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Effectiveness of Aberdare Electric Fence on Human-Wildlife Conflicts in Amboni Community, Nyeri County, Kenya

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Abstract
Conflicts between humans and wildlife are a paramount threat to conservation of flora and fauna around the world. For instance, in Kenya, with much of the wildlife living outside protected areas, enhanced and sustainable coexistence between people and wildlife has been a challenge. Humans expose themselves to wildlife through poaching or settling along wildlife areas hence amplifying conflicts with wildlife. The main objective of the study was to assess the impact of the Aberdare electric fence on human-wildlife conflict (HWC) in Amboni area, Nyeri County, Kenya. The study purposively focused on three villages (Kiguru, Mutishieni, and Ex-pages) which are directly adjacent to the border of the park fence, with 30% of the villages' households taking part in the study. Data was collected through questionnaires and interviews while Statistical Package for Social Sciences (SPSS v25) was used in data analysis. Results from paired t-test analysis showed that paired sample test had negative t values and, therefore, significant for all the pairs. Only two of the pairs showed non-significant values (P > 0.05). It was evident that variable changes for 7 of the paired differences (type of crop damage, animal involved, land size affected, causal wild animal, domestic animal depredated, physical infrastructure destroyed and access to natural resources in the park) were statistically significant with their p-values less than 0.05. However, results of estimated losses (M = -0.03, SD = 0.67, t (155) = -0.445) and income earned (M = 0.03, SD = 0.43, t (155) = -0.686) did not have a statistical significance change as a result of the electric fence installation. The research concludes that the electric fence installed along the boundaries of Aberdare National Park especially at the Amboni community has reduced some of the perennial human-wildlife conflicts that were experienced before. The electric fence has facilitated reduction in the crop damages, livestock depredation, reduction in affected farm coverage and reduction in property losses.

Key words: *Human-wildlife conflict, Household, Problem Animal Control, Sustainable Development Goals.*

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I. INTRODUCTION

Electric fence has been used globally as a tool for conservation, especially to control human-wildlife conflicts (HWC), with single stand electric fence being common (Lindsey et al., 2012). However, most electric fences are not effective in mitigating HWC, as some wild species such as deer can jump over the fence or others like wild boars and warthogs can burrow their way outside protected areas (Sapkota et al., 2014; Kassilly&Tsingalia, 2008). In Kenya, HWC is a challenge to small scale farmers bordering national parks and reserves, especially those bordering the Mount Kenya forest (Embu, Kirinyaga, Nyandarua Meru, and Nyeri). Aberdare National Park (ANP) borders five counties, covering an area of 766 km2 and was electrified in 2009 with a solar-powered fence covering 400 km (Gross, 2009). ANP's electric fence was initially installed to conserve the declining rhino population, but also ended up mitigating HWC and protecting the park from illegal activities. The Amboni community, which borders ANP, experiences HWC from animals such as baboons, elephants, warthogs, porcupines, and monkeys. Before the installation of the electric fence, the park faced frequent HWC issues and local communities experienced negative impacts such as crop damage and human death. Rhino Ark charitable organization was established in 1988 to mobilize funds for the erection of the fence, which was completed in 2009 covering 400 km (Rhino Ark, 2010).

Statement of the Problem

Human population has grown over time within the settlement land of Amboni, and like other protected areas, Aberdare National Park (ANP) has faced increasing incidents of human-wildlife conflict (HWC). The escalation of these conflicts has been attributed to the high population density and changes in land use within nearby communities. Farmers have faced crop damage and human casualties due to wild animals such as baboons and elephants. In response, a conservation effort led to the installation of an electric fence around ANP in the 1990s, aimed at mitigating HWC. However, despite the fence, HWC incidents within the community continued to be reported. Hence, the purpose of this study was to evaluate the efficacy of the fence in reducing HWC and its impact on the community.

Study Objective

To assess HWC issues within the Amboni community before and after the erection of the Aberdare electric fence.

OVERVIEW ON TYPES OF HUMAN-WILDLIFE CONFLICTS

The term "Human-wildlife conflict" refers to the negative interactions between wild animals and people and its impact on either party (Matseketsa et al., 2019; Mekonen, 2020; Nyhus, 2016). Although HWC has been around for a long time (Anand, 2017), studies in Africa show that it continues to pose a threat to biodiversity (Amaja et al., 2016; Zisadza-Gandiwa et al., 2016). The effects of HWC can be divided into direct and indirect impacts. Direct impacts refer to the physical harm experienced by people, including crop damage, livestock predation, zoonotic diseases, and human fatalities (Guinness, 2014). Indirect impacts, on the other hand, include economic losses from direct impacts and insecurity (Linnell et al., 2010; Baruch-Mordo et al., 2009).The negative interactions between humans and wildlife pose a significant challenge for conservationists (Karanth&Vanamamalai, 2020). The diversity of species involved can range from squirrels to man-eaters such as tigers. HWC has been a point of contention between conservationists and affected communities. The lack of effective methods to reduce these conflicts has caused communities surrounding protected areas to distance themselves from their lands (Linnell et al., 2010).

Causes of Human-Wildlife Conflicts

Human-wildlife conflict (HWC) is a growing problem around the world, with most of the wild animals living outside protected areas (Nyamwamu et al., 2015). The root cause of HWC is believed to be the increasing human population and the pressure it puts on land (White & Ward, 2011). In Kenya, for example, the population has grown from 23.72 million in the 1990s to 47.6 million in 2019 (Kenya National Bureau of Statistics, 2019), which has led to competition between humans and wildlife for land as a resource. Human activities, such as urban development and agriculture, have resulted in the loss of wildlife habitats and escalated HWC (Digun-Aweto et al., 2020).

