An assessment of human-elephant conflict in Manas National Park, Assam, India

Naba K Nath [1], Bibhuti P Lahkar [2], Namita Brahma [2], Santanu Dey [2], Jyoti P Das [2], Pranjit K Sarma [2] & Bibhab K Talukdar [2]

[1,2] Aaranyak, 50, Samanwoy Path, Survey, Guwahati, Assam 781028, India
Email: [1] naba@aaranyak.org

Abstract: An assessment of human-elephant conflict was carried out in the fringe villages around Manas National Park, Assam during 2005-06. The available forest department conflict records since 1991 onwards were also incorporated during analysis. Conflict was intense in the months of July-August and was mostly concentrated along the forest boundary areas, decreasing with distance from the Park. Crop damage occurred during two seasons; paddy (the major crop) suffered the most due to raiding. Crop maturity and frequency of raiding were positively correlated. Single bull elephants were involved in conflicts more frequently (59%) than female herds (41%), while herds were involved in majority of crop raiding cases. Of the single elephants, 88% were *makhnas* and 11.9% were tuskers. The average herd size recorded was 8 individuals, with group size ranging up to 16. Mitigation measures presently adopted involve traditional drive-away techniques including making noise by shouting, drum beating, bursting fire crackers and firing gun shots into the air, and using torch light, pelting stones and throwing burning torches. *Kunkis* have been used in severe cases. Machans are used for guarding the crops. Combinations of methods are most effective. Family herds were easily deflected, while single bulls were difficult to ward off. Affected villagers have suggested methods like regular patrolling (39%) by the Forest Department officials along the Park boundary, erection of a concrete wall (18%) along the Park boundary, electric fencing (13%), simply drive away (13%), culling (11%) and lighting the Park boundary during night hours (6%). Attempts to reduce conflict by changing the traditional cropping pattern by introducing some elephant-repellent alternative cash crops (e.g. lemon and chilli) are under experiment.

Keywords: Assam, India, Manas National Park, Asian elephant, conflict, mitigation measures, alternative crop.

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Author Details: See end of article

Author Contribution: See end of article

Introduction

The Asian Elephant *Elephas maximus* (Linn.) was once common all over the tropical south and south-east Asia, from India to Vietnam and Sumatra. Although its general range has remained almost the same, expansion of human habitation, destruction of habitat for agriculture and poaching have resulted in a sharp decline in wild populations and severe habitat fragmentation (Choudhury 1999). Asian elephants are presently confined to 13 Asian range countries, of which India holds over 50% of the global population – approximately 24,000–28,000 distributed across 18 states (Menon 2003; Sukumar 2003). Northeastern India holds around 30% of the country's total elephant population (Bist 2002) of approximately 11,000, found in discrete populations distributed within 14 habitat fragments as identified by Choudhury (1999) across the region. Within this north-eastern countryside the state of Assam is known as the key conservation region of Asian elephants (Stracy 1963; Gee, 1964; Lahiri Choudhury 1980; Santiapillai & Jackson 1990; Choudhury 1991, 1997 & 1999; Bist 2002), with an elephant population of about 5200 as assessed in the year 2005 (Talukdar 2006). Manas National Park (MNP) within the Chirang Ripu Elephant Reserve in Assam is one of the major strongholds of wild Asian Elephants, with a fluctuating population of average 500 individuals. Unfortunately, during the late 1980s this landscape experienced a severe socio-political crisis which has completely devastated the infrastructure of the region and caused large scale destruction of the precious forest habitat and its wildlife. This crisis has resulted in animal depredation in the adjoining fringe areas of the Park, the principal source of human-elephant conflict (HEC). Prior to this study no effort has been made to document the nature of HEC in this region due to the crisis situation, which was resolved in 2003. The present study was initiated in 2005-2006 as a first step to assess HEC in the fringe areas around MNP. This paper presents an analysis of past conflict records maintained by the Forest Department and preliminary observations from an initial one year survey.

Study Area

MNP is located at the foothills of the Bhutan Himalayas in Baksa and Chirang districts of Assam, India (26°35'-26°50'N & 90°45'-91°15'E) within Chirang Ripu Elephant Reserve, declared by the Assam Government in the year 2003 under the guidelines of Project Elephant of Government of India with an area of 2600km² (Fig. 1a). Manas Tiger Reserve (MTR) was created in 1973 with an area of 2837km² covering

