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Assessing human-leopard conflict in Gulmi, Lumbini Province, Nepal

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Abstract

In recent years, human-leopard conflict has become a significant issue in the Gulmi district. This study aims to explore the current situation of such conflicts by conducting field visits from August 2019 to January 2020 and documenting data from the past five years through questionnaires. A total of 743 livestock were reported as victims of leopard attacks. There was a significant positive correlation between the frequency of livestock incidents and the number of losses ($r = 0.907$, $p = 0.574$ at a significance level of 0.05). The gender of the livestock also showed a positive correlation with incident frequency ($r = 0.972$). Most incidents involved free-grazing livestock, with the highest occurrence in August (11.27%). A strong relationship was found between people's responses to leopard activities and the distance of their residence from the forest ($\chi^2 = 39.97$, $df = 6$, $p < 0.05$). Additionally, there was a significant association between the level of education and people's responses to leopard behavior ($\chi^2 = 13.69$, $df = 9$, $p < 0.05$). The most conflicting areas were marginal zones between forests and private farmlands, with most encounters occurring at night. Affected individuals expressed dissatisfaction with the government's compensation scheme. To mitigate human-leopard conflicts, it is recommended that livestock be reared in controlled environments, and that forest entry by people be limited to low-risk times.

Keywords: Behaviour, conservation, forest, livestock, wild animal

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Introduction

Increasing human activities in both protected and non-protected areas, along with pressure on natural resources, play a vital role in Human-Wildlife Conflict (HWC). Recently, HWC has become a serious issue for various sectors of society (Conover, 2001). This conflict, common in the past, has grown to be a significant global concern. The most frequent types of conflicts with wildlife include crop raiding, property destruction, animal predation, and human casualties (Wang and Macdonald, 2005).

HWC refers to any interaction between people and wildlife that adversely affects human social, economic, or cultural well-being, the preservation of wildlife populations, or the environment (Atharya *et al*., 2016). Human-leopard conflict is widespread and particularly affects large carnivores (Dickman, 2008; Qamar *et al*., 2010). Carnivores are especially vulnerable in changing environments (Steinberg, 2013), and conflicts often arise in areas where livestock and large carnivores coexist (Karlsson and Johanson, 2010).

Nepal is home to three species of leopards: the Common Leopard (*Panthera pardus*), the Clouded Leopard (*Neofelis nebulosa*), and the Snow Leopard (*Panthera uncia*). The Common Leopard, also known as the forest leopard, is the most prevalent species, thriving in both dense forests and open areas (Prater, 1998). This species is the fourth largest of the seven big cats, which include tigers, lions, jaguars,

cheetahs, leopards, and cougars. Notably, the Common Leopard is an adept climber, capable of carrying prey heavier than itself up into trees. Its distinctive coat features black rosettes on a yellow background, with each leopard's pattern being unique, similar to human fingerprints (Pocock, 1932; Brakefield, 1993).

HWC occurs when humans encroach on wildlife habitats due to activities such as logging, livestock grazing, agricultural expansion, and development projects, leading to habitat loss, degradation, and fragmentation (Madden, 2004). As a result, people may lose crops, livestock, property, and even their lives, while wildlife may become endangered or threatened due to retaliatory killings by humans (Mishra *et al*., 2003).

In the Gulmi district, predation on livestock by leopards is a significant issue. Every year, locals lose a substantial number of livestock to leopard attacks. While some studies have focused on protected areas, there is limited research on human-leopard conflicts in local and community forests outside protected areas. This study aims to explore the existing scenario of human-leopard conflicts in Resunga Municipality, Gulmi district, Lumbini Province. It assesses not only people's attitudes towards leopard conservation but also provides insights for managing issues caused by leopards.

Materials and methods

Study area

The study was conducted in Resunga Municipality, located in the Gulmi district in western Nepal, named after the holy place Resunga. The municipality is situated at 28°40' N and 83°15' E, with an altitude of 1838 meters above sea level. The Resunga Forest, spanning 3400 hectares in the mid-hill region, ranges from 560 to 2300 meters in elevation and encompasses diverse wildlife and plant species from sub-tropical to temperate climatic zones (Khadka and Pokharel, 1999; Acharya, 2012). This area also has approximately 252 watersheds, providing the main source of drinking water for local residents (Panthi, 1984). The forest resources are traditionally used for wood, fodder, firewood, leaf litter, and medicinal plants (Khadka and Pokharel, 1999).

