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Human-Elephant interactions and associated damage in the northern transboundary areas of Bangladesh

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Abstract

We have studied human-elephant interactions in the northern transboundary of Bangladesh and estimated the scale of associated damage due to the negative interaction by visiting conflict area, performing focus group discussions key informant interviews and using secondary data sources. Around 70-80 non-resident elephants regularly intruded to the study area through the international border fence using several trespassing points and engaged in conflicts with frontier villagers. We discussed the nature and scale of conflict and the financial losses due to the conflict. Besides severe casualties in both ends, the enumerated economic loss was USD 1,171, 665 in 2013 and 2014 due to the damage to cropland, houses and properties, trees and orchards. We have identified major human-elephant conflict (HEC) zones adjacent to the border fence through spatial analysis with different level of intensity. Appropriate human-elephant conflict mitigation measures such as habitat improvement and management, monitoring of elephant population, alternative income generation, awareness programs for the local people and working together with India regarding this issue is a timely and urgent need for Bangladesh.

Key words: Non-resident **e**lephant, human-elephant conflict, raiding, damage, economic assessment

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Introduction

Asian-elephants (*Elephas maximus*) are Critically Endangered in Bangladesh (IUCN Bangladesh, 2015). Approximately a population of 210 to 330 resident elephants exist with 79 to 107 non-resident individuals in the country (IUCN Bangladesh, 2016). In the north-east, non-resident elephants occur in Kurigram, Sherpur, Netrokona, Jamalpur and Moulvibazar districts overlapping with neighboring Meghalaya and Assam states of India (IUCN Bangladesh, 2004). The presence of non-resident elephants in Bangladesh coincides principally with paddy harvesting seasons, i.e., February-May and September-December (Islam *et al.*, 2011). The northern districts of Sherpur and Jamalpur are predominantly plain lands where paddy is cultivated as the staple crop, apart from border-adjacent hilly areas. These bordered areas are known to support a fraction of non-resident elephants coming from neighboring Indian state of Meghalaya. Most of these hilly areas across Bangladesh border have forest remnants, often scattered bushes and social forestry plots where illegal encroachment, over-exploitation of resources and cattle grazing are common. As a result, these areas have experienced severe human-elephant conflict (HEC) over recent past.

A number of studies was carried out on status and distribution (Islam *et al.,* 2006; Islam *et al.,* 2011), human-elephant conflict issues

(Aziz, 2002; Aziz *et al.*, 2005; Shamsuddoha and Aziz, 2014; Shamsuddoha, 2015; Aziz *et al.*, 2016), conservation management (Motaleb et al., 2011; Islam *et al.*, 2011) and human attitude towards elephant conservation (Sarker and Roskaft, 2010) in Bangladesh. Efforts are underway for mitigating HEC in these areas by conservation and management agencies, but there is a dearth of comprehensive spatial and temporal HEC information, a crucial element in developing improved mitigation measures. To supplement this shortcoming, we investigated current status of elephants, food and feeding behavior, economic assessment of loss due to HEC, with particular focus on identifying major HEC zones in Sherpur and Jamalpur districts.

