Demographic Circumstances and People’s Sentiments towards Elephants in the Human–Elephant Conflict Hotspot Villages of Keonjhar Forest Division in Eastern India

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Abstract: The socio-economic aspects of the people who directly share space with elephants not only influence the occurrence of human-elephant conflict (HEC) but also shape their sentiments towards coexistence with elephants. The objectives of this paper are to (i) assess the demographic situation and map people’s sentiments towards elephants in the HEC hotspot villages of the Keonjhar forest division in India and (ii) rank the most suitable policy instruments and the urgency of mitigation strategies. The results indicated that cultivation and marginal agriculture were positively related with HEC incidences, whereas literacy and employment were negatively associated. Despite being severely affected by human–elephant conflict, many of the respondents (78%) in the HEC hotspot regions still had positive sentiments towards elephants. According to expert opinions, strengthening of laws regarding land use facilitation and interlinking conservation values to socio-cultural aspects need urgent implementation in order to balance infrastructural development and protection of ecosystems by enhancing community participation. Communal crop guarding, chilly-dung and honeybee fencing, accompanied by tracking and maintaining an elephant locational database are suggested as the HEC mitigation methods with highest urgency.

Keywords: Asian elephant; human–elephant conflict (HEC); people’s sentiments; coexistence; HEC mitigation; policy instruments

1. Introduction

The endangered Asian elephants (Elephas maximus) currently survive in only around five percent of their original habitat range [1–3] surrounded by 20% of the world’s human population [4,5]. Deforestation has immensely degraded natural habitats, and less than 10% of the protected areas in the world are structurally connected [6,7], adversely affecting the dispersal of especially wide-ranging species and causing disruptions in the ecological processes. Elephants are drawn towards human-dominated landscapes to fulfil their basic requirements, such as food and water [8,9]. Such dispersal activities of elephants have often resulted in negative interactions with people that escalate to diverse forms of human-elephant conflict (HEC) such as crop raiding, house damage, or human death/injury from elephant attack [10–12]. Consequently, victims who bear these costs tend to opt for retaliatory responses which are often lethal and pose a significant threat to the survival of this large mammal [11,13,14].

Incidences of HEC have become more intricate to manage as they regularly affect these marginalized communities [15], especially in places where people are generally poor and often face food insecurity, with inadequate access to water, health care, education, and transportation in the developing nations [16]. Impoverished farmers often live on the forest fringes that provide a more diversified livelihood and access to resources such as arable...
land for cultivation and permanent water sources [17–19]. As crops are more nutritious and palatable than natural food [20], elephants are easily attracted towards crop fields leading to HEC. Crop raiding by elephants affects the livelihoods of predominantly marginalized farmer communities [21–23]. Although India hosts two-thirds of the global Asian elephant population [24–26], only 22% of them survive within protected areas and the rest are mostly spread out among multipurpose reserved forests scattered with human habitations, agricultural land, and transportation networks [22,27]. These overlapping regions demand sharing of resources between people and elephants, which tends to aggravate conflicts to such an extent that around 1400 people and over 300 elephants have been killed as a result of HEC from 2018 to 2020 [28], and on average 500,000 families were affected from crop raiding by elephants annually [29].

HEC management generally comprises a combination of short-term approaches, such as deterrence methods, physical barriers, early detection and warning systems, compensation schemes, and translocation of problematic elephants, along with long-term approaches, such as community awareness, adaptive land use planning, crop guarding, and patrolling [15,19,30,31]. Unfortunately, the resolution on long-term conflict mitigation is rare, as the underlying factors are multi-dimensional and deep-rooted [32,33]. Moreover, policies and laws that impact upon ecosystem service provisioning can, on the other hand, reduce communities’ access to natural resources, possibly further provoking antagonistic attitudes and jeopardizing the likelihood of coexistence with wildlife [15,34,35]. Thus, striking a balance between HEC management and the development of socioeconomic conditions of local people has proven to be difficult, making it challenging to gather community support for conserving this endangered species [36–38].

