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A Status Study on Human-Elephant Conflict in and Around Savandurga State Forest

KEYWORDS: Human-Elephant Conflict; Savandurga; Crop Raiding; Line-Transect; Land Cover.

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ABSTRACT *The problem of crop raiding by elephants is new to this part of Bangalore rural district. Elephants used to visit this area occasionally and the number would be no more than 3-4. But since then the elephant problems have escalated at a rapid pace. The land cover mapping revealed that urbanization is not a major threat in the area. 73.143% of the total area of the range is covered by agricultural land. Encroachment on all around the forest patches was evident during the field studies. 18.7% is forest and 2.7% is water body in this range. 1.5% area is hillocks. Quarrying activities in these hillocks cause disturbance to elephants. Even though the forest patches degraded by the forest fire, cattle grazing, illegal felling of trees for firewood and trade, majority of the people denied venturing into the forest. Major occupation in this area is agriculture and animal husbandry. Studies revealed that the crop raiding intensity is more in the vicinity of the forest boundary. 93% of the affected villages were within 3 kilometers from the forest boundary. T-test values revealed that there is no difference in damage done to small and medium landholding farmers. The mean elephant density of the range is 0.07 which is less than that in Bannerghatta National Park. BNP is the nearest elephant habitat to the study area.*

INTRODUCTION

India holds by far the largest number of wild Asian elephants, estimated at about 26,000 to 28,000 which is nearly 60% of the population of the species (N. Baskaran 2011).In Karnataka, wild elephants are found in Eastern Ghats and also in Western Ghats. But Western Ghats supports major part of the population. (Karnataka elephant census 2010). Indiscriminate felling of forests, encroachments and development activities, such as industry, mining, dams, etc. have led to the shrinkage and degradation of elephant habitat leading to the escalation of Human-Elephant Conflict (Rakesh k Singh 2002).

Human-elephant conflict poses a major obstacle to elephant conservation efforts in the country. It is estimated that every year elephants damage 10,000 to 15,000 houses and 8, 00,000 to 10, 00,000 ha of crops (A Study of Man-Elephant Conflict in Nagarhole National Park and Surrounding Areas of Kodagu District in Karnataka, India 2007).Despite decades of research and significant financial resources invested, we still lack a fundamental understanding of which ecological and social factors drive human–wildlife conflicts. Even with significant financial resources and decades of research, we lack basic understanding of which ecological and social factors drive human-wildlife conflicts.

STUDY AREA

The Savandurga State Forest is situated in Bangalore rural district between latitudes 12.847° and 12.945°N, and longitudes 77.275° and 77.326°E, covering an area of 27 km2. A temple is situated on an enormous mass of granite, which stands on a base about 12 km in circumference and raised to a height of 1226 m above mean sea level. The Savandurga State Forest forms a part of the Deccan plateau and is covered by peninsular gneiss, granites, basic dykes and laterites. (Harish R P 2002). According to 2011 census, there are 49624 households in Magadi taluk with total population 203841 out of which 167122 is rural population and 36719. Average rainfall in Magadi taluk for the last decade is 806mm.

OBJECTIVES

1. Understand the land cover of the study area.
2. Conduct Line-transect to understand the population density of the study area.
3. Study the spatial and temporal distribution of the conflict in the area.

RESEARCH METHODOLOGY

LAND COVER MAPPING:

Land cover map of the study area was generated using ENVI 4.7 and ARC GIS 10 computer softwares. Toposheets numbering D43R4, D43R8, D43X1 and D43X5 were procured for Survey of India (SOI), Government of India. The images are of the size of a top sheet of scale 1:50,000. Satellite data was of Indian Remote Sensing Satelite-P6, linear imaging self-scanning satellite III (IRS-P6, LISS III) dated 12th November 2008. These satellite images were procured from National Remote Sensing Agency (NRSA) website, with ortho-rectification from Indian Space Research Organization, Bangalore. Since the study area was falling on 4 satellite images, all 4 satellite images had to be mosaiced. The shape file of the study area boundary was created from the topo sheets in ArcGIS 10 once they were georeferenced in the same. This shape file was then overlaid on the mosaiced satellite image. Using the clip option in ArcGIS 10 the mosaiced image was cropped according to the shape of the boundary of the study area. Supervised classification was carried out on the cropped image (study area) using ENVI 4.7. Maximum likelihood classifier performed the best out of all the classifications. The land cover was classified into 5 major classes i.e., urban area, hillock, forests, water bodies and cropland. Post-classification technique to obtain class statistics was carried out and its results were documented. The classified image was converted into a map and appropriate map keys were assigned using overlay annotation.

