

**SPATIO-TEMPORAL CHANGES OF WILDLIFE ATTACK AND  
EFFECTIVENESS OF MITIGATION MEASURES IN  
SHUKLAPHANTA NATIONAL PARK, NEPAL**



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Batch: 2075

A thesis submitted in partial fulfillment of the requirements for the  
award of the Degree of Master of Science in Zoology with  
special paper Ecology and Environment

**Submitted to**

Central Department of Zoology

Institute of Science and Technology

Tribhuvan University

Kirtipur, Kathmandu

August 2022

## 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 author(s) or institution(s).

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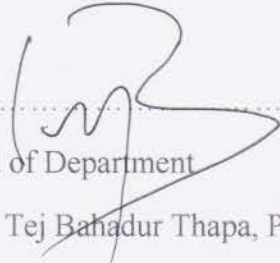
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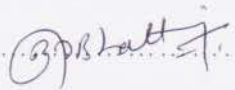
The thesis work submitted by Ms. **Bhinda Pant** entitled "**Spatio-temporal changes of wildlife attack and effectiveness of mitigation measures in Shuklaphanta National Park, Nepal**" has been accepted as partial fulfillment for the requirements of the degree of Master of Science in Zoology with special paper Ecology and Environment.

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## ACKNOWLEDGEMENTS

Foremost, I would like to express my gratitude and indebtedness to my supervisor Associate Prof. Dr. Hari Prasad Sharma, Central Department of Zoology for his guidance, immense help, valuable suggestions, information and knowledge regarding the subject matters. This thesis would not have taken its present shape and quality without his untiring efforts.

I want to thank Prof. Dr. Tej Bahadur Thapa, Head of the Central Department of Zoology for providing administrative supports and facilities. I am highly obliged and extend my thanks to all faculty members and staff of Central Department of Zoology for their kind support, guidance, and feedback on my research project and other academic courses during my study at the department.

I am highly grateful and express my cordial thanks to Ministry of Industry, Tourism, Forestry and Environment Dhangadhi, Kailali for providing financial support for this study. I would like to thank Department of National Parks and Wildlife Conservation and Shuklaphanta National Park office for providing permission to this work.

I thank Mr. Laxmi Prasad Joshi, Conservation Officer of National Trust of Nature Conservation (NTNC) ShNP, Dev Raj Joshi, Wildlife Technician of NTNC ShNP and my brother Chitra Raj Pant for their assistance during field work. I thank Dr. Bhagawan Raj Dahal, Deputy Country Manager of Zoological Society of London, Nepal office for his supports to develop theoretical frame work of the study. I want to express my deep gratitude to my colleague Mr. Sandeep Regmi for his support for this work.

I would like to express my deep gratitude to local community and respondents of ShNP buffer zone, for their co-operation and unconditional support during my field survey. I express my sincere gratitude to my parents who support financially, and encouraged me during field work. I am very much grateful to my friends who directly and indirectly helped for completion of this work.

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# TABLE OF CONTENTS

Page No.

<b>DECLARATION</b> .....	<b>ii</b>
<b>RECOMMENDATION</b> .....	<b>iii</b>
<b>LETTER OF APPROVAL</b> .....	<b>iv</b>
<b>CERTIFICATE OF ACCEPTANCE</b> .....	<b>v</b>
<b>ACKNOWLEDGEMENTS</b> .....	<b>vi</b>
<b>ABSTRACT</b> .....	<b>xi</b>
1.1 Background .....	1
1.2 Objective .....	3
1.3 Justification of study.....	3
<b>2. LITERATURE REVIEW</b> .....	<b>5</b>
2.1 History .....	5
2.2 Human Casualty .....	6
2.3 Livestock Depredation.....	7
2.4 Crop Damage.....	8
2.5 Property loss .....	9
<b>3. MATERIALS AND METHODS</b> .....	<b>10</b>
3.1. Study area .....	10
3.2 Methods .....	12
3.3 Data analysis.....	13
<b>4. RESULTS</b> .....	<b>14</b>
4.1 Respondent's demographic characteristics.....	14
4.2 Human Casualty .....	15
4.3 Livestock depredation .....	16
4.4 Crop production and raiding.....	19
4.5 Property loss .....	24
4.6 People's perception towards HWC .....	24
4.7 Effectiveness of mitigation measures .....	25
4.8 Hot spot areas of human-wildlife conflicts.....	26
<b>5. DISCUSSION</b> .....	<b>27</b>
<b>6. CONCLUSION AND RECOMMENDATIONS</b> .....	<b>31</b>

<b>6.2. Recommendations .....</b>	<b>31</b>
<b>REFERENCES .....</b>	<b>33</b>
<b>APPENDICES .....</b>	<b>45</b>
<b>Appendix 1: Photo plates of livestock killed by wild animals.....</b>	<b>45</b>
<b>Appendix 2. Questionnaire format .....</b>	<b>46</b>

## LIST OF TABLES

<b>Table No.</b>	<b>Table Title</b>	<b>Page No.</b>
<b>Table 1:</b>	Demographic and social information of respondents .....	14
<b>Table 2:</b>	Generalized linear model to identify factors related to cattle killed .....	16
<b>Table 3:</b>	Model-averaged parameters and their lower and upper (95%).....	17
<b>Table 4:</b>	Patterns of livestock depredation .....	18
<b>Table 5:</b>	Yearly crop damage by wild animal .....	20
<b>Table 6:</b>	Generalized linear model to identify factors related to crop. ....	21
<b>Table 7:</b>	Model-averaged parameter estimates .....	22
<b>Table 8:</b>	Crop damage (Rs.) by wild animal in. ....	22

## LIST OF FIGURES

<b>Figure No.</b>	<b>Figure Title</b>	<b>Page No.</b>
Figure 1.	Shuklaphanta National Park and its buffer. ....	11
Figure 2.	The number wildlife attacked on human. ....	15
Figure 3.	Number of livestock depredation (A);.....	18
Figure 4.	Annual crop production in Nepalese. ....	19
Figure 5.	Total amount of crop damage near. ....	23
Figure 6.	Number of respondent's perception .....	25
Figure 7.	Hotspot of human-wildlife .....	26

## **LIST OF ABBREVIATIONS AND ACRONYMES**

BNP :	Bardia National Park
CNP :	Chitwan National Park
HWC :	Human-wildlife Conflict
INGO :	International Non-governmental Organization
NGO :	Non-governmental Organization
NTNC :	National Trust for Nature Conservation
PA :	Protected Area
ShNP :	Shuklaphanta National Park
USD :	United States dollar
Rs. :	Rupees
GLM :	Generalized Linear Model

## ABSTRACT

Use of common resources for food and shelter increases human and wildlife interaction, and is more frequent near to protected area (PA). These interactions mostly become detrimental to human and on their properties. Increasing wildlife population in PAs aids more interaction and cause major loss including human casualty, livestock depredation, crop raiding and property loss. This study investigated the issues caused by wildlife in and around Shuklaphanta National Park by using a questionnaire survey to the people affected by wildlife between 2016 and 2022. In this survey, among 300 respondents' almost equal number of male and female respondents were participated for the survey. Nineteen people were attacked by the wildlife and mostly by Wild Boar (*Sus scrofa*). Ninety-two livestock were killed by Leopard (*Panthera pardus*), and among them majority of livestock were killed near the park boundary. In addition, crops were maximum raided by Asian Elephant (*Elephas maximus*) and was followed by Wild Boar. Among the crops, the paddy was the highly raided crops in terms of monetary loss and followed by sugarcane, wheat, mustard, maize, and potato. The Asian Elephant was the only one reason for all forms of property loss, and property damage like house, shed and oil seed. Majority of these attacks were found in Bhimdatta Municipality Ward No. 15, and seems the most hotspot for conflict. More than two thirds of respondents appreciated the implemented mitigation measure as an effective measurement tools except 18.43% respondents. Even after addressing the mitigation measures, animal damage is occurring in Shuklaphanta National Park. Therefore, this study recommends use of more efficacious deterrent technique such as electric fencing, in addition government and NGOs should collaborate with locals to test and share ideas on innovative methods to deter wildlife using unpalatable crops.

# 1. INTRODUCTION

## 1.1 Background

Human-wildlife interaction occurs when human and wildlife live in close proximity (Lamichhane et al. 2019), and share common resources for food and shelter (Graham et al. 2005). Rapid human population growth and competition for resources causes human intervening in wildlife habitat resulting into the conflict (Rodgers 1989). Further, increasing wildlife population due to protected areas also somewhat aids to this conflict (Messmer 2009). This generated conflict between them with adverse effect on either one or both (Conover 2001). The conflict between human and wildlife is omnipresent in both developed and developing countries (Manfredo and Dayer 2004). The losses from wildlife include crop damage (Osborn and Hill 2005), livestock depredation (Treves and Bruskotter 2014) and human injuries (Sponarski et al. 2015). These activities increase negative attitude of people towards wildlife (Khan et al. 2018). This scenario becomes one of the most critical threats to many wildlife species' survivals mainly due to potential retaliatory killing (Dickman 2010, Khan et al. 2018), natural habitat loss, rapidly increased human population and wildlife population change (Rodgers 1989, Saberwal et al. 1994).

Most of the attacks from wildlife are generally found more severe to farmers who are living in rural communities (Treves and Bruskotter 2014, Akampulira et al. 2015), however, little is known on the damage or economic losses caused by wildlife from all affected areas (Messmer 2009). In Asia and Africa, communities may lose up to 15% and 10% of their total agricultural production from Asian Elephants (*Elephas maximus*) and African Bush Elephant (*Loxodonta Africana*) respectively (Lamarque et al. 2009, Madhusudan and Sankaran 2010). Further, in low-income countries such as Mozambique and Namibia, over a hundred people get killed annually by Nile Crocodiles (*Crocodylus niloticus*; Lamarque et al. 2009). In Nepal, people are mostly attacked by large mammals like Tiger (*Panthera tigris*; Dhungana et al. 2019), Leopard (*P. pardus*; Woodroffe 2000, Woodroffe and Frank 2005, Baral et al. 2022), Greater One-horned Rhino (*Rhinoceros unicornis*; Sedhain and Adhikary 2016), Asian Elephant (Acharya et al. 2016) and Himalayan Black Bear (*Ursus thibetanus*; Thakur et al. 2007). The conflicts developed from wild animals, especially elephants started entering human settlements in the region as a result human intervening and encroachment of forested areas and vice versa (Deuba

2019). Natural areas are being continuously exploited due to increment in human population and their requirements and it has altered the global landscape (Limbu and Karki 2003). Illegal and unmanaged settlements in and around the protected area had hindered preservation effort and activities such as logging, grazing and poaching had seriously damaged the natural environment and wildlife habitats (Bhattarai 2001). Likewise, anthropogenic noises also impact wildlife, reducing the capacity of their sound perception which being crucial to survival and reproduction has caused stress and behavior alteration in animals (Buxton et al. 2017).

