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Full Length Research Paper

Human–elephant conflict: Do elephants contribute to low mean grades in schools within elephant ranges?

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African elephant' interfering with pupils' attendance at school is one of the often mentioned, but less documented form of human-elephant conflict (HEC) and can result in reduced education standards of pupils and schools, human deaths and injuries and the retaliatory killing of elephants. This, however, has not been proven, apart from the anecdotal evidence; hence no mitigation measures have been tested to ameliorate the problem. Crop raiding by elephants remains the most researched and documented form of HEC with elephant deterrents devised, promoted and tested as tools for reducing such conflict across the elephant range states. We compared performance of pupils and schools, both within and outside the elephant range in Transmara District, Kenya, adjacent to Maasai Mara National Reserve. We evaluated schools and pupils performance using National examinations means scores, standardized and set by the Kenya National Examination Council(KNEC). We compared the performance of pupils who were affected versus those not affected by variables such as days absent from school, the distance covered by pupils to school and their ethnic background, to assess the effect of other factors on performance. We found that mean pupil scores within elephant range were significantly lower than mean scores outside elephant range, but factors such as distance traveled to school and ethnic background may influence performance more strongly than HEC. We found little evidence to support the notion that elephants contribute towards the lower mean score of pupils within the elephant range. We recommend that a more detailed study be carried out that includes the proxy variables for teacher-pupil ratio; parental characteristics; as well as schools characteristics; learning and non-learning infrastructure using a product function approach to derive any mitigation strategies aimed at improving performance or the mean score within elephant range.

Key words: Human-elephant conflict, Maasai Mara National Reserve, schools performance, pupil scores.

INTRODUCTION

Human-elephant conflict (HEC) is a major threat to the African elephant *Loxodonta africana* (Stephenson and Ntiamoa-Baidu, 2010). Many forms of HEC have been identified, most of which relate to crop-raiding (Sitati, 2003; Stephenson, 2004; WWF, 2005). A less well documented form of HEC is elephants presence interfering with children's attendance at school, perceived as a media driven issue. Apart from the risks of elephants attacking pupils and their parents on the way to and from school, such conflicts would be expected to have a negative impact on the pupils' education and their school grades. Understanding the negative impacts of elephants on school children is crucial to designing HEC mitigation strategies and is therefore important for the conservation of this species (Sitati, 2003). However, till date, the issue

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is mentioned in just a handful of studies (Ngure, 1995; Munyungi, 1997; Mwathe et al., 1998).

Transmara District is one of the hot spots for HEC conflict in Kenya (Kenya Wildlife Service, 1995; Sitati, 2003; Sitati et al., 2003). African elephants were once widespread throughout the district and beyond (c. 2,900 km^2) but are now restricted to the central part of the district (~ 1,200 km^2) due to human settlement, cultivation and habitat loss. The current range supports both resident and migratory elephant populations whose population has increased from between 200 to 300 individuals (Wamukoya et al., 1997) to about 650 individuals (Sitati, 2007) that occupy mainly the unprotected intact forest complex. The increasing elephant population is explained by a low level of poaching incidences and a low number of retaliatory killings by the local community and an increased presence of community scouts on the ground, as a result of an HEC mitigation project implemented over several years by the Durrell Institute of Conservation and Ecology and World Wide Fund (WWF) with KWS (KWS warden pers. Comm.). Due to high rainfall and fertile soils, the district supports vast amount of nutritious forage, making Transmara a dry season refuge for elephant population from the Masai Mara National Reserve. Elephants disburse out of the forest into human settlements in the evening to forage and in most cases end up destroying people's crops at night and return back into the forest in the morning (Personal observation). However, the time spent out of the forest depended on the weather conditions and the availability of forage. For instance, during wet and cloudy seasons in April to June and September to December, elephants leave the forest early (1700 h) and return late (0700 to 0800 h). These times, however, coincide with the time primary school pupils aged between 6 and 15 years either going to school in the morning or leaving school in the evening.