The use of land around protected areas has intensified conflicts between humans and wildlife. Conflicts between farmers and wildlife species, such as crop damage and livestock depredation, have increased (Ogutu et al., 2014). Land-use changes, such as infrastructure construction and human settlements, have led to human encroachment and decreased the size of protected areas (Browne-Nuñez& Jonker, 2008). These lands were previously buffer zones or migratory routes for wildlife (Dickman, 2010), but with the increase in human population and commercialization of communal lands, the migration of wild animals has been affected (Western et al., 2009). Infrastructure development has also contributed to land degradation, fragmentation, and pollution, which in turn affects wildlife (Okello & Kioko, 2010). Privately owned land outside protected areas is often fenced and divided, which has further impacted the migration and distribution of wild animals (Okello & Kioko, 2010).

Crop Damage

Global issues concerning human-wildlife conflict (HWC) are prevalent, especially in agricultural lands surrounding protected areas (Gordon, 2009). This conflict is largely driven by crop raiding, as crops serve as food for both humans and wildlife, particularly herbivores (Dickman, 2010). Raiding is common in areas near protected area borders (Karanth et al., 2012), as farms provide easy access to food sources for wildlife. These raids are often perpetuated by the shortage of resources and limited carrying capacity in protected areas (Guinness, 2014). In a study conducted in Hungary, it was found that wild boar and red deer were the leading causes of crop damage among wild ungulates (Bleier et al., 2012). In Uganda, a study of perceptions of baboons, monkeys, and chimpanzees in the Bunyoro kingdom found that these primates were responsible for damaging agricultural crops, with baboons being considered the most destructive as they raided in organized groups (Hill & Webber, 2010). Another study in Mt. Cameroon National Park found that rodents also played a role in causing economic losses through crop damage (Stanley et al., 2018). With regards to electric fencing as a mitigation measure, macaques have been observed using trees near the fences to jump into farms. This has been problematic as the tenants or landowners are often unable to cut these trees, as they serve as farm boundary markers or park boundaries (Suzuki &Muroyama, 2010).

Human Injury/ Deaths

Reducing costs associated with wildlife conflict is a challenge, particularly when considering human fatalities and injuries. In some cases, these costs surpass those of crop damage and livestock loss from wild species (Gulati et al., 2021). In Mozambique, a study conducted over a 27-month period (July 2006 to September 2008) showed that 265 human deaths were reported as a result of wildlife attacks, with crocodiles, lions, elephants, and hippopotamuses being the leading causes (Dunham et al., 2010). Similarly, in Nepal, human fatalities and injuries are caused by large mammals, particularly African elephants and leopards, which were frequently reported in home settlements (Acharya et al., 2016). A study in Zambia between 2004 and 2008 looked at the extent of crop damage in the Luangwa valley and the measures in place to reduce it. The study considered the type of crop, the animal involved, the season of the raids, and the stage of growth. African elephants, bushpigs, hippopotamuses, African civets, and porcupines were among the dominant animals involved in community farm raids. The African elephant was responsible for the most damage, with 67.82% of the raids occurring during the wet season and 98.41% during the dry season (Nyirenda et al., 2011).

Livestock Depredation

According to Valeix et al. (2012), while livestock depredation can result in conflicts and associated costs, they are generally less severe and impactful to local communities compared to crop-raiding. In Bardia National Park, Nepal, a study conducted by Bhattarai and Kindlmann (2012) found that tigers were responsible for significant losses of livestock, with cows/oxen being the most affected (15.7%), followed by goats/sheep (13.1%), pigs (4.3%), and buffalo (1.7%).Proximity to protected area boundaries has been found to have a relationship with human-wildlife conflicts, with cattle depredation being most common within 1000m proximity in Brazil (Widman & Economics, 2018). In a study on compensation costs for livestock depredation in Sweden between 2001 and 2013, it was found that the highest compensation costs were in unfenced pastures, caused by wild boars (Widman & Economics, 2018).Muhly andMusiahi (2009) have documented that when local communities experience repeated losses of their livestock from wild carnivores, they may resort to killing the carnivores to protect their livestock. This was also seen in Kenya, where 75% of Maasai respondents preferred killing lions that caused the depredation of up to 10% of their livestock (Hazzah et al., 2014).

Wildlife Tolerance Model

The Wildlife Tolerance Model is a framework used in human-wildlife conflict and management studies. As shown in Figure 1, it consists of two components: an outer model and an inner model. The outer model contains six variables, the first being experiences, which can be positive or negative and refer to recent exposure to a species and its significance to the person involved. The costs and benefits of these experiences are the next variables, which can either be tangible (monetary) or intangible (such as stress and fear). The model predicts that costs and benefits are derived from experiences, meaning that if positive experiences outweigh negative ones, there will be a positive shift towards viewing the species as having benefits and vice versa. This is referred to as the first hypothesis. The second hypothesis is that the costs and benefits perceptions determine tolerance (the willingness and ability to incur extra costs from conflicts). In this study, the researcher aims to examine the experiences of the Amboni community before and after the installation of the ANP electric fence, with a focus on the costs of HWC. This will provide insight into the fence's effectiveness and the community's perceptions towards wildlife conservation. The inner model consists of variables that influence the perception of costs and benefits, including institutions, individual interests, anthropomorphism, taxonomic bias, personal norms, and wildlife value orientation (Kansky et al., 2016).