To avoid conflicts in Nepal different measures are used, mainly electric fencing which seems to be significantly effective and found to reduce crop damage (Sapkota et al. 2014). Different compensatory and incentive-based programs have been conducted in various form at local communities such as community based conservation and integrated conservation and development projects (Brandon and Wells 1992, West et al. 2006, Spiteri and Nepal 2008, Sapkota et al. 2014) in Bardia National Park area to minimize the social costs for local communities (Karki 2013). Despite some differences between these two programs, various authors have used the term incentive-based programs to describe projects that aimed to balance conservation with the livelihood needs of local residents around protected areas (Hutton and Leader-Williams 2003, Spiteri and Nepal 2008).

With frequent incidents like tusker attacks causing seven deaths and twelve injuries in the past five years (Deuba 2019), death of a woman due to Tiger attack (Post 2016), human wildlife conflict seems to be common in Shuklaphanta National Park (ShNP), and yet is not properly studied. Since it occupies large area with nine buffer zone user community and 42 community forests, it indicates the major sources to local people's livelihood. This has led to conflict related problems like crop raiding, livestock depredation and to an extent, some wildlife attacks. This has forced local people to develop a negative attitude for wildlife. Therefore, identifying the frequency as well as the conflict related activities by wildlife near (<500 m) and far (>500 m) from the park boundary with evaluating various measures taken by park is prerequisite for developing policy of biodiversity conservation with sustainable livelihood of local people. The authority of National Park to address the wildlife conflict as well as to find the most effective measure among the adopted one. This study helps to explore new measures that can be fruitful for minimizing those conflicts.

## **1.2 Objective**

The general objective of this study was to identify the wildlife attacks on human and their properties near and far from the Shuklaphanta National Park, Nepal.

### **Specific objectives**

- To assess the spatio-temporal changes of wildlife attacks on human, livestock, crop and property near and far from the Shuklaphanta National Park.
- To evaluate the effectiveness of mitigation measures in Shuklaphanta National Park.
- To identify the hot spot of wildlife attack in Shuklaphanta National Park.

## **1.3 Justification of study**

Shuklaphanta National Park has nine buffer zone user communities and 42 community forests, and these user group members depend on the park resources. Every year in ShNP area, Asian Elephants enter the human settlements and destroy houses and crops (Bhatta 2019). In 2016, a woman died of tiger attack while grazing her goats in ShNP area (Post 2016). As of December 2019, two women were killed and four others were injured in Asian Elephant attack in Makuri Community forest. Further, seven people were killed and 12 injured by elephant attack in the last past five years in Kanchanpur (Deuba 2019). Like this, wild animals from the protected areas frequently enter human settlements in the buffer zone areas and damage crops, even taking lives. The park and other institutions are working to minimize the conflict; however, no proper management was applied in these cases. Although many measures have been adopted by the authority to control the conflict, they haven't been so effective. On the other hand, victims of wildlife attacks, some with lifelong disabilities, are deprived of compensation, which has added further negative attitudes towards wildlife. This shows that a site-specific management plan is necessary to establish harmonious relationship between human and wildlife, and to develop that, updated information is necessary. For developing policy or management plan to minimize the conflict, a baseline data on the level of conflict severity is urgently needed along with the effectiveness of mitigation measures. Therefore, this study focused to understand severity and concentration of conflicts by evaluating the various measures taken by the authority of national park to address the wildlife conflict as well as pointing

out the most effective measure among the adopted ones. The data generated from this project supports for developing management plan to minimize a human wildlife conflict along with biodiversity conservation.

## **2. LITERATURE REVIEW**

### **2.1 History**

Human-wildlife conflict is typically refers to as wildlife creating problems to human (Peterson et al. 2010), However, the conflict is man made problem because human is one of the main driver of biodiversity loss, and become one of the greatest threats to biodiversity conservation (Ravenelle and Nyhus 2017, Milich et al. 2021). Wild animal mostly damages crop as well as attacks human, depredates livestock and cause property loss (Milich et al. 2021). Among the conflicts, human attack and livestock depredation are the more serious threats of human wildlife co-existence.

Wild animals and human have a long-standing and complicated relationship (Treves and Naughton-Treves 1999). To understand these interactions different studies, try to comprehend these relationships by describing them and by looking at the difficulties of coexisting with animals (Bostedt and Grahn 2008, Carter et al. 2012, Bhatia et al. 2020). There are both positive as well as negative outcomes of the interaction between human and wildlife (Soulsbury and White 2015). Positive interaction offers benefits such as recreational, educational and ecosystem services (Soulsbury and White 2015), while negative interaction harms to human such as human attacks, livestock depredation, crop raiding and property loss (Bostedt and Grahn 2008, Carter et al. 2012, Acharya et al. 2016, Pandey et al. 2016) and livelihood of local people (Baral et al. 2021).

The history of human-wildlife conflict is as old as human civilization (Anand and Radhakrishna 2017). According to Anand and Radhakrishna (2017) in India, the human-wildlife conflict was firstly recorded in 1976, where majority of studies were occurred after 1996. Need of balance between human and conservation in Chitwan National Park (CNP) was held first time in 1982 (Mishra 1982). However, the compensation scheme for victim as an initiative for wildlife related damages was started from 2005 in CNP to minimize the potential conflict between human and wildlife (Lamichhane et al. 2019). All over the Nepal, 463 cases of human casualty were reported from 2010–2014 (Acharya et al. 2016).

## 2.2 Human Casualty

Wildlife attacks on human is becoming one of the main challenging issues all over the world (Nyhus et al. 2005, Inskip and Zimmermann 2009, Marchini and Crawshaw Jr 2015, Silwal et al. 2017). In Asia, human population is doubled in the last few decades and people are growing more and closer to the wild animals encroaching into their habitats (Nyhus and Tilson 2004, Inskip and Zimmermann 2009). Mostly the people who live near the protected areas will be in contact with wildlife (Newmark et al. 1994). They are mostly indigenous people and lower caste with no or few opportunities, receive informal education and typically own a smaller piece of land (Lamichhane et al. 2018). These people generally have an agricultural and usually become victims of wildlife attack (Treves and Bruskotter 2014, Akampulira et al. 2015, Lamichhane et al. 2018).

Historically, the extent of wildlife attacks on human is global and is resulting severe consequences around the world (Thirgood and Woodroffe 2005). For example, in Mozambique, Nile Crocodiles, Asian Elephants, Lions (*Panthera leo*) and Common Hippopotamuses (*Hippopotamus amphibious*) were the main wild animals for human attack. Among them 66% of total human death was caused by crocodile during 2006 to 2008 (Dunham et al. 2010). In eastern India from 2017 to 2021, 374 (90.9%) injuries were caused by snake bites and 37(9.1%) were caused by mammals (Pradeep Kumar et al. 2021). In Bangladesh, 223 cases of human casualty (175 death) were caused by Asian Elephant (Hossen 2013).

In Nepal wildlife attack on human is more severe in lowland (Acharya et al. 2017), and the lowlands of Nepal is experiencing an increasing frequency of wildlife attacks (Acharya et al. 2016). In CNP, 732 (168 fatalities and 564 injuries) attacks on human by 11 wild animals were reported from 1998 to 2016 (Lamichhane et al. 2018), and 135 incidents of human casualties occurred between 2016 and 2018 (Bhandari et al. 2020). In Bardia National Park (BNP), 11 attacks (7 fatalities and 4 injury) on human by Tiger were reported between 1994–2007 (Bhattarai and Fischer 2014). After 2007, there were no records of human fatalities around BNP. Upadhyaya et al. (2020) also mentioned that there were no records of human fatalities between 2013 and 2017, however, there were one non-fatal attack in 2013 and two attacks in 2016 (Bhattarai et al. 2019). Baral et al. (2022) stated that Leopards killed 23 people and caused injured for eight people in

Baitadi district between 2011 and 2019. In ShNP, only a single case of human death and 5 injuries were recorded between 2016 and 2020 (Pant 2018, Bhatta and Joshi 2021).

### **2.3 Livestock Depredation**

Global efforts to conserve carnivores are facing major threats across the globe, due to the increasing cases of wild carnivores related livestock depredation (Dickman 2010). The population decline of prey species as well as alteration and diminishment of wildlife habitats are the main causes of livestock depredation (Peterson et al. 2010). Wildlife habitat loss and fragmentation also positively affect livestock predation (Schneider 2001), where it is more common in and around the protected areas (Jackson and Wangchuk 2004, Sijapati et al. 2021). Rapid population growth around the protected areas with predators of large home range size increases the livestock depredation (Gurung et al. 2008). Livestock depredation is increasing dramatically all over the world (Jackson et al. 1996, Mijiddorj et al. 2018, Mitchell et al. 2019). During 2014 to 2016 in Botswana, Africa, 116 livestock were killed and 13 were injured (LeFlore et al. 2019) by wild animals. Similarly, in Bhutan, during 2012 to 2016, a total of 666 livestock were killed (Jamtsho and Katel 2019). Livestock depredation seems serious problem observed in Nanda Devi Biosphere Reserve India also, where a total of 875 livestock depredation were recorded during 1988 to 1997 (Rao et al. 2002). Additionally, 146 respondents mentioned that 870 livestock were killed during 1978 to 1997 by Tiger in Sumatra, Indonesia (Nyhus and Tilson 2004). In CNP the incidents of livestock depredation were mainly caused by large carnivores i.e. Tiger and Leopard (Tamang and Baral 2008). Further, 424 livestock were killed by Leopards (Dhungana et al. 2019). Similarly, in ShNP, 503 livestock were killed by Leopard and Golden Jackal (*Canis aureus*; Pant 2018).

Massive ungulate hunting reduces prey population, which could lead to an increase in livestock predation (Soofi et al. 2019). In addition, the incidents of livestock depredation by large carnivores occurs during different season and time (Tumenta et al. 2013). In Waza National Park, Cameroon, incidents of livestock depredation showed no difference in frequency between summer and winter season. In BNP, livestock depredation mostly occurred in hot dry season (Dinerstein 1979, Tamang and Baral 2008), however, according to Sijapati et al. (2021) livestock depredation mostly reported during the winter season. In CNP, incidents of livestock depredation were similar during dry and wet

seasons (Lamichhane et al. 2018, Dhungana et al. 2019). Also in ShNP, majority of livestock depredation occurred in dry season (Pant 2018). The reason behind the livestock depredation during dry season might be due to insufficient food inside the park (Xiao et al. 2011).