In Kenyan primary schools, pupils are supposed to be in school by 0700 h and lessons begin at 0820 h. In the evening, the normal time for schools to close is 1700 h and pupils walk varied distances to their home, up to more than 5 km. In Transmara, as a result of concerns over elephant encounters, pupils arrive in school later (0800 to1000 h) and leave school earlier (between 1500 and 1600 h) (Sitati, 2003). By losing valuable school time, teachers are unable to complete the syllabus by the time pupils sit for National examination set by the Kenya National Examinations Council (KNEC) but are subjected to the same assessment with other pupils in the country that do not experience problems with wildlife and all compete for the few good public secondary schools. Hence, mitigation of this complex problem is an essential part of efforts to ensure children gain access to quality education. High illiteracy levels in the district (56%) may be related to the high poverty levels (64%) (Government of Kenya, 2007).

Elephant attacks on people and interference in their day-to-day chores is a common media story and the local people sometimes retaliate by killing or injuring elephants or by pushing the authorities to remove problem elephants (see Melissa groo media postings). This is done by either shooting them or by scaring using blanks, which however, does not solve the problem but simply shifts the problem from one area to another (Sitati and Walpole, 2006). Due to confinement of elephants in a small area, this approach makes elephants more aggressive, posing more risks to people. Elephant attacks on people are ranked as the number one conflict (Sitati and Ipara, 2007) and the local people develop negative attitudes towards elephants and protected areas (Nyhus et al., 2000; Sitati, 2003). Effective mitigation of this form of HEC is therefore an essential part of efforts to conserve elephants. To cope with the problem, children are escorted to school by parents or guardians. Others have polygamous family units where one wife is settled near a school away from elephant areas and takes the responsibility of taking care of school going children from wives living in elephant areas while she is exempted from livestock keeping (Sitati, 2003). Other coping strategies include sending children to boarding schools or children staying with family friends and relatives away from elephants.

The novel strategies employed to deter elephants from crop raiding cannot be applied in this form of conflict. For instance the use of chilli deterrent which has been tried across the range as hand-held pepper sprays (aerosols) or smoke canister bombs fired from simple mortar-like launchers and burning chilli-dungs (Osborn, 2002; Osborn and Parker, 2002, 2003, 2006; WWF, 2005) can endanger the lives of children and escorts.

There have, however, been no studies to determine if elephants contribute to lower performances in schools located within the elephant range. We therefore compared performance of schools within and outside the elephant range using the mean scores from the examination council over the last five years, and propose strategies aimed at reducing this form of conflict in the Mara ecosystem. Specifically, we compared mean scores of affected and non-affected pupils from the elephant range in relation to other variables like distance to school, days absent and ethnicity. We report here on the results of those comparisons and discuss the various strategies of conflict mitigation employed in some detail.

Study area

The study was conducted in schools located both within and outside elephant range in Transmara District, adjacent to Maasai Mara National Reserve in Kenya (Figure 1). The district covers 2,900 km^2, of which only360 km^2 is a protected area (Kiyiapi et al., 1996). Transmara receives a high rainfall of c. 1200 mm per annum with double peak seasons in April to May and November to December (Thurrow, 1993, 1996).