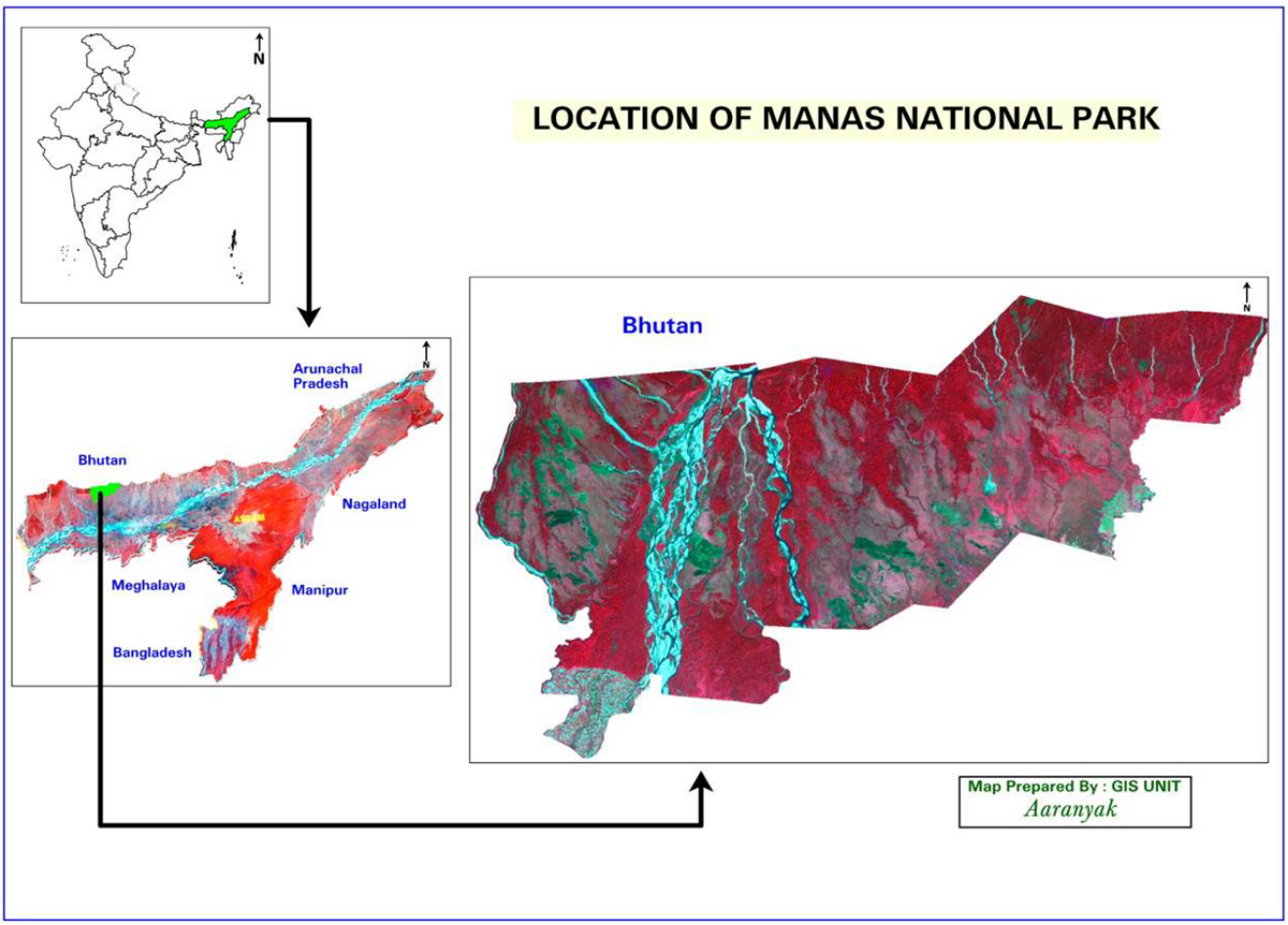

Figure 1a. Map of the study area, the Manas National Park

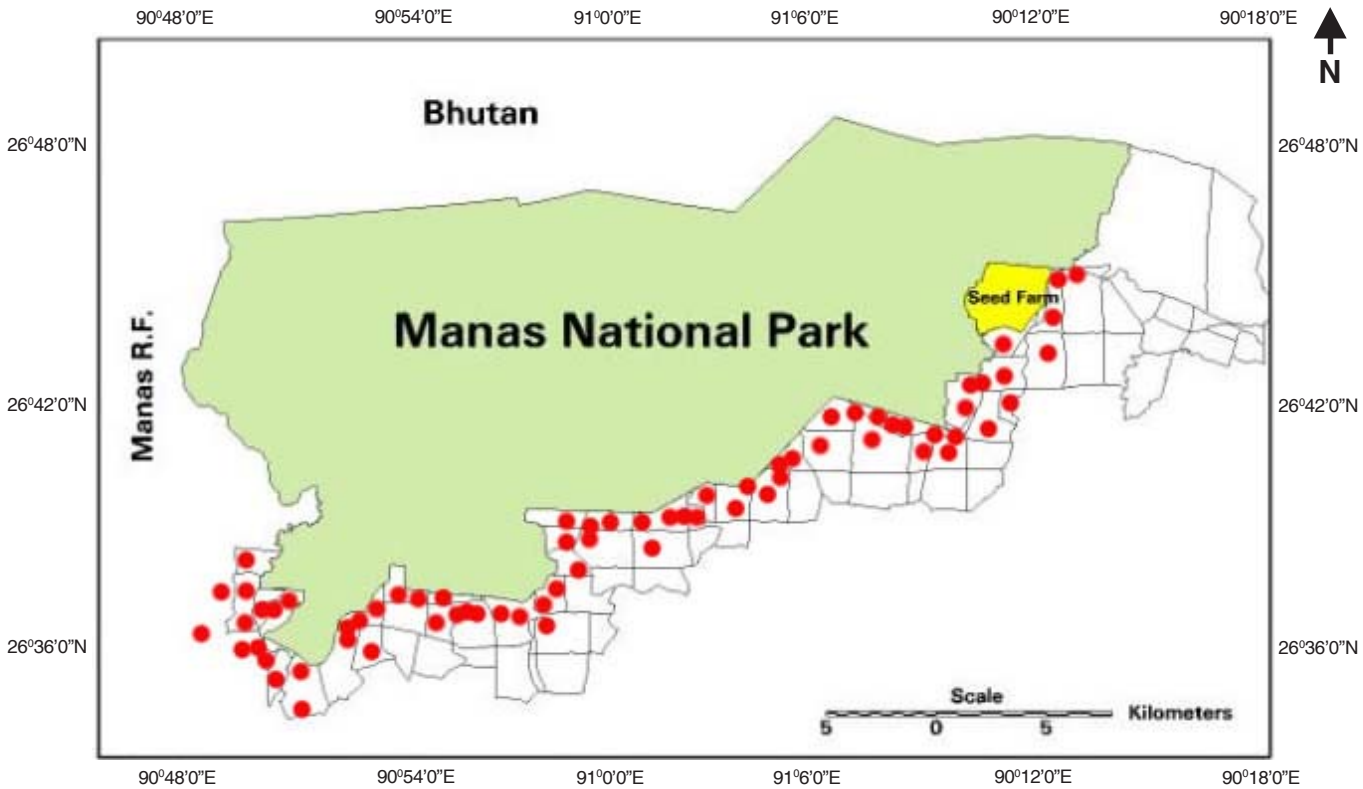

Figure 1b. Map of the study area showing the location of the villages (red dots) surveyed during the year 2005-06.