Out of the 3400 hectares, 18 community forests cover 1973.93 hectares, religious forests cover 165.17 hectares, and the remaining land is government-owned (DFO, 2014). Major plant species include *Pinus roxburghii*, *Alnus nepalensis*, *Schima wallichii*, and *Rhododendron arboreum*. The forest is home to various wildlife species, such as the Common Leopard (*P. pardus*), Barking Deer (*Muntiacus muntjak*), Ghoral (*Naemorhedus goral*), Jungle Cat (*Felis chaus*), Indian Crested Porcupine (*Hystrix indica*), and Hanuman Langur (*Semnopithecus entellus*) (Pandey and Chalise, 2014). Additionally, the historical pond in this range provides suitable habitats for birds like the Red Jungle Fowl (*Gallus gallus*), Spotted Dove (*Streptopelia chinensis*), Indian Nightjar (*Caprimulgus asiaticus*), and Parakeet (*Psittacula* sp.).

The study was conducted in four villages within Resunga Municipality. Six wards with high prey density (wards 1, 2, 4, 6, 7, and 11) were randomly selected for the study due to frequent leopard visits.

Sampling method

Data was collected through household surveys, interviews, questionnaires, focal group discussions, and direct observations.

The total number of households was obtained from the municipality office. Sample households were randomly selected from the more affected areas, resulting in a sample of 97 households. Table 1 shows the distribution of sampled households in Resunga Municipality.

Questionnaire survey

The questionnaire survey was conducted from August 2019 to January 2020, covering information from the past five years (2015-2020) regarding HWC. Household data were obtained from the municipality office, and households in each ward were randomly selected. Interviews were primarily conducted with the heads of families, but other household members also provided input.

Focal group discussion

Group discussions were held with chairpersons and executive members of community forestry groups, ward office members, villagers, and village leaders.

Direct observation and interview with the sampled households

Intensive field visits were made to assess the impacts of human-leopard conflict. Open discussions were conducted with local people to gather insights on the common leopard, past and present conditions, and ongoing threats. Simple questions related to these topics were prepared and asked to the locals.

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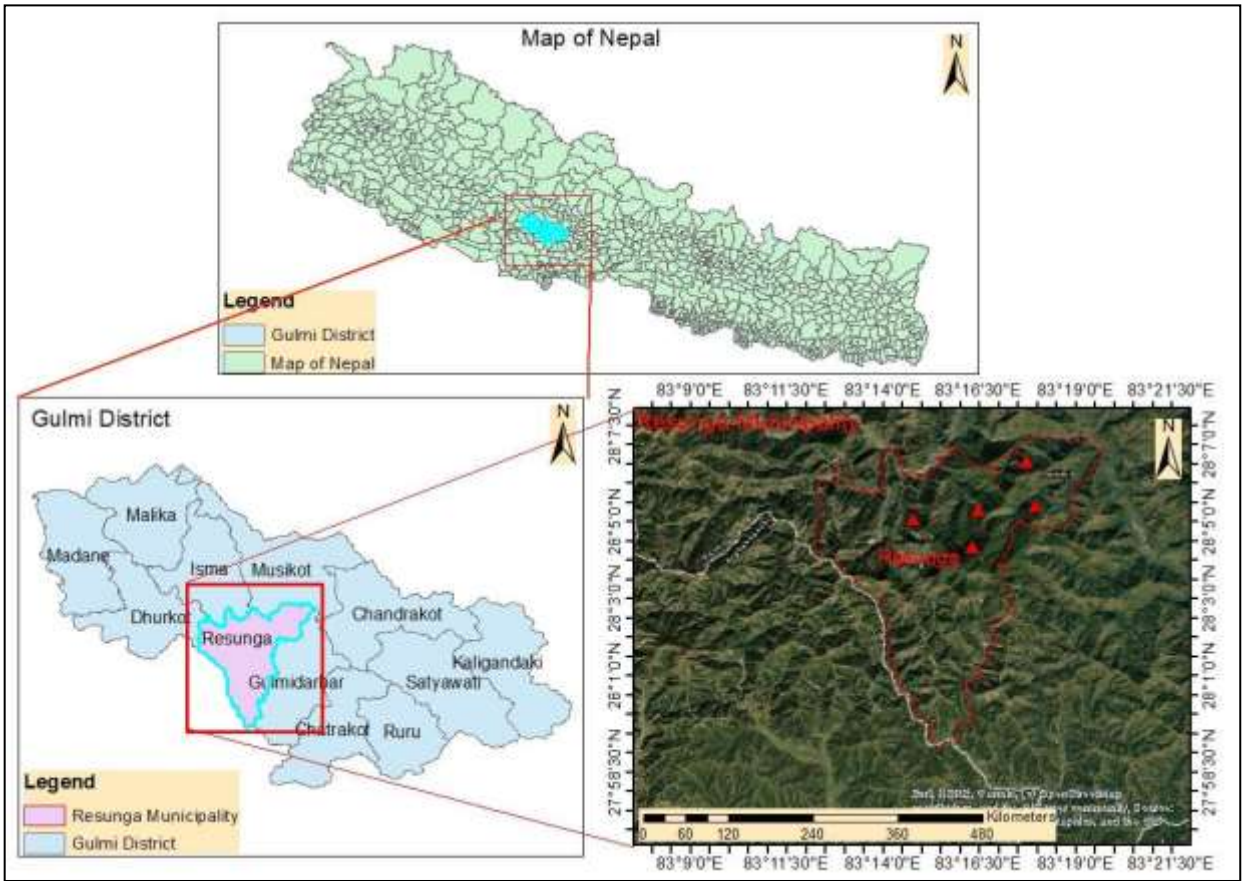

