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Indigenous Ecological Knowledge of a Human-Elephant Interaction in Transmara District, Kenya: Implications for Research and Management

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Indigenous ecological knowledge (IEK) of the Maasai community in the context of their interaction with elephants around Masai Mara National Reserve (MMNR), Kenya is explored. Although Maasai community land sustains a huge elephant population, it is experiencing increased human-elephant conflict (HEC). Focus group discussions combined with scientifically collected data were used in assessing the relevance of IEK to elephant related ecological research. The Maasai narrated their experiences with elephants which were then formulated into hypotheses and tested scientifically by designing experiments that were monitored to prove the authenticity of IEK. Respondents had in-depth knowledge of some key ecological processes. Drunken people were more likely to be attacked by elephants, and elephant movement into adjacent group ranches increased with increasing wildebeest density. Elephants mainly raided ripe or mature crops while pupils within the elephant range performed poorly in national examinations. Based on this, there is strong evidence that IEK could be used to design sustainable conservation strategies. It is recommended that understanding of IEK in mitigating HEC and its subsequent integration into HEC decision support system is necessary in order to resolve conflicts.

Keywords: Indigenous Knowledge; Masai Mara; Human-Elephant Conflict

Introduction

The semi-arid savannah ecosystem in Eastern Africa supports a large population of the African elephant (*Loxodonta africana africana*) and pastoral communities. Pastoralism is viewed as a compatible form of land-use with elephant conservation (Western, 1994). However, concerns have been raised over recent introduction of agriculture in the Mara ecosystem (Sitati et al., 2003) by immigrant farmers, which some Maasais are adopting. Consequently, human-wildlife conflicts have ensued and threaten livelihoods and wildlife conservation (Sitati et al., 2003; Kamonjo et al., 2007). The conservation of savannah ecosystems is therefore becoming a priority for conservation organisations (WWF, 2007). Understanding the new challenge of conflict and putting in place the necessary mitigation measures are crucial for future survival of wildlife and their habitats.

Among the approaches to elephant conservation, community involvement has in recent years received widespread acceptance, despite recent critiques and project failures (Sitati & Walpole, 2006; Parker & Osborn, 2006). This approach views local participation as a prerequisite to sustainable conservation of natural resources, and its promotion has been accompanied by a raised awareness and appreciation of IEK (Ashenafi & Leader-Williams, 2005).

Globally, IEK is not only recognised for its intrinsic value, but also due to its potential instrumental value to science and conservation. Local communities have in-depth knowledge about their immediate environment and IEK has been used where baseline data are needed to improve ecological research and to design conservation programmes. Due to scarcity of scientific data, IEK may offer an alternative source of information which can be rooted in long-term ecological studies (Ashenafi & Leader-Williams, 2005). Despite this, indigenous knowledge on human-elephant interaction has neither been applied nor well-documented in elephant studies.

In this paper, we report results from an assessment elephant related Maasai IEK with respect to ecological processes and elephant-environment relationships.

Methods

Transmara lies in the south-west of Kenya on the border with Tanzania, and encompasses the western portion of MMNR. The district supports 540 - 820 residents and migratory elephants on community land (Sitati, 2007), while Narok supports over 2000 elephants (KWS, 2006) some of which move up the escarpment out of MMNR seasonally and cause conflicts like crop raiding, property damage, and stopping children from going to school among others (Sitati et al., 2003). Traditionally, over 25,000 affected Maasais attempt to mitigate the conflict.

Assessment of Indigenous Ecological Knowledge

Twenty four Maasai community members with different background experiences participated in focus group discussions and gave historical accounts of the status, distribution and behaviour of elephants in the district, and past human-elephant

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relationships. During the discussions, leading questions were either read to participants or asked indirectly and this elucidated more questions. Discussions were complimented with other probing techniques that depended on the responses in order to gather information that participants could not disclose openly and also to collect diverse views. Interesting responses were treated with an echo probe to allow a participant to continue talking while baiting probe was used to reaffirm what had already been learned, and to elicit further what participants were reluctant to discuss.

