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Integrating Multiple Aspects of Human-Elephant Conflict Management in Dharamjaigarh Forest Division of Chhattisgarh, India

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Authors' contributions

This work was carried out in collaboration among all authors. Author AK did field visit and wrote the manuscript. Author AB framed the research work, performed the statistical analysis and wrote the manuscript. Author PS compiled the data and wrote the manuscript. Author SSD edited and finalized the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Reducing human-elephant conflict (HEC) has recently been recognized as one of the important aspects of wildlife conservation worldwide. Hence, a site-specific study of the efficacy of different traditional methods is necessary to mitigate the HEC in a particular area. Data on elephant visits and the efficacy of different deterrent methods were collected from twelve forest villages in

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Dharamjaigarh Forest Division of Chhattisgarh, India through field surveys during 2017-21. Findings revealed that both the small male and family herds of elephants mostly visit during the evening hours (50.4%). Interestingly, the family herd of the elephants preferred (95%) the agricultural plot while the small male herd visited mostly (80%) the village area during the entire study period. Making noise was the most common (100%) method practiced by all the villages followed by a fireball (80%). However, in 20% of the cases observed, noise, fireballs, and firecrackers were used to chase out elephants. There were variations in success rate attempts where a maximum (41.7%) was observed in Kudelela and a minimum in Potia (26.4%). Hence, the traditional method is found to be efficient in mitigating the HEC to some extent, however, modern technologies need to be integrated for accruing more efficient results.

Keywords: Human-elephant conflict; conflict mitigation; Asian elephants; Elephus maximus; Dharamjaigarh forest division.

1. INTRODUCTION

Throughout the distribution range of Asian elephants (Elephus maximus), the humanelephant conflict (HEC) largely exhibits crop damage which is one of the biggest challenges for the local fringe villagers. The other form of damage is property loss (infrastructural damage and stored grain) which not only causes severe economic loss but also affects the psychology of the common people. Being the marginal farmer whose crops are cultivated mainly for subsistence use and having no alternate livelihood option other than agriculture, local farmers become bound to safeguard their crops not only for the safety and security of their life but also for the matter of bread and butter (survivability). So people often take risks and are engaged in protecting their crops from elephant raids.

Previous studies found that HEC is strongly seasonal and usually takes place between dusk and dawn [1,2]. Site-specific spatial patterns have also been recorded in different areas. It was also found that the HEC is generally highest close to the forest areas that act as elephant refuges [3-5]. So, this is an important issue to understand a thorough sequence of the problem to develop and direct mitigation strategies [6,7]. Hence. conservation authorities and nongovernmental agencies around the world are trying to find out the technique to mitigate the HEC to provide the protection of humans as well as the conservation of wild elephants in the wild [8,9].

The improvement of crop security methodologies by various aggravation techniques is the commonest way to cope with this problem. Across the landscape, marginal farmers utilize a wide range of traditional techniques to pursue the elephants. All these techniques involve, drums sound and flames overwhelming. Farmers depend on many relief methods (e.g., actual obstructions, impediments, or hearing out elephants) to battle HEC. However, all these techniques were found to be insufficient on a long-term basis [10]. Also, these techniques and temporary ways can bring about an increase in HEC and may increase the number of cases of harm to people by elephants. So it is necessary to evaluate the site-specific mitigation measures practiced by the local farmers and their efficacy rate. This further will help in drawing short and long-term mitigation measures by the forest managers and other agencies.

2. STUDY AREA

The study was conducted in Dharamjaigarh Forest Division which is located (22.47°N 83.22°E) in Raigarh District of Chhattisgarh, India on Raigarh-Ambikapur highway, about 77 km north-west of Raigarh. This forest division covers an area of 1084592.399 sq kms with an average elevation of 300 m (980 ft) and is divided into six ranges namely, Dharamjaigarh, Chhal, Boro, Kapu, Bakaruma, and Lelunga. This area has connections with the western part of Odisha and the southern part of Jharkhand. About 60 elephants are roaming in the division from both states. Under Dharamjaigarh Forest Division, villages (Maharajganj, Jogada, Hati, Sithara, Khadgaon, Koilar, Chhal, Lailunga, Boro, Kapu, etc.) are located both inside and peripherv of the forest and people often faces confrontation with elephants (Fig. 1). The most affected villages are Chhal, Hati, Lailunga, Boro, Kapu, etc. Dharamjaigarh Forest Division harbors tropical deciduous forests with bamboo forests. The area is the home to high-density of primate species like rhesus macaque (Macaca mulatta), Hanuman langur (Semnopithecus sp.),



Fig. 1. Map of Dharamjaigarh Forest Division of Chhattisgarh where the present study was conducted

Chausingha (*Tetracerus quadricornis*), Sloth Bear (*Melursus urnsinus*), Wild Boar (*Sus scrofa*), Sambhars (*Rusa unicolor*), Spotted deer (*Axis axis*) and Jackals (*Canis aureus*).

3. METHODOLOGY

Twelve forest villages were randomly selected in the Dharamjaigarh Forest Division of Chhattisgarh state. Two different field methods were followed for this study namely; the field observation method and night visit [11]. Data on elephant visits and the efficacy of different deterrent methods were collected using field data sheets. The data were analyzed at p<0.05 level by t-test and chi-square test using SPSS version 20 software.

