

Understanding the Dynamics of Human-Tiger Conflict in Chitwan National Park, Nepal

by

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## **Author's Declaration**

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

## **Abstract**

The forests of Chitwan National Park in the southern lowlands of Nepal provide habitat for more than 100 Bengal tigers. Recently, the tiger populations have increased in the region, which has increased the chances of conflict between tigers and people living in the vicinity of the park. In this study, the aim was to determine the dynamics of human-tiger conflicts and assess the perspectives of the local community towards tigers. Firstly, through desk research on human-tiger conflicts, the spatial and temporal variations of tiger attacks were assessed. Furthermore, clustering analysis was done to determine if the conflicts were uniformly distributed or not. Secondly, semi-structured interviews (n=54) were conducted with key informants and affected households across four municipalities of Chitwan district using targeted sampling. The results clearly revealed that there were hot spots of human-tiger conflicts, particularly concentrated in Bagai and Amaltari sectors. However, the presence of tigers was concentrated in the central core zone of the park. The findings from the interviews suggested that most of the tiger attacks are happening in the morning during collection of fodder in community forests, especially in a period between autumn and spring. The key informants (n=29) suggested that Madi, Meghauli and Kumroj are the areas more prone to attacks from ill and old tigers. The affected households (n=25) experienced tiger attacks within a kilometer from the core park boundaries. In general, people had a positive response towards tiger conservation, which could be attributed to the effective relief distribution scheme and public awareness. However, these affected households suggested that heavy dependency on forest resources compels them to visit community forests frequently despite the danger of the attacks. The coexistence between humans and tigers can be promoted

by adopting conservation strategies such as ecotourism, which will uplift the livelihoods of the forest-dependent populations living along the boundaries of the park. Besides, timely identification and management of problem tigers is recommended, which may minimize the human-tiger conflicts.

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## **List of Abbreviations**

BZ	Buffer Zone
BZCF	Buffer Zone Community Forest
BZCFUG	Buffer Zone Community Forest User Group
BZUC	Buffer Zone User Committee
CE	Conservation Enterprises
CNP	Chitwan National Park
DFSC	Department of Forests and Soil Conservation
DNPWC	Department of National Parks and Wildlife Conservation
FAO	Food and Agriculture Organization of the United Nations
FRTC	Forest Research Training Centre
HH	Affected Household
HTC	Human-Tiger Conflict
IDW	Inverse Distance Weighting
IUCN	International Union for Conservation of Nature
KI	Key Informant
LULC	Land Use Land Cover

MOFE	Ministry of Forests and Environment
NBSAP	Nepal Biodiversity Strategy and Action Plan
NP	National Park
NPWC	National Parks and Wildlife Conservation
NPR	Nepalese Rupee
NTCC	National Tiger Conservation Committee
NTNC	National Trust for Nature Conservation
NWCCCC	National Wildlife Crime Control Coordination Committee
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
RCC	Reinforced Cement Concrete
SD	Standard Deviation
SE	Standard Error
SDM	Species Distribution Modeling
SECR	Spatially Explicit Capture Recapture
TAL	Terai Arc Landscape
UNDP	United Nations Development Programme
USAID	United States Agency for International Development

VMR	Variance by Mean Ratio
WCCB	Wildlife Crime Control Bureau
WWF	World Wildlife Fund for Nature
ZSL	Zoological Society of London

# **Chapter 1: Introduction and Research Context**

## **1.1 Background**

Worldwide, anthropogenic activities including expansive agricultural practices, clearing of forests, and enlargement of residential areas result in damage and deterioration of protected lands (Yang et al., 2019). Therefore, protected lands are becoming smaller, more fragmented, and farther from each other and hence more isolated due to deterioration and loss of habitat in the vicinity of protected areas (Castro-Prieto et al., 2017). As a consequence of increasing habitat fragmentation, there is an increase in human-wildlife interactions often leading to loss of lives and livelihoods of people and/or the physical impairments or death for wildlife (Hahn et al., 2023; WWF, 2008). An adverse action between two or more than two parties can be defined as conflict (Redpath et al., 2015). Physical interactions between humans and wildlife, which have had detrimental effects on either of the parties, is known as human-wildlife conflict (Marchini, 2014). The circumstance arises because of the action by either humans or wildlife leading to a negative effect on the other (Conover & Conover, 2001).

Globally, the occurrence of human-wildlife conflicts is frequent within the vicinity of protected areas (König et al., 2020). Such occurrences can be vividly observed in landscapes where land altered or developed by humans and wildlife habitat overlap (Batavia & Nelson, 2016). There might be several adverse impacts on local people if they reside next to the wildlife, that includes depredation upon livestock, attack on humans, destruction of crop or stored food, disease transmission to humans or livestock and a threat to economic livelihoods because of the change in lifestyle choices due to the presence of animals or protected areas (Dickman, 2010).

Unfortunately, human-wildlife interactions result in the mortality of wildlife due to various retaliatory actions by humans (Hill et al., 2020). Human-wildlife conflict has always been a complicated issue to manage and resolve, mainly because the issue is investigated by conservationists who are working to mitigate the ecological impacts instead of the social dimensions (Redpath et al., 2015). The issue can be better managed if the affected communities are also involved in the process from the beginning along with the individuals who have good negotiation skills. Knowledge on the specific mortality rate of wildlife due to anthropogenic impacts is of utmost importance for effective management of the wildlife species in human dominated landscapes (Hill et al., 2020). Moreover, the knowledge on the niche overlap with the wildlife, especially around transitional landscapes, is also equally important.

The human-wildlife conflict covers issues associated with several species, all the way from rodents such as mice and squirrels that eat grains to man-eating tigers (Dickman, 2010). However, the sustainable coexistence of threatened wildlife with humans is a focus in conservation science and policy (Carter et al., 2012). The International Union for Conservation of Nature (IUCN) Red List has divided threatened wildlife into three categories, which are critically endangered, endangered, and vulnerable species. Among the threatened wildlife, majority of large terrestrial carnivores fall into the endangered category (Wolf & Ripple, 2016).

Large carnivores are vital to an ecosystem because they control the prey populations and indirectly assist numerous endangered small mammals by limiting the population of other carnivores (Wolf & Ripple, 2016), but more than three-fourth of the existing large carnivores have decreasing population trend (Hoffmann & Montgomery, 2022). Their absence alters the

predator-prey relationships and inter-specific competition (Bhattarai & Fischer, 2014). In other words, large carnivores are important because they regulate the population of both large herbivores through predation and other co-predators through competition in the food web of the ecosystem (Ripple et al., 2014). Additionally, for the existence of large carnivores, the conservation and protection of prey species is equally important (Thapa & Kelly, 2017).

## **1.2 Research Rationale**

Human-carnivore conflict is an issue that exists all over the Earth. The examples include, human-coyote conflict in North America (Windberg et al., 1997), human-African lion conflict in Tanzania (Kissui et al., 2019) and Uganda (Schwartz, 2024), human-Amur tiger conflict in China (Pettigrew et al., 2012), and human-snow leopard conflict in India (Bagchi & Mishra, 2006), which have been observed due to livestock depredation by carnivores. Similarly, human-tiger conflict exists in Russian Far East, Bangladesh and India due to killing of people by tigers (Dhungana et al., 2018). But, on a global scale, the depredation of livestock by tigers is the primary cause of human-tiger conflict (Goodrich, 2010).

In the context of Nepal, large carnivores such as leopards and tigers are common cat species involved in human-carnivore conflict. The human-leopard conflict exists due to predation on livestock and people by leopards (Adhikari et al., 2020). While the attacks on people and livestock by tigers (*Panthera tigris tigris*) is the principal cause of human-tiger conflicts in Nepal (Dhungana et al., 2018), especially in tiger bearing parks, which lies in southern lowlands.

The tigers in Nepal are found in five protected areas, including the Chitwan National Park (CNP). Recently, tiger populations have increased from 121 to 355 between 2009 and 2022 in Nepal

(Sharma et al., 2024), while the protected tiger habitat has increased by only 25% (Bhatt et al., 2023). At the same time, buffer zone forests in protected areas of Nepal has led to the expansion of wildlife habitat beyond the core park boundaries, which serves as corridors for tiger movements (Silwal et al., 2017). As a result, the tigers of Chitwan are observed to have increased their movements outside the park, particularly in search of their main prey, the spotted deer, which have been driven away due to the excessive growth of invasive species *Mikania micrantha*, a perennial creeper, in the grasslands of core park area (Dhungana et al., 2018). As a consequence, numerous male tiger mortalities have occurred because of territorial disputes for food and space post 2018 due to rising populations of tigers in protected areas (Bhatt et al., 2023). Thus, the tigers are expected to move out of the park in search of new territories, which will increase the likelihood of human-tiger conflict. In response to attacks on people and livestock, the movement of tigers outside the park will increase their vulnerability to retaliatory killings (Dhungana et al., 2018).

Hence, this study focusses on human-tiger conflict in the context of Chitwan National Park as the tiger density in the Park has increased from 3.12 to 4.06 tigers per 100 km<sup>2</sup> between 2018 and 2022 (DNPWC & DFSC, 2022). Also, it has been reported that there have been 222 human-tiger conflict incidences between 2018 and July 2023 in Chitwan National Park (CNP, 2024). As the tiger population and human-tiger conflict are on the rise, it is equally important to assess the hotspots of human-tiger conflicts and the attitude of the local community towards tiger conservation in Chitwan National Park. In addition, the knowledge on the aspects of mortality and the severity of risk can be key to conservation efforts in regions where the instances of human-wildlife conflict are high (Adhikari et al., 2022).

### **1.3 Research Objectives and Questions**

The purpose of this research is to understand the dynamics of human-tiger conflict in Chitwan National Park, which is a protected region located in the southern lowlands of Nepal and assess the attitude of the local community towards tiger conservation. The proposed research has following objectives:

- i. to assess and characterize the human-tiger encounters in Chitwan National Park
- ii. to understand the perspectives of local communities towards human-tiger conflict

The research question associated with the first objective are:

- i. How does tiger attack vary by season and locations in Chitwan National Park?
- ii. What is the proximity of tiger attacks from various geographic features?
- iii. Are human-tiger conflict locations clustered spatially in and around Chitwan National Park?

The research questions associated with the second objective are:

- i. What is the major cause of tiger attacks?
- ii. When and where are the attacks happening and are there areas more prone to tiger attacks?
- iii. What is the attitude of local community towards tiger conservation?

### **1.4 Thesis Outline**

The second chapter of this thesis conducts a review of the literature, relevant information, and previous studies. It presents information on human-wildlife conflict, human-carnivore conflict,

and human-tiger conflict. Furthermore, the chapter emphasizes information on drivers of human-tiger conflicts, habitat and prey of tiger, human-tiger encounters, and perceptions on tiger. The chapter ends with methods of controlling human-tiger conflict and relevant past studies associated with human-tiger conflicts.

The third chapter is divided into two parts. The first part includes description of study area, which includes information about the topography, climate, vegetation, and biodiversity of the Chitwan National Park. The second part of the chapter presents the methods used to conduct the study including collection of primary and secondary data. The chapter ends with data analysis of the study.

The fourth chapter reports the results obtained after performing data analysis. The first half of the result section demonstrates the findings obtained through desk research including severity, temporal variation, hotspots, and distribution of conflicts. The second half of the chapter illustrates the findings obtained from semi-structured interviews, which were conducted with key informants related to human-tiger conflicts and households affected by tiger attacks.

The fifth chapter is divided into three parts. In the first part, the discussion of findings obtained from desk research is presented. The discussion of findings obtained from interviews is presented in the second part. In the final part, the implications of conservation including recommendations for policy and practice are discussed.

The sixth and final chapter of the thesis presents summary and conclusions of the research. The chapter also includes the limitation of the research, recommendations for future study, and further actions for additional research in this field.

## **Chapter 2: Literature Review**

### **2.1 Human-Wildlife Conflict**

Globally, human activities are responsible for mortality of more than 25% of terrestrial vertebrates (Adhikari et al., 2022). These anthropogenic activities include land use changes and creation of physical human barriers, which function as impediments to the movement of species. For instance, in Tanzania, human-induced activities such as agriculture, urbanization and infrastructure development has led to the deterioration of wildlife habitats, including animal corridors, which has emerged as a challenge for ensuring persistence of wildlife populations (Elisa et al., 2024). As a consequence, such activities lead to human-wildlife conflict, which is an ever increasing phenomenon, particularly in the vicinity of protected areas (Singh et al., 2023). That is where the role of protected areas in conservation of biodiversity and associated ecosystems becomes vital as protected areas occupy about 12 to 15% of the total surface on Earth (Baig et al., 2022).

The human-wildlife conflict emerges whenever humans and wildlife are compelled to share a limited available resources with each other, including land, wild prey, livestock, or fish (Singh et al., 2023). Due to the sharing of limited resources, human-wildlife conflict can be observed across the world. The examples include human-elephant conflict arising due to land use changes in Katavi-Mahale corridor of Tanzania, which led to reduction of more than 50% of suitable habitats for elephants from 2008 to 2020 (Elisa et al., 2024). In the same way, human-hyena conflict is evident in Kenya due to depredation of shoat, which is a hybrid between a sheep and a goat, by hyena that leads to the retaliatory killing of the predator (Bauer et al., 2010). Similarly, in North

American cities, human-coyote conflict is on the rise (Raymond & St. Clair, 2023), where coyote encounters were greater in regions with higher building intensity that led to increased chances of human-coyote interactions due to higher population density (Drake et al., 2021).

The most severe aspect of these interactions or conflicts between humans and wildlife is the decrease in wildlife populations, and in some cases, the extinction of the species. To give an example, the human-wildlife encounters has led to the decline in populations of various carnivores such as the Cheetah (*Acinonyx jubatus*), the Asiatic lion (*Panthera leo*), and the tiger (*Panthera tigris*) (Treves & Karanth, 2003). While frequent interactions with humans has resulted in the extinction of the Javan tiger, and the Bali tiger (Nyhus & Tilson, 2004), which were part of *Panthera tigris sondaica* sub-species. The human-wildlife conflict becomes a contentious topic when it involves attacks on humans by large carnivores such as lions in Africa and tigers in Asia (Singh et al., 2023). Due to this reason, the vulnerability of smaller species to human-induced mortality is less when compared to larger mammals (Hill et al., 2020).

## **2.2 Human-Carnivore Conflict**

The human-carnivore conflict exists in every continents where both humans and carnivores live in close proximity, except for Australia and Antarctica, where conflict between humans and large carnivores do not exist (Ravenelle & Nyhus, 2017). Globally, for carnivore species, factors such as changes in habitat, depletion of habitat and human-carnivore conflict poses as a significant concern related with conservation due to human population growth (Titus & Jachowski, 2024). Large terrestrial carnivores are prone to conflict because of their enormous size, exclusively meat-eating diet, and wide-ranging behaviour (Pooley et al., 2017).

Carnivores are viewed as a threat to life, and they often ignite conservation debates because of their predation on livestock, companion animals and on humans (Chapron & Treves, 2016; Kuijper et al., 2016; Loveridge et al., 2017). Such predatory behaviour is a part of an opportunist characteristic possessed by large carnivores, especially, when it comes to depredation on livestock (Bagchi & Mishra, 2006). Despite the threats of predation by carnivores, their conservation significance is high.

The conservation of large carnivores is of the highest importance in maintaining the health of the ecosystem because they serve as an umbrella and flagship species for wider conservation issues and extensive habitat protection (Loveridge et al., 2017). Large carnivores are also responsible for controlling the vegetation dynamics by directly regulating the population of herbivorous prey (Kuijper et al., 2016). Besides, most large mammal species such as carnivores require large territories for their vigorous development (Woodroffe & Ginsberg, 1998). Due to this reason, the probability of human-carnivore encounter increases, which leads to human-carnivore conflict. For example, the conflict between humans and carnivores such as snow leopards, lions and tigers. Snow leopards (*Panthera uncia*) are notorious for livestock depredation. The studies from Mongolia, China, India, and Pakistan suggest bulk of snow leopard diet (20 to 70 percent) comprise domestic livestock (Hussain, 2019). Such characteristic of snow leopard jeopardizes their safety and existence. Survival threats such as direct hunting, infrastructure development (WWF, 2023), retaliatory killings by farmers and loss of wild prey are causing the decline in the snow leopard population across its range (Devkota et al., 2013). Apart from these threats, poaching, illegal trade, and climate change are additional risk factors for species in the Himalayas

(Koju et al., 2021), including snow leopards. Additionally, energy and natural resources development, linear infrastructure leading to habitat loss, and fragmentation are emerging as new threats for snow leopards (Li et al., 2020). All these factors lead to snow leopards moving out of their natural habitat and encountering humans.

Similarly, the predation of livestock in Africa is central in creating threats for lions from humans. One of the reasons for that is the availability of easy prey for lions in the form of sheep, cattle and goats (Heydinger, 2021) in the surroundings of protected areas, which has led to adopting lethal control measures by the farming community. For instance, the retaliatory killing of lion (*Panthera leo*) was significantly associated with depredation on both cattle and shoat in Kenya (Bauer et al., 2010). Similarly, the depredation of livestock by lions, living in unfenced protected areas in Uganda, caused retaliatory killings by poisoning the livestock carcasses by the farming community (Schwartz, 2024). While in northern Kenya, lions that killed livestock were shot by farmers; but they waited for several incidences to occur before adopting the lethal control measure (Woodroffe & Frank, 2005). Overall, the mitigation of conflict between humans and lions remains a challenge as long as the livestock are present in the vicinity of lion's habitat (Heydinger, 2021).

While, human-tiger conflict is common in South Asia, which also happens to be the focus of this study. Among the large cats, tigers account for the most conflicts with humans as suggested by the historical evidence (Dhungana et al., 2018). In India's Ranthambhore Tiger Reserve, the local villagers retaliated by poisoning two sub-adult male tigers as they caused large livestock

depredation (R. Singh et al., 2015). The detailed description on human-tiger conflict is presented in the next section.

## **2.3 Human-Tiger Conflict**

This section includes habitat, characteristics and prey of tiger, drivers of human-tiger conflicts, human-tiger encounters, and perceptions of local community on tigers.

### **2.3.1 Habitat, Characteristics and Prey of Tiger**

Tiger, an endangered species, occurs in 13 countries of Asia (Thapa & Kelly, 2017). Tiger is an opportunistic species and demonstrates adjustment to varied forest types, climatic conditions, landscapes, and prey species (Kawanishi & Sunquist, 2004). There are about 5,574 tigers in the wild that are found across tropical rainforests, evergreen forest, temperate forests, mangrove swamps, grasslands, and savannas (WWF, 2024). Tiger, a predatory cat species, is native to the forests of south and south-east Asia, the easternmost part of Russia, and north-east China (Forrest et al., 2011). In South Asia, the Churia or the Siwalik is not only one of the important habitats for tiger and their prey but also a vital connection pathway between the protected areas in southern Nepal and northern India (Thapa & Kelly, 2017).

According to IUCN, tigers have two sub-species: the continental tiger (*Panthera tigris tigris*) and the Sunda island tiger (*Panthera tigris sondaica*) (WWF, 2024). Both sub-species are found exclusively in the continent of Asia. The former is found in mainland Asia, while the latter exists in the Indonesian island of Sumatra. An adult male continental tiger may weigh up to 300 kilograms, while the male Sunda tiger can reach a maximum weight of 140 kilograms (Sunquist, 2010). Apart from body weight, the length of the tiger varies between 6 to 10 feet.

*Panthera tigris* is a solitary species, however, the associations can be found during the mating season or sexual activity (Sunquist, 1981), and between the mother and the cubs (Smith, 1993). In every two to two and a half years, a tigress gives birth to 1 to 7 cubs until she is 15 years old (Sunquist, 1981). Throughout the lifetime, a tigress under favourable conditions may give birth to 13 to 18 cubs, however, only half of them may reach adulthood (Sunquist, 1981). The cubs stay with their mothers for 17 to 24 months (Smith, 1993). At the age of 3 to 6 years, female tigers become sexually mature, while male tigers gain sexual maturity at the age of three and a half years (Sunquist, 1981).

Large ungulate species such as gaur (*Bos gaurus*), banteng (*Bos javanicus*), sambar (*Rusa unicolor*), and water buffalo (*Bubalus bubalis*) account for 90.3% of tiger diet in South-East Asia (Khaewphakdee et al., 2020). Similarly, in South Asia, spotted deer (*Axis axis*) and sambar are the principal prey species of tigers whereas secondary prey species include gaur, nilgai (*Boselaphus tragocamelus*) and wild pig (Aryal et al., 2016). In addition to wild prey, domestic animals, at regular intervals, serve as the secondary prey of tigers. For instance, a study conducted in Russia found that dogs followed by cows were the most frequently killed domestic animals (Goodrich et al., 2011).

For hunting, tiger is mainly dependent on its eyesight and hearing capacity compared to smelling (Thapar, 2004). The hunting success rate of tiger is somewhere between 5 to 50%, and it likes to feed by dragging the kills to a thick forest, while it feeds at the kill site only if the prey is large (Sunquist, 2010). Tigers are known to consume 10% of the available prey in their territory (Carter et al., 2015). Tiger is a large predator that requires at least 8 kilograms of meat on a daily basis

for the maintenance of its health conditions (Basak et al., 2020). However, within 24 hours, a male tiger can consume a maximum of 45 kilograms of meat (Sunquist, 2010). A prey species usually weighing between 60 to 250 kilograms is preferred by the tiger (Basak et al., 2020). In the context of Chitwan, female tigers consume around 5 to 6 kg of prey on a daily basis (Sunquist, 1981). The consumption depends on prey density, which varies in parks of Nepal (Table 2.1). The prey of tiger is proportional to the land cover, with highest concentration of prey biomass in complexes of riverine/grassland forest (Carter et al., 2015).

**Table 2.1:** Tiger and prey density in protected areas of Nepal

Species	Tiger density/100 km <sup>2</sup> (SE) and individual prey density (per km <sup>2</sup> )			
	Chitwan NP	Parsa NP	Bardiya NP	Banke NP
Tiger	4.06 (0.22)	1.70 (0.17)	7.96 (0.29)	2.18 (0.28)
Barking deer	3.50 (2.33-5.25)	2.69 (1.37-4.33)	0.77 (0.34-1.75)	1.15 (0.61-2.17)
Hog deer	5.67 (3.51-9.16)	-	11.15 (2.73-45.49)	-
Spotted deer	51.95 (36.14-74.68)	13.96 (8.07-24.13)	61.15 (45.77-81.72)	32.12 (16.08-64.18)
Wild boar	2.81 (1.67-4.73)	9.44 (5.72-15.56)	0.78 (0.19-3.25)	3.84 (0.95-15.51)
Sambar deer	7.65 (5.37-10.89)	4.82 (3.24-7.17)	1.90 (0.96-3.75)	0.90 (0.34-2.83)

Source: Shah et al., 2024; Dahal et al., 2023; DNPWC & DFSC, 2022

### **2.3.2 Drivers of Human-Tiger Conflicts**

Population growth leads to urban expansion, which is a principal factor of habitat loss, and imposes serious threat to biodiversity. The land use changes caused by anthropogenic activities have led to the fragmentation of the habitat of native species (Lechner et al., 2017). Extensive habitat fragmentation, isolation, loss of habitat quantity, and loss of habitat quality are the primary causes that threaten urban biodiversity (Balbi et al., 2021).

The livelihoods and overall safety of people living in the vicinity of wildlife could be jeopardized, which acts as a stimulant for the community, thus, leading to destruction of wildlife habitat, retaliatory killings, and defiance of wildlife protection rules (Carter et al., 2014). Besides, a study conducted in Bhutan suggests that apart from poor livestock protection practices, overall decline in natural prey population may be one of the drivers of rise in livestock depredation (Katel et al., 2014).

Loss of habitat, degradation, and fragmentation are responsible for the decrement in the suitable habitats of isolated tiger populations (Khaewphakdee et al., 2020). Apart from hunting of tigers and their prey, habitat destruction linked with agricultural activities, infrastructural development, urban advancements, and resource extraction pose significant threats to tigers (Forrest et al., 2011). The danger of extinction of tiger exists globally due to habitat fragmentation, poaching, and prey depletion (Thapa & Kelly, 2017).

The human-induced extinction of tigers have been reported from Bali and Java islands in Indonesia and from regions in Central Asia that includes Caspian and Aral Sea (Bhattarai et al., 2019). In Sumatra, illegal logging of tropical hardwood trees caused massive forest

fragmentation. Not only has this activity restricted the habitat of Sumatran tigers, but also has increased the chances of human and tiger conflicts (Lubis et al., 2020).

### **2.3.3 Human-Tiger Encounters**

Tigers require extensive areas along with sufficient natural prey for their survival (Karanth & Nichols, 2017), and these requirements create a problem if the tiger populations increase within a park, while the tiger habitat remains constant. Such issue leads to an increase in the frequency of contacts between humans, tigers and livestock as the tiger searches for prey outside of their natural habitat (Bhattarai et al., 2019) due to intra-species competition for limited resources. Ultimately, it increases the chances of human-tiger conflicts beyond the park boundaries. However, unless threatened, the probability of humans getting attacked by a solitary predator such as the tiger is low, as humans are not its natural prey (Atreya et al., 2021).

The restriction of tigers to limited habitats invites conflict between tigers and the local community. For instance, a large population of tigers were restricted to only five protected areas in the lowland forests of Nepal due to excessive fragmentation of tiger habitat, especially after the 1950s (Dhungana et al., 2018). As found across the globe, there are several forest-dependent communities living in the vicinity of protected areas in Nepal. These communities, which live nearby the tiger bearing forests, graze their livestock as well as collect fodder and firewood from the forest (Bhattarai et al., 2019). As a consequence, the presence of people or community nearby tiger bearing forests increases the chances of tiger attacks. To give an example, people living in the vicinity of the tiger habitats in Sundarbans, which is home to the largest mangrove forest in the world, has the highest tiger attack rates on humans (Inskip et al., 2013).

Similar to Sundarbans, the surroundings areas of Chitwan-Parsa and Bardiya-Banke complexes in Nepal are susceptible to tiger attacks, as these two parks provide habitat to around 90% of total tiger populations in Nepal (DNPWC & DFSC, 2022). Historical data suggests that tiger attacks in Chitwan National Park are responsible for the increase in deaths of local inhabitants by almost 11 times between 1998-2006 compared to the 1989-1997 period (Carter et al., 2014). Moreover, the human mortality rate, due to tiger attacks, has increased by six times from an average of 1.2 annual deaths (1979-1998) to 7.2 (1998-2006) in CNP (Lamichhane et al., 2017). Overall, tigers accounted for 21% of all the wildlife attacks on humans, while rhinoceros were responsible for the highest number of wildlife attacks (38%) between 2003 and 2013 in the periphery of Chitwan National Park (Silwal et al., 2017). While in Bardiya National Park, tiger attacks have caused seven deaths and four injuries to people from 1994 to 2007 (Bhattarai & Fischer, 2014).

There may be other factors associated with tiger attacks apart from proximity to tiger bearing forests. For example, a seasonal trend in human-tiger conflict was observed in Russia. The tiger attacks on humans increased in winter due to the higher presence of people in the forest during hunting season, which lies between the end of fall and winter (Goodrich et al., 2011). As the forest becomes common ground, this leads to potential conflict between humans and tigers (Nyhus & Tilson, 2004).

#### **2.3.4 Perceptions about Tigers**

The perceptions of a community about tigers may vary due to several factors such as employment, religion, ethnicity or other socioeconomic factors. To give an example, in Nepal's Bardiya National Park, a positive attitude towards tigers and their conservation was observed among the

greater proportion of the local population which may be credited to the financial benefits from ecotourism (Bhattarai & Fischer, 2014). However, in the Sundarbans, the perceptions of risks from tigers was directly associated with lack of job opportunities, poor health and education facilities, and natural disasters (Inskip et al., 2013).

While, in South India's Mudumalai Tiger Reserve, the attitude of local community on declaration of Tiger Reserve varied with their respective ethnicities (Ramesh et al., 2019). Another example of difference of opinions on tiger comes from Nepal's Chitwan National Park, where almost one-third of the respondents were not fond of the presence of tigers in nearby locations (Carter et al., 2014), which may be attributed to the changing socioeconomic and political contexts in Chitwan.

Apart from ethnic and socioeconomic backgrounds, the faith of an individual or community also plays vital role in determining the attitude towards tiger conservation. For instance, the overall positive attitude of inhabitants of Bardiya National Park towards tiger may be associated with the religious backgrounds of the people as most of the people in the area were Hindu, who see tiger as the vehicle of one of their goddesses (Bhattarai & Fischer, 2014). Similarly, in the Sundarbans of Bangladesh, where 85% of respondents were Muslim, the attack by tigers on people or livestock were often credited to the will of God, and such tolerating perceptions can cause an increase in risk taking activity (Inskip et al., 2016).

At the same time, the tolerance towards wildlife attacks is also dictated by locations or regions. For example, the tolerance towards tiger populations in Nepal and Bangladesh is higher than the tolerance towards pumas in Montana, USA as the respondents who accepted to see an increase in tiger populations were 47% in Bangladesh and 40% in Nepal, whereas only 12% respondents

wanted an increase in pumas in Montana (Inskip et al., 2016). In addition, community level programmes such as ecodevelopment programmes involving local communities in Chitwan National Park, Nepal augmented the coexistence between tiger populations and local residents at finer geographic level (Carter et al., 2012).