Nevertheless, socio-economic aspects such as attitudes of the community victimized by HEC not only influence the occurrence of HEC but also shape their sentiments towards conservation and coexistence with elephants [11,31,39,40]. For instance, women in India were equally affected by HEC as men [41], and women in Uganda [42] and Kenya [43] were less supportive of coexistence than men because of their higher involvement in agriculture, which was now being threatened by HEC. Therefore, the demographic circumstances of people who directly share space with the elephants have to be taken into account during HEC mitigation. Moreover, understanding the sentiments of communities that live with elephants is essential for assessing their willingness to coexist with elephants, which will ultimately help in developing HEC mitigation strategies and conservation management [38,44–46]. Recognizing these demographic variables will also help stakeholders (such as policy makers, conservationists) in the appraisal of the practicality/feasibility of implementing certain mitigation strategies or management plans in these regions.

The impact of elephant-induced damages, especially crop damage, will inevitably shape victim perception, predominantly among the local people whose main income comes from agriculture [46]. Thus, our objectives were to (i) evaluate the demographic situation and map people’s sentiments towards elephants in the HEC hotspot villages of the Keonjhar forest division and (ii) assess the most suitable policy instruments and rank the urgency of different mitigation strategies to be implemented for controlling conflict, based on the opinions of local key informants (such as forest staff/conservationists/activists/non-governmental organizations (NGOs). More than 500 villages distributed within the Keonjhar district of India were affected from 2000 to 2018, where nearly 4100 house damage incidents, 12,700 acres of cropland damage, and more than 300 human casualty incidents were recorded by the forest department. However, we especially focused on the 45 hotspot villages, where elephant-led crop damage was the most frequent type of HEC, and nearly 65,500 people were under high risk of HEC during 2013 and 2018 [47].
2. Materials and Methods

2.1. Study Area

The study was conducted in the Keonjhar forest division (Figure 1) in the state of Odisha in Eastern India, located between 21°1′ N–22°10′ N and 85°11′ E–86°22′ E and covers an area of approximately 6038 km². There are seven forest ranges in the study area: Barbil, Champua, Keonjhar, Bhui yan-Juang Pihra (BJP), Patna, Ghatgaon, and Telkoi. The majority of the tree species found in this district are dry deciduous and semi-evergreen, where the Sal tree (Shorea robusta) is the dominant species followed by some other tree species, such as Asan (Terminalia elliptica), Jamun (Syzygium cumini), Arjuna (Terminalia arjuna), Kusum (Schleichera oleosa), Kendu (Diospyros Melanoxylon), Mahua (Madhuca longifolia), and Mango (Mangifera indica) [48–50]. The Keonjhar forest division is rich in mineral resources such as iron, manganese, chromite, magnesite, and quartzite, mined at 133 different sites. There are five national highways and a rail link of 118 km, which facilitates transportation and communication. The study area supports 60 elephants within patchy forests; the northern part of the study area acts as an elephant pass across the neighbouring provinces [51], but its forest cover has declined by 18% from 2001 to 2018, mainly due to agriculture and human settlements followed by urbanization, mining activities, timber smuggling, and forest fires [52–54].

![Figure 1. Location of the study area in the Keonjhar forest division, eastern India. Green triangles indicate villages where telephone interviews were conducted.](image-url)

The Keonjhar district has a total population of around 1.8 million people with a population density of about 217 people/km² [55] (Census 2011), where 50.31% are males and 49.69% are females. The overall literacy rate is 68.24% and the literacy of males (78.12%) is higher than that of females (58.28%). Over 85% of the total human population lives in the rural regions, which are also home to around 55 tribal communities. Furthermore, among the 42.5% of people who worked for a living in the Keonjhar district, many (42.3%) were involved in marginal occupations such as working as cultivators (owner or co-owner) and agricultural labourers. This scenario indicates that the study area is lacking modern economic development, as most people are still rural and engaged in agriculture-based occupations for their livelihood over other forms of employment.
2.2. Data Collection