4. RESULTS

4.1 Elephant Visits

During the study period, elephants mostly visit in the evening hours (50.4%) followed by the night or late hours (35%) and late night (11.7%). They were also occasionally found to visit during day hours (Fig. 2).

Both the small male and family herd mostly preferred to visit in the evening hours as compared to other hours of the day. However, night or late hours was the second preferred timing for visits in both herds (Fig. 3).

Interestingly, the family herds of elephants were found avoiding the village area and preferred (95%) to visit mostly the agricultural plot. This may be because the family herd did not want to take the risk in the village area due to the presence of elephant calves in the herd. On the other hand, the small male herd mostly preferred (80%) the village area during the entire study period (Fig. 4). There was a significant difference between elephant herd sizes and sites visited by the elephants (χ^2 =1.51E2, p<0.05). This may be because of their risk-taking attitude toward raiding homegrown crops and stored grains.

4.2 Preventive Measures Undertaken by the Farmers

In all the villages, there were temporarily constructed watch towers at the agricultural plots to monitor the intrusion of elephants. These numbers varied from 1 to 6 with the highest in Potia village and the least in Koilar village. However, less number of watch towers were found at the village boundary as compared to agricultural plots (Fig. 5). This further indicates that more watch towers must be constructed in both village boundary and agricultural plots to safeguard their crop from depredation.



Fig. 2. Diurnal variation of elephant visits during 2017-21



Fig. 3. Preference of timing for visit by different elephant herds



Fig. 4. Preference for crop raiding sites by different elephant herds



Fig. 5. Number of watchtowers to monitor elephants



Fig. 6. Traditional methods applied for preventing elephants



Fig. 7. Village-wise success attempt (%) in preventing elephants

The noise was the most common (100%) method practiced by all the villages followed by a fireball (80%). On the other hand, other traditional methods were used comparatively with very less frequency. Firecrackers were used only in 10% of cases while *chili* powder was used in only 5% of cases. However, in 20% of the cases, noise, fireball, and firecrackers together were used to chase elephants (Fig. 6). There was no case where the *kunki* elephant was used by the forest department to chase the elephants during the study period.

There was a variation in successful attempts by different villages in preventing elephants from doing any kind of damage during the study period. Maximum success attempts (41.7%) were observed for Kudelela whereas it was minimum for Potia (26.4%) (Fig. 7). This variation was found to be statistically significant (t=19.21, $p\leq0.05$). This indicates that more initiative will be required from the villagers' side to prevent elephants.

5. DISCUSSION

Many species face increasing competition with people for space and resources [12,13]. As a result, some are coming into increasing conflict with people, and this is particularly true in the case of large mammals. Therefore, the large herbivores and carnivores face a huge scarcity of food that lead to confrontation with humans which is one of the major causes of the population declining trend and leading to critically endangered status [14,15]. The issue of HEC has become increasingly significant as human populations have expanded and encroached upon elephant habitat [16,17], particularly where people practice cultivation. Moreover, elephants are also dangerous to people and intolerable [18,19].

In Chhattisgarh, elephants move to new areas and continuously search for favorable conditions for their survival in such places we need short, effective, and simultaneous management plans to counter this problem and to avoid any uncircumstantial happenings. The finding revealed that a small herd creates more problems mostly during evening hours which is similar to the previous studies in different parts of India [20-22]. People used noise as an important repellent for mitigating HEC in the present study which is consistent with the other studies [22,23] that differ the smell as the most efficient method to tackle this issue [24]. For a long-term management plan, the forest manager should understand the elephant's ecology and their nature. Further, the installation of physical barrier (construction of trench and electric fence) around the paddy field and village area, construction of the watch tower at some strategic point, regular monitoring of wild elephants, deployment of *kunki* elephants and trained persons, formation of *Hathi Mitra Dal* and JFMCs, habitat improvement program, etc. could be initiated. An early warning system may also be installed; firecrackers, kerosene oil, high-power searchlights, etc. may be supplied by the forest department as part of the short-term recovery plan.

Improving conservation success depends on the active participation of the local people that make it sustainable for a longer period [25-28] and provide economic opportunities that support conservation efforts. potentially through community-based programs [29]. It is therefore an utmost requirement of the forest department to gain support from local communities for the cause of mitigating the HEC. For that, some community development [30-35] should be initiated to share the benefits among the victim people that could improve the livelihood options and develop a positive attitude towards elephant conservation [32,36-38]. The main focus of the conservationists/ forest authorities is to find a way to check encroachment in the elephant's bearing habitat [39]. Many wildlife conservationists and the organizations that have been working to reduce the conflicts so far didn't cover the matter completely [40]. Some strategies and policies must be taken by the forest department for the conservation of elephants and safety measures for the people, crops, and their livelihood.

6. CONCLUSION

The traditional method is found to be efficient in mitigating the HEC to some extent in the present study, however, modern technologies need to be integrated for accruing more efficient results. Further, the success of HEC mitigation measures depends on the people's response to this issue, and proper planning is required along with the elephant visits as well as the entry points that may help in preventing elephants. However, cooperation among the villagers and support from the forest department is utmost required to mitigate this problem. The people also must learn the way of co-existence in a proper scientific way so that the conservation of elephants as well as the life of human beings can be saved. This study could be useful for the stakeholder and policymakers in framing the road map for HEC mitigation measures in India and elsewhere.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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