An Assessment of Human Elephant (*Elephas maximus*) Conflict (HEC) in Mahanadi Elephant Reserve and Suggested Measures for Mitigation, Odisha, India

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Abstract: The Mahanadi Elephant Reserve is situated between Norths: 20°. 10′ to 21°.5′′N latitude and East: 84°. 15′ to 85°.58′ longitude. This Elephant Reserve is enriched with 8036.32 km^2 km forest cover which is 38.97% geographical area and 2.07 of state geographical area. Human-elephant conflict is a major issue at present. Habitat fragmentation and loss, habitat degradation, developmental project such as Irrigation project, canal project, electric power line, road ways, railways, industries, expansion of agricultural field, increase of anthropogenic pressure on habitat, have posed is wide spread and significant threat to elephants and their habitats leading to human elephant conflict. Each year on an average about 15 people and 20 elephants death are being killed in Mahanadi Elephant Reserve. The human elephant conflict data were obtained from the State Forest Departmental record and were verified through field visits, through personal interview to the affected family members and also to others who were directly or indirectly associated with the incident. The data for the last 12 yrs 2000-01 to 2012-13 were examined. During this period 157 people lost their lives 46 people were injured in elephant attack. Elephants are destroyed at least 287 houses and damage 11606.708 acres of paddy field in 12 years. Peak depredation seasons were August and October to January. Most of human killing was by lone male tuskers and depredation of crop by elephant herd when they pass between two habitats The authors suggest improvement of the effectiveness of elephant trenches, the need to establish solar power fences, establishment and improvement of elephants corridors, alternative crops through Government as well as and greater public awareness for the purpose external support. Payment of timely compensation to villagers for damages caused by the wild elephants will help to have the support of local people which is very much needed for long term protection and conservation of elephant in Odisha.

Key words: Asian Elephant · Human Elephant Conflict (HEC) · Elephant Mortality · Mahanadi Elephant Reserve · India

INTRODUCTION

Asian elephant is categorized as endangered as per the IUCN red list (IUCN 2013), listed on appendix I of CITES (Convention on International Trade of Endangered Species of Wild Fauna and Flora) and In India it is listed under Schedule 1 of the Wildlife (Protection) Act, 1972. Historically, the range of the Asian elephant extended from the Euphrates and Tigris rivers in West Asia to the Yangtze-Kiang River and perhaps beyond to China [1]. The Asian elephant is an important flagship species for the conservation of biodiversity as well as a cultural symbol of the people of this region. Today the Asian elephant is believed to number about 45,000 in the wild and is distributed across several populations over South and Southeast Asia [2]. The population of elephants has been affected adversely by a growing human population and the resultant destruction of natural habitats for settlement and cultivation.

Human-elephant conflict (HEC) is a major issue at present. Habitat fragmentation and loss, habitat degradation along with developmental projects such as

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Irrigation projects, canal projects, electric power lines, road ways, railways, industries, expansion of agricultural fields, increase of anthropogenic pressure on habitat etc have posed wide spread and significant threat to elephants and their habitats leading to Human Elephant Conflict(HEC) in the country [3-8].

Odisha elephants constitute nearly 72% of the total elephant population in the eastern region of the country. Nearly 50% of the elephants are using 12 of the 19 Sanctuaries in the State. Such Protected areas of where elephant conservation activities are being taken up includes Simlipal National Park (845.70sq.km), Simlipal Wildlife Sanctuary (2200 sq.km), Hadgarh Wildlife Sanctuary (191.06 sq.km), Kuldiha Wildlife Sanctuary (272.75 sq.km), Satkosia Wildlife Sanctuary (795.52 sq.km), Baisipali Wildlife Sanctuary (168.35 sq.km), Chandaka-Dampara Wildlife Sanctuary (175.79 sq.km), Kotgarh Wildlife Sanctuary (399.05 sq.km), Lakhari vdley Wildlife Sanctuary (185.87 sq.km), Khalasuni Wildlife Sanctuary (116.00 sq.km),Badarma Wildlife Sanctuary (304.03 sq.km) and Kapilash Wildlife Sanctuary (304.03 sq.km). In eastern elephant region Odisha state consists of designated three Elephant Reserves that contain mosaic of vegetation types and ecosystems harbouring high diversity of flora and fauna. Elephant Reserve (ERs) covering 20000 sq km spread over 20 Forest Divisions about 1500 elephants' population. The population of elephants in Mahanadi Elephant Reserve as the state elephant census 2012 is 534 which is the largest in comparison to three Elephant Reserves (ERs)

