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Human-Elephant Conflict and Its Consequences: A Preliminary Appraisal and Way Forward

V.K. Bhagat, D.K. Yadav and M.K. Jhariya*
Department of Farm Forestry, Sarguja University, Ambikapur-497001 (C.G.), INDIA
***Email:** manu9589@gmail.com

ABSTRACT
Human-elephant conflict (HEC) and its consequences are a burning issue in corridors of northern Chhattisgarh. Although the region has lost a lot of property and human lives, we do not have proper estimate of the damage. The study endeavored to assess the outcomes of HEC on socio-economic vulnerability in Jashpur district (Chhattisgarh, India). To get a preliminary data, study was carried out with particular emphasis on incidents relating to conflict. Local people including victims of conflict were interviewed through well structured questionnaires. The data was recorded through primary and secondary sources. Studies have recorded 11 human and 04 elephant deaths, damage to 196 houses and total 718 acre of crops. In the study, it was observed that human deaths or injuries occurred during crop raiding by elephants and killing of elephant's occurred mostly due to poisoning, electrocution or other means. Increasing human pressure on forested areas accelerated HEC incidences. This necessitated a detailed assessment of habitat suitability and dispersal corridor for elephants in the area with management implications.
Keywords: *Conflicts, corridors, crop damage, HEC, habitat, questionnaire*

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INTRODUCTION

Due to marvelous anthropogenic pressure, forest patches have experienced substantial degradation. Unplanned developmental and illegal activities within and proximity of elephant corridor are barricading the free movement of elephants and are chief drivers of the HEC [1-2]. Currently, HEC has become a serious matter of concern and arise as a foremost dispute towards socio-economic significance and conservation perspectives [1, 3-6]. India holds by far the prevalent number of wild Asian elephants (*Elephas Maximus*), estimated about 26000-28000 (nearly 60%) of the total population [7]. Elephants were known to coincide with humans for long times but then there were fewer humans and more land and therefore, more carrying capacity of habitats for elephants. Conflicts in past also existed due to agricultural damage and other incidence [8].

HEC is a symptom of inappropriate land-use practices such as permanent human settlements and growing food crops adjacent to elephant habitations [9-11]. Loss or fragmentation of habitat and blocked traditional routes restrict elephants' access to food, water etc., and they compensate for this loss by eating crops and stored grain [12]. Elephants are progressively caught in the pincer grip of habitat loss/fragmentation and reprisal caused by increasing conflict. Diversion of forests into agriculture, fragmentation, settlements, shrinkage and degradation has resulted in increased HEC [13-14]. Elephants, in search of food and water tend to enter into human habitations and in the process, often come into direct conflicts [3-5, 15].

Conservation and restoration of corridors are an important aspect of reducing the negative effects of habitat fragmentation [3-5, 16-17]. Corridors are narrow strips of forests connecting two larger forest areas and in that way enabling movement and dispersal of wildlife between these patches [18]. Northern Chhattisgarh in central India has been home of Asian elephants since historical times, however, in the early 20th century they gradually extinct locally. Since then, HEC has been increasing due to straying of migratory elephants in the state [1, 3-5, 14]. Major reason for prolonged stay of elephants in the Chhattisgarh state may be due to better forest cover (44%), heavy mining, habitat degradation and deforestation in the neighboring states of Jharkhand and Orissa [1, 3-5, 14, 19]. The Jashpur division is

primarily inhabited by tribal communities which are largely dependent on agriculture and forest produces. Any incidence of HEC directly interfere the socioeconomic status and livelihood of the people, posing challenges for conservation. Therefore, this paper deals with the various aspects of HEC, their consequences, valuation and possible solution along with the conservation and management implication in this region.

MATERIAL AND METHODS

Study Sites

The study on Human-Elephant Conflict was carried out at four blocks of Jashpur district *viz.*, Bagicha, Kunkuri, Duldula and Farsabahar, respectively. District Jashpur is lying under northern hill zone of Chhattisgarh (between 22° 17" and 23° 15" North latitude and 83° 30" and 84° 24" East longitude) having abundance of natural resources and biodiversity. More than 35% area is covered under forest with various floral and faunal diversity. A gradient of variation is observed in the district in regards to topography, soil structure soil type, rainfall pattern, vegetation, cropping pattern, fertility etc. Jashpur district is divided in two parts as per the geographical point of views, the hilly belt (northern part), called Upperghat and southern part is called Nichghat. The Upperghat is an extension plateau covering 1384 sq kms, which is about 1200 meters above sea level and is covered with dense forest [20]. The elevated plateau called "Pat" Nichghat is plane in general, but it also having many big mountains. Kunkuri is the hottest region in Nichghat during summer and Pandrapat is the coldest region in upper ghat in winter. The flora of Nazzul and other areas are changing frequently with the human activities and land-use. Climate, soil and biotic factors are the functions of natural vegetation.