## **2.4 Methods of Controlling Human-Tiger Conflict**

There are two approaches to minimize human-wildlife conflicts. The first approach deals with preventing the conflict from occurring by eradicating the sources of conflict that includes legal hunting or illegal retaliation; the second approach is based on the promotion of the coexistence of both humans and wildlife through the mitigation of the impacts brought by conflict (Ravenelle & Nyhus, 2017). The first approach is not considered because human-tiger conflict was one of the major reasons for the extinction of Bali tiger (*Panthera tigris balica*) and Javan tiger (*Panthera tigris sondaica*) (Nyhus & Tilson, 2004). Besides, the sport hunting of tigers is not possible as they are threatened species requiring conservation. The following section emphasizes on the second approach to alleviate or mitigate the issues related with human-tiger conflicts, which includes collaboration and compensation scheme, conservation strategy, and relocation and animal corridors.

### **2.4.1 Collaboration and Compensation Scheme**

To support the conservation of iconic species and landscapes, conservation enterprises (CE) have gained popularity; and enhance more traditional strategies such as protected areas (PAs) and legislation (Buschke, 2015). There are several examples of collaboration involving park, people, organizations and countries for conservation of tigers. For example, Nepal's Annapurna

Conservation Area has been deemed a triumphant and groundbreaking community-based ecotourism and business growth for conservation of snow leopards as well as community development through snow leopard CE (Hanson et al., 2023). Similarly, in India, near Corbett National Park, a collaboration between a local NGO and WWF-India has been successful because of the implementation of the immediate compensation to farmers whose livestock has been killed by tigers (Hussain, 2019). In addition to park and people, the Global Tiger Initiative, funded by the World Bank, is an example of a successful coalition of 13 tiger range countries for conservation of tigers (Ripple et al., 2014).

Apart from collaboration, compensation is popularly used as a mitigation tool in the aftermath of the conflict to prevent retaliatory killing (Ravenelle & Nyhus, 2017). Studies show that the wildlife tolerance of poor farmers increased with the compensation for their losses, while the attitude of the well-to-do farmers did not change (Hussain, 2019). As a matter of fact, the attitude of pastoralists towards wild carnivores can be influenced by financial security through alternative income sources (Bagchi & Mishra, 2006). In addition to requiring damage control measures such as livestock corrals, compensation programs usually call for recording information or expert certification on the damage caused by the wildlife (Ravenelle & Nyhus, 2017), which is where the disagreement may arise. Particularly in low-income communities, the insufficient compensation for death or injury of primary breadwinner results in increased poverty, hardships, and animosity towards the wildlife (Dhungana et al., 2016).

### **2.4.2 Conservation Strategy**

Global Tiger Conservation Framework is an example of a successful conservation strategy adopted by the 13 tiger range countries. Apart from addressing habitat destruction and promoting connectivity, these 13 countries work on establishing new tiger reserves along with formulating and implementing wildlife law enforcement (Ripple et al., 2014). As part of the framework, the protected areas have been seen as an essential part of tiger conservation strategy. The protected areas such as India's Nagarhole Tiger Reserve, Nepal's Chitwan National Park and Indonesia's Bukit Barisan Seletan National Park were created with the aim of establishing a safe location to live and reproduce for tigers and their prey (Forrest et al., 2011).

The safety of the tigers in range countries can be achieved through different approaches. For instance, in Russia, a Tiger Response Team was created in 1999 with the aim of minimizing the tiger threats to humans, and decreasing deaths of tigers due to human-tiger conflict (Goodrich et al., 2011). While, in the context of Nepal, to avoid an ever-growing tiger population from roaming outside the forests, implementation of integrated monitoring system in the national park and its surrounding area is pivotal to avoid human-wildlife conflicts (Aryal et al., 2016).

Research conducted in Nepal's Chitwan National Park found that policies formed for enhancing the habitable environments and decreasing exploitation are of significant importance for conservation of tigers (Carter et al., 2012). Additionally, it is essential to understand the gender-based perceptions towards wildlife because it tends to correlate with their advocacy for conservation of wildlife (Carter & Allendorf, 2016).

### **2.4.3 Relocation and Biological Corridors**

According to the research conducted in the Russian Far East, shifting ill, old, and physically impaired tigers at regular intervals from forests could aid in decreasing the number of conflict incidences (Bhattarai et al., 2019). Such approach could be applicable to countries like Nepal, where human-tiger conflicts are frequent. Based on the multiple fatalities caused, removing the problem tigers from forests, especially the man-eaters, and shifting them to zoo or certain confined enclosures could reduce the human-tiger conflict (Bhattarai et al., 2019) along with reducing the rage of the villagers (Lamichhane et al., 2017).

Other than relocation of tigers, establishment of biological corridors, which facilitates unhindered movement of tigers could assist in minimizing conflicts (Lamichhane et al., 2017). The movement and scattering of species, preservation of population dynamics, retention of genetic diversity, and enlargement of habitat availability in general for threatened and endangered species can be achieved through corridors (Puri et al., 2022). Additionally, public lands adjacent to protected areas may benefit from greater development for conservation and related ecotourism (Ghosh-Harihar et al., 2019), provided the habitat of tigers is expanded.

### **2.5 Previous Studies**

While conducting a study in Sumatra, Nyhus & Tilson (2004) relied on numerous documents that were published in the span of 1978 to 1997 to identify the human-tiger conflict incidents; these documents included media reports, reports from governmental and non-governmental organizations, and a journal article. Additionally, they conducted more than hundred informal

interviews with representatives of governmental organizations to supplement the information from reports.

Similarly, Karanth & Nepal (2012) carried out structured and open-ended surveys in five protected areas across India and Nepal to retrieve information on demographic details, use of resources, human-wildlife incidents, and attitude towards tourism, protected area staff and the protected area.

In a study conducted by Bhattarai & Fischer (2014), structured questionnaire survey and interviews were used to collect information on the human perspectives of human-tiger conflict. The obtained information on livestock loss and human victims was then verified through the documents available at National Parks and through consultation with neighbours, and key persons to establish authenticity.

To assemble the details of conflict-causing tigers in the span of 2007 to 2016, Lamichhane et al. (2017) relied on the field data of the researcher, who had been carrying out a study in CNP since 2009, the veterinary section of CNP office, and the National Trust for Nature Conservation (NTNC).

Dhungana et al. (2018) relied on the information provided by the CNP on human casualties and incidents of predation on livestock that took place between 2007 and 2014. The basis for this information was compensation applications and reliable personal accounts associated with human casualties inside the park. The information on human casualties consisted of casualty type (i.e., injured or killed), time, place, and the coordinates of the location where the casualties were found while the livestock depredation statistics included information on the type of livestock killed,

time, and place of depredation. Also, it was reported that CNP has initiated a method to verify the legitimacy of the wildlife attacks (Dhungana et al., 2018).

Building on previous studies, this study aims to characterize and understand the perceptions of local residents on human-tiger conflicts in Chitwan National Park, Nepal. As limited such studies have been conducted after the increment of tiger population between 2018 and 2022 in Chitwan National Park (DNPWC & DFSC, 2022), this study attempts to categorize the conflict type and determine the timing and spatial distribution of attacks. Also, it focusses on assessing the causative agents behind tiger attacks in recent times and the attitude of local community towards tiger conservation. The data collected using field data based on interviews and secondary sources seeks to grasp the dynamics and perceptions related with human-tiger conflicts.

## Chapter 3: Methodology

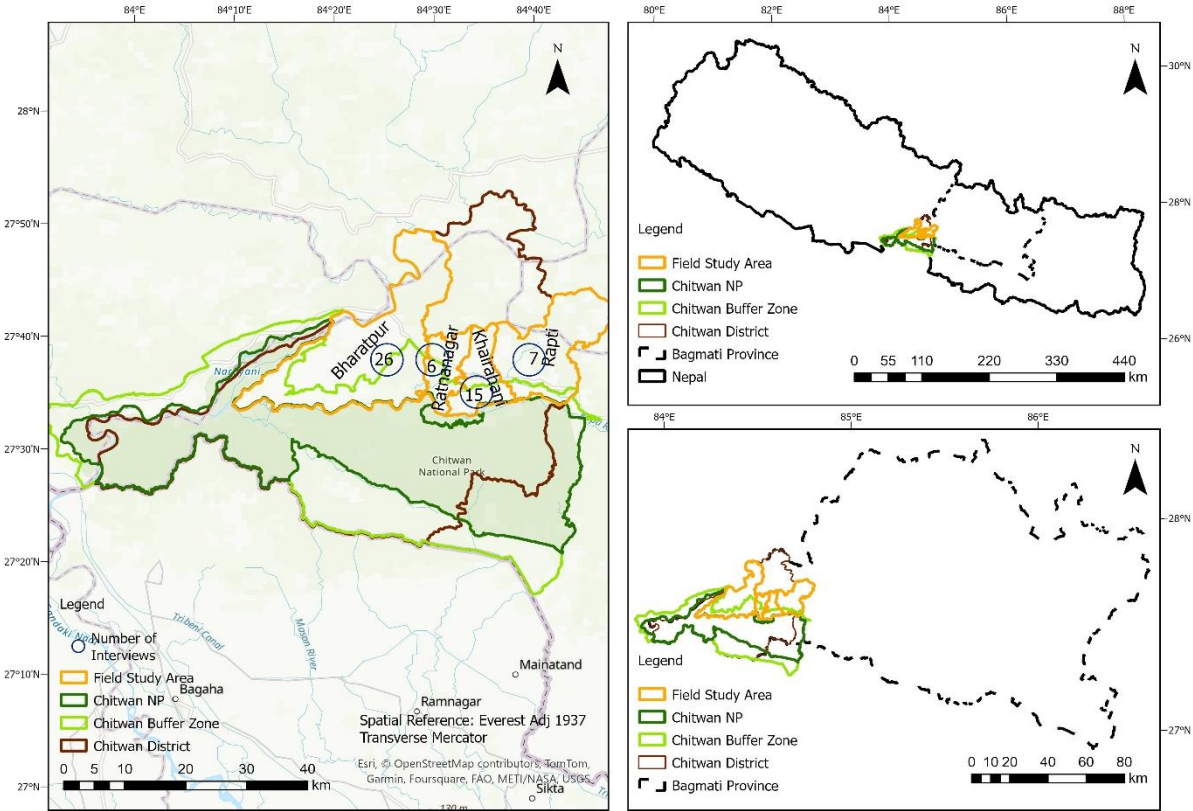
### 3.1 Study Area Description

This study was undertaken in Chitwan National Park (Figure 3.1), which is located in southern part of central Nepal. The park was established in 1973 and has an area of 952.63 km<sup>2</sup> encompassing Chitwan, Nawalpur, Makwanpur and Parsa districts. The area of the park was increased from 544 to 952.63 km<sup>2</sup> in 1977. Besides, an area of 729.37 km<sup>2</sup> has been declared as the buffer zone of the park. The park is located in a river valley basin with elevation varying between 150 to 815 m (Carter et al., 2015). The Rapti river in the north and the Narayani river in the west forms the natural boundary inside Chitwan district. The park borders Parsa National Park in the east and India's Valmiki Tiger Reserve in the south.

In addition, the major settlements in the peripheral boundaries of the park are Parsa Bazar, Meghauri, Tikauri, Sauraha, Thori and Triveni (Figure 3.2). In terms of administrative divisions, the park has been divided into four management sectors (Figure 3.4) for its smooth operation. The names of the sectors are Sauraha (Eastern), Kasara, Amaltari (Western) and Bagai (Madi).

Variation in topography can be observed within the park such as tectonic synclinal basin, Churia range, Someswar hills, ox-bow lakes, and the floodplains of Rapti, Narayani and Reu rivers (Nepal & Weber, 1993). The out-wash deposits carried from the north are found in Churia range and Someswar hills. Sandstones, conglomerates, quartzites, shales and micaceous sandstones are the major rocks found. These rocks belong to the Pliocene or Pleistocene epoch and have fluvial origin.

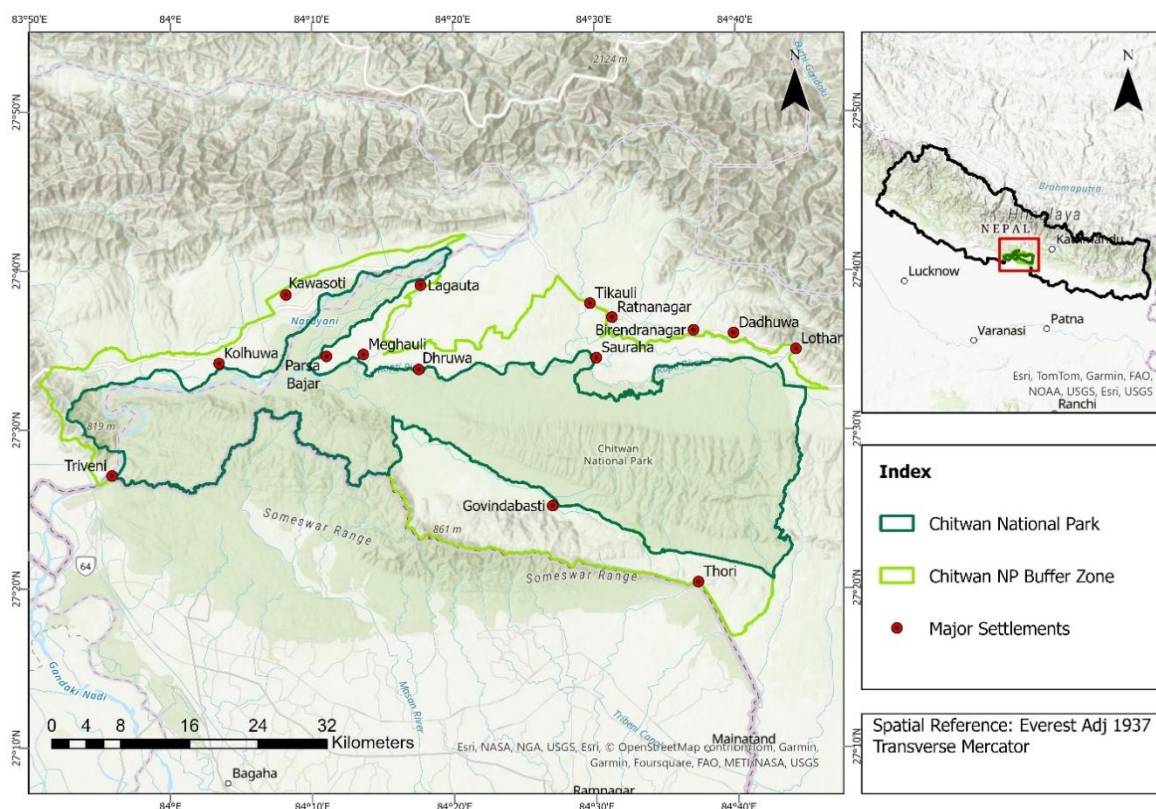
The heavy rainfall received during monsoon is not able to percolate through the soil because of the low permeability of the Siwaliks. The rainfall transforms into runoff and reaches various streams and rivers (Nepal & Weber, 1993). Water is limited to small lakes or ponds, which occur throughout the park, during the dry season.



**Figure 3.1:** Study area map representing Chitwan National Park in Nepal

While during the monsoon, large areas of grassland and forest remain saturated for extensive periods. There are numerous ox-bow lakes along with other permanent and temporary lakes within the park. The flow in the river decreases during the dry season. Similarly, inside the park,

the lakes are dried during the winter. In spite of this, there is ample amount of water on the surface which aids in the growth of tall grasslands even during the dry season.



**Figure 3.2:** Major settlements around Chitwan National Park

The park is characterized by three major types of vegetations, namely the Sal (*Shorea robusta*) forest, the riverine forest and the grasslands. Sal trees, which reaches 25 meters in height, covers 70% of the total park area (Nepal & Weber, 1993). While the riverine forest exists along the banks of river. The riverine forest constitutes around 7% of the total park area (Nepal & Weber, 1993). There are four types of riverine forests in CNP, which are Khair-sissoo (*Accacia catechu-Dalbergia sissoo*), Semal-vhellar (*Bombax ceiba-Trewia mediflora*), tropical evergreen forest

and *Eugenia* woodland. Similarly, one-fifth of the park is covered by grasslands. Variety of grasses can be found in the park including *Themeda villosa*, *Saccharum-Narenga*, *Arundo Phragmites*, *Cynodon dactylon* and *Chrysopogan aciculatus*.

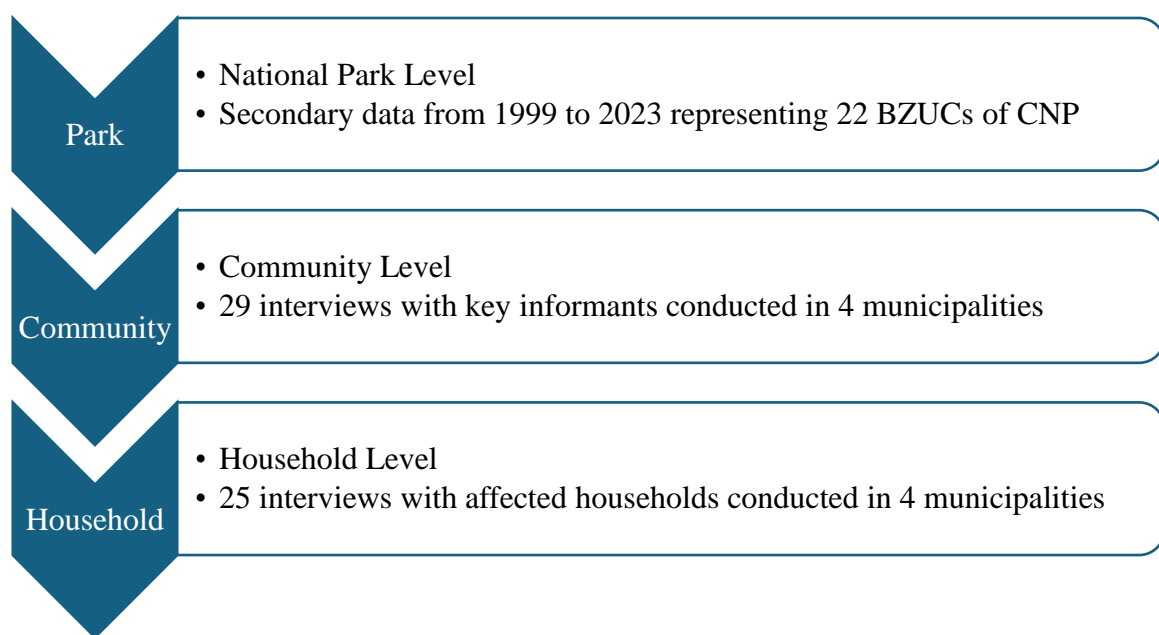
Additionally, the park provides habitat for 55 amphibians and reptiles, more than 525 bird species, and over 50 mammals (DNPWC, 2024). Moreover, the threatened species such as one-horned rhinoceros (*Rhinoceros unicornis*), royal Bengal tiger (*Panthera tigris tigris*), pangolin (*Manis crassicaudata*), golden monitor lizard (*Varanus flavescens*), great hornbill (*Buceros bicornis*), lesser florican (*Sypheotides indicus*), and Bengal florican (*Houbaropsis bengalensis*) can be found in the park. Besides, the park has tiger prey such as hog deer (*Axis porcinus*), spotted deer (*Axis axis*), barking deer (*Muntiacus muntjak*), sambar (*Rusa unicolor*), gaur (*Bos gaurus*), and wild boar (*Sus scrofa*) in large numbers (Carter et al., 2015). The hog deer have large populations, while spotted deer form the second largest group of ungulates. These species mostly graze in tall grasslands and sometimes on short grasses at forest boundaries. They are also found grazing along the open riverbanks (Nepal & Weber, 1993). In terms of size, sambar deer are the biggest deer species in Chitwan, which exists in low density, and are found across all habitat types (Nepal & Weber, 1993).

Chitwan National Park, Parsa National Park and Valmiki Tiger Reserve form a complex, which is one of the 19 priority tiger conservation regions of South Asia (Dhungana et al., 2018). In early 1990's, the population of the Bengal Tiger was approximated to be 60 (Nepal & Weber, 1993). As per the 2018 census, the tiger population was 93 (DNPWC & DFSC, 2018) in Chitwan

National Park while the number of tigers increased from 93 to 128 as per the 2022 census (DNPWC & DFSC, 2022).

### 3.2 Methods

The research was conducted by collecting information on human-tiger conflicts through primary and secondary sources. The semi-structured interviews conducted with key informants and affected households represented the primary data, while publicly accessible data of Chitwan National Park was the basis of secondary data. Both primary and secondary sources were used to conduct analysis on three levels (Figure 3.3).



**Figure 3.3:** Representation of levels of data

As illustrated in Figure 3.3, in the 1<sup>st</sup> stage, the overall secondary data collected at the national park level represented the birds eye view. It includes all the human-tiger incidents to have occurred between 1999 and 2023 across 22 buffer zone user committees.

Similarly, in the 2<sup>nd</sup> stage, the interviews were conducted with key informants at community scale and in the 3<sup>rd</sup> stage, the interviews were conducted with respondents from affected households at household scale.

### **3.2.1 Data Collection**

This section covers information regarding process of collection of field and secondary data. The section also presents information about the sources of data.

#### **3.2.1.1 Field Data**

Initially, a household questionnaire in Kumroj village was supposed to be done. But, after visiting the field and talking to the key informants in Kumroj, it was found that the household questionnaire was not possible to achieve in a single village as the cases of human-tiger conflicts were less than expected. The information was verified by visiting the office of Budhirapti User Committee, which keeps record of the incidents that occurred in Kumroj community forest. Based on the records, it was found that there were 10 cases of humans-tiger conflicts in the last 9 years. So, semi-structured interviews with key informants and affected households were conducted.

Using field data based on semi-structured interviews, the second objective was achieved, which is to understand the perspectives of local communities towards human-tiger conflict.

The interviews conducted with key informants and sample household heads allowed to understand the position of local community on various aspects of human-tiger conflicts. The response in the interviews provided their stance on nature and wildlife in general along with the attitude towards tigers. These responses determined the general perspectives of a community living around Chitwan National Park.

In addition, the information on current conflict mitigation strategies along with the organizations working towards minimization of human-wildlife conflict was determined. The respondents also shared their opinions on improvements in mitigation measures.

#### **3.2.1.1.1 Sampling and Design of Interviews**

A targeted sampling was done after approval of research ethics application (#46789) by selecting people who were most relevant to human-tiger conflict related research. The relevant people included the key informants on tiger and household heads of tiger affected households. The focus of the research were the relevant respondents living in the vicinity of Chitwan National Park.

The key informants included representatives from park authorities, community forests, buffer zone user committees, and other organizations. Some of the professions of key informants included social worker, advocate, forester, ranger, and park caretaker.

While the affected households, primarily farmers, included those households that were victims of tiger attacks leading to human casualties and livestock losses. In terms of affected households, the heads of the households were the prioritized population for this research.

Initially, the aim was to conduct the research in a village in the vicinity of Kumroj Buffer Zone Community Forest as numerous tiger attacks had been reported recently (Paudel, 2022). After realizing that it was not possible to conduct questionnaires with 50 to 55 households in Kumroj, the primary data collection was initiated by interviewing the key informants in their respective offices in Kumroj. Then, through the key informants, the affected households in the region were identified. But, before heading to visit the affected households, the key informants were requested to ask the affected households if they would allow me to interview them. After the permission to

visit the affected households was granted, the interviews with the affected households were conducted. Such approach was applied throughout the field study across all 4 municipalities, and in all places, the key informants helped in identifying the affected households.

After completing first phase of interviews (n=7) in Kumroj, which lies in Khairahani municipality, the decision to head towards Rapti municipality, which lies in the east of Khairahani municipality, was made. The choice was made to visit Rapti municipality because firstly, it is the neighbouring municipality, and secondly, new cases of tiger attacks were emerging. After choosing these two municipalities for interviews, the logical thing was to select another neighbouring municipality of Khairahani. So, Ratnanagar municipality, which lies in the west of Khairahani, was chosen. Lastly, Bharatpur municipality, which lies next to Ratnanagar, was chosen. In this way, the interviews were conducted across 4 municipalities of Chitwan district, which runs east to west and lies north of Chitwan National Park.

### 3.2.1.1.2 Interviews

A well-organized semi-structured interview sheet was prepared that imitated the questionnaire, which was initially developed for a study related to human-snow leopard conflict (Laidlaw, 2023). The interview sheet included questions on various themes (Table 3.1). The detailed guiding questionnaire of the interviews has been attached in Appendix B.

**Table 3.1:** Interview themes and sample questions

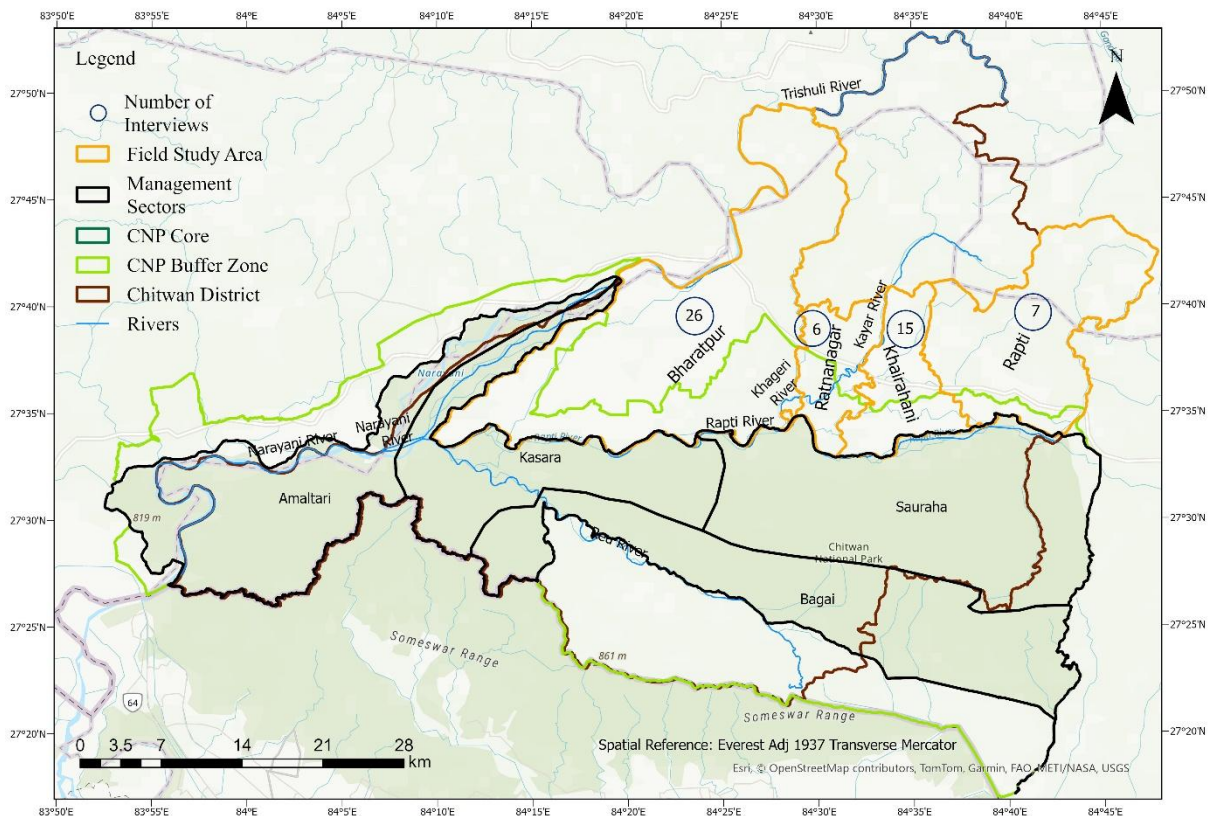
Interview Themes	Sample Question
Encounters with tigers	Have the human-tiger encounters increased with the increase in tiger populations?

Timing of attack	What is the most common time of the day and the season of tiger attacks on humans?
Riskiest areas	Where are the riskiest areas of tiger attacks?
Conflict mitigation strategies	What kind of mitigation measures can be implemented to reduce human-tiger conflicts?
Attitude towards tiger conservation	How important is the conservation of tigers?
Socio-demographic information	What is your age/sex/occupation?

The information was collected from individuals representing park authorities, community forests, buffer zone user groups, other organizations, and affected households across four adjoining municipalities of CNP (Figure 3.4), which encompasses the eastern sector of CNP.

The interviews were conducted between 2024/10/24 and 2024/11/20 in Nepali and the permission to record the interviews was requested. The average length of interviews was approximately 20 minutes for key informants and 10 minutes for affected households.

A total of 54 interviews were conducted in various locations (Appendix D); 29 interviews were conducted with key informants, while 25 interviews were conducted with affected households. The interviews with key informants were conducted in four municipalities namely Rapti (n=3), Khairahani (n=7), Ratnanagar (n=3) and Bharatpur (n=16). Similarly, 4, 8, 3 and 10 interviews were conducted with affected households in the same four municipalities, respectively.



**Figure 3.4:** Map of management sectors and locations of interviews

### 3.2.1.2 Secondary Sources of Data

Using secondary sources of data from institutions such as the Office of the Chitwan National Park and WWF-Nepal, the first objective was achieved, which is to assess and characterize the human-tiger encounters in Chitwan National Park.

