Month	High	Medium	Low
January		36.40	
February			31.56
March			25.01
April			28.71
May		34.66	
June	82.33		
July	78.92		
August		39.52	
September			
October			
November	79.98		
December	68.56		

4.2.2 Loss of property, human casualties and death caused by elephant

Within 2011-2018 A.D., 12 people had general injury, 35 people were seriously injured, 35 people were killed (Fig 6) and 1,582 people had their house/shed/crops/stored crops damaged in Jhapa district. Among these, 16 incidents of injuries and eight deaths were recorded in the study area (*Annex II*). More than 90% of incidents of crop damage, destruction of house and property, human casualty or death were recorded from Mechinagar Municipality area.

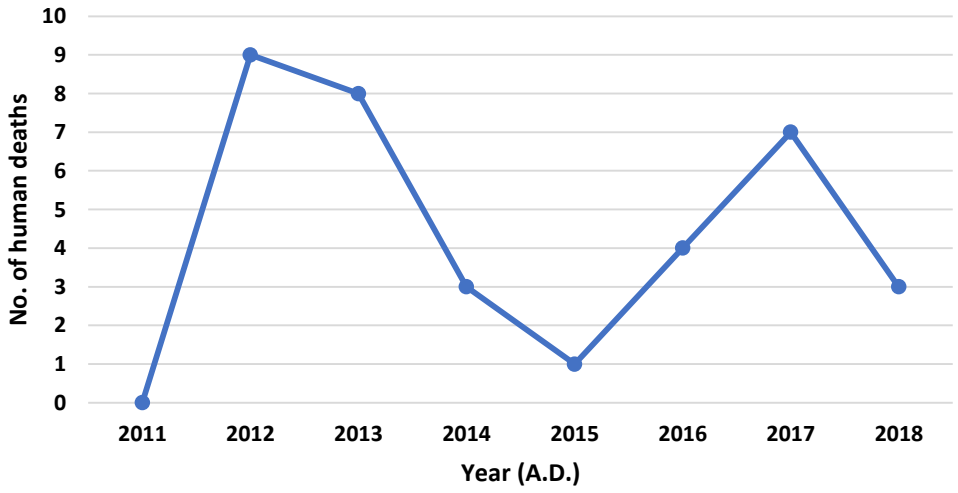

Fig 6. Human deaths caused by elephants in Jhapa district (2011-2018 A.D.)

4.2.2.1 Intensity of human casualties/injury based on months

Based on questionnaire, human casualties/injury by elephant in the research area was found to be higher during November followed by July. Least incidents of injury/death

were recorded during the months of June, October and December. Out of 16 injuries, eight incidents occurred during November, six during July and two during October. Out of eight incidents of deaths, four deaths occurred during November, two during December and single incident during June and July (Fig 7).

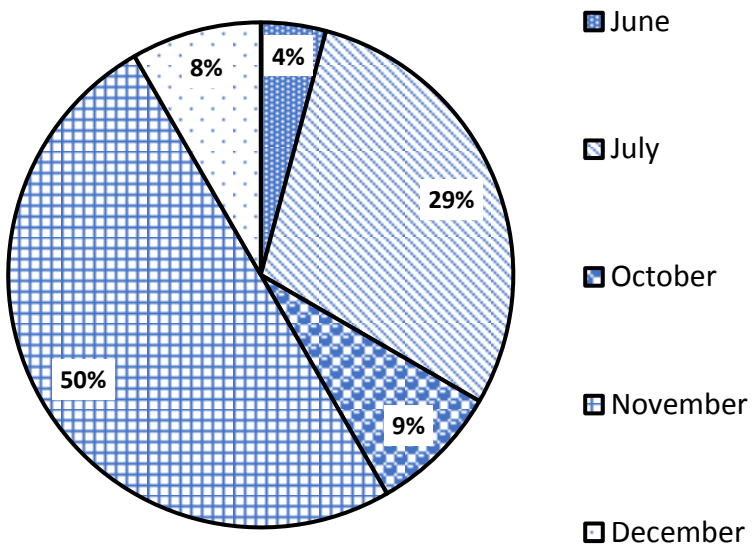

Fig 7. Intensity of injury/casualty due to elephant in monthly basis

4.2.3 Elephant death

Within the time period of 2011 to 2018 A.D., ten elephants were dead in Jhapa district. In average, the loss of elephant ranges between one-two deaths per annum. Among them, eight elephants died within the territory of Mechinagar Municipality. Juveniles are found to be more susceptible to death than adults. Most of the elephant deaths were human induced, caused due to injury. Beside this, electric shock was another cause for elephant death (DFO Jhapa 2018).

4.3 Causes of HEC

Based on the questionnaire survey and group discussion, the main causes of HEC in Mechinagar area were found to be, due to the lack of habitat and corridor in the border area followed by due to the lack of vegetation in forest, due to its old route and due to the migratory nature of elephant (Fig 8). Beside these, few respondents believe that elephant enter into the village for nutritious cultivated crops.

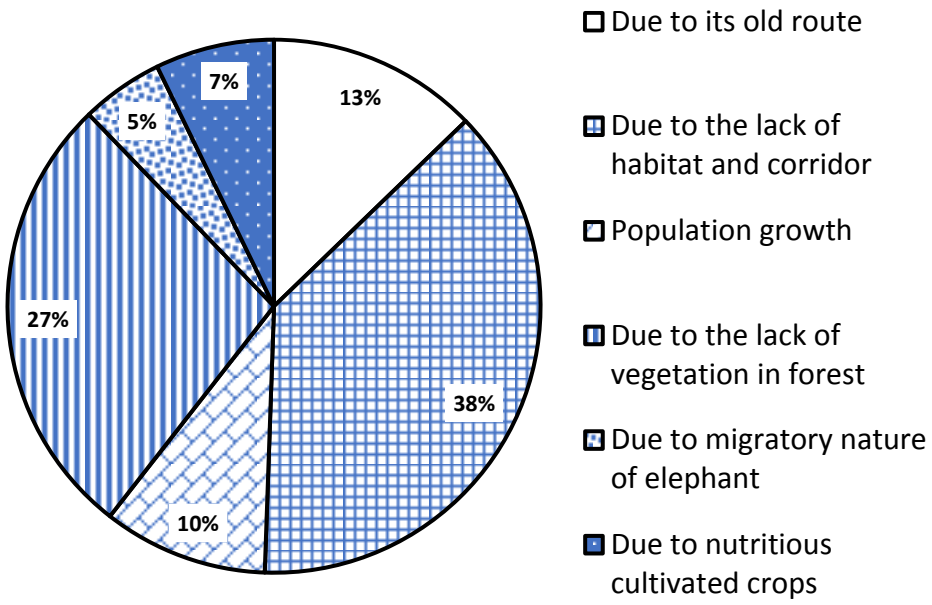

Fig 8. Causes of HEC in the Mechinagar Area

Approximately, seven to eight local/residential elephants are found in Mechinagar Municipality area. These elephants are solitary and roam within the Bahundangi and Bahuban forest. These elephants are large and damage houses, sheds, stored and field crops.

Migratory herd possess nearly hundred individuals including juveniles. The herd is headed towards the village from Indo-Nepal border by crossing Mechi River. They are responsible for huge crop loss, human injuries and deaths. Female elephants with their babies are found to be more aggressive and sometime attack humans.

4.4 Mitigation measures applied for minimizing HEC in the research area

The HH questionnaire survey and focal group discussion indicated that, the most common method used to deter elephant was shouting and chasing with stones, beating tins, using foggy lights and fire crackers followed by electric fencing or solar fencing built by the Government along the bank of Mechi River (Fig 9). Beside these methods, use of watch towers, vehicle patrolling, awareness programmes and relief distribution were in practice for managing HEC. Moreover, very few respondents were aware about growing alternate crops to reduce the elephant intervention into the village.