ESTIMATION OF ELEPHANT DENSITY USING LINE-TRANSECT DUNG COUNT METHOD:

In line transect sampling lines are placed at random in the survey region, or more commonly, a set of equally spaced parallel lines is randomly superimposed on the survey region.

Direct method is recommended when there is good visibility and when the elephant density is high in the area. While in cases of low elephant density areas, indirect method is adopted.

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Indirect method (dung count) was adopted for this research work. The reason to adopt this method is the low density of the pachyderms, less visibility due to presence of hillocks and thick thorny shrubs.

A total of 14 line transects were walked in the study area. Theoretically, that is on a toposheet a line transect of length of 2 Kms was decided. But on the field it was not possible to walk all 14 line transects of length 2 Kms. By fixing the compass in the direction of the line transects, they were walked. Any sightings of the dung pile, perpendicular distance was measured from the line-transect to the middle of the dung pile. Any inevitable obstruction on the way of walk, the walk was shifted parallely either to left or right to the transect keeping in mind the direction of the line transect.

SPATIAL AND TEMPORAL PATTERN OF THE CONFLICT:
Questionnaire survey
To understand the nature, intensity and people's perception about the conflict with the elephants a questionnaire survey was carried out in the study area. All questions were close ended. From the compensation data obtained from the Karnataka Forest Department, we could arrive at the number of villages which are experiencing Human Elephant conflict. After analyzing the compensatory data, it was found that a total of 58 villages had experienced conflicts with the elephants. These 58 villages were categorized into rare, low, moderate, high, very high, and intense according to the number of compensation claims.

Table 1: Details of the questionnaire survey based on the number of compensation claims

Degree of conflict	No of villages affected	No of villages to be surveyed	No of people to be interviewed
Rare	37	11	66
Low	7	4	24
Moderate	2	2	12
High	9	5	30
Very high	2	2	12
Intense	1	1	6
Total	58	25	150

(Source: Magadi Range Office, Karnataka Forest Department)

30% of the villages falling under the rare category were selected randomly and surveyed. In the case of low and high category 50% of the villages were surveyed by selecting them on a random basis. All the villages falling under moderate, very high and intense were surveyed. So a total of 25 villages were surveyed in my study area. From each village that was randomly selected, 6 individuals were interviewed. This included 2 farmers, 2 women and 2 from non-agricultural background and a total of 150 people were interviewed for this study.

Analysis of quantitative data:
Descriptive statistics was applied to evaluate the average distance at which the crops are grown from the forest boundary. The variation between the damage per acre and the different categories of land holdings was understood by applying box plots for these two variables. Student's t test was applied to check if there is any there is any difference in the damage done by the elephants to the farmers of different landholdings.

For three pairs of variables were correlated to evaluate the association between them. Distance from the land to the forest and damage per acre were correlated to check if the Pearson's coefficient is positive or negative. One more pair of variables which was correlated is distance of the land and area of cultivation. The third pair of variables for which Pearson's correlation coefficient was obtained is area of cultivation and amount of damage.

Analysis of qualitative data:
To analyze the qualitative data, cross tabs were applied to the different variables and also Chi-square tests were applied to check the level of significance between the attributes.

Attributes such as education, dependency of the villagers on the forest resource, landholding, and mitigation measures followed. Chi-squared tests were applied for different sets formed from the above variables.

RESULTS AND DISCUSSIONS
LAND COVER MAP OF MAGADI RANGE
By carrying out Maximum likelihood classification for the study area the land cover was classified into 5 different classes such as urban area, croplands, forest cover, hillocks and water bodies. This land cover classification was carried out at an accuracy of 80.8652% (486/601). The class statistics of the classification are as follows-

Table 2: Statistics of the land cover Magadi range

Class	Area in percentage	Area in km^2
Water bodies	2.678	22.9135
Forest area	18.782	160.7025
Urban land	3.882	33.2152
Crop land	73.143	625.8362
Hillocks	1.51	12.92
Total	100	855.5874

Table 3: Confusion matrix of Maximum likelihood classification.