Annual reports of CNP were the major component of secondary data, while there were other secondary sources as well (Table 3.2). The data were collected through publicly accessible annual reports of CNP. The data from 1999 to July 2015 were compiled by Mr. Shashank Poudel of WWF-Nepal, whereas the data from 8<sup>th</sup> of July in 2015 to 18<sup>th</sup> of June in 2023 were compiled in

worksheet by me. The information on victim’s name and ethnicity was present in the secondary data along with information on municipality, coordinates of incidents, management sector, buffer zone user committee (BZUC), coordinates of BZUC, year of incident, problem animal, conflict type, loss incurred, claim amount, relief received, and claim difference.

**Table 3.2:** Types and sources of secondary data

Category	Data type	Data source	Format
Secondary data on human-tiger conflicts in CNP	Report	Office of CNP (CNP, 2024)	.PDF
LULC	Raster	ESRI (Karra et al., 2021)	.TIFF
Forest cover	Vector	Regional Database System (Forest Research Training Centre, 2021)	.SHP
Grassland cover	Vector	Regional Database System (Forest Research Training Centre, 2021)	.SHP
River	Vector	Regional Database System (ICIMOD, 2020)	.SHP
Road	Vector	ArcGIS Living Atlas (ESRI India, 2024)	.SHP
Settlements	Vector	Settlements in Nepal (United Nations Office for the Coordination of Humanitarian Affairs, 2015)	.SHP
Tiger locations	Raster	MOFE (DNPWC & DFSC, 2022)	.JPEG

Livestock density	Raster	Gridded Livestock of the World (Food and Agriculture Organization of the United Nations, 2022)	.TIFF
CNP boundaries	Vector	Office of CNP (CNP, 2024)	.SHP

The collected secondary data on human-tiger conflicts, which includes both human casualties and livestock losses, were further categorized based on buffer zone user committees, months, seasons, years, and affected ethnicities.

### **3.2.2 Data Analysis**

This section covers information on data analysis of both field and secondary data. The obtained data were analyzed across several platforms such as ArcGIS Pro, Microsoft Excel Worksheet and Jupyter Notebook.

#### **3.2.2.1 Field Data**

The field data was obtained through interviews with key informants and affected households across the four municipalities of Chitwan district. As the interviews were conducted in Nepali, the recorded interviews were transcribed in English. The interviews were transcribed by me (student investigator), a native of Nepal. After transcribing, the information obtained from the interviews were broken down into several themes, and each theme was assigned a colour (Table 3.3). Through colour coding, extraction of information on several themes related to human-tiger conflicts was done.

**Table 3.3:** Colour coding of themes

Themes	Colour coding
Human-tiger encounters and tiger populations	Red
Movement of tigers near human settlements	Blue
Location and riskiest areas of tiger attacks	Dark Blue
Common time of the day and season of tiger attacks on human	Green
Organizations working for minimization of human-tiger conflicts	Cyan
Mitigation measures	Black
Relief and compensation	Purple
Attitude towards tiger conservation/Tiger and ecotourism	Light Green

In addition, information on locations of human-tiger conflict incidences of affected households (n=25) were noted in Google Earth in the field, and were analyzed using Near analysis tool in ArcGIS Pro. The distance between the core park boundaries and the locations of conflicts for these 25 affected households was determined.

Besides, information such as responses that reflect attitudes towards tigers and attitudes towards tiger conservation, was analyzed using a 3-point Likert scale. The 3-point Likert scale included positive, indifferent, and negative options. The 3-point Likert scale was selected to make things simpler for the respondents, and to avoid confusion between options such as “very positive” and “positive” or “very negative” and “negative”. A similar 3-point Likert scale was used in a human-snow leopard conflict study (Laidlaw, 2023).

### **3.2.2.2 Secondary Data**

The secondary data on human-tiger conflicts were gathered from annual progress reports of CNP from 1999 to July 2023. The secondary data was then divided according to dates, season, buffer zone user committees and management sectors to determine the frequency of conflicts in the given conditions.

This information helped in the identification of the most and least affected regions as well as the most severe season and month for tiger attacks. Furthermore, the quantification of tiger attacks on humans or livestock was achieved.

After the frequency of conflicts were determined, basic charts, graphs and histograms were prepared in Microsoft Excel Worksheet. Subsequently, the excel sheet was added to ArcGIS Pro, and the display XY data option was selected to plot the available latitude and longitude of human-tiger conflict incidents. In doing so, all the relevant information were attached to the attribute table. Then, maps were produced for overall conflicts and human casualties based on BZUCs.

Overall, there were 1,713 human-tiger conflict incidents between 1999 and 2023 in the secondary data. While only 1,362 such incidents had geographic coordinates, and 1,096 of these conflict points lied within the boundary of Nepal. These 1,096 conflict incidents were only considered while performing spatial analysis. However, 1,633 conflict incidents were represented by geographic coordinates of BZUC, and they were considered while creating bar graphs or performing calculations on conflict percentage.

Other than basic mapping of conflict incidents, four distinct types of spatial analysis were performed in this study, which included inverse distance weighting (IDW) interpolation, quadrat and clustering analysis, Near analysis and regression analysis.

Firstly, the IDW interpolation was performed to prepare the tiger presence map based on Tiger National Survey, 2022. The tiger density map presented in the report titled "Status of Tigers and Prey in Nepal 2018" (DNPWC & DFSC, 2022) was georeferenced using known coordinates in ArcGIS Pro. Tiger presence and camera locations were digitized. In the process of digitization, 189 locations were marked as tiger presence locations as these camera locations showed the presence of tigers, while 316 other camera locations, where tigers were not observed, were marked as tiger absence locations. A new point shapefile was created, and the tiger presence value was set to 1 in places where tigers were present, and the value was set to 0 in camera locations where tigers were absent. Then, using the tiger presence values, IDW with power 2 was performed, and then the output map with 200 m x 200 m resolution was clipped based on the extent of the polygon of CNP. Eventually, the symbology in numbers was changed to text, by dividing the values into three classes, namely low, medium and high. The class with inverse distance weighting value 0 to 0.33 was marked as low, value 0.33 to 0.67 was marked as medium and value 0.67 to 1 was marked as high.

Secondly, the human-tiger conflict incidents were represented using heat map symbology in ArcGIS Pro. A dynamic method, where the density values change with the map scale changes, was followed. To verify the findings of heat map, quadrat and clustering analysis for human-tiger conflict incidences and camera trap locations with tiger presence were performed using R in

Jupyter notebook. The sf package was used in R for this analysis. The study extent used for this analysis was the polygon representing Chitwan National Park and the surrounding municipalities. Such study extent was chosen because the events were observed beyond the boundaries of the park. The quadrat analysis was performed at resolutions of 3000 (3 x 3 km), 5000 (5 x 5 km) and 8000 (8 x 8 km) m. For similar analysis, various quadrat resolutions were chosen in a study conducted in Alberta, Canada (Rooney et al., 2022). These resolutions were chosen because it considered the mean territory size of tigers in Chitwan, which is 20.7 km<sup>2</sup> for females and 54.4 km<sup>2</sup> for males (Carter et al., 2015). Quadrat size of 9 km<sup>2</sup> (3000 m resolution) represented half territory size of female tigers, while quadrat size of 25 km<sup>2</sup> (5000 m resolution) represented half territory size of male tigers. Using quadrat analysis, variance was calculated (Equation 3.1), which measures dispersion (O’Sullivan & Unwin, 2010), followed by variance by mean ratio (VMR) to determine the distribution of events in space. The VMR value greater than 1 indicates spatial clustering, while VMR < 1 indicates uniform distribution.

$$s^2 = \frac{\sum X(K - \mu)^2}{(m - 1)}$$

**Equation 3.1:** Formula for variance calculation

Source: O’Sullivan & Unwin, 2010

Then, to determine if human-tiger conflict regions and tiger locations were spatially clustered, a Getis-Ord Gi\* statistic (Getis & Ord, 1992) was performed at various resolutions. The clustering analysis was applied to determine the high intensity human-tiger conflict regions and tiger

locations. The Getis-Ord  $G_i^*$  statistic (Equation 3.2) measures spatial autocorrelation (Ord & Getis, 1995). It produces a z-score, where a positive value indicates clustering of high values, and a negative value indicates clustering of low values.

$$G_i^* = \frac{\sum_{j=1}^n w_{i,j} x_j - \bar{X} \sum_{j=1}^n w_{i,j}}{S \sqrt{\frac{n \sum_{j=1}^n w_{i,j}^2 - \left( \sum_{j=1}^n w_{i,j} \right)^2}{n-1}}}$$

**Equation 3.2:** Formula for Getis-Ord  $G_i^*$  statistic

Source: Ord & Getis, 1995

For clustering analysis, Queen's case, which describes that any shared point between two polygons make them neighbours, was considered.

Thirdly, the conflict points were added to ArcGIS Pro. Using the shapefiles of major rivers, forest and grassland cover, settlements, roads, and tiger locations, the distance from conflict points to nearest such features was calculated using ArcGIS Near tool in Geoprocessing with Everest Adjusted 1937 Transverse Mercator as the projected coordinated system. The nearest distance from each conflict point to these features were then added in the attribute table of conflict points. Using the Statistics option in attribute table, the mean value of nearest distances for each features were calculated.

Lastly, the shapefile of locations of conflict points, after the performance of Near analysis, was loaded in Jupyter Notebook. A linear regression analysis of the geographic features was performed using R in Jupyter Notebook. The number of human-tiger conflict incidences in a

particular location was chosen as a dependent variable, while distance to river, distance to forest, distance to grassland, distance to road, distance to settlement, distance to tiger locations and livestock density were selected as independent variables. After performing linear regression in R using 'lm ()' function (DataCamp, 2024), the coefficients of the variables, p-values and R-squared values were determined.

### **3.2.3 Ethical Considerations**

Upon the suggestion from a resource person at WWF-Nepal, an application for field research permit (Appendix A) was submitted at DNPWC, followed by CNP, before the approval of research ethics application because it was anticipated as a time-consuming process.

A University of Waterloo research ethics application (#46789) was approved by Human Research Ethics Board on October 21<sup>st</sup>, 2024, as the research involved human subjects. The fieldwork was conducted after the approval of both the research ethics application and the research permit.

During the interviews, the participants were not forced to answer the questions, and their privacy was respected; off the record sharing of sensitive information regarding the details of the incidents was not disclosed. Additionally, the participants willingly provided the details of their age, sex, caste/ethnicity, religion, education, and major occupation. The interviews were recorded, and after the completion of interviews, the participants were allowed to listen to the first couple of minutes of their interview to verify their responses and personal opinions.

## Chapter 4: Results

### 4.1 Tiger Populations, Density and Deaths

Five national parks provide habitat to tigers in Nepal. The two largest parks in terms of tiger populations are Chitwan National Park and Bardiya National Park. These two parks account for 71.27% of total tiger populations in Nepal. In addition to tiger populations, these two parks are ranked first and second on the basis of core park area (Table 4.1). Also, Chitwan National Park has the largest buffer zone among the tiger bearing parks of Nepal.

Besides, Chitwan National Park and Parsa National Park form Chitwan-Parsa complex, while Bardiya National Park and Banke National Park form Bardiya-Banke complex. These complexes are important from conservation point of view because they account for 89.86% of the total tiger population in Nepal.

**Table 4.1:** Tiger populations status across the protected areas and their buffer zones of Nepal

Protected areas	Total tigers in 2022	Core park area (km <sup>2</sup> )	Buffer zone area (km <sup>2</sup> )
Chitwan National Park	128	952	729
Bardiya National Park	125	968	327
Parsa National Park	41	627	285
Banke National Park	25	550	343
Shuklaphanta National Park	36	305	243

Source: DNPWC & DFSC, 2022

On a broader scale, Chitwan National Park and Parsa National Park in Nepal and Valmiki Tiger Reserve in India are part of a common complex within the Terai Arc Landscape (Dhungana et al., 2018), which serves as an extended habitat for tigers in the region.

In Nepal, national tiger population survey is being conducted in an interval of 4 to 5 years. As of 2022, Chitwan National Park is home to 128 tigers (DNPWC and DFSC, 2022), while the adjacent Parsa National Park provides habitat to 41 adult tigers (Table 4.2).

**Table 4.2:** Tiger population trend in Nepal from 2009 to 2022

Survey year	Total tigers in protected areas					Total tigers in Nepal
	Chitwan NP	Bardiya NP	Parsa NP	Banke NP	Shuklaphanta NP	
2009	91	18	4	-	8	121
2013	120	50	7	4	17	198
2018	93	87	18	21	16	235
2022	128	125	41	25	36	355

Source: DNPWC & DFSC, 2022

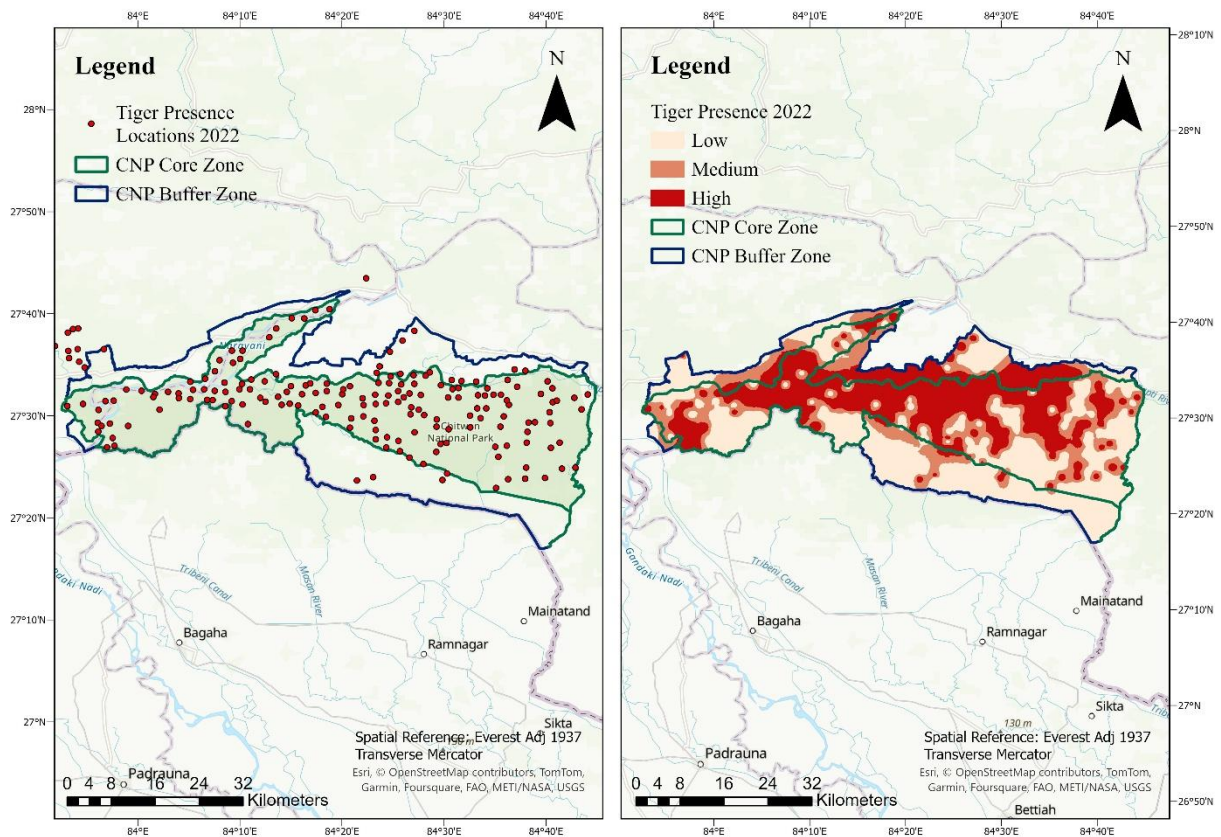
Based on Table 4.2, it can be observed that the population of tigers has increased by 35 (37.63%) individuals in CNP in a period between 2018 and 2022. At the same time, the consideration must also be on the increase in tiger populations in Parsa National Park, as these two parks are adjoined, and the movement of tigers between these two parks have been recorded (ZSL, 2022). Overall, the combined tiger populations of these two parks have increased from 111 to 169 (52.25%) individuals in a span of four years.

On this basis, there are 7.61 tigers per 100 km<sup>2</sup> of both core and buffer zone in CNP as of 2018, while there were 5.53 tigers per 100 km<sup>2</sup> of park area in 2018. Similarly, between 2018 and 2022, the tiger population have increased from 1.97 to 4.49 per 100 km<sup>2</sup> of park area in Parsa National Park. But, through the use of Bayesian-SECR, the mean posterior density of tigers per 100 km<sup>2</sup> of CNP and adjoining forests was estimated at 3.12 in 2018 (DNPWC & DFSC, 2018) and 4.06 in 2022 (DNPWC & DFSC, 2022). The size of camera trap grid cells used for surveying tiger populations was 2 km x 2 km.

Based on tiger density map (2018) of CNP, adjoining forests and corridors, the tiger density varied between 0.01% to 43.55% (DNPWC & DFSC, 2018). Also, the higher density regions can be spotted towards the northern boundaries of the core zone and few towards the north-western boundaries of the core zone. Major settlements such as Megghauli, Dhruwa and Sauraha are quite closer to these high-density tiger regions (Figure 3.2).

As indicated in tiger density map (2022) of CNP, adjoining forests and corridors, the tiger density varied between 0.01% to 87.53% (DNPWC & DFSC, 2022). Contrary to 2018, the higher density regions have shifted towards the north-eastern boundaries of the core zone, while zones with tiger density varying between 21.44% and 45.80% are present towards the north boundaries of the core zone. Major settlements such as Dadhuwa and Lothar lie in the proximity of these high-density regions (Figure 3.2). Moreover, the presence of tigers has been observed near Kolhuwa and Megghauli. Besides, both in 2018 and 2022, tigers have been located outside the buffer zone boundaries in the western direction of the park.

The tiger presence and absence locations were georeferenced using tiger density map (2022) of CNP, adjoining forests and corridors (DNPWC & DFSC, 2022) in ArcGIS Pro to produce interpolated tiger presence map (Figure 4.1) by inverse distance weighting approach.



**Figure 4.1:** Camera trap locations with tiger presence (left) and interpolated tiger presence map (right)

Camera traps with tiger location in tiger density map (2022) of CNP, adjoining forests and corridors (DNPWC & DFSC, 2022) were marked as tiger presence and assigned a value 1, whereas camera locations that did not capture the presence of tiger were marked as tiger absence

and assigned a value 0. Inverse distance weighting (IDW) with power 2 was used for interpolation.

Not only presence of tigers was evaluated, but an observation on tiger deaths was also made based on the annual reports of Chitwan National Park, between 2010 and 2023. Tigers found dead inside the park occurred for several reasons, which include natural causes, retaliation killings and unknown causes. The details of cause of death and sexual orientation of dead tigers were collected between July 2010 and July 2023 (Table 4.3).

**Table 4.3:** Cause of death of tigers between 2010 and 2023 in Chitwan National Park

Period	Tiger deaths inside CNP	Sex			Cause of death		
		Male	Female	Unknown	Natural	Retaliation killing	Unknown
2010/11	1	0	0	1	1	0	0
2011/12	9	4	3	2	8	0	1
2012/13	3	1	1	1	3	0	0
2013/14	1	1	0	0	1	0	0
2014/15	5	4	1	0	5	0	0
2015/16	1	0	0	1	1	0	0
2016/17	4	2	0	2	2	0	2
2017/18	6	1	3	2	4	1	1
2018/19	8	4	2	2	5	2	1

2019/20	3	-	-	-	3	0	0
2020/21	2	1	0	1	2	0	0
2021/22	6	3	2	1	6	0	0
2022/23	3	1	1	1	3	0	0
Grand Total	52	22	13	14	44	3	5

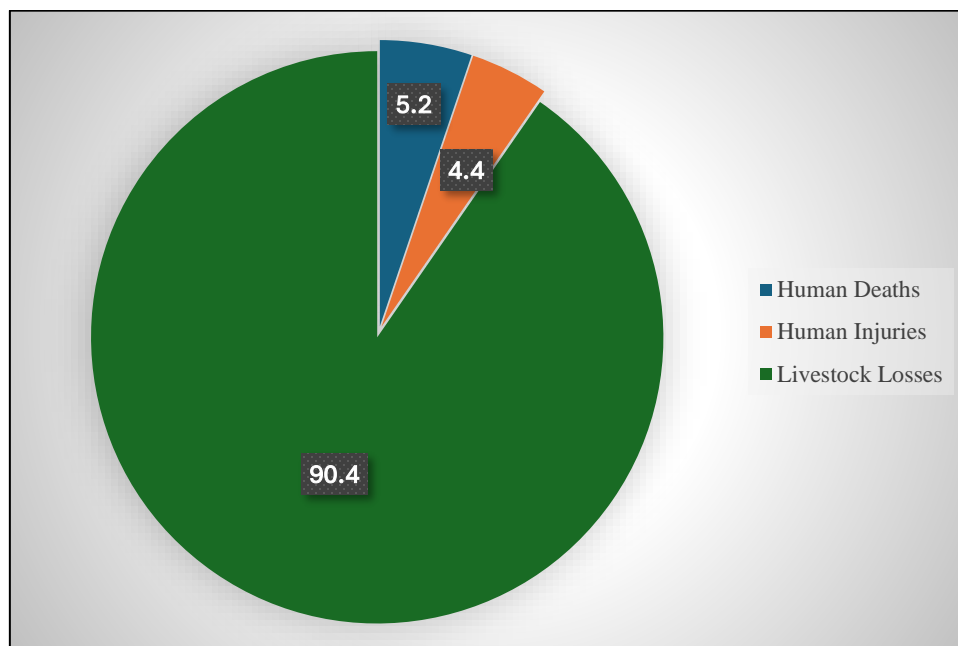
Source: CNP, 2024

Natural cause was the principal reason for death of tigers between 2010 and 2023 inside the park. Retaliation killing was the cause of death for only 3 tigers, while the death of 5 tigers could not be traced. Besides, the death count of male tigers was higher than female tigers.

#### **4.2 Assessment and Characterization of the Human-Tiger Encounters**

The tiger populations have increased by 37.63% between 2018 and 2022, while in the same period (2018/19 and 2022/23), the human-tiger conflicts have increased by 68.75%. The quantification of tiger populations and human-tiger conflicts between 2018/19 and 2022/23 highlights the recent trend.

From 1999 to 2023, there have been 1,713 incidents involving human-tiger conflicts in and around Chitwan National Park. Out of 1,713 incidents, 1,548 incidents are reported as livestock depredation, while there have been 165 incidents of tiger attacks on human leading to injury or death. Of the total human-tiger conflicts between 1999 and 2023, only 9.63% of total conflicts have resulted in human casualties (Figure 4.2).



**Figure 4.2:** Severity of human-tiger conflicts between 1999 and 2023

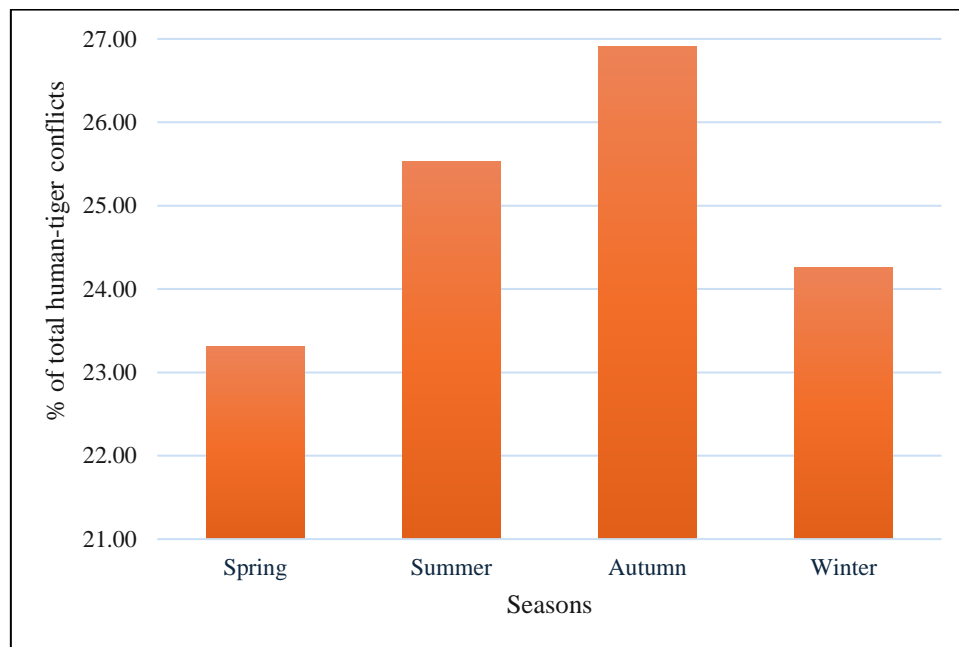
Between May 2019 and June 2023, 77.17% of total incidents involved livestock depredation by tigers, while 22.83% of total incidents involved attacks on human by tigers. Between 1999 and 2019, 8.25% of total incidents accounted for attacks on human by tigers. The attacks on human by tigers have risen by approximately 14.50% between 2019 and 2023 compared to the period of 1999 and 2019. The 2019-2023 period was considered for comparison with 1999-2019 period as the tiger population increased by 37.63% post 2018 survey year.

Over the years, the number of tiger (Table 4.2) and the number of human-tiger conflict incidents have changed. To determine if the conflicts between humans and tigers have increased with the increase in tiger population, a graph between tiger population and number of human-tiger conflict incidents was plotted. An R-square value of 0.387 was obtained (Appendix C). However, the

number of observations were only four as the tiger survey have been conducted on four occasions (Table 4.2), which is not enough to reach a conclusion.

#### 4.2.1 Seasonal and Temporal Variation in Conflicts

There is not much difference between seasons regarding the human-tiger conflicts (Figure 4.3). The human-tiger conflicts across the 4 seasons are almost equal. The difference between the seasons with highest and lowest percentage of total human-tiger conflicts is only 3.60%.

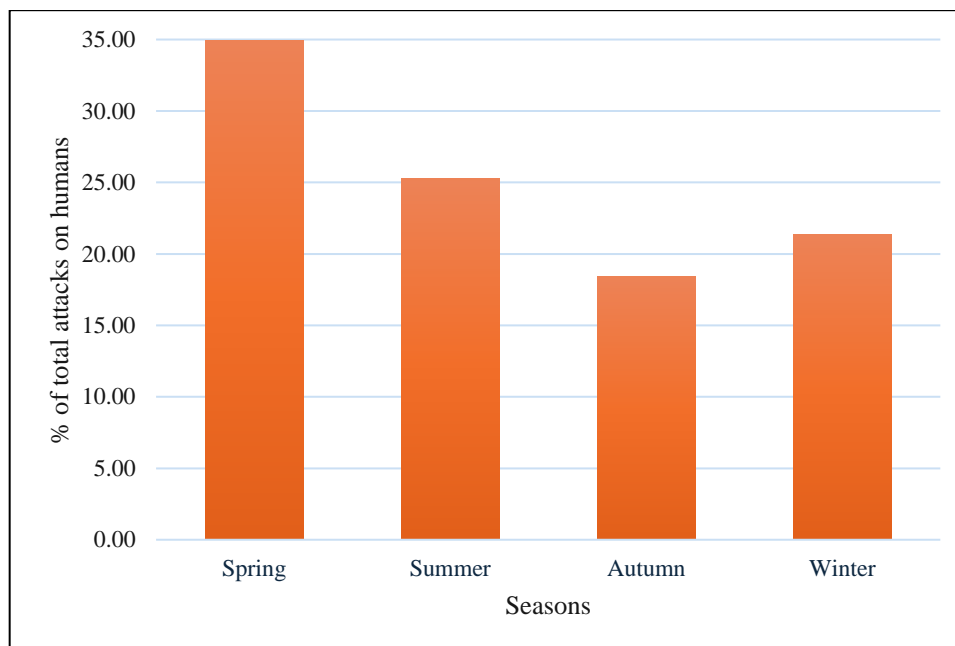


**Figure 4.3:** Seasonal variation in human-tiger conflicts between 2001 and 2023

Autumn is the season with the highest percentage of human-tiger conflicts, which is 26.91% followed by 25.53% in summer, 24.26% in winter and 23.31% in spring.

However, a seasonal variation can be clearly observed when only attacks on humans by tigers are considered (Figure 4.4). The difference between the seasons with highest and lowest percentage

of total tiger attacks on humans is 16.50%, which is greater when compared with the overall human-tiger conflicts.



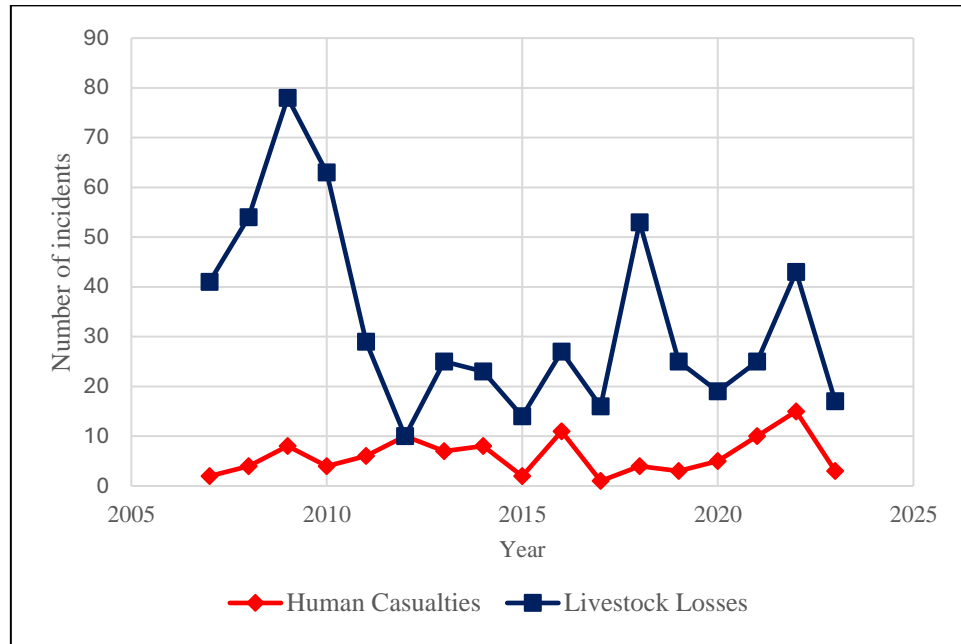
**Figure 4.4:** Seasonal variation in attacks on humans by tigers between 2007 and 2023

As shown in Figure 4.4, spring is the season with highest number of attacks on humans, which is 34.95% followed by 25.24% during summer.