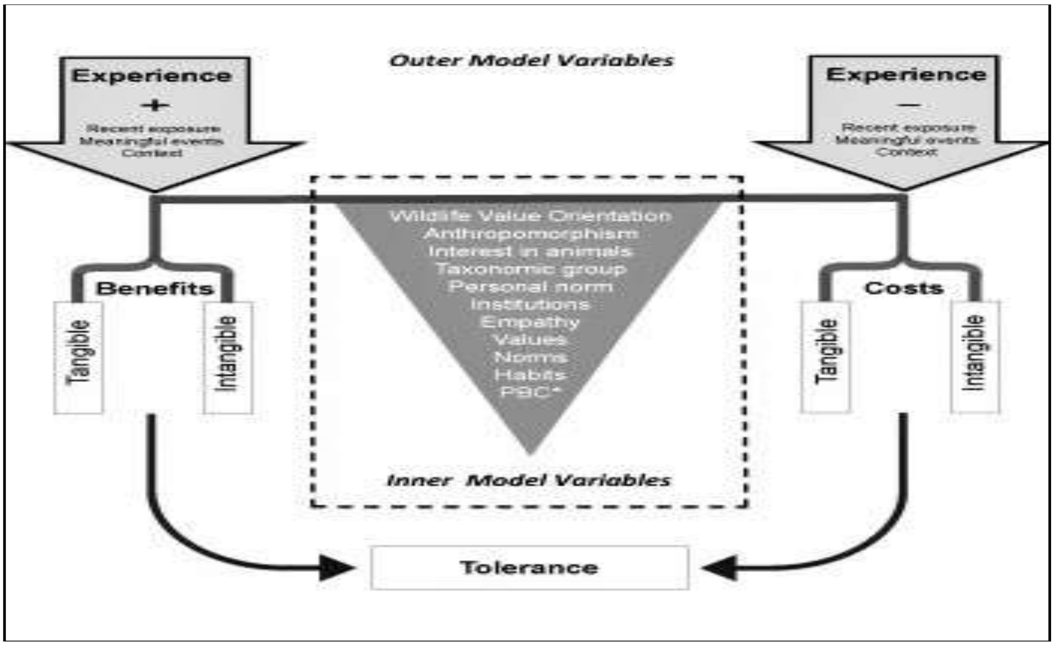

Figure 1: Wildlife Tolerance Model(Kansky et al., 2016).

II. METHODOLOGY

The study used descriptive research to describe the current state and recent history of human-wildlife conflicts (HWC). This was done to answer questions about who is affected by HWC, what causes these conflicts, when and where they occur. A survey research design was employed, specifically a cross-sectional survey, which assumes that data collected from a sample can be generalized to the larger population (Check & Schutt, 2011). The target population was the Amboni community, which had a total population of 4,344 people and 1,194 households in 11 villages (Kenya National Bureau Statistics, 2019). The researcher used purposive sampling, a technique where the researcher selects a population based on their knowledge and experience, to select three villages (Kiguru, Ex-pages, and Mutisheni) as the focus of the study. These villages were selected because they are directly bordering the Amboni National Park and are the most affected by HWC. According to Mugenda & Mugenda (2013), 30% of the target population is considered an adequate representation for analysis when the target population is less than 10,000. Hence, the study used 30% of the three villages as computed in Table 1, which totalled 195 households, as research respondents and these respondents were selected randomly.

Table 1: Computation of the samples and number of questionnaires to be administered

Village	No of households	Sampling ratio	Sample size
Kiguru	400	0.3	120
Mutishieni	121	0.3	36
Ex-pages	130	0.3	39
TOTAL	**651**		**195**

(Source of number of households; KNBS, 2019)

Primary data was collected using questionnaires and interviews. The study utilized structured questionnaires to achieve its primary objective. These questionnaires were distributed to the selected households through enumerators, with the family heads being the targeted recipients. The study involved key informants, such as local chiefs, elders, community wildlife wardens, and land use planners who reside within the Amboni community. These individuals were included in the research to provide clarification and to gather additional information from these groups. The validity of the research was assessed to determine if it truly measured what it aimed to and the accuracy of its results (Golafshani, 2003). Internal validity was used to determine the relationship between the independent and dependent variables. External validity helped generalize the findings from the sample size. Reliability, which measures the consistency, repeatability, and trustworthiness of the research instruments (Guwahat, 2013), was ensured through administering the instruments in another area with similar characteristics as the study area. A pre-testing was conducted at Lake Nakuru National Park to ensure the instruments would gather the necessary information to meet the research objectives and improve the clarity and flow of questions in the questionnaire. The data was analyzed using descriptive statistical methods, including determining the mean and mode of continuous variables. A paired t-test was also performed to compare continuous data sets before and after the installation of the fence. Data was visualized through frequency tables, pie charts, bar graphs, histograms, and other diagrams. Inferential statistics were applied to analyze relationships between sampled data variables and draw conclusions about the entire population based on the sample data collected. The researcher obtained a research permit from NACOSTI (National Commission for Science Technology and Innovation). To maintain confidentiality, the enumerators were instructed not to record the names of the respondents and informed the participants that the collected data was solely for academic purposes.

III. FINDINGS AND DISCUSSIONS

Respondents Demographics Information

The study aimed to survey 195 household heads from the Amboni community. The questionnaires were distributed and collected with the assistance of enumerators. Out of the distributed questionnaires, 155 were properly completed and returned while 40 were disregarded due to incompleteness. This resulted in a response rate of 79.5%, which is considered sufficient for analysis (Saunders et al., 2009), as it is above the minimum threshold of 50%. This response rate allowed the study to generate meaningful conclusions. The demographic information revealed that 60% of the study participants were male and 40% were female. 35% of the respondents were aged between 40-50 years, the largest age group in the study. The other age groups represented were 50-60 years (21%), 60-70 years (17%), 30-40 years (17%), and 18-30 years (10%). The majority of the households had 5 members (24.5%) with the other household sizes being 3 (17.4%), 6 (14.8%), 1 (9%), 2 (6.5%), 4 (11%), 7 (5.8%), 8 (5.2%), 9 (1.3%), 10 (2.6%), 12 (1.3%), and 13 (0.6%) members. The highest level of education for the majority of the respondents (31%) was secondary education, followed by college education (23%), primary education (21%), no formal education (18%), adult education (6%), and university education (1%). In terms of occupation, the majority (79.4%) of the participants were farmers, followed by businessmen (10.3%), house helps (1.3%), mechanics (1.3%), teachers (5.2%), and chief, civil servants, lecturer, and tailor (0.6% each).