Experimental Details

The study area was surveyed in depth during the year 2015-2016. The entire frame of the study is categorically built on rigorous field investigation and observation in consultation with forest department and the local residents. The field study was conducted in the affected villages/forest fringe areas of corridors where migrated elephants were encountered. After preliminary survey of the HEC affected areas, collection of information from the households (10% of the total households of the villages) was done by informal interviews, questionnaire method, participatory rural appraisal and personal observations [21]. Incidents relating to conflict such as crop damage, house damage, human death and injury, elephant death, cause of all such conflicts were observed. In order to collect the exact information victims of HEC were concerned from each village in each block. Victims were identified after preliminary survey followed by discussion with residing people. Then they were interviewed and the conversation followed documentation [1, 3-5]. Primary source of data included extensive field investigations in HEC areas by some specific questions such as existing problems, elephant behaviour, their movement, crop fed, species preferred, elephant entry track, their stay in the region, exit track etc. The records whatsoever available on HEC of forest department were also taken into consideration during analysis. Data collected on various aspects of HEC from different blocks were compiled and analyzed after getting opinion and expression of the respondents.

RESULTS AND DISCUSSION

Socio-Economic Profile

Jashpur district of Chhattisgarh is mainly inhabited by different tribal communities whose main occupation is agriculture in addition to collection of forest products. Out of the total households interviewed nearly 87% respondents were male while remaining were female. Majority of the respondents (48.75%) belongs to middle age group (36-55 years), followed by 38.75% young age group (up to 35 years), whereas 12.5% respondents belongs to old age group (>55 years). The family size in the study sites comprised 55% large family (>5 members) and 45.0% small family (up to 5 members). During the field study it was found that about 35% of respondents had primary to middle school education, followed by 23.75% which had higher secondary and above education, 18.75% had gained high school education, while 22.5% were found to be illiterate.

Source of Income

During the study it was found that the foremost source of income was farming. Besides farming, they also earn from additional creativities such as NTFPs collection (67.5%), livestock rearing (37.5%), employed (16%), business (5%) as well as wage labors (Table 1). It was found that agriculture and livestock rearing in study area is not practiced scientifically or commercially but only for household consumption. Hence, any damage to crops by elephant raid had direct concern on the livelihood of the farmers.

Table 1 Source of income (respondents) in the study area

Source of income	Contribution (in %)
Agriculture	98.50
NTFP collection	67.50
Livestock	37.50
Employed	16.00
Hunting	12.00
Business	5.00

Major Crops Grown

Paddy (97%) and Maize (45%) are the major crops grown in study site, while the other crops grown are ground nut, red gram, sesame, black gram etc. (Table 2).

Table 2 Major crops grown in the study area

Major Crop Grown	(%)
Paddy	97.00
Maize	45.00
Ground nut	37.50
Red gram	37.50
Black gram	21.25
Sesame	13.50

Land Holding and Land Use Pattern

It was found that 11.25% respondents have more than 10 acre of land. While 21.25% respondents have 5-10 acre net cultivated area and 42.50% have less than 5 acre under uncultivated land (table 3).

Table 3 Land holding and land use pattern in the study area

Land - Total Area (Acre)	(%)
0 -5	66.25
5-10	22.50
<10	11.25
Net cultivated	
0 -5	67.50
5-10	21.25
<10	11.25
Uncultivated	
0 -5	42.50
5-10	0.00
<10	0.00
Fallow Land	
0 -5	28.27
5-10	0.00
<10	0.00
Irrigated Area	
0 -5	41.25
5-10	0.00
<10	0.00

Source of Irrigation

Majority of the people depend upon rain (51.25%) as a source of irrigation for farming, while the other sources are shown in table 4.

Table 4 Source of irrigation in the study area

Source of irrigation	(%)
No available (Rain fed)	51.25
Well	38.75
Tube well	18.75
River	16.00
Others	12.00

Farm Assets

Most of the respondents have their own land (98.75%) & other farm assets are shown in as below (table 5):

Table 5 Farm assets holding of respondents in the study area

Farm assets	(%)
Land	98.75
Katcha house	95.00
Plough	91.25
Animals	77.50
Cattle shed	60.00
Cows	57.50
Well	38.75
Electronic motor	28.75
Tube well	18.75
Farm shed	13.75
Buffaloes	7.50
Pakka house	5.00

Elephant Overview and Incidence Scenario

Elephant arrival time

A distinct pattern of arrival can be seen in the studied corridors where the frequency increases during the monsoon season. The availability of food source to the animal is mainly from the agriculture field. It was found that the elephants were usually seen in the evening and the number of adults in a herd ranged from 2-40 and calf from 0-8 (Table 6).