Group discussions elicited information for testing scientifically among them an outline of some long term observations of human-elephant interactions based on experience, and which derived the following checklist questions: Do elephants have a high preference for mature maize? Under what circumstances are people attacked by elephants? Does wildebeest migration increase the number of elephants on community land? Do pupils located within the elephant range have lower mean scores in national examinations? These questions formed the hypotheses and were subjected to scientific investigation for confirmation.

Elephant's Preference for Mature Maize

To test the hypothesis that elephants damaged more mature and dry maize than young and middle level maize, ten community scouts were trained to enumerate crop-raiding incidents to circumvent the problem of exaggeration of reported conflict by farmers (Siex & Struhsaker, 1999). Farmers reported elephant crop raiding incidents to their local enumerator who visited the farm and recorded details of each incident on a standard form (Hoare, 1999b) which included: level of maize maturity using four categories; "young" (maize fields without tassels), "middle" (tasselled maize with immature cobs), "mature" (ready green maize), and "dry" (maize getting ready for harvesting). Data were, first, subjected to Kolmogorov-Smirnov test for normality, and then the percentage of the different maturity levels of maize was derived. The chi-square goodness of fit test was used to test whether the observed proportions for a maize maturity level differed from hypothesized proportions.

Assessment of Elephant Attacks on People

In order to test the hypothesis that elephant attacks on people usually occur in the morning or at night, and that drunk people are more likely to be attacked, focus group participants enumerated the names and areas of past cases of elephant attacks on humans. The information was verified using Kenya Wildlife Service (KWS) Occurrence Books (OBs) records and District Compensation Committee documents. Families of victims were visited and interviewed and information on victims' sex, tribe and state (whether drunk or sober), and time collected. A chi-square goodness of fit test was used to test whether the observed proportions for a categorical variable differ from hypothesized proportions while a logistic regression was used to analyse the factors that may determine the likelihood of elephant attack on people (Drapper & Smith, 1981).

Monitoring of Elephant-Wildebeest Interaction

Elephant counts and wildebeest densities were used to test the hypothesis that elephant movement between the reserve and adjacent community lands increases with increasing wildebeest density. Focus group participants identified three frequently used elephant corridors between MMNR and communal lands for monitoring elephant movements. Community scouts and KWS rangers were stationed in the corridors and recorded elephant numbers and time of using the corridors daily for 12 months. A monthly count of wildebeests was undertaken in MMNR using seven permanent road transects to determine the wildebeest density for 12 months. Wildebeests within a distance of 200 m on both sides of the road were counted for a distance of 10 km, and the density calculated as the number of wildebeests per km^2. The Analysis of variance (ANOVA) and correlations were used for analysis.

Performance of Schools in National Examination

Finally, to test the hypothesis that pupils from elephant range have lower mean scores than those from outside the range, a comparison between the mean scores of 96 schools in the primary school national examination, both in (n = 31) and out (n = 65) of the elephant ranges was made. The schools' mean scores for performance in national examinations were collected from the District Education Office and used to test the hypothesis that schools within the elephant range have lower mean scores in national examinations. Nonetheless, since not all the pupils within the elephant range experienced problems with elephants, the mean scores of 277 pupils who sat for the national examination in 1999, both within and outside the elephant range, were obtained from 18 randomly selected primary schools. Other details collected included: the number of days absent, distance covered to school, and whether or not elephants interfered with the pupils. The mean scores for schools and pupils with respect to elephant range were compared using ANOVA.

Results

Elephants Preference for Mature and Dry Maize

According to IEK based on group discussions, elephants have high preference for mature and dry maize, and disappear from farming areas once maize has been harvested until the next planting season. Results also revealed that a total of 329 farms were raided by elephants. Data collected on levels of maize maturity were normally distributed (Kolmogorov-Smirnov z = 4.57, p = .000). Since maize was planted in February and March, elephants did not raid farms with very young maize. In April all maize was either young or middle, while from May to September maize was mainly mature or dry. The second planting season was September and October leading to mature and dry maize from November to January. Surveys of raided farms showed that elephants attacked more mature (53.7%, n = 261) and dry maize (37.2%, n = 181) than young (3.3%, n = 16) or middle (5.8%, n = 28) maize crops (χ^2 = 177.565, df = 3, p = .000, **Figure 1**).