A precise comprehension of livestock predation patterns is essential to address human-carnivore conflict (Dar et al., 2009) in order to pinpoint areas and times with high predation rates. It is necessary to evaluate the ecological, sociological, and climatic characteristics of depredation as well as the monetary loss caused by depredation and related compensatory payments (Dhungana et al. 2018).

## **2.4 Crop Damage**

Among human wildlife conflicts, crop damaged is most prevalent near to protected areas (Milich et al. 2021). Crop raiders varied depending upon the geographic as well as ecological features of study areas. For example, in Africa, Baboons (*Papio Anubis*) were reported as the worst crop raider (Warren 2009), while in Southwest Ethiopia, Olive Baboon (*Papio Anubis*), Vervet Monkey (*Chlorocebus pygerythrus*), Bush Pig (*Potamocgoerus larvatus*) and Crested Porcupine (*Hystrix cristate*) were the major ones (Mamo et al. 2021). In Nepal Wild Boar is major crop raider across all the protected areas. For example, in Shivapuri Nagarjun National Park Wildlife damaged USD 24,000 between March 2009 and April 2010 (Pandey et al. 2016). In BNP, Chital (*Axis axis*), Asian Elephant and Wild Boar are major wild animals for crop damage (Thapa 2010), whereas Chital, Barking Deer (*Muntiacus vaginalis*), Sambar Deer (*Rusa unicorn*), Wild Boar, Greater One-horned Rhino and Asian Elephant were the major wild animals for crop raiding in CNP, which is estimated to be a economic loss of Rs. 6,45,403 caused by wild ungulates between 2002 and 2003. Paddy, maize, lentil, wheat, mustard and vegetable were the reported crop damaged in Barandabhar Corridor Forest (Bhattarai and Basnet 2004). In ShNP, paddy, maize and wheat were the major cultivated crops damaged by Wild Boar, Asian Elephant, Deer, Rhesus Monkey and Peacock (*Pavo cristatus*). Among these animals Wild Boar and Barking Deer were the main wild animals for crop raiding (Bhatta and Joshi 2021). The majority of crop damage occurs near the protected areas (Studsrod and Wegge 1995, Naughton-Treves 1998), which might be due to easy availability of food near protected area or might be due to their habitat at the edge of forest (Di Fonzo 2007).

## **2.5 Property loss**

Asian Elephant is the major animal which causes the property loss with increasing the human population in Asian Elephant habitat (Cordingley 2008). Habitat fragmentation of elephant is the major cause of human elephant conflict in Sri Lanka (Weerakoon 1999). In Nepal most of the property damage was caused by Asian Elephant during night time (Pradhan et al. 2011). Property loss by Asian Elephant was the second most problem faced by the people of Jhapa, Nepal (Neupane et al. 2018), however in Central Nepal property damage (53%) was the most common type of damage among all of the reported damage (Pant et al. 2016).

Human-wildlife interactions have been the subject of numerous studies. It should be carried out in all impacted areas because the interaction problem and its solution vary greatly depending on location. Intensity of wildlife attacks on human and their properties should be properly studied. For improved management of protected areas, regular documentation of crop and livestock damage is required. Spatial and temporal level analysis is rarely studied in conflict of Shuklaphanta National Park. It should be carried out to identify the patterns, location and seasonal variation of wildlife damage. Though many studies have been done in Shuklaphanta National Park to understand the human wildlife conflict (Pant et al. 2016, Bhatta and Joshi 2021), most of these studies are focused on single or particular area only (Pant et al. 2016). So far, less study has incorporated the whole ShNP buffer zone.

### 3. MATERIALS AND METHODS

#### 3.1. Study area

The Shuklaphanta National Park (28°45'47"–29°02'52"N and 80°05'45"–80°21'43"E) is situated at the south-west corner of Nepal (Figure 1). Initially, it was established as a wildlife Reserve in 1979, and was changed to National Park in 2017. It comprises 305 km<sup>2</sup>. The altitude of the Park ranges from 174 m to 1386 m and has an average maximum temperature of 37°C and a minimum temperature of 7°C. The majority of its area is in the Gangetic flood plains, the Park is connected to settlements, forests and the Dadeldhura District boundary in the Siwalik Hills in the North, Syali river in the East, Indian border (Grasslands of Pilibhit Tiger Reserve and Lagga Bagga forests) in the South and Mahakali river in the West.

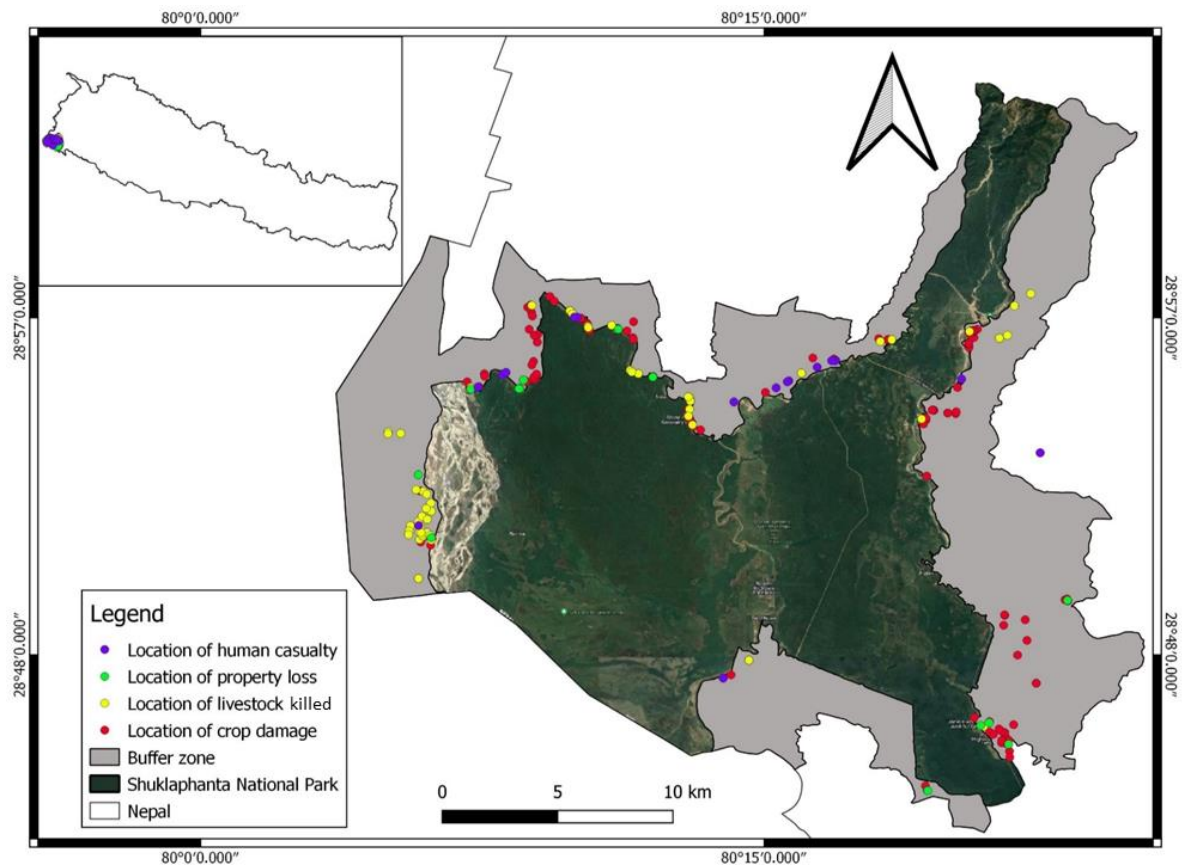
The park area has a tropical monsoon climate, which supports and protects more than 665 species of plant species such as Sal (*Shorea robusta*), Khayar (*Acacia catechu*), Karam (*Adina cardifolia*), Jarul (*Lagerstromia parviflora*), Malbar Kino (*Pterocarpus marsupium*), Siru (*Imperata cylindrical*), Sissoo (*Dalbergia sissoo*), Saj (*Terminalia tomentosa*) and Black Speargrass (*Heteropogon contortus*) (Nyaupane et al. 2020).

Many faunal species are inhabiting in the park including 71 species of herpeto-fauna (56 Reptiles species, 15 Amphibians), 423 bird species and more than 53 mammal species (Rawat et al. 2020). The major fauna of the park includes Asian Toad (*Duttaphrynus melanostictus*), Skittering Frog (*Euphlyctis cyanophlyctis*), Marbled Toad (*Duttaphrynus stomaticus*), Pierre's Cricket Frog (*Minervarya pierrei*), Syhadra Cricket Frog (*Minervarya syhadrensis*), Terai Cricket Frog (*Minervarya teraiensis*), and some of the major reptiles are Oriental Garden Lizard (*Calotes versicolor*), Rock Lizard (*Laudakia tuberculata*), Shuklaphanta Fan-throated Lizard (*Sitana Schleichi*), Brook's Gecko (*Hemidictylus cf. brookii*), Rufous Woodpecker (*Celeus brachyurus*), Indian Grey Hornbill (*Ocyrceros birostris*), Oriental Pied Hornbill (*Anthracoceros albirostris*), Great Hornbill (*Buceros bicornis*), Sloth Bear (*Melursus ursinus*), Honey Badger (*Mellivora capensis*), Leopard, Asian Elephant, etc. (Nyaupane et al. 2020).

Thirty-four wards of five Municipalities and two Rural Municipalities such as Bhimdatta Municipality (Ward No. 13–19), Bedkot Municipality (Ward No. 9 and 10), Belauri Municipality (Ward No. 9), Mahakali Municipality (Ward No. 1–10), Shuklaphanta Municipality (Ward No. 1–7 and 12), Beldadi Rural Municipality (Ward No. 2,4 and 5)

and Laljhadi Rural Municipality (Ward No. 3, 4 and 6) were located in the buffer zone. According to the Municipality office there are about 27067 household in the study area that includes 7330 in Bhimdatta Municipality (population = 37865; male = 18612, female = 19253), 2031 in Bedkot Municipality (population = 11043; male = 5260, female = 5783), 996 in Belauri Municipality (Population = 5855, male = 2814, female = 3041), 7392 in Mahakali Municipality (population = 29253, male = 18130, female = 21123), 4438 in Shuklaphanta Municipality (population = 29553; male = 16791, female = 15762), 2164 in Beldadi Rural Municipality (population = 42447; male = 5755, female = 6692) and 2716 in Laljhadi Rural Municipality ( population = 11884; male = 5825, female = 6059) (CBS 2011).

The occupation of the people in this area is mostly labor work, animal husbandry and agriculture. Among agricultural practice paddy, wheat, maize, sugarcane and mustard are the major crops including bananas as a fruit while livestock includes cows, buffaloes, goats, sheep and pigs.