Table 6 Identification of Elephant and Elephant Damage Incidents

Query	Response	Percentage/Range
Do you know that long ago wild elephants were widely distributed in the forests of C.G.	Yes	100.00
Source of information	Grandparents	58.75
	Self	45.00
Have seen an elephant	Yes	95.00
	No	5.00
Location of sighted wild elephant	Neighboring forest	40.00
	Outside forests	60.00
Activity of sighted wild elephant	Feeding	30.00
	Standing	22.50
	Walking	39.25
	Damaging property	8.75
Number of sighted wild elephants	Loner	43.75
	Pair	30.00
	Herd	26.25
Before observing wild elephant causing property damage your opinion about wild elephant	God	67.50
	Beautiful Creature	10.00
	Dangerous Animal	22.50
Are you satisfied with the present compensation	Yes	33.75
scheme in relation to	No	66.25
Are you satisfied with present steps undertaken by	Yes	33.75
forest department to reduce conflict	No	66.25

Place	Forest	5.00
	Non forest	95.00
Which elephant sighted	Loner	43.75
	Pair	30.00
	Herd	26.25
If loner then	Tusker	17.50
	Tusk less	21.25
If pair then	Tusker	12.50
	Tusk less	23.75
No. of Adult elephant sighted		0-40
No. of Calf elephant sighted		0-8
Elephant arrival time	Morning	12.50
	Day time	0.00
	Eveninig	16.25
	Night	71.25
	No fixed timing	0.00
Local mitigation measures used	Torches	73.75
	Banging tins & drums	45.00
	Fence	22.00
	Throwing stones	0.00
	Night guarding on guard house	35.00
	Chili	63.00
	Firecrackers	87.00
House damages		196
Human injury		14
Major crop damage area in acre	Paddy	88.00
	Maize	41.25
	Groundnut	41.25
	Pigeon pea	23.75
	Black gram	15.00

House and Crop Damage

The information collected during the study from various sources revealed that nearly 196 houses and total 718 acre of crops were damaged by elephant in different seasons during the study period (2015-2016). The crops damaged by elephants mainly constituted paddy (88%) and maize (41.25%), respectively. This is also due to the fact that the main crop grown in this region are paddy and maize besides black gram, groundnut, millets etc. as can be seen with the land use pattern and these are preferred crops by the elephants.

Human Death

A total of 46 human death occurred as a result of HEC during 2011-2016 recorded by Forest Department of Jashpur. While, during the study period (2015-16) a sum of 11 human (08 male & 03 female) death and 14 human injuries were observed. An analysis of intensity of conflict over a period of 05 years showed that the maximum number of human death was occurred in 2011-2012.

Elephant Death

There is dearth of information regarding elephant deaths. Secondary data collected from the local newspaper reveals that 04 adult elephants were dead during the study period.

Attitude and Perceptions of People towards Elephant

The elephant is highly respected and worshiped among the people as it is a culturally important species and having a spiritual prestige. It was found that 67.5% of the respondents respect the animal as a religious figure and pray, although at the same time 22.2% fear from the animal. Though, most of the respondents have referred to the animal as a religious figure but at the same time they also seemed a little bit frustrated with the problems of HEC.

Mitigation measures

Most common mitigation measures used by the people to keep away elephants are the torches (73.45%), firecrackers (87.5), chilli (63.25), rattling tins and drums (45%), defending crops nighttime on guard houses (35.75%), fences (22.50%) etc. The most effective as said by the respondents are use of torches, shouting, banging tins and drums and use of chili (*Mirch mashals*). However, these methods are only effective if used in combination depending upon the size of herds. More the number of people the more effective they are and the use of an individual method are not known to be effective.

Compensation

The study included few aspects to know how the people felt about compensation that experience loss directly. Most of the respondents (66.25%) felt that compensation was necessary for those who had experienced crop and property damages. However, 33.75% of the respondents felt that compensation should be awarded only in cases of severe damage. The compensation provided by forest department of Jashpur on different incidents *viz*., house, animal, crop damage etc. is presented in table 7.