Class	Water bodies	Forest area	Urban area	Crop lands	Hillocks
Water bodies	119	0	0	0	0
Forest area	0	126	0	5	0
Urban area	66	0	60	0	27
Crop lands	0	0	0	45	0
Hillocks	0	0	0	17	136
Total	185	126	60	67	163

ESTIMATION OF ELEPHANT DENSITY USING LINE-TRANSECT DUNG COUNT METHOD
Elephant density of a particular area can be calculated using the formula

$$E = \frac{Y * R}{D}$$

Where,
E = Elephant density,
Y = Dung density,
R = Rate of decomposition per day,
D = Number of defecations/ elephant/ day.

The dung density (Y) was estimated using the computer software Distance 6.0 after feeding the data obtained from the field studies. The value of rate of decompositions per day and number of defecations/elephant/day were arrived from A Roacha who estimated the R value to be 0.0104 and D value to be 16.33

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Table 4: Elephant population density estimated by Line transect dung count method

Mean dung density (per Km^2)	SE	Mean elephant density (per Km^2)	95% CI	
			Lower limit	Upper limit
109.73	51.004	0.07	0.02	0.17

By substituting the values in the above formula, it is evident that the average number of elephants present in the range is 6. Minimum and maximum numbers of elephants present based on the lower limit and upper limit values are 2 and 14 respectively. The study conducted in Bannerghatta National Park by A Rocha India in collaboration with Karnataka Forest Department proved an Elephant density of 0.7 elephants/ Km^2. Synchronized population estimation carried out by Karnataka Forest Department with the help of ANCF and IISC in all the forest divisions in Karnataka witnessed an elephant density of 0.27. The Elephants residing in this range are not the native ones. From the field studies conducted revealed that Elephants started to appear in this region from past 8 to 9 years.

SPATIAL PATTERN OF THE CONFLICT

A total of 58 villages were affected by elephants within the Magadi range. Out of these 58, 25 villages i.e., 43% of the villages fall within 1 kilometer from the forest boundary and 47 villages (81%) which are facing conflicts with elephants are falling within a distance of 2 kilometers from the forest boundary. 93% of the villages are within a distance of 3 kilometers from the forest boundary. All villages affected by Human-Elephant conflict in this area are within a distance of 4 kilometers from the forest boundary. Similar trend was seen after a study was conducted on HEC around Nagarhole National Park (NNP). 98.8% of the conflict incidences occurred in villages that lie within 6 km from the national park boundary. (Sanjay Gubbi). Similar trends were observed in another study conducted by Karnataka Forest Department in collaboration with Asian Nature Conservation Foundation in Mysore Forest Division.

Fig 1: Maps depicting the spatial pattern of the conflict in the Magadi range.

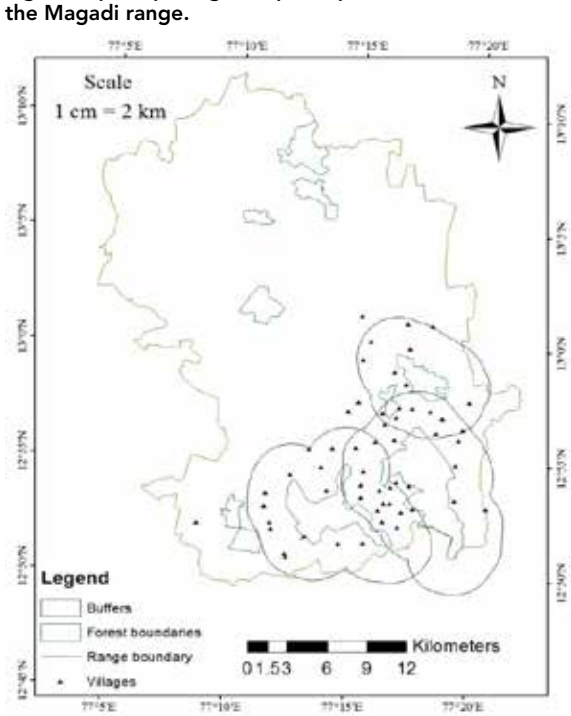

Table 5: Pearson's correlation coefficient between distance from land to the forest (Kms) and damage per acre for different crops.