Descriptive Analysis

Table 2: Crop affected

Crop affected before fence erection	**Frequency**	**%**	**Crop affected after fence erection**	**Frequency**	**%**
Maize	148	95.5	Maize	131	84.5
Beans	50	32.3	Beans	43	27.7
Irish Potatoes	48	30.9	Irish Potatoes	34	21.9
Banana	38	24.5	Banana	30	19.4
Cabbage	22	14.2	Cabbage	10	6.5
Macadamia	19	12.3	Macadamia	18	11.6
Avocado	22	14.2	Avocado	11	7.1
Sweet Potatoes	13	8.4	Sweet Potatoes	11	7.1
Mangoes	4	2.6	Mangoes	0	0
Pumpkins	14	9	Pumpkins	16	10.3
Sugarcane	14	9	Sugarcane	15	9.7
Kales	8	5.2	Kales	12	7.7
Onion	6	3.9	Onion	9	5.8
Tomatoes	8	5.2	Tomatoes	8	5.2
Cassava	1	0.6	Cassava	2	1.3
Passion	3	1.9	Passion	6	3.9
Hay	1	0.6	Hay	0	0

The study results, as shown in Table 2, reveal that maize was the crop most affected by wildlife interaction before and after the fence was installed. Prior to the fence, 95.5% of respondents reported their maize crops being destroyed by wild animals. After the fence was erected, this percentage decreased to 84.5%. This finding aligns with a study conducted by Long et al. (2020) that also showed maize as the most affected crop. Beans were the second most impacted crop with 32.3% of respondents reporting damage prior to the fence and 27.7% after. The same trend was observed for Irish potatoes, with 30.9% being damaged before the fence and 21.9% after. A decrease in damage was also seen for bananas and cabbages, while an increase was observed for crops such as sugarcane, kales, onions, tomatoes, cassava, and passion. This indicates that the fence may have effectively contained some wild animals, especially larger herbivores, but did not prevent primates and rodents from reaching the crops.

The study documented the kinds of harm caused by wild animals to farmers' crops, as presented in Table 3. Participants were permitted to report multiple types of crop damage based on their own experiences, as the question was open-ended. Thus, the table displays the frequency of damage mentioned by respondents before and after the installation of the electric fence.

Table 3: Type of Damage

Before Fence			After Fence		
Type of Damage	**Frequency**	**%**	**Type of Damage**	**Frequency**	**%**
Feeding on Mature crop	113	72.9	Feeding on Mature crop	102	65.8
Uprooting	39	25.2	Uprooting	36	23.2
Plucking	8	5.2	Plucking	1	0.6
Trampling	12	7.74	Trampling	2	1.3

The study investigated the ways in which wild animals caused damage to crops based on the farmers' reports as displayed in Table 4. The survey allowed farmers to indicate multiple types of damage, making the table show the number of times each type of damage was mentioned by the farmers before and after the installation of the electric fence. The results showed that the majority of the damage to crops was from eating mature crops, with 72.9% of respondents reporting this before the fence was installed, and 65% after. The results also revealed that crop uprooting affected 25.2% of respondents prior to the fence, but decreased to 23.2% after the fence was erected. Plucking of crops impacted 5.2% of respondents before the fence was installed, and was reduced to 0.6% after. Trampling of crops affected 7.74% of respondents before the fence was put in place, but was reduced to 1.3% after the installation of the fence around the park.

Table 4: Wild Animal Involved

Before Fence			After Fence		
Animal Involved	**Frequency**	**%**	**Animal Involved**	**Frequency**	**%**
Baboon	108	69.7	Baboon	89	57.4
Elephant	92	59.4	Elephant	56	36.1
Porcupine	6	3.9	Porcupine	8	5.2
Squirrel	4	2.6	Squirrel	3	1.9
Buffalo	2	1.3	Buffalo	1	0.6
Monkey	9	5.8	Monkey	30	19.4

The study aimed to identify the wild animals that were causing destruction of crops and property among the Amboni locals. The results, shown in Table 4, revealed that Baboons were the primary culprits of crop damage among the Amboni community and at the interface of the Mt. Kenya National Park. Before the fence was installed, 69.7% of the respondents attributed their crop damage to baboons, which decreased to 57.4% after the fence was put in place. Elephants were also identified as a cause of crop damage, with 59.4% of the respondents blaming them before the fence compared to 36.1% after. Porcupine attacks on crops increased from 3.9% before the fence to 5.2% after, while squirrel attacks reduced from 2.6% to 1.9%. Buffalo damage to crops decreased from 1.3% to 0.6% after the fence was put in place. However, the study found that the fence was not effective in keeping out smaller and more intelligent animals, like monkeys, whose attacks increased from 5.8% to 19.4% after the fence was installed. The fence also faced various challenges, including theft of electric wires, warthog holes, and elephant damage, leading to fence malfunctions. Despite the fence, a higher number of elephants were still able to enter the community through these weak points.