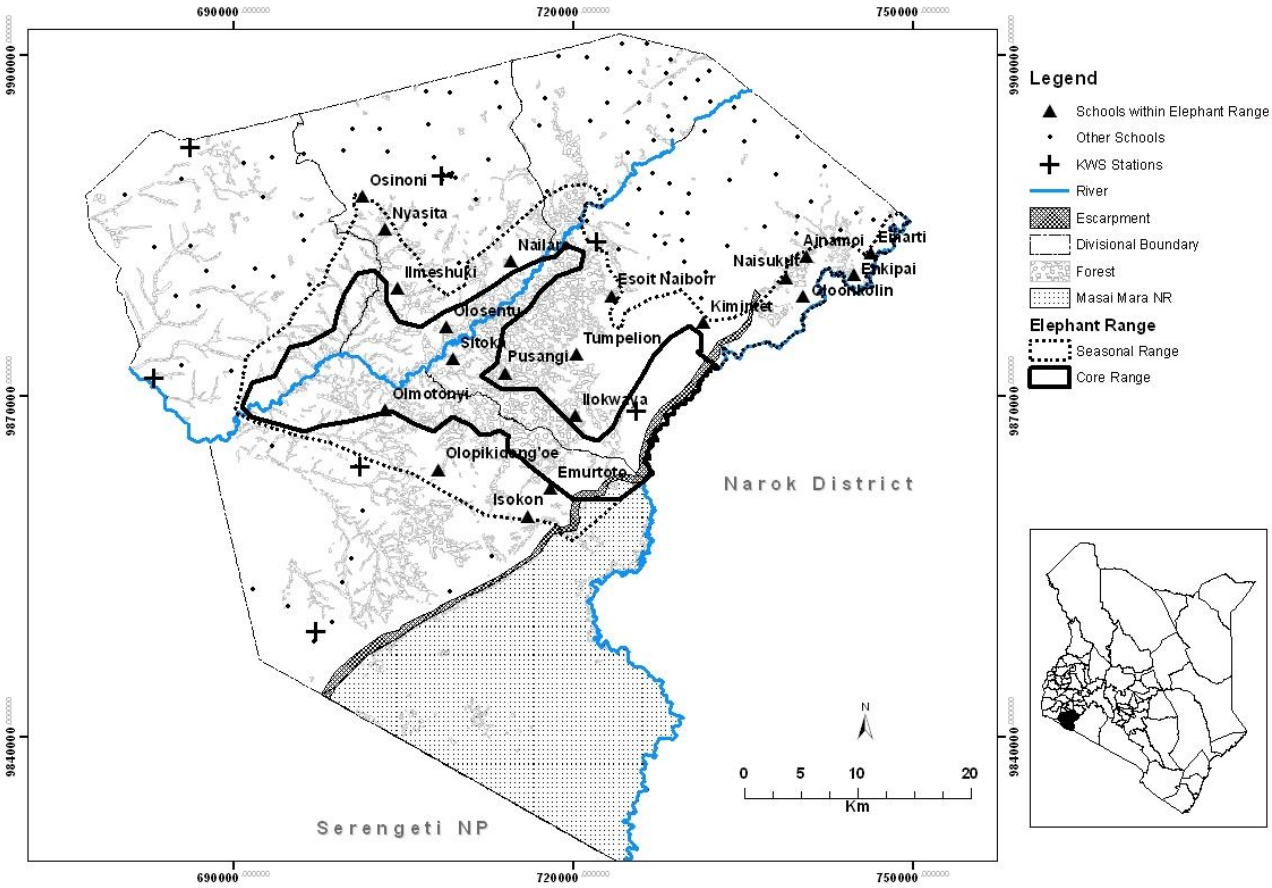

Figure 1. Map of Transmara District showing the location of primary schools both within and outside the elephant range.

Classified as a high agricultural potential zone due to fertile soils, the district has a forest cover measuring about 15,000 ha. Due to the high biomass, the area supports a resident population c. 400 and a migratory population c. 350 of elephants (Sitati, 2007) which utilize the area during the dry season. As a result of high agricultural potential more than 1,000 km^2 of land is under cultivation mainly by immigrant non-Maasais. However, the Maasais have also started farming resulting in loss of the elephant habitat and range (Sitati, 2003). Crop raiding incidences have been increasing from 329 in 1999 to 2000 (Sitati et al., 2003; Sitati, 2003) to 568 between 2001 and 2003 (Sitati and Walpole, 2006) and to over 800 between 2004 and 2006 (Sitati et al., 2007).

METHODS

Selection of schools

Transmara District has 132 primary schools of which 31 (23.5%) are located within elephant range. A high concentration of schools is located in densely populated areas which are mainly settled by non-Maasais (TDP, 1999). The central part of the district which is mainly occupied by the Maasai tribe and is inhabited by elephants have fewer, more widely disbursed schools (Figure 1).

Not all schools within and outside the elephant range, sat for the National exams, usually taken by class eight pupils. For standardization of the schools' means scores, a five-year average of the mean scores for 96 primary schools that sat for the Kenya National Examinations Council (KNEC) examinations for at least five years, between 1995 to 1999, were used in the analysis. Hence only 19 (20%) schools were identified as the most affected schools by elephants based on reports from the Ministry of Education (the elephant range schools) and 77 (80%) schools were not affected by elephants and were located far from the elephant range (the out of elephant range schools) had sat for KNEC examinations for at least five years. The mean score for schools and pupils were obtained from data generated by the Kenya National Examinations Council.