**Figure 1:** Shuklaphanta National Park and its buffer zone with wildlife attacks on human, livestock and property losses between 2016 and 2022.

### **3.2 Methods**

During this study both the secondary and primary data of wildlife attack in ShNP were collected. The secondary data were the existing household numbers, the number of humans attacks , livestock depredation, crop raiding, and property and economic loss from wildlife between 2016 and 2021, which are available in the park office. Name and location of 900 households who had reported their loss or casualties to ShNP office were used for this analysis. For primary data, a questionnaire survey (Appendix 2) with affected local people was conducted.

#### **Questionnaire Survey**

Among those 900 affected households, 300 households for the questionnaire survey were selected even though the minimum required sample size was 270 households at 95% confidence interval with 5% margin of error (Krebs 2014). Based on the random sampling, 34 wards of five Municipalities and two Rural Municipalities such as Bhimdatta Municipality (Ward No. 13–19), Bedkot Municipality (Ward No. 9 and 10), Belauri Municipality (Ward No. 9), Mahakali Municipality (Ward No. 1–10), Shuklaphanta Municipality (Ward No. 1–7 and 12), Beldadi Rural Municipality (Ward No. 2,4 and 5) and Laljhadi Rural Municipality (Ward No. 3, 4 and 6) were selected for questionnaire survey. The questionnaire survey was conducted between 28 September 2021 and 8 January 2022. The survey was conducted to the people who were older than 18 years, and only one person from a household. The survey was focused only to the person who was witness to the incidence. There was no discrimination between educated and uneducated people, male and female, ethnic group and religion. Both demographic data such as age, gender, education, family size and religion, and socio-economic condition were taken during the questionnaire survey. Furthermore, the number of livestock owned, crop production by respondents in the last six years from 2016 – 2022 were also recorded during this survey. In addition, they were asked whether they are suffering from wildlife i.e. human casualties, livestock depredation, crop-raiding and other property loss in the last six years after managing the mitigation measures. These data were also confirmed with park official's data. During the interview with the victims, they were requested to show the site where the incidents took place and noted the coordinate points. In case of death, the interview was taken with victim's relatives or eye-witness.

### 3.3 Data analysis

The data was categorized in four types of losses a) human casualty (death and injury), b) livestock depredation (buffalo/bull, cow/ox, goat/doe), c) crop raiding (wheat, paddy, maize, mustard, potato and sugarcane) and d) property loss. The Chi-square and Man-Whitney U Test were performed for binary and numeric data, respectively.

The Generalized linear model (GLM) was used to identify the factors affecting livestock depredation and crop damage. For livestock depredation, the total livestock killed between 2016–2022 was used for response variable and total livestock owned (cow/ox, buffalo/bull and goat/doe), distance (far and near from the park), season (summer and winter) and mitigation measures applied by park authority (yes/no) were used as predictive variables. For crop damage, total crop damage was used for response variable, and total land owned, distance (far and near from the park), mitigation measures applied by park authority (yes/no) and preventive measures applied by the local people (yes/no) were used for predictive variables. Akaike's information criterion(AICc) was used to compared the models as it is suitable for small samples (Burnham and Anderson 2004). Akaike model weight is used to identify the capability of each model to describe the scenario of conflict. A hotspot map of wildlife attacks were developed using coordinates of each incidents. The monetary value of crop loss was estimated based on every year's annual selling price of each crop, and also converted to USD according to Nepal Rastra Bank's Exchange rate. All analyses were performed in R program (R Core Team 2020).

## 4. RESULTS

### 4.1 Respondent's demographic characteristics

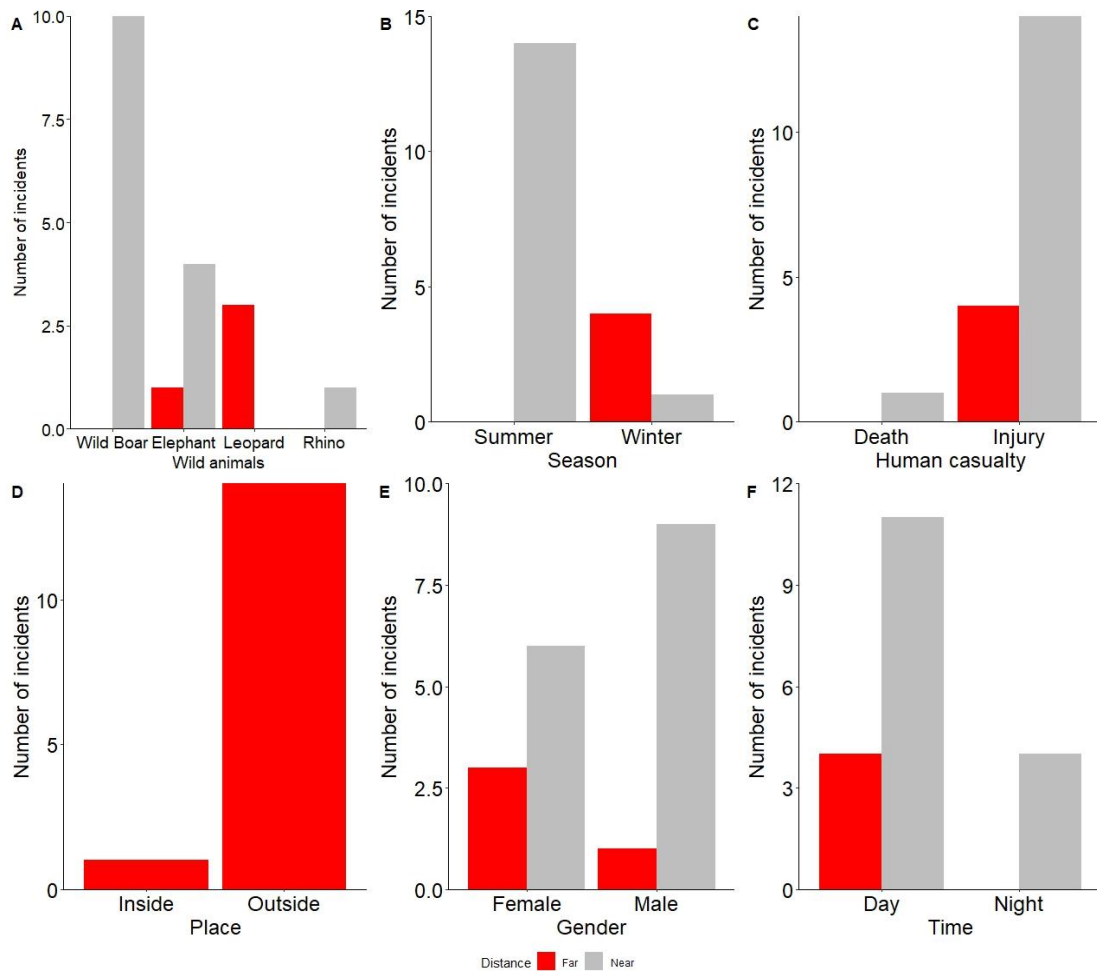
Majority of respondents (77.6%, n = 233) lived near the park boundary (<500 m). Among the respondents, 626 incidents of wildlife attacks were recorded during 2016–2022, and 77.96% (n = 488) of these incidents were near the park boundary. The incidents were recorded upto 5 km from the park boundary during this period. There was no variation on the demographic characteristic of the respondents, gender (male and female), educated and uneducated, age, and occupation living in close proximity and away from the park boundary (Table 1). However, the number of livestock owned by the people living near and far from the park was varied (Man-Whitney Test,  $W = 9129.5$ ,  $p = 0.033$ ), and was more to the respondents living far from the park boundary (median: 5) than near (median: 4; Table 1).

**Table 1:** Demographic and social information of respondents living <500 m and >500 m from Shuklaphanta National Park boundary. Variable age (year), gender (male and female), education (educated: people who attended school through grade five or above; uneducated: did not attend school), Agriculture based livelihood (people who do agriculture for their livelihood), family size (number), and livestock owned (number: all hoofed livestock including cow/ox, buffalo and goat/doe) used for data analysis. Value in parenthesis is range.

Parameters	Near	Far	Statistics
Age (Median)	40 (18 – 85)	40 (20 – 90)	Man Whitney test, $W = 7472$ , $p = 0.594$
Gender (male %)	51	49	$\chi^2 = 0.069$ , $df = 1$ , $p = 0.793$
Educated (%)	42	44	$\chi^2 = 0.157$ , $df = 1$ , $p = 0.692$
Agriculture-based livelihood (%)	93	96	$\chi^2 = 0.501$ , $df = 1$ , $p = 0.479$
Family size (Median)	6 (1 – 34)	6 (2 – 23)	Man Whitney test, $W = 8879.5$ , $p = 0.084$
Livestock owned (Median)	4 (0 – 20)	5 (0 – 25)	Man Whitney test, $W = 9129.5$ , $p = 0.033$

## 4.2 Human Casualty

Wildlife attacked on 19 respondents in and around the ShNP between 2016 and 2022. The average age of the victim was 46 years (range: 11 to 76 years). Mostly, the Wild Boar attacked to the respondents (52.6%, n = 10; near = 10), and followed by Asian Elephants (26.32%, n = 5; near = 4, far = 1), Leopards (15.78%, n = 3; far = 3), and Greater One-horned Rhino (5.26%, n = 1; near = 1; Figure 2A).



**Figure 2:** The number wildlife attacked on human (A); seasonal attack on human (B); number of human casualties (C); attack on human inside and outside the park (D); attack on human according to gender (E); and attack on human according to time of the day (day and night) (F) near (<500 m) and far (>500 m) from the Shuklaphanta National Park boundary between 2016 and 2022.

The wildlife attack on human was varied among the season ( $\chi^2 = 14.632$ ,  $df = 2$ ,  $p < 0.001$ ), and more attacks 73.68% (n = 14; near = 14) were found in summer, followed by

winter (26.32%, n = 5; near = 1, far = 4; Figure 2B). One people died by Wild Boar attack near the park boundary (Figure 2C). The majority of the attacks (89.5%, n = 17) were outside the park [near house premises (36.84%, n = 7), agricultural land (36.84%, n = 7), road (15.79%, n = 3)] and remaining (10.5%, n = 2) was inside the park (Figure 2D). There was no differences on the number of attacks between gender [ $\chi^2=0.053$ , df = 1, p = 0.819 (male: n = 10; near = 9, far = 1, female: n = 9, near = 6, far = 3) (Figure 2E)]. More wildlife attacks on human were recorded at daytime (68.4%, n = 15; near = 11, far = 4) than night (31.6%, n = 4; near = 4; Figure 2F).