Table 5: Size of Affected Land

Before Fence			After Fence		
Size of Land (Ha)	**Frequency**	**%**	**Size of Land (Ha)**	**Frequency**	**%**
0.5-5	133	85.8	0.5-5	135	87.1
6-10	21	13.5	6-10	7	4.5
11 Ha and above	1	0.7	11 Ha and above	0	0
Not Affected	0	0	Not Affected	13	8.3

The researcher learned from the respondents that most land owners in the Amboni community had 0.5-5 Ha of land. The study's findings, presented in Table 5, were based on an open-ended question that was categorized by the researcher for ease of analysis. The results revealed that before the fence was installed, 85.5% of the respondents had between 0.5-5 Ha of their land impacted by wild animal activities, which was consistent with Tobgay et al. (2019) who found that most affected land sizes ranged between 0.15-7.06 Ha. The number increased to 87.1% of the respondents after the fence was put in place. The study found that before the fence was erected, 13.5% of the respondents had 6-10 Ha of their land affected by wild animals, which was significantly reduced to 4.5% after the fence was put in place. The findings also showed that before the park was fenced, 0.7% of the respondents had land affected by wild animals that was more than 11 Ha in size, but this number reduced to 0% after the fence was put in place. The study also found that 8.3% of the respondents reported no wild animal invasion on their land after the fence was installed around the park, which implies that there were fewer cases of wild animal interference and the only cases that arose impacted smaller pieces of land owned by Amboni residents.

Table 6: Estimated Losses

Before Fence			**After Fence**		
Loss Estimates (KES)	**Frequency**	**%**	**Loss Estimate (KES)**	**Frequency**	**%**
0-50,000	84	54.2	0-50,000	117	75.5
50,001-100,000	67	43.2	50,001-100,000	37	23.9
100,001-150,000	1	0.7	100,001-150,000	1	0.7
150,001-200,000	3	1.9	150,001-200,000	0	0
Total	**155**	**100**		**155**	**100**

The results presented in Table 6 indicate that 54.2% of the respondents estimated crop losses of between KES 0-50,000 caused by wild animal invasions before the fence was installed. This number was lower compared to 65.2% of the respondents who estimated similar losses after the fence was erected. There were 43.2% of the respondents who estimated property losses of between KES 50,001-100,000 before the fence was installed, which was higher compared to after the fence was erected at 23.9%. The study also showed that 0.7% of the respondents estimated losses of KES 100,000-150,000 for both before and after the fence was installed. In contrast, there were no estimated losses in the range of KES 150,000-200,000 after the fence was put in place, compared to 1.9% of the respondents who estimated such losses before the fence was erected. The results indicate that the fence installation reduced the estimated losses on property. This was demonstrated by the high number of respondents who did not expect losses and the decrease in mid-range losses. However, the findings imply that the estimated cost of loss for the people of Amboni is influenced by other factors besides human-wildlife conflicts.

Table 7: Death and Injuries

Before Fence			**After Fence**		
Death and Injuries rate	**Frequency**	**%**	**Death and Injuries rate**	**Frequency**	**%**
Death	34	21.9	Death	2	1.3
Injuries	108	69.7	Injuries	18	11.6

Table 7 shows that before the park fence was installed, 34 people in the Amboni community died due to wild animal attacks, which was a death rate of 21.9%. Additionally, there were 69.7% estimated cases of injury caused by wild animal attacks. After the fence was put in place, the number of deaths and injuries decreased, as reported by 1.3% and 11.6% of the respondents, respectively. The conflict between humans and wild animals was also reduced. Since the government compensates family members with KES 5 million for deaths and less than KES 2 million for injuries caused by wild animals, the Kenya Wildlife Service (KWS) aimed to prevent such financial burdens by protecting both the wildlife and the people living near the park.

Table 8: Animal Depredation experience

Before Fence			**After Fence**		
Experienced Livestock Depredation	**Frequency**	**%**	**Experienced Livestock Depredation**	Frequency	%
Yes	102	65.8	Yes	63	40.6
No	53	34.1	No	92	59.4
Total	155	100		155	100

The findings in Table 8 indicate that before the fence was installed around the park, 65.8% of the respondents had experienced livestock loss due to wild animal attacks. Only 34.1% of the respondents reported that they had not experienced such losses. However, after the fence was put in place, the number of respondents who experienced livestock loss decreased to 40.6%, with 59.4% reporting no such losses. This suggests that the fence has led to a reduction in the number of livestock depredated by wild animals. However, there were instances where the electric feature of the fence failed, such as due to theft of wire, digging by warthogs, extreme weather conditions, or destruction by elephants, leading to wild animal attacks on domestic animals.

Table 9: Causal Wild Animal

Before Fence			**After Fence**		
Causal WildAnimal	**Frequency**	**%**	**Causal WildAnimal**	**Frequency**	**%**
Elephant	6	3.9	Elephant	0	0

Leopard	87	56.1	Leopard	60	38.7
Hyena	22	14.2	Hyena	16	10.3
Serval Cat	1	0.7	Serval Cat	0	0
Wild Dog	0	0	Wild Dog	1	0.7
Mongoose	0	0	Mongoose	2	1.3

According to Table 9, leopards were the main culprits of livestock depredation according to 56.1% of respondents before the installation of the fence around the park. The same was confirmed by 85% of other studies (Bhatta et al., 2021). Elephants were found to be involved in livestock depredation by 3.9% of respondents prior to the fence, while hyenas were cited by 14.2% of respondents. One respondent reported a single case of a serval cat killing livestock. However, after the introduction of the fence, the rate of livestock depredation decreased, with leopards being responsible for 38.7% of cases, and hyenas responsible for 10.3%. Mongoose and wild dogs were also involved in a few livestock attacks, as reported by 0.7% and 1.3% of respondents, respectively. This indicates the impact of the fence in reducing the number of attacks on domestic animals in the Amboni community by wild animals.