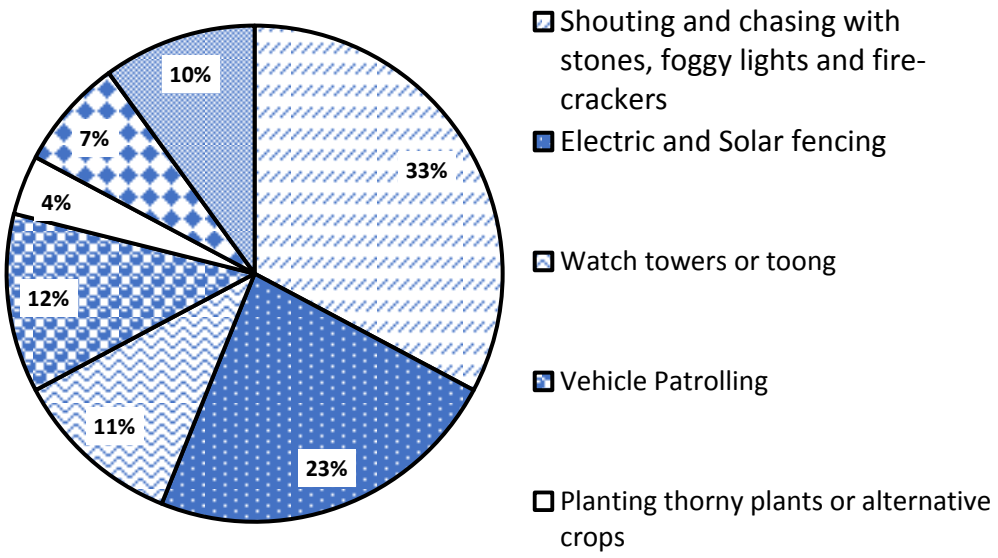

Fig 9. Perception of respondents for mitigating HEC in the research area

However, the mitigation measures adopted by local people for the management of HEC in Mechinagar Municipality are broadly divided under two categories as mentioned below:

4.4.1 Temporary measures

4.4.1.1 Chasing elephants by shouting, beating tins, foggy lights and fire crackers

It is the practice of chasing elephants by producing loud and scary sound. Although this method is the oldest and traditional method, it was being used as the most popular method for the repelling elephants in Mechinagar Municipality. DFO Jhapa, Mechinagar Municipality, Bahundangi Jaycees and DDC Jhapa were providing fund for purchasing the required devices such as foggy torch lights, fire crackers, catapult. Chasing elephants by this method was found to be somewhat effective. However, this method is dangerous and detrimental. Many villagers have been injured or killed while chasing the elephants by these methods.

4.4.1.2 Construction of Watch Towers (*Toong* or *Machan*)

Watch towers (*Toong* or *Machan*) were used to observe, scare and drive away the elephants entering into the village through Mechi River. Seventeen concrete watch towers have been constructed at the Passes (*Gauda*) near the bank of Mechi River by the aid of Ministry of Forest and Soil Conservation. Few wooden watch towers were built during late 90s. Although, due to poor maintenance, these watch towers have become vulnerable to damage. Solar lights, foggy lights, mats and binoculars was provided by DDC Jhapa to the observer who stay at those towers.

4.4.1.3 Vehicle Patrolling

Armed Police Force (APF), Nepalese Army and local forest representatives were involved in vehicle patrolling along the bank of Mechi River. APF and Nepalese Army were providing vehicles required for patrolling. However, this method was not common and frequent. The roads at the river bank were vulnerable due to which it was difficult for patrolling during rainy seasons.

4.4.1.4 Awareness Programmes

Local people were made aware about the HEC and its harsh situations through programmes, awareness campaigns, plays, trainings, pamphlets, posters etc. Frequent programmes were being conducted by Forest user group with the co-ordination of Bahundangi Jaycees and Nepal Police. The entry of elephant in the village, its movement and locations are informed to the villagers by local F.M. radios. Some of the schools were providing information and relevant trainings for safety measures with the aim that, these students will be able to guide and insist their family members. Local people are required to be conscious and aware about causes and effects of HEC to remain safe.

4.4.2 Long-term measures

4.4.2.1 Solar Offset Fence

Solar Offset Fence was constructed by Community based Human-Elephant Conflict Management Project under Ministry of Forest and Soil Conservation in 2015 with the support of National Trust for Nature Conservation (NTNC) and The World Bank, with the investment of Rs. 12,000,000. The fence runs along the western bank of Mechi River extending from Jirmale-3 Ilam to Mechinagar-10, Jhapa. The length of the fence is 17.14 Km, containing 25 gates for the entrance and exit of local people across the Indo-Nepal border. Eighteen energizers each having the energy of 4.2 Joules have been used in the fence. Solar panels with the capacity of 75 Ampere and Batteries with 100 Ampere were being used for the regulation of Direct Current (D.C.) in the fence. For the proper maintenance and regulations of the fence 12 technicians have been involved. Two wires on the top contain the voltage of 10,000 volt and lower wire contains the voltage of 8,000 Volt. Upper wires obstruct the adult elephant from entering to the agricultural field while lower wire obstruct the juveniles. Solar fence is regarded as very useful practice for preventing the entrance of migratory herd coming from India. Due to this fence, the agricultural productivity in Mechinagar Municipality has been increased due to the minimization of damage in recent years. This fence is not much useful for controlling residential elephants. From the study, it was found that elephants were invading through the southern region of Mahendra Highway along the bank of Mechi river, after the installation of solar fence on northern side.

Beside solar fence, it was found that local people from the research area were also using electric fencing on their own. Electric fences are being used for guarding the agricultural fields and houses by the use of Alternating Current (A.C.) from their houses. Although, this fence was found to be dangerous. As per the record of Nepal Police, till November 2018, four people have been died due to electric shock from local electro-fencing.

4.4.2.2 Alternative Crops

Alternative crops such as Lemon (*Citrus limon*), Tea (*Camellia sinensis*), Bay leaves (*Laurus nobilis*) and Asian broomgrass (*Thysanoleana latifolia*) have been planted at the agricultural field near to the bank of Mechi River to repel away elephants. These plants have spiny thorns or strong smell due to which elephants are avoided to enter in to the village. Similarly, a plant called *Hattibar* (*Agava americana indica*) was brought from Sikkim, India and planted along the entry points of elephants near the bank of Mechi River in early 2000s. This plant grew up to six feet and had thorns in it. This plant was believed to provide formidable barrier for the entry of elephant. At present, those plants have been destroyed due to the lack of care. Very few bushes of *Hattibar* was seen at the bank of Mechi River, which has no any influence on elephants. Among the alternative crops grown in the research area, tea plantation was the most effective alternative. Elephants dislike the tea plant and are deterred away by its thorns.

4.4.2.3 Relief distribution and evaluation of effectiveness

Relief was being provided to the victims depending upon the nature of damages and their severity (*Annex III*). Local Community Forest User Groups were providing timber required to build house for the victims who had lost their house by elephant attack.

Within the time period between 2011-2018 B.S., altogether 1,726 victims of HEC have received relief of Rs 31,572,614 under various titles in Jhapa (Table 7). Among them, 12 victims received compensation for general injury, 35 received relief for serious injury and 35 families received relief for death of their family member. Beside these, 1,644 victims received relief for damages of house/crops or both.

About 41% of the respondents were unsatisfied by the compensation/relief amount as victims of HEC were not getting the relief amount they claimed for their loss. Moreover, the process to receive the relief was so long. Some of the victims claimed that, they received compensation or relief amount after a year of their injury which they do not find fruitful. Few respondents were dissatisfied as fake people were getting the relief amount rather than real victims, due to the lack of proper and scientific documentation of the damage/loss.

Table 7. Nature of damages and relief amount distributed for the victims in Jhapa district (2011-2018 A.D.)

S.N.	Nature of damage	Number of Victims	Relief Amount (Rs)
1.	General Injury	12	83,320
2.	Serious Injury	35	2,061,154
3.	Death	35	13,350,000
4.	Destruction of house	134	1,239,200
5.	Destruction of field crops	1,088	8,715,775
6.	Destruction of stored grains	28	239,450
7.	Destruction of house and stored grains	310	4,618,990
8.	Destruction of house, stored grains and field crops	22	342,875
9.	Destruction of house and field crops	11	391,400
	Total	**1,726**	**31,572,614**

4.5 Attitude of local people towards wild elephants

Based on the data obtained from questionnaire, it was found that more than 72% of respondents had negative thoughts about elephants due to the threats created by them. They have negative attitude towards elephant due to the negative impacts caused by HEC such as crop loss, property damage and human casualty or death. Questionnaire survey and opportunistic discussion revealed that, uneducated and elderly aged people were more aggressive towards the elephant than educated and young generations. The aggression and stimulating behaviour of local people have resulted more cases of human casualties and threats. However, few old aged respondents had religious thought about elephants and were against hurting them.