MATERIALS AND METHODS

Study Area: The Mahanadi Elephant Reserve (MER) is situated on the banks of the river Mahanadi in central Odisha. This Elephant Reserve as notified the "Mahanadi Elephant Reserve" constituted in the year 2002 vide notification no, 8F(W)17/02.10162/F&E Department, dated 19 June 2002 of the State Government. At the time of its notification the name was "Satkosia Gorge – Baisipalli Elephant Reserve" covering an area of 1,038.30 sq km. The present perspective plan includes its extension to an area of 8,036.32 km is located in the state of Odisha. It is spread over the civil districts of Angul, Cuttack, Nayagarh, Kandhmal, Dhenkanal districts of the state and includes Forests Divisions such as: entire Satkosia Wildlife Division, Mahanadi Wildlife Division and Athamallik Forest Division. Portions of Angul, Athagarh, Cuttack, Nayagarh, Boudh and Dhenkanal and A total of 32 Forest Ranges have their jurisdiction within this Elephant Reserve.

The reserve has dry deciduous, moist deciduous and semi evergreen forests [12]. May is the hottest month when the mean maximum temperature rises to about 48°C. December is usually the coldest month of the year on the minimum temperature drops down to 7°C. The average annual rainfall is 1260 mm. The forests of this area are mainly tropical moist and dry deciduous type, which are considered to be one of the favored habitats of elephants.

The Mahanadi Elephant Reserve hold several species of mammals, amphibians, reptiles and birds, apart from the endangered Asian elephant *(Elephas maximus)*. The other prominent mammals seen in the Elephant Reserve includes, Tiger *(panthera tigris),* leopard (*Panthera pardus*), Indian gaur (*Bos gaurus*), sambar *Rusa unicolor*), spotted deer (*Axis axis*), wild dog (*cuon alpines*) wild boar (*Sus scrofa*), sloth bear (*Melurus ursinus*), pangolin (*Maniscrassicaudata*), common mongoose (*Herpestes vitticollis*) and slender loris (*Loris lardigradus*), etc.

Vegetation Type: The reserve has dry deciduous, moist deciduous and semi evergreen forests.The main flora of Mahanadi Elephant Reserve are *Shorea robusta, Dillenia pentagyna, Bridelia squamosa, Terminalia alata, Terminalia arjuna, Syzygium cuminii, Adina cordifolia, Mitragyna parviflora, Lagerstroemia parviflora, Mangifera indica, Bursera serrata, Pterocarpus marsupium, Terminalia bellerica, Anthocephalus cadamba, Bombax ceiba, Gmelina arborea, Garuga piñnata. Miliusa velutina, Polyalthia cerasioides, Lannea coromandelica, Pterospermum xylocarpum, Macaranga peltata, Derris indica, Mallotus philippensis, Careya arborea, Bambusa arundinacea. Grewia helicterifolia, Flemingia strobilifera, Cycas circinalis, Strobilanthes scaber, Helicteres ixora, Clerodendrum viscosum, Thysanolaena maxima, Panicum species.* and the Perennial grasses are *Aristida setacea, Bothriochloa pertusa, B.bladhii, Cymbopogon martini, Chrysopogan gryllus, Chrysopogan gryllus C.montanus, Dicanthium annulatum, Dicanthium annulatum, D. Carricosum, Eragrostic coarctata, Eulaliopsis binata, Iseilema prostratum, Imperata cylindrical, Ichaemum rugosum Panicum species, Pseudosorghum fasciculare, Sporobolus indicus, Cyondon dactylon,, Heteropogon* etc.

Methodology: Information from 2000-01 to 2012-13 from the Forest Department records was used to quantify elephant depredations in the Mahanadi Elephant Reserve. Data on crop damage and house damage in incidents, human kill, human injury and elephant mortality was

collected from office of the Divisional Forest Officers and O/o Principal Chief Conservator of Forests (Wildlife), Odisha. Data was collected through field evaluations, site inspections, interviews and group discussions with villagers and rapidly assessments were carried out using the focus groups, field visit to area of elephant damage and reconnaissance in to the forest with villagers to observe habitat types and the conflict questions were asked about the land use pattern, details of human death and injury, ethnic composition of the villages and preventive measures.