Table 10: Domestic Animals Affected

Before Fence			**After Fence**		
Domestic Animal Affected	**Frequency**	**%**	**Domestic Animal Affected**	**Frequency**	**%**
Cow	34	21.9	Cow	12	7.7
Goat	23	14.8	Goat	22	14.2
Sheep	62	40	Sheep	40	25.8
Dog	9	5.8	Dog	4	2.6
Rabbit	4	2.6	Rabbit	0	0
Chicken	2	1.3	Chicken	1	0.7

According to the data presented in Table 10, sheep were found to be the most vulnerable to wild animal attacks. One respondent stated, "A leopard would quench its thirst by killing a sheep and leaving the carcass for the owner to mourn the loss." Before the installation of the fence, 40% of respondents reported sheep as the most commonly attacked animal, followed by cows (21.9%), goats (14.8%), dogs (5.8%), rabbits (2.6%) and chickens (1.3%). The findings also showed that after the fence was put in place, the depredation of livestock was reduced to 7.7% for cows, 14.2% for goats, 25.8% for sheep, 2.6% for dogs, 0% for rabbits, and 0.7% for chickens. This suggests that the introduction of the fence has provided security for the livestock of the Amboni community.

Table 11: Affected Physical Infrastructure

Before Fence			**After Fence**		
Physical Infrastructure	**Frequency**	**%**	**Physical Infrastructure**	**Frequency**	**%**
Residential Houses	23	14.8	Residential Houses	4	2.6
Granaries (Store)	32	20.6	Granaries (Store)	25	16.1
Toilets	4	2.6	Toilets	0	0
Water Pipes	5	3.9	Water Pipes	0	0
Fences	59	38.1	Fences	26	16.7
Dams	8	5.2	Dams	0	0
None	48	30.9	None	93	60

As Table 11 reveals, before the fence was installed around the park, 30.9% of the respondents reported no damage to their infrastructure by wildlife. 14.8% of the respondents' homes were physically damaged by wild animals roaming around their homes, while 2.6% reported damage to their toilets, 3.9% damage to their water pipes, 38.1% damage to their fences and 5.2% damage to their dams due to wildlife activity in the Amboni area. However, after the introduction of the fence, it was noted that the rate of infrastructural damage caused by wildlife had declined. The incidents of damage to homes dropped to 2.6%, damage to granaries (storage facilities) reduced to 16.1%, damage to fences decreased to 16.7%, and there were no reports of damage to toilets, water pipes, or dams. A greater number of respondents reported no disruption to their infrastructure from wild animals after the introduction of the fence within the area.

Paired sample T-test

The study sought to determine the statistical significance of the changes in the test variables before and after the installation of an electric fence around the Aberdare National Park in the Amboni area.

Table 12: Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	**Std. Dev**	**Std. Error Mean**	**Lower**	**Upper**	**t**	**df**	**Sig. (2-tailed)**
Pair 1	Type of Damage Before – Type of Damage After	-.53000	.91514	.09151	-.71158	-.34842	-5.791	154	.000
Pair 2	Animals involved Before – Animal Involved After	-1.18000	1.73135	.17314	-1.52354	-.83646	-6.815	154	.000
Pair 3	Land size affected before – Land size affected after	-.13000	.54411	.05441	-.23796	-.02204	-2.389	154	.019
Pair 4	Estimated Loss Before – Estimated Loss After	-.03000	.67353	.06735	-.16364	.10364	-.445	154	.657
Pair 5	Causal Animal Before- Causal Animal After	-1.65000	1.99178	.19918	-2.04521	-1.25479	-8.284	154	.000
Pair 6	Animal Depredated Before – Animal Depredated After	-1.84000	1.58095	.15809	-2.15369	-1.52631	-11.639	154	.000
Pair 7	Physical Infrastructure Before – Physical Infrastructure After	-1.55000	1.55294	.15529	-1.85814	-1.24186	-9.981	154	.000
Pair 8	Income Before – Income After	.03000	.43705	.04370	-.05672	.11672	.686	154	.494
Pair 9	Natural Resources Before – Natural Resources After	-3.63000	1.60589	.16059	-3.94864	-3.31136	-22.604	154	.000

The findings from Table 12 indicate that most of the paired sample t-tests had negative and significant t-values. Only two pairs showed non-significant values (P > 0.05). The negative t-statistic value implies that the means prior to the fence installation were lower than the means after its installation. Seven of the paired differences were found to be statistically significant with p-values less than 0.05, including type of crop damage, animal involved, land size affected, causal wild animal, domestic animal depredated, physical infrastructure destroyed, and access to natural resources in the park. However, the change in estimated losses and income earned did not show statistical significance (M = -0.03, SD = 0.67353, t(155) = -0.445 and M = 0.03, SD = 0.43705, t(155) = 0.686, respectively). This suggests that the financial well-being of the respondents was affected by other factors besides the electric fence implementation to mitigate human-wildlife conflict in the area. The fence had a significant impact on the livelihood of the people in Amboni, but conflicts with wild animals still remained a challenge for them to achieve financial success.

The results of the paired sample T-tests showed that there was a significant reduction in crop damage after the electric fence was installed (t = -5.791, p-value = 0.000). However, complaints about destruction of maize due to escaping elephants persisted, mainly because the fence was frequently damaged by people stealing its electric wires. The T-tests also indicated a significant reduction in the number of animals involved in crop damage after the fence was installed (t = -6.815, p-value = 0.000). Despite this, feeding on mature crops remained a major issue for residents of the Amboni area. The results showed that the size of land affected by wild animals was significantly reduced after the installation of the fence (t = -2.389, p-value = 0.019). However, residents who lived closer to the fence still had larger land affected than those who lived further away. The T-tests showed that there was no significant difference in the estimated losses before and after the fence was installed (t = -0.445, p-value = 0.657). However, some respondents reported frustration from the wild animal menace leading to high estimated losses in both periods.

