Assessment of Human-Tiger Conflict and Its Community Based Mitigation Efforts in Madi Valley of Chitwan District, Nepal

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Abstract

Human fatalities and livestock depredation are the ultimate manifestation of human–tiger conflict (HTC). It is one of the major challenging issues that need to be sorted out where such incidences occur frequently. This study aimed to investigate the status of HTC and mitigation measures adopted by local communities in Madi valley adjacent of Chitwan National Park (CNP). Data were collected through household interviews (n=52, including 25% victim's households), direct field observation and CNP archive records from 2014 to 2018. This study revealed that average livestock depredation was 15.60 (n=78, mean=5.06, SE±1.66) animals per year and among them goats were highly depredated animals (n=39, mean=7.80, SE±2.33). It also showed that livestock depredation trend increased at the rate of 4.1 animals per year but that of human casualties decreased at the rate of -0.3 persons per year during 2014 to 2018. Predation proof corrals, mesh wire fencing, traditional fencing using white cloths and livelihood diversifications were the major local mitigation efforts adopted by local people. However, detailed studies on effectiveness of locally adopted mitigation techniques along with further investment to implement them from government line agencies and conservation partners are suggested for strengthening human-tiger co-existence in the study area.

Keywords: Human casualties, livestock depredation, co-existence, conservation, mitigation

Introduction

Human-Wildlife Conflict (HWC) is a widespread manifestation throughout the world and has become a major problem for many centuries (Wang and Macdonald, 2006; FAO, 2009). The most common forms of HWC are loss of livestock, human casualties, crop raiding and property damage (Gurung *et al.*, 2008; Ogra and Badola, 2008; Inskip and Zimermann, 2009; Silwal *et al.*, 2017; Lamichhane *et al.*, 2018; Joshi *et al.*, 2020). Conflicts are particularly severe in the regions where large predators occur (Polisar *et al.*, 2003; Wang and Macdonald, 2006; Lamichhane *et al.*, 2017), and where the resource use by local people and wildlife overlaps (Karanth and Kudalker, 2017). Large carnivores are the most conspicuous species of HWC and are usually considered as a risk to human safety and livestock depredation.

Among the large felids, especially tigers are predominantly disposed to conflicts with human beings due to their large home range and dietary necessities (Inskip and Zimmermann, 2009).

Historically, man-eating by tigers was low in places where there was an ample supply of natural prey and widespread habitat into which human encroachment was only gradual (Tilson and Nyhus, 2010). The common forms of human-tiger conflict (HTC) are tiger attacks on humans and their livestock and threats to human safety in the vicinity of human settlements (Goodrich, 2010). However, there were increased cases of livestock predation by tigers in many places due to poor livestock husbandry and management practices (Mishra *et al.*, 2003). Possible causes of livestock depredation by tigers are often related to guarding and herding practices, grazing pastures, and poor quality of corrals to keep livestock at night (Jackson, 1999; Wang and Macdonald, 2006). In many parts of the Asian region, such incidences are likely to be higher where livestock are unrestricted to roam without close supervision (Tilson and Nyhus, 2010).