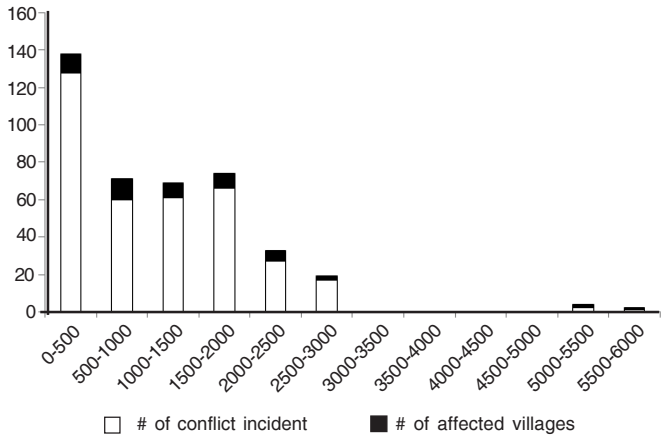

Figure 2. Graph showing the decrease in conflict incidents with increasing distance (in m) from the Park (Period 1991-2006). The X-axis shows distance in metres, and Y-axis shows the number of reports.

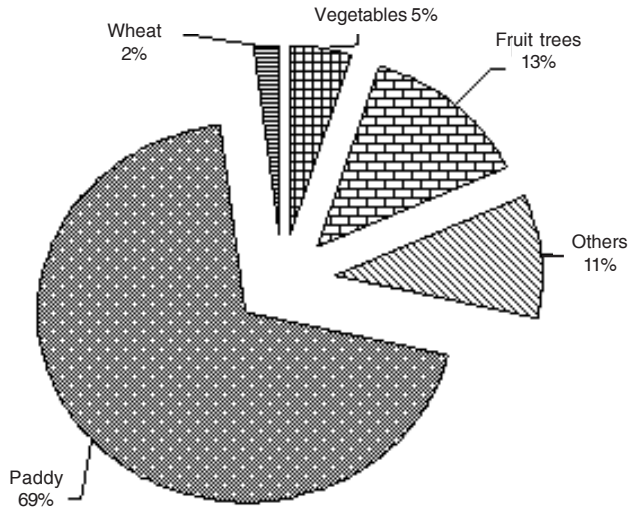

Figure 3. Frequency of damage to different crops during 1991-2006 in the fringe villages around Manas National Park. (n=305)

five forest divisions viz. Kachugoan, Haltugoan, Aie Velly, North Kamrup and Darrang. However, in the past decade encroachment occurred and human settlements took place in few reserve forests of North Kamrup division. Hence, during the time of declaration of elephant reserve (in the year 2003), 237km^2 disputed land of MTR was excluded from the original area of 2837 sq km. Except this 237km^2 area, the size & habitat of Chirang Ripu Elephant Reserve is the same with MTR. The core area (500km^2) of the Manas Tiger Reserve was later declared a National Park in 1990. MNP is one of the prime habitats of the endangered Asian Elephants within the Bhutan Biological Conservation Complex in the Eastern Himalaya Biodiversity Hotspot (CEPF 2005), and facilitates trans-boundary movement of elephants and other wildlife species. It spans both sides of the Manas River and is restricted by reserve forests on the east and west, the international border of Bhutan on the north and a belt of some thickly populated revenue villages on the south. There are 62 fringe villages within 2km distance from MNP boundary where the on site assessment was carried out during 2005-06. Another five villages (Kalpani, Maulaghati, Panbari, Poran Bongaon and Pub Jangrengpara) that lie outside this 2km belt were also assessed where elephant depredation occurred during study period (Fig.1b).

Methods

Each conflict incident was considered as a sampling unit. Villages affected by elephant depredation were visited. On the basis of raiding incidence, a total of 67 villages within 5km distance from MNP boundary have been identified. The information on elephant depredation was collected by interviewing the local people or farmers using Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA) approach (Chambers 1994). The questionnaire sought information on: location of raided crops, types of crops cultivated, extent of different crops cultivated, month of cultivation, composition of raiding herds, frequency of raiding, extent of damage to the crop, mitigation methods used to deter elephants and attitudes and expectations of the local people towards human-elephant conflict situations. During analysis, available historic incidents from 1991 onwards were also investigated to get a broader picture of the nature of conflict (Hoare 2001). Details of such incidents were obtained from the Field Director's office, MTR, which maintains records of ex-gratia claims made by the victims.

Results & Discussion

Though conflict incidents have been reported from time to time in the fringe villages around MNP, the intensity of conflict occurrence seems to be comparatively low in contrast to other HEC areas of Assam. During the period 1991 till 2006 there were only 305 crop raiding cases, 172 household and property damage cases and 31 human death and injury cases reported (Table 1). However, the current pace of disturbance factors like logging, grazing, encroachment and over exploitation of non-timber forest product (NTFP) (pers. obs.) could cause serious crisis for elephants and humans in the near future. Though the reported cases of crop raiding, household and property damage of the previous years (1991-2004) collected from the ex-gratia claims might render some sort of bias due to unsystematic data maintenance, and other reasons (such as increased local awareness of the compensation system, dissatisfaction over the slow and faulty recompense process as mentioned by Nelson (2003), no response from FD even after repeated follow-ups etc.), the cases of human deaths due to elephants were well authenticated for use for better understanding of the status of HEC situation in MNP.