Selection of pupils

All pupils (n = 277) from 18 (58%) out of 31 randomly selected schools within the elephant range who had sat for the Kenya National Examination Council examinations in 1999 were used in the analysis. This was after we realized that not all pupils within the elephant range are affected by elephants since elephants take long (including several years) before re-visiting their villages and disappear again. The mean scores were based on the seven subjects examined and 700 being the maximum score. Each school was visited and a teacher was assigned to fill a detailed form and

Table 1. The proportion of the number of days absent and distance (km) traveled by pupils located within the elephant range relative to the mean scores. Also ethnical differences shown between Maasai and non-Maasai (comprising Kalenjin, Luo, Kisii, Luhyia and Kikuyu).

Variable	Disturbance of pupils by elephants					
	Pupils affected			Pupils not affected		
	Number (%)	Mean score	S.E	Number (%)	Mean score	S.E
Absent (days)						
0-20	17 (27.4)	282.118	18.013	41 (15)	323.585	8.291
21-40	33 (53)	289.909	17.764	117 (54)	322.760	7.528
41-60	6 (10)	286.000	49.582	32 (15)	313.688	12.059
>60	6 (10)	216.241	18.503	25 (12)	246.240	14.137
Distance traveled (km)						
0-0.9	6 (10)	369.667	28.122	55 (26)	351.254	9.529
1-2.9	14 (23)	284.714	26.813	75 (35)	302.467	8.671
3-4.9	17 (27)	300.881	26.344	48 (22)	287.833	11.316
>5	25 (40)	242.242	12.823	37 (17)	308.216	11.540
Tribe						
Maasai	32 (52)	250.781	13.113	102 (47)	299.735	8.007
Non-Maasai	30 (48)	311.667	18.743	113 (53)	324.345	6.771

the information needed included; the means scores, distance to school, number of days absent from school, ethnicity and whether affected by elephants or not.

Descriptive, analyses of variance and chi square tests were used to make comparative tests between variables using SPSS (2003).

RESULTS

Performance of schools

The mean scores for schools were normally distributed (Kolmogorov-Smirnov z = 0.765, p = 0.601). Generally, schools within the elephant range had lower mean scores than those outside elephant range. Of the 132 primary schools in the district, significantly fewer schools (n = 31, 24%) were located within elephant range (χ^2 = 35.042, df = 1, p = 0.001). The mean scores of schools located within elephant range were significantly lower (250.44 ± 11.61) than schools outside elephant range (311.24 ± 6.20; $F_{1,213}$ = 19.541, p = 0.001).

Schools outside elephant range had more pupils enrolled (311.507 ± 15.65) than schools within the range (208.16 ± 33.41). The mean number of teachers also varied between schools outside (9.23 ± 0.27) and within (7.95 ± 0.46) the range ($F_{1,213}$ = 4.753, p = 0.032). 78% of the schools fell within the Ministry of Education recommended teacher-pupil ratio of 1:40 of which 89% of schools within the elephant range and 78% of schools outside the range had the recommended ratio.

Transmara District had only three mixed boarding primary schools for both boys and girls and two were located outside the elephant range and only one was in the elephant range. However, the mean scores for boarding schools (316.39 ± 32.74, n = 3) were not significantly different from day schools (298.65 ± 59.37, n = 93) mean scores ($F_{1,94}$ = 0.263, p = 0.609). The boarding school within the elephant range had a higher mean score (348.66) compared with the two boarding schools outside the elephant range whose mean score were 317 and 283, respectively.

Performance of pupils

The mean scores of 277 pupils who sat for the Kenya National Examination Council examinations selected from 18 schools within the elephant range were normally distributed (Kolmogorov-Smirnov z = 0.857, p = 0.454) and were compared with other variables. A small number (22%, n = 62) of pupils were affected by elephants while 78% (n = 215) were not affected by elephants (χ^2 = 84.509, p=0.001). Pupils affected by elephants had a significantly ($F_{1,275}$ = 7.702, p = 0.006) lower mean score (280.242 ± 11.88) than those who were not affected by elephants (312.670 ± 5.26).

The ethnicity of pupils was categorized as Maasai and non-Maasai. 48.4% (n = 134) of pupils were from the Maasai tribe of whom only 32 (24%) were affected by elephants while 102 (76%) were not affected (Table 1). The remaining 143 (51.6%) were from non-Maasai tribe of whom 30 (21%) were affected by elephants while 113 (79%) were not affected, despite being in the elephant

Nairobi Star (Nairobi)

Kenya: Taita Taveta Leaders Decry Human-Wildlife Conflict

Raphael Mwadime 2 January 2012

LEADERS and residents of Taita Taveta county have attributed the dismal performance of the county in last years Kenya Certificate of Primary Education examinations to the persistent human wildlife conflict in the region.The county was the third last among 47 counties in the country.