Type of crop	Pearson's co-efficient
Areca nut	-.351
Banana	-0.076
Coconut	-0.2
Finger millet	-0.158
Jackfruit	-0.452
Mango	-0.54

When the distance from the land to the forests were correlated against damage per acre for different crops, Pearson's co-efficient for all the crops were negative, indicating the crop damages per acre is more in the vicinity of the forest boundary. Greater the distance from the forest boundary, lesser is the damage. Similar studies conducted also show that the intensity of the conflict is more near the forest boundaries. A study conducted on patterns of human–wildlife conflicts and compensation in 5 wildlife reserves, the model adapted in the study also showed a similar pattern in conflict (Krithi K. Karanth 2013). Crop raiding incidents were mostly concentrated along the Mansa National Park boundary and significantly higher depredation occurred in the villages that were adjacent to the park (χ=13259.35, P<0.001) (Naba K. Nath 2013).

Hypothesis formulation: H_0- There is no significant difference in damage done to small and medium landholdings.

H_1-There is significant difference in damage done to small and medium landholdings.

α =0.05

Table 6 : Results of independent sample t-tests carried out between landholdings and amount of damage.

Type of crop	T	df	P-value	Mean Difference	Std. Error Difference
Areca nut	-.524	24	.605	-1.20833	2.30647
Banana	-.338	12	.741	-3.08333	9.11774
Coconut	1.172	24	.253	2.60784	2.22462
Finger millet	2.282	67.844	.026	.34379	.15063
Jackfruit	.887	16	.388	.73757	.83143
Mango	.808	10	.438	4.00000	4.95311

Independent sample t-test was applied to confirm whether the damage caused to the farmers depends on the landholding. Farmers in this region were of the small and medium landholding type. 10% of the respondents of the (all small landholding farmers) during the questionnaire survey who don't have irrigation facilities admitted that they have stopped cultivation of crops and adopted animal husbandry or taken up other means of likelihood due to the havoc created by the elephants in the area. But the results from independent sample t-test show otherwise. Since the P value is less (if P is low null must go) than 0.05, null hypothesis was rejected, proving that there is no significant difference between landholdings and the damage done by the elephants per acre

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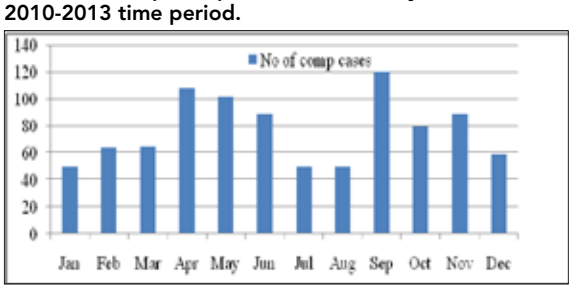
TEMPORAL DISTRIBUTION OF THE CONFLICT:

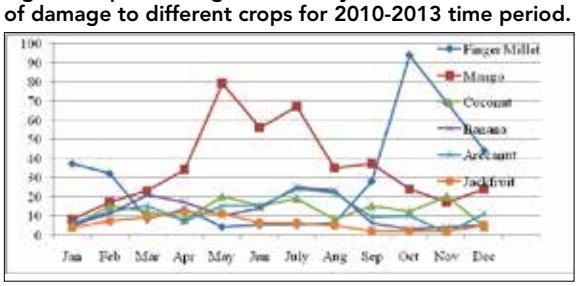
Fig 2 : Graph depicting the monthly trend in the average number of crop compensation claims by the victims for 2010-2013 time period.



(Source: Magadi Range Office, Karnataka Forest Department)

This graph clearly indicates two peaks in crop damages caused by the elephants. Two vastly damaged crops are finger millet and mango. The 1st peak (April-June) is mainly due to the damage of mango plantations. The second peak coincides with the mature and harvesting season of Finger millet. Depreciation in the number of crop damage cases in the month of July is because of the better availability of fodder and water in the forests. One more reason can be the unavailability of matured finger millet crops during these months. Similar studies conducted in Sambalpur Elephant Reserve in shows maximum damage was caused to paddy fields during the harvesting months of November and December (Nimain C. Palei 2013).

Fig 3 : Graph showing the monthly variation in the extent of damage to different crops for 2010-2013 time period.