Elephant Attacks on People

Group discussions revealed that the majority of the people attacked by elephants were those who stayed out late in bars and in homesteads during traditional ceremonies and walked back home late. People who engaged in early morning activities also risked being attacked. A total of 56 elephant attack cases on people were recorded between 1960 and 2000. Out of 53 such cases, 17 people were reported as "drunk", and 36 were

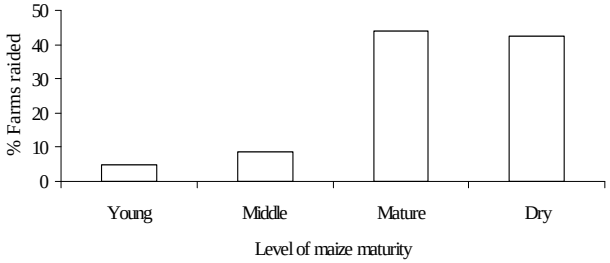

Figure 1.
Maize maturity level and percentage composition of raided farms by elephants.

"sober". The proportion of human deaths to injuries was not varied (χ^2 = 2.283, df = 1, .131) over time. However, the Maasai suffered more attacks (χ^2 = 23.11, df = 1, p = .001) than non-Maasai. More males were attacked than females (χ^2 = 25.83, df = 1, p = .001), and the six females (13%) attacked were all Maasai. Most elephant attacks on people occurred early in the morning (0600 - 0900 hr) and late in the evening (1900 - 2900 hr), while fewer (χ^2 = 14.075, df = 2, p = .001) cases occurred during mid-day and afternoon (**Figure 2**).

The logistic model for factors that might have determined the likelihood of an elephant attack on people produced a goodness of fit of 73.3% of observed to expected values. Results showed that of the factors examined including a person's state, sex, tribe and time of attack, the state of the person, whether drunk or sober, was the only factor that determined the likelihood of attack (**Table 1**).

Wildebeest Migration and Elephant Movement

The IEK from group discussions revealed that seasonal migration of wildebeests from Serengeti into the Mara ecosystem from July drove elephants out of the reserve into adjacent community lands. A total of 13,059 elephants were recorded moving between MMNR and community lands between July 1999 and June 2000. The composition of elephant groups using the corridors differed between months ($F_{11,981}$ = 14.365, p = .000). Mixed herds dominated between August and December while more bulls used corridors from January to July. Increased elephant movement coincided with the end of the crop raiding season meaning that crop raiding was mainly by the resident elephant population. Elephant numbers correlated positively (p = .001) with wildebeest density (**Figure 3**).

Schools and Pupil Performance in Relation to Elephant Range

According to group discussions, school children were affected by the presence of elephants and had to report to school late and/or leave early to avoid elephants on the way. This affected their performance in national examinations. Five year averages of the mean scores of 96 schools were obtained for 1995 to 1999. The mean scores were normally distributed (Kolmogorov-Smirnov z = .765, p = .601). ANOVA showed there were differences between scores and the location of schools within and outside the elephant range ($F_{1,94}$ = 19.54; p = .001). There were only three boarding schools which had a high mean grade (316.39 ± 32.74, n = 3) compared to day schools (298.65 ± 59.37, n = 93). However, scores for boarding schools did not differ from day schools ($F_{1,94}$ = .263, p = .609). Finally, a boarding school within the elephant range had a mean score of 348.66 compared with the two boarding schools outside the elephant range whose mean scores were 317 and 283 respectively.

Table 1.
Factors determining elephant attacks on humans based on logistic regression.

Variable	B	SE	Wald	p
Constant	–5.014	2.159	5.389	.0203*
State (drunk or sober)	2.816	1.154	5.959	.0146**

Level of significance shown with * = p < .05, ** = p < .01.