In addition, a total of 89 lives have been lost due to tiger attacks from 1999 to 2023. On average tiger attacks have led to 6 (SD 3.83) human casualties annually from 2007 to 2023 (Figure 4.5). While 33 (SD 19.21) livestock on an annual average were lost due to depredation by tiger from 2007 to 2023.

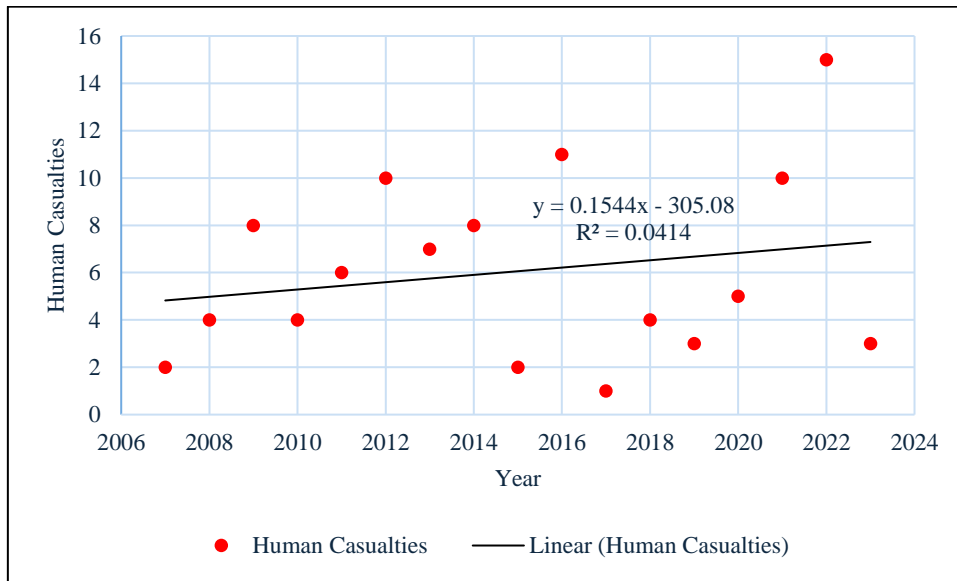
Besides, in an attempt to establish the relationship between human casualties and progression of time as well as livestock losses and progression of time, a linear regression with single

independent variable was run. However, in both cases, statistical significance was not obtained, and R-squared values were less than 0.3. The R-squared value was 0.04 for human casualties versus time (Figure 4.6), while the R-squared value was 0.21 (Figure 4.7) for livestock losses versus time.



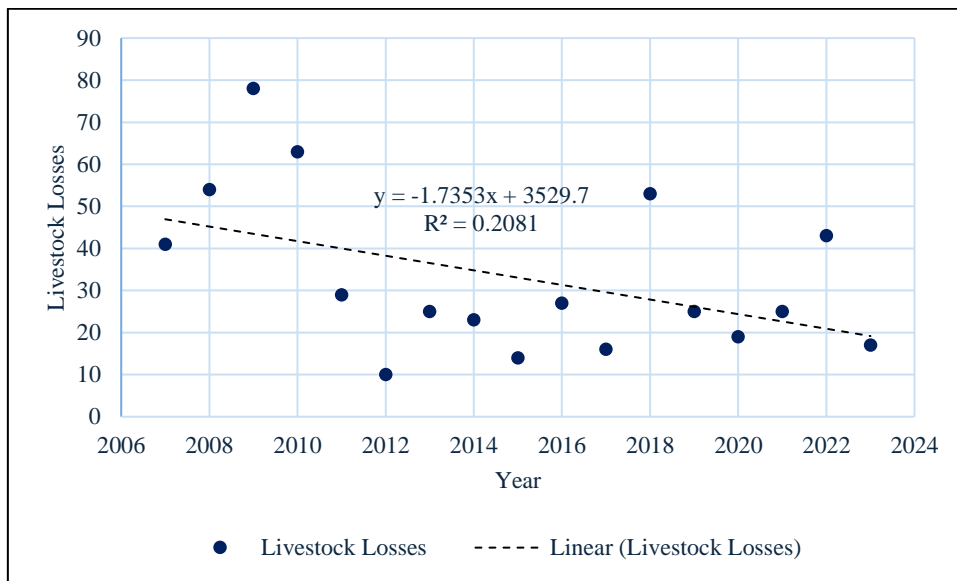
**Figure 4.5:** Temporal variation (2007 to 2023) of tiger attacks

Based on Figure 4.5, the human casualties peaked in 2022 with 15 cases, while the livestock losses peaked in 2009 with 78 cases. A rise in human casualties can be observed between 2019 and 2022 (Figure 4.6). Additionally, human casualties in 2023 represent only the incidents that occurred in the first six months.



**Figure 4.6:** Human casualties to tiger attacks versus time

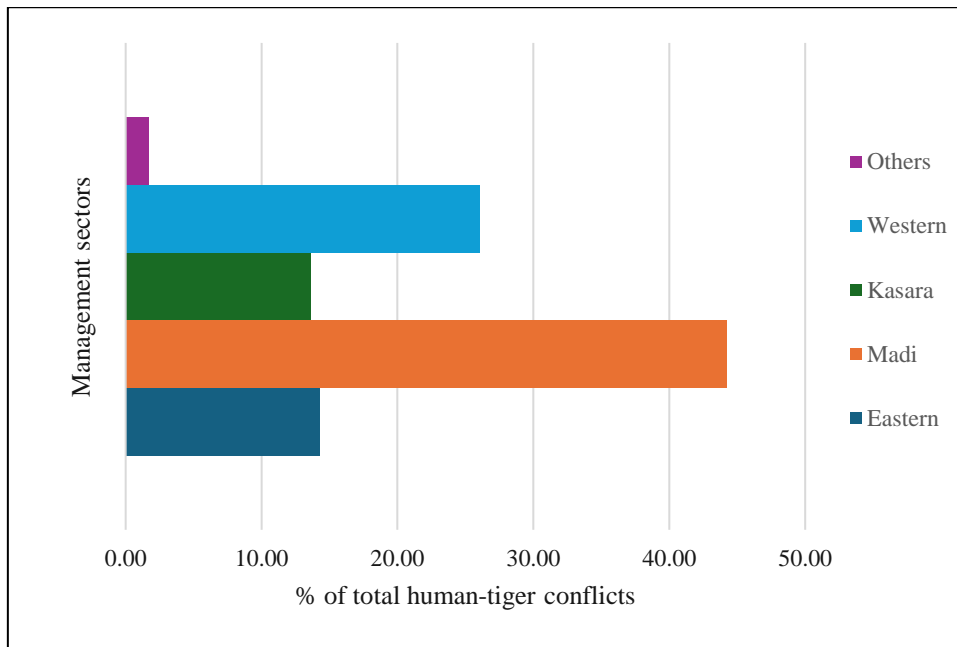
As presented in Figure 4.7, more than 50 livestock losses per year have been recorded only on four occasions – in a period from 2008 to 2010 and in 2018.



**Figure 4.7:** Livestock losses to tiger attacks versus time

#### 4.2.2 Conflicts by Management Sectors and Buffer Zone User Committees

In terms of management sector, Madi management sector is reported to have recorded the highest percentage of total human-tiger conflicts (Figure 4.8). A total of 49 human casualties and 709 livestock losses occurred in Madi between 1999 and 2023 due to tiger attacks. In Madi sector, 44.25% of total conflicts occurred, followed by 26.04% in western sector. Similarly, the total human-tiger conflicts in Kasara and Eastern sector is almost identical.

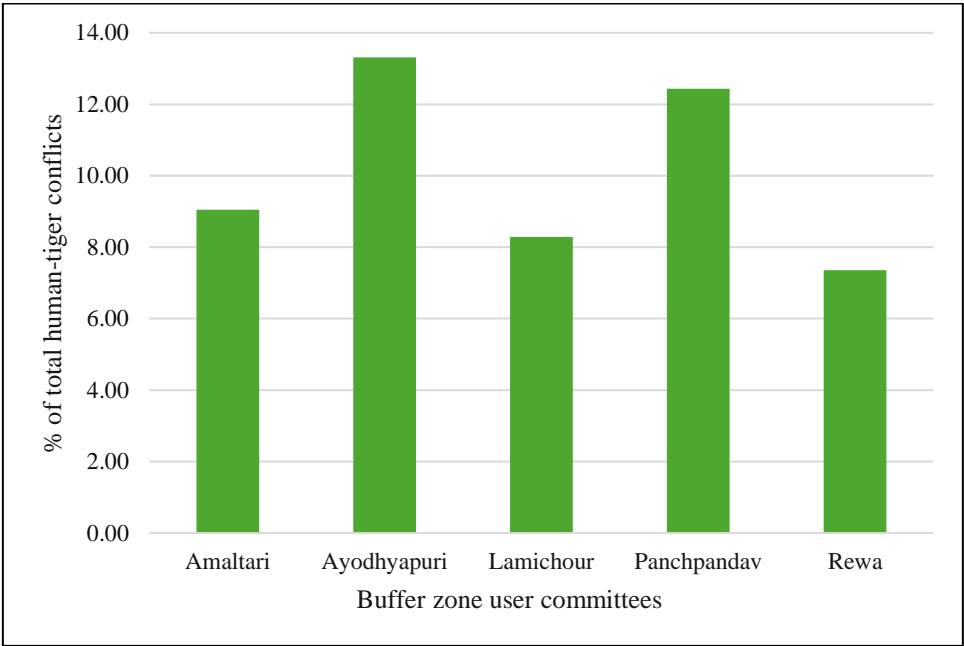


**Figure 4.8:** Distribution of human-tiger conflicts based on management sectors of CNP

Similarly, in terms of buffer zone user committees (BZUCs), Ayodhyapuri, Panchpandav, Amaltari, Lamichour and Rewa are the top five BZUC with highest human-tiger conflicts recorded between 1999 and 2023 (Figure 4.9). Although the human-tiger conflicts were recorded in 22 different BZUCs in and around CNP, these five BZUCs accounted for 50.44% of the total

human-tiger conflicts. In addition, three out of the top five BZUCs with highest human-tiger conflicts are located in Madi region, which is surrounded by protected areas on all the sides.

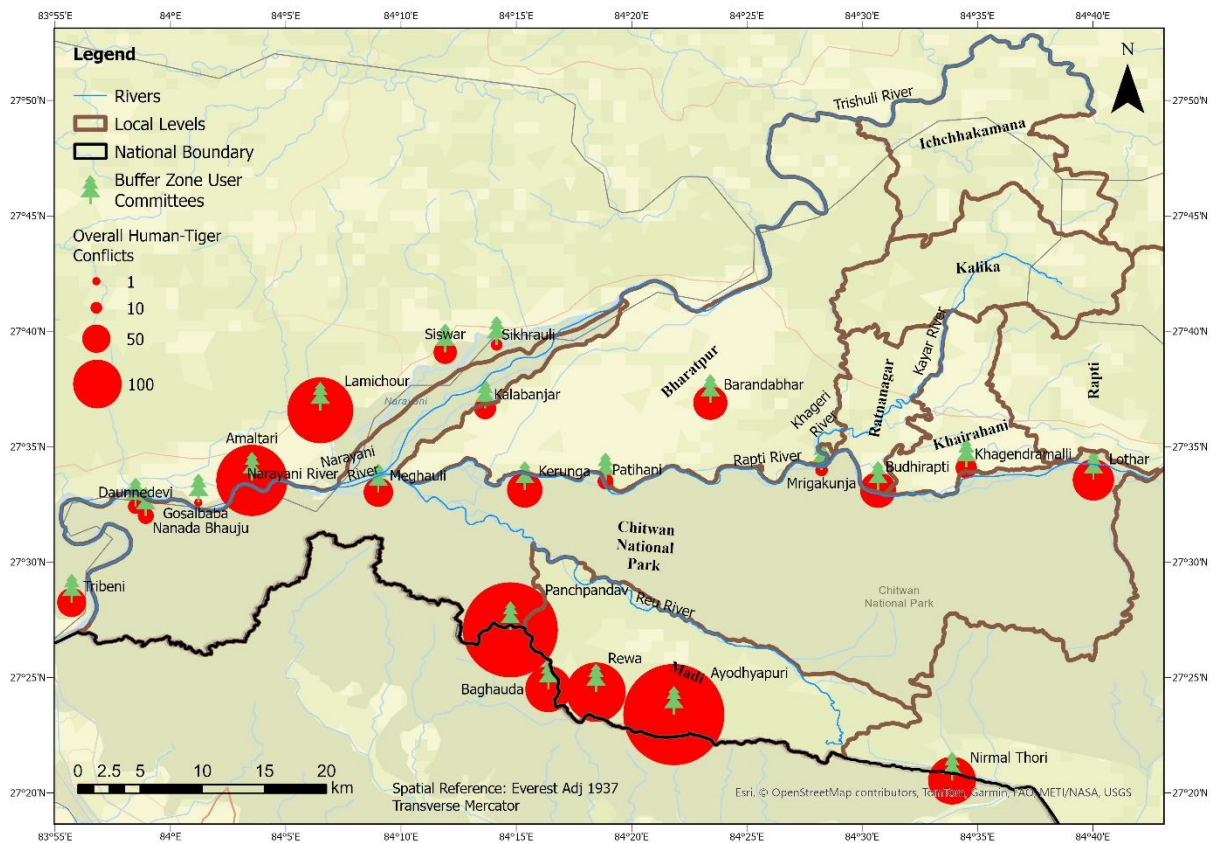
Ayodhyapuri, which is the largest BZUC in terms of area, recorded the highest human-tiger conflicts for BZUCs between 1999 and 2023. Around 13.31% human-tiger conflicts have occurred in Ayodhyapuri, while Panchpandav accounted for 12.43% of total conflicts. A combined 25 human casualties and 416 livestock losses occurred between these two BZUCs in a period of 24 years.



**Figure 4.9:** Distribution of human-tiger conflicts in different BZUCs of CNP

Furthermore, the BZUCs south of Reu river such as Rewa, Panchpandav, Baghauda and Ayodhyapuri, and west of Narayani river such as Lamichour and Amaltari have more overall human-tiger conflicts compared to other BZUCs (Figure 4.10). While the BZUCs located along the banks of Rapti river such as Kerunga, Lothar, Khagendramalli, Mrigakunja and Patihani have

comparatively less share in overall human-tiger conflicts. The size of circles in Figure 4.10 represents the magnitude of human-tiger conflict incidents in BZUC. Larger circles represent BZUC with high human-tiger conflict incidents.

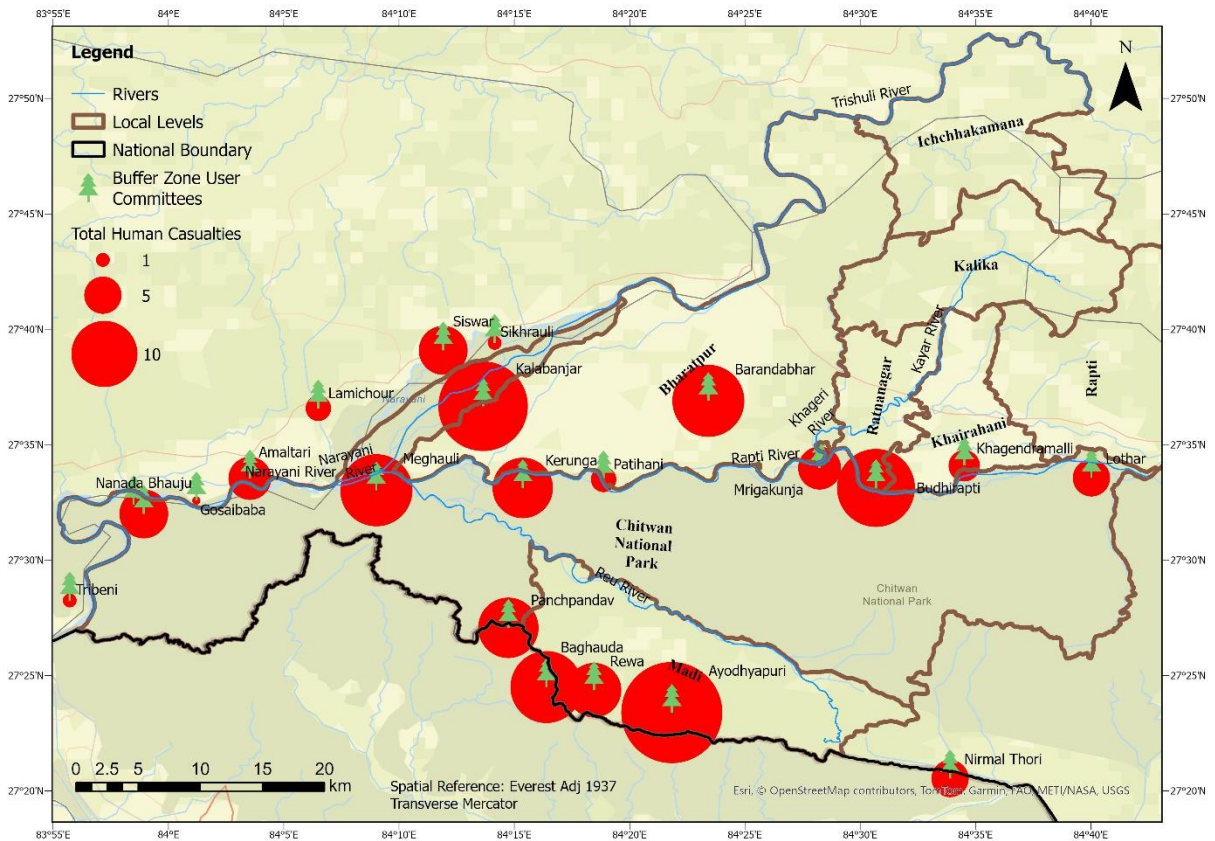


**Figure 4.10:** Human-tiger conflict incidents in different BZUCs of CNP

As per Figure 4.10, Barandabhar and Nirmal Thori BZUC are the only BZUCs that are far away from major river. However, a major lake named Bis Hazari Tal is nearby Barandabhar BZUC.

Although, the overall human-tiger conflicts in BZUCs in and around Rapti river is less compared to other BZUCs, however, in terms of human casualties due to tiger attacks between 1999 and 2023 (Figure 4.11), BZUCs such as Budhirapti, Barandabhar, Kalabanjar and Meghauli, which

are nearby Rapti river, are as vulnerable as the BZUCs south of Reu river. The size of circles in Figure 4.11 represents the magnitude of human casualties due to tiger attacks in BZUC. Larger circles represent BZUC with high human casualties.



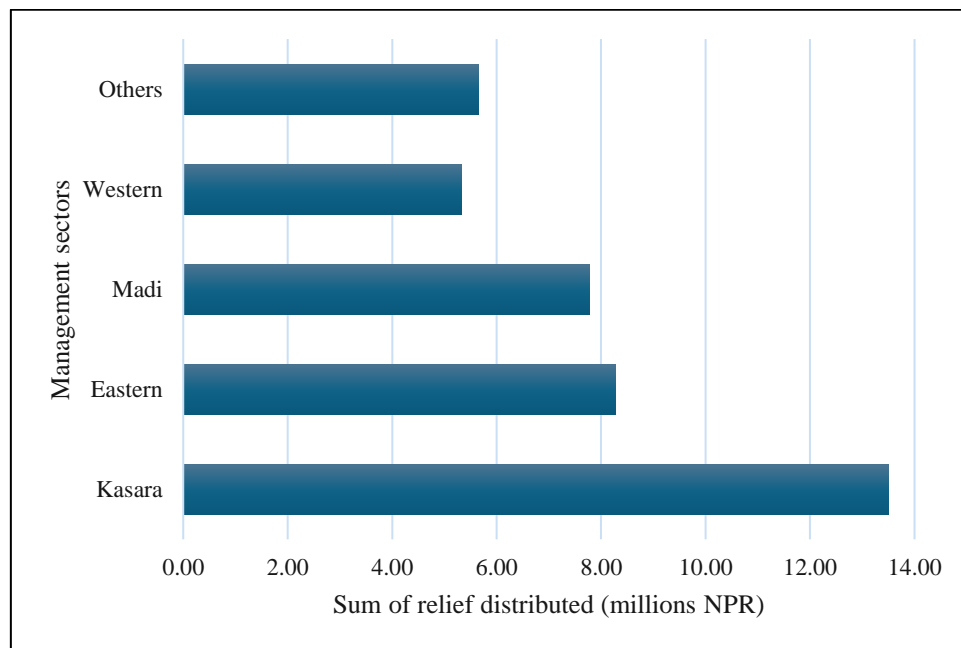
**Figure 4.11:** Human casualties due to tiger attacks (1999-2023) in different BZUCs of CNP

The human casualties due to tiger attacks varied between 0 to 16 among the 22 different buffer zone user committees located in and around CNP. As illustrated in Figure 4.11, Ayodhyapuri, Kalabanjar, Budhirapti, Barandabhar, Megghauli and Baghauda rank in the top six BZUCs in terms of human casualties due to tiger attacks between 1999 and 2023.

Besides, the four BZUCs of Madi region namely Ayodhyapuri, Baghauda, Panchpandav and Rewa, which lies south of Reu river (Figure 4.11), account for 26.67% of total human casualties in and around CNP between 1999 and 2023.

#### 4.2.3 Relief Distributed by Management Sectors and Buffer Zone User Committees

The victims of tiger attacks receive monetary relief, except for incidents that occur inside the core area of national park. The monetary value of relief is different for livestock losses, human injuries, and human deaths. The contribution of management sectors of CNP in terms of relief distribution to victims of tiger attacks between 1999 and 2023 is different (Figure 4.12).

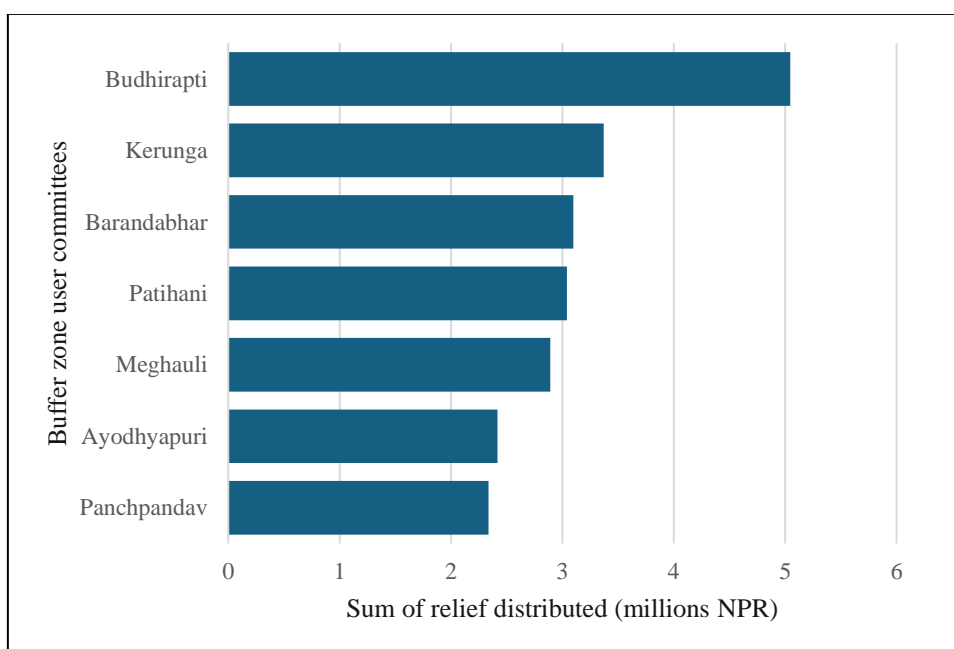


**Figure 4.12:** Sum of relief distributed by management sectors between 1999 and 2023

From Figure 4.12, it can be observed that the sum of relief distributed to victims is highest in Kasara management sector, which is Nepalese rupee (NPR) 13.49 million, while it is lowest in

western management sector, which is NPR 5.33 million. Similarly, the sum of relief distributed to victims in Madi, and eastern management sector are NPR 7.78 million and NPR 8.27 million, respectively.

In terms of buffer zone user committees (BZUCs), Budhirapti, Kerunga, Barandabhar, Patihani, Meghauli, Ayodhyapuri and Panchpandav are the top seven BZUC associated with the highest sum of relief distributed to the victims in and around CNP between 1999 and 2023 (Figure 4.13).

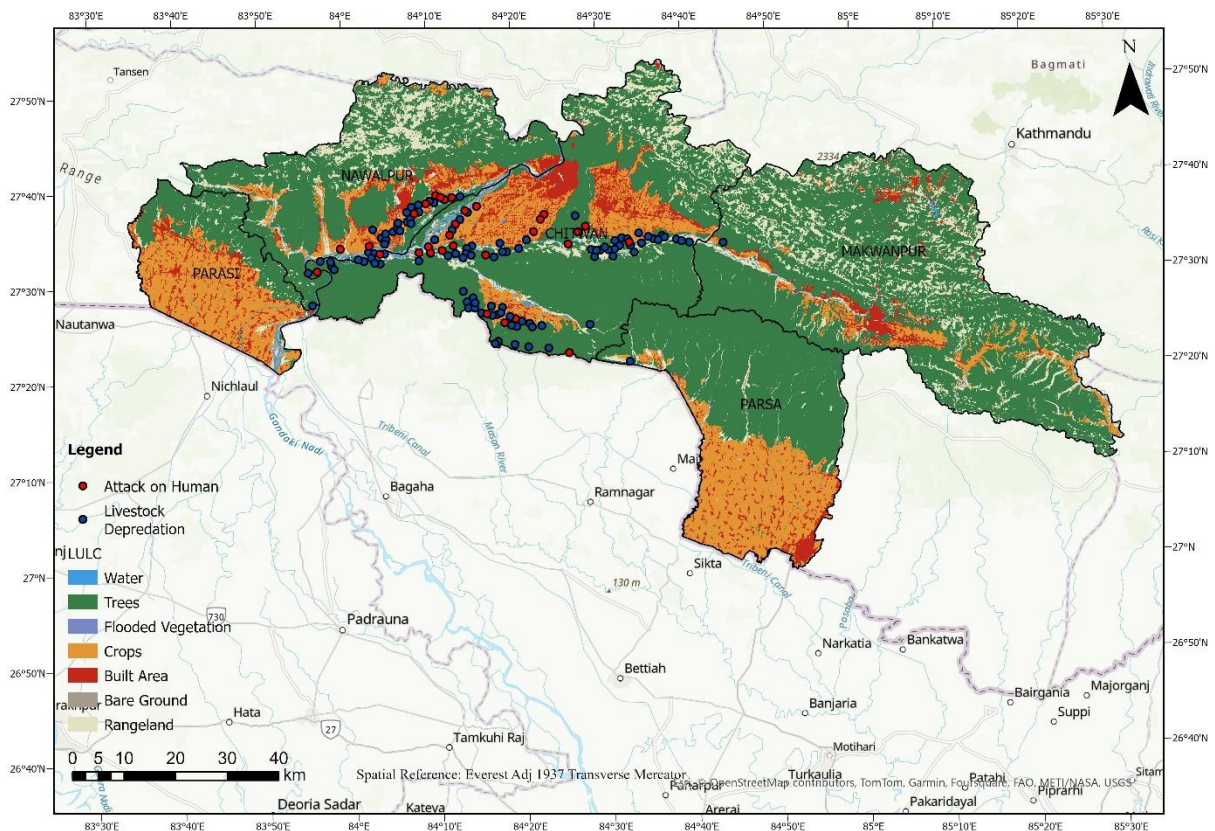


**Figure 4.13:** Sum of relief distributed by BZUC between 1999 and 2023

From Figure 4.13, it can be observed that the sum of relief distributed to victims is highest in Budhirapti BZUC, which is NPR 5.04 million, followed by Kerunga BZUC with NPR 3.37 million. These 7 BZUCs account for NPR 22.20 million in terms of relief distributed to victims, which is more than 50% of the total sum of relief distributed to the victims across the 21 BZUCs between 1999 and 2023.

#### 4.2.4 LULC and Heat Map of Human-Tiger Conflicts

Apart from distribution of human-tiger conflicts based on season and BZUC, the conflict locations based on land cover was achieved by using the land use land cover (LULC) information for 2023 of districts surrounding the CNP. It was obtained from ESRI World Atlas (Figure 4.14) through Sentinel-2 Land Cover Explorer, which had a resolution of 10 meters.