### 4.3 Livestock depredation

The best model for livestock depredation includes park distance, season and livestock owned (Table 2). The second best model, however, adds up mitigation measures to the best model. Season and livestock owned is the third best model while mitigation measures, season and livestock owned were included for the fourth best model. Livestock depredation is more likely in a location near ShNP and varied seasonally (Table 3). The depredation was increased with increasing the number of livestock at low practices area of mitigation measures.

**Table 2:** Generalized linear model to identify factors related to cattle killed by wild animals, Shuklaphanta National Park, Nepal between 2016 and 2022. For model construction, livestock killed (number) was response variable; livestock owned (number), season (number of livestock killed: summer, winter), mitigation measures (applied by the park or not), park distance (near <500m and far: >500m from the park boundary), df is the degree of freedom,  $\Delta AICc$  is the difference between the AICc value of the best-supported and successive models, and  $w_i$  is the Akaike weight.

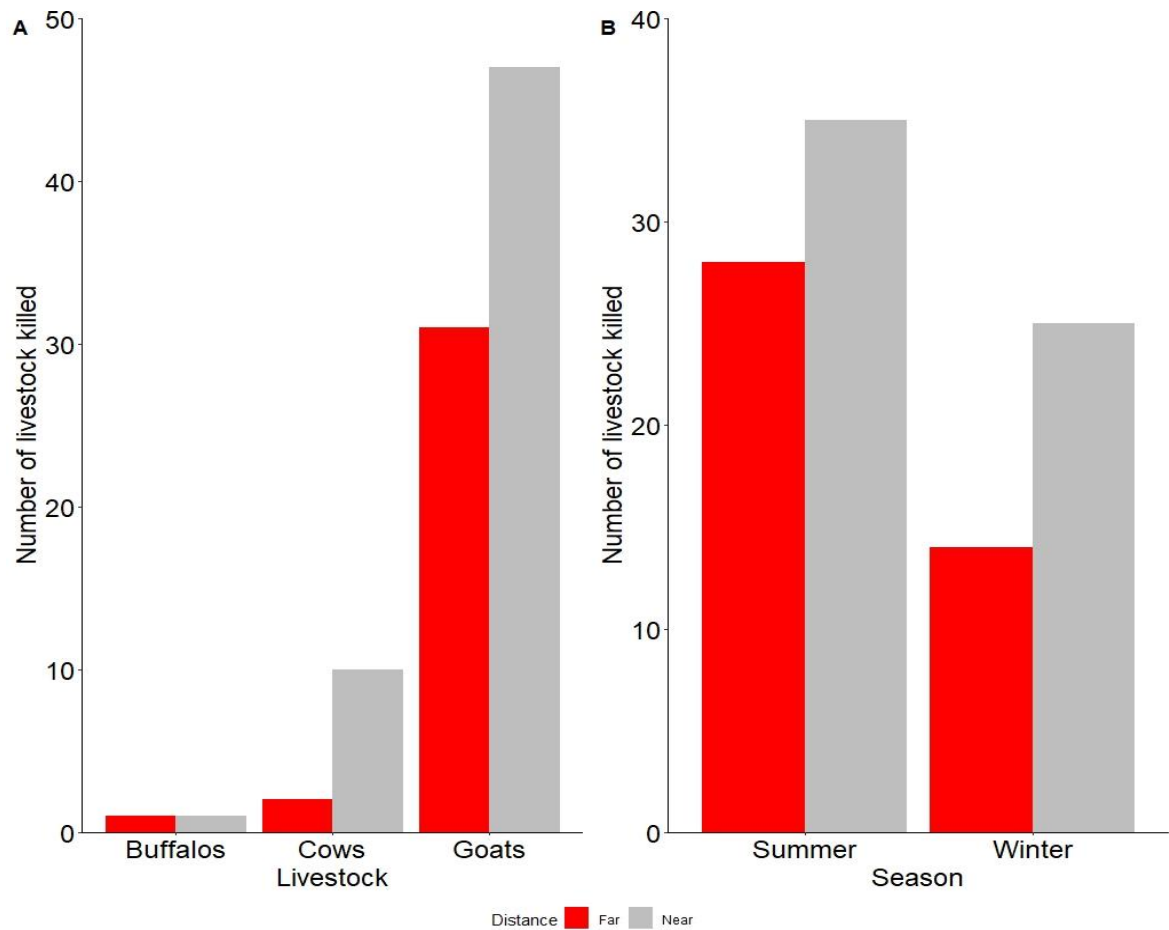
Covariate	df	AICc	$\Delta AICc$	wi
Distance + Season + Livestock owned	4	276.6	0	0.336
Distance + Mitigation measures + Season + Livestock owned	5	277.1	0.54	0.257
Season + Livestock owned	3	277.8	1.25	0.18
Mitigation measures + Season + Livestock owned	4	278.1	1.51	0.158
Distance + Season	3	281	4.42	0.037
Distance + Mitigation measures + Season	4	282.4	5.85	0.018

Season + Livestock owned	2	283.8	7.22	0.009
Mitigation measures + Season	3	285	8.43	0.005
Distance + Mitigation measures + Livestock owned	4	439.7	163.13	0
Distance + Livestock owned	3	440.6	163.99	0
Distance + Mitigation measures	3	441.9	165.34	0
Distance	2	444.1	167.56	0
Livestock owned	2	445.2	168.63	0
Mitigation measures + Livestock owned	3	446.2	169.6	0
Null	1	452.2	175.58	0
Mitigation measures	2	452.6	176.08	0

**Table 3:** Model-averaged parameters and their lower (LCI) and upper (UCI) (95%) confidence limits describing livestock depredation in Shuklaphanta National Park between 2016 and 2022.

	<b>Estimate</b>	<b>LCI</b>	<b>UCI</b>	<b>SE</b>	<b>z</b>	<b>P</b>
(Intercept)	-2.465	-3.149	-1.834	0.335	-7.356	<b>&lt;0.001</b>
Total livestock owned	0.076	0.022	0.125	0.026	2.894	<b>0.004</b>
Season	1.629	1.366	1.911	0.138	11.769	<b>&lt;0.001</b>
Distance from park	-0.391	-0.816	0.050	0.220	-1.777	0.076
Mitigation measures	-0.318	-0.800	0.193	0.252	-1.262	0.207

In ShNP, the Leopard was the only wild animal reported for livestock predation, and majority of the attacks ( 64.04%, n = 58) were near the park boundary. Out of 92 livestock depredation, goat/doe was mostly depredated livestock (84.78%, n = 78; near = 47, far = 31), and followed by cows (13.043%, n = 12; near = 10, far = 2) and buffalos (2.17%, n = 2; near = 1, far = 1) in the last six years (Figure 3A). Majority of reported depredations were found in summer (57.6%, n = 53; near = 35, far = 18), then winter (42.4%, n = 39; near = 25, far = 14) (Figure 3B).



**Figure 3:** Number of livestock depredation (A); and seasonal livestock depredation (B) near (<500 m) and far (>500 m) from the Shuklaphanta National Park boundary between 2016 and 2022.

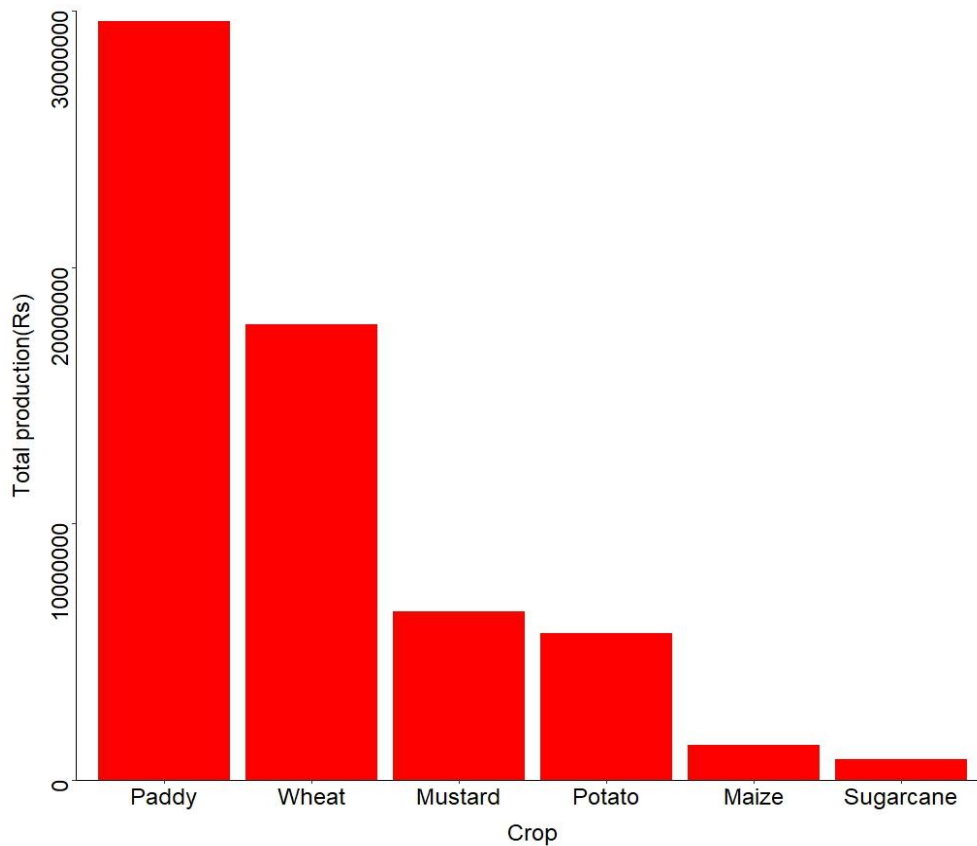
**Table 4:** Patterns of livestock depredation in Shuklaphanta National Park between 2016 and 2022.

Livestock	2022	2021	2020	2019	2018	2017	2016	Total
Goat	1	6	19	27	18	2	5	78
Cow	0	4	1	3	2	1	1	12
Buffalo	0	1	0	0	0	1	0	2

## 4.4 Crop production and raiding

### 4.4.1 Crop production

The respondents living around the park cultivate major six crops: paddy, wheat, mustard, potato, maize and sugarcane. Majority of the respondents (n = 264) cultivate paddy, and followed by wheat (n = 263) and mustard (n = 234). The annual income from the paddy was Rs. 29,599,125 (250,988.9 USD) and followed by wheat (Rs. 17,756,550; USD 145,152.9), mustard (Rs. 6,581,100; USD 53,797.92), potato (Rs. 5,730,300; USD 54,993.28), maize (Rs. 1,356,400; USD 11,501.74) and sugarcane (Rs. 819,968.8; USD 6953.012) among the respondents (Figure 4).