In a previous study, Tripathy et al. [47] had analyzed the spatial occurrence of conflict incidences between 2013 and 2018 and classified around 45 villages in this study area under the high-risk zone of HEC. These 45 villages had over 11,000 households with a total population of about 51,000 people (48% male; 52% female) [54]. The annual average of HEC incidences was around 55 cases per village; many of these incidences involved crop-raiding, followed by house damage. The highest number of people’s sentiment records were collected from the villages within the Champua and Keonjhar forest ranges because they were also more seriously exposed to conflict incidents. We collected demographic data from these 45 conflict-prone villages from the Keonjhar District Census Handbook (2011) which includes data on area, human population, number of households, castes, literates, workers, household industry workers, cultivators, and agricultural labourers as well as marginal cultivators and marginal agricultural labourers.

We augmented the data through telephone interviews with the village headmen, representatives from a few community centres, women welfare societies, labour welfare groups and youth clubs of these 45 HEC hotspot villages. This survey was conducted between 8th and 29th of September 2021, and each conversation lasted 7 to 10 min. Our main intention was to assess the sentiments of the interviewees towards elephants and their willingness for co-existence based on their past experiences with elephants. We requested the interviewees to express their opinion on elephants based on their HEC experiences, using one of the three responses: (a) a major issue, (b) a minor-moderate issue, or (c) not an issue and tried to categorize their sentiments towards elephants and willingness for co-existence as (a) positive or (b) negative.

Moreover, we created an online form to collect data on policy instruments (Supplementary File S1) and distributed it among key personnel such as forest staff (assistant forest conservators/rangers/guards), experts, scientists, professors, researchers, activists, and NGO representatives. We conducted an opinion poll of 36 key informants from the study area. The primary objective of this opinion poll was to review the most suitable policy instruments applicable for fostering socio-ecological resilience based on their experience with the landscape. We categorized the policy instruments into four classes based on the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2022, namely (1) strengthening of the environmental standards and legal regulations to improve socio-ecological resilience and environmental performance for the preservation of environmental functions and the wellbeing of the people sharing resources with elephants; (2) interpretation of human rights and community norms for conservation of ecosystems to fit the socio-ecological systems, management of natural resources, promotion of adaptive governance, and building resilience; (3) necessitation of a payment in return for using ecosystem services; (4) economic incentives to promote environment-friendly investments and; (5) direct incorporation of social and cultural components into conservation management practices. Furthermore, we also requested them to rank the approaches of HEC management based on their urgency, where all the possible mitigation methods were categorized into six classes: (1) habitat connectivity, management, and enrichment; (2) real time tracking and monitoring; (3) deterrents, repellents, and barriers; (4) early-warning systems; (5) ex-situ management; and (6) community strategies.

2.3. Data Analysis

We first examined the multicollinearity among all the demographic variables using variance inflation factors analysis (VIF; where VIF < 10 and \( p < 0.01 \)), during which the highly correlated variables were removed. Then a linear regression model was built to evaluate the significant variables and their underlying relationship with HEC incidences. The least significant variables were removed in a stepwise manner based on Akaike information criteria (AIC). We used ‘olsrr’ package in R [55], which eliminated the predictor variables with the lowest AIC value in each step until there were no variables with AIC values less than that of the model with the remaining variable.
People’s sentiments were assigned +1 or −1 based on their positive or negative responses towards elephants. In some telephone conversations, the interviewees’ answers/statements were too vague to assess their sentiments. In such instances, polarity classification approach [56,57] was used, where each sentence of the conversation was assigned a sentiment score (−1 or +1) in context to the polarity of the conversation [58]. Polarities were then categorized into positive, negative, and neutral, and finally summation of these scores provided the overall sentiment score for the whole conversation. These sentiments were plotted in ArcMap 10.5 using kernel density (KD), where a raster surface of 0.5 km cell size was built based on the polarity of the sentiments.