Although pupils from the elephant range had low mean grade, the scores for 277 pupils were normally distributed (Kolmogorov-Smirnov z = .857, p = .454). ANOVA showed that there was a difference between other factors that may influence performance (mean scores) including distance from home to school ($F_{3,273}$ = 10.346; p = .001); tribe ($F_{1,275}$ = 12.101; p = .001); length of absenteeism ($F_{3,261}$ = 7.76; p = .001); and, school location relative to elephant range ($F_{1,275}$ = 7.70; p = .006).

Discussion

Due to past experiences with elephants, the Maasai practise intensive guarding of crops as they mature. The Maasai believe that elephants usually send a few animals to investigate the status of crop maturity and then appear in big numbers when maize is mature. Study results revealed that the levels of maize maturity determined the seasonal patterns of crop raiding (**Table 1**). Young and middle level maize farms were raided mainly when: 1) farms were located along elephant routes; 2) an area had young, middle and mature maize and/or 3) elephants went out to inspect the level of maize maturity. In the later case, maize maturity raiding appears explanatory and conforms to indigenous knowledge. Elephants come in contact with agricultural land more easily during their natural movement patterns and not necessarily to raid crops (Sukumar, 1989; Hoare, 1997; Osborn, 1998). However, the ability to sense the maturity level of maize has not been understood. Mature maize is preferred because of its high nutritive value and higher percentage of moisture during the dry season than grass and browse (Osborn, 1998).

According to Sam et al. (1997) crop raiding occurred when crops were mature during the dry season, and natural forage is in short supply. Hence mature crops provide an important dry season food source (Osborn, 1998). In contrast, Hoare (1997) reports that crop raiding did not necessarily occur when crops were mature. These contradictory findings suggest that crop raiding may either be opportunistic, implying a preference for, rather than reliance upon, crops as a source of food.

Results revealed a strong correspondence between the Maasai IEK and experience of human-elephant interaction. This however, does not imply that Maasai knowledge of ecological interactions is equal to that of scientific ecology. A trained ecologist may benefit from in-depth dialogue with local people (Donovan & Puri, 2004). Based on this, participants suggested that 1) elephants are more likely to attack men than women; 2) most elephant attacks on people occurred mostly in the evening or in the morning (**Figure 2**); and 3) drunk people were more

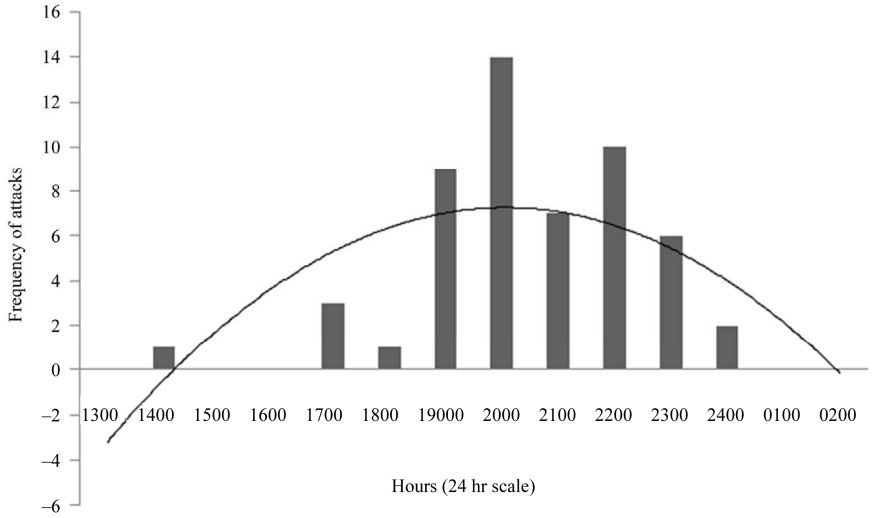

Figure 2.
Time and frequency of elephant attacks on people in transmara district.