RESULT AND DISCUSSION

Crop Damage: Description of Human Elephant Conflict (HEC) incidents during the period from 2000-01 to 2012-13 was analysed. A total of 1968 incidents of HEC from Mahanadi Elephant Reserve were recorded. Crop damage was the most common from of HEC, present 80% of the incidents. Crop damage included different type of cultivations such as paddy (*Oryza sativa*), gram (*Cicer aretinum*), sugarcane (*Saccharum afficinarum*), maize (*Zea mays*) and jack fruits (*Artocarpus heterophyllus*), mango (*Mangifera indica*), cashew (*Anacardium occidentale*) and vegetables. The highest incidences of crop raiding was recorded in paddy (96%) followed by sugarcane (75%), mango (21%), jack fruit (15) gram (8%), maize (5%), cashew (4%) and vegetables (2%) etc. of which damage to paddy in the field. In Mahanadi Elephant Reserve(MER) Human Elephant Conflict(HEC) was most in Angul Forest Division where crop damage due to elephant (8712.11 acres) during the year 2000-01 to 2012-13 (Figure 6).

House Damage: During the period from 2000-01 to 2012-13. A total of 287 houses was damaged, It included 146 houses fully damaged and 141 houses partly damaged. In Mahanadi Elephant Reserve where Angul Forest Division mostly affected by the HEC, the highest number of cases relates to House damage (251) occurred. Elephants attacked houses to consume stored food (commonly food) and mahua flower and to consume salt from kitchens. Maximum in such incidents damage to house holds and property damage was caused by females followed by its herd and tuskers.

Human Death and Human Injury: A total of 157 human death and 46 case of human injury occurred during the period from 2000-01 to 2012-13, Table 2 (Figure 2). All these incidence of them are accidental, as the victim came face to face with wild elephants accidentally, Human

mortality due to elephants in Mahanadi elephant Reserve represents 75 % of total cases of the three ERs that occurred during 2000-01 to 2012-13, tuskers were responsible for 65% of the cases of the death and human injury. The maximum number of human deaths occurred in Dhenkanal Forest Division, including 71 human death and 15 human injury incidents during the period from 2000-01 to 2012-13, (Figure 1). Must of the human deaths have occurred when the victims were in the crop fields.

Elephant Mortality: From the available records, it is seen that between 2000-01 to 2012-13, a total of 264 elephants were lost in the wild in Mahanadi Elephant Reserve (Figure 4) with an average of approximately 20 elephants deaths per year. Of these 43 were killed by poacher in field. This indicates into an annual loss of about 20 elephants. More recent data from the Mahanadi Elephant Reserve shows that in the year 2010-11 alone, about 30 elephants lost their lives, of which 63 died due to accidents, 27 were electrocuted, 7 were poisoned, 28 died due to natural, 55 died due disease and 48 due to "unknown causes". Mortality rates fluctuated some what within a year. Higher mortality was recorded during the month of October to January (harvesting time of the crop). The 264 elephant deaths recorded include 73 male elephants (28%), 89 female elephant (34%), 33 Juvenile (12%), 26 calf (10%) and 43 elephant whose sex was un identified (16%) (Figure 7). Division wise elephant death due to different reason in (Figure 5). The main causes of the death was poaching (18%), accidental (26%), electrocution (12%), Natural (23%), Disease (21%) reason not know (18%) (Figure 3).The mortality data indicates that nearly two third of the elephants that die are males. There fore the sex ratio of the wild elephants in the reserve is likely to change in future creating a female bias. In Mahanadi Elephant Reserve in 2010 a total of 37 elephants and 28 people were killed in the conflict. 50% of elephant mortality was recorded from the Northern sides of the Mahandi Elephant Reserve. The vast majority of elephants reported killed in the conflict succumbed to accidentally. In desperation farmers also use poison, often concealed inside palatable fruits, cash crops, sugar cane, to kill elephants. In addition, an elephant was also electrocuted, knocked down by trains