Figure 1. Map of study area.

Table 1. Distribution of sampled households in Resunga Municipality.

Ward No.	Total Household	Total Population	Sampled Household	Highly affected Household (loss)	Often affected (disturbed only)
1	1,330	4,990	10	1	2
2	752	2,609	12	0	4
3	355	1,541			
4	489	2,165	30	22	5
5	341	1,360			
6	464	1,927	20	15	5
7	432	1,907	10	7	2
8	1,090	3,666			
9	521	1,973			
10	839	3,550			
11	384	1,613	15	11	4
12	383	1,736			
13	228	916			
14	695	2,895			
Total	**8,353**	**32,548**	**97**	**56**	**22**

Data analysis

Quantitative data and statistical measures were analyzed using standard formulae in Microsoft Excel 2016.

Results

Livestock depredation

Every household kept more than one form of livestock. This study unequivocally established that the locals viewed conflict between humans and leopards as a serious problem. Of the 97 respondents, 56 households reported a total loss of 157 livestock (ox: 5, cow: 5, calf: 12, buffalo: 9, goat: 40, dog: 5, poultry: 81) over the past five years due to leopard attacks. The total number of livestock incidents was 743, with 389 males and 354 females affected. A total of 217 incidents were documented over five years. The mean loss of livestock per sampled household was 0.32 head per year.

There was a strong positive correlation between the number of livestock incidents and livestock losses ($r = 0.907$). The association between livestock incidents and losses was high ($p = 0.574$ at significance level 0.05). The relationship between the gender of livestock involved in incidents and the number of livestock losses was positively associated ($r = 0.972$).

Livestock management system

Among the people who were affected and lost their livestock, most (49.48%, n=48) did not take their livestock for grazing or used purely stall feeding. Slightly more than half of the respondents/ households (50.52%, n=49) grazed their livestock in different fields. Among the grazers, about 20.40% (n=10) used private land, 40.81% (n=20) used both private land for grazing and partly stall feeding, and 38.77% (n=19) used a combination of stall feeding and grazing in community forests.

Human factors contributing to conflict

Human-leopard conflict increased due to deforestation and habitat fragmentation. The majority of respondents (59.07%, n=58) revealed that going to the forest for various purposes was a major contributing activity. About 18.56% (n=18) stated that some people let their livestock graze freely in the forest. According to 14.33% (n=14) of respondents, some residents of Resunga have tried to capture wild animal offspring. Additionally, 7.21% (n=7) of respondents indicated that hunting any wildlife also creates conflict.

Month-wise record of conflict

In the past five years, the events of human-leopard conflict for each month were recorded. The results showed that the highest number of events occurred in August (11.27%), followed by September (10.52%). July and October both recorded the third highest number of events at 9.77%. The least number of events occurred in January (7.37%). The mean value of these data was 18.083, with a standard deviation of 2.429 and a standard error of 0.7012.