Patterns of elephant depredation

Distribution of crop raiding incidents: The temporal distribution of crop raiding was not uniform in MNP. Crop damage incidents were mostly concentrated in the paddy fields along the southern Park boundary, due to which major losses seem to occur to the fringe villages. It has already been found that raiding of agricultural fields by elephants sometimes occurs due to proximity with cultivation (Sukumar 1990). In MNP, since the crop fields are adjacent to the forest boundary, frequent crop raiding by elephants could be well understood. Studies in Africa by Naughton-Treves (1998), O'Connell et al. (2000),

Table 1. Records of injury, death and damage from elephants in Manas National Park

Year	Number of human injuries	Number of human deaths	Number of Crop raiding incidents	Household & property damage
1991-92	2	1	20	10
1993-94	17	4	105	46
1995-96	-	1	54	16
1997-98	-	-	9	15
1999-2000	1	3	2	2
2001-02	-	-	6	4
2003-04	-	-	5	1
2005-06	2	-	104	78
Total	**22**	**9**	**305**	**172**

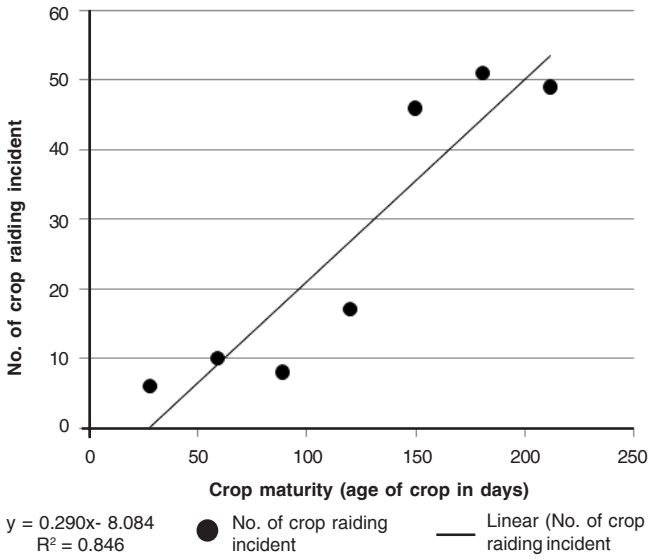

Figure 5. Graph showing increase in the number of raiding incidents with increasing crop maturity (Data of 2006 summer paddy).

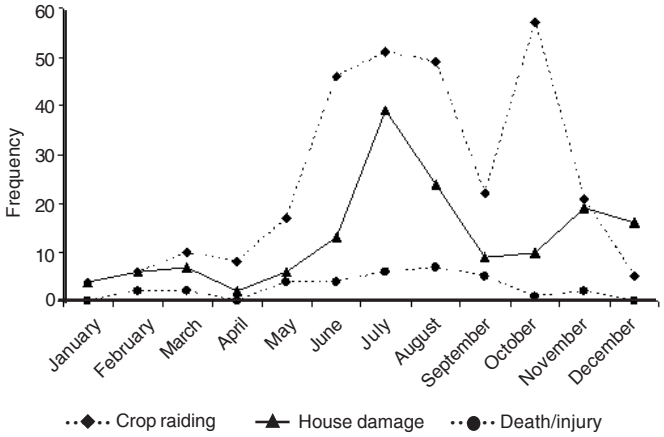

Figure 4. Monthly frequency of crop-raiding/house-damage/human-death/human-injury incidents in Manas National Park during 1991-2006.

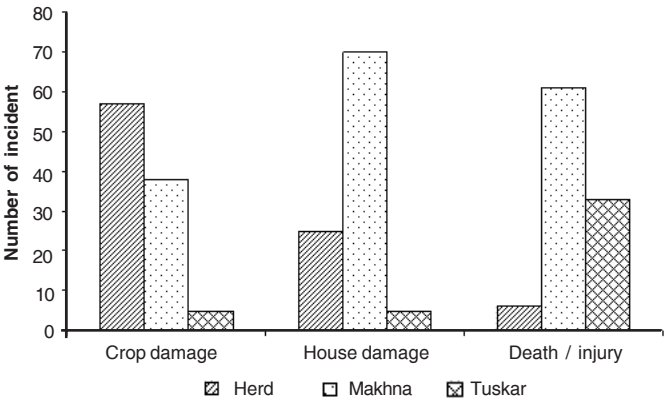

Figure 6. Proportions of crop raiding/house damage/death-injury caused to humans by different groups of elephants during 1991-2006 in fringe villages around Manas National Park

Parker et al. (2007) and Bell, (1984) showed similar results. In MNP, it was observed that as the distance increases the frequency of conflict gradually decreases (Fig. 2). Parker et al. (2007) also observed the relationship of distance factor with crop raiding during their study on African elephants in Kenya. The maximum straying distance we recorded in MNP during 2005-06 was 5526m by a *makhna*, although about 10 to 20 years ago raiders (single bulls) used to stray up to 10-12km distance from the forest, as mentioned by the local farmers. Possibly due to increased human population density and change in the land-use pattern over time, the movement of the raiders outside the forest area is restricted. During analysis we have identified 48 villages (out of total 67) that have suffered crop raiding during 1991-2006. During this period the village *Barengabari* suffered the highest occurrence of crop damage (n=48). This was followed by *Raghobil* (n=21) and *Gobardhona* (n=20) (χ^2_4=17.11, P<0.01).

Raiding seasons & crop preferences: Crop raiding in MNP is a dual season phenomenon. Both summer (March-August) and winter (June-November) season crops are affected due to raids. Summer crops were marginally more damaged when crop guarding slackens due to heavy rains. In his study, Barnes et al. (2006) also reported rainfall is one of the physical variables that influence crop raiding by elephants.