**Figure 4.14:** Distribution of human-tiger conflicts based on land use land cover

The LULC data for zones 44N and 45N were selected because parts of CNP lied in these two zones. Similarly, the extent chosen for LULC was the neighbouring districts of CNP, which includes Chitwan, Nawalpur, Parasi, Makwanpur and Parsa.

From Figure 4.14, it can be observed that majority of the conflict points do not lie in denser and inner forest regions. Most of these conflicts have occurred in edge habitats.

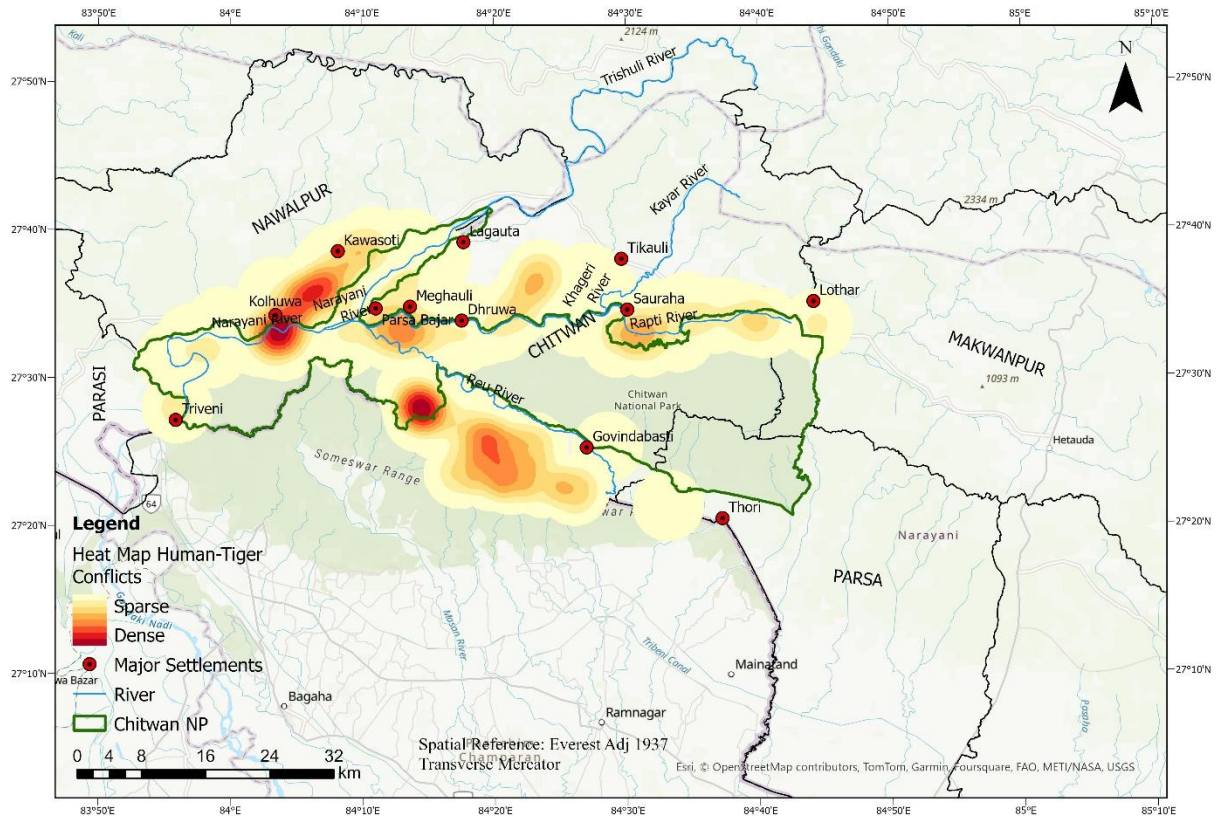
Based on the 1096 conflict points recorded in a span of more than a decade, only 5.57% of the total conflicts occurred in built area, while 22.08% of the conflicts were observed in cropland (Table 4.4). However, forests and water bodies inside the forests accounted for 60.86% of the total conflicts. The majority of the conflict points can be observed in the vicinity of major rivers that flow through CNP.

**Table 4.4:** Conflict points based on LULC

LULC	Number of conflict points	Percentage (%)
Water	74	6.75
Trees	593	54.11
Flooded vegetation	0	0.00
Crops	242	22.08
Built area	61	5.57
Bare ground	48	4.38
Rangeland	78	7.12
Total	1096	100

Similarly, the heat map (Figure 4.15) clearly shows that there are primarily two regions which are at closer distance from the regions with warm colours, such as red. These warm colour regions, which represent high concentration of human-tiger conflict incidents, are Kolhuwa in

Nawalpur district, which is west of Narayani river and Madi region in general that lies south of Reu river. Both these regions lie between the boundaries of CNP core and the buffer zone.

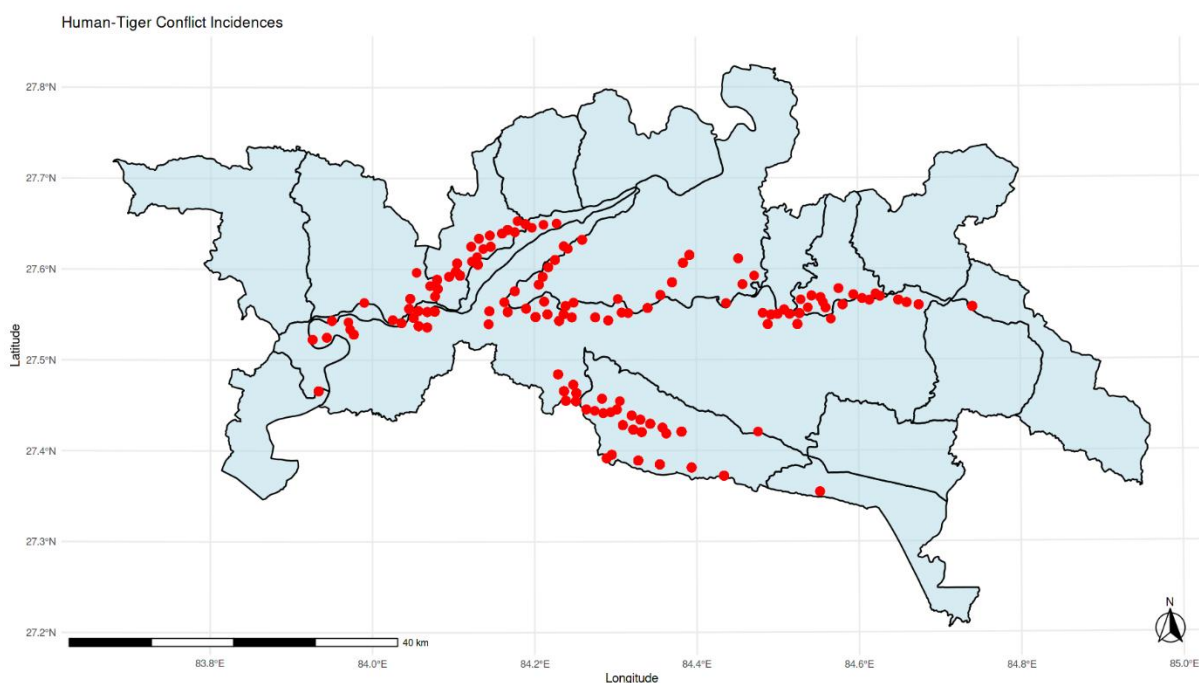


**Figure 4.15:** Heat map of human-tiger conflicts nearby major settlements

Based on Figure 4.15, regions with cool colours, such as light yellow, are north of Rapti river, where 4 of the 5 local levels of Chitwan district are located. Regions where colours are cool represent low concentration of human-tiger conflict incidents. In addition, Madi, the only local level of Chitwan district that lies south of Rapti river, is located between Chitwan National Park in Nepal and Valmiki Tiger Reserve in India.

#### 4.2.5 Quadrat and Clustering Analysis

To verify the findings of the heat map, a quadrat and clustering analysis was performed. The study extent used for this analysis represents Chitwan National Park and the surrounding municipalities (Figure 4.16). Such study extent was chosen because both the human-tiger conflict incidents and tiger locations were observed beyond the boundaries of the core zone.



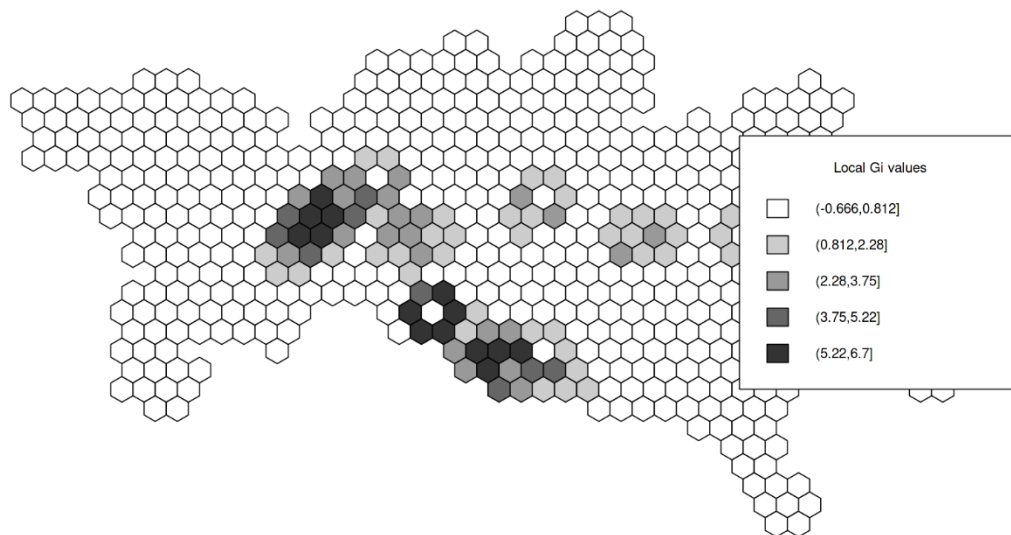
**Figure 4.16:** Human-tiger conflict incidences in CNP and neighbouring municipalities

For quadrat analysis, variance to mean ratio (VMR) was calculated at multiple scales (3000, 5000 and 8000 m resolution) for both human-tiger conflict incidences and tiger locations (Table 4.5). The VMR values revealed that there was tendency towards clustering in all the cases of human-tiger conflict incidences and tiger locations as the VMR values were greater than 1.

**Table 4.5:** Variance to mean ratio at different quadrat resolutions

Quadrat resolution (m)	Variance to mean ratio	
	HTC Incidences	Tiger Locations
3000	26.76	1.45
5000	44.01	2.77
8000	60.81	5.16

The clustering analysis performed by calculating local Getis-Ord Gi values revealed that there were distinct high intensity human-tiger conflict regions. For instance, three hot spots were observed at quadrat resolution of 3000 m (Figure 4.17). Two of these hot spots were located in south of the park (Bagai sector), and one was observed in the west (Amaltari sector).



**Figure 4.17:** Local Gi statistic values of human-tiger conflict incidences

Similarly, the local Getis-Ord  $G_i^*$  values for tiger locations at 5000 m resolution indicated three distinct high tiger presence regions across the park (Figure 4.18).



**Figure 4.18:** Local  $G_i^*$  statistic values of tiger presence locations

Based on Figure 4.18, the hotspots of tiger presence can be observed in the western, central and eastern regions of the park, which indicates high concentration of tigers in core park areas compared to the edges of park boundaries. The clusters of human-tiger conflict incidences and tiger presence at different resolutions, which have been quantified using  $G_i^*$  statistics, are attached in Appendix E.

#### 4.2.6 Near Analysis and Vulnerable Region

Following cluster analysis, the proximity of 1,096 conflict points from several geographic features was determined using Near analysis in ArcGIS Pro. It was done to evaluate the average

distance of conflict points from various predictors, which potentially contributes to human-tiger conflicts.

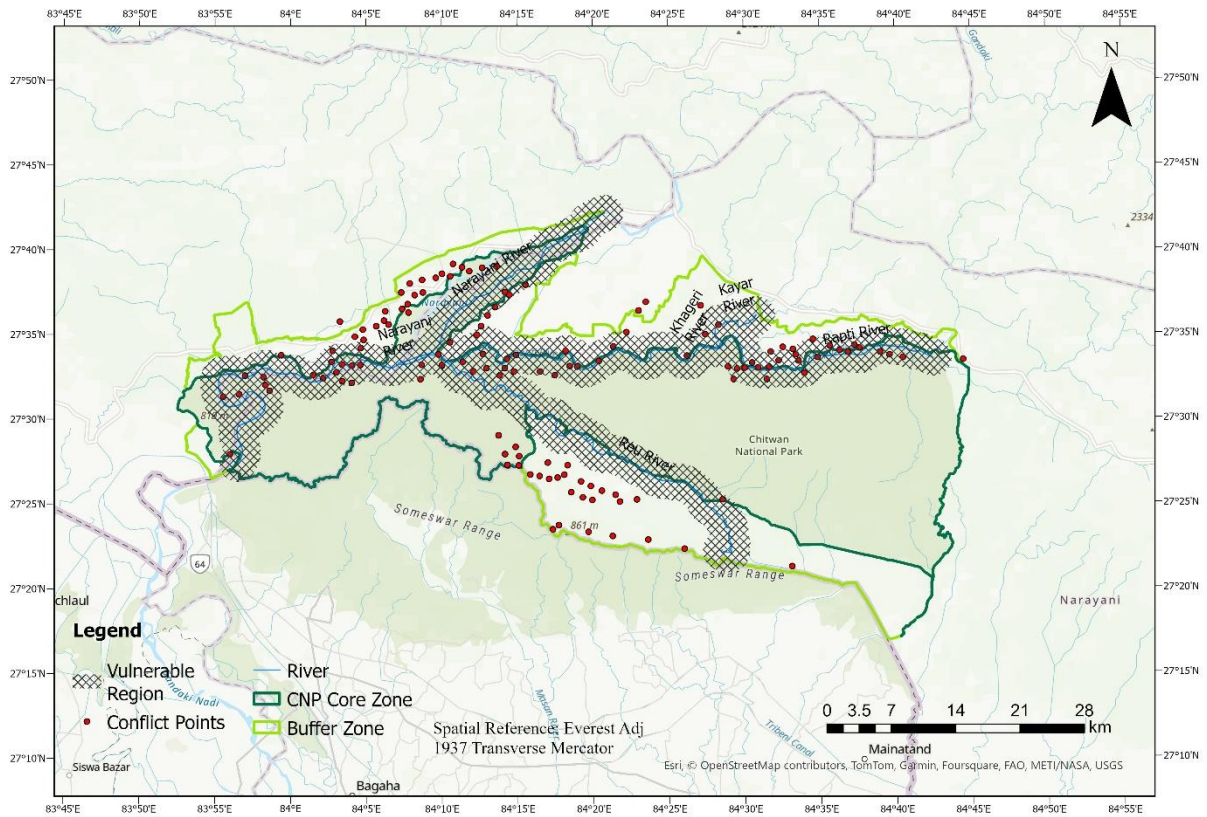
As per Figure 4.14, the majority of the conflict points can be observed in the vicinity of major rivers that flow through the Chitwan National Park. Using Near analysis, it was found that the average distance of a conflict point from the nearest major river was 2.96 kilometers (SD 2.47 km). Besides, Narayani, Reu and Rapti rivers were the nearest major rivers for 33.30%, 39.96% and 26.10% of 1,096 conflict points, respectively.

However, when Near analysis was performed for only 711 points, excluding the points south of Reu river in Madi region, the average distance of these conflict points from the nearest major river was 1.50 kilometers (SD 1.25 km). The 385 conflict points in Madi region were excluded because these points were significantly far away from the river corridor. Moreover, Madi is a region which is completely surrounded by protected areas (Chitwan National Park, Parsa National Park and Valmiki Tiger Reserve) on all the sides. So, factors other than the nearness to the major rivers could be important for Madi region.

Based on Near analysis, a 2-kilometer linear buffer was performed (Figure 4.19) on both sides of major rivers namely Narayani, Rapti, Reu, Kayar and Khageri to obtain the vulnerable regions in and around Chitwan National Park.

A 2-kilometer linear buffer was performed although a buffer of 1.50 kilometers would have been sufficient based on the results obtained from Near analysis. It was done to highlight the extended region where the chances of tiger attacks could be high as the tiger is a territorial carnivore, which

prefers to roam in large territories. Besides, the 2-kilometer buffer could serve as an additional caution to the people while entering the forest.



**Figure 4.19:** Vulnerable regions near rivers for human-tiger conflicts

From Figure 4.19, it can be observed that the major rivers present in Chitwan National Park divides the core park area from the national park buffer zone. Also, most of the conflicts are recorded to have occurred in regions that lie between the boundaries of the core park area and the national park buffer zone.

In the same way, Near analysis was performed for distance of conflict points from nearest forest, grassland, rivers (both major and minor), road, human settlements and tiger locations. In doing

so, the average distance of 1,096 conflict points from nearest forest was 0.50 kilometers (SD 0.71 km), while the average distance from grasslands was 3.24 kilometers (SD 3.07 km). Similarly, the average distance from all river sources was 0.94 kilometers (SD 0.99 km), whereas the average distance from the tiger locations was 2.74 kilometers (SD 1.88 km). The average distance from settlements and roads accounted for 1.85 kilometers (SD 1.84 km) and 2.60 kilometers (SD 1.97 km), respectively.

#### **4.2.7 Regression Analysis**

Using seven predictor variables – six generated from Near analysis in section 4.2.6 and an additional one (livestock density), a regression analysis was performed using R in Jupyter Notebook. The dependent variable was the number of human-tiger conflict incidences in a given location (Table 4.6). The independent variables were the nearest distances (in km) from human-tiger conflict locations to road, settlement, river, forest, grassland, tiger locations and livestock density (per km<sup>2</sup>).

Upon performing simple linear regression, at confidence level of 95%, a R-squared value of 0.173 and an adjusted R-squared value of 0.127 was obtained. It indicates that the model is weak as the independent variables only explain 17.3% of the variability in the dependent variable. Only variable X3 (distance to river) is statistically significant, while other variables (X1, X2, X4, X5, X6 and X7) are not significant ( $p > 0.05$ ). The graph of observed incidences versus predicted incidences has been added in Appendix C.

**Table 4.6:** Coefficients and p-values for seven independent variables

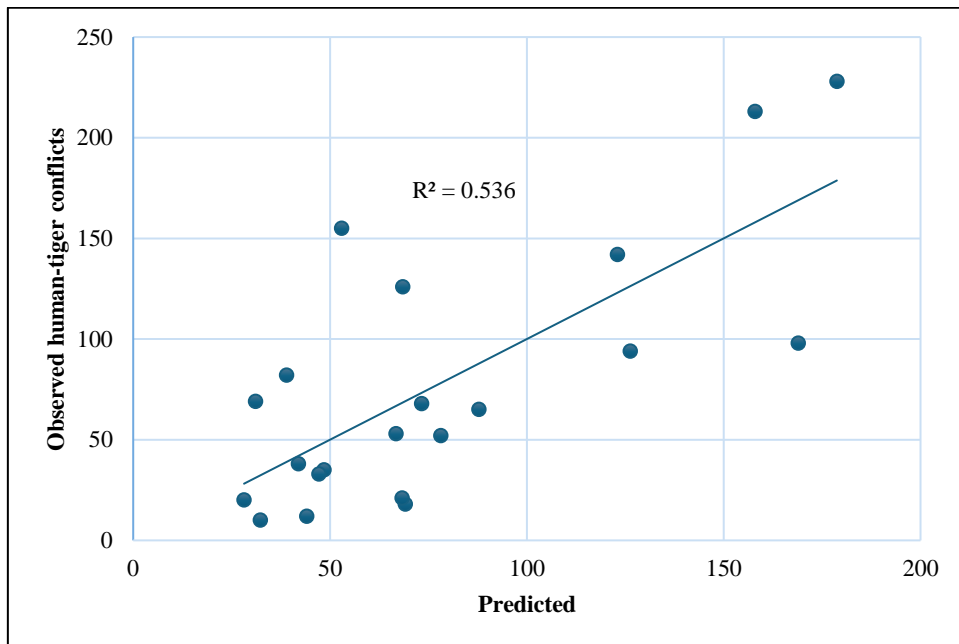
<b>Variable</b>	<b>Coefficients</b>	<b>Standard Error</b>	<b>t-Stat</b>	<b>P-value</b>	<b>Significance</b>
Intercept	3.677	1.854	1.983	0.049	Significant
Distance to road (X1)	0.471	0.538	0.874	0.384	Not significant
Distance to settlement (X2)	0.934	0.795	1.174	0.242	Not significant
Distance to river (X3)	2.471	1.066	2.318	0.022	Significant
Distance to forest (X4)	0.511	1.105	0.463	0.644	Not significant
Distance to grassland (X5)	0.332	0.441	0.753	0.453	Not significant
Distance to tiger locations (X6)	-0.159	0.542	-0.293	0.770	Not significant
Livestock density (X7)	-0.002	0.014	-0.180	0.858	Not significant

However, when the number of human-tiger conflict incidences for each BZUC was considered, a different result was obtained (Table 4.7). In this case, the number of human-tiger conflict incidences was chosen as an independent variable, while distance to river from BZUC (km), livestock density (per km<sup>2</sup>) and BZUC area (km<sup>2</sup>) were the independent variables. The values of BZUC area varied between 7.86 to 115.1 km<sup>2</sup> (Appendix D). Since there was information for 21 BZUCs, the number of observations were 21. Socioeconomic variables and tiger density were not included because of lack of availability of data at the buffer zone user committee level.

**Table 4.7:** Coefficients and p-values for three independent variables

Variable	Coefficients	Standard Error	t-Stat	P-value	Significance
Intercept	-7.430	23.933	-0.310	0.760	Not significant
Distance to river (X1)	38.789	13.578	2.857	0.011	Significant
Livestock density (X2)	0.355	0.264	1.342	0.197	Not significant
BZUC area (X3)	1.412	0.400	3.528	0.003	Significant

At confidence level of 95%, a R-squared value of 0.536 (Figure 4.20) and an adjusted R-squared value of 0.454 was obtained. It indicates that the model is moderately strong as the independent variables explain 53.6% of the variability in the dependent variable.



**Figure 4.20:** Predicted versus observed values with three independent variables

As presented in Table 4.7, variables X1 and X3 (distance to river and BZUC area) are statistically significant, while variable (X2) is not significant ( $p>0.05$ ). Based on the values of the coefficients in Table 4.7, for every 1 km<sup>2</sup> increase in BZUC area, the number of human-tiger conflict incidences increases by 1.41, provided distance to river and livestock density remain constant. Besides, the coefficient value of distance to river is on the higher side compared to other two variables because the unit of distance to river is in kilometers.

### 4.3 Local Perspectives on the Human-Tiger Conflicts

To understand the local perspectives on the human-tiger conflicts, 54 interviews were conducted in four different municipalities of Chitwan district. For this study, 29 key informants and 25 affected households were interviewed. In this study, the respondents were interviewed across four municipalities namely Rapti (n=7), Khairahani (n=15), Ratnanagar (n=6) and Bharatpur (n=26). The key informants and participants from affected households belonged to various socio-economic backgrounds (Table 4.8).

**Table 4.8:** Demographic information of respondents

Variable	Frequency (n)	
	Key Informant	Affected Household
Sex		
Male	27	12
Female	2	13
Age		
Below 30	2	6

30 to 50	10	11
Above 50	17	8
Ethnicity		
Janajati	4	15
Hill Group (Khas-Arya)	24	10
Newar	1	-
Religion		
Buddhism	2	8
Christianity	-	1
Hinduism	27	16
Education		
Primary	-	10
Lower Secondary	2	6
SLC/Secondary	15	9
10+2/Intermediate or Higher	12	-

Similarly, key informants were representatives from community forests, BZUCs and service, whereas the representatives from 25 affected households belonged to farming community. These interviewed affected households were the victims of tiger attacks causing human death, human injury or livestock loss. Besides, 20 out of 25 incidents with affected households had occurred between 2020 and 2023 near Sitamai (n=7), Kumroj/Sauraha (n=9) and Piple (n=4).

The interviews conducted with the respondents (n=54) have been broken down into several themes, which are elaborated in the subsequent subsections.

#### **4.3.1 Findings from Interviews**

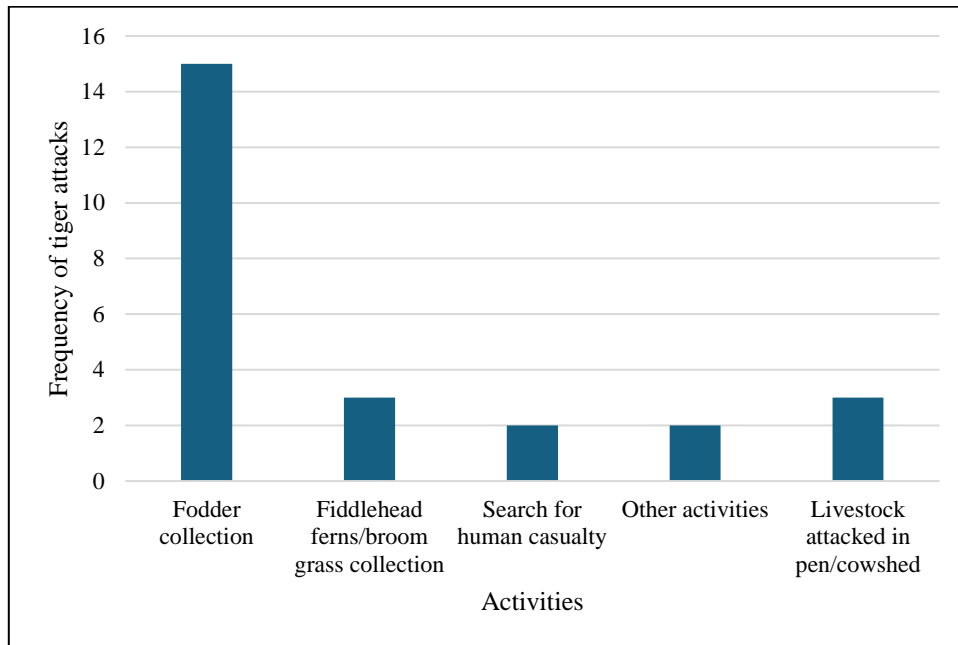
This sub-section presents the findings from the interviews based on the several themes discussed during the interviews.

##### **4.3.1.1 Human-Tiger Conflicts**

Based on the 29 interviews conducted with key informants, it was found that most of the tiger attacks on humans happen when people are involved in forest resources collection activities inside the community forest. Collection of fodder, firewood, fiddlehead ferns or fishing received n=20 responses. While n=3 responses included attack by tiger inside human settlements, whereas n=1 response was received for equal attacks both inside and outside the forest.

Meanwhile 25 households were interviewed, who were victims of tiger attacks leading to human casualties or livestock losses. Out of these 25 households, n=5 households had their family member injured by tiger attacks, while n=17 households had their family member killed by the tiger. Only n=3 households had lost their livestock due to depredation by tiger.

As per the interviews with affected households, the incidents leading to human casualties due to tiger attacks primarily occurred during the collection of forest resources in the community forests (Figure 4.21).



**Figure 4.21:** Involvement in activities during tiger attacks

Additionally, the interviews with affected households also revealed that the survivors or victims of tiger attacks had significantly reduced visiting the community forests for collection of forest resources. The major reason behind that was the traumatic experience. For instance, a participant from affected household expressed that:

*“It is not wise to enter the forest. We are extremely afraid because of the incidents.*

*We have the fear of new incident as well.” (KI5, 2024/11/11)*

Collection of fodder (n=15), fiddlehead ferns (n=2) and Nepalese broom grass (n=1) were the forest resources collection activities during which the tiger attack happened. As indicated in Figure 4.21, n=2 cases occurred while searching for someone who had been attacked by the tiger. Similarly, n=1 case occurred while sleeping at home, whereas n=1 case occurred when visiting a temple inside the community forest.

#### 4.3.1.2 Human-Tiger Encounters and Tiger Populations

Out of 29 key informants, 21 reported that the increase in human-tiger encounters is due to the increase in tiger populations, while 2 key informants believed that the human-tiger encounters had decreased, and it had no relation with the increase in tiger populations. For instance, a key informant interviewee opined that:

*“Before, the conservation practice was not there, due to which the incidents were low. But now the incidents have increased due to the increase in tiger populations.”*

(KI6, 2024/10/24)

In support of the above statement, criticizing the management practice, another key informant respondent believed that:

*“The management of 128 tigers in the present at Chitwan National Park and 50 tigers in the past is not the same.”* (KI7, 2024/10/27)

Besides, there were three key informants who believed both the tiger populations and human-tiger encounters had increased, but they did not link increase in tiger populations with increase in human-tiger encounters. One of these three key informants expressed that:

*“A mathematical association between increase in tiger populations and increase in conflict hasn't been found.”* (KI29, 2024/10/20)

In addition, there were two key informants who believed that human-tiger encounters have not occurred recently.

Out of 25 participants from affected households, n=6 participants believed that the increase in human-tiger conflict was due to the increase in tiger populations. While n=1 participant implied lack of space inside the forest as the cause for increase in human-tiger conflict, whereas n=1 participant indicated old and injured tigers were the reason behind the increase in human-tiger conflict. Moreover, n=13 participants expressed that there has been increase in tiger attacks or human-tiger encounters. In this regard, an affected household interviewee stated that:

*“The tiger attack has increased. It has significantly increased compared to the past. It is very difficult to go inside the forest because of the risk involved. We enter into the forest in a group, we cannot go alone in the forest.”* (HH21, 2024/11/17)

Similarly, n=2 respondents suggested that they have heard of tiger attacks recently, whereas n=1 respondent stated that they do not have tiger-related problems in their locality. Besides, there was no response on this matter from n=1 respondent.