Materials and Methods

Study area

The study area compromises of four adjacent administrative upazillas (mid-level administrative unit), three (Sreebordi, Jhenaigati and Nalitabari) from Sherpur district and one (Bakshiganj) from Jamalpur district. We selected two unions (lower level administrative unit) from Sreebordi (Shinga Boruna and Ranishimul), two from Jhenaigati (Kangsha Dhansail and Nolkura Gauripur), two from Nalitabari (Ramchandrakura Mandaila and Nunni Poragao) and one from Bakshigonj (Dhanua) (Fig. 1). These areas are bounded by Meghalaya state of India to the north, Mymensingh and Jamalpur districts to the south, Mymensingh district to the east and Jamalpur district to the west. We selected 54 bordered villages for this study from four upazillas based on geographical location and previous HEC incidents. Most of southern parts of the study areas are human dominated landscapes while remnant and degraded forest patches exist to the northern parts near the border. The area is located in the tropical monsoon region and its climate is characterized by high temperature (with mean of 27°C), heavy rainfall (approximately 2,000-2,500 mm), often excessive humidity (average 75%) and fairly marked seasonal variations. The topography of this low hilly area is very rugged and irregular with series of ridges and the landscape is steep and soils were mainly developed on steep slopes. The forest is dominated by Sal (*Shorea robusta*) with admixture of many tropical semi-evergreen and tropical deciduous trees, occurring in association with bamboo jungles and bushes. In the plain land, the Bengali Muslim and Hindu, and several ethnic communities (such as *Garo*, *Hazong*, *Hodi*, *Mandi* and *Koch*) live in these areas with the overall density of about 803 per km^2 (BBS, 2011). Agriculture (70%) and commerce (10%) are the main sources of income and remaining comes from a variety of livelihood activities (BBS, 2011). Besides, the major cultivated crop is the rice (with three principal varieties: *Aman*, *Boro* and *Aus*) including various kinds of timber plants, vegetables, fruits and spices.

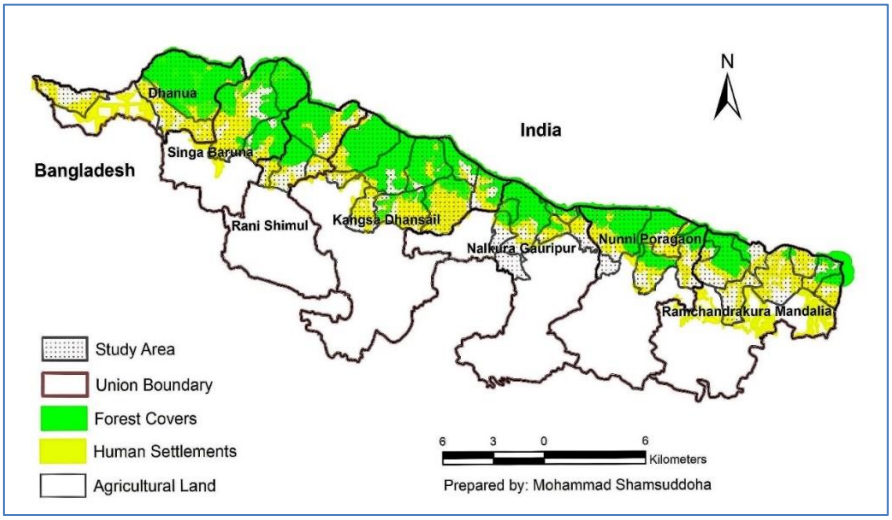

Figure 1. Study area of Jamalpur and Sherpur districts in northern Bangladesh.

Data collection

Several data collection methods were followed for this study, such as transect, conflict area visit, focus group discussion (FGD), key informant interview and use of secondary data sources. We conducted 25 FGDs with a total of 376 participants and interviewed 94 key informants by using semi-structured questionnaire from 54 villages covering all four *upazillas* (mid-level administrative units) and seven unions (lower level administrative units). Major issues covered in FGDs and interviews included HEC localities, intensity, elephant movement areas, damage of crops and houses, livestock loss, injuries and death of both humans and elephants. For assessing damage and economic loss, the collected data reflects the local market price with relevant accessary costs and the value of estimated loss. In particular, for crop damage, we recorded the portion of damaged area, then calculated crop price with ancillary costs; for house damage, we considered price of raw materials and construction costs; for tree damage, we assessed matured tree value with plantation and maintenance cost (Sukumar, 1989). We have collected our data from the field between 2013 and 2014. We used Garmin eTrex Global Positioning System (GPS) to record elephant movement areas, point data for HEC areas and incidents. GPS collected data was imported on to the Geographic Information System in ArcGIS 10.3.1 and Google Earth to delineate major HEC zones. In ArcGIS, point density tool was used to make major HEC zones from point data of HEC incidents. Microsoft excel software was used for data analysis.