5. DISCUSSION

The study about the impacts of HEC and its management practices was conducted in Mechinagar Municipality, Jhapa. This region is a prone area which has severe effect on human lives and agricultural crops by elephant. Local people of this area are being troubled by wild elephants since many decades. Wild elephants migrate from West-Bengal, India to Mechinagar Municipality area of Nepal due to lack of corridor, insufficient food and lack of habitat.

The major causes of HEC in the research area were due to the lack of habitat and corridor in the border area, due to the lack of vegetation in forest, due to its old route and due to the migratory nature of elephants. Similar causes of HWC were recorded by Bajracharya (2009) in Nepal and by Kangwana (1995) in India. Similarly, habitat fragmentation, high population density and nutritious agricultural crops near the settlement area are other possible causes of HEC (Balasubramanian et al. 1995).

In north-east Jhapa, elephants are categorized into Residential (local) elephant and Migratory elephant. Local elephants are relatively larger than migratory elephants and have solitary habit. These elephants are distributed within the forests of Bahundangi, Bahuban, Magurmadi, Shantinagar, Budhabare and Sanischare. These elephants are rarely recorded in the forests of Khudunabari, Kanakai and sometime up to Satashidham in the west. Their population is estimated to be seven to eight at present. These elephants roam singly and rarely found in a group with 3-4 individuals. Local elephants remain in an area for few days and damage houses, sheds and sometimes destroy trees and stored crops. The result reinforced with the study of Yadav (2002). He recorded small herd of elephant residing whole year in eastern Nepal.

Migratory elephants enter into the research area from West-Bengal, India by crossing Mechi River. They are smaller in size compared to local elephants and found in herds. Every year, large herd of migratory elephants visit the areas nearby Mechi River and destroy large amounts of agricultural crops. The migration of elephant usually occurs during the harvesting period of Maize, Paddy and Millet. The herd of migratory elephant may include up to 100 individuals. Baidya (2010) has also documented that, Bahundangi, Jhapa is the main entry point of the migrating elephant herds. It was found that wild herds enter through a village in Bahundangi to reach the nearby forest Telpani north-west to Bahundangi (Ram 2014). Many local people are killed by those elephants while chasing out them.

As per the results of Koirala et al. (2016), wild elephants generally feed on *Spatholobus parviflorus*, *Shorea robusta*, *Saccharum* spp., *Sorghum* spp., *Mallotus philippensis*, *Garuga pinnata*, *Bambusa* spp., *Panicum* spp., *Listea monopetala*, *Cymbopogan* Spp., *Phoenix humilis*, Succulent plants, tree barks, shrubs, climbers and creepers found in the forest. The major attraction for elephants in the research area was due to the presence of

similar types of vegetation in the forest of border area. However, due to increase in population size, these resources found in forest are insufficient for them. So, elephants are believed to be migrated towards the agricultural fields. Similarly, the nutritious agricultural crops grown by the use of fertilizers are the main attractions for the migration of these elephants.

Mechinagar ward number one and four were highly affected by the wild migratory elephants. This area lies at the western bank of Mechi River which is situated at the northern side of Mahendra highway. Wild elephants enter into the Mechinagar area from West Bengal, India by crossing Mechi River. Since, ward number one possess more forest area, elephants usually follow this route for migration. The main reason for the invasion of elephant in Mechinagar area is due to the lack of barrier at the border area. Yadav (2002) also reported that elephants are frequently recorded at the bank of Mechi River.

The household survey indicated that crop damage was the most common negative interaction of HEC in Mechinagar Municipality. Similar incidents of HEC was recorded in Sri-Lanka by Campos-Arceiz et al. (2009). The patterns of HEC from the research area resemble with the incidents from India (Sukumar 1990). Sukumar (1990) has also reported that crop raiding is the part of an elephant's optimal foraging strategy and raiding peaks during specific time of the year when Paddy becomes more palatable and nutritious as it approaches harvesting. The crop damage by wild elephant follow similar seasonal pattern in Mechinagar. The peak seasons of crop raiding are June-July during the maturing period of maize and November-December, during the paddy maturing time in the research area. This result supports the result obtained by Pradhan et al. (2011). Maize and paddy are the mostly raided crops. Paddy and Maize are the main field crops grown in terai region and crop raiding is at peak during their harvesting time. Lakhar et al. (2007) has reported that, crop raiding in India takes place during June-July and October-November. Maize was found to be mostly damaged crop in the research area which was followed by paddy and millet. Unlike to this, in the buffer zones of CNP and PWR, paddy was the most preferable to wild elephants than wheat and maize (Yadav et al. 2012).

According to Archie and Chiyo (2012), male elephants are twice likely to raid crops at their reproductive peak and younger males are more likely to raid if they are following older role models. Some individuals of problem-elephant raid crops, damages house for stored grains and may become very aggressive if confronted in the process (Sukumar 2006). Similarly, female elephants with their babies are more likely to attack human while chasing them. The incidents of human death or injury in the research area were induced by both problematic male elephants and female elephants with their babies.

The result documented that, the average economic loss in crops damaged by elephants in each household was found to be Rs 23,592.29. While the total economic loss from crop damage in sampled households due to elephant was Rs 3,526,525 annually. About 43,787 Kg of Paddy and 68,760 Kg of Maize were destroyed by elephants among the 180 HH in the research area. Annually, there was 8.10% loss of Paddy, 24.78% loss of Maize and

22.31% loss of Millet in terms of expected production. The total economic loss of maize was Rs 2,131,560 and that of paddy was Rs 1,094,675. The economic loss recorded by Nepal (2011) in same area was found to be lesser than this data. Although, the quantity of the damaged crops was higher in his study, due to increased market price of those crops in 2018, economic loss was found to be higher in this research. The total paddy loss was 93,341 kg (43.87%), maize 1,10,326 kg (51.80%) and millet 9,289 kg (4.36%) in Bahundangi VDC, Jhapa (Nepal 2011).

Beside crop damage, other negative interactions of HEC in the research area were property damage, destruction of stored grains and human casualty. Data records from DFO, Jhapa shows that, since 2000 A.D. eight people have been killed, 15 people have been seriously injured and more than hundred people had general injury by wild elephants in Mechinagar area. Most of the victims were of the age between 20-45 years. Most of the human casualties occur while chasing elephants and sometime due to accidental encounter with elephants on the way. But, in the year 2002 A.D., couple sleeping in the house were pulled out and killed by elephant. Shambhu Thapa and Durga Thapa were the victims from Mechinagar Municipality area. Also, there are thousands of cases of damages in stored grains and property damage. Due to HEC, 35 people have been killed and ten elephants were dead in Jhapa district within 2011-2018 A.D. (DFO Jhapa 2018).

Cases of livestock damage by HEC is minimum in compared to other damages in Mechinagar area. Being herbivore, domestic animals are unlikely to be killed by elephants. Thus, livestock damage by elephant can only occur by chance or accidently. Rather than elephants, other wild elephants such as Tiger, Leopard, Fox, Jackal, Wolf are responsible for severe damage on livestock in Central and Western regions of Nepal (Mishra and Margaret 1991, Uperety 1995). Tiger and leopard were identified as livestock depredators in CNP (Sharma 1991) and Bardia National Park (Jnawali 2002). Jackal, Indian fox, common mongoose and jungle cat have been reported as livestock lifter around the CNP (Uperety 1995). Similarly, Leopard, Jackal, Wild dog and Grey wolf were identified as livestock depredators in Makalu-Barun Conservation Area (Jackson 1990).

Several techniques were being applied in Mechinagar Municipality for the mitigation of HEC. Among them, most popular technique was chasing elephants by shouting, beating tins, foggy lights and fire crackers. Although, this practice is just a temporary solution for reducing HEC. This method is risky and sometimes elephant become more aggressive and can harm people or their properties. Same practices have been applied in Northeast India (Choudhary 2004). Other temporary practices used by the local people were construction of watch towers, vehicle patrolling and awareness programmes. However, spending whole night in watch towers had adverse effects on the people's health as well as on the efficiency of villagers' work (Nepal 2011). Awareness programmes were not conducted efficiently. Due to the network problem, it was difficult to inform the villagers about the occurrence and locations of the elephants in the research area. Vehicle

patrolling was not convenient during rainy seasons due to the lack of efficient roads at the bank of Mechi River.