3. Results

3.1. Understanding People’s Demography and Sentiments

We found that around 56% of the residents were literate (58% male; 42% female) and nearly 45% of them engage in livelihood activities. Nearly 70% were involved in farming as their primary occupation, which included cultivators (34%) and agricultural labourers (36%) who worked year-round as well as marginal cultivators and marginal agricultural labourers who worked seasonally. Magnitude of coefficient estimate (Table 1) in stepwise backward regression analysis indicated their expected influence, where (+) or (−) signs determine their relationship with HEC occurrence. The attributes of the human population such as literates, cultivators, workers, and marginal agriculture labourers were significant predictors for HEC. Cultivator and marginal agricultural labourer were positively related with HEC incidences, whereas literacy and employment (worker) were found to be negatively associated.

Table 1. Demographic variables that are significantly associated with HEC occurrence, where * = p-value < 0.05, ** = p-value < 0.01, *** = p-value < 0.001.

| Variables                   | Coefficient Estimate | Standard Error |
|-----------------------------|----------------------|----------------|
| Intercept **                | 0.661                | 0.025          |
| Literacy *                  | −0.255               | 0.058          |
| Worker *                    | −0.161               | 0.008          |
| Cultivator ***              | 0.3934               | 0.016          |
| Marginal agricultural labourer ** | 0.085               | 0.065          |

We observed (Figure 2) that 78% of the villages from the conflict-prone regions had positive sentiments towards the elephants, and they had no objections to coexisting with them but only criticized the failures of the administration in controlling conflict occurrences. The majority of conflict-prone villages in the Champa forest region that primarily depend on cultivations had negative sentiments towards elephants. On the other hand, we found positive sentiments among most hotspot villages in the Keonjhar and Ghatgaon regions, where the percentage of employment and literacy were higher than those of the villages with negative sentiments. Overall, we observed positive sentiments in the regions where the percentage of employment and literacy were higher (Table 2). Meanwhile negative sentiments were observed where people were mostly active in agricultural activities and dependent on cultivation, and they were also not willing to share space with elephants and preferred them to be restricted to jungles.
Table 2. People’s sentiments classified by demographic categories within the forest ranges impacted by human-elephant conflict of the Keonjhar district.

| Forest Range | Sentiments | No. of Villages | Percentage out of Total Workers in the Forest Range | Literates |
|---------------|------------|----------------|-----------------------------------------------------|-----------|
|               |            |                | Cultivators | Agri. Labourers | Employees |          |
| Barbil        | positive   | 2              | 47         | 33             | 9         | 61       |
| Champua       | positive   | 8              | 36         | 31             | 22        | 57       |
|               | negative   | 5              | 47         | 28             | 19        | 51       |
| Keonjhar      | positive   | 11             | 31         | 23             | 36        | 63       |
|               | negative   | 3              | 37         | 29             | 28        | 49       |
| BJP           | positive   | 3              | 21         | 39             | 17        | 53       |
|               | negative   | 1              | 26         | 47             | 11        | 49       |
| Patna         | positive   | 3              | 35         | 32             | 20        | 57       |
|               | negative   | 2              | 41         | 40             | 12        | 55       |
| Ghatgaon      | positive   | 5              | 24         | 41             | 23        | 60       |
|               | negative   | 2              | 26         | 45             | 18        | 55       |

Figure 2. Map showing people’s sentiments towards elephants and coexisting with them in the human-elephant conflict hotspot regions, where green regions are showing people’s positive sentiments whereas red regions represent negative sentiments.

3.2. Expert Opinion on Policy Instruments and HEC Mitigation Strategies

Strengthening of the laws enacted to protect the environment was voted by 74% of the experts (Figure 3a) as the policy that needs to be most urgently implemented in the study area. Experts’ suggestions advocate for the articulation, reinforcement, and proper implementation of laws, Acts, standards, and legal certainty at different levels, which can help to substantially improve socio-ecological resilience and environmental performance, which are in turn essential for the sustainable development agenda as well as harmonious preservation of environmental functions. The policy that recommends payments for ecosystem services was voted by 68% of the experts as necessary to be implemented with urgency. Experts deemed that it is essential to necessitate a payment...
(in terms of taxes, charges, subsidies, and fiscal transfers) in return for using ecosystem services by reinforcing economic guidelines to change people’s attitudes and behaviours whilst using ecosystem services. As the third most voted policy instrument, 61% of experts conferred with the urgent need for implementing polices interlinking socio-cultural aspects with the ecosystem, for instance, by highlighting and demarcating sites of socio-cultural value as conservation regions for the better participation of local community and boosting conservation efforts.