Electrocution Death: The recent and dramatic deterioration of habitats of these many elephant's remaining in Elephant Reserve and forest habitats are facing immeasurable risks to the existing elephant population. There are many reasons of human related elephant's deaths such as poaching and killing for the
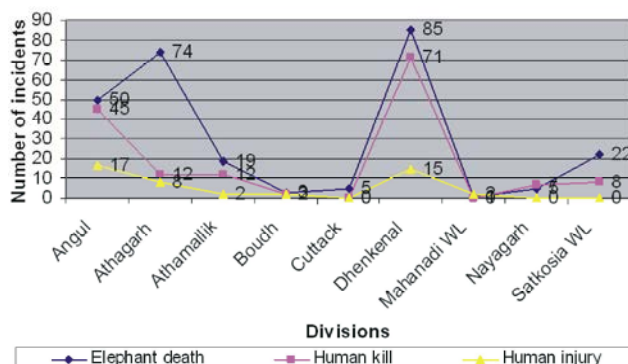
Fig. 1: Division wise elephant, deaths human deaths and human injury incidents period from during the 2000-01 to 2012-13 in Mahanadi Elephant Reserve, Odisha
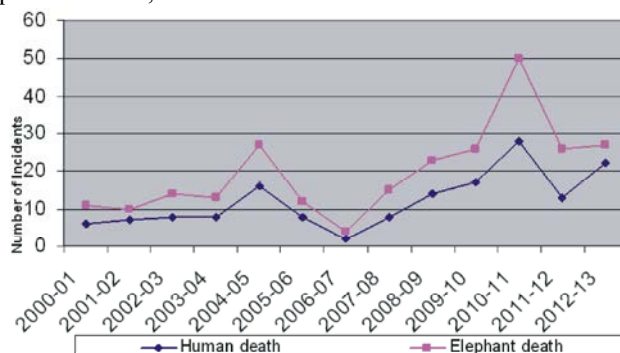

Fig. 2: Year wise elephant death and human death during the period from 2000-01 to 2012-13 in Mahanadi Elephant Reserve, Odisha
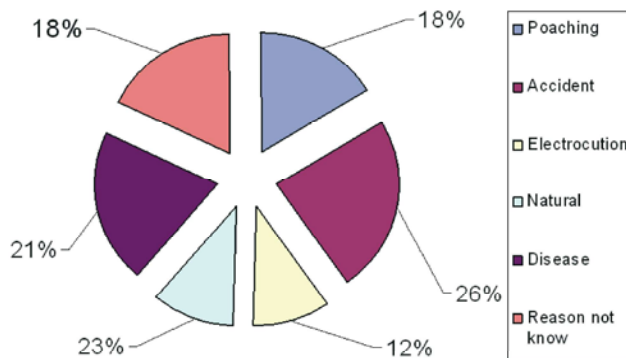

Fig. 3: Elephant death due to different reason (N=233) in Mahanadi Elephant Reserve during the period from 2000-01 to 2012-13
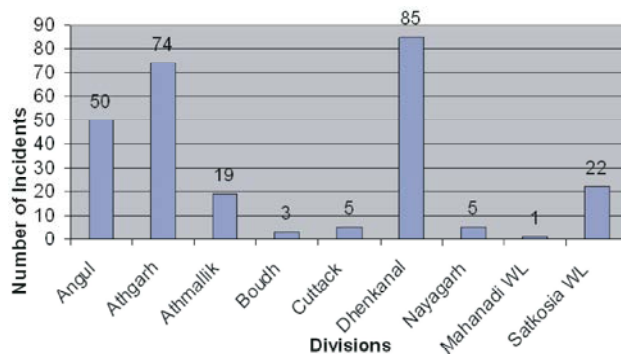