Beside these, long term practices such as installation of solar fence, growing alternative crops and compensation distribution are common in the research area. Among all practices, installation solar fence was found to be most effective measure to control the entry of elephants from West Bengal, India to Mechinagar area in recent years. After the installation of solar fence along the border area, crop raiding and its damage have been significantly decreased in Mechinagar Municipality. This year people were able to harvest almost 90% of paddy in the research area. Results obtained by Nepal (2011) in the same research area indicated that, the annual loss of crops was found to be lesser than that of past years. Subsequently, the number of incidents of conflict (human casualty and injury, crop, property damage and retaliatory killings of elephants) was sharply decreased from 747 cases (before fence installment) to 30 (after fence installment) in 2016 with the percentage decreased of 96.13% (Neupane et al. 2018). But still, the solar fence has not completely blocked the entry of wild elephants to the research area. Tusker elephants find it easy as they use their tusks to lower down the wire. Tuskless elephants (*Makna*) also sometime use logs to cross the fence. Another major challenge and threat to the sustainability of the fence was that the smugglers often cut the wire and the fence was covered by the grasses and climbers in some places. The study conducted by Kioko et al. (2008) in Kenya have reported that the success of electric fences depends upon the location of fences in relation to landscape factors, regular maintenance and proximity of fences to areas of high elephant concentration. However, Choudhary (2004) reported that, construction of electric fencing has failed to eliminate conflicts in Gibbon Sanctuary despite its initial success. When the fencing was erected, the elephants innovated an intelligent method of breaking fencing posts by holding the top of the wooden posts by their trunk and breaking at the middle by gently pushing their foot, thus avoiding the live wires. After the installation of solar fence along the bank of Mechi river northern side to Mahendra Highway, elephants have started to follow the southern route to enter into Nepal. This has increased HEC in villages south to the Mahendra Highway such as Anarmani, Prithivinagar, Baniyani, Jalthal and Goldhap.

Alternative crops include the crops that elephants dislike or act as barrier to prevent the elephants to enter into the village area. Alternative crops such as Lemon (*Citrus limon*), Tea (*Camellia sinensis*), Bay leaves (*Laurus nobilis*) and Asian broomgrass (*Thysanoleana latifolia*) have been planted at the agricultural field near to the bank of Mechi River to repel away elephants. Similar practice was recorded by Sukumar (1990) in India. Beside these plants, *Hattibar* (*Agava americana indica*) was planted along the entry points of elephants near the bank of Mechi River in early 2000s (Nepal 2011). This plant grew up to six feet and had thorns in it. This plant was believed to provide formidable barrier for the entry of elephant. Similarly, practice on plantation of alternative crops like Sunflower, Mulberry and Tobacco help to avoid elephants and consequent crops damage. Among the alternative crops grown at the bank of Mechi river,

tea cultivation was found to be most effective measure to control elephant invasion. There is a need of identification of more plant species as alternative crops

Compensation is complex and not always effective; individuals and/or communities often do not file claims for compensation due to numerous obstacles, i.e. lack of awareness of the scheme, time consuming, logistically complicated, gender-based restrictions, and unclear property ownership (Ogra 2008). Alike this, Mechinagar Municipality is also facing difficulties for relief and compensation distribution for the victims. Similarly, in Meghalaya, India, individuals and families affected by human–elephant conflicts are usually paid compensation by government agencies, but the lack of adequate funding, delays in processing, and the tendency among many villagers to submit false claims complicate the problem (Choudhary 2004). As a major HEC mitigation tool, compensation should be viewed as a short-term approach; eventually compensation should be replaced by other strategies and used only to support severely affected people so that they can overcome crisis situations. Municipality office, DFO Jhapa, Community Forest User Groups, Red Cross Society, World Bank, Government of Nepal (MoFSC) and local Jaycees are providing assistance for the compensation distribution. The lack of standardized assessment guidelines and compensation approaches create opportunities for conflict and corruption (Ogra and Badola 2008).

The use of acrid smell such as chilli smoke has been tested in Africa (Osborn and Rasmussen 1995) and Asia (Baishya et al. 2012) and reported as being successful to deter elephants from raiding crops. Perera (2009) suggested the plantation of Agave as bio-fencing against elephants. Similarly, Reports of Chelliah et al. (2010) revealed the effectiveness of shiny objects, minor sound producing devices and rotating lamps along with the fence.

Most of the people in the research area are of poor economic condition. Every year they have to face extra financial burden due to crop damage and property loss by wild elephants. They were finding it difficult to upgrade their financial status. Most of the victims were dissatisfied as the compensation/relief they were getting was insufficient in compared to their loss and the process to obtain the relief was time consuming. The records of DFO Jhapa shows that, relief distribution has been conducted after the consecutive year of each incidents. Matured and older people generally have negative attitudes towards wildlife as they have experienced damage from wildlife while the people with higher levels of education tend to be more positive towards wildlife (Røskaft et al. 2007). Similar result was found in Mechinagar Municipality. More than 72% of people have negative thought about wild elephants. Only young and educated people are aware about sustainable management of HEC. However, few respondents above the age of 60 years showed the religious importance of elephants and were against harming elephants in any way. They believed elephants as the symbol of Lord *Ganesh* and harming them would be considered as a sin. Despite the increase in incidents of human–elephant conflict in the CNP and PWR, 37% of respondents had positive attitudes towards elephant conservation (Pant et al. 2016).

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study was conducted in ward numbers one and four of Mechinagar Municiplaity of Jhapa district with an aim of exploring the effects of HEC and its mitigation measures applied by the local people. Crop damage was the major impact of HEC in the research area and the total economic loss was estimated to be Rs 3,526,525 annually. Each household had the burden of Rs 23,592.29 in average. Maize was found to be the mostly raided crop followed by Paddy.

Many villagers were killed and injured by wild elephants. The victims were not totally satisfied with the compensation being distributed. Due to low economic condition most of the villagers were finding it difficult to survive the sustainable life and upgrading their economic status.

Although, chasing elephants by producing loud sounds and using foggy lights was most common method applied to repel elephants, solar fence was found to be the most effective mitigation measure as crop damage and human harassment has been decreased to some extent after its installation.

6.2 Recommendations

The following are relevant management recommendations:

- Regular maintenance of solar fence is required. Well-trained technicians should be engaged for regular monitoring and maintenance of the fence.
- Trenches could be built along the border area. This would prevent the elephants crossing the boundary.
- Old and damaged watch towers should be repaired or reconstructed.
- Alternative crops like sunflower, tobacco and other thorny plants should the encouraged in the agricultural field near the bank of Mechi River.
- Effective and transparent relief/compensation distribution scheme should be managed and relief should be distributed based upon the nature and severity of loss/damage.

7. 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):1-18.

Adams, T.S.F., Chase, M.J., Rogers, T.L., and Leggett, K.E.A. 2017. Taking the elephant out of the room and into the corridor: can urban corridors work? Oryx **51**:347-353.

Archie, E.A. and Chiyo, P.I. 2012. Elephant behaviour and conservation: social relationships, the effects of poaching, and genetic tools for management. Molecular Ecology **21**:765-778.

Ayyapan, S., Agrawal, P.K., Vasudevarao, V. and Tripathi, R.S. 2016. Human-Wildlife 'conflict to coexistence' in Agro-pastoral landscape, A report submitted to National Council of Agricultural Research, New Delhi, India.

Baidya, N.G. 2010. Trans-boundary movement of elephants in Eastern Nepal. Tiger Paper **37**(4):5-9.

Bailey, R. 2011. A study of the relationship between crop damages inflicted by the one-horned Indian rhinoceros and the defensive response to these damages by farmers in Chitwan National Park, Nepal. A research report submitted to Simon Fraser University.

Baishya, H.K., Dey, S., Sarmah, A., Sharma, A., Gogoi, S., Aziz, T., et al. 2012. Use of chilli fences to deter Asian elephants–A pilot study. Gajah **36**:11-13.