Figure 2. Human-wildlife conflict usually blamed by politicians as the cause of poor performance in National examinations.

range.

There was an inverse relationship between days absent and pupils mean score. The number of days of absenteeism by pupils affected by elephants increased at first followed by a reduction but this had no significant impact on pupils mean score ($F_{3,211}$ = 1.075, p = 0.367; Table 1). The same trend applied to pupils who were not affected by elephants, however, their mean score varied significantly ($F_{3,211}$ = 7.808, p=0.001) by the days absent with more days of absence scoring the lowest mean score (Table 1).

The mean scores of pupils affected by elephants varied ($F_{3,211}$ = 4.008, p = 0.012) with the distance traveled with those traveling longer distances scoring low mean scores (Table 1). Equally, pupils who were not affected by elephants had significant variations ($F_{3,211}$ = 7.320, p = 0.001) in the mean scores in relation to distance from school. Pupils living within 1 km radius of the school generally scored higher mean scores (Table 1).

Pupils affected by elephants from the Maasai tribe scored lower mean scores than pupils from other tribes ($F_{1,213}$ = 7.234, p = 0.009; Table 1). For pupils not affected by elephants, Maasai pupils still scored lower than the non-Maasai pupils ($F_{1,213}$ = 5.573, p = 0.019). However, the mean score of the Maasai pupils who were not affected by elephants were significantly higher than those who were affected ($F_{1,213}$ = 6.902, p=0.048; Table 1). One pupil was killed between 1997 and 2002 but elephant threats were reported throughout the range including temporary closure of three schools for 3 to 5 days until the wildlife authority stepped in to chase the elephants away.

DISCUSSION

Pupils within elephant range had lower mean scores than those outside. Although media reports suggest pupils are regularly disrupted by elephants and that their school grades suffer as a consequence, there has been no clear demonstration that elephants are the main factor effecting performance (Figure 2). A suite of factors may be implicated, including pupil intelligence, nutrition and environment, among others (Kremer 1995; Anderson et al., 2001; Burger and Van der Berg, 2003; Van der Berg, 2006; Glewwe and Kremer, 2006). We found a negative inverse relationships between mean scores and distances traveled and the number of days absent, respectively. Pupils from distant areas were more likely to be absent and reported to school late. Furthermore, pupils from the Maasai community generally had lower mean scores than non-Maasai pupils despite being within the same environment. This could be explained by the fact that the non-Maasais lived on market centres which are close to schools and were often absent from school. Cultural differences in attitudes towards education although not tested could add significant effect to performance (Bhorat and Oosthuizen, 2008). Other studies have found that pupils wasted substantial amounts of school time whenever elephants were present by either reporting to school late or being absent altogether (Sitati, 2003; Walpole et al., 2003).

Transmara District has three primary boarding schools and only one is located within the elephant range. Boarding schools reduced any possible conflict between elephants and pupils/teachers, but there was no guarantee that pupils would score higher marks. While it is an extra cost to parents, pupils would have equal time meant for school like any other pupil not affected by elephants including attending private studies at night which most pupils in day schools cannot because of poor housing, lack of enough light in the houses (manyattas). Equally, sometimes the morans (young Maasai warriors) are involved in guarding livestock against cattle rustlers

and predators or guard crops against wildlife damage. The factors of distance traveled to school and absenteeism will also be contained by boarding education system.

The Maasais embrace polygamy, a social practice which not only reduces the risks pupils are likely to face from elephants but also reduces the distance covered by pupils to school. It also allows children to continue providing labor and supporting their parents such as looking after cattle. Polygamy is acceptable and is part of the Maasai culture (Kituyi, 1990) although the practice is dying slowly. Maasai women are known to encourage their husbands to add more wives to support each other in their busy daily chores. In this study we have concerns about the high concentration of human settlements around schools and the increased environmental degradation if large numbers of adults adopt this strategy in areas susceptible to elephant problems. Another aspect of polygamy is that it may result in increased population, high fertility rate and increased poverty levels and hence high environmental degradation (Kituyi, 1990).