Fig. 4: Division wise elephant death (N=264) in Mahanadi Elephant Reserve during the period from 2000-01 to 2012-13
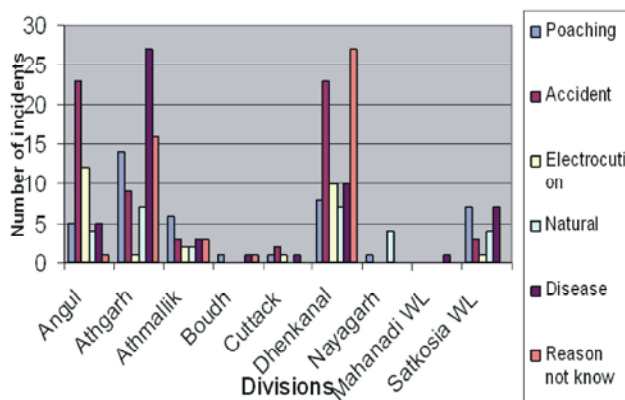
Fig. 5: Division wise elephant death due to different reason (N=264) in Mahanadi Elephant Reserve during the period from 2000-01 to 2012-13
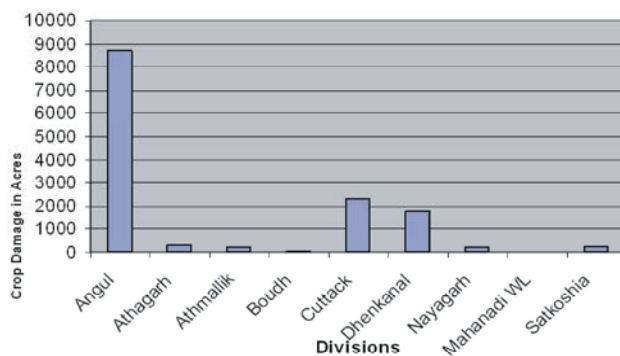

Fig. 6: Crop damage due to elephant in Mahanadi Elephant Reserve during the period from 2000-01 to 2012-13
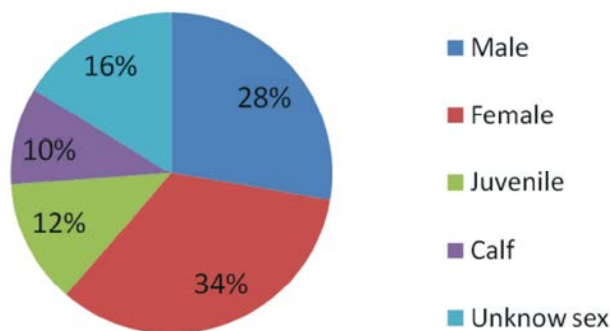

Fig. 7: Categories wise elephant mortality due different reason (N=264) in Mahanadi Elephant Reserve during the period from 2000-01 to 2012-13
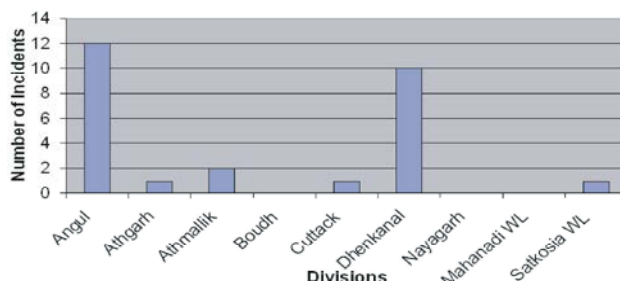

Fig. 8: Elephant death due to electrocution in Mahanadi Elephant Reserve from during 2000-01 to 2012-13

tusks, accidents on roads and railway tracks, poisoning, etc. Electrocution as a means to kill elephants is known in India from all parts of the elephant range [1]. but normally this is a crop protection endeavor by the farmers or a retaliatory killing by the affected villagers. Electrocution as an organised poaching method has only been documented thus far in rhinos on any scale that would cause concern [2]. However, a few elephants have also been electrocuted for their tusks in Odisha as else where in the country.

Electrocution is one of the most common causes of elephant's death in Mahanadi Elephant Reserve. In this Reserve a total 27 elephant deaths due to electrocution have been recorded during the period 2000 to 2012-13. In Angul Division and Dhenkanal Forest Division, elephant deaths due to electrocution have been 12 and 10 respectively. Recently one male elephant death in Athgarh Forest Division of Mahanadi Elephant Reserve has been recorded. Due to high tension electric power lines passing through in the forest area. The electric poles supporting the wires are placed a apart, resulting in sagging to having low. At times an elephant passing under the sagging wires accidentally touché it and gets electrocuted. In case of villagers/poacher the high tension wire are illegally trapped by the local people from the near by electric poles and used as a means to prevent crop raiding by elephants, poachers also follow the same method for poaching as seen in Athgarh Forest Division of Mahanadi Elephant Reserve [3].