In many places on the Indian subcontinent and parts of South East Asia, tiger attacks on human beings exerted a substantial toll a century ago (McDougal, 1987). Since then, tiger population and the forests in which they once colonized have decreased at alarming rates (Dinerstein *et al.*, 2007). This has decreased the human fatality cases, and the places where tiger attacks happen (McDougal, 1987; Sanderson *et al.,* 2006). Conversely, human-killing is still a problem in Chitwan National Park (CNP), where the rate of human-killing has been augmented six folds from an average yearly death of 1.2 (1979 - 1998) to 7.2 person per year from 1998-2006 (Gurung *et al.,* 2008). In between 2007 and 2014, an average of 4 persons were killed and 2.7 persons injured, and similarly an average of 44 livestock were killed per year (Dhungana *et al.,* 2017). Within the buffer zone of CNP, the highest number of human killing was recorded from Ayodhyapuri buffer zone user committee in Madi valley (Lamichhane *et al.,* 2018). In recent years, increased tiger population (Karki *et al.,* 2015; DNPWC and DFSC, 2018) with reduced poaching and forest restoration in community forests in buffer zones has increased the probability for HTC (Wegge *et al.,* 2016; Chanchani *et al.,* 2014; Gurung *et al.,* 2008). The high-quality tiger habitat in CNP serves as a source for tigers dispersing into more marginal habitat adjacent to human settlements (Smith, 1993). Besides, CNP harbours other mega animals (rhinoceros, elephants, etc) that commonly attack human beings (GON, 2013). Similarly, Chitwan district population has been increasing due to high immigration and birth rates (Gurung *et al., 2008*) after the eradication of Malariya in 1950s. Increased risks of attacks on humans and livestock depredation by tigers led to a negative attitude toward tigers (Goodrich, 2010) and such incidences also reduce support from local people in tiger conservation (Löe and Röskaft, 2004; Karanth and Gopal, 2005; Carter *et al.,* 2013).

There are several factors like behaviour

of tigers, distance of park boundary, livestock holdings and community response are crucial to determine the level of conflicts in a particular location (Van Bommel *et al.*, 2007). However, previous studies on HTC have mainly focused on spatial and temporal patterns of human casualties, livestock loss and retaliation killings in CNP (Nyhus and Tilson, 2004; Muhammed *et al.*, 2007; Gurung *et al.,* 2008; Bhattarai and Fischer, 2014; Silwal *et al.*, 2017; Dhungana *et al.,* 2017), and recommended enhancing the management practices in and around the protected areas. For effective conservation of large carnivores like tigers, the greatest challenge is to minimize the conflicts with human beings. It is difficult to eradicate the risk of tiger attacks completely; however, it can be reduced to an endurable level so that local communities can accept it. The fourth amendment of Nepal's National Parks and Wildlife Conservation Act 1973 made in 1993 aims to address some of those issues by making provision of integrated community - based conservation and development approach to enhance the level of tolerance among local people (GON, 1973). Similarly, the second amendment of Wildlife Damage Relief Guideline 2013 also aims to increase the level of tolerance of wildlife damage with some additional provisions so that people and wildlife can co-exist (GON, 2013). In contrast, local people claim that BZUCs spend more funds in community development activities than on conflict mitigation measures (Silwal *et al.,* 2013). In many locations local communities are compelled to implement some locally available mitigation measures such as electric and mess wire fences, predation proof enclosures to escape from tiger attacks (Lamichhane *et al.,* 2018). There have been limited studies on trends of tiger attacks and its mitigation strategies adopted by local communities in CNP and Madi valley in particular. Therefore, we investigated both the incidence of HTC and its community-based mitigation efforts in greater depth as effective conflict mitigation measures require comprehensive information on the underlying causes contributing to those conflicts (Thorn *et al.,* 2012). There is an utmost need to develop a proper database on conflict incidences and processes to respond to those conflicts immediately when they occur. Without a better understanding of HTC and a concerted effort to address the problem proactively, future landscape-level tiger conservation efforts may be jeopardized (Nyhus and Tilson, 2004). This study could substantially support tiger conservation initiatives by documenting the existing conflict mitigation practices adopted by local communities residing in the vicinity of tiger habitation.

Materials and Methods

Study Area

Chitwan National Park (CNP), located in south central Nepal, was established in 1973 as Nepal's first national park covering an area of 952.63 km^2 in the subtropical lowlands of the inner Terai.