Table 7 Compensation provided by Jashpur forest department (2011- March, 2016)

Year	Compensation Amount (Rs.)							
	No. of Incidence	Human death	No. of Incidence	Human Damage	No. of Incidence	House Damage	No. of Incidence	Crop Damage
2011-12	15	2805000.00	17	122798.00	263	314481.00	4632	5076868.00
2012-13	5	800000.00	7	71958.00	168	415084.00	2815	2913735.00
2013-14	9	1800000.00	20	164343.00	206	587105.00	2903	5086375.00
2014-15	4	1100000.00	6	66091.00	165	563900.00	3328	5394852.00
2015-16 March, 2016	13	5100000.00	20	263794.00	782	6546245.00	4326	11091349.00

In the study it was found that 48.75% household belongs to joint family while 51.25% were nuclear family. Majority of respondents had small size of land holding. Similarly, Pal [22] reported that the division of land generation after generation resulted in nuclear families in community, marginal and small size of land holding. The main source of occupation in this region is farming. Likewise, Geetha and Devi [23] were found that agriculture being the prevailing foremost profession and back bone of the economy for most of the households in their study sites. Equally, farming and associated activities being chief source of livelihood of the households, the possession of minimal farm implements is requisite [24]. The families engaged in wage labour, business, service, traditional occupation and other activities as their main occupation were also doing agriculture as their supplementary profession [22]. NTFP (Non-Timber Forest Produce) ranks second (67.50%) source of income followed by livestock rearing (37.50%) occupation after farming in the study area. Holding good number of livestock could be attributed to the fact that livestock rearing was the most preferred secondary occupation [22]. Livestock support agriculture and allied activities besides providing nutritional, social, economic, religious and recreational benefits to the people [25]. Low agricultural production due to lack of irrigation facilities, scientific know-how, improved equipment and machinery, mono-cropping system, low fertility of land and erratic climatic condition accrue paltry income to the farmers [26]. Similarly, majority of the wage labourers are unskilled, they are not getting consistent income due to irregular employment and underpayment [27]. The low housing status (95.0% katcha house) in the study area could be attributed to low socioeconomic condition, poverty, lack of infrastructure, rural environment etc. [28]. The findings on HEC of present study were well comparable with HEC affected regions of India and other parts of the world (Table 8).

Table 8 Comparative account of Human-Elephant Conflict in certain regions

Study area	Nature of HEC						Reference
	Crop	House	Human	Elephant	Animal	Other	
Corridors of Northern C.G., Jashpur, India	718 acre	196	11 (8- Male & 3 Female	04	05	14 Human Injury	Present Study
Assam, India	1590 bigha Paddy	735	84	30	157	7 School 16 Shop	[2]
Northern Lakhimpur, Assam, India	175 acre	-	10	-	34		[6]
Bangalooru, India	468.67(km^2)	-	10		-	-	[29]
Odisha, India	7297 acre	398	36	37		87 Human Injury	[30]
Chennai, India	2084 acre	-	31	33	-	-	[31]
Eastern Nepal		-	66	22	-	-	[32]
Assam, India	61-100 acre	-	-	119-204	-	-	[33]
Southern Bhutan	114 acre	-	-	-	-	-	[34]
Northern C.G., India	939.02 acre	112	3	4	-	12 human Injury	[5]
Coimbatore, India	300 acre	-	13	-	-	-	[35]
India (Total estimates)	8,00,000 - 10,00,000 ha	10,000 - 15,000	-	-	-	-	[36]

Degradation of forest areas due to increasing human pressure tend towards HEC. When the interactions between elephants and human beings become very close certainly there would be a conflict between man and elephant. Elephants cause crop damage and attacks people which lead to severe injuries and ultimately to death. Besides this elephants also damage to human and properties. Crop (718.0 acres) and house (196 Nos.) damage by elephants was reported to be main consequence of HEC in the study site. Likewise, house damage and human injury are due to the habitation in forest fringe areas and availability of palatable tree species nearby their homestead, farm lands etc. and the tribals of this region store the rice, wheat and local made liqueur (mahua wine, rice bear, tadi, sulfi, hadiya etc.) in house which attracts the elephant as a result of which severe incidences takes place [1, 3-5]. Fernando and Pastorini [37] found that the HEC as the main threat to Asian elephants, while Fernando *et al*. [11] describe crop raiding as the primary reason for HEC. Therefore, many workers identified Asian elephant as a serious agricultural pest [38-39]. Cost of human-wildlife conflicts is of three types: direct, indirect and opportunity costs [9, 40]. Direct cost which is of serious concern is imposed by crop, property and life damages and investment on capital and raw materials. Subsistence farmers may require direct compensation for survival but the amount compensated should not be the full amount lost, as this may encourage complacency. This can be expressed as annual income loss as a result of HEC [41]. In order to impose economic losses by HEC government provides monetary compensations to the victims. Compensation is generally a non-preventive mitigation measure that does not reduce the HEC [9]. Nevertheless, this scheme has come under severe criticism as compensation payments are often too meagre, delayed and the procedures to avail of these compensations are time-consuming.