Local attitudes towards leopards

Most of the respondents demonstrated positive thinking towards leopard conservation. About 54.63% (n=53) liked leopards, while 45.36% (n=44) did not like them in the community forest, in their locality. Out of the 56 victims who didn't like leopards, the majority (80.36%) believed this was solely due to leopards' attacks on humans and livestock. Among male respondents, 86.21% showed a positive attitude towards leopards, while only 51.85% of females favored leopard conservation.

The views about leopards during the survey were documented as follows.

- About 35.84% (n=19) revealed that leopards were beautiful creatures but their numbers were decreasing.
- Some respondents (16.98%, n=9) expressed the ecological value of leopards, stating their presence indicates a healthy ecosystem.
- Others (18.86%, n=10) mentioned that leopards helped to flourish the tourism industry.
- About 11.32% (n=6) believed that conservation would bring development and prosperity at the local level.

There was a strong relationship between a person's response regarding leopards and the distance of their residence from the forest area ($df=6$, $\chi 2 = 39.97$, $p< 0.05$).

Leopard behavior and ecology

We found that the locals were quite knowledgeable about some aspects of leopard ecology. According to 49.48% (n=48) of respondents, leopards emerge from the forest in search of food because the prey base in their habitat has been depleted. About 11.34% (n=11) said that leopards prefer domestic livestock over wild prey as they are easier to kill. Additionally, 6.18% (n=6) of respondents mentioned that leopards come out due to insufficient places to live in the jungle. However, places to live in the jungle. However, 32.98% (n=32) of respondents were unsure why leopards come out of the forest.

Education level and knowledge on leopard behavior

The academic qualifications of respondents and their responses were evaluated. From the obtained data, it can be concluded that there was a significant relationship between the level of education of local people and their responses on the behavior of common leopards (df=9, $\chi 2 = 13.69$, $p < 0.05$).

Trend and conflict zones

The study showed that the most conflicting zones were the marginal areas of community forests and private farmland. Among the respondents (N=97), 61.85% (n=60) reported experiencing the same level of threat as the previous year, 32.98% (n=32) reported an increasing threat, and only 5.15% (n=5) felt a decreasing threat.

Out of the 157 reported losses:

- About 55.41% (n=87) of livestock losses occurred in stalls or houses due to leopard attacks.
- 20.38% (n=32) of livestock losses occurred during grazing in community forests and private land.
- 15.92% (n=25) of livestock losses occurred in the core forest.
- 8.28% (n=13) of livestock losses occurred in other places.

Timing of conflict events

The timing of the total events (N=217) was documented. Most of the encounters with leopards occurred at night (46.54%, n=101), followed by the evening (27.18%, n=59). Encounters in the morning were less common (15.66%, n=34), while the fewest events were documented during the daytime (10.59%, n=23).

Compensation scheme

None of the respondents (N=97) were fully satisfied with the compensation process. Some stated that the information and services provided were inadequate (47.42%, n=46), while others felt that the information and services were incomplete (36.08%, n=35) or excessively lengthy (5.15%, n=5). Additionally, 11.34% (n=11) had other concerns. Respondents criticized the service providers for not delivering sufficient information and for failing to fulfill their roles in assisting with the compensation process.

Conflict management

In our study, most respondents indicated that conservation education could help reduce human-leopard conflict. Educating people about avoiding dangerous situations such as during leopard mating times, predation periods, breeding seasons, and potential breeding sites was seen as crucial. The main priorities should be education and raising awareness. However, relevant parties, such as nature guides, local government officials, and managers of protected areas, have not sufficiently addressed this issue. The study also found that only marginalized, uneducated individuals, and children or elderly people remained in the villages, with no effective education provided by stakeholders or government officials regarding these critical situations.

Discussion

The mean loss of livestock per household in this study was 0.32 head per year, which is lower than the 0.70 head per household per year reported in the Annapurna Conservation Area due to snow leopard (*Panthera uncea*) depredation (Oli, 1994) but higher than the 0.26 reported for Bardiya National Park (Bhattarai and Fischer, 2014).