Paddy, being the major crop (69%, n=239) in both seasons, suffered maximum events of raiding (χ^2_4=537.7, P<0.01) (Fig. 3). Depredation of paddy generally starts right from the vegetative stage and continues through the reproductive phase till the crops reach maturity. Peak months of raiding in MNP were identified as June-July-August for the summer crop and October for the winter crop (Fig. 4). Studies from Africa show that with increasing maturity the intensity of raiding also increases, as the crops are more palatable during their mature phase (Bell 1984; Kangwana 1995; Tchamba 1995; Parker et al. 2007). Crop maturity and frequency of raiding around MNP were also found to be positively correlated (r_s=0.929, n=7, P<0.01) (Fig. 5). Other economically important field and garden crops also underwent a considerable amount of raiding (Fig. 3), including fruit trees (banana, jackfruit, pineapple, coconut), sugarcane (13%), vegetables (pumpkin, summer squash, cabbage, cauliflower; 5%), wheat (2%), betel nut, bamboo and jute (11%). During the study a total of 29 cultivated plant (crop) species were recorded in the diet of MNP elephants. Of the total, 57% of crop raiding cases were

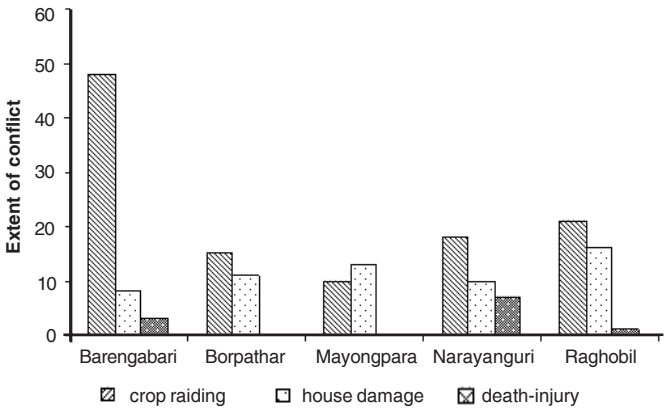

Figure 7. Intensity of HEC in the top five most affected villages identified in Manas National Park during 1991-2006.

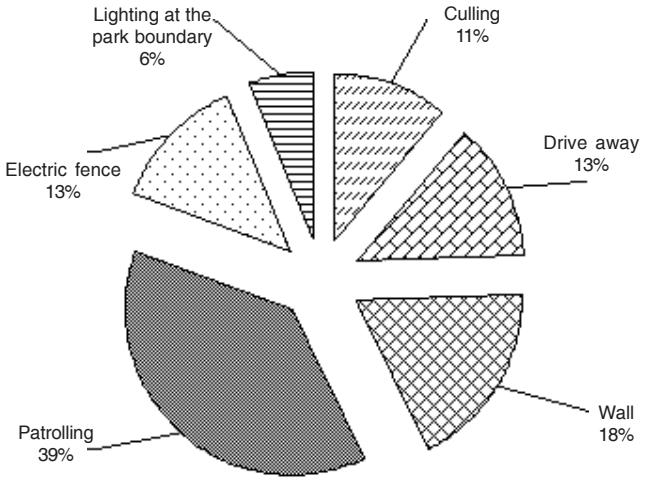

Figure 8. Mitigation measures suggested by villagers during 2005–2006 questionnaire survey in the fringe villages around Manas National Park.

caused by herds, followed by *makhnas* (38%) and tuskers (5%) (Fig. 6).

Household and property damage: In 60% of cases houses with stored paddy and salt were damaged. Damage to households and property occurred more or less throughout the year with a peak in July (n=39) followed by August (n=24) and November (n=19) (Fig. 4). This was found to coincide with the harvesting period of paddy. The village *Raghobil* (n=16) reported the highest number of house damage cases (Fig. 7). It was followed by *Lakhijhora* (n=15) (χ^2_s=17.11, P<0.01). Of the total incidents, 93.6% (n=161) were residential houses (mostly granaries and kitchens), and the rest 6.4% (n=11) were grocery shops. Maximum household and property damage (70%) was caused by the *makhnas*, followed by herds (25%) and tuskers (5%) (Fig. 6).

Human injury and death due to elephant: During 1991–2006 only nine death cases (29%) and 22 cases of human injury (71%) were reported. Human mortality due to elephant in MNP represents only 1.61% of the total cases that occurred in