Bajimaya, S. 2012. Managing Human-Wildlife Conflict in Nepal. In: Acharya, K.P. & Dhakal, M. (eds.) Biodiversity Conservation in Nepal: A Success Story. Department of National Parks and Wildlife Conservation, Kathmandu, Nepal.

Bajracharya, S. 2009. An assessment of crops damage by wild animals in the southern parts of Shivapuri National Park. M.Sc. Thesis. Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Balasubramanian, M.N., Baskaran, S., Swaminathan, A. and Desai, A.A. 1995. Crop raiding by Asian elephant (*Elephas maximus*) in the Nilgiri biosphere reserve, South India. In: Daniel, J.C. and Datye, H.S. eds. Proceedings on "A week with Elephants" Bombay Natural History Society, Bombay, India :350-367.

Balasundaram, R. and Sivaraj, K. 2018. Human and Elephant (*Elephas maximus*) deaths due to conflict in Coimbatore Forest Division, Tamil Nadu, India, Zoo's Print **9**(8):12-19.

Barua, P. 1995. Managing a problem population of elephants. In: A week with elephants. Bombay Natural History Society, Bombay, India :150-161.

Baruch, S., Webb, C.T., Breck, S.W. and Wilson, K.R. 2013. Use of patch selection models as a decision support tool to evaluate mitigation strategies of human–wildlife conflict. Biological Conservation **160**:263-271.

Baskaran, N. 2002. Ranging and resource utilization of Asian elephants (*Elephas maximus*) in Nilgiri Biosphere Reserve. Ph.D. Thesis, Bhartidasan University, Tiruchirapalli, Tamil Nadu, India.

Baskaran, N., Balasubramanian, M., Swaminathan, S., and Desai, A.A. 1995. Ranging behaviour of elephants and its implication for the management of Nilgiri Biosphere Reserve, India, A Week with Elephants :296-313.

Bennett, G. and Mulongoy, K.J. 2006. Montreal: Secretariat of the Convention on Biological Diversity, A Report on Review of experience with ecological networks, corridors and buffer zones, Technical Series, Montreal, Quebec, Canada.

Bhandari, C. 2011. An assessment of human-wildlife conflict, a case study form buffer zone of Shuklaphanta Wildlife Reserve. A project report submitted to Institute of Forestry, Pokhara.

Bhatta, S.R. 2006. Efforts to conserve Asian elephants in Nepal. Gajah **25**:87-89.

Bist, S.S. 2002. An overview of elephant conservation in India. The Indian Forester **128**:121-136.

Brooks, J., Waylen, K.A., and Mulder, M.B. 2013. Assessing community-based conservation projects: a systematic review and multilevel analysis of attitudinal, behavioural, ecological, and economic outcomes. Environmental Evidence **2**:2-34.

Busch, J. 2008. Gains from configuration: The transboundary protected area as a conservation tool. Ecological Economics **67**:394-404.

Calabrese, A., Calabrese, J.M., Songer, M., Wegmann, M., Hedges, S., Rose, R., et al. 2017. Conservation status of Asian elephants: the influence of habitat and governance. Biodiversity Conservation **26**:2067-2081.

Campos-Arceiz, A., Takatsuki, S., Ekanayaka, S. and Hasegawa, T. 2009. The Human-Elephant Conflict in South-eastern Sri Lanka: Type of Damage, Seasonal Patterns and Sexual Differences in the Raiding Behaviour of Elephants, Gajah **31**:5-14.

CBS. 2011. Nepal Living Standards Survey 2010-11: Statistical Report, Volume 2. Central Bureau of Statistics, National Planning Commission Secretariat, Government of Nepal.

Chelliah, K., Kannan, G., Kundu, S., Abhilash, N., Madhusudan, A., and Baskaran, N. 2010. Testing the efficacy of a chilli-tobacco rope fence as a deterrent against crop raiding elephants. Current Science **99**(9):1239-1243.

Chen, Y., Marino, J., Chen, Y., Tao, Q., Sullivan, C.D., Shi, K. et al. 2016. Predicting Hotspots of Human-Elephant Conflict to Inform Mitigation Strategies in Xishuangbanna, Southwest China. PLoS ONE **11**(9):1-15.

Choudhary, A. 2004. Human–Elephant Conflicts in Northeast India. Human Dimensions of Wildlife **9**:261-270.

Choudhury, A., Choudhury, D.K., Desai, A., Duckworth, J.W., Easa, P.S., Johnsingh, A.J.T., et al. 2008. "*Elephas maximus*". The IUCN Red List of Threatened Species. https://www.iucnredlist.org/species/7140/12828813. Accessed on 25 June 2019.

Clutton-Brock, J. 2012. Animals as Domesticates: A World View Through History. East Lansing, MI: Michigan State University Press, USA.

CNP. 2012. A Report on Problem Elephant submitted to Department of National Park and Wildlife Conservation Submitted by Chitwan National Park, Chitwan, Nepal.

Datye, H.S. and Bhagawat, A.M. 1995. Man-Elephant Conflict: A case study of human deaths caused by elephants in parts of Central India, In: Daniel, J.C. and Datye, H.S. eds. Proceeding of "A week with Elephants", Bombay Natural History Society/Oxford University Press, Bombay, India :340-349.

DDC. 2018. District profile of Jhapa, Nepal: District Development Committee, Bhadrapur, Jhapa.

Desai, A.A. and Baskaran, N. 1996. Impact of Human Activities on the Ranging Behaviour of Elephants in the Nilgiri Biosphere Reserve, South India, Journal of the Bombay Natural History Society **93**(3):559-569.

Dey, S.C. 1991. Depradation by wildlife in fringe areas of North Bengal with special to elephant damage, The Indian Forester **117**(10):901-908.

DFO Jhapa. 2018. Annual Report 2018. District Forest Office, Jhapa, Government of Nepal.

DHM. 2018. Department of Hydrology and Meteorology, Government of Nepal.

DNPWC. 2008. The Elephant Conservation Action Plan of Nepal. Department of National Parks and Wildlife Conservation, Kathmandu, Nepal.

DNPWC. 2013. Protected Areas of Nepal. http://www.dnpwc.gov.np/protected-areas (Accessed 30 May 2019).

Draheim, M.M., Madden, F., McCarthy, J.B. and Parsons, E.C.M. 2015. Human-wildlife conflict: complexity in the marine environment. Oxford University Press, Oxford, UK.

Easa, P.S. and Sankar, S. 2001. Study on man-wildlife interaction in Wayanad Wildlife Sanctuary, Kerala. A Research Report submitted to Kerala Forest Research Institute (KFRI), Kerala, India.

Fayrer-Hosken, R. 2008. Controlling animal populations using anti-fertility vaccines. Reproduction in Domestic Animals **43**(2):179-185.

Fernando, P. and Pastorini, J. 2011. Range-wide status of Asian elephants. Gajah **35**:15-20.

Fernando, P., Kumar, M.A., Williams, A.C., Wikramanayake, E., Aziz, T, Singh, S.M. 2008. Human-Elephant Conflict Mitigation Measures Practiced in South Asia. A report submitted to World Wildlife Fund (WWF).

Fernando, P., Leimgruber, P., Prasad, T., and Pastorini, J. 2012. Problem-elephant translocation: translocating the problem and the elephant? PLoS ONE **7**(12):1-24.

Fernando, P., Wikramanayake E., Weerakoon, D., Jayasinghe, L.K.A., Gunawardene, M. and Janaka, H.K. 2005. Perceptions and patterns of human-elephant conflict in old and new settlements in Sri Lanka: insights for mitigation and management. Biodiversity and Conservation **14**:2465-2481.

GoN. 2009. Elephant Conservation Action Plan for Nepal, Government of Nepal, Ministry of Forests and Soil Conservation, Department of National Parks and Wildlife Conservation.

Goswami, V.R., Vasudev, D., and Oli, M.K. 2014. The importance of conflict-induced mortality for conservation planning in areas of human–elephant co-occurrence. Biological Conservation **176**:191-198.

Gross, E.M., McRobb, R., and Gross, J. 2016. Cultivating alternative crops reduces crop losses due to African elephants. Journal of Pest Science **89**:497-506.

Haynes, G. 1993. Mammoths, Mastodonts, and Elephants: Biology, Behaviour and the Fossil Record. Cambridge University Press, UK, 8p.