Elephant Population in Odisha: The total Geographic area of Odisha is 1,55,707 sq. km (4.7% of the Country's total area) covering 30 districts, out of which 28 districts have presence of elephants as per Elephant Census 2012. In two districts ie. in Jagatsinghpur and Kendrapada so far presence of elephants have not been reported. The total population of elephants 1930 as per 2012 census report of Odisha Forest Department [4]. It is about 7% of the Indian elephant population. Odisha elephant constitute nearly 72% of the total population in the eastern India region. The eastern region population often called the Central India population includes the forest habitat in Jharkhand and Southern part of West Bengal. In the year June 2012 in 46 of the 50 Forest Division (barring Mangrove Forest Division Rajnagar, Puri Wildlife Division, Malkanagiri and Cuttack Forest Division). In the State, found 334 tuskers, 1087 female, 46 unknown sex and 463 calves the count was done based on direct sighting of elephant.

Status of Asian Elephant in Mahanadi Elephant Reserve: The elephants are found to be distributed in the entire Elephant Reserve. The present elephant population is in the elephant Reserve is bout 642 during the 2012 elephant census, there are 108 tuskers, 377 female, 18 unknown sex and 139 calves. The population is presently increasing but the human elephant conflict becoming biggest threat to their survival. Details of elephant population of Mahanadi Elephant Reserve given are (Table 1). A comparison of the state level elephant population in different census year 2005, 2007, 2010 and 2012 indicate have been: 464,595,568 and 642 which is indicates an increasing trend. The number of elephants has increased due to good habitat with improved water body, water harvesting structures, game tank and sufficient fodder species in this elephant Reserve [5].

Recommendations for Mitigating Conflict:

- All Elephant Reserves should have approved Management Plans which is not there at present. The management plans should have an approved budget for a specific plan period of 5 years with annual break up for activities such as for protection, conservation and research. The management plans prescriptions should also take in to account mitigative measures to avoid and minimize Human elephant Conflict (HEC) in the reserve and surrounding areas.

- Since increasing numbers of elephants are dying each year due to electrocution and as per the present study a total of 27 elephant death have taken place in this Elephant Reserve, Electricity department /Power Grid Corporation/National Thermal Power Corporation etc should be required to maintain the high tension lines at such heights which the adult elephant may not able to rich even when their trunks are fully raised, The existing guideline of CEC (Central Electricity Commission) should be strictly followed in this regard [6].

- It may be made mandatory that before lying of high voltage lines in elephant reserves, the Electricity department /Power Grid Corporation/National Thermal Power Corporation, etc, shall take prior permission from State Board for Wildlife/National Elephant Conservation Authority (NECA). This may also be made as a pre condition of of forest and wildlife clearance when such permission are granted by competent authorities of concerned departments

of Ministry of Environment & Forest, Government of India as well as the State Forest and Environment Department.

- Award schemes to be initiated for persons providing information relating to sagging of power lines and poles which may help prevent accidents and reduce to Human elephant Conflict (HEC).
- Check dams should be created in area where perennials water sources are available within elephant habitats. Similarly Game tanks should also be made where there is water scarcity in Summer Season, such that wild elephants do not come out of this habitat resulting in their deaths.
- Protection of elephant habitats along with establishment and development of elephant corridors should be made through rigid enforcement of provisions of existing laws.
- Emphasis should be given on capacity building of frontline staff and local villagers to mitigate Human elephant Conflict (HEC).
- Qualitative and quantitative information on dependency of local villagers on elephant habitats are required for evolving strategies for Eco-development and Eco-tourism Programme to reduce such dependencies and for providing alternative livelihood option to the local communities.
- Besides normal annual migration pattern, when elephant are reported to be straying out of their habitats causes of such straying has to be properly documented and scientifically evaluated so as to evolve strategies towards reducing such straying of wild elephants.
- Study on impact of climate change on elephants and their habitats should be initiated on a priority basis for minimizing adverse impacts, if any, This may be institutionalized by setting up of State Research Centre through funding support. Climate Change Action Plan of Government of India and Government of Odisha and Other Global agencies.
- Short drives which basically focus on driving elephants deeper into the forest or anyway from a particular village are often employed in high conflict areas.
- Anti depredation teams are crucial for drivers: Anti – depredation squad / drive teams are essential for containing elephants in high conflict areas.
- Barriers to elephant's movement are an important tool to contain damage, but they require careful planning, good execution and good maintenance.