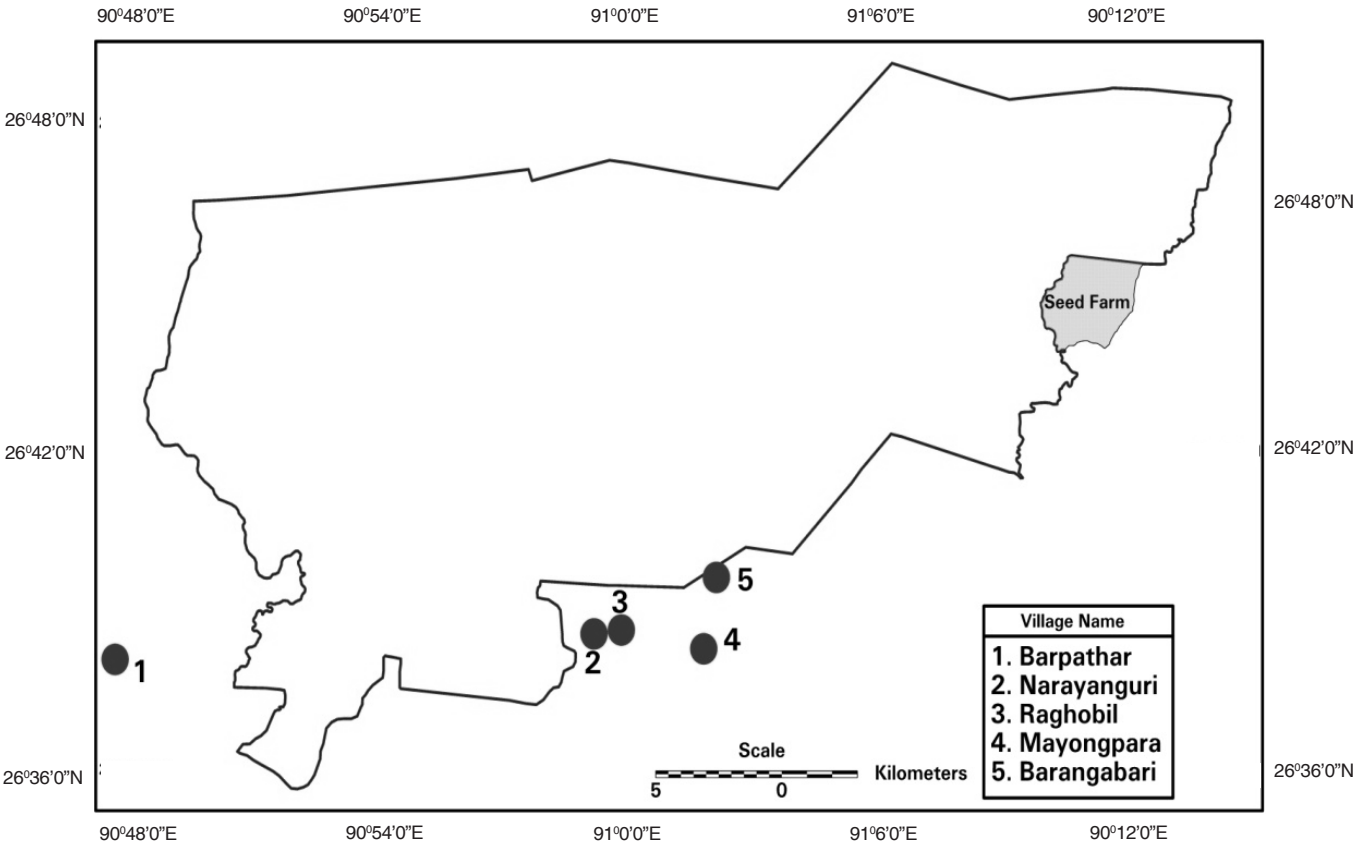

Figure 9. Location of the five villages in the periphery of Manas National Park which were the most affected due to elephant-related conflict during 1991-2006.

Assam (n=558) during 1991-2003. *Makhnas* were responsible for 61% of the cases of death and injury. Tuskers were involved in 33% cases and herds only in 6% cases (Fig. 6). The maximum number of human deaths was reported during the year 1993-94 and the village *Narayanguri* topped the list (Fig. 7). Of the injury cases, 27% were major (fracture of bone, head injury etc.) and 73% minor (scratch, sprain etc). In a majority of the human death/injury cases the elephants responsible were either in the state of *musth*, injured or a marauding individual as revealed by the local people during interview. However, there were some accidental encounters where humans and elephants were unaware of each other's presence due to obscurity at night. The majority of the human death and injury cases took place during May-September with a peak in the month of August (n=7) (Fig. 4), which is found to coincide with the summer crop harvesting season.

It has been observed that crop raiding, house damage and human death/injury cases reported in MNP coincided with the harvesting phase of the summer crop, with a peak during the months of July-August (Fig. 4). In MNP, the villages located near the forest boundary areas grow paddy earlier than the villages that are located towards the south. This is because the monsoon water in these boundary areas does not last long enough due to the porous nature of the soil (*Bhabar* zone) and sloppy terrain. When harvesting is over in these areas, the elephants expand their search for paddy located further south. To reach these distant crop fields elephants have to move through villages. This is the time when many of the animals cause damage to the houses when they discover stored grains kept inside, and encounter humans on their way to these outlying crop fields during the night.

Animal group size: We were able to determine animal group sizes in 227 out of total 508 cases. In MNP, the number of conflict incidents due to single bull elephants was greater (59%, n=134) than the number due to female herds (41%, n=93) (χ^2_1=7.42, P<0.01). Of the singles, 88% were *makhnas* (n=118) and 11.9% (n=16) were tuskers. The average herd size recorded was 8, with group size ranging from 1 to 16.

Mitigation measures

The methods used to ward off elephants in the fringes of MNP include the age old, traditional drive away techniques which include noise-making activities like shouting, drum beating, bursting fire crackers, firing gun shots into the air by forest officials, using torch light, pelting stones, and throwing burning fuel-woods. Depending on the severity, *kunki* (captive trained elephants to drive away the raiders) operations are also provided by the Forest Department. During the harvesting period, the farmers guard their crops every night from *"tangsi/machan"*s (temporary shelters build by the farmers during cropping seasons) built near the crop fields. Discussion with the villagers revealed that none of the active drive away methods is fully effective if used singly. A combined effort is more effective. Use of combinations of methods was also suggested by Hoare (2001), since reliance on one or two individual methods is particularly vulnerable to failure. Because, each single mitigation method may help a little but would not, on its own, be sufficient to make much difference to the human-elephant conflict problem. On the other hand, acting together, the whole "package of methods" may be more effective than the sum of its individual constituent parts. This is called "*synergy*". It probably works because although problem elephants are very resourceful, if their intentions are hindered or blocked in several different ways, most of them may give up trying (Hoare 2001). While family herds could be deflected easily, the solitary bulls were always more difficult to ward off and required lots of effort, time and manpower as stated by the local farmers during the interview.

Attitude and expectation of the local people

In India, traditional, cultural and religious attitudes towards wild animals make local people tolerant towards wildlife, despite the damage to crops and livestock (Imam et. al. 2002). The general reverence towards plants and animals in some Indian regions has often been reported to be the main reason for a positive attitude towards wildlife and nature reserves (Sekhar 1998; Vijayan & Pati 2002; Madhusudan 2003; Mishra et al. 2003). Though positive attitudes towards elephants still persists among the fringe villagers, the majority (95%) of them expect more intensive crop, human life and property saving initiatives from the Forest Department of Assam. The villagers affected by HEC expressed their dissatisfaction with the current compensation process due to its lengthy and complicated procedure. They also reported that they are paid much less than the actual amount they claim and sometimes they do not even get any response despite repeated follow-ups. During the survey when the villagers were asked to recommend some possible effective measures against elephant depredation, the majority of them suggested regular patrolling (39%) by the Forest Department officials along the Park boundary areas and special joint patrolling (with villagers) during peak raiding period. Next to patrolling, the majority of the respondents recommended a concrete wall (18%) along the Park boundary, followed by electric fencing (13%), simply drive away (13%), culling (11%) and lighting the Park boundary during night hours (6%) (Fig. 8).