Around 85% of the experts ranked (Figure 3b) deterrents, barriers, and communal crop guarding followed by real-time tracking and monitoring of elephant locations in the hotspot regions as the most urgent mitigation strategies that need to be immediately implemented to control HEC in this region.

![Figure 3. Experts’ opinions on (a) the most suitable policy instruments to manage human-elephant interaction by protecting the ecosystems and preserving the elephant range and (b) high priority human-elephant conflict mitigation strategies for the conflict-prone regions.]

4. Discussion
4.1. A Context to People’s Demography and Sentiments in the HEC Hotspots

Our results highlighted that occupations related to agriculture were positively associated with HEC and was the primary livelihood among the inhabitants of the conflict-prone villages. Particularly, forest fringe villages with their social challenges such as poverty, inequality, and under nutrition are more vulnerable to HEC as they are heavily dependent on the forest and agriculture [4]. On the other hand, crops easily attract elephants, due to their palatability and higher nutrition availability over natural food [10,20], and elephants raid crops ignoring the high risk associated with this foraging behaviour [20,27]. As a result, elephant interaction with the human society was frequent in these hotspot regions which is a combination of forest cover and cropland [47,52,59,60]. Notably, agricultural activities and literacy are interlinked to some extent, as people having only a basic education or lower educational levels were very actively involved in cultivation and worked as agricultural labourers. This indicates the prominence of agricultural activities in the HEC hotspot regions where croplands, especially paddy fields [47,52,59,60], were the dominant land use type. As a result, people involved in agricultural practices will actively participate in resolving HEC, because persistent damage caused by elephants can turn into a potential barrier for their livelihood by deterring them from agricultural production. Furthermore, literacy levels will reasonably determine people’s consciousness towards their environment and also their willingness for coexistence with elephants, as they can understand the importance of conservation and better comprehend the problem [29,57,58].
Despite widespread costs of HEC, including its hidden impacts such as fear for personal safety, cost of crop guarding, or dealing with the aftereffects of HEC damages, people still have positive attitudes towards elephants and willingness for coexistence, which is contrary to the outcomes of other studies where feelings of helplessness and resentment towards the animals were observed, post human-wildlife conflict [16,61–63]. This may be closely related to religious traditions and mythologies, and also because elephants are sometimes revered as sacred animals and deities, especially in the Southeast Asian countries. Some of the interview respondents stated that they had come to know how the Asian elephant was a protected animal and how their suitable habitats were being reduced, through various educational and public awareness programs conducted by the forest department. In addition, the compensation scheme continues to help retain people’s tolerance and lenience towards elephants by reimbursing the monetary costs of those affected by HEC [64,65].

We noticed that many of the respondents in the conflict-prone regions are enthusiastic about conflict management, and some of them have even taken charge of protecting their nearby jungles voluntarily with the support of the forest department. They are habituated with the seasonal elephant movement in their locality and are accustomed to driving away elephants by mass howling, although it is an ineffective method in the long run [66]. Although less in number, a few respondents had claimed that the presence of elephants in their locality is a periodic concern rather than a major one that would hinder improvements to their quality of life. Due to the damages caused by elephants and as it was a matter which impacted their personal safety, few villagers were more inclined towards elephant deterrence and restricting them within forests, over coexistence. Moreover, there was a lack of interest among villagers to invest their time, energy, and money in conservation, when sharing space with elephants did not translate into anything beneficial for them, which is indicative of people’s willingness to coexist on the condition of socio-economic benefits.