Results and discussion

We have estimated 70-80 non-resident elephants, which trespass to Sherpur and Jamalpur districts in Bangladesh coming down from Meghalaya states of India especially during three main crop seasons. However, previous studies estimated the elephant population of 60-70 (IUCN Bangladesh, 2004), 40-45 (Islam, 2006) and more than 60 (Islam *et al.*, 2011). In 2008-2009, Wildlife Trust of Bangladesh and Zoo Outreach Organization, India, also reported 100-120 elephants in Nalitabari of Sherpur districts. Our observation and previous reports suggest that elephants are using these transboundary areas for temporary stay, probably due to lack of adequate shedding trees and shortage of natural food and water source which make the area unsuitable for resting and breeding. Our analysis on secondary data indicated that human-elephant conflict started in this area in 1997. Though elephant ventured freely in these areas before 1997, but never had conflict with human settlers. Destruction of forest cover gradually impaired the co-existence of human and elephant. Besides this, the completion of 3 layered strong barbed fences by India throughout the area in 2010 HEC reduced for a while, but soon after that conflicts became more intense. Now elephants venture in 54 border villages under four upazillas which cover an area of approximately 178 sq km and intruded upon the settlements up to 7 km inside the fence. These invaders use metal gates (n=44), rivers and stream beds (n=11), and few open areas as trespassing point with varied intensity (Fig. 2). We identified 40 active routes which were used by these trespassing elephants in varied frequency (Fig. 3).

Figure 2. Metal gate on fence, which used as entrance for elephant to the study area.

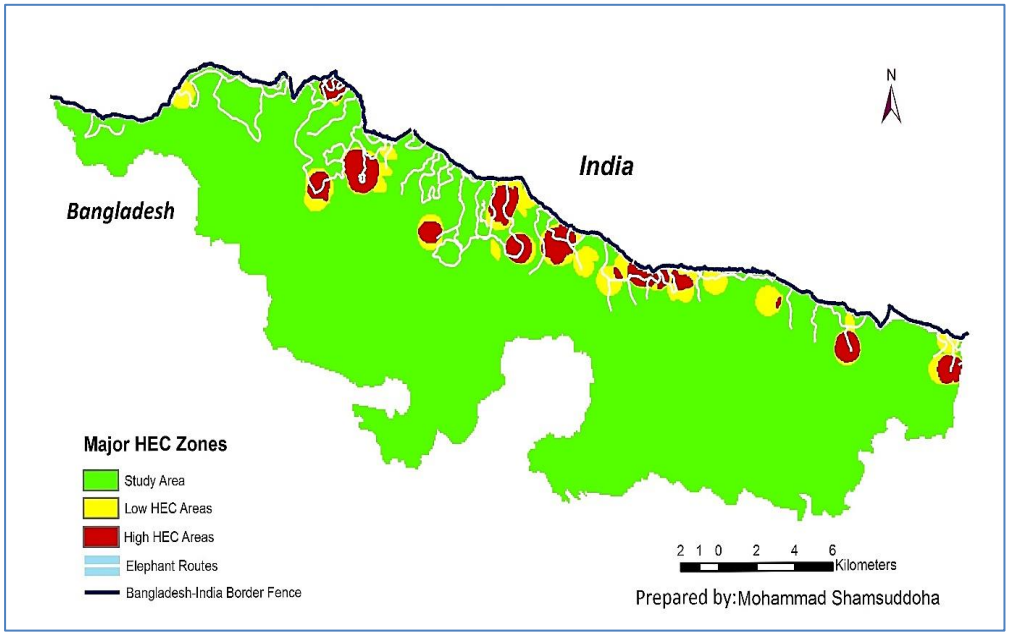

Figure 3. Study area showing non-resident elephant routes and major HEC zones.

A total of 46 plant species were recorded as elephant fodder, which has been compiled from the identification of the leaves and fruits directly or taken from those plants that had signs of elephant feeding, and are based on their vernacular names. From the recorded plants, 22 were trees, 14 herbs, 3 shrubs and 7 climbers. Though it seems that there is significant number of species that might be taken by elephant as fodder, majority (59%) of them is in homestead region. Plant species that found in forest areas are comparatively small numbers (35%) and probably unable to fulfill the demand of the elephants due to their insufficiency.