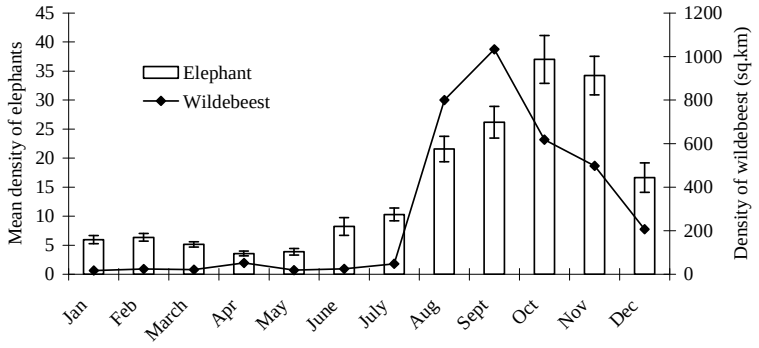

Figure 3.
Relationship between wildebeest density in Masai Mara national reserve and the mean (±SE) number of elephants moving into communal areas between January and December 2000.

likely to be attacked by elephants (Sitati et al., 2003). The scientific data generated confirmed all the three suggestions as true.

Migration corridors exist in most elephant ranges, and this influences elephant movement (Soule & Gilpin, 1991; Sam et al., 1997). In Luangwa Valley, elephants moved from the valley to the higher slopes of the Muchingas to get *Musuku* (wild fruit), or to a pool of medicated water known as *Chipatala* (hospital of sick and wounded elephants) (Melland, 1938). Elephants in Transmara District move up the escarpment to feed on *Acacia*, which is not in the northern part of the reserve and to access forest products and salt licks (Sitati et al., 2003).

Elephant corridors along the escarpment in Transmara influenced elephant movement between the reserve and communal land especially during the migration of wildebeests. Elephants from the reserve move up the escarpment every evening and return to the reserve in the morning (Sitati et al., 2003). According to Laws et al. (1975) and Leader-Williams et al. (1990b), elephants form large herds in situations where they feel threatened and these aggregation behaviour and their movement while it is dark possibly serves as a security measure on community land. However, bulls have been reported to venture into risky movement (Sukumar, 1991; Thouless & Dyer, 1992) to access high nutritive food for reproductive purposes. Despite this, elephants are now losing their fear of humans (Tchamba, 1995).

Although elephants are often cited as interfering with learning activities (Ngure, 1995; Mwathe et al., 1998), this allegation has never been explored scientifically. Study results however, showed that pupils and teachers lose many hours as elephants sometimes block all routes between home and school. Some schools also close earlier than usual, to enable children to look for safer routes back home, and sometimes adults have to escort children to school. Such factors could definitely have a negative impact on pupil performance and this probably explains why schools outside the elephant range have higher mean scores than schools within the elephant range. Despite this, distance from school was the most important factor in determining pupil performance as pupils who are exhausted from a long walk cannot concentrate in class, are often absent, and do not have enough time to finish their assignments. Pupils with unfinished assignments may also avoid school.

Elephants were often used as an excuse for absenteeism and late arrival in schools, which was difficult for teachers to verify.

According to Mwathe et al. (1998), elephants alone may not be responsible for pupils' absenteeism.

Hence the establishment of boarding schools is seen as the best mitigation measure. Additionally, some Maasais have resorted to having two homesteads. One homestead is located near a school so that children can attend while the other, mainly for livestock, is away in elephant areas.

This study has demonstrated that the Maasai community has detailed knowledge of elephants and their ecology and interaction with people. The relevance of Maasai IEK to elephant research and management is threefold. First, the congruence between Maasai and scientific knowledge of elephants suggests that local experts may be consulted for rapid and reliable ecological assessments since local experts often recognize unique elephant characters better than external scientists. Secondly, understanding the cause of HEC shows that there is great potential for combining elephant conservation and mitigating of conflict and improving local livelihoods. Lastly, local concepts and understanding of ecological processes may provide valuable inputs to ecological research, and locally rooted knowledge based on long-time observations may be crucial, especially in the absence of a scientific base.

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