CNP was enlisted as an UNESCO's world heritage site in 1984 for its unique ecosystems of international significance (Majupuria and Majupuria, 1998). Madi valley (including Madi Municipality) lies in the buffer zone of CNP extending over 218.52 km^2 (Fig. 1). There were four buffer zone user committees (BZUCs), namely Panchpandav, Rewa, Bagauda and Ayodhyapuri; and 10 buffer zone community forests user groups. These buffer zone (BZ) forests link CNP to Parsa National Park in the east and the Valmiki Tiger Reserve (India) in the south, and these three protected areas support to one of the largest tiger populations in South Asia (Wikramanayake *et al.*, 1998; Dinerstein *et al.,* 2006; Ranganathan et al., 2008). At about 77% area of Madi valley is functional wildlife habitat, which includes grasslands, shrub land, forests, river and water bodies, and the rest (33%) includes agriculture land and settlements (MM, 2017). Madi valley is home to more than 43,402 people comprising of mainly Bramhan/Kshetri and Tharu followed by other ethnic groups (MM, 2017). Livelihoods of local people are predominantly based on subsistence farming system including agriculture, livestock and fish farming, and this is similar across most ethnic groups (Sharma, 1991; Budhathoki, 2012). As a result, local communities and tigers have to share limited resources, leading to several cases of HTC in the buffer zone of CNP including Madi valley (Gurung *et al.,* 2008; Dhungana *et al.*, 2017; CNP, 2019).

Data Collection and Analysis

We collected data (incidents of human casualties and livestock depredation) from the archives kept by CNP office, mainly recorded in applications for relief fund (Gubbi, 2012; Silwal *et al.*,

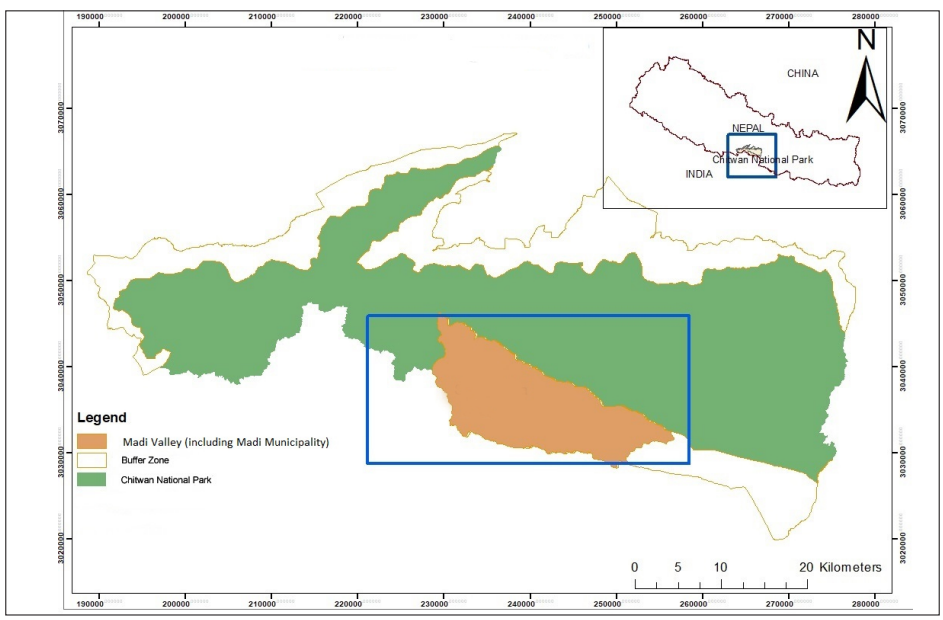

Figure 1: Location map of study area showing Madi valley of Chitwan district, Nepal