**Figure 4:** Annual crop production in Nepalese rupees around Shuklaphanta National Park between 2016 and 2022.

#### 4.4.2 Crop raiding

Out of 300 respondents, 267 people cultivated crops, among them almost all (96.25%, n = 257) (near = 209, far = 48) of the respondents' crops were raided by wildlife during 2016-2022. Among them 81.32% (n = 209) of these incidents were near, and 18.67% (n = 48) at far from the park boundary. Crop was mostly damaged in 2020 which is followed by 2021, 2019, 2016, 2018 and 2017 (Table 5).

**Table 5:** Yearly crop damage by wild animal in Shuklaphanta National Park between 2016 and 2022.

<b>Crop</b>	<b>2021</b>	<b>2020</b>	<b>2019</b>	<b>2018</b>	<b>2017</b>	<b>2016</b>	<b>Total</b>
<b>Paddy</b>	11,70,035	13,89,695	14,86,911	84,605	37,000	6,28,800	47,97,046
<b>Wheat</b>	6,14,695	6,24,570	6,90,180	3,19,600	0	0	22,49,045
<b>Sugarcane</b>	11,44,200	28,94,075	0	0	1,26,000	2,25,000	43,89,275
<b>Maize</b>	4,100	0	40,400	35,200	0	0	79,700
<b>Mustard</b>	0	1,05,135	12,400	16,000	0	0	1,33,535
<b>Potato</b>	0	0	0	0	50,400	0	50,400
<b>Total</b>	29,33,030	50,13,475	22,29,891	4,55,405	2,13,400	8,53,800	1,16,99,001

The major factors such as park distance, land area, mitigation measures and preventive measures were supporting factors for crop raiding best model (Table 6). The second best model includes park distance, land owned, mitigation measures and crop production. The number of crop raiding events were increased with decreasing park distances. However, crop raiding is not decreasing with increasing number of mitigation measures, land owned, but by stepping up preventive measures, the crop raiding events were reduced (Table 7).

**Table 6:** Generalized linear model to identify factors related to crop loss by wild animals. Crop loss (number) used as response variable; total land owned (number), mitigation measures applied by the park (mesh wire, barbed wire, electric wire, and trench), preventive measures (setting the fire, noise-making, lightning, chemical, exploding firecracker), distance from the park (near <500m and far: >500m from the park boundary), df is the degree of freedom, AICc is the difference between the AICc value of the best-supported and successive models, and  $w_i$  is the Akaike weight.

<b>Covariates</b>	<b>df</b>	<b>AICc</b>	<b><math>\Delta</math>AICc</b>	<b>wi</b>
Distance+Land Owned+Mitigation Measures+Preventive Measures	5	320545.9	0	1
Distance+Land Owned+Preventive Measures	4	320562.5	16.63	0
Distance+Land Owned+Mitigation Measures	4	320619.2	73.36	0
Distance+Land Owned	3	320635.5	89.6	0
Land Owned+Mitigation Measures+Preventive Measures	4	320958.2	412.32	0
Land Owned+Mitigation Measures	3	321020.3	474.42	0
Land Owned+Preventive Measures	3	321021	475.18	0
Land Owned	2	321081.2	535.36	0
Distance+Mitigation Measures+Preventive Measures	4	343653.9	23108.06	0
Distance+Mitigation Measures	3	343655.5	23109.6	0
Mitigation Measures+Preventive Measures	3	343779.8	23234	0
Mitigation Measures	2	343780.2	23234.31	0
Distance+Preventive Measures	3	344898.8	24352.95	0
Distance	2	344900.6	24354.73	0
Null	1	345302.7	24756.87	0
Preventive Measures	2	345302.7	24756.88	0

**Table 7:** Model-averaged parameter estimates and lower and upper 95% confidence limits describing crop damage by wild animals in Shuklaphanta National Park. Model parameters are averaged after obtaining suitable models.

	<b>Estimate</b>	<b>SE</b>	<b>Lower Limit</b>	<b>Upper Limit</b>	<b>Z</b>	<b>P</b>
(Intercept)	6.836	0.0181	6.801	6.826	375.475	< <b>0.001</b>
land owned	0.009	0.0001	0.081	0.098	20.133	< <b>0.001</b>
Distance Near	0.089	0.004	0.009	0.100	164.903	< <b>0.001</b>
Mitigation measures	0.017	0.004	0.009	0.025	4.303	< <b>0.001</b>
Preventive measures	-0.159	0.018	-0.193	-0.124	8.872	< <b>0.001</b>

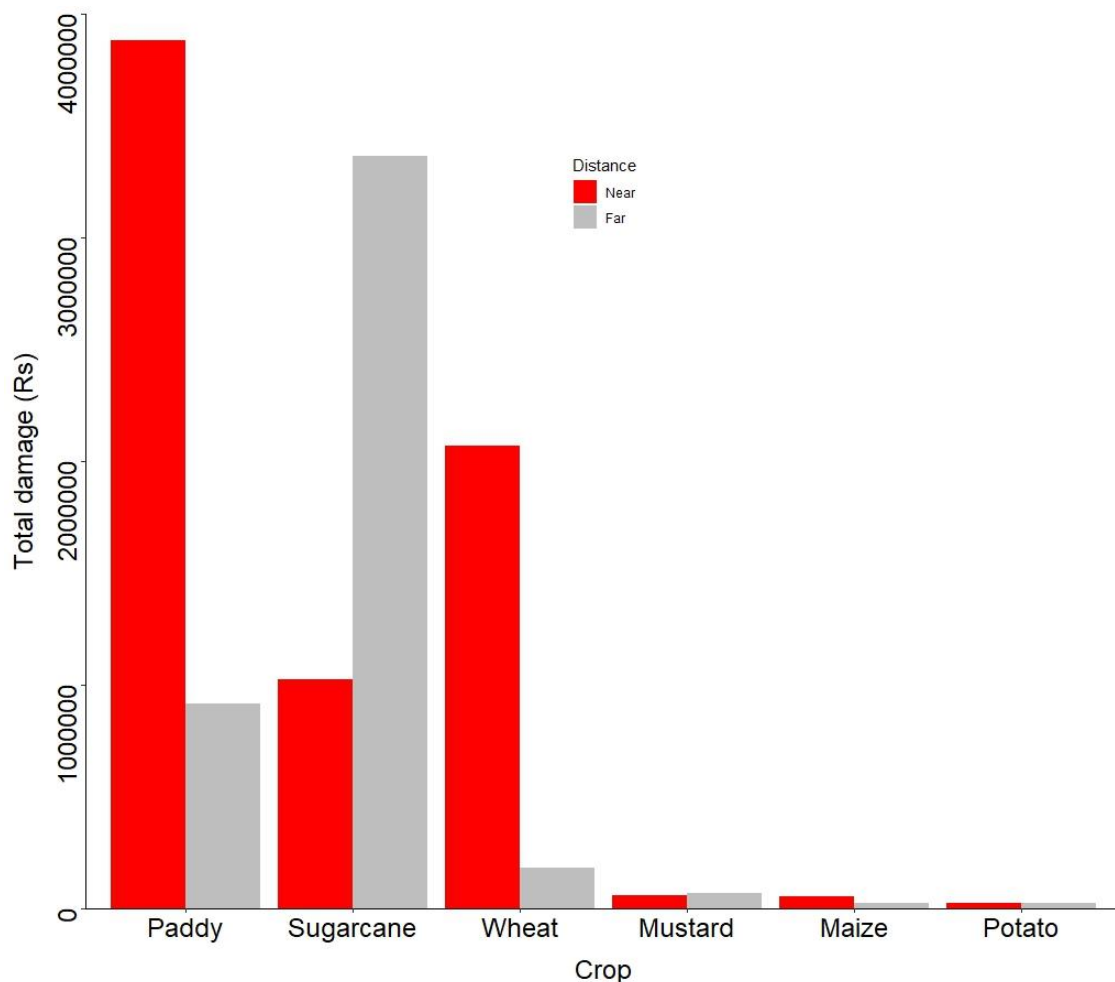
Wildlife includes Asian Elephants raided almost all types of crops, and found major loss in monetary values followed by Wild Boar, Greater One-horned rhino, Spotted Deer, Nilgai and Rhesus Monkey (Table 8).

**Table 8:** Crop damage (Rs.) by wild animal in Shuklaphanta National Park between 2016 and 2022.

<b>Wildlife</b>	<b>Wheat</b>	<b>Paddy</b>	<b>Maize</b>	<b>Mustard</b>	<b>Potato</b>	<b>Sugarcane</b>
Asian Elephant	10,15,870	32,64,806	42,900	32,400	0	43,89,275
Wild Boar	10,64,425	13,06,675	36,800	1,01,135	50,400	-
Nilgai	94,600	62,130	-	-	-	4,250
Greater One-horned Rhino	-	1,11,470	-	-	-	-
Spotted Deer	53,250	42,620	-	-	-	-
Rhesus Monkey	20,900	9,345	-	-	-	-
<b>Total</b>	<b>22,49,045</b>	<b>47,97,046</b>	<b>79,700</b>	<b>1,33,535</b>	<b>50,400</b>	<b>43,93,525</b>

The crop raiders primarily caused damage to paddy, sugarcane, wheat, potato, mustard and maize as these crops were the most cultivated in the study area. Based on the monetary value maximum damage was caused to paddy [Rs. 47,97,04 (USD 41,595.42);

near = 38,80,616, far = 9,16,430], followed by sugarcane [Rs. 43,93,525 (USD 37,600.865); near = 10,27,225, far = 33,66,300], wheat [Rs. 22,49,045 (USD 19,412.55); near = 20,67,245, far = 1,81,800], mustard [Rs. 1,33,535 (USD 1,137.52); near = 61,535, far = 72,000], maize [Rs. 79,700 (USD 701.094); near = 55,200, far = 24,500] and potato [Rs. 50,400 (USD 490.42); near = 24,000, far = 26,400] (Figure 6). In monetary terms, the overall loss to farmers was estimates to be Rs. 1,17,03,251 between 2016-2022. Majority of the respondents (n = 233) mentioned that the crop raiding was found mostly at night then at any other time (n = 48). All respondents mentioned that, animals raided crops from the time of germination to the time of harvesting, most damages occurred during the time of harvesting.



**Figure 5:** Total amount of crop damage near and far from the Shuklaphanta National Park between 2016 and 2022.

#### **4.5 Property loss**

Asian Elephant was major driver for all forms of property loss, and damaged 22 properties between 2016 and 2022. The Asian Elephant mostly damaged the house (86.36%, n = 19), and followed by shed (9.09%, n = 2), and oil seed (4.55%, n = 1), which was a total loss for Rs. 7,71,500. All of the incidents were took place at night. More respondents (77.27%, n = 17) mentioned that the property loss was more severe near the park than far from the park (22.73%, n = 5).