(Source: Magadi Range Office, Karnataka Forest Department)

Out of all the crop damages caused by the elephants, maximum damage (33%) was done to the mango plantations. The main reasons for maximum of this particular crop are the fact that it is a perennial crop and it is extensively cultivated. Finger millet consisted about 27% of the damage. Since it is a kharif crop, the intensity of the damage is more during the mature and the harvest seasons. 11% of the damages were caused to Coconut plantations. Banana and Areca nut crop were damaged to an extent of 11% each. Others crops which were damaged summed up to 11%.

The damage of the crops cultivated around the vicinity Nagarhole National Park are as follows-Finger millet (20.61%), maize (20.51%), cotton (19.43%), paddy (14.17%) and sugarcane (11.61%) formed 86.34% of the total crop losses. Paddy was the most commonly predated crop (30.1%) by the wild elephants followed by cowpea (27.0%) and coconut (23.8%) in Hambegamuwa in Thanamalwila which is one of the agricultural areas next to the Northern border of the Udawalawa National Park (UNP) in Sri Lanka (Jayantha. D). This shows elephants raid most of the cultivated crops and the extent of crop raids are site specific.

CONCLUSIONS:

In the study area the land cover is dominated by crop lands/ agricultural land. There is not much of urbanization compared to Bangalore urban. The forests in this region are highly fragmented. The biggest forest patch is of the size 29.89 (Savandurga State Forest) kilometer^2. This is where maximum number of elephants reside for maximum time. Two more patches of forests close to Savandurga State Forest are also frequently used by the elephants. The area of these three forests sum up to 66% of the total forest area. This proves that elephants wide ranging and need large habitats. If all patches of forests were in a one cluster, it would have been comfortable habitat for elephants. Even though the elephant density in this region is less compared to the one of BNP and whole of MER, residents of the Magadi range are witnessing conflict. The main reason is the highly fragmented forest area.

In this region, crop raiding instances are reported in all months of the year. Almost all the crops are raided by these animals. From this we can infer that there is lack of fodder in the forests throughout the year and also cultivated crops are easy pickings for these pachyderms. Elephants raid the crops only during the night and also 93% of the conflict villages are within a distance of 3 kilometer from the nearest forest boundary. From this it is evident that elephants avoid face off with human beings. They just venture out of the forests for food and water.

Since this problem escalated recently in this region, the residents of the affected villages fear venturing out of their houses after dark. Knowledge on the group size and age-sex structure of the elephants in the area is poor.. The forest cover present in the Tumkur Division is also used by these elephants. During the month of March and April a herd of elephants had forayed to Tumkur. Even in 2013, this movement pattern was seen in more than 5 occasions. Experts say that these elephants have migrated from Bannerghatta National Park. Only traditional measures such as bursting crackers, beating drums, screaming, and shouting are followed. Even solar fences and elephant proof trenches are found to be ineffective in mitigating this problem.

However, parameters like elephant behavior, movement patterns, maintenance of physical barriers could be more important determinants of the conflict

REFERENCE

1. Sanjay Gubbi., (2012) Patterns and correlates of human–elephant conflict around a south Indian reserve, Biological Conservation, 148, 88–95. | | 2. Ananda Kumar, M., Divya Mudappa. and Shankar Raman, T. R. (2010) Tropical Conservation Science, Vol.3 (2), 143-158. | | 3. Krithi K. Karanth., Arjun Gopalaswamy, M., Parvathi K. Prasad. and Shreya Dasgupta. (2013) Biological Conservation, 166, 175–185. | | 4. Krithi Karanth, K., Lisa Naughton Treves., Ruth DeFries. and Arju Gopalaswamy, M. (2013) Living with Wildlife and Mitigating Conflicts Around Three Indian Protected Areas Environmental Management, DOI 10.1007/s00267-013-0162-1. | | 5. Baskaran, N., Surendra Varma., Sar, C.K. and Raman Sukumar. (2011) Current Status of Asian Elephants in India, Gajah, 35, 47-54. | | 6. Ahimsa Campos-Arceiz. and Steve Blake. (2011) Megagardeners of the forest e the role of elephants in seed dispersal, Acta Oecologica 37, 542-553. | | 7. Rudra Narayan Pradhan., Pandab Behera and Sandeep Ranjan Mishra. (2013) | | 8. Man-Elephant Conflict: Case Study from Angul Forest Division, Odisha, India, International Research Journal of Environment Sciences, Vol. 2(11), 106-110. |