The paired sample tests showed that there was a significant decrease in the number of causal animals that attacked crops before and after the installation of the electric fence (t = -8.284, p = 0.000). This was due to a significant reduction in elephants, leopards, and hyenas after the fence was put up. The difference in the number of domestic animals depredated before and after the fence was also significant (t = -11.639, p = 0.000), with fewer cows, sheep, dogs, rabbits, and chickens being preyed upon. The destruction of physical infrastructure before and after the fence installation was found to be significant (t = -9.981, p = 0.000) with the fence preventing larger animals from entering the village and causing damage. The study found no significant relationship between income earned before and after the fence installation (t = -0.686, p = 0.494), due to the diversity of economic activities each person depended on. The relationship between natural resources accessed before and after the fence was found to be highly significant (t = -22.604, p = 0.000), with the fence and regulation enforcement reducing the number of accessible resources.

IV. CONCLUSION

The results of the study indicate that the installation of the electric fence between the Amboni community and the ANP has been successful in reducing the conflicts between humans and wildlife. The fence has led to a decrease in crop damage, livestock depredation, farm coverage affected, and property losses. Additionally, the fence has also reduced the number of human casualties resulting from human-wildlife conflicts. Most residents of the Amboni community have experienced HWC due to the proximity of their farms to the park. The study also found that the introduction of the electric fence has reduced the amount of interruption in the daily activities of local residents, such as children going to school, workers reporting to work, and farmers tilling their land. However, the income of farmers was found to be dependent on several factors, including the cost of farming, cost of living, and weather conditions. The study also found that the electric fence has reduced the entry of humans into the park to gather resources and has contributed to a change in the local community's perception of wildlife conservation. The community now values wildlife conservation and is against illegal activities in the park.

V. RECOMMENDATION

Policy Recommendation

The study offers several recommendations based on its findings and conclusions. These include: The government, travel industry investors, and NGOs should support KWS in establishing a compensation or insurance fund to cover local community losses caused by wildlife damage, particularly from primates which are not covered by the wildlife compensation scheme. Implementing comprehensive land use planning that includes community conservancies can help reduce conflicts between humans and animals in competition for resources and ensure wildlife migratory paths. This can be achieved by promoting human settlement away from these paths and establishing buffer and human use areas. The government should encourage eco-tourism and other conservation and development projects such as beekeeping outside parks, which can benefit the local community by providing a source of income and improving their well-being. KWS should establish an effective mobile Problem Animal Control unit with sufficient personnel and resources to respond to HWC incidents quickly. This, along with environmental education, can change the community's unfavorable perception of wildlife and wildlife conservation.

Further Research

Further research is recommended to evaluate the effectiveness of electric fencing on reducing HWC across other parks in the country. Additionally, research should be conducted to determine the attitudes and perceptions of local communities towards the effectiveness of fencing parks and identify any challenges with the installation, maintenance, and repair of electric fencing along park boundaries.

REFERENCE

[1]. Acharya, K., Paudel, P., Neupane, P., & One, M. K. (2016). Human-wildlife conflicts in Nepal: patterns of human fatalities and injuries caused by large mammals. PLoS One, 11(9).

[2]. Amaja, L. G., Feyssa, D. H., & Mekonnen Gutema, T. (2016). Assessment of types of damage and causes of human-wildlife conflict in Gera district, south western Ethiopia. Journal of Ecology and the Natural Environment,8(5), 49–54.

[3]. Anand, S. R. S. (2017). Investigating trends in human-wildlife conflict: is conflict escalation real or imagined? Journal of Asia-Pacific Biodiversity, 10(2), 154–161.

[4]. Barua, M., Bhagwat, S. A., & Jadhav, S. (2012). The hidden dimensions of human-wildlife conflict: Health impacts, opportunity and transaction costs. Bioological Conservation, 157(2013), 309–316.

[5]. Baruch-Mordo, S., Breck, S. W., Wilson, K. R., & Broderick, J. (2009). A tool box half full: How social science can help solve human-wildlife conflict. Human Dimensions of Wildlife, 14(3), 219–223.

[6]. Bhattarai, B. P., & Kindlmann, P. (2012). Interactions between Bengal tiger (Panthera tigris) and leopard (Panthera pardus): Implications for their conservation. Biodiversity and Conservation, 21(8), 2075–2094.

[7]. Bleier, N., Lehoczki, R., Újváry, D., Szemethy, L., & Csányi, S. (2012). Relationships between wild ungulates density and crop damage in Hungary. Acta Theriologica, 57(4), 351–359.

[8]. Browne-Nuñez, C., & Jonker, S. A. (2008). Attitudes Toward Wildlife and Conservation Across Africa: A Review of Survey Research. Human Dimensions of Wildlife, 13(1), 47–70.

[9]. Check, J., & Schutt, R. (2011). Research methods in education.

[10]. Cromsigt, J. P. G. M., Kuijper, D. P. J., Adam, M., Beschta, R. L., Churski, M., Eycott, A., Kerley, G. I. H., Mysterud, A., Schmidt, K., & West, K. (2013). Hunting for fear: Innovating management of human-wildlife conflicts. Journal of Applied Ecology, 50(3), 544–549.

[11]. Digun-Aweto, O., Van Der Merwe, P., & Saayman, M. (2020). Tolerance factors in human-wildlife conflicts in protected areas: the case of Cross River National Park, Cross River State Nigeria. 31(2), 260–275.