A significant number of respondents (59.07%) identified human activities, such as frequent forest visits, as the primary cause of human-leopard conflict. Additionally, 18.56% reported that allowing livestock to graze freely in the forest contributed to the conflict. This finding is consistent with research from Kaeng Krachan National Park in Thailand, which showed that local activities significantly affected leopard behavior (Ngoprasert *et al*., 2007). However, Ngoprasert *et al*. (2017) found that human and leopard activities alternated, and Baral *et al*. (2022) documented 1139 instances of wildlife mortality due to human actions, highlighting the issue of retaliatory wildlife mortality.

The temporal distribution of conflict events showed that the highest number occurred in August (11.27%), followed by September (10.52%), with the fewest incidents in January (7.37%). This contrasts with other studies, such as Baral *et al*. (2021), which found that attacks were more common between September and December, and Sangay and Vemes (2008), who reported higher livestock predation rates in summer and autumn. Badhe and Jaybhae (2021) also noted increased attacks during the sugarcane cutting season in Pune, India, suggesting that local factors may influence the timing of conflicts.

Regarding local attitudes towards leopards, 54.63% (n=53) of respondents had a positive view, while 45.36% (n=44) did not. This differs from findings by Oli *et al*. (1994) and Bagchi and Mishra (2006), who reported negative attitudes towards large carnivores due to livestock depredation. Bhattarai and Fischer (2014) found positive attitudes towards tiger conservation in Bardiya National Park, while Dhungana *et al*. (2022) noted mixed attitudes toward

both leopards and tigers. In Ethiopia, public responses varied by habitat (Gidey *et al*., 2011), and Jhamvar-Shingoteand Schuett (2013) highlighted positive local perceptions of leopards in India.

The most conflict-prone zones were the margins of community forests and private farmlands. Among respondents, 61.85% (n=60) reported the same threat level as the previous year, 32.98% (n=32) reported an increasing threat, and 5.15% (n=5) reported a decreasing threat. This finding aligns with Gunawan *et al*. (2017), who identified conflict zones around degraded forests in Western Java, Indonesia, and Agarwal *et al*. (2011), who noted higher conflict in scrub-covered areas in Uttaranchal, India. Badhe and Jaybhae (2021) also found conflicts near agricultural areas.

Most leopard encounters occurred at night (46.54%, n=101), with fewer events documented during the day (10.59%, n=23). This is consistent with Kissui (2008) and Van Cleave *et al*. (2018), who reported nocturnal leopard attacks in Northern Tanzania and Kenya, respectively. Lamichhane *et al*. (2022) observed that 27% of incidents occurred between midnight and 4 AM, and 26.72% occurred between 12 noon and 4 PM.

Regarding compensation, respondents expressed dissatisfaction with the current scheme. Previous studies, such as Pandey *et al*. (2016), have highlighted difficulties in the compensation process and the need for alternative economic measures. Sherchan and Bhandari (2017) recommended revising compensation amounts, and Sherchan *et al*. (2022) found that compensation for crop damage was statistically significant in Nepal. Pokharel and Aryal (2020) also suggested implementing immediate and effective compensation and community-based conflict management strategies.

Our findings suggest that conservation education could help reduce human-leopard conflict. However, Lamichhane *et al*. (2019) recommended focusing buffer zone funds directly on reducing human-wildlife conflicts in Chitwan, indicating that targeted interventions may be more effective.

Conclusion

This study conducted in Resunga, Gulmi District, found that every household kept multiple forms of livestock and that human-leopard conflict was prevalent in the area. Annually, hundreds of livestock fall victim to leopard depredation. The findings indicate that the conflict is exacerbated by the lack of controlled areas for livestock and the frequent intrusion of people into leopard habitats for daily needs.

Over the past five years, the highest number of conflict incidents occurred in August, while the fewest were recorded in January. Despite ongoing conflict, most respondents exhibited a positive attitude toward leopard conservation. Locals believed that the depletion of natural prey drives leopards out of the forest in search of food.

The study also revealed a significant relationship between the level of education and the respondents' perceptions of leopard behavior. The most conflict-prone areas were identified as the marginal zones of community forests and private farmlands. Additionally, most leopard encounters occurred at night, with fewer incidents during the day.

The local population expressed dissatisfaction with the current compensation scheme under the Wildlife Damage Relief Assistance Guideline, 2013, citing inadequate compensation amounts. To mitigate human-leopard conflict, it is recommended that livestock be managed in a more controlled manner, forest entry be limited to low-risk times, and further demographic and behavioral studies on common leopards be conducted.

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