Hill, C. 2000. Conflict of interest between people and baboons: Crop raiding in Uganda. International Journal of Primatology **21**:299–315.

Hockings, K. and Humle, T. 2009. Best practice guidelines for the prevention and mitigation of conflict between humans and great apes. Gland, Switzerland: IUCN/SSC Primate Specialist Group.

IUCN. 2010. IUCN Red List of Threatened Species. www.iucnredlist.org. Accessed on 18 April 2019.

Jackson, R. 1990. Threatened wildlife, crop and livestock depredation and grazing in the Makalu-Barun Conservation Area. The Makalu-Barun conservation project. Working Paper Publication Series **12**:105.

Jepson, T.P., and Canney, S. 2003. The state of wild Asian elephant conservation in 2003. London: Elephant Family. Oxford, UK.

Jnawali, S.R. 2002. Final report habitat restoration in Bardia National Park (scaling up effort to conserve the wild tiger population in and around Nepal's Bardia National Park). A Report submitted to Save the Tiger Fund, US. National Trust for Nature Conservation.

Joshi, D.P. 1986. The Climate of Terai and inner Terai of Nepal: A Bio-Climatic Analysis. Proceeding of First conference on Science and Technology, Kathmandu, Nepal **6**:14-29.

Kangwana, K. 1995. Human-elephant conflict: the challenges ahead. Pachyderm **19**:11-14.

Kassilly, F.N., Tsingalia, H.M., and Gossow, H. 2008. Mitigating Humans wildlife Conflicts Through Wildlife Fencing: Akenyan Case Study. Wildlife Biology in Practice **4**(1):30-38.

Kioko, J., Muruthi, P., Omondi, P. and Chiyo, P.I. 2008. The performance of electric fences as elephant barriers in Amboseli, Kenya. South African Journal of Wildlife Research **38**(1):52-58.

Kissui, B.N. 2008. Livestock predation by lions, leopards, spotted hyaena and their vulnerability to retaliatory killing in the Moasai Steppe, Tanzania. Animal Conservation **11**:422-432.

Koirala, R.K., Raubenheimer, D., Aryal, A., Pathak, M.L. and Ji, W. 2016. Feeding preferences of the Asian elephant (*Elephas maximus*) in Nepal. BMC Ecology **16**(54):1-9.

Kurt, F. and Kumarasinghe, J.C. 1988. Remarks on body growth and phenotypes in Asian elephant *Elephas maximus*. Acta Theriologica **5**:135-153.

Lahkar, B.P., Das, J.P., Nath, N.K., Dey, S., Brahma, N. and Sarma, P.K. 2007. A study of habitat utilization patterns of Asian elephant (*Elephas maximus*) and current status of human elephant conflict in Manas National Park within Chirang-Ripu Elephant Reserve, Assam. A technical report submitted to Manas National Park, Guwahati, Assam, India.

Lamarque, F., Anderson, J., Fergusson, R., Lagrange, M., Osei-Owusu, Y. and Baker, L. 2009. Human-wildlife conflict in Africa: Cause, consequences and management strategies. Food and Agriculture Organization (FAO), Forestry Paper 157.

Lamsal, S. 2012. The park people conflict in Chitwan National Park with reference to one horned Rhinoceros. A Report submitted to Department of Biology, Norwegian University of Science and Technology, Norway.

Macura, B., Zorondo-Rodriguez, F., Grau-satorras, M., Demps, K., Laval, M., Garcia C.A. et al. 2011. Local community attitude towards forests outside protected areas in India. Impact of legal awareness, trust, and participation. Ecology and society **16**(3):10 p.

Madden, F. 2004. Creating Coexistence between Humans and Wildlife: Global Perspectives on Local Efforts to Address Human–Wildlife Conflict, Human Dimensions of Wildlife **9**(4):247-257.

Madhusudan, M.D. 2003. Living amidst large wildlife: livestock and crop depredation by large mammals in the interior villages of Bhadra tiger reserve, South India. Environmental Management **31**:466–475.

Mallick, J. 2013. Trans-boundary human-elephant conflict in the Indo-Nepal terai landscape, Tigerpaper **39**:7-13.

Mambelo, A. A., Doscher, C. and Paterson, A. 2017. Are elephants the most disastrous agricultural pests or the agents of ecological restorations? Journal of Biodiversity and endangered species **5**(1):1-10.

McKay, G.M. 1973. The ecology and behaviour of the Asian elephant in southeastern Ceylon. Smithsonian Contributions to Zoology **125**:1-113.

Mishra, H. R. and Margaret, J. 1991. Chitwan National Park, Wildlife Heritage of Nepal. WWF/USAID. The Mountaineers, 192 p.

Mitra, S. 2013. Human-Elephant Conflict due to movement of elephants between India and Nepal and WWF-India Initiatives to address it, Gajah **38**:33-36.

Nath, N.K., Lahkar, B.P., Brahma, N., Dey, S., Das, J.P., Sarma, P.K. et al. 2009. An assessment on human-elephant conflict in Manas National Park, Assam, India. Journal of Threatened Taxa **1**(6):309-316.

Naughton-Treves, L. 1998. Predicting patterns of crop damage by wildlife around Kibale National Park, Uganda, Conservation Biology **12**(1):156-168.

Nelson, A., Bidwell, P. and Sillero-Zubiri, C. 2003. A Review of Human Elephant Conflict Management Strategies. People and Wildlife Initiative, Wildlife Conservation Research Unit, Oxford University, UK.

Nepal, K. 2011. Human-Elephant Conflict in Eastern Nepal: A case study of Bahundangi VDC, Jhapa, District, M.Sc. Thesis. Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Neupane, B., Budhathoki, S. and Khatiwoda, B. 2018. Human-Elephant Conflict and mitigation measures in Jhapa district, Nepal, Journal of Forest and livelihood **16**(1):103-112.

Neupane, D., Johnson, R.L. and Risch, T.S. 2017. How do Land-use Practices Affect human-elephant Conflict in Nepal? Wildlife Biology :1-10.

Nyhus, P.J., Osofsky, S.A., Ferraro, P., Madden, F., and Fischer, H. 2005. Bearing the costs of human–wildlife conflict: The challenges of compensation schemes. In: Woodroffe, R., Thirgood, S. and Rabinowitz, A. eds. People and Wildlife, Conflict or Co-existence? Conservation Biology, Cambridge University Press, Cambridge, UK **9**:107-121.

Ogra, V.M. 2008. Human-Wildlife conflict and gender in protected areas border lands: A case study of costs, perceptions and vulnerabilities from Uttarakhand, India, Geoforum **39**:1408-1422.

Ogra, V.M. and Badola, R. 2008. Compensating human-wildlife conflict in protected areas communities: ground level perspectives from Uttarakhand, India, Human Ecology **36**:717-729.

Okello, M.M, Njumbi, S.J., Kiringe, J.W. and Isiiche, J. 2014. Prevalence and Severity of Current Human-Elephant Conflicts in Amboseli Ecosystem, Kenya: Insights from the Field and Key Informants. Natural Resources **5**(9):462-477.

Osborn, F.V. 2004. Seasonal variation of feeding patterns and food selection by crop-raiding elephants in Zimbabwe. African Journal of Ecology **42**:322-327.

Osborn, F.V. and Anstey, S. 2007. Elephant/Human Conflict and Community Development around the Niassa Reserve, Mozambique. A Report submitted to WWF Southern African Regional Programme.

Osborn, F.V. and Rasmussen, L.E.L. 1995. Evidence for the effectiveness of an Oleoresin capsicum aerosol as a repellent against wild elephants in Zimbabwe, Pachyderm **20**:55-64.

Owen-Smith, R.N. 1988. Megaherbivores: the influence of very large body size on ecology, Cambridge University Press. Cambridge U.K.

Pant, G., Dhakal, M., Pradhan, N., Leverington, F., and Hockings, M. 2016. Nature and extent of human–elephant *Elephas maximus* conflict in central Nepal. Oryx **50**(4):724-731.

Pant, G. 2013, Understanding the Nature and Extent of Human-Elephant Conflict in Central Nepal, A research report on Master of Environmental Management submitted to The University of Queensland, St. Lucia, Australia.