During the study period 46 food plants of 21 families were recorded (Table 1). Although the elephant is a generalist feeder, the most commonly eaten plants were only from six botanical families: Gaminae (26%), Moraceae (11%), Musaceae (9%), Fabaceae (7%), Dioscoreaceae (7%) and Myrtacae (7%). These taxa accounted for 66% (n=30) of the recorded species that constituted the highest quantitative intake.

Table 1. Plant species eaten/damaged by elephants in the study areas.

S.N	Scientific name	English name	Notes on plant types, seasonality and damage
1.	*Musa ornata*	Bronze Banana	Herb. Grows mostly in wild areas almost throughout the year; elephants eat them whole parts during raid.
2.	*Musa acuminata*	Dwarf cavendish	Herb. Abundantly grown by local people in and around home fields all year around; elephants eat them whole parts during raid.
3.	*Musa* sp.	Banana	Herb. Abundantly grown by local people in and around home fields all year around; elephants eat them whole parts during raid.
4.	*Musa sapientum*	Banana	Herb. Abundantly grown by local people in and around home fields all year around; elephants eat them whole parts during raid.
5.	*Brassica oleracea*	Cabbage	Herb. Abundantly grown by local people in and around home fields during winter months across study areas; elephants eat them whole parts during raid.
6.	*Psidium guajava*	Guava	Tree. Grown by local people in homestead areas all year around, fruit available throughout the year except summer season; elephants prefer young leaves and fruits.

7. *Syzygium cumini*	Blackberry	Tree. Grows in homestead areas, fruits start ripening in pre-monsoon; elephants prefer to take soft bark and fruits.
8. *Eucalyptus brassiana*	Eucalyptus	Tree. Abundantly planted by local people in and around home and fields all year around; elephants eat their barks during raid.
9. *Cucumis melo*	Muskmelon	Herb. Grown by local people in and around home all year around, fruiting occurs in winter; elephants eat their fruits during raid.
10. *Mangifera indica*	Mango	Tree. Abundantly planted by local people in and around home all year around, fruiting occurs in summer; elephants eat their flower and fruits during raid.
11. *Tectona grandis*	Teak	Tree. Both wild and plantation occurs in the study areas throughout the year; elephants eat their barks during raid.
12. *Ziziphus mauritiana*	Jujube	Tree. Grows in homestead areas, fruiting occurs after winter; elephants prefer to take flowers and fruits.
13. *Ziziphus rugosa*	Wild Jujube	Tree. Grows in wild areas, fruiting occurs after winter; elephants prefer to take flowers and fruits.
14. *Carica papaya*	Papaya	Shrub. Grows in homestead areas, fruiting occurs almost year around; elephants prefer to take fruits.
15. *Imperata cylindrica*	Sungrass	Herb. Grows in wild areas; elephants prefer to take leaves and shoots.
16. *Zea mays*	Corn	Herb. Grows in homestead areas, fruiting occurs in winter; elephants prefer to take fruits and leaves.
17. *Bambusa teres*	Makhal Bamboo	Treelike herb. Grows mostly in wild areas almost throughout the year; elephants eat them whole parts except roots during raid.
18. *Bambusa tulda*	Tulda Bamboo	Treelike herb. Grows mostly in wild areas almost throughout the year; elephants eat them whole parts except roots during raid.
19. *Schizostachyum dullooa*	Dolu Bamboo	
20. *Oryza sativa*	Paddy	Herb. Abundantly planted by local people in and around home all year around, fruiting occurs in 3 main season; elephants eat their grains and leaves during raid.
21. *Triticum aestivum*	Wheat	Herb. Abundantly planted by local people in and around home all year around; fruiting occurs in winter and spring; elephants eat their grains, stem and leaves during raid.
22. *Saccharum officinarum*	Sugarcane	Herb. Grows mostly in wild areas almost throughout the year; elephants eat them whole parts during raid.
23. *Thysanolaena maxima*	Tiger grass	Shrub. Grows mostly in wild areas almost throughout the year; elephants eat them whole parts during raid.
24. *Saccharum spontaneum*	Wild sugarcane	Herb. Grows mostly in wild areas almost throughout the year; elephants eat them whole parts during raid.
25. *Hymenache pseudointerupta*	Wick grass	Shrub. Grows mostly in wild areas almost throughout the year; elephants eat them whole parts during raid.
26. *Sacciolepis myosuroides*	Grass	Herb. Grows mostly in wild areas almost throughout the year; elephants eat them whole parts during raid.
27. *Hevea brasiliensis*	Rubber	Tree. Grows in homestead and wild areas almost throughout the year; elephants eat their young leaves during raid.
28. *Artocarpus heterophyllus*	Jackfruit	Tree. Abundantly planted by local people in and around home all year around, fruiting occurs in summer; elephants eat their leaves, twigs and fruits during raid.
29. *Artocarpus lacucha*	Monkey jack	Tree. Grows in homestead areas almost throughout the year; elephants eat their fruits during raid.
30. *Ficus benghalensis*	Banyan tree	Tree. Grows both in homestead and wild areas almost throughout the year; elephants eat their leaves, twigs and fruits during raid.
31. *Ficus auriculata*	Australian Fig	Tree. Grows in homestead areas almost throughout the year; elephants eat their leaves, twigs and fruits during raid.
32. *Dioscorea alata*	Potato	Herb. Abundantly planted by local people in and around home all year around; elephants eat their leaves and fruits during raid.
33. *Dioscorea batatas*	Sweet potato	Herb. Abundantly planted by local people in and around home mostly in winter; elephants eat their leaves and fruits during raid.