#### **4.3.1.3 Movement of Tigers near Human Settlements**

The responses from 23 key informants suggested that the tigers have been moving towards the human settlements. Majority of the key informants indicated that the tigers have been moving towards the human settlements due to old age, injury, lack of prey, and increase in tiger populations. In support of this belief, a key informant interviewee opined that:

*“Firstly, the increase in tiger populations is one of the reasons. Secondly, lack of prey availability inside the core area, although the populations of sambar deer and spotted deer have increased, but due to lack of management of grasslands and large size of bushes inside the park, the tiger are having difficult times hunting their prey. The*

*deer are entering the buffer zone in search of grasslands, and the tigers are getting attracted to buffer zone because it is easier for them to hunt in buffer zone.” (KI9, 2024/10/27)*

However, only 4 out of these 23 key informants corroborated their statement by suggesting that the pugmarks of the tiger can be seen on the edges of the forest. For instance, one of such 4 key informants stated that:

*“We don’t see tigers. Tigers can be spotted at nights. All we see is the pugmarks of the tiger. Only an unhealthy tiger can be spotted. A healthy tiger cannot be spotted as it hides and moves secretly.” (KI17, 2024/11/05)*

While 4 out of 29 key informants suggested that the tigers are either rarely seen or not seen at all near the human settlements. In this context, a key informant suggested that:

*“We have installed mesh wires, fences, and walls in the boundaries of the park due to which the tigers are spotted less frequently compared to the past.” (KI7, 2024/10/27)*

Whereas majority of the respondents from affected households suggested that tigers are sighted inside the community forest rather than the human settlements. While only n=2 respondents had no response on this topic. The n=19 respondents from these households have not seen a tiger entering the human settlements. However, they have indicated that the tigers can be seen of the edges of the community forest. On this basis, an affected household interviewee stated that:

*“Before, the tigers would kill on the other side of the river. But now, the incidents are taking place in the community forest. Before, the tigers wouldn’t be spotted in the community forests.”* (HH20, 2024/11/17)

On the contrary of the majority belief, n=4 participants from affected households suggested that the tigers along with other wildlife are entering the human settlements. Of the 4 participants, 3 of them provided evidence of tiger entering the human settlements by pointing out their livestock losses inside the human settlements. In this sense, a participant from affected household claimed that:

*“There are a lot of open spaces from where the wildlife enters the settlements.”* (HH 19, 2024/11/17)

#### **4.3.1.4 Location and Riskiest Areas of Tiger Attacks**

Based on the interviews, n=24 respondents replied that the tiger attacks were happening inside the community forest, and rarely the tiger attacks were happening in the human settlements. While only one respondent believed that the tiger attacks are equally taking place in human settlements and inside the forest.

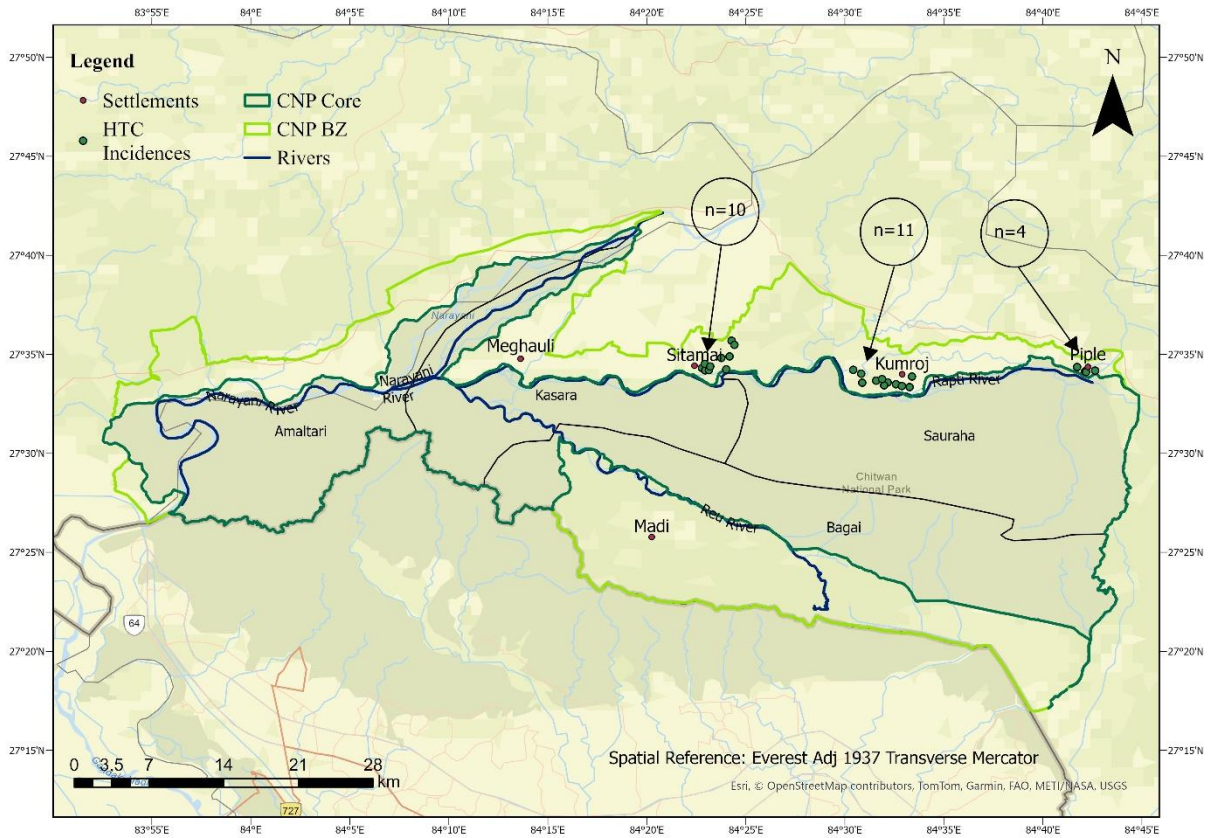
Majority of the respondents have suggested that the incidents of tiger attacks are happening during the collection of fiddlehead ferns or firewood inside the community forest. In this context, a key informant interviewee opined that:

*“We haven’t witnessed the tiger attacks in human settlements. People, who go to the forest to collect firewood and fodder, are often the victims of tiger attacks.”* (KI15, 2024/10/29)

Besides, as per the interviews with key informants, 32 locations have been identified as areas prone to tiger attacks. These locations in order of responses are Lothar, Kumroj, Barandabhar, Pidani, Kathar, Narayani bridge, Rapti, Madi, Parasi, Thori, Meghauli, Mrigakunja, Sitamai, Kasara, Batuli Pokhari, Devnagar, Tikauli, Belsahar, Krishnapur, Ghailaghari, Patihani, Ujjwalnagar, Sauraha, Khorsor, Padampur, Tribeni, Champanagar, Bharatpur, Khagendra Malli, Baghmara, Icharni and Bodhreni. Among these locations, Kumroj, Madi and Meghauli were identified as the top three areas more prone to tiger attacks with each receiving 11, 7 and 5 responses, respectively.

Whereas, as per the respondents from affected households, n=21 respondents replied that the tiger attack happened inside the community forest, which is similar to the responses of key informants. While n=4 cases occurred inside the human settlements, but within the buffer zone, which led to 1 human casualty and 3 livestock losses.

Based on the information from n=25 affected households, it was found that the locations of human-tiger conflict incidences were within the buffer zone (Figure 4.22) and located nearby settlements such as Sitamai (n=10), Kumroj (n=11) and Piple (n=4). The distance between core park boundaries and conflict locations on average was 1.07 km (SD 0.61 km). In addition, 20 of these cases had occurred between 2020-2023.



**Figure 4.22:** Locations of human-tiger conflict incidences of affected households

Additionally, the respondents from affected households have identified some of the areas prone to tiger attacks. These locations include Simraini, Magar tole and Rapti riverbanks in Kumroj. Similarly, Ganganagar, Ujjwalnagar, Simal Gairi, Janashakti community forest, Janakauli buffer zone community forest (BZCF), Mrigakunja BZCF, Devnagar, Belsahar BZCF, Batuli Pokhari, Sitamai and Madi.

#### **4.3.1.5 Common Time of the Day and Season of Tiger Attacks on Human**

There was a consensus among all the key informants regarding the common time of the day of tiger attack, which was early mornings and sometimes in the evenings.

Regarding the common season of tiger attacks, 9 key informants responded that the period between August to January has been susceptible for tiger attacks, while 6 key informants believed that the likelihood of tiger attacks in March to August was high. In the same way, June to October received 3 votes from key informants for the common period of tiger attacks. In addition, by providing a religious context, a key informant interviewee suggested that:

*“Based on the date of the incidents, most of the tigers are found to be active before festival season during the 16-day window in which death anniversaries rituals are done. During that period, most of the incidents have occurred. Most of the incidents occur in the months of September, October and November.”* (KI27, 2024/11/13)

Similarly, 4 key informants credited the monsoon season for tiger attacks compared to the summer season. For instance, a key informant opined that:

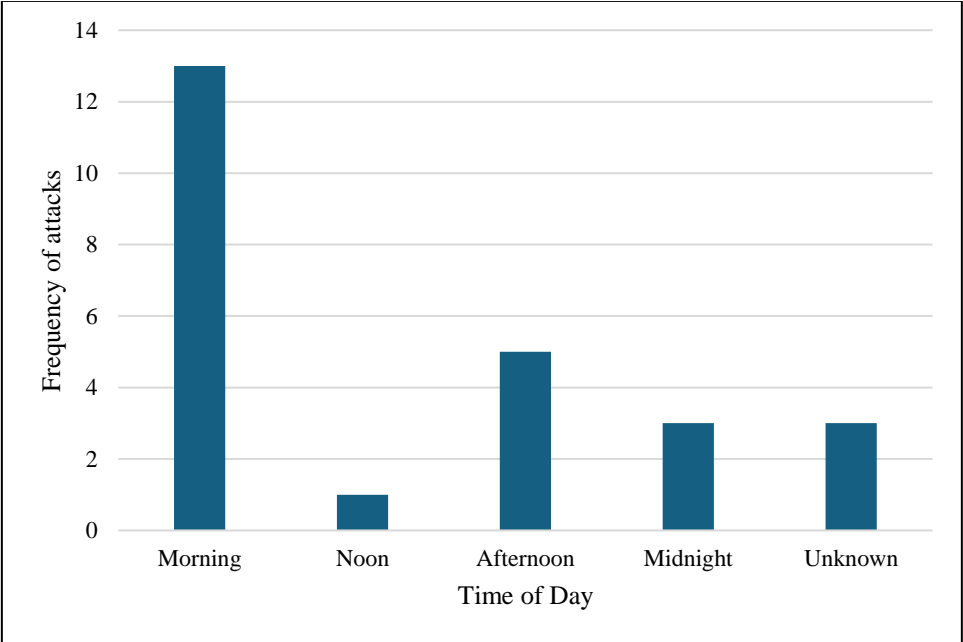
*“Most of the tiger attacks happen during the monsoon because the people enter the forest without proper safety measures. The bushes are thick, and water is available in the community forest during monsoon due to which the wildlife is attracted towards the community forest.”* (KI8, 2024/10/27)

Besides, 3 key informants believed that there is no particular month for tiger attacks, while 3 key informants didn't provide specific replies on this theme. In support of the belief that tiger attacks can happen anytime, a key informant respondent suggested that:

*“In my opinion, when the flow of people entering the forest increases, at that time the tiger attack also increases.”* (KI20, 2024/11/06)

While the responses from the 25 affected households suggested that n=13 attacks happened in the morning (Figure 4.23). For instance, an affected household respondent suggested that:

*“She had gone to the forest in the morning around 9 AM. The incident had taken place before the noon. We reached just before 12 PM. When we took the elephant to search for her, it was around 12 PM. When we reached there, the incident had already taken place.”* (HH11, 2024/11/14)

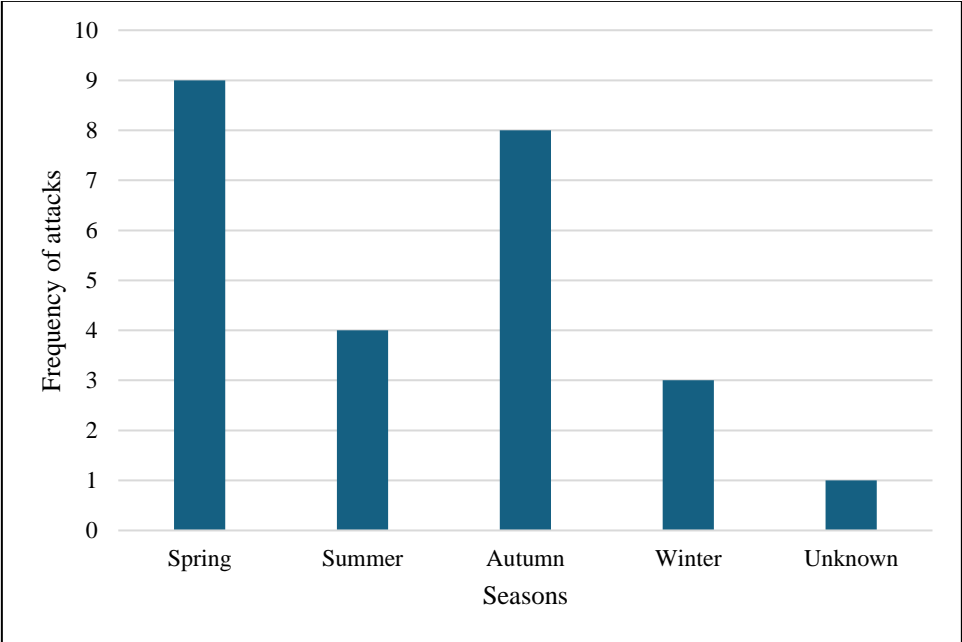


**Figure 4.23:** Time of day during tiger attacks on affected households

As presented in Figure 4.23, n=6 attacks happened between the noon and the evening, whereas all 3 attacks that happened in the midnight caused depredation of livestock by tiger. Besides, there were n=3 cases in which the timing of the tiger attack could not be recalled. It was because the incident had taken place a long time ago (n=1) or the family was unsure on the whereabouts of the lost person for several days (n=2).

Similarly, based on months, May was identified as the most vulnerable month for tiger attack with n=6 cases among the affected households. Besides, the cases of tiger attacks among these affected households were reported throughout the year except for the months of January and July.

Based on the months of attacks, the incidents have further been classified into season of tiger attacks (Figure 4.24), namely spring (March to May), summer (June to August), autumn (September to November) and winter (December to January).



**Figure 4.24:** Season during human-tiger conflicts on affected households

On this basis, it was found that the most vulnerable season of tiger attack was spring (n=9), followed by autumn (n=8). As illustrated in Figure 4.24, summer and winter accounted for n=4 and n=3 attacks, respectively, whereas only one affected household was not able to recall the season in which the incident occurred.

#### 4.3.1.6 Organizations Working for Minimization of Human-Tiger Conflicts

Only 3 out of 29 respondents did not reply on the organizations working for minimization of human-tiger conflicts. There were 16 responses that included the name of NTNC as an organization working for minimization of human-tiger conflicts. To support the role of NTNC in the region, a key informant representing a BZUC stated that:

*“NTNC is the closest organization, which has been working actively.”* (KI3, 2024/10/25)

Similarly, WWF/Terai Arc Landscape (TAL) and CNP received 13 responses each, whereas user committees received 9 responses. To emphasize the current activities performed by WWF’s TAL initiative, a key informant respondent stated that:

*“We have an organization named TAL, who work for the conservation, management of water and management of grasslands for wildlife.”* (KI10, 2024/10/28)

While organizations such as Zoological Society of London (ZSL) received 2 responses. Highlighting the contribution of ZSL, a key informant interviewee expressed that:

*“ZSL has supported us. There is a lake inside the community forest named Daraibhure lake; the support in that lake is all from ZSL. They have spent around NPR 1.7 million to 1.8 million in the management of that lake.”* (KI28, 2024/11/18)

Other than that, community forest received 7 responses, and USAID received 3 responses, while district forest, anti-poaching unit and UNDP received 1 response each as organizations working for the minimization of human-tiger conflicts.

On the contrary, as per the interviews with respondents from affected households, much information on the organizations working for minimization of human-tiger conflicts could not be collected. Majority of the affected households were aware only about the role of National Park and the community forest.

#### **4.3.1.7 Mitigation Measures**

Based on the interviews conducted, numerous mitigation measures were suggested by respondents (Table 4.9). Majority of the key informants stressed on discouraging people from entering the forests frequently and reducing dependency on forest resources to mitigate human-tiger conflicts. While majority of the respondents from affected households believed an effective physical barrier such as concrete walls, wire mesh, fences, electric fencing, metal posts and barbed wire fences would be an appropriate measure to keep away the tigers from entering the human settlements.

To emphasize the current state of physical barriers, an affected household participant suggested that:

*“Yes, the tiger has been seen in the premises of the households. They have created problems by entering the settlements. We have wire mesh, which are damaged by the elephants. The tigers enter into the settlements through the openings in wire mesh.”*

(HH20, 2024/11/17)

**Table 4.9:** Mitigation measures suggested by respondents

Mitigation measures	Frequency of responses	
	Key informants	Affected households
Relief/compensation scheme	1	3
Physical barriers	9	13
Protection and management of tiger habitat	5	2
Management of grasslands	5	0
Management of prey species	9	1
Preservation of water resources	4	0
Knowledge on behaviour/movement of tigers	5	1
Monitor movement of tigers/Alert system	1	2
Management/relocation of problem tigers	5	5
Discourage people from entering the forest frequently	11	1
Public awareness programmes	6	1
Demarcate area to collect fodder/firewood and graze livestock	1	2
Enter forest in groups/Wear environmentally friendly clothing	3	0
Clearing bushes on the edges of forest boundaries	2	0

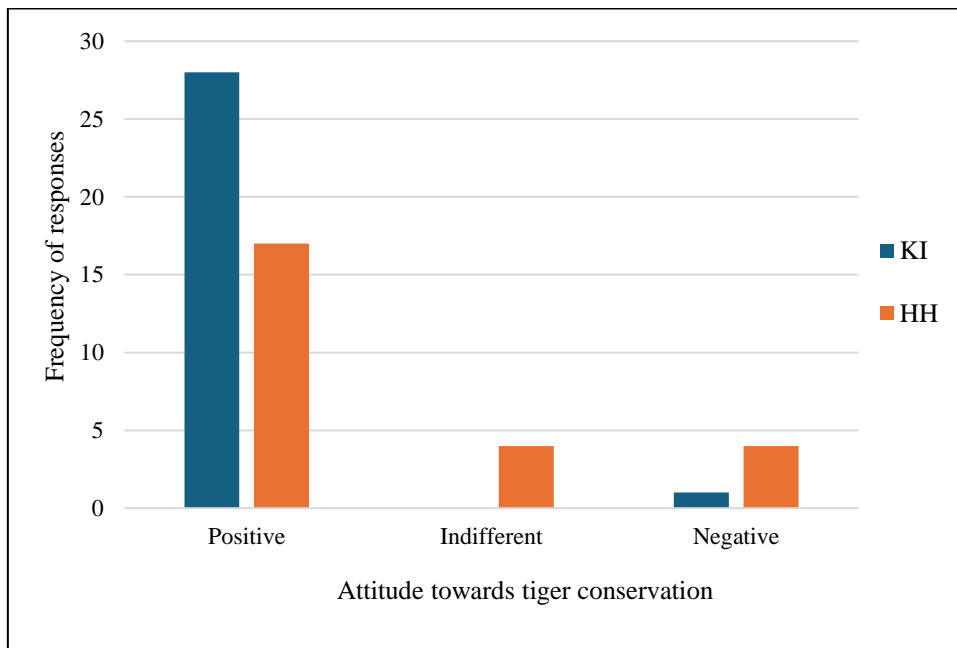
Reduce dependency on forest resources/employment opportunities	11	0
Distribution of modern cooking stoves to vulnerable populations	2	0
Lethal control	2	0
Others	1	1
Do not know/No response	0	2

As suggested by few respondents in Table 4.9, relief/compensation scheme is one of many mitigating measures for human-tiger conflicts. Based on the interviews with affected households, it was found that 21 out of 25 affected households had received relief for their losses caused by tiger attacks. The relief received varied between NPR 10,000 to NPR 1.05 million depending upon the severity of conflict. Currently, for a loss of human life due to tiger attack in Nepal, a household would receive NPR 1 million from the Department of National Parks and Wildlife Conservation (DNPWC) and an additional NPR 50,000 from the NTNC.

While only 4 out of 25 affected households did not receive relief for their losses. There were three households among such 4 households that had lost a family member. After verification with the key informants, it was found that these households did not receive relief because the dead body of their family member was found in core park area.

#### 4.3.1.8 Attitude Towards Tiger Conservation

Majority of the respondents, both key informants and affected households, were positive towards tiger conservation (Figure 4.25). All except one key informant had negative attitude towards tiger conservation. Majority of the key informants (n=28) highlighted the importance of tigers from ecological and tourism perspective. There were many key informants (n=10) that stressed on jeep safari to spot tigers, while a few key informants (n=4) suggested establishing homestays so that the wildlife enthusiasts could stay overnight outside the park.



**Figure 4.25:** Tiger conservation attitude of respondents

Regarding control of tiger populations through lethal control, a key informant respondent suggested that:

*“What I suggest, I used to say it before as well, there must be a limit on tiger populations, we shouldn’t allow the number to decrease, but in case of rise in population above the limit, the old tigers should be killed.” (KI5, 2024/10/25)*

On the other hand, respondents from n=17 affected households had positive towards tiger conservation. While n=4 affected households were indifferent and n=4 affected households negative towards tiger conservation. In support of the belief to kill tigers, a participant from affected household opined that:

*“We are not allowed to kill the tigers, but killing few tigers is not a bad idea.” (HH14, 2024/11/15)*

In general, the interviewees had positive response towards conservation of forest, wildlife, and tigers.

## Chapter 5: Discussion

### 5.1 Reflections of Desk Research

It has been found that there are 7.61 tigers per 100 km<sup>2</sup> of park area (both core and buffer) of CNP based on tiger national survey of 2022, which is an increase by 37.61% tigers per 100 km<sup>2</sup> compared to 2018. The increase also highlights that the higher tiger density regions have shifted towards the north-eastern boundaries of the core national park zone. Major settlement such as Lothar (Figure 3.2), is quite closer to these high-density regions. The movement of tigers from core zone of the national park towards the buffer zone and further outside the buffer zone could be linked with the recent rise in tiger populations (Dhungana et al., 2016). Besides, as per IDW interpolation, the chance of encountering a tiger is higher in western buffer zone of CNP compared to the southern buffer zone.

The movement of tigers from core zone to buffer zone increases the chances of human-tiger conflicts. Based on the obtained data, around one-tenth of the overall human-tiger conflicts from 1999 to 2023 have resulted in human casualties, while majority of the incidents are associated with livestock losses. However, in the period of 2019 to 2023 the tiger attacks on human have increased by almost 14.50% compared to the incidents during 1999 to 2019.

But this cannot be linked with the increasing populations of tiger as it was found that the human-tiger conflict incidents had a decreasing trend when the tiger populations were increasing, with a R-squared value of 0.387. Although a definite conclusion cannot be made as there were only 4 data points. There could be numerous reasons for increase in the tiger attacks, as the attacks are taking place in different times and locations.

These incidents are taking place throughout the year. However, the results suggest that the most common season of human-tiger conflicts is autumn (26.91%). But if attacks on humans only are considered, spring is found to be the most vulnerable season with 34.95% of incidents leading to human casualties. The period between November to April has been identified as the peak time for sexual activity of tigers, which could be the reason for majority of the tiger attacks occurring in spring and autumn (Sunquist, 1981). Besides, from 1999 to 2023, an average of 4 human lives are lost annually due to tiger attacks, which is slightly higher than the previous study conducted in Chitwan National Park (Gurung et al., 2008). However, loss of 4 human lives annually for 1999 to 2023 is lower than the periods of 1998 to 2006 and 2007 to 2014 (Dhungana et al., 2018). Similarly, if the conflicts on a yearly basis between 2007 and 2023 are taken into consideration, the year in which the livestock losses peaked was 2009 with 78 cases of livestock depredation by tigers, whereas the greatest number of human casualties (15) occurred during 2022.

From the perspective of management sectors of CNP, majority of the human-tiger conflicts have occurred in Madi sector, which is 44.25%, while the sector to experience the least human-tiger conflicts was Kasara with 13.66% of overall human-tiger conflicts. In terms of hierarchy, the buffer zone user committees lie under the management sectors. Madi sector has been the most affected by human-tiger conflicts, which can be validated by three of its BZUCs namely, Ayodhyapuri, Panchpandav and Rewa. These three BZUCs are among the top five BZUCS with highest number of incidents along with Amaltari and Lamichour. Particularly, Ayodhyapuri BZUC has experienced the most human-tiger conflicts, which is 13.31%, and it is consistent with the findings of a past study conducted in CNP (Dhungana et al., 2018).

Although most of the incidents occur in Madi sector and Ayodhyapuri BZUC, these two entities are not at the top when it comes to distribution of monetary relief to the victimized families. Kasara is at the top in terms of distribution of monetary relief despite the fact that it experiences the least number of cases for management sectors, whereas Budhirapti is the top distributor of monetary relief to victimized families. The fact that Budhirapti is the richest BZUC in terms of revenue collection also helps their cause in monetary relief distribution.

Upon further categorizing these incidents from Land Use Land Cover perspective, it was found that most of the incidents, 60.86%, took place either in tree cover or water bodies inside the forest, while 22.08% incidents have occurred in croplands. Additionally, majority of the incidents have occurred in a landscape that divides the denser forest regions from the croplands or the built area. In this regard, based on Figure 4.19, two predominant patterns can be clearly observed, which are incidents occurring along rivers and in settlements of buffer zones.

The first pattern is along the rivers. Most of the incidents have been observed along Rapti river, which runs east to west, and Narayani river, which runs north to south. These rivers, especially Rapti, divides the core park area from the buffer zones. Similarly, the second pattern is along the settlements that can be observed in regions west of Narayani river and south of Reu river in Madi region.

Based on the evidence presented by these patterns, whether the conflict points and tiger locations were uniformly distributed or not was determined using quadrat analysis at multiple scales. The VMR calculated using quadrat analysis suggested that there was tendency towards clustering ( $VMR > 1$ ) in all the cases. Furthermore, clustering analysis was done by calculating the local

Getis-Ord  $G_i^*$  statistic. At quadrat resolution of 3000 m, three conflict hot spots were observed: one in Amaltari sector and two in Bagai sector. Additionally, at 5000 m resolution, high tiger presence regions were concentrated in the centre of the park (Sauraha sector), which could be associated with the recent rise in human-tiger conflicts in settlements such as Kumroj and Piple.

Adding to the above patterns, the nearness of conflict points from geographic features (forest, grassland, river, road, settlement and tiger locations) was calculated by performing Near analysis.

It was found that Reu river was the nearest river for 39.97% of the conflict points, which reflects the concentration of conflicts in Madi region. It is also supported by the fact that Madi region is surrounded by Chitwan National Park to the north and west, Parsa National Park to the east and India's Valmiki Tiger Reserve to the south. Based on Near analysis, the average distance of a conflict point from the nearest major river was 2.96 km, whereas the average distance was only 0.94 km if all the larger and smaller rivers were considered. In the same way, the average distance of conflict points from grasslands was 3.24 km, which was highest among the six variables (distance to forest, distance to grasslands, distance to river, distance to settlements, distance to road and distance to tiger locations) considered. Similarly, the average distance of conflict points from tree or forest cover was 0.50 km, which clarifies the 54.11% (Table 4.4) of conflicts occurring in such land use land cover.

Lastly, a simple linear regression analysis was performed using the distance variables that were built during Near analysis, and an additional livestock density was added. Other than the distance to river, all the independent variables were found to be weak predictors. The model was improved by removing weak predictors and working with variables such as BZUC area, distance to river

and livestock density. A moderate positive relationship was found between the number of human-tiger conflict incidences and area of BZUC.

## **5.2 Reflections of Interviews**

As reported by 25 affected households, the human-tiger conflicts led to human casualties in 88% of the affected households, while 12% of the affected households suffered livestock losses. It is quite evident that most of these human-tiger conflicts are occurring during the collection of forest resources as it received 20 votes from key informants and 18 votes from affected households. It emphasizes the fact that the dependency on forest resources is the major cause of human-tiger conflicts, which is consistent with the findings from previous studies on human-wildlife conflicts (Nyhus & Tilson, 2004; Gurung et al., 2008; Silwal et al., 2017; Dhungana et al., 2018; Sharma et al., 2024).

Exactly 50% of the total interviewed respondents believe that the increase in human-tiger encounters is due to the increase in tiger populations. Similarly, n=13 respondents have observed an increase in tiger attacks or human-tiger encounters.

Due to the increase in tiger populations, 79.31% key informants believe that the tiger has been moving towards the human settlements but has not entered the settlements yet. This information was corroborated by 76% participants from affected households who have not spotted a tiger entering the human settlements, which is consistent with the findings of a study conducted in Nepal's Bardiya National Park (Sharma et al., 2024). But they pointed out that the tigers can be spotted nearby forest boundaries.