4.2. Suitable Policy Instruments and Mitigation Strategies

In the Keonjhar district, the rate of increase in mining activities (4% on average, annually) from 1989 to 2016 is one of the factors contributing to the loss of 13.7% of the forest cover, followed by an increase in human settlements (3.8%), and an expansion of agricultural land (2.7%) [53]. Derivation of diverse benefits from the environment in terms of mining, industry, agricultural productivity, or timber for short-term financial gain has not only exploited the elephant habitat range but also affected their food availability and altered their dietary preference to crops. Thus, most experts had voted for enactment and strengthening of relevant laws and regulations at different stages of such land use facilitation for urgent implementation. Also, implementation of the concept of paying for ecosystem services, while not aimed at commodification of natural resources, will foster a sense of value and responsibility among people during consumption of natural resources. These policies can help to bring about a balance between infrastructural development and protection of ecosystems. More importantly, it will facilitate preservation of the elephant range along with uplifting the local peoples’ economic wellbeing by allowing them to utilize the land productively as their frequent use of goods and services from the forest makes their livelihood inseparable from it.

Installing barriers (such as bee hives or chilly-cow dung fences) along with community crop guarding were preferred as the most urgent HEC mitigation strategies for the HEC hotspot regions, which are also proven evidence-based methods for controlling HEC [30,66–69]. In the case of other barriers such as electric fences, however, the poorest or underprivileged members of the community are incapable of investing in such expensive mechanisms or maintaining them effectively [4,70]. Production of marketable commodities such as honey as a by-product of deterrence [30,69,71] has shown to support community livelihood and motivate tolerance of elephants [19], whereas schemes that compensate the losses incurred by subsistent rural communities and farmers have been met with difficulties [19,31,65,67]. Real-time tracking and monitoring of elephants was also a popular
suggestion by the experts. Equipment such as GPS collars makes it possible to monitor daily movement activities of elephants, which means that if any elephant has been distracted out of a forest range or is injured or trapped, the forest department can react in a timely manner to assist and chase these elephants back to the jungle, helping to minimize negative interactions with human society. Research can also be directed towards assessing elephants’ movement patterns, factors influencing their presence, elephant population demographics, and inter-species interactions for the conservation of these species.

5. Conclusions

Demographic analyses indicated that cultivation and marginal agriculture were positively related with HEC incidences, whereas literacy and employment were negatively associated. We found that 78% of the respondents in the HEC hotspot regions had positive sentiments and were willing to coexist with elephants, which shows great prospects for conserving this endangered species. People’s support for coexistence with elephants in the HEC hotspot zones, through their continued collaboration, will endorse conservation of this endangered species. This study will help stakeholders to understand the local sentiments towards elephants and coexistence with respect to people’s socio-economic context and to come up with adaptive management strategies that will encourage the necessary community participation that is expected for a sustainable solution.

Further research is required in this direction to develop mitigation strategies considering the socio-economic conditions of the people to ensure that the proposed methods are affordable for implementation by local standards, and their regular maintenance will not add an additional strain on the already existing economic burdens of these impoverished communities. The mitigation strategies suggested by the experts should be routinely assessed for their efficacy and deliverability of expected results, over a significant period, and it will also be useful to evaluate their socio-economic impacts on the local community. Following the experts’ suggestions, conservation values can be tied up with the socio-cultural aspects of the locality by demarcating conservation areas encompassing sacred sites which already serve as cultural emblems to the local people in order to facilitate execution of these management approaches among villagers in a more relatable manner. Also, promoting ecotourism in places of cultural significance will not only enhance community involvement but also create remuneration opportunities for the local residents. Additionally, as villagers were interested in the economic incentives of sharing space with elephants, conservation efforts should be coupled with opportunities for economic gain through community-based programs aimed at improving their quality of life, in order to increase their tolerance and change their perceptions towards elephants. Simultaneously, since people are an integral part of HEC, it is very important to convince the local community that their expectations and concerns are being integrated into the HEC mitigation strategy for effective conflict management.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/d14050311/s1, File S1: Expert opinion questionnaire.

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