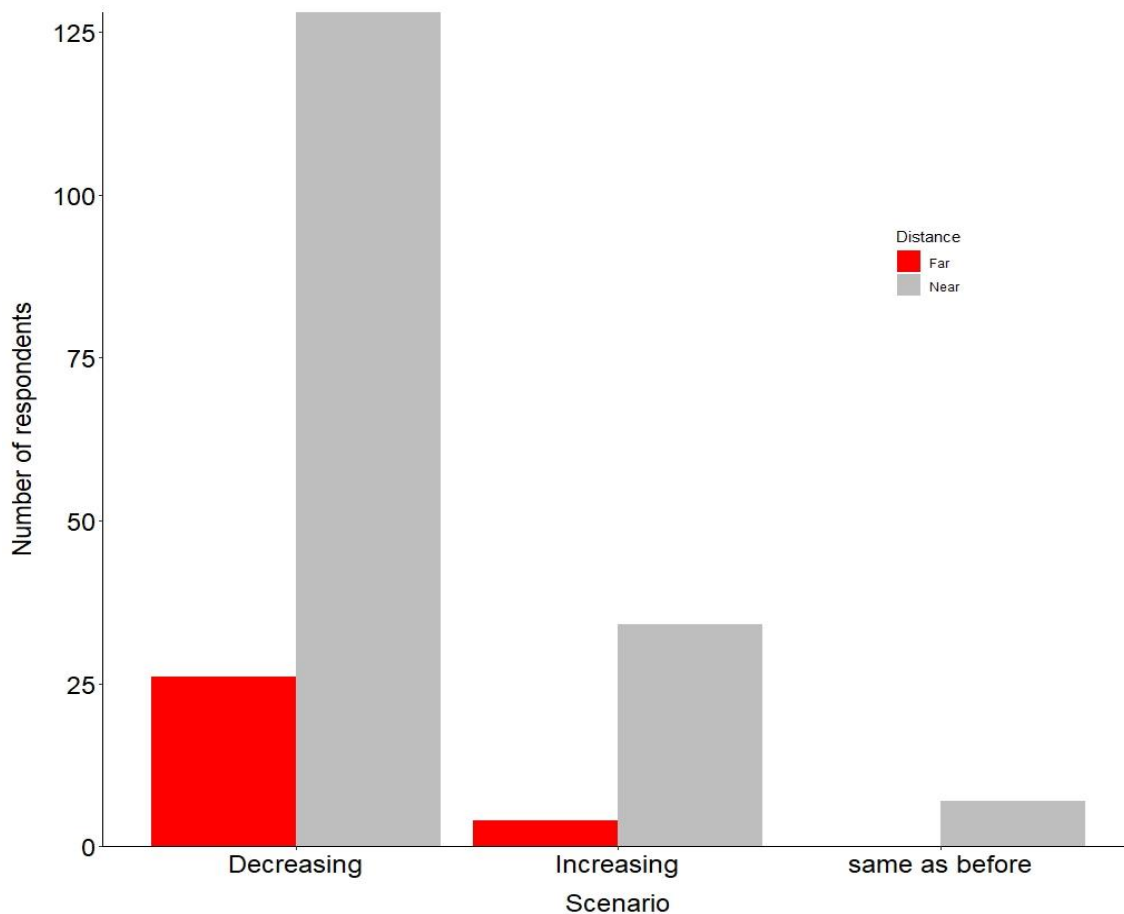
#### **4.6 People's perception towards HWC**

Out of 300, 34 respondents had a strong affinity to wildlife conservation, 146 said they like them, 24 respondents were in indifference, 86 respondents mentioned that they dislike and remaining 10 respondents said they strongly dislike the wildlife. Out of 300 respondents, 47.67% (n = 143) respondents agreed that wildlife should be conserved even if their family member is killed, 36.67% (n = 110) disagreed and the remaining respondents (15.66%, n = 47) were neutral. However, 50.33% (n = 151) support wildlife conservation, 31% (n = 93) opposed it and 18.67% (n = 56) were neutral, if a family member is harmed by wildlife. In case of respondents whose livestock is killed, 52% (n = 156) of these respondents support wildlife conservation, however, 26% (n = 78) opposed it and 22% (n = 66) were neutral. Around 53.33% (n = 160) of respondents mentioned that they want to support for wildlife conservation, whereas 24.67% (n = 74) oppose it and 22% (n = 66) were neutral if wild animals damage their crop.

Only 192 of the 300 victims received compensation from the park authorities, of whom 125 were content with the amount and the others were not. There was no difference between respondent's attitudes toward wildlife conservation and satisfaction with compensation ( $\chi^2 = 3.650$ ,  $df = 1$ ,  $p = 0.056$ ). If head of the family is killed by wild animal we asked if the park authority should pay for their children's education or give the money to the victim's family, 72% (n = 216) respondents mentioned that the park authority should pay for the children's education while just 28% (n = 84) disagreed. Similarly, for satisfaction with compensation procedure, 64.33% (n = 193) of respondents reported that they were not satisfied with the compensation procedure, while 35.67% (n = 107) of them were satisfied.

#### 4.7 Effectiveness of mitigation measures

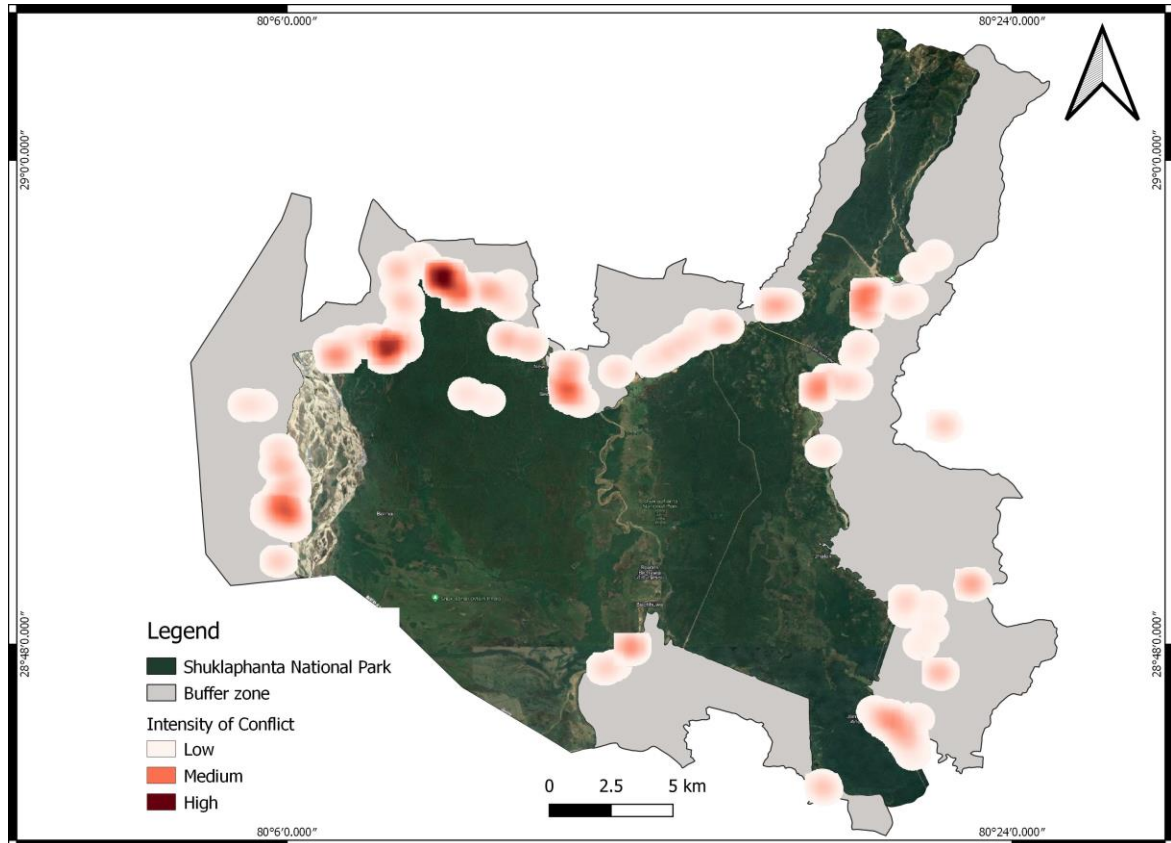
Out of 300 respondents, 65.67% respondents reported that the scenario of wildlife affect is reducing, 28% respondents mentioned that it is increasing, and the remaining respondents (6.33%) reported it as a constant. One hundred and ninety-nine respondents had knowledge on the mitigation measures applied by the park. More respondents 76.9% (n = 154, near = 128, far = 26) had agreed a decreased wildlife effect due to the effective implementation of mitigation measures, however, 18.43% (n = 38, near = 34, far = 4) respondents mentioned increased effect, and 1.67% (n = 7, near = 7) reported same as before (figure 6). Mitigation measures has been successful to cope up with current scenario of conflict ( $\chi^2 = 44.553$ ,  $df= 2$ ,  $p <0.001$ ).



**Figure 6:** Number of respondent's perception towards the scenario of human-wildlife conflict after applying mitigation measures near and far from the Shuklaphanta National Park between 2016 and 2022.

#### 4.8 Hot spot areas of human-wildlife conflicts

All together 361 coordinates were recorded, of which 19 (near = 15, far = 4) represented human casualties, 63 (near = 43, far = 20) livestock depredation, 257 (near = 209, far = 48) crop raiding, and 22 (near = 17, far = 5) property loss. By the intensity of these coordinates, the Ward No. 15 of Bhimdatta Municipality's was highly affected area for wildlife loss (Figure 7).



**Figure 7:** Hotspot of human-wildlife conflict most and least affected by wild animals in Shuklaphanta National Park between 2016 and 2022.

## 5. DISCUSSION

This study performed an empirical estimation of the extent of wildlife effects on human, livestock and crop near and far from the ShNP. The wildlife effect is more severe nearer to the park boundary. The majority of people living around the PA depends on agricultural-based livelihood, which has a close connection with the park's forest and thus increasing the chances of human and wildlife interaction (Nepal 2002). Young and active working people involve for agriculture and farming, and these are prone to victim from wildlife. Both male and female involve in agricultural activity, and also go to the park for resource collection. Further, both the genders are equally involved in crop safeguarding, which makes the number of attacks uncertain between genders. As most of the people do these kind of activities more during the daytime than night, most attacks in the study area are noticed at daytime (Silwal et al. 2017, Bombieri et al. 2018). Further, rapid human population growth near the PA and humans intervening inside the PA increases the conflict (Rodgers 1989).