Experimentation with elephant deterrent alternative cash crop

Initiatives have already been undertaken to change the traditional cropping pattern by introducing some elephant-repellent alternative cash crops like lemon and chilli. These were introduced in the fringe villages on an experimental basis. This alternative cropping pattern is expected to compensate the annual crop loss, and at the same time due to their deterrent effects also thought to act as a "*bio fence*" to check the elephant depredation/movement into the villages.

Conclusion

To ensure the future of Asian Elephants in MNP, it is important to clearly understand the ecological processes that drive HEC, alongside the attitude, expectations and tolerance level of the local people living nearby. The enquiry processes that involve more than one government department and the compensation process should be expeditious for loss of life and property. This will help the Forest Department get back the lost support of the local community. As a long term measure, restoration of already degraded habitats is of utmost necessity. Protection and proper management planning should be immediately made to foster natural regeneration of forest.

Communities living within or near forests can be an essential component of forest conservation, by actively engaging with forest management activities and defending their territories against poachers and loggers (Schwartzman et al. 2000; Schmidt-Soltau 2003). Involvement of the local community in minimizing elephant depredation and managing the critical issues of HEC could be a strong initiative in MNP. Improving the livelihood security, introduction of alternative living options and improved agricultural practices will reduce the pressure for annual land expansion too, which should in turn lessen the need for forest clearance. Eco-development initiatives need to be encouraged in the fringe villages around MNP, along with a series of conservation education and awareness programs. The alternative elephant-deterrent cash crop concept could be a promising move towards minimizing the conflict. However, it may take a couple of years as such activity is new for the villagers.

References

Barnes, R.F.W., U.F. Dubiure, E. Danquah, Y. Boafo, A. Nandjui, E.M. Hema & M. Manford (2006). *Crop-raiding elephants and the moon* (Notes and Records), pp. 1-4. Journal compilation. Blackwell Publishing Ltd, African Journal of Ecology.

Bell, R.H.V. (1984). The man-animal interface: An assessment of crop damage and wildlife control. *Conservation And Wildlife Management in Africa*: Bell, R.H.V. & McShane-Caluzi (eds) US Peace Corps Seminar, Malawi, pp.387-416.

Bist, S.S. (2002). Conservation of Elephants in NE India: Past, Present and Future. *Newsletter of the Rhino Foundation for Nature in NE India* 4: 7-10.

CEPF (2005). *Critical Ecosystem Partnership Fund, Ecosystem Profile, Eastern Himalayas Region*. Final Version, February 2005. WWF-US, Asia Program, 100pp.

Chambers, R. (1994). Participatory Rural Appraisal (PRA): analysis of experience. *World Development* 22(9): 1253–1268.

Choudhury, A.U. (1991). Status of Wild elephants in Cachar and N.C. Hills, Assam a reliminary investigation. *Journal of Bombay natural History Society* 88(2): 512-221.

Choudhury, A.U. (1997). *Checklist of the Mammals of Assam.* Revised 2nd edition. Gibbon Books & ASTEC, Guwahati, 103pp.

Choudhury, A.U. (1999). Status and conservation of the Asian elephant *Elephas maximus* in north-eastern India. *Mammal Review* 29(3): 141-173.

Gee, E.P. (1964). *The Wild Life of India.* St. James Place, Collins, London.

Hoare, R.E. (2001). *A Decision Support System for Managing Human-Elephant Conflict Situations in Africa*. IUCN/SSC African Elephant Specialist Group, Kenya, 110pp.

Imam, E., H. Yahya & I. Malik (2002). A successful mass translocation of commensal rhesus monkeys *Macaca mulata* in Vrindaban, India. *Oryx* 36(1): 87-93.

Kangwana, K. (1995). Human-elephant conflict: the challenge ahead. *Pachyderm* 19: 11-14.

Choudhury, D.K.L. (1980). An interim report on the status and distribution if elephants in north-east India, pp. 43-58. In: Daniel, J.C. (Ed.). *The Status of the Asian Elephant in the Indian Sub-Continent.* IUCN/SSC report, BNHS, Bombay.

Madhusudan, M.D. (2003). Living amidst large wildlife: livestock and crop depredation by large mammals in the interior villages of Bhadra Tiger Reserve, south India. *Environmental Management* 31(4): 466-475.

Menon, V. (2003). *A Field Guide to Indian Mammals.* Dorling Kindersley (India) Pvt. Limited, 201pp.

Mishra, C., P. Allen, T. McCarthy, M. Madhusudan, A. Bayarjargal & H. Prins (2003). The role of incentive programmes in conserving the Snow Leopard. *Conservation Biology* 17(6): 1512-1520.

Naughton-Treves, L. (1998). Predicting patterns of crop damage by wildlife around Kibale National Park, Uganda. *Conservation Biology* 12(February): 156-158.

Nelson, A. P. Bidwell & C. Sillero-Zubiri (2003). *A Review of Human Eephant Conflict Management Strategies. People and Wildlife Initiative.* Wildlife Conservation Research Unit, Oxford University, 25pp.

O'Connell-Rodwell, E. Caitlin, T. Rodwell, M. Rice & L.A. Hart (2000). Living with the modern conservation paradigm: can agricultural communities co-exist with elephants? A five-year case study in East Caprivi, Namibia. *Biological Conservation* 93: 381-391.