In many villages located within elephant range, older family members escort pupils to school by employing the traditional skills of avoiding elephants including: listening keenly before making any move, elaborate traditional information sharing called lomon, determining the direction of the wind using pieces of grass or saliva so as to keep downwind of animals. These traditional techniques are slowly acquired by the children as they grow up. In the past, elephants would run away if people shouted or shot an arrow at them. This is no longer the case as elephants have become more bold and aggressive. Children have also learnt to evade elephant attack by hiding in aardvark burrows or culverts in the road, though this can be a dangerous strategy if the holes are also used by animals such as spotted hyena *Crocuta crocuta*, warthog *Phacochoerus aethiopicus* and deadly snakes.

Efforts must be doubled to help mitigate HEC and to empower people living near wildlife to make informed decisions on the choices available to mitigate or minimize the risk of conflict (Stephenson, 2004). Even if it remains unclear to what extent HEC is correlated with school performance, pupils remain threatened by wildlife and more must be done to reduce the risks. Discouragingly, our experience, like those of Hoare (1995, 2000) and Parker and Osborn (2006), show that it is not possible to keep elephants out of human settlements adjacent to the core elephant habitat using scaring methods since it involves shifting the problem from one area to another, and pupils will be exposed to higher risks arising from stray and agitated elephants. Pupils will often make an excuse to stay at home. A quick solution calls for separation of pupils by, either building boarding schools or removing elephants from the area (Walpole et al., 2003). Ecologically, the last option may not be viable for two reasons. Firstly, the sustainability of the only forest cover in the landscape depends on the elephants (Dublin, 1986) and, secondly, Transmara District provides refuge for the migratory elephant population from the Mara during the dry season (Sitati, 2003; Sitati, 2007). Their removal may also interfere with tourism, which is the backbone of the districts' economy.

CONCLUSIONS AND RECOMMENDATIONS

Academic performance of pupils and the overall school performance within elephant range is generally low. However, there is no clear evidence as to whether elephants contribute to low scores. Many schools also benefits from tourism revenue for infrastructural development and paying of fees for pupils from poor families, which can add value to pupils' education. However, our work calls into question the impact of factors other than elephants as causes of poor performance which were not addressed comprehensively. Specifically, there is no direct evidence to show the link between elephant presence and low mean score. In contrast, non Maasai pupils from within the elephant range had higher mean scores than the native Maasai pupils meaning other complex factors could be under play. No other studies have attempted to identify what contribution, if any, elephants make towards the low mean scores, so it is not possible to make a general conclusion about their impact. We suggest, therefore, that further studies are needed to evaluate the other factors better, under a variety of underlying conditions like pupils, teachers and infrastructure as possible causal factors, before the mitigation measures are further proposed and promoted. For example, it is possible that boarding school facilities methods may provide some high mean scores but is more costly and/or may deny parents an opportunity for children to look after livestock while out of school.

More generally, our work in Transmara adds to the growing body of evidence that pupils and schools within elephant areas and hence wildlife among other factors may directly or indirectly interfere with learning in schools located in wildlife dispersal areas. That way, forgotten children in wildlife areas can also access education and this will contribute towards achieving some of the objectives of the Millennium Development Goals. We recommend the use of a product function model to determine the actual causes of low mean scores in schools within the elephant range. This being the first paper on this form of HEC, we presume it is an eye opener to many elephant researchers and further research into the problem is needed. We advance that researchers should consider including the five vectors determinants of school and pupil mean score, namely, metric of school achievement, which can be, for example, standardized test scores or grade attainment, versus (a) school characteristics (quality of infrastructure, teacher-

pupil ration, etc,) (b) teacher characteristics such as level of training, (c) child characteristics such as intellectual ability, (d) parental characteristics such as tastes for education, and, (e) house hold characteristics which includes socio-economic variables. However, this is difficult because it is dependent on the quality and range of the data available, especially in range states within the developing countries which usually suffer from poor government records. Despite the draw-backs of this study, this is the first detailed analysis of its kind for this form of HEC, and could potentially be a guide for improving on future studies of this sort with better quality data. Secondly, it acts as an important benchmark for quick fixes of mitigation strategies.

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