2017) of wildlife victims caused by tigers, for fiscal year 2014/15-2018/19. The data of tiger attacks on humans included types of damage (kills or injuries), location and date (park or buffer zone), whereas the livestock loss data included type of livestock (goats, buffalo, cow/ox or pigs), location and date (village, BZUC and ward number of Madi Municipality). Wildlife victims of the buffer zone report the conflict incidents through formal applications to the local authorities (BZUC or park) mainly to claim relief fund. Local authorities (especially representatives from local government, BZUC, police, etc) verify the conflict incidents and consequently release relief as per Wildlife Damage Relief Guideline 2013 (GON, 2013). We cross-checked the park archival data set of livestock depredation and human casualties by triangulating them through household questionnaire surveys (n=52) with victims or their family members, and other neighboring people and got supplementary information about those incidents. In our survey, we interviewed about 25% of the total victim households including both those suffering attacks of tigers on humans and those suffering livestock depredation (n=20) purposively and in addition to that at least one neighboring household (n=32) was selected randomly representing each BZUC in Madi valley to reduce the biasness (Table 1). We used a semi-structured questionnaire survey (Punch, 2006) to obtain information on perceived HTC as well as the mitigation measures adopted by local communities to minimize the conflicts. The household surveys were conducted in Nepalese language with consent of all respondents during the month of February and March 2018. Data were analyzed using descriptive statistics such as mean, frequencies in MS Excel to analyze the pattern of human casualties and livestock loss during fiscal year 2014/15 to 2018/19. Further, the research team observed the conflict prone sites and meanwhile recorded the mitigation measures adopted by local people in the study area.

Table 1: Sampled households (HHs) during household interviews

Buffer Zone UserCommittee (BZUC) Name	Total victim HHs	Sampled HHs	
		Victim HHs	Non-victim HHs
Panchpandav	18	5	7
Rewa	15	4	7
Bagauda	1	1	3
Ayodhyapuri	39	10	15
Total	73*	20**	32

** CNP records; HHs affected by tigers (livestock lost and human casualties) since the last five years (2014 to 2018)*
***25% of the total victim HHs*

Results

The average livestock holding of the sampled households was 7.72 animal per household and among them goat rearing (mean=3.20) was frequent in the study area (Fig. 2). During the fiscal year

2014/15 to 2018/19, there were 3 human casualties and 3 injuries followed by 78 incidents of livestock depredation in 73 households resulting from tiger attacks (Table 2). The average human victims were 1.20 persons (injured, mean=0.60, SE and killed, mean=0.60, SE per annum, whereas the average livestock depredation was 15.60 animals (n=78, mean=5.06, SE±1.66) per annum. So, our study revealed that the trend of livestock depredation has increased at the rate of 4.1 animals per year but that of human casualties has decreased at the rate of -0.3 persons per year (Fig. 3). Among livestock loss incidents, goats were highly depredated animals (n=39, mean=7.80, SE followed by buffalo (n=17, mean=3.40, SE and cow/ox (n=20, mean 4.00, SE). Among them, about half (50%) of the livestock killings were of goats, followed by cow (26%) and buffalo (22%). The conflict incidents occurred most frequently (53.42%) in Ayodhyapuri BZUC followed by Panchpandav, Rewa and Bagauda BZUCs respectively (Table 1). In contrast, there were no cases of tiger retaliation due to HTC in the study area within the selected time frame. Most of the human casualties were recorded at the fringe of buffer zone forests and national park. Majority of depredation incidents (48%) were of the livestock grazing in the fringes of buffer zone forests followed by livestock in the sheds at night (33.33%) and livestock grazing in fallow agricultural land (19.04%).

Our study revealed that only about 17% of total respondents applied preventive and mitigation measures such as mesh wire fencing, predation proof enclosures and traditional fence with white cloths to minimize livestock loss due to tiger attacks. Among them, predation proof enclosures followed by traditional fence with white cloths were commonly practiced mitigation techniques. During field visits, we observed that CNP through BZUC has implemented some