Of the four mammalian species, the Wild Boar is main wildlife to human attack. More attack from Wild Boar might be due to increased its population in the PAs (Pandey et al. 2016). Not only in this study, the Wild Boar is one of the major driver for human-wildlife conflict (Thapa 2010, Barrios-Garcia and Ballari 2012, Pandey et al. 2016). However, there is a lack of spatial and temporal changes of Wild Boar population and carrying capacity of the PA. The majority of attacks during summer are in agricultural land and near to the settlement might be due to less grazing areas inside the park (Bhandari et al. 2020). Another reason might be due to the behavior of Wild Boar as it needs open habitat during summer and moves closer to human settlement (Thurfjell et al. 2009). The attacks being inversely related to the distance from the PAs might be the consequence of wild animals roaming to find better habitats and entering buffer zone forests thus increasing the chances of contact between human and wildlife (Nyhus et al. 2005, Pant et al. 2016). According to the victims, animals act aggressively when people try to fend them off from the cultivated areas, which results in fatal encounters.

The majority of livestock depredation was observed at proximity to the park, which might be due to the foraging behavior of wild carnivores (Gaynor et al. 2019), and the increasing population of large carnivores across all PAs of Nepal (Thapa et al. 2017). Higher number of livestock depredation during summer might be due to length of the day

and grazing time of livestock (Wells et al. 2019), which is supported by Tamang and Baral (2008). Most of the livestock depredation occurs during the summer season (Bhadauria and Singh 1994, Srivastav 1997, Woodroffe and Frank 2005, Kolowski and Holekamp 2006). According to the respondents, people keep their livestock in an open air passing during the summer due to extremely hot temperature, however, during the winter season they are kept in air tight sheds as the temperature drop drastically. This can be one of the underlying factors for higher number of depredation in summer. As the mostly farmed and raised animals in the study area are goat, it is the highest depredated livestock. In case of depredating animals, the frequency of livestock depredation by Leopard is more prevalent than any other large carnivores (Stein et al. 2017, Sijapati et al. 2021). This is also supported by the ecological behavior of Leopard as it prefers to hunt smaller-sized hoofed animals such as goat, sheep and calves (Murphy 1998, Kissui 2008, Adhikari et al. 2020). Their preferred prey species ranges between 2 and 40 kg (Hayward et al. 2006, Lovari et al. 2013), which might be due to the lower cost of energy spent in handling smaller prey species (Hayward et al. 2006). Livestock depredation by wildlife frequently occurs in the area where little or no fencing is implemented, as well as shoddy construction of animals shelter and letting livestock roaming on the open pastureland (Sijapati et al. 2021). Therefore, better husbandry techniques, such as building secure enclosures, installing stronger fencing, and providing stall feeding, would aid in discouraging and preventing many incidents of wildlife predation on livestock (Amador-Alcalá et al. 2013).

According to Pant (2018), wild animals increased after the establishment of ShNP, and the temporal pattern of land use changes showed the forest cover over the years been declining (Acharya et al. 2016). With increasing wildlife and decreasing forest area nutrition deficiency stress has occurred (Jones and James Reynolds 2008), which caused herbivores to reach the cultivated lands. Six herbivore species are reported to enter agricultural land and cause crop damage in the study area among which Asian Elephant and Wild Boar were the most crop raiders. It might be due to the lack of natural food in the forest due to the pressure of human encroachment and settlement near PAs (Xiao et al. 2011). Before 1950s, most of the Tarai region of Nepal was unoccupied due to the high risk of malaria. However, after eradication of the disease and resettlement schemes by the government, human population has exponentially increased (Kansakar 1979). Encroachment of elephant habitat by humans is the one of the leading causes of increased

crop raiding by Asian Elephant (Pradhan et al. 2011). According to Shrestha (2007), the rate of incidents of human-elephant conflict is increasing in Nepal. However, from 2016–2022, there was no significant trend in the number of human-elephant conflict incidences in ShNP. Crop damage is more common in nearer the park it might be due to the higher forest cover in the edge of ShNP (Shrestha 2007). Previous studies on the area also revealed that there is a significant difference in distance and quantum of damages (Bhatta and Joshi 2021). The Wild Boar is the one of the major crop raider and it might be due to high abundance of the species in and around the PAs of Nepal (Pandey et al. (2016). Due to its preference towards agricultural crops rather than wild ones (Mackin 1970). The mostly damaged crop in the study area was paddy as it is a major crop grown all over Nepal and is more palatable than other crops (Chaudhuri and Gharde 2017, Bhatta and Joshi 2021). Further, previous studies in human wildlife conflicts in ShNP also reveal that paddy was a highly damaged crop which accounted for nearly 70% of the total crop loss (Nepal 2007). Most of the crop was damaged during harvesting time as mature crops are high on nutrition (Malugu and Hoare 2007, Ntalwila et al. 2011), highly palatable (Chaudhuri and Gharde 2017) as well as take less time to reach from the park boundary (Tweheyo et al. 2005, Ntalwila et al. 2011).

During the search of nutritious food, Asian Elephant reportedly caused property damage. According to Sukumar (2006), some aggressive Asian Elephant, if disturbed during crop raiding they can inflict human casualty as well as property loss. Elephant mostly damages crops in cultivated areas adjacent to the PAs due to their habitats (Di Fonzo 2007). This study identified Ward No. 15 of Bhimdatta Municipality to be the hotspot of human wildlife conflict between 2016 and 2022. This might be due to the large area of the ward being in close proximity of the forest (Michalski et al. 2006) as well as the dense settlement there (Baral et al. 2021).

Government try to give compensation to those victims, however, most of them are unsatisfied because the system of compensation has a cap (Faure and Skogh 1992) on the amount at Rs. 10,000 even though the harm exceeds that amount. Some people are not satisfied with the compensation procedures because of the lengthy procedures. Further, reasons like inadequate information from both the park authority and buffer zone user group committee are also the reasons behind the dissatisfaction with compensation procedures (Sillero-Zubiri et al. 2007). Park authority tried to implement mitigation

measures to manage this types of conflicts in ShNP. However, the respondents claim that because of incomplete implementation of mitigation measures, pressure of animals entering near human settlement is high that cause increase in human-wildlife conflict, which is also supported by Okello and D'amour (2008).

## **6. CONCLUSION AND RECOMMENDATIONS**

### **6.1 Conclusion**

Human casualty, livestock depredation, crop damage and property loss are the major types of effect caused by wildlife of ShNP. The Wild Boar is the main wild animal recognized for human attack, whereas Leopard and Asian Elephant are for livestock depredation and crop raiding and property loss, respectively. Maximum amount of damage is found in paddy which is followed by sugarcane, wheat, mustard, maize and potato. These incidents are mostly near the PAs compared to far from the park boundary. This study revealed that the maximum number of incidents are in Bhimdatta Municipality Ward No. 15. Government is still implemented some preventive measures to reduce wildlife attacks and loss but not seems more effective. Thus better investigation and planning are needed for minimizing wildlife attacks on human, livestock, crop raiding and property loss so that appropriate actions can be taken in time to prevent from further attacks.

### **6.2. Recommendations**

Based on the results of this study, there are some recommendation to manage wildlife damage:

To reduce wildlife attack on human, timely identification and management of wildlife and public awareness program should be needed. One of the family member of the victim should provide job opportunity and bear education cost of their children. Establishment of proper emergency rescue team, awareness in local people about conflict prone areas as well as areas of species movements, regulation and limitation of anthropogenic activities in and around the PAs.

To manage livestock loss, well-managed shed for livestock and livestock insurance for relief fund is urgently needed. People should be encouraging to use effective wildlife deterrent technique.

Adopting alternative farming crops, for which the production can be increased by testing the soil and carrying out alternative farming (unpalatable and less preamble crop) in such a way that wild animals do not damage it (for this work, the municipality has to fully support the farmers). Such as: cultivation of chilli, lapsi, ginger, turmeric, millet, yam,

walnut, bamboo etc. Discuss more with various concerned agencies for controlling damage by wild animals and declare it as a national problem and seek cooperation from the state government and the central government. Apiculture training and knowledge about its probable profit should be given to the locals as it is one of the best methods to deter elephant loss. The municipality should adopt a policy of providing reference materials and financial support to those conducting research on wildlife control plans. Crop insurance with special government subsidies should be done. All the municipalities of the district should run a campaign and make a common agenda for wildlife damage control, so that it can be controlled a lot even though it cannot be completely controlled. Government and NGOs should collaborate with locals to test and share ideas on innovative methods to deter wildlife. Electric fencing is urgently needed for protecting all types of conflicts.

The knowledge of payment procedure should be given to all the affected people and amounts of compensation should be given by calculating their loss and cap of compensation amount should be removed.

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## APPENDICES

### Appendix 1: Photo plates of livestock killed by wild animals.



Source: NTNC ShNP

### Appendix 2: Photo plates of questionnaire with local affected peoples.



## **Appendix 2. Questionnaire format**

Questionnaire used to survey 300 households from the buffer zone of Shuklaphanta National park

### **Section I Demographic condition of the respondents**

1. Age 2. Gender: Male/Female 3. Education: Illiterate/Literate 4. Agriculture-based livelihood: Yes/No 5. Family size 6. Livestock owned

### **Section II Human attack**

1. Age of the victim 2. Affected wild animal 3. Season: Summer/Winter  
4. Casualty: Death/Injury 5. Place of incident: Inside/Outside 6. Gender: Male/Female  
7. Time: Day/Night

### **Section III Livestock Depredation**

1. Depredated Livestock: Goat/Doe, Cow/Ox, Buffalo/Bull 2. Month: Summer/Winter 3. Number of livestock kill

### **Section IV Crop production/damage**

1. Amount of crop (paddy, wheat, mustard, potato, maize and sugarcane) production in

1 kattha and total area cultivated for each crop 2. Total area of crop damage

3. Responsible animal for crop damage

### **Section V Property loss**

1. Type of property loss 2. Responsible animal for property loss 3. Time

### **Section VI People perception and attitude**

1. Attitude towards wildlife: Like/Dislike/ In difference

2. Conserve wildlife: If family member is killed: Agree/Disagree/Neutral

If family member is injured: Agree/Disagree/neutral

If livestock killed: Agree/Disagree/neutral

If crop damaged: Agree/Disagree/neutral

3. Compensation: Yes/No

4. What should be given for if head of the family is killed: Bear Education cost of their children, 500000, 700000, 1000000

5. For Livestock kill: market value of livestock /75% of value/50% of value/25% of value  
6. For crop damage: market value of crop/75% of value/50% of value/25% of value

7. Satisfied with compensation procedure: Yes/No

8. If not: it is too lengthy/ Information and service from park authority is not adequate/  
Information/service from BZUG/BZUC is not sufficient.

### **Section VII Mitigation measures**

1. Mitigation measures applied by park: Yes/No    2. Any changes after applying mitigation measure: Decreasing/Increasing/Same as before    3. Preventive measures applied: Setting fire/ Noise making/ Lightening/ Others ....