In terms of location, 83.33% key informant interviewee (n=24) indicated that the tiger attacks were happening inside the community forests. The key informants also highlighted that Kumroj, Madi and Megghauli are the areas more prone to tiger attacks. Besides, 84% (n=21) participants from affected households confirmed that the tiger attacks had taken place inside the community forest. The average distance between conflict locations of 25 affected households and core park boundaries was found to be 1.07 km.

These attacks are happening especially in the morning as suggested by the key informants. There was an agreement of 52% of the affected households upon this particular information provided by the key informants. But, it is not consistent with the findings from a study conducted in Nepal's Bardiya National Park, where most of the tiger attacks occurred during day and night compared to early morning or evening (Sharma et al., 2024). However, almost a quarter (24%) of affected households experienced human-tiger encounters between the noon and the evening.

From seasonal perspective, key informants suggested that tiger attacks are occurring in a period between August to January (n=9) and March to August (n=6). The suggestion from key informants implies that the tiger attacks are happening after the onset of autumn and spring. The mating season could be reason for increased tiger attacks during these periods as mating mostly takes place from the end of November to the first half of April (Sunquist, 1981; DNPWC, 2023). In the same way, 36% affected households experienced tiger attacks during spring (March to May) and 32% experienced it in autumn (September to November). Besides, if a single month had to be highlighted, then May was identified as the most vulnerable month for tiger attack with n=6 cases among the affected households.

As the spatial and temporal variation of conflicts are evident from the interviews, it is essential to minimize these human-tiger conflicts. For minimization of conflicts, several organizations are working in and around CNP including the government authorities and the community forest user groups. However, 55.17% key informants (n=16) have identified NTNC as the flag bearing organization for minimization of conflicts. Other than NTNC, some of the major organizations working in the region are WWF and ZSL. Conversely, the affected households are not aware of the organizations working for minimization of mitigation measures. The reason for this could be their level of education, as majority of these respondents had not completed schooling, or lack of exposure to such organizations and programmes. However, almost all respondents were aware about the Chitwan National Park as an organization that conducts programmes related to human-wildlife conflicts.

These organisations are mainly involved in implementation of various mitigation and preventive measures. Some of such measures, which are currently in practice and were the popular choices of the respondents are discouraging people from entering the forest frequently (n=12), installation of physical barriers (n=22), and trainings on alternative livelihoods to reduce dependency on forest resources (n=11).

Based on responses regarding mitigative measures, key informants highlighted on discouraging people from entering the forest frequently (n=11) and reducing dependency on forest resources (n=11), whereas affected households prioritized installation of physical barriers (n=13). The responses of affected households are consistent with the suggestions provided by locals in Koshi Tappu Wildlife Reserve (Dahal et al., 2022), where they suggested to construct concrete walls.

The contrast in opinions between key informants and affected households can be observed and can be translated to level of education, accessibility to resources and exposure to events. Affected households are likely to choose installation of physical barriers because neither they can choose reducing dependency on forest resources nor entering the forests frequently due to their economic conditions as they are part of marginalized populations, who have less land. Thus, it increases their dependency on forest resources such as fodder and firewood. Such resources are necessary to rear the livestock. Also, the responses of affected households could be influenced by the events that they get themselves to observe in person because they may not be aware of the other programmes. For example, installation of physical barriers in front of affected houses.

Other than these mitigation measures, relief/compensation scheme is also a valuable tool for mitigating human-tiger conflicts. It was revealed that 84% of the interviewed affected households (n=21) had received relief for their losses caused by tiger attacks, which is contrasting to the findings from Western Ghats of India (Karanth et al., 2013). Such finding explains that the relief/compensation scheme has been effectively implemented.

Besides, the effective relief/compensation scheme could be the primary reason for positive attitude towards tiger conservation of 68% affected households (n=17), which is similar to the study conducted in Nepal's Bardiy National Park (Bhattarai & Fischer, 2014). Only 16% (n=4) of the affected households had negative attitude towards tiger conservation. These affected households may have had negative attitude towards tiger conservation because of insufficient monetary relief received or due to the involvement in complicated and time-consuming process. As a result, people constantly complain about the compensation scheme (Hanson, 2022).

### **5.3 Conservation Implications**

Currently, tigers exist in five protected areas of Nepal. The total core park area is 3,402 km<sup>2</sup> and total buffer zone area is 1,927 km<sup>2</sup> for these protected lands (Table 4.1). According to tiger national survey 2022, the tiger populations in Nepal is 355. Hence, an area of 19,170 km<sup>2</sup> is needed based on the average habitat size of 54 km<sup>2</sup> per tiger (Aryal et al., 2016), which is an additional 13,841 km<sup>2</sup>. But this calculation does not consider potential overlap in home range size among tigers or the unoccupied but suitable habitats along the Chure range. Between 2018 and 2022, the tigers have increased by 2.08 per 100 km<sup>2</sup> of park area in CNP, which has increased the probability of encountering a tiger, especially in western buffer zone of CNP. However, the attacks are occurring all over the park, and throughout the year. So, for the management and conservation of increasing tiger populations, formulation of effective policies and management practices are the way forward for minimization of human-tiger conflicts.

#### **5.3.1 Policy and Legislations**

In November 2010, all the 13 tiger range countries pledged for doubling the tiger populations by 2022 (Dhungana et al., 2016). Nepal is one of the two countries that has met the target by increasing their tiger populations by almost three times (Table 4.1). It was possible due to the stringent regulations of the government of Nepal. Some of the major tiger related legislations in Nepal are discussed in chronological order in the subsequent paragraphs.

Firstly, the National Parks and Wildlife Conservation (NPWC) Act, 1973 of Nepal listed tiger as a protected species. Then, in 2010, a National Tiger Conservation Committee (NTCC) was formed that provided policy directives for tiger conservation in Nepal (DNPWC, 2023). Towards

the end of 2010, National Wildlife Crime Control Coordination Committee (NWCCCC) was established, and it was given the responsibility of formulating policies, legislation and directives to improve the coordination among key stakeholders and helping the national body in policy matter (DNPWC, 2023). Then, Nepal Biodiversity Strategy and Action Plan (NBSAP) 2014 to 2020 committed for conservation of endangered species, including tigers (DNPWC, 2023). Presently, a new Tiger Conservation Action Plan (2023-2032) has been formulated by the Ministry of Forests and Environment for the conservation of these majestic species.

Besides, Wildlife Crime Control Bureaus (WCCBs) was formed by the cabinet of ministers both at federal and district levels with the representatives from DNPWC, Department of Forests, National Investigation Department, Department of Customs, Nepal Army, Armed Police Force, Crime Investigation Bureau of Nepal Police and NGOs. The WCCB is actively involved in wildlife conservation, and it prevents wildlife crime by adopting necessary policy.

Due to these stringent tiger conservation policies, legislations, and directives, only 3 tigers have died of retaliatory killings in the period of 2010 to 2023 in CNP as indicated in Table 4.3. A fine of NPR 500,000 to 1 million and/or 5 to 15 years of imprisonment has been in place for offenders involved in poaching or illegal trade of tiger. Besides, it would be advantageous if the security is increased inside the core zone to lessen the disturbance, including the ban of livestock from grazing inside the core zone (Pettigrew et al., 2012).

### **5.3.2 Current Mitigation Practices**

The current mitigation practices implemented by the authorities primarily include installation of physical barriers, alternative livelihood trainings and programmes, distribution of relief/compensation, and wetlands and grassland management.

#### **5.3.2.1 Physical Barriers**

The wildlife causes human casualties, livestock depredation, infrastructural damages, destruction of crops and other damages by entering into the human settlements from core park and buffer zone forests. To minimize the human-wildlife conflict, the community forest buffer zone user committees in collaboration with Chitwan National Park have been involved in setting up physical barriers. It includes installation of wire mesh, RCC walls and electric fencing (CNP, 2023).

In the year 2023/24, the National Park and Reserve Project was able to install 4.47 kilometers of wire mesh in the human-wildlife affected regions of Kerunga user committee, Nandabhauju user committee and Meghauri user committee (CNP, 2023).

#### **5.3.2.2 Alternative Livelihood Trainings and Programmes**

To reduce dependency on forest resources and to uplift the financial level of the vulnerable populations, NTNC has been conducting several training programmes. The training programmes on carpet making, nature guide, driving, house wirings and plumbing are conducted by NTNC in collaboration with local technical institutions. These training programmes prioritize the unemployed youth who are dependent on forest resources (NTNC, 2023).

Similarly, trainings on vegetable farming, apiculture, livestock rearing and management, health campaigns for livestock, distribution of top quality of cattle, distribution of goats to marginalized communities is also done frequently (NTNC, 2023).

### **5.3.2.3 Relief/Compensation Scheme**

The relief/compensation scheme is an indispensable mitigation measure as it contributed to significantly reducing lion poisonings in community rangelands of Kenya (Schwartz, 2024). It is equally essential to pay the victims on time, otherwise the people may develop negative attitude towards the tiger (Cheng et al., 2024).

As per the wildlife damage compensation guideline of government of Nepal, there is a provision for relief if an individual gets injured or killed due to wildlife attack (Bhattarai et al., 2019). In case of minor injuries, an individual receives a maximum of NPR 20,000, while the victim receives a minimum of NPR 200,000 in case of severe injuries. Depending upon the extent of the injury, a victim's entire treatment cost will be covered by the government if it exceeds NPR 200,000. Similarly, if a victim suffers catastrophic injuries such as limb loss or paralysis, the victim will receive a lump sum of NPR 500,000 for their livelihoods. Besides, there is a provision of NPR 1 million if a human life is lost due to wildlife attacks (MoFSC, 2023).

Additionally, the guideline has provision for livestock losses. In an event of loss of cattle due to predation by wildlife, the owner receives NPR 60,000 per cattle, whereas a maximum of NPR 10,000 per livestock is distributed if the killed livestock is other than the cattle.

#### **5.3.2.4 Wetlands and Grassland Management**

Wetlands and grassland serve as pivotal components of tiger habitat. The transformation of grasslands to shrublands and forests poses threat to tiger habitat conservation (DNPWC, 2023). For instance, within CNP, the grassland area has dropped from 20% in 1970's to 9.5% in 2015 (CNP, 2016). The grasslands in Chitwan National Park were turning into thick bushes and riverine forests as well as getting affected by the spread of Crofton weed (*Ageratina adenophora*) and *Mikania micrantha*.

Due to these reasons, in recent years, the grasslands were managed through the use of machine across 201.3 hectares of land in Icharni, Sauraha Dhungaghat, Jaymangla Phant, Patna Tal area, old Gaur Machan area, Dumriya Phant, Machan Number 2 and Kachuwani Phant (NTNC, 2023). Around 600 hectares of grassland is managed by CNP annually (DNPWC, 2023). Besides, every year the park authorities conduct controlled burning, eliminate woody vegetation, remove top of the trees and control invasive species for managing grasslands (CNP, 2023). In the year 2023/24, the National Park and Reserve Project was able to manage 225 hectares of grasslands in Sukibhar Phant (Lami Tal) area and 50 hectares in Tamor Tal Phant. Besides, through TAL program, a total of 95.27 hectares of grassland was managed in the year 2023/24 (CNP, 2023).

#### **5.3.2.5 Additional Mitigation Measures**

Mitigation measures such as predator proof pens are also in practice as they are being promoted by Terai Arc Landscape (TAL) programme. The pens are distributed to the livestock rearing households that are located in the buffer zone. Although the pens are designed to protect the livestock from leopards, it also serves as a shield for protection against tiger predation.

### **5.3.3 Future Mitigation Strategies**

In this section, the discussion is on the improvements that can be made in the current mitigation practices such as physical barriers, alternative livelihoods and training programmes, and relief/compensation scheme as well as propose new mitigation measures including increase in wild prey populations and ecotourism.

#### **5.3.3.1 Physical Barriers**

As indicated by one of the respondents from affected households in section 4.3.1.7, there are still many open spaces from where the wildlife enters the human settlements. During the fieldwork in places like Kumroj, it was observed that the boundary walls of the park were neither very wide nor very tall. As a result, in Kumroj, tigers are reported to often visit human settlements and agricultural lands (Pathak, 2023). The boundary walls could be improved in order to significantly reduce the rate of wildlife entering the human settlements. Similar to this study, concrete walls were suggested by most respondents as a solution to mitigate human-wildlife conflicts in Koshi Tappu Wildlife Reserve (Dahal et al., 2022). Also, Kumroj happens to be the place where tigers are spotted moving from the forest to the banana plantation, which is located next to the forest boundaries.

Installation of physical barriers must be given continuation in other affected areas, such as Kumroj, Madi and Meghauri, which were the top three responses suggested by the key informants in terms of areas more prone to tiger attacks. Also, installing physical barriers will provide a sense of security to the local community, especially the affected households, as majority (n=13) of the affected households during interviews suggested it as a mitigating measure to combat human-

tiger conflicts. However, physical barriers such as fences should be considered an conservation option until other methods of mitigation are identified (Hayward & Kerley, 2009).

#### **5.3.3.2 Alternative Livelihood Trainings and Programmes**

Based on this study, it was found that majority of the tiger attacks on humans are happening while collecting forest resources including fodder, firewood, fiddlehead ferns and broom grass. Furthermore, the victims are the people living along the edges of forest boundaries. Most of these people rear livestock and have limited land to grow grasses for livestock, while some even do not possess land ownership documents. The farming community are the residents of the CNP, who are surviving on less than 1 hectare of land (Pathak, 2023). Due to these reasons, the poor farmers are heavily dependent on forest resources to fulfill their household needs (Ayalew & Melese, 2025), and frequently enter the forests, which increases the chances of getting attacked by the tigers.

To overcome such issue, a programme could be conducted at the community level to help identify forest-dependent families, as these families are exposed to higher level of human-tiger conflicts (Sharma & Neupane, 2023). Through the programme, modern cooking stoves must be distributed or subsidized to these families so that they can utilize their time in other economic activities rather than collecting forest resources. Such measure will not only reduce the human-tiger conflicts, but it will also uplift their standard of living.

#### **5.3.3.3 Relief/Compensation Scheme**

Although the respondents suggested that the relief/compensation scheme was effective, however, there are some imperfections in the scheme. In the process of interviews with the affected

households, a few cases came across in which the tiger had killed a person in the buffer zone and dragged the body deep inside the core zone. As per the wildlife damage compensation guideline of government of Nepal, there is no provision of relief or compensation to the victims if the dead body is found inside the core zone of the park. The level of investigation for such cases has to be improved so that there is no unjust towards the real victims.

In addition, the compensation schemes for livestock depredation has to be improved as victims received only 50% of the total market value of livestock for cases that took place between January 2007 and July 2009 (Dhungana et al., 2016). With the current wildlife damage compensation guideline of government of Nepal, the livestock owners are less likely to get the compensation according to the market value for their livestock losses.

#### **5.3.3.4 Increase Wild Prey Populations**

To sustain a single tiger, 500 deer-sized prey individuals are required annually (Thompson, 2010). The daily requirement of meat for a tiger is 8 kilograms (Sunquist, 1981). However, it may require less meat in captivity as suggested by one of the key informants from park authorities. The adult problem tigers kept in captivity at Devnagar, Chitwan are fed 7.5 kilograms of meat on every other day. But the tigers in the wild and wild prey populations are the concern.

As the tiger population is increasing in CNP, it is equally important that the wild prey populations increase proportionally. The drop in wild prey may lead to rise in attacks by carnivores on both livestock and humans (Pettigrew et al., 2012). So to avoid these situations, the wild prey populations must be introduced in those forest patches that have occupancy less than 0.5, since such regions are more likely to experience human-tiger conflicts (Lubis et al., 2020). Similarly,

in a protected forest system, the livestock predation rate may be decreased by increasing the availability of several ungulates and controlling grazing activities, which will ultimately decrease the conflicts between humans and large predators (Basak et al., 2020).

Apart from increasing wild prey populations for growing tiger populations, the policymakers should shift narratives from increasing number of tigers to preventive mitigation strategies. It is because a recent study conducted in Chitwan has suggested that the park has reached its ecological carrying capacity for tigers (Dahal et al., 2023), which is 177 adult tigers in Chitwan-Parsa complex. As a matter of fact, current tiger population in the complex has reached 169 (DNPWC & DFSC, 2022).

#### **5.3.3.5 Ecotourism**

Ecotourism has proven to be advantageous for the conservation of endangered species (Stronza et al., 2019). Due to this reason, ecotourism has become an essential conservation strategy because the community forests of Chitwan cannot survive by solely selling wood and timber to the public. The introduction of ecotourism will reduce the animosity between humans and wildlife as it promotes local economic development and wildlife conservation (KC et al., 2022). Based on this study, the key informants suggested several measures to promote ecotourism such as jeep safari, view towers, homestays and open zoos. Such measures would not only prioritize on conservation of tigers, but it will also enhance the livelihoods of people. Consequently, it would promote positive relationship between tigers and people through ecotourism (Sharma & Neupane, 2023).

The most popular opinion for ecotourism was facility of jeep safari (n=10) through the park to spot wildlife such as wild boar, deer, crocodile, rhino, tiger, and migratory birds that arrives from Siberia to places such as Bis Hazari lake and Batuli Pokhari. The current status of jeep safari in CNP varied depending on the buffer zone community forest user groups (BZCFUGs). Some of the BZCFUG such as Kumroj have already started jeep safari by seeking permission from CNP, whereas Shri Bandevi BZCFUG have the permission of operating jeep safari, and they have also established a track. While BZCFUGs such as Navajyoti and Dakshinkali are planning to introduce jeep safari in the future. At the same time, n=2 key informants were against jeep safari because they think it is dangerous and not environmentally friendly. Furthermore, the jeep safaris could be made more environmentally friendly by using electric vehicles.

Similarly, homestays could be established outside the park where tourists who come to visit the park could stay overnight. It was also suggested by some (n=4) key informants. The homestays would create employment opportunities for the local community and utilize local resources. Besides, the concept of open zoos, rescue/care centres, and enclosures can also be discussed to generate revenue. An enclosure with the capacity to hold couple of problem tigers is already established in Devnagar, Chitwan where everyday no less than 50 people visit the place by paying NPR. 25 per person. The concept of relocation of problem tigers to such enclosures is consistent with the suggestion made by a previous study (Bhattarai et al., 2019).

Ecotourism contributes to the diversification of the livelihoods of people living in and around the protected areas (Stronza et al., 2019). Also, ecodevelopment programmes at the community level have proven to improve the coexistence between tigers and local populations ( Carter et al., 2012).

Such community participatory programmes along with other robust mitigation measures should be promoted to minimize the human-tiger conflicts. Overall, involving community in promotion of ecotourism will create employment opportunities, generate revenue, and hold people accountable for the conservation of ecology and tigers.

#### **5.3.3.6 Additional Mitigation Measures**

The current mitigation practices could be further improved by banning illegal grazing of livestock within the park boundaries, providing training on alternate grazing husbandry methods, and clearing thick bushes on the edges of forest boundaries, which invites predators to kill prey (Schwartz, 2024).

In addition, a land could be demarcated for growing grasses, especially to feed the livestock, which could be done in collaboration with local government and buffer zone user committees. Moreover, if community manages such resources, it will create employment opportunities while keeping alive the sociocultural ties to wildlife (Schwartz, 2024). Besides, public awareness programmes to prevent frequent visits to the forest must be conducted by prioritizing marginalized and vulnerable populations.

## Chapter 6: Summary and Conclusion

### 6.1 Summary

The summary of the study, which includes results obtained from both first and second objectives are presented in the form of points.

- Both the tiger populations and human-tiger conflicts have increased between 2018/19 and 2022/23, however, a relationship between these two variables could not be established statistically due to limited data availability
- Spring was found to be the most vulnerable season for tiger attacks on humans
- Ayodhyapuri was the most affected BZUC by human-tiger conflict incidents
- Budhirapti BZUC had the best contribution in terms of relief/compensation distribution
- More than 50% of the human-tiger conflict incidents have occurred in forest/tree cover
- The conflict events were spatially clustered near Bagai and Amaltari sector at quadrat resolution of 3000 m
- The average distance of conflict points from nearest forest cover and river sources was 0.50 km and 0.94 km, respectively
- The human-tiger conflict incidences in a BZUC increased by 1.41 for every 1 km<sup>2</sup> increase in BZUC area, provided distance to river and livestock density were constant
- 68.96% key informants suggested that collection of forest resources was the primary cause of human-tiger conflict, and 72% of the affected households became victims
- 83.33% respondents indicated that the tiger attacks were happening inside the community forests

- As per the key informants, Kumroj, Madi and Meghauri are the areas more prone to tiger attacks
- Most of the tiger attacks were happening in the morning as suggested by the key informants
- An average distance between core park boundaries and human-tiger conflict locations of affected households was 1.07 km
- 68% of the affected households experienced tiger attacks during spring or autumn, while in May, 24% affected households reported tiger attacks
- NTNC was identified as the leading organization working towards human-tiger conflict mitigation
- 84% of the affected households have received relief/compensation for tiger attacks
- Two key informants suggested lethal control to reduce the increasing tiger populations
- The attitude of 68% affected households was positive towards tiger conservation, while only 16% of the affected households had negative attitude

## **6.2 Conclusion**

Most of the human-tiger conflict incidents occur during autumn, while tiger attacks on humans are high during spring. The buffer zone user committees lying in Madi sector are more vulnerable to human-tiger conflict incidents. On an average, these incidents occur within 1 km distance from nearest tree cover or river sources. The human-tiger conflict events were spatially clustered near Bagai and Amaltari sector at quadrat resolution of 3000 m.

As per the respondents, most of the tiger attacks occurred during collection of forest resources, and areas such as Kumroj, Madi and Meghauri are more prone to tiger attacks. In general, the attitude of local community towards tiger conservation was found to be positive.

### **6.3 Recommendations**

Although the data suggests that the concentration of tiger attacks is high in Amaltari and Bagai sector, however, settlements such as Kumroj and Piple in the east (Sauraha sector) are emerging as the new hotspots. Furthermore, 80% of the interviewed affected households had encountered tiger attacks between 2020 and 2023 in these locations. It could be linked with the expansion of tiger territory in search of prey and increase in intra-species competition in the core area. As suggested by many respondents, old and ill tigers are more likely to attack humans and livestock because of lack of ability to hunt wild prey. Through this research, it is suggested that timely identification and management of old, ill, and problem tigers should be done, which will minimize the human-tiger encounters. The reduction in human-tiger conflicts will create an environment for coexistence of both humans and tigers, and it will pave the way for conservation of tigers through adoption of conservation strategies such as ecotourism, which has a lot of potential to uplift the economic conditions and improve the livelihoods of people living in the vicinity of Chitwan National Park.

The limitations of the study as well as the improvements that can be made in the future research are:

- Inclusion of all 1,713 conflict points with coordinates could enhance the result, as the study used only 1,096 points for spatial analysis, however, 1,633 points were used for mapping based on coordinates of their respective BZUCs
- Addition of strong predictors such as wild prey density can further strengthen the simple linear regression model
- Alternately, species distribution modeling (SDM) can be used to predict the distribution of conflicts based on environmental variables
- This research was conducted in all the adjoining municipalities of CNP in Chitwan district, except Madi, which could be incorporated in the future research as most of the human-tiger conflicts are concentrated there

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[events/feature/bengal-tiger-conservation-nepal](https://www.zsl.org/news-and-events/feature/bengal-tiger-conservation-nepal)

## Appendix A: Research Permit



**नेपाल सरकार**  
**वन तथा वातावरण मन्त्रालय**  
**राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण विभाग**

फोन नं. : ४२२०८५०  
: ४२२०९१२  
: ४२२०९२६  
फ्याक्स नं. : ४२२०६७५



पत्र संख्या : - २०८१/०८२ इको ४०  
चलानी नं. : - ४१३



शाखा)

पो.ब. नं. - ८६०  
बबरमहल, काठमाडौं  
Email : info@dnpsc.gov.np  
http://www.dnpsc.gov.np

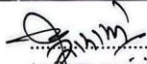
मिति: २०८१/०५/१६  
नेपाल सम्वत् १९४४

विषय: अध्ययन-अनुसन्धान अनुमति सम्बन्धमा ।

श्री चितवन राष्ट्रिय निकुञ्ज कार्यालय  
कसरा, चितवन।

प्रस्तुत विषयमा तहाँ राष्ट्रिय निकुञ्ज क्षेत्रमा निम्नानुसारको अध्ययन अनुसन्धानको अनुमति प्रदान गरिएको व्यहोरा आदेशानुसार अनुरोध छ ।

अनुसन्धानकर्ताको नाम	सुब्रत अधिकारी		
ठेगाना	विरगंज, पर्सा	इमेल : s22adhik@uwaterloo.ca	फोन नं: ९७०२०४५९७४
सम्बद्ध संस्था	University of Waterloo, Waterloo, Canada		
अनुसन्धानको प्रकृति	व्यक्तिगत		
पद	विद्यार्थी		
अनुसन्धानको तह	स्नातकोत्तर		
अनुसन्धानको शीर्षक	Understanding the Dynamics of Human Tiger Conflict in Chitwan National Park, Nepal		
अनुसन्धान विधि	Household Questionnaire and Secondary Sources	नमूना संकलन	नमूना परिक्षण कहाँ गर्ने
		नगर्ने	
अनुसन्धानको अवधि	९ सेप्टेम्बर २०२४ देखि ९ डिसेम्बर २०२४ सम्म		
शर्तहरू:			
१. अनुसन्धानकर्ताले राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण ऐन, २०२९ र नियमावली, २०३० तथा मातहतका सबै नियमावलीहरूको पूर्ण पालना गर्नु पर्नेछ ।			
२. अनुसन्धानकर्ताले आफ्नो अनुसन्धानको प्रस्ताव सम्बन्धित राष्ट्रिय निकुञ्ज कार्यालयमा समेत पेश गर्नु पर्नेछ ।			
३. अध्ययन अनुसन्धान गर्दा सम्बन्धित राष्ट्रिय निकुञ्ज कार्यालयसँगको समन्वयमा गर्नु पर्नेछ ।			
४. अनुसन्धानकर्ताले अनुसन्धान समाप्त भएपछि प्राप्त तथ्यांक, एक प्रति कागजी र एक प्रति इलेक्ट्रोनिक प्रतिवेदन यस विभाग र सम्बन्धित राष्ट्रिय निकुञ्ज कार्यालयमा बुझाउनु पर्नेछ ।			
५. अध्ययन अनुसन्धानका क्रममा नमूना संकलन गर्न पाइने छैन ।			
६. तोकिएका शर्तहरूको पालना नगरेमा विभागले कुनै पनि समयमा अनुमतिपत्र रद्द गर्न सक्नेछ ।			
७. तोकिएको शर्तहरूको हकमा सोही बमोजिम र अन्य बाँकीको हकमा प्रचलित कानून बमोजिम हुनेछ ।			

  
(ऋ.पारशराम ढकाल)  
इकोलोजिस्ट

बोधार्थ:

श्री सुब्रत अधिकारी: चितवन राष्ट्रिय निकुञ्ज कार्यालयसँग समन्वय गरी अध्ययन अनुसन्धान गर्नु हुन ।

Figure A.1: Research permit from Department of National Parks and Wildlife Conservation (Nepal)



नेपाल सरकार  
वन तथा वातावरण मन्त्रालय  
राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण विभाग  
चितवन राष्ट्रिय निकुञ्ज कार्यालय

पत्र संख्या:- २०८१/०८२  
चलानी नं.:- ३९५



मिति: २०८१/०५/२५  
ने.सं ११४४ यंलाथ्व ०७, मंगलवार

विषय: अध्ययन अनुमति दिईएको सम्बन्धमा ।

श्री सुब्रत अधिकारी  
विरगंज, पर्सा ।

प्रस्तुत विषयमा श्री राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण विभाग, बबरमहल, काठमाडौंको च.नं. ४१३ मिति २०८१/०५/१६ गतेको पत्रानुसार तपाईंलाई यस चितवन राष्ट्रिय निकुञ्जको मध्यवर्ती क्षेत्रमा "Understanding the Dynamics of Human Tiger Conflict in Chitwan National Park" विषयमा अध्ययन अनुसन्धान गर्ने प्रयोजनार्थ ११ सेप्टेम्बर २०२४ देखि ९ डिसेम्बर २०२५ सम्म यस चितवन राष्ट्रिय निकुञ्जको मध्यवर्ती क्षेत्रमा अध्ययन अनुसन्धानको लागि राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण ऐन २०२९, चितवन राष्ट्रिय निकुञ्ज नियमावली २०३० र विभागको शर्त सहित तपसिलका शर्तहरूको अधिनमा रही सम्बन्धित सेक्टर कार्यालय, रेञ्जपोष्ट तथा पोष्टसंगको समन्वय एवं निर्देशनमा अध्ययन गर्न अनुमति दिइएको व्यहोरा आदेशानुसार अनुरोध छ ।

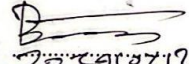
तपसिल

१. अनुसन्धान टोलीले राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण ऐन २०२९, नियमावली २०३०, चि.रा.नि. नियमावली २०३० तथा यस मातहतका सबै नियमावलीहरूको पूर्ण रूपमा पालना गर्नुपर्नेछ ।
२. अध्ययन अनुसन्धान गर्दा गराउदा यस कार्यालयको नजिकको सेक्टर, पोष्टसंग अनिवार्य रूपमा समन्वय गरी उक्त अध्ययन अनुसन्धानको कार्य गर्नुपर्नेछ ।
३. तोकिएको तथ्यांक बाहेक अन्य कुनै पनि नसुना संकलन गर्न पाइने छैन ।
४. उक्त कार्य सुयोदय पूर्व र सुर्यास्त पछि गर्न पाइने छैन ।
५. वन र वन्यजन्तुलाई कुनै पनि प्रकारले हानी नोक्सानी गर्न पाइने छैन ।
६. तोकिएको शर्तहरूको पालना नगरेमा कार्यालयले कुनै पनि समयमा अनुमति पत्र रद्द गर्न सक्नेछ ।
७. सहभागीहरू: सुदिप सिवाकोटी

बोधार्थ:

श्री नयाँ गोरख गण, कसरा व्यारेक, चितवन: जानकारीको लागि अनुरोध छ ।

श्री कसरा/सौराहा सेक्टर, देवनगर रेञ्जपोष्ट /चि.रा.नि.का: जानकारी तथा अनुगमन गर्नु हुन अनुरोध छ ।

  
डिल बहादुर पुर्जा पुन।

वरिष्ठ संरक्षण अधिकृत  
तरिष्ठ संरक्षण अधिकृत

ईमेल :info@chitwannationalpark.gov.np ,वेब:www.chitwannationalpark.gov.np

Figure A.2: Research permit from Chitwan National Park (Nepal)

## **Appendix B: Guiding Questionnaire**

Interview Date:

Key Informant's Code:

Age:

Sex:

Name of Interviewer:

Place of Interview:

### **Guiding questionnaire for Key Informants:**

1. How common is the human-tiger conflict in your locality?
2. In the past 5 years, have you observed the change in human-tiger encounters?
3. Have the human-tiger encounters increased with the increase in tiger populations?
4. What is the reason behind increase in tiger sightings near the human settlements?
5. What is the most common time of the day and the season of tiger attacks on human?
6. Does the tiger attack take place in human settlements or buffer zone?
7. Where are the riskiest areas of tiger attacks in your locality? Can you identify the households that have been victims of tiger attacks, as I intend to visit those households for sampling or data collection? Or can you provide a list of those households, which would be willing to share their exact location of their houses? We would greatly admire if you could contact those houses via cell phone and ask for their permission if they are okay being contacted by the researcher?
8. How is a tiger attack reported to the authority?
9. Are there any compensation schemes related to tiger attacks?
10. What are the governmental and non-governmental organizations working in your locality for the minimization of human-tiger conflict?