34. *Dioscorea pentaphylla*	Yam	Herb. Abundantly planted by local people in and around home all year around; elephants eat their leaves and fruits during raid.
35. *Citrus grandis*	Pomelo	Tree. Planted by local people in and around home; elephants eat their leaves and fruits during raid.
36. *Smilax* sp.	Greenbrier	Shrub. Grows mostly in wild areas almost throughout the year; elephants eat them whole parts during raid.
37. *Dalbergia sissoo*	Indian Rosewood	Tree. Grows in homestead areas almost throughout the year; elephants eat their leaves and twigs during raid.
38. *Acacia mangium*	Acacia	Tree. Grows in homestead areas almost throughout the year; elephants eat their barks during raid.
39. *Vigna unguiculata*	Bean	Herb. Grows both in homestead and wild areas almost throughout the year; elephants eat them whole parts during raid.
40. *Bombax ceiba*	Cotton tree	Tree. Grows in homestead areas almost throughout the year; elephants eat their leaves, bark and twigs during raid.
41. *Shorea robusta*	Sal	Tree. Grows in homestead areas almost throughout the year; elephants eat their barks during raid.
42. *Ananas comosus*	Pineapple	Herb. Grows in homestead areas, fruiting occurs in winter and summer; elephants prefer to take fruits.
43. *Cocos nucifera*	Coconut	Tree. Grows in homestead areas, fruiting occurs almost year around; elephants prefer to take fruits, central rachis, pith and young leaves.
44. *Areca catechu*	Betel palm	Tree. Grows in homestead areas; elephants prefer to take central rachis and pith.
45. *Diospyros peregrine*	Indian persimmon	Tree. Grows in homestead areas almost throughout the year; elephants eat their fruits during raid.
46. *Manihot esculenta*	Cassava	Shrub. Grows in homestead areas, fruiting occurs in winter; elephants prefer to take fruits and leaves.

Human-elephant conflict in the study area results into financial losses and damage both to the human and elephant lives. During the study period, total financial loss accounted for USD 1,171, 665 (BDT 9,13,89, 850). Tree damage alone accounted for the highest (69%), followed by crop damage (29%), houses and property damage (2%), and comparatively less significant losses of stored products, livestock and fruits.