- Supply of the Anti-depredation equipment at Range and beat level such as Siren, Drum, Powerful light, spot light with batteries and chargers, crackers, masal with kerosene, hooters etc.
- Emphasis should be given on capacity building of frontline staff and local villagers to mitigate Human elephant Conflict (HEC).
- Fences and Trenches can only work only as a part of larger landscape level planned intervention. Considering the persistent and common grievance in some areas that officials are not easily accessible to cultivators and other villagers affected by elephant and other wildlife crop damage, it is recommended that public hearings be held at least twice a year, at the start of the *kharif* and *rabi* sowing seasons (depending on locality), at taluka level.
- Practical means of valuing farmer investment in crop protection: The extent and severity of crop losses has led to deep resentment due to the burden on cultivators. In agricultural areas that lie adjacent to or within the elephant's range, the priority must instead be to increase effective protection to farmlands by implementing barriers that are non lethal to elephants. It is important to explore means of creating those barriers that go beyond the efforts of forest departments alone. Novel business models such as ones that provide "crop protection as a service", involve community-led collective action or private – public partnership must be encouraged to provide a diversity of crop protection options for varied contexts. Once created and maintenance agreements for these barriers have been reached with local communities insurance must become the standard means of offsetting further crop losses to elephants. Schemes such as the recently revised Modified National Agricultural Insurance Scheme must be adapted for this purpose and implanted in collaboration with entities such as Agricultural Insurance Company of India.

There may be a structured approach to crop compensation to ensure social justice. The maximum amount payable to an individual (family) should be based on some predetermined percentage of what the minimum wages (government rate in that area) a person's would earn in a year.

Status of Elephant Corridor in Mahandi Elephant Reserve (MER): Elephants are big migratory animals and move a long distance in search of food and require

Table 1: Number of elephants estimated in different Forest Divisions during different census year using direct count method

Divisions	2005	2007	2010	2012
Satkosia Wildlife Division	98	194	224	229
Mahanadi Wildlife Division.	17	1	7	5
Angul Forest Division	39	76	26	56
Dhenkanal Forest Division	71	132	129	162
Athagarh Forest Division	114	139	133	131
Athmalik Forest Division	62	23	15	28
Boudh Forest Division	43	16	8	4
Nayagarh Forest Division	0	6	12	5
Cuttack Forest Division	20	8	14	22
Total	464	595	568	642

Table 2: Elephant corridors in Mahanadi Elephant Reserve

Sl. No.	Name of the Corridor	Name of the Division	Width of corridor km	Length of the corridor km	Total area Sq km	Number of villages inside the elephant Corridor	House Hold	Human Population
1	Maulabhanja - Jiridamali- Anantapur	Dhenkanal	0.25-0.28	6.5	1.55	8	669	3327
2	Kahneijena-Anantapur	Angul	0.4-1.1	6.6	5.22	7	982	5021
3	Buguda-Central RF of Nayagarh	Nayagarh	0.8-0.6	2.6	0.76	3	99	422
4	Nuagaon-Baruni	Athmallik	0.4-4.6	4.5	20.7	12	399	1632

substantial areas to support the ecological need of elephant. But habitat loss, expansion of human habitation and fragmentation of traditional elephant corridors has forced the elephants to split into a number of meta populations or herds and move to new areas in search of food and shelter, in Mahanadi Elephant Reserve, four elephant corridor in different location of the divisions (Table 2) [7-11].

CONCLUSION

Most human killing was by lone male tuskers and depredation of crop by elephant herd when they pass between two habitats The authors suggest improvement of the effectiveness of elephant trenches, the need to establish solar power fences, establishment and improvement of elephants corridors, alternative crops through Government as well as and greater public awareness for the purpose external support. Payment of timely compensation to villagers for damages caused by the wild elephants will help to have the support of local people which is very much needed for long term protection and conservation of elephant in Odisha.

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