Parker G.E., F.V. Osborn, R.E. Hoare & L.S. Niskanen (eds.) (2007): *Human-Elephant Conflict Mitigation: A Training Course for Community-Based Approaches in Africa*. Participant's Manual. Elephant Pepper Development Trust, Livingstone, Zambia and IUCN/SSC AfESG, Nairobi, Kenya.

Santiapillai, C. & P. Jackson (1990). *The Asian Elephant: an Action Plan for its Conservation.* IUCN/SSC Action Plans, Gland. Switzerland.

Schmidt-Soltau, K. (2003). Conservation-related resettlement in central Africa: environment and social risks. *Development and Change* 34: 525–551.

Schwartzman, S., A. Moreira & D. Nepstad (2000). Rethinking tropical forest conservation: perils in parks. *Conservation Biology* 14: 1351–1357.

Sekhar, N.U. (1998). Crop and livestock depredation caused by wild animals in protected areas: the case of Sariska Tiger Reserve, Rajasthan, India. *Environmental Conservation* 25(2): 160-171.

Stracey, P.D. (1963). *Elephant Gold.* Weidenfeld and Nicolson, London.

Sukumar, R. (1990). Ecology of the Asian elephant in southern India: II. Feeding habits and crop raiding patterns. *Journal of Tropical Ecology* 6(1): 33–53.

Sukumar, R. (2003). *The Living Elephants: Evolutionary Ecology, Behavior and Conservation.* Oxford University Press, 476pp.

Talukdar, B.K, J.K. Boruah & P. Sarma (2006). Multi-dimensional mitigation initiatives to human-elephant conflicts in Golaghat district and adjoining areas of Karbi Anglong, Assam, India. *International Elephant Conservation & Research Symposium-2006*, Copenhagen Zoo, pp.197-204.

Tchamba, M. (1995). The problem elephants of Kaele: a challenge for elephant conservation in northern Cameroon. *Pachyderm* 19, 23-27.

Vijayan, S. & B.P. Pati (2002). Impact of Changing Cropping Patterns on Man-Animal Conflicts Around Gir Protected Area with Specific Reference to Talala Sub-District, Gujarat, India. *Population and Environment* 23(6): 541-559.

Appendix 1. Data sheets used during the study.

Crop damage assessment in Manas National Park

DATE: DATASHEET NO.:
VILLAGE: OBSERVER:

SNo. Date of incident Name of victim GPS location Type of Crop Phenology Extent of cultivation (Area) Extent of damage (Area)

SNo. Season of cultivation Animal responsible Single/Herd (size) Age-sex classification Mitigation methods used Efficacy (%)

SNo. Compensation claimed, Yes/No Received, Yes/No Are you satisfied with the compensation system? Effective mitigation measure according to you Remark

Manslaughter-Human injury

DATE: DATASHEET NO.:
VILLAGE: OBSERVER:

SNo. Date Victim Age-sex Death/Minor/Major injury Animal responsible Herd/single (M/T)/rogue GPS location

SNo. Age-sex classification of animal Possible cause Compensation claimed, Yes/No Received, Yes/No Remarks

Elephant death due to conflict

SNo. Place of incident GPSLocation Age/sex of the animal Age of the carcass Possible cause of death Distance from village / forest Remarks

Property damage assessment

DATE: DATASHEET NO.:
VILLAGE: OBSERVER:

SNo. Date of incident Victim Name of structure Damage partial/complete GPS location Animal responsible: Single/Herd (size)

SNo. Age-sex classification Cause of visit Compensation claimed, Yes/No Received, Yes/No Remarks

Author Details: Naba Krishna Nath is a field researcher associated with Aaranyak since 2005. He started his research work on Asian Elephants and is currently looking after the critical aspects of human-elephant interactions in Manas National Park. He is also presently involved in a rapid presence/absence survey of Hispid Hare in the north bank landscape of Assam and Arunachal Pradesh. Bibhuti P Lahkar, the programme secretary of Aaranyak (also the Principal Investigator of this present project) has been conducting research and monitoring of the grassland ecosystem dynamics in Manas National Park since 2001. Currently he is coordinating the Asian Elephant Research & Conservation Programme of Aaranyak. Namita Brahma is a field researcher associated with Aaranyak since 2005. She started her research career on large mammals in Manas National Park and then shifted to birds. Presently she is looking after the Bengal Florican Research and Monitoring Programme in the north bank landscape. Santanu Dey is a field researcher associated with Aaranyak since 2005. He is a field taxonomist and is involved in documentation and conservation of flora of northeastern India. Jyoti P Das is a field researcher associated with Aaranyak since 2005. He has been conducting research on large mammal ecology in northeastern India and is presently involved in habitat utilization and habitat suitability modelling studies on Asian elephant in Manas National Park. Pranjit K Sarma is the programme coordinator of the Planning & GIS of Aaranyak. He has the responsibity to integrate and manage the biodiversity related information (spatial and non spatial) of northeastern India in to GIS environment. Currently he is involved in research on habitat analysis of different species, environment and deforestation. Dr. Bibhab K Talukdar, Secretary General of Aaranyak, (also presently the Co-chair of Asian Rhino Specialist Group, IUCN/SSC) has conducted a good lot of studies on human-elephant conflict issues in Assam. He has published his papers in many journals and has presented his research works at many national and international seminars. He is also a member of National Board of Wildlife, Government of India.

Author Contribution: NKN was involved in the field survey, data processing, data analysis and writing the paper. BPL coordinated the entire project and also helped during data analysis and writing the paper. NB was involved in the field survey and data processing. SD was involved in the field survey and data processing. JPD was involved in field survey, data processing and data analysis. PKS helped during spatial data analysis and preparing the GIS maps. BKT advised the project team throughout the project period and reviewed the paper and made necessary corrections.

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