Parker, G.E., Osborn, F.V. and Hoarse, R.E. 2007. Human-elephant conflict mitigation: a training course for community-based approaches in Africa (participant's manual). Nairobi, Kenya. A report submitted to Elephant Pepper Development Trust, Livingstone, Zambia.

Paudel, P.K. and Heinen, J.T. 2015. Think globally, act locally: on the status of the threatened fauna in the central Himalaya of Nepal. Geoforum **64**:192-195.

Perera, B.M.A.O. 2009. The human-elephant conflict: A review of current status and mitigation methods, Gajah **30**:41-52.

Pinter-Wollman, N. 2009. Spatial behaviour of translocated African elephants (*Loxodonta africana*) in a novel environment: using behaviour to inform conservation actions. Behaviour **146**:1171-1192.

Pradhan, N.M.B., Williams, A.C. and Dhakal, M. 2011. Current Status of Asian elephants in Nepal. Gajah **35**:87-92.

Ram, A.K. 2014. Geospatial modeling to assess Asian elephant habitat suitability, migration routes and human elephant interface in eastern Nepal. M.Sc. Thesis, Institute of Forestry, Tribhuvan University, Pokhara, Nepal.

Ramakrishnan, B., Sivaganesan, N., and Srivastava, R. K. 1997. Human interference and its impact on the elephant corridors in Sathyamangalam and Coimbatore forest divisions, Tamil Nadu, Southern India, Indian Journal of Forestry **20**(1):8-19.

Redpath, S.M., Bhatia, S., Young, J.C. 2015. Tilting at wildlife: reconsidering human–wildlife conflict, Oryx **49**(2):222-225.

Riddle, H. 2007. Elephant Response Units (ERU). Gajah **26**:47-53.

Ripple, W.J., Wolf, C., Newsome, T.M., Galetti, M., Alamgir, M., Crist, E., et al. 2017. World scientists' warning to humanity: a second notice. Bioscience **67**:1026-1028.

Roe, D., Nelson, F., Sandbrook, C. 2009. Community management of natural resources in Africa: Impacts, experiences and future directions, Natural Resource, International Institute for Environment and Development, London, UK.

Røskaft, E., Handel, B., Bjerke, T. and Kaltenborn, B.P. 2007. Human attitudes towards large carnivores in Norway. Wildlife Biology **13**:172-185.

Saaban, S., Othman, N.B., Yasak, M.N.B., Burhanuddin, M.N., Zafir, A., and Campos-Arceiz, A. 2011. Current status of Asian elephants in Peninsular Malaysia. Gajah **35**:67-75.

Santiapillai, C. and Jackson, P. 1990. The Asian elephant: An action plan for its conservation. Gland, Switzerland: IUCN/SSC Action Plans.

Sapkota, S., Aryal, A., Baral, S.R., Hayward, M.W., and Raubenheimer, D. 2014. Economic analysis of electric fencing for mitigating human-wildlife conflict in Nepal. Journal of Resources and Ecology **5**(3):237-243.

Seidensticker, J. 1984. Managing elephant depredations in agriculture and forestry projects, Technical Paper. The World Bank, Washington D.C., USA.

Shafer, C.L. 1999. National park and reserve planning to protect biological diversity: some basic elements. Landscape Urban Plan **44**:123-153.

Sharma, U.R. 1991. Park-People interaction in RNCP, Ph. D. Thesis, Faculty of committee in Wildlife and Fisheries science, Graduate College, University of Arizona, USA.

Shoshani, J. and Eisenberg, J.F. 1982. *Elephas maximus*, Mammalian Species, The American Society of Mammalogists **182**:1-8.

Shoshani, J. 2005. "Order Proboscidea". *In* Mammal Species of the World: A Taxonomic and Geographic Reference, Wilson, D.E.; Reeder, D.M. (3rd eds). Johns Hopkins University Press 90 p.

Shrestha, R., Bajracharya, S.B. and Pradhan, N.M.B. 2007. A Case Study on Human-Wildlife Conflict in Nepal with particular reference to Human-Elephant Conflict in Eastern and Western Terai Regions. A Report submitted to WWF Nepal Programme, Kathmandu, Nepal.

Sillero-Zubiri, C., Sukumar, R. and Treves, A. 2007. Living with wildlife: the roots of conflict and the solutions. Key top, Conservation Biology :266-272.

Sinu, P.A. and Nagarajan, M. 2015. Human-wildlife conflict or coexistence: what do we want? Meeting Report. Current Science **108**:1036-1038.

Sitati, N.W., Walpole, M.J., Smith, R.J. and Leader-Williams, N. 2003. Predicting spatial aspects of human-elephant conflict. Journal of Applied Ecology **40**:667-677.

Sitati, N.W., Walpole M.J. and Williams, N.L. 2005. Factors affecting susceptibility of farms to crop raiding by African elephants using a predictive model to mitigate conflict. Journal of Applied Ecology **42**:1175-1182.

Smith, R.J. and Kasiki, S.M. 2014. A Spatial Analysis of Human-Elephant Conflict in the Tsavo Ecosystem, Kenya. A Report submitted by African Elephant Specialist Group to IUCN.

Snyman, S. 2014. Assessment of the main factors impacting community members' attitudes towards tourism and protected areas in six southern African countries. Koedoe **56**:1-12.

Southwood, T. 1977. The relevance of population dynamic theory to pest status. Origins of pest, parasite, disease and weed problems. Blackwell Publications, Oxford, UK :36-54.

Sukumar, R. 1989. Ecology of the Asian elephant in southern India. I. Movement and habitat utilization patterns, Journal of Tropical Ecology **5**(1):1-18.

Sukumar, R. 1989. The Asian elephant: ecology and management, Cambridge University Press, Cambridge, New York, USA, 251 p.

Sukumar, R. 1990. Ecology of the Asian elephant in Southern India. Feeding habits and crop raiding patterns. Journal of Tropical ecology **6**:33-53.

Sukumar, R. 1991. The management of large mammals in relation to male strategies and conflict with people. Biological Conservation **55**:93-102.

Sukumar, R. 1992. The Asian elephant: Ecology and Management; in centre for ecological sciences, Indian Institute of Science, Bangalore, India, 255 p.

Sukumar, R. 2003. The living Elephants: Evolutionary Ecology, Behaviour, and Conservation. Oxford University Press, Oxford, UK.

Sukumar, R. 2006. A brief review of the status, distribution and biology of wild Asian elephants *Elephas maximus*. International Zoo Yearbook **40**:1-8.

Thouless, C., Dublin, H.T., Blanc, J., Skinner, D., Daniel, T., Taylor, R. et al. 2016. African Elephant Status Report 2016. Occasional Paper Series of the IUCN Species Survival Commission, 60 p.

Timalsina, T., and Ranjitkar, P. 2014. Factors Influencing Human Wildlife Conflict in Communities around Protected Area - The Case of Koshi Tappu Wildlife Reserve in Eastern. International Journal of Scientific Research and Reviews **3**:200-213.

Treves, A., Bruskotter, J. 2014. Tolerance for predatory wildlife. Science **344**:476-477.

Uperety, H.K. 1995. An assessment of agricultural and livestock depredation through wild animals at Pathihani and Jagatpur areas near Chitwan National Park. M.Sc. Thesis. Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Vancuylenberg, B.W.B. 1977. Feeding behaviour of the Asian elephant in South-East Sri Lanka in relation to conservation. Biological Conservation **12**:33-54.

Williams, A.C. 2002. Elephants (*Elephas maximus*), Their Habitats in Rajaji-Corbett National Parks, Ph.D. Thesis, Saurashtra University, Rajkot, Gujarat, India.

Williams, A.C., Johnsingh, A.J.T., and Krausman, P.R. 2001. Elephant-human conflicts in Rajaji National Park, Northwestern India. Wildlife Society Bulletin **29**:1097-1104.

Woodroffe, R. 2000. Predators and people: using human densities to interpret declines of large carnivores. Animal Conservation **3**:165-173.

WWF. 2007. A Case Study on Human – Wildlife conflict in Nepal. A report Submitted to species programme, WWF international.

Yadav, B.R. 2002. Elephant (*Elephas maximus*) People interface in East Nepal. M.Sc. Thesis, Agricultural University of Norway, Aas, Norway.