More than 750 acres of cropland from 30 villages was damaged due to elephant raid and the total loss was USD 334,720 (BDT 2,61,08,150). Among the crop damage, the highest loss occurred to the paddy *Oryza sativa* (96%), followed by wheat *Triticum aestivum* (3%) and other crops like Ginger (*Zingiber officinale*), Cassava (*Manihot esculenta*) and vegetables. During this period, at least 777 farmers affected seriously by losing their crops due to HEC. Highest crop damage occurred in October (36%), followed by May (25%) and February (20%). July and September had no crop raiding incident and rest of the months in the study period faces minimum damage to the crops. Our analysis showed that the matured crops (especially the paddy) were more vulnerable to elephant raid as the highest raiding occurred just before harvesting of this crop. Jhulgao, Baijhuri and Rangajan of Sreebordi experienced the highest crop loss (15%) due to raiding. We found significant preference of elephants on some local paddy varieties (Kalojira, Tilkaush, Paizam, Guiamuri and Tulshimala) in these areas. These varieties are significantly luxuriant in growth as well as have fragrance than other varieties.

During the study period, at least 228 houses from 25 villages were destroyed by the elephants (Fig. 4). Total loss during this period accounted for USD 19,859 (BDT 15,49,000) under this category. As a consequence, at least 133 families suffered from the damage of their houses over this period. Maximum 32% incidents occurred in June followed by the month of May (24%), August (21%) and January (13%), but no incidents in February, March, April and December.

Besides house and property loss, elephants caused huge damage to the stored grains/crops, and the total economic loss accounted for USD 4,260 (BDT 3,32,300). Damage to the stored paddy grain alone compromised 59% followed by stored paddy seedlings (21%), Cassava (6%), Ginger (3%) and Turmeric (3%). Elephant also preferred to eat fruits, especially the Jackfruit and

Banana, and the total loss was USD 115 (BDT 9,000) (Fig. 5).

Figure 4. House destroyed by elephants in Nalitabari.

Figure 5. An elephant browsing on Banana plantation.

Besides crops and orchards, elephants caused damage to trees in social forestry plantations, with a total the economic loss of USD 811,300 (BDT 6,32,81,400). The highest of this loss accounted 66% for *Eucalyptus* sp. plantation followed by *Acacia* sp. plantation (28%), fruit bearing trees (5%), bamboo and other trees. Elephants also killed livestock during raiding, and the enumerated total loss was USD 1,410 (BDT 1,10,000). During the study period, at least 8 people were killed and 26 injured by elephants, whereas two elephants were killed by people during the same period.

Our spatial analysis with HEC point data identified several major HEC zones (Fig. 3) with different levels of intensity of HEC. All of these zones are very close to the border fence and it showed a pattern that elephants frequently engaged in conflict in these zones. High HEC zone areas were across three villages, namely the Hariakona, Jhulgaon and Balijhuri in Sreebordi; five villages, viz. Gajni, Gandhigao, Noukuchi, Gamara and Holdigram in Jhenaigati; and two villages, viz. Daodhara and Mayaghashi in Nalitabari. Low HEC zones were Dumurtala village of Dhanua, five villages in Jhenaigati (Dudhnoi, Baruamari, Rangtia, Jhokakura and Shondhyakura) and three in Nalitabari (Panihata, Burunga and Samashchura).

Conclusion

Human-elephant conflict has substantially increased over the last decade, which is a serious threat to both local people and elephant population. Local people experienced severe economic loss due to elephant raiding, which tended to develop negative attitude towards the elephants and strongly influenced the behavior of elephants and humans to retain combatant situation since they don't have alternative for their livelihood. Awareness programs in the fringe villages could help sensitizing local communities towards elephant conservation, in addition to cut down the rate of further habitat exploitation. Regular monitoring of elephant population and social research can be useful to better understanding and mitigating the HEC in the region. Improvement and proper management of degraded habitat, construction of solar fence, eco-development initiatives, sustainable utilization of forest resources, development of national elephant conservation action plan and bilateral collaboration with Indian government can accelerate the better future of elephants in these areas.

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