11. As tigers are precious creature, and a lot of tourists visit this region to see a tiger, how do you think eco-tourism can be promoted in your locality?
12. What kind of mitigation measures can be implemented to reduce human-tiger conflicts?
13. And lastly, can you please share your age and sex? We don't want to force you to share it, you can share it only if you feel comfortable in doing so. We want to keep the record of age and if possible sex of the key informants.
14. What are your additional comments?

Interview Date:

Affected Household's Code:

Age:

Sex:

Name of Interviewer:

Place of Interview:

**Guiding questionnaire for Affected Households:**

1. How common is the human-tiger conflict in your locality?
2. In the past 5 years, have you observed the change in human-tiger encounters?
3. Have the human-tiger encounters increased with the increase in tiger populations?
4. What is the reason behind increase in tiger sightings near the human settlements?
5. What is the most common time of the day and the season of tiger attacks on human?
6. Does the tiger attack take place in human settlements or buffer zone?
7. Where are the riskiest areas of tiger attacks in your locality?
8. How is a tiger attack reported to the authority?
9. Are there any compensation schemes related to tiger attacks?
10. What are the governmental and non-governmental organizations working in your locality for the minimization of human-tiger conflict?
11. How important is the conservation of tigers?
12. What kind of mitigation measures can be implemented to reduce human-tiger conflicts?
13. And lastly, can you please share your age and sex? We don't want to force you to share it, you can share it only if you feel comfortable in doing so. We want to keep the record of age and if possible sex of the respondents from affected households.
14. What are your additional comments?

### Appendix C: Graphs

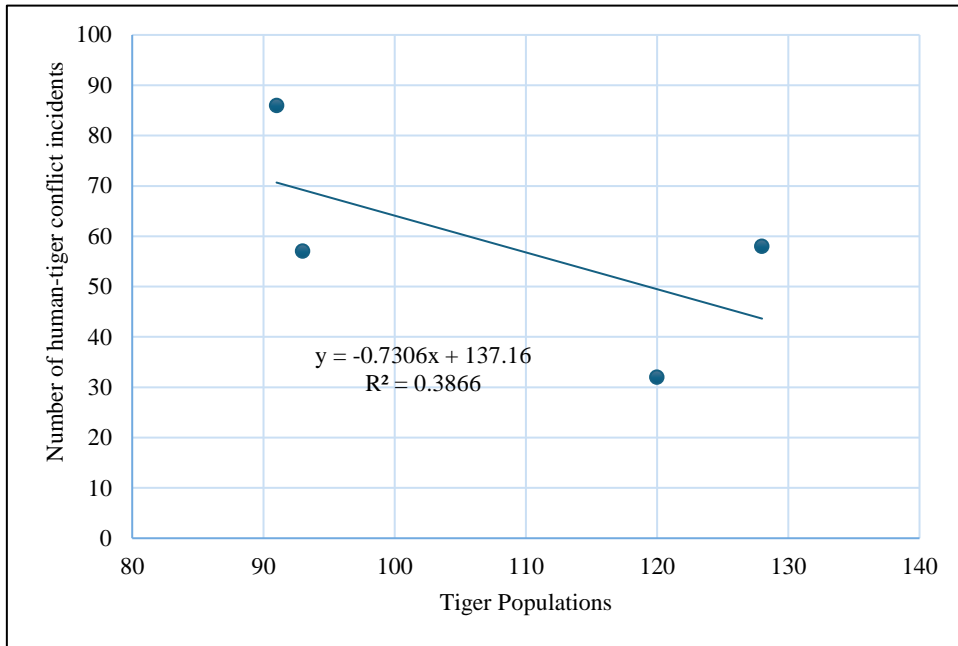


Figure C.1: Tiger populations and number of human-tiger conflict incidents

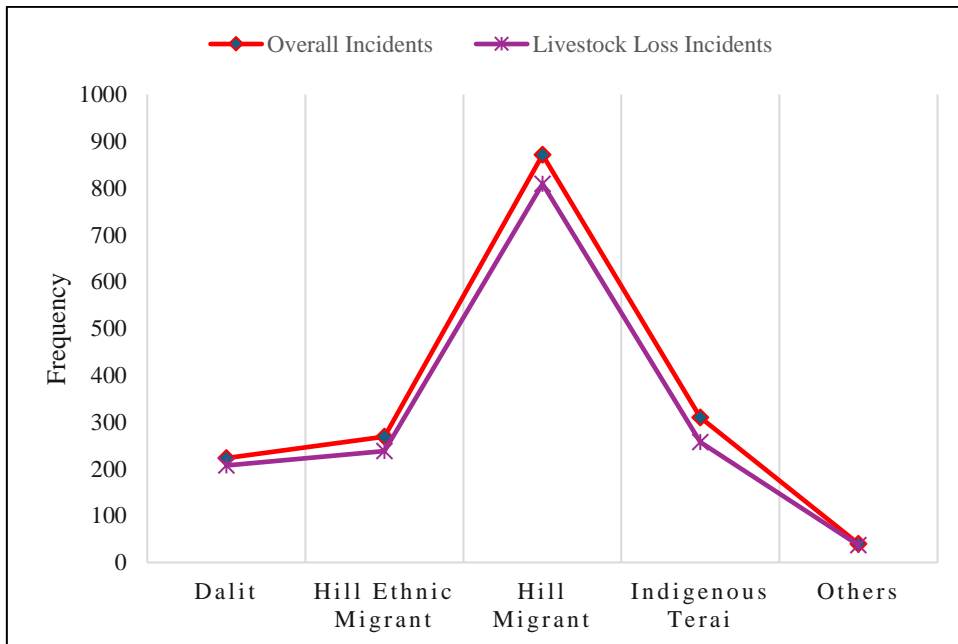


Figure C.2: Livestock loss and overall incidents based on ethnic groups

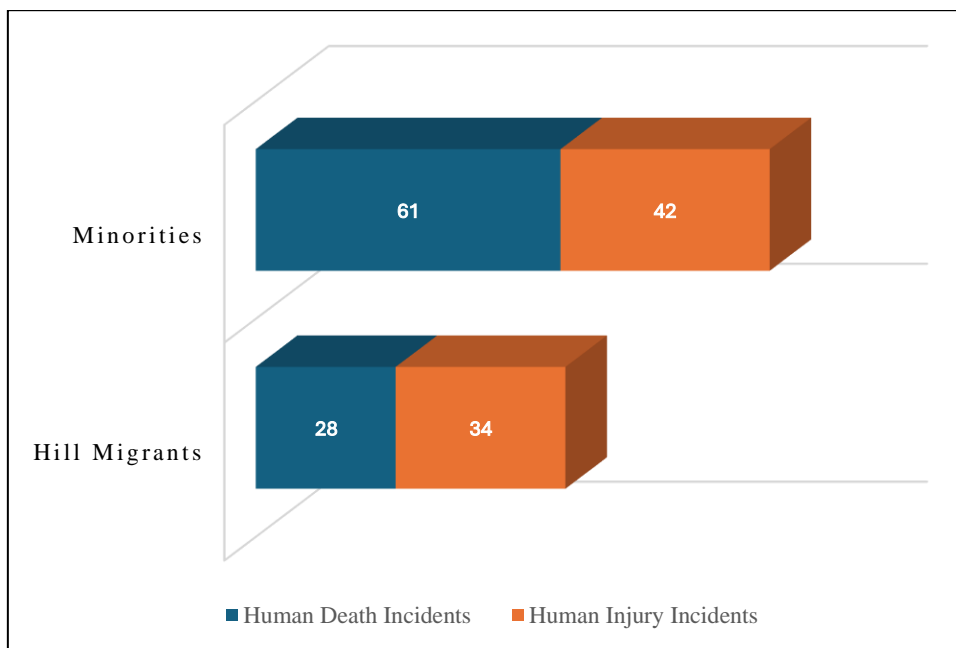


Figure C.3: Tiger attacks on minorities and hill migrants

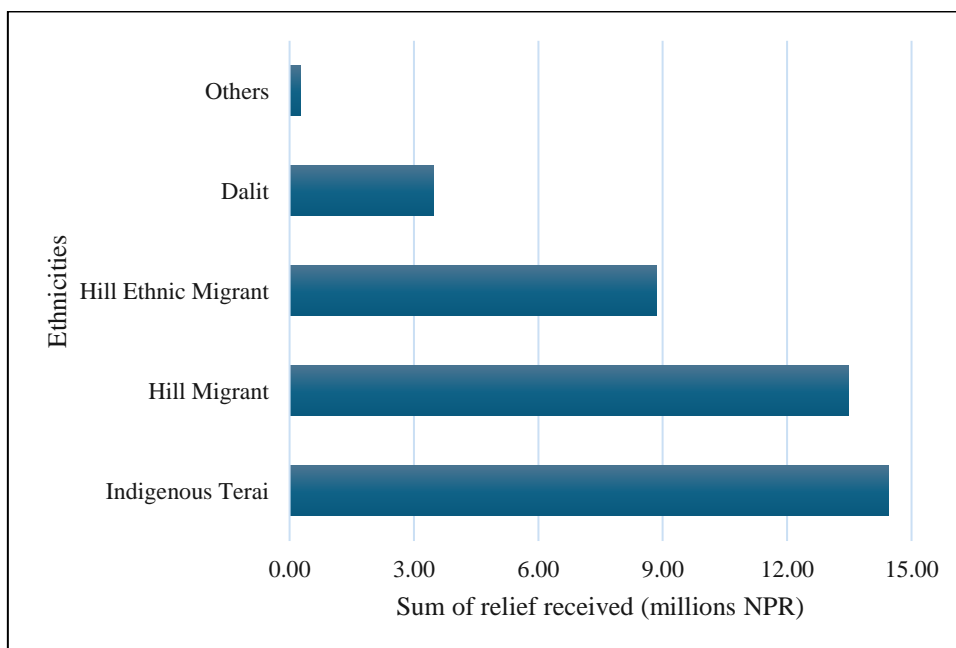


Figure C.4: Sum of relief received by ethnicities between 1999 and 2023

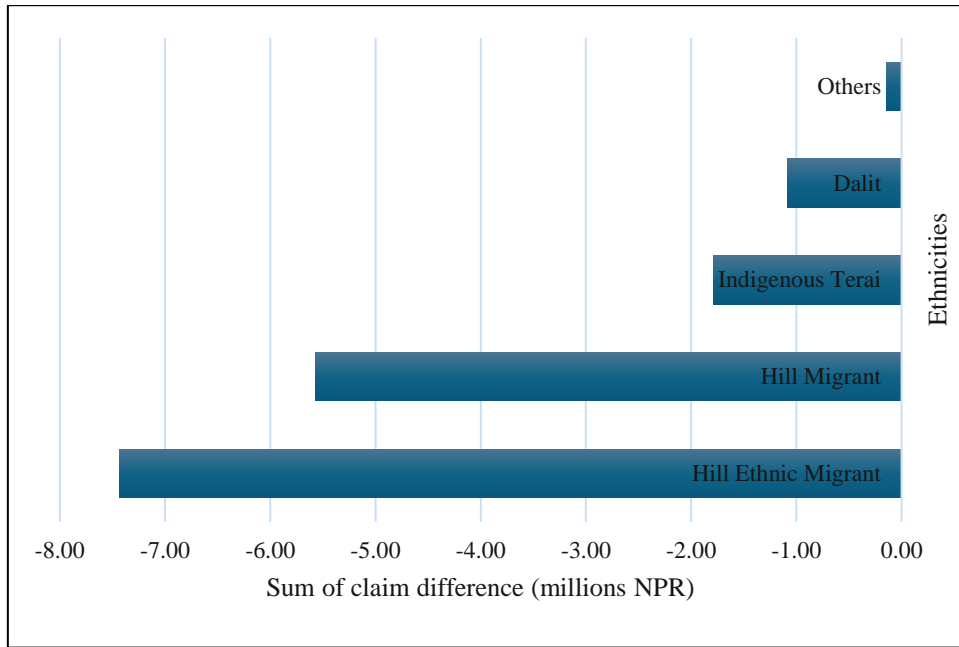


Figure C.5: Sum of claim difference by ethnicities between 1999 and 2023

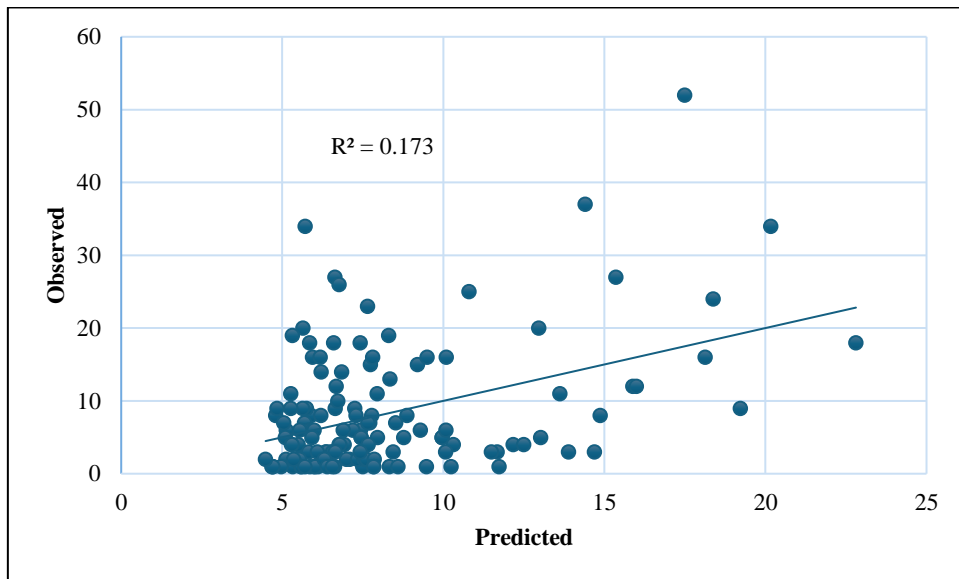


Figure C.6: Predicted versus actual number of incidences with seven independent variables

## Appendix D: Tables

Table D.1: Details of interviews with key informants

<b>Code</b>	<b>Place of Interview</b>	<b>Date of Interview</b>
KI1	Khairahani Municipality-13	2024/10/24
KI2	Khairahani Municipality-10	2024/10/25
KI3	Khairahani Municipality-10	2024/10/25
KI4	Khairahani Municipality-10	2024/10/25
KI5	Khairahani Municipality-10	2024/10/25
KI6	Rapti Municipality-1	2024/10/26
KI7	Bharatpur Municipality-6	2024/10/27
KI8	Bharatpur Municipality-6	2024/10/27
KI9	Bharatpur Municipality-6	2024/10/27
KI10	Bharatpur Municipality-8	2024/10/28
KI11	Bharatpur Municipality-8	2024/10/28
KI12	Bharatpur Municipality-8	2024/10/28
KI13	Bharatpur Municipality-8	2024/10/28
KI14	Bharatpur Municipality-6	2024/10/29
KI15	Bharatpur Municipality-6	2024/10/29
KI16	Bharatpur Municipality-6	2024/10/30
KI17	Bharatpur Municipality-13	2024/11/05
KI18	Bharatpur Municipality-13	2024/11/05

KI19	Bharatpur Municipality-13	2024/11/05
KI20	Bharatpur Municipality-8	2024/11/06
KI21	Ratnanagar Municipality-9	2024/11/06
KI22	Bharatpur Municipality-6	2024/11/08
KI23	Bharatpur Municipality-6	2024/11/08
KI24	Rapti Municipality-1	2024/11/10
KI25	Rapti Municipality-1	2024/11/10
KI26	Ratnanagar Municipality-6	2024/11/12
KI27	Khairahani Municipality-12	2024/11/13
KI28	Khairahani Municipality-13	2024/11/18
KI29	Ratnanagar Municipality-6	2024/11/20

Table D.2: Details of interviews with affected households

<b>Code</b>	<b>Place of Interview</b>	<b>Date of Interview</b>	<b>Loss Incurred</b>
HH1	Khairahani Municipality-11	2024/10/24	Human Injury
HH2	Khairahani Municipality-11	2024/10/24	Human Injury
HH3	Bharatpur Municipality-6	2024/10/30	Human Death
HH4	Rapti Municipality-1	2024/11/10	Human Death
HH5	Rapti Municipality-1	2024/11/11	Human Death
HH6	Rapti Municipality-1	2024/11/11	Human Injury
HH7	Rapti Municipality-1	2024/11/11	Human Death

HH8	Ratnanagar Municipality-5	2024/11/12	Human Death
HH9	Ratnanagar Municipality-7	2024/11/12	Human Injury
HH10	Bharatpur Municipality-6	2024/11/14	Human Injury
HH11	Bharatpur Municipality-6	2024/11/14	Human Death
HH12	Bharatpur Municipality-13	2024/11/14	Human Death
HH13	Bharatpur Municipality-13	2024/11/15	Human Death
HH14	Bharatpur Municipality-13	2024/11/15	Human Death
HH15	Bharatpur Municipality-13	2024/11/15	Livestock Loss
HH16	Bharatpur Municipality-13	2024/11/15	Livestock Loss
HH17	Bharatpur Municipality-13	2024/11/16	Human Death
HH18	Bharatpur Municipality-6	2024/11/16	Human Death
HH19	Khairahani Municipality-12	2024/11/17	Livestock Loss
HH20	Khairahani Municipality-12	2024/11/17	Human Death
HH21	Khairahani Municipality-13	2024/11/17	Human Death
HH22	Khairahani Municipality-13	2024/11/17	Human Death
HH23	Khairahani Municipality-13	2024/11/18	Human Death
HH24	Khairahani Municipality-13	2024/11/18	Human Death
HH25	Ratnanagar Municipality-6	2024/11/20	Human Death

Table D.3: Details of Buffer Zone User Committees (BZUCs)

BZUC	Latitude	Longitude	Total HTCs	Distance to River (km)	Livestock Density (per km <sup>2</sup> )	BZUC Area (km <sup>2</sup> )
Amaltari	27.5589	84.0589	155	0.0008	74.8	23.98
Ayodhyapuri	27.3897	84.3639	228	0.4064	22.35	115.10
Baghauda	27.4082	84.2732	94	1.6922	22.28	42.52
Barandabhar	27.6149	84.3903	65	1.6129	60.17	7.86
Budhirapti	27.5521	84.5115	69	0.0791	17.92	20.43
Daunnedevi	27.5401	83.9748	18	0.0376	73.69	34.60
Kalabanjar	27.6109	84.2274	35	0.2920	63.74	14.72
Kerunga	27.5520	84.2562	68	0.9708	15.68	23.93
Khagendramalli	27.5681	84.5752	33	0.2472	17.92	26.89
Lamichour	27.6095	84.1083	142	0.1918	191.31	39.11
Lothar	27.5593	84.6672	82	0.3241	18.28	18.40
Meghauli	27.5503	84.1503	53	0.4932	28.55	30.67
Mrigakunja	27.5664	84.4706	12	0.0405	7.81	33.32
Nanada Bhauju	27.5333	83.9822	21	0.6193	73.69	16.58
Nirmal Thori	27.3422	84.5650	98	0.7408	29.39	95.03
Panchpandav	27.4511	84.2458	213	3.1259	9.23	26.36
Patihani	27.5582	84.3145	20	0.0595	15.68	19.51
Rewa	27.4060	84.3076	126	0.4533	22.28	34.55
Sikhrauli	27.6568	84.2358	10	0.0296	63.74	11.26
Siswar	27.6514	84.1986	38	0.0134	63.74	18.61
Tribeni	27.4706	83.9287	52	1.5488	20.77	12.73

## Appendix E: Getis-Ord Gi Values

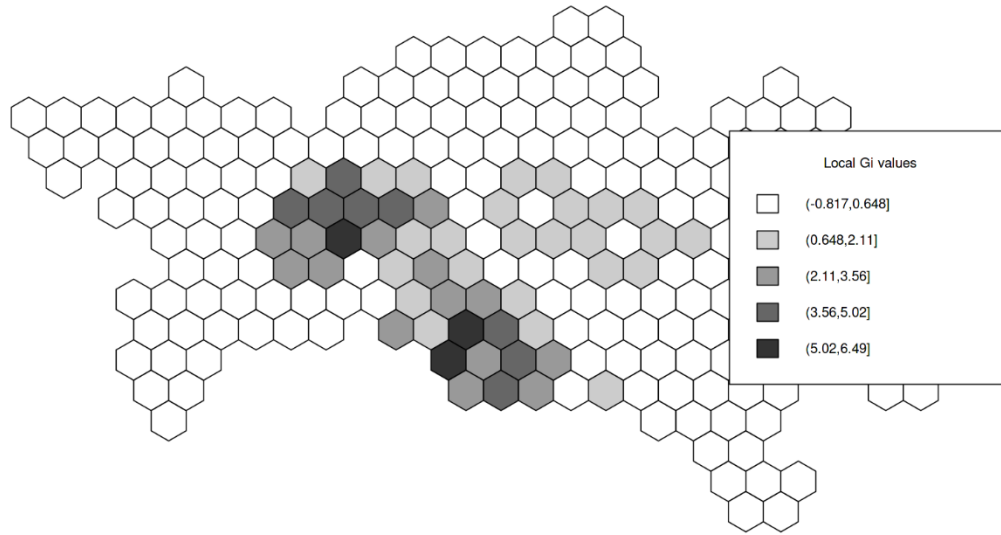


Figure E.1: Local Gi statistic values of HTC incidences at 5000 m quadrat resolution

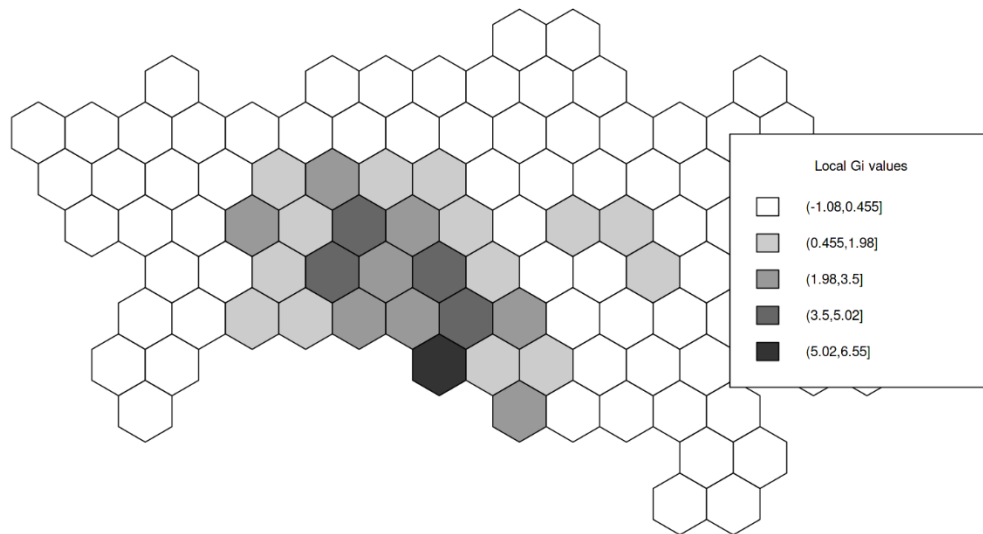


Figure E.2: Local Gi statistic values of HTC incidences at 8000 m quadrat resolution

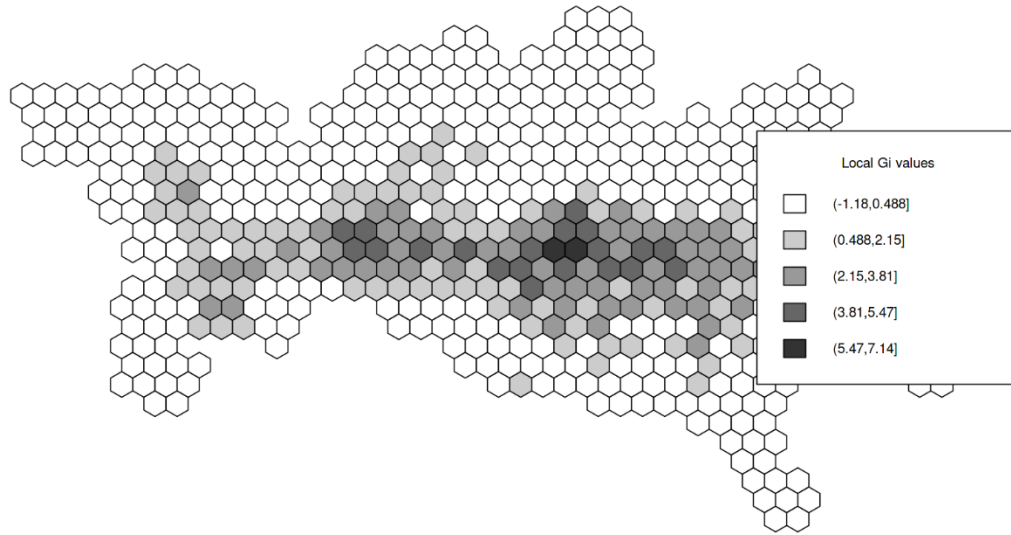


Figure E.3: Local Gi statistic values of tiger presence locations at 3000 m quadrat resolution

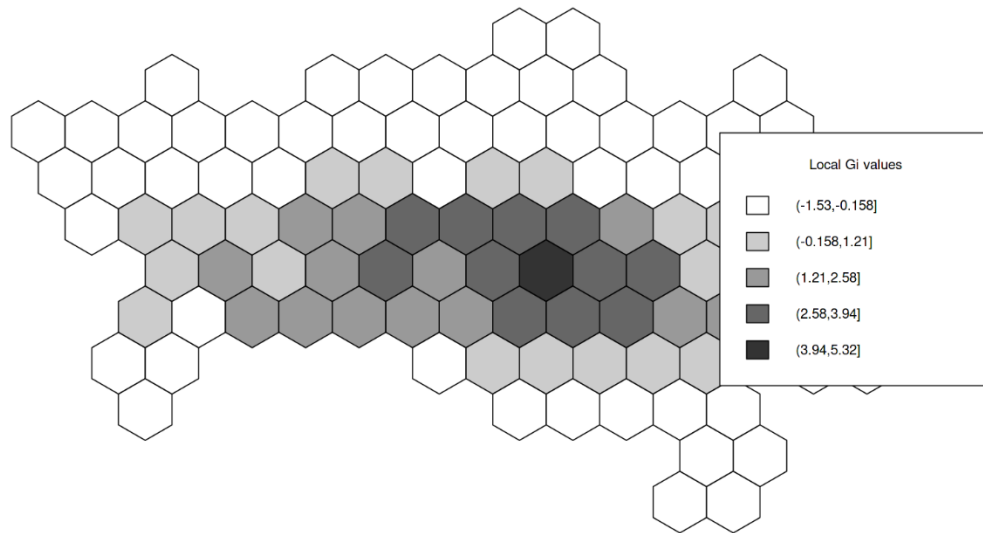


Figure E.4: Local Gi statistic values of tiger presence locations at 8000 m quadrat resolution