Yadav, B.R. 2004. Human-elephant relationships and conflicts in eastern Nepal. In: Endangered Elephants: Past, Present and Future. Jayewardene, J. (ed.) Biodiversity & Elephant Conservation Trust, Colombo, Sri Lanka pp.90-92.

Yadav, B.R. 2007. Human-elephant Relationships and Conflicts in Eastern Nepal. The Initiation **1**:93-99.

Yadav, B.R. and Chalise, M.K. 2012. *Jangali Hatti ra manis tatha dwanda* (Wild Elephant and human and conflicts). World Environment Day June 05. Hamro Sampada **12** (1):84-89.

Yadav, B.R., Dutta, I.C., Chalise, M.K. and Williams, C. 2012. Human-Asian wild elephant (*Elephas maximus*) conflicts and its socio-economic consequences in and around the protected areas of Central Terai, Nepal. Banko Janakari **24**(1):47-54.

PHOTOGRAPHS

Photo 1. Maize crop damaged by elephant

Photo 2. Elephant roaming in the agricultural field

Photo 3. Elephant with cyst in hind limb

Photo 4. Technicians maintaining electric fence

Photo 5. House damaged by elephant

Photo 6. Pugmark of elephant in the agricultural field

Photo 7. Dead elephant

Photo 8. Relief distribution to the victim

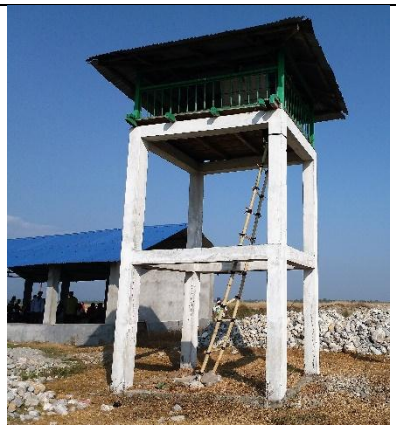

Photo 9. Newly constructed watch tower (*toong*)

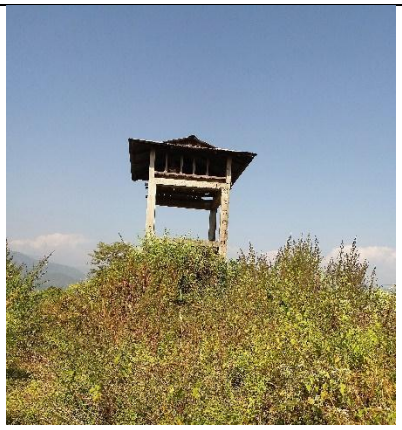

Photo 10. Old watch tower for viewing elephants

Photo 11. Interview with local respondent

Photo 12 Technician describing about electric fence

Photo 13. Household survey for data collection

Photo 14. Harvested paddy near the electric fence

Photo 15. Villager showing the footprints of elephant	Photo 16. Interview with key informant (field guide)

Photo 17. Tea plantation as alternative crop

Photo 18. Paddy field near the bank of Mechi river

Photo 19. Observation of electric fencing

Photo 20. HECMECF office, Bahundangi

Photo 21. Local farmer during the interview

Photo 22. Group discussion

ANNEX I

HOUSEHOLD QUESTIONNAIRE

Name: ……..
Age: ……...
Sex: ……
Address: ……..
==========

1. How many members are there in your family? ……

2. Since how long are you living in this area? …….

3. How much land do you have?

   Bigha……. Kattha……..

4. What are the sources of income?
   (a) Agriculture (b) Government job (c) Private job (c) Business (d) Other

5. How often do you visit the jungle?
   (a) Regularly (More than 5-6 times a month)
   (b) Sometime (2-3 times a month)
   (c) Rarely (Once in 2-3 months)
   (d) Do not go (No need to go)

6. For what purpose do you go to the forest?
   (a) For fire wood (b) For fodder (c) For leaf litter (d) For timber

7. How often do you encounter with the sign of elephant?
   (a) Every time (b) Sometime (c) Not very often (d) Very rarely
   (e) Not encountered yet

8. Why do you think elephants enter into your village?
   (a) Due to its old route (b) Due to the lack of habitat and corridor
   (c) Due to population growth (d) Due to the lack of vegetation in forest
   (e) Due to the migratory nature of elephant
   (f) Due to the nutritious cultivated crops

9. What type of negative interaction is common between people and elephant in your village?
   (a) Crop Damage (b) Property damage (c) Threats to family members

(d) Harm or disturbances (e) Other ……

10. What is the status of the HEC in your village?

(a) Increasing (b) Decreasing (c) Same

11. What type of Crop do you cultivate and in which season?

Season/Month	Crop types
(a) …….	…….
(b) ……	……
(c) ……	…….
(d) ……..	……

12. Do the elephants damage your crops?

(a) Yes (b) No

13. What type of crop do elephants destroy and in which seasons?

Season/Month	Damaged Crop types
(a) …….	…….
(b) ……	……
(c) ……	…….
(d) ……..	……

14. In which season do you find high intensity of crop raiding? ……

15. How much crop did you expect to produce in this year?

Crop types	Expected Production
(a) …….	…….
(b) ……	……
(c) ……	…….
(d) ……..	……

16. How much crop were you able to harvest this year?

Crops	Actual Production
(a) …….	…….
(b) ……	……
(c) ……	…….
(d) ……..	……

17. Do you think elephant with infant damage more?

(a) Yes (b) No (c) Equal (d) Do not know

18. Among residential and migratory elephants which one do you think as more destructive?

(a) Residential (b) Migratory

19. Have you applied any technique for the protection of crop and house?
(a) Yes (b) No

20. If yes, what are the techniques that you apply?
(a) Shouting and chasing with stones, fire, foggy lights, fire crackers
(b) Electric and Solar fencing
(c) Watch towers
(d) Vehicle patrolling
(e) Planting thorny plants and alternative crops
(f) Awareness programmes
(g) Others ……

21. Which techniques are most effective? ……..

22. Is the damage problem increasing in spite of applying techniques?
(a) Yes (b) No

23. Do elephant attack local people?
(a) Yes (b) No

24. If yes, what is the name of the person and date of attack?
Name: ……. Date: ……

25. If, injured by elephant, do you receive any compensation or medical help from concerned authorities?
(a) Yes (b) No

26. Are you satisfied with the compensation you got for your loss?
(a) Yes (b) No

27. Do you think we need to conserve elephants and their habitat?
(a) Yes (b) No

28. What can be done for the conservation of elephant?
(a) Habitat should be maintained
(b) Sufficient food for elephants can be grown in forest area
(c) Captive breeding center should be established
(d) Awareness programmes

ANNEX II

Table 8. Human casualties due to elephant in Mechinagar Municipality (2000-2018A.D.)

S.N.	Name of the victim	Nature of damage	Year (A.D.)
1	Yubaraj Dahal	Seriously Injured	2000
2	Rana Bahadur Diyali	Killed	2002
3	Shambhu Thapa	Killed	2002
4	Durga Thapa	Killed	2002
5	Diwakar Neupane	Seriously Injured	2002
6	Mohan Bhujel	Injured	2002
7	Prem Khadka	Injured	2004
8	Chandra Bahadur Dangi	Killed	2007
9	Hari Prasad Ghimire	Seriously Injured	2009
10	Ram Bahadur Parajuli	Seriously Injured	2009
11	Yasodha B.K.	Injured	2010
12	Rana Bahadur Gurung	Seriously Injured	2012
13	Sharada Kattel	Seriously Injured	2012
14	Asali Rai	Killed	2012
15	Bhote Tamang	Injured	2013
16	Maan Bahadur Katuwal	Seriously Injured	2014
17	Raju Dahal	Seriously Injured	2014
18	Laxmi Ramtel Sarki	Killed	2014
19	Damber Bahadur Kunwar	Killed	2015
20	Jit Bahadur Khatiwada	Seriously Injured	2015
21	Manohari Dhungel	Killed	2016
22	Lamba Bahadur Pradhan	Seriously Injured	2016
23	Sikkime Saila	Injured	2018

ANNEX III

Table 9. Nature of damage and relief provided to the victims of HEC (GoN)

S.N.	Nature of damage	Relief Amount (Rs)
1	General Injury	5,000-10,000
2	Serious Injury	100,000
3	Death	500,000
4	Destruction of Crops/house	5,000-100,000