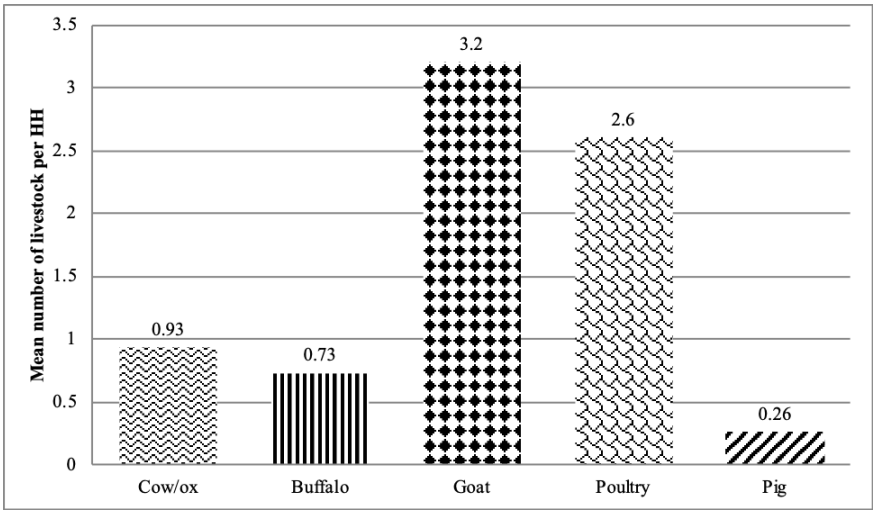

Figure 2: Livestock holding status in Madi valley of Chitwan district, Nepal

mitigation measures such as solar fencing, mesh wire fencing, support for fish farming and skill development program (tailoring program for women, house-wiring, plumbing) as means of livelihood diversification.

CNP by Gurung et al., 2008 (7.2 human deaths per annum, during 1998-2006) and Dhungana *et al.,* 2017 (4 human deaths per annum, during 2007-2014). This reveals that the rate of human fatalities has been decreasing (-0.3

Table 2: Human-tiger conflict incident records in Madi valley during fiscal year 2014/15 to 2018/19.

Fiscal Year	Human Casualties			Livestock depredation			
	Injured	Killed	Total	Goat	Buffalo	Cow	Total
2014/15	1	2	3	4	1	2	7
2015/16	0	0	0	6	5	0	11
2016/17	1	0	1	6	1	6	13
2017/18	1	0	1	17	2	5	24
2018/19	0	1	1	6	8	7	21
Total	3	3	6	39	17	20	78

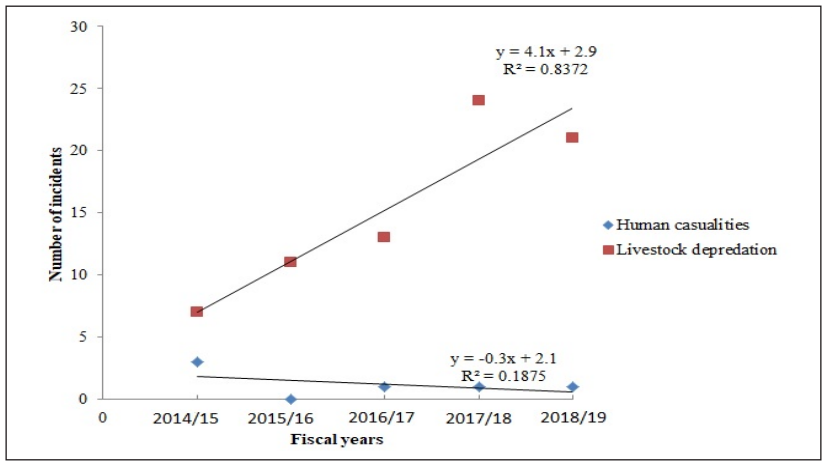

Figure 3: Trends of human casualties and livestock depredation in Madi valley of Chitwan district, Nepal.