Outlook towards Protection, Conservation and Management Perspectives

Elephas maximus (The Asian elephant) is listed as an endangered species under Schedule-I of Indian Wildlife Protection Act (1972), which permits high protection and conservation priority by Indian law. Precisely, the significance of the elephant in Indian culture and mythology, as well as its economic role etc., has contributed to a remarkable tolerance level and support of people towards its survival and conservation [42]. Therefore, it has very high conservation value regarded as key stone species [43], flagship species [44] and heritage species [45], Umbrella species [46]. Moreover, they have ecological significance and known as mega-gardeners of the forest as they prune the trees as they feed, disperse countless amount of seeds in their droppings and each produces on average a tonne of manure weekly which fertilises the forest and increases its productivity. HEC is mainly arising along the forest fringes nearby their habitats. Human settlement expansion into elephant ranges as well as increasing elephant populations within confined areas has led to heightened levels of HEC.

There is no solitary effective solution in this regard and its need to be integrated different approaches to address HEC. Lack of a robust policy also leads to an inordinate focus on the symptoms rather than the causes of the problem. With the increase in population and land use changes resulting in further conversion of elephant habitat into agricultural land, there would not be an end to the problem of HEC.

The encroachment of its natural habitat and conversion to settlement is of primary concern which results in conflict. A participatory approach on the basis of the forest's need and existing pattern is essential which needs to be adapted to check the problem of HEC. Establishing good communication network along with awareness programmes involving local people, forest dwellers and forest department [1, 3-5]. Some suggestions are forwarded to mitigate the problem of HEC in the study region which includes: facilitate food, shelter and water source to the elephants, proper emphasis should be given to develop a more variable and feasible dense forest cover, open up the elephant corridors for free movement of elephants, alternatives should be given to the livelihood of the affected villages, proper zonation of corridors can be created, incorporation of unpalatable crops like chilly, citrus and tobacco, etc in cropping systems along with live fencing, local people along with forest officials should be imparted proper training by the experts, so that they can drive away the elephants using proper scientific methods.

In northern parts of Chhattisgarh, elephant corridors are being blocked due to the excessive pressure from deforestation, illicit felling, poaching, land use change, fragmentation, infrastructure development, expanding farming activities as well as illegal encroachment. Forest department is taking several initiatives which include awareness among the local people, *Haathi Sahayata Kendras*, workshops, seminars, trainings, compensations etc. [1, 3-5]. The current approach dealing with conflict predisposed to failure because of inappropriate application of methods, lack of involvement of local people, lack of monitoring of conflict and conflict mitigation measures and inadequate understanding of elephant ecology [10]. Therefore, it is desirable to increase awareness and the adoption of effective and sustainable mitigation tactics. Improving villager tolerance towards elephant is the only way to ensure the long-term survival of wildlife populations and to establish kind interactions between people and wildlife. There is need for the rational design for the effective preventive and control measures of HEC in corridors or its surrounding areas along with a vibrant policy and strategic planning to resolve HEC and elephant conservation.

CONCLUSION

In a region where conservation and the socioeconomic needs of the rural people have equal priority growing conflicts are impacting efforts to both people's livelihoods and wildlife conservation. Increase in population and land use changes resulted further transformation of elephant habitat into non-forest land, agricultural land, there would not be an end to the problem. The more frequent role of elephants as crop raider recently has lead to their increased media coverage and has lead more people to perceive this animal as a rogue and fear it rather than respect it as God. Although the responses from the present investigation showed that the positive attitude towards the animal is still strong, the conflict is increasing rapidly in corridors and could reverse the present situation. Increased conflict incidents and most people being victims of damage, the negative attitude could take with the passing of time. When attacks by elephants on humans occurs the victim families demand compensation from the forest department. However, in some cases the question arises about illegal activities of victim families. As a result, most of the victim families fail to achieve compensation because of their forest related illegal activities. Economic incentives given to people to increase their tolerance, such insurance schemes, performance payments would be important components of future conservation strategies for conflict species. The present study will be useful for the government and non-government bodies, conservationist for the improvement of corridors and livelihood of the tribal.

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