Discussion

We relied primarily on conflict incident records of CNP and BZUC followed by household surveys for the validation of wildlife damage cases (Dhungana *et al.,* 2017). This study shows lower incidence of human casualties by tigers in the study area (killed = 0.60 persons per year, injured = 0.60 persons per year, during fiscal year 2014/15-2018/19) than the study conducted in

persons per year), and it could be for the reason that our study is concentrated only in the Madi valley, southern buffer zone of CNP. In spite of increasing tiger population in the park (Karki et al., 2015; DNPWC and DFSC, 2018) and human population in the buffer zone, no increase on human fatalities or injuries from tiger were recorded during the study period. This could be attributed to less human-tiger interaction as an impact of installation of solar and mesh

wire fence along the forest border in the buffer zone to separate forests and farmlands/settlements through buffer zone management programs, reduction of dependency on forests and livelihood diversifications. Our results revealed that the annual average loss of livestock were 15.60 animals with an increasing trend of 4.2 animals per year, which is lower than what was found in the study conducted by Dhungana *et al.*, (2017) in and around CNP including Mady valley between 2007 and 2014 (an average of 44 livestock killed per annum). The highest number of livestock depredation occurred in the areas of Ayodhyapuri BZUC of Mady valley, which is consistent with the study conducted by Gurung *et al.,* (2008) in CNP. It could be for the reason that Ayodhyapuri BZUC has the longest adjoining boundary with the national park. Our study found that goats were most frequently depredated animal (50%) in the study area, which is similar to the finding of the study conducted by Dhungana *et al.,* (2017). It may be for the reason that most of local people prefer goat rearing (3.2 goats per HH) in the study area. The study conducted by Miller *et al.,* (2015) found that goats were killed closer to fields and villages. Most of the local people have ordinary livestock corrals and graze them in their fallow agricultural fields, and thus this could be also another responsible factor for frequent livestock depredation. Most of the livestock sheds for corralling at night-time were unusually open; only a few people have put their livestock (goats and pigs) in predation proof corrals. Furthermore, decrease of natural prey species in the national park and buffer zone forests may be forcing the tigers to kill livestock (Kolowski and Holekamp, 2006; Gusset *et al.,* 2009). Our data do not enable us to discern whether these risk distributions are shaped more by carnivores or by livestock and people; so, we suggest future studies to directly pursue the reasons behind depredation.

Grazing inside the buffer zone forests and park is prohibited (GON, 1973) and so local people living in high-risk areas could consider implementing additional mitigation techniques such as traditional fence with white cloth, mesh wire solar fence, predator-proof enclosures and livelihood diversifications at community level to further reduce attacks of carnivores (Shivik, 2006) due to the increasing trend of livestock depredation since 2014 (Fig. 3). A study conducted by Lamichhane *et al.,* (2018) in CNP showed that implementing conflict mitigation measures (solar fence, concrete/mess wire fences), community awareness program, and reduction on forest dependency along with livelihood diversification (increased off-farm household income and reduced grazing on forests) have essentially helped lessen the damage from wildlife including tigers. Similarly, previous research in Central India (Karanth *et al.,* 2013) and in east Africa (Kolowski and Holekamp, 2006) also found that fencing was especially useful in mitigating attacks.

Conclusion

This study revealed that the rate of livestock depredation in the Madi valley has been increasing for the last five years with goats and buffalo as the most depredated livestock, but in the rate of human attacks has decreased. The restoration of buffer zone forests in recent years had dwindled the physical distance between human beings, livestock and the tigers, which in turn has augmented the HTC cases. However, the trend of human fatalities has decreased as a result of less human-wildlife interactions due to reduction in forest resources dependency and other livelihood diversification options, for example, fish and poultry farming practiced by local communities in the recent years. Further, other activities and practices including the promotion of stall feeding by discouraging free grazing in forests and improvement of livestock corrals could minimize livestock depredation by tiger. In addition, to minimize the conflict, local communities have adopted some mitigation measures like using predation proof livestock shed for night -time corralling, change in livestock management system from open grazing to stall feeding, mesh wire solar fencing, fence using white cloths and livelihood diversifications. However, effective HTC resolution needs further investment on implementing some mitigation measures that are compatible to local people from CNP, BZUC and other conservation partners to support tiger conservation initiatives in the study area. Therefore, we recommend further detailed research on the effectiveness of local preventive and mitigation measures adopted by local communities to minimize HTC.

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Conflict of Interest

The authors declare no conflict of interest.

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