[12]. Dunham, K., Ghiurghi, A., Cumbi, R., & Urbano, F. (2010). Human–wildlife conflict in Mozambique: a national perspective, with emphasis on wildlife attacks on humans. Oryx, 44(2), 185–193.

[13]. Gemeda, D. O., & Meles, S. K. (2018). Impacts of human-wildlife conflict in developing countries. Journal of Applied Sciences and Environmental Management, 22(8), 1233.

[14]. Golafshani, N. (2003). Understanding reliability and validity in qualitative research. The Qualitative Report, 8(4), 597–607.

[15]. Golafshani, N. (2003). Understanding reliability and validity in qualitative research. The Qualitative Report, 8(4), 597–607.

[16]. Gross, M. (2009). Fence protection progress.

[17]. Guinness, S. M. (2014). The effects of human-wildlife conflict on conservation and development: a case study of Volcanoes National Park, Northern Rwanda. Doctoral Dissertation, Trinity College Dublin.

[18]. Gulati, S., Karanth, K., … N. L.-P. of the, & 2021, U. (2021). Human casualties are the dominant cost of human–wildlife conflict in India. Proceeding of the National Academy Sciences, 118(8).

[19]. Hazzah, L., Dolrenry, S., Naughton, L., Edwards, C. T. T., Mwebi, O., Kearney, F., & Frank, L. (2014). Efficacy of two lion conservation programs in Maasailand, Kenya. Conservation Biology, 28(3), 851–860.

[20]. Hill, C. M., & Webber, A. D. (2010). Perceptions of nonhuman primates in human-wildlife conflict scenarios. American Journal of Primatology, 72(10), 919–924.

[21]. Jadhav, S., & Place, M. B. (2012). The Elephant Vanishes: Impact of human–elephant conflict on people’s wellbeing.

[22]. Kansky, R., Kidd, M., Knight, A., & Knight, A. T. (2016). A wildlife tolerance model and case study for understanding human wildlife conflicts. Bioological Conservation, 201, 137–145.

[23]. Karanth, K. K., & Vanamamalai, A. (2020). Wild Seve: A Novel Conservation Intervention to Monitor and Address Human-Wildlife Conflict. Frontiers in Ecology and Evolution, 8(198).

[24]. Karanth, K. K., & Vanamamalai, A. (2020). Wild Seve: A Novel Conservation Intervention to Monitor and Address Human-Wildlife Conflict. Frontiers in Ecology and Evolution, 8(198).

[25]. Karanth, K. K., Gopalaswamy, A. M., DeFries, R., & Ballal, N. (2012). Assessing Patterns of Human-Wildlife Conflicts and Compensation around a Central Indian Protected Area. PLoS ONE, 7(12).

[26]. Kassilly, F., & Tsingalia, M. (2008). Mitigating human-wildlife conflicts through wildlife fencing: A Kenyan case study Article in Wildlife Biology in Practice · Modelling the influence of carbon stocks and stock changes in agroforestry practces in Western Kenya View project Determination of .

[27]. Kenya National Bureau of Statistics. (2019

[28]. Lindsey, P. A., Masterson, C. L., Beck, A. L., & Romañach, S. (2012). Ecological, social and financial issues related to fencing as a conservation tool in Africa. In Fencing for Conservation: Restriction of Evolutionary Potential Or a Riposte to Threatening Processes? (pp. 215–234). Springer New York.

[29]. Manral, U., Sengupta, S., Hussain, S. A., Rana, S., & Badola, R. (2016). No Title:"Human wildlife conflict in India: A review of economic implication of loss and preventive measures.". Indian Forester, 142(10), 928–940.

[30]. Matseketsa, G., Muboko, N., Gandiwa, E., Kombora, D. M., &Chibememe, G. (2019). An assessment of human-wildlife conflicts in local communities bordering the western part of Save Valley Conservancy, Zimbabwe. Global Ecology and Conservation, 20, e00737.

[31]. Mekonen, S. (2020). Coexistence between human and wildlife: The nature, causes and mitigations of human wildlife conflict around Bale Mountains National Park, Southeast Ethiopia. BMC Ecology, 20(1).

[32]. Mugenda, A., & Mugenda, A. (2013). Qualitative research methods.

[33]. Nyamwamu, R., … J. M.-… J. of A., & 2015, undefined. (2015). Untapped Potential of Wildlife Agricultural Extension Mitigation Strategies in Influencing the Extent of Human-Wildlife Conflict: A Case of Smallholder Agro-Pastoralists. Journals.Esciencepress.Net.

[34]. Nyhus, P. J. (2016). Human–Wildlife Conflict and Coexistence. Annual Review of Environment and Resources, 41(1), 143–171.

[35]. Nyirenda, V. R., Chansa, W. C., Myburgh, W. J., & Reilly, B. K. (2011). Wildlife crop depredation in the Luangwa Valley, eastern Zambia. Journal of Ecology and the Natural Environment, 3(15), 481–491.

[36]. Ogutu, J. O., Piepho, H.-P., Said, M. Y., & Kifugo, S. C. (2014). Herbivore Dynamics and Range Contraction in Kajiado County Kenya: Climate and Land Use Changes, Population Pressures, Governance, Policy and Human-wildlife Conflicts. Open Ecology, 7(1), 9–37.

[37]. Okello, M. M., & Kioko, J. M. (2010). Contraction of Wildlife Dispersal Area in Olgulului-Ololorashi Group Ranch Around Amboseli National Park, Kenya. In The Open Conservation Biology Journal (Vol. 4).

[38]. Rhino Ark. (2010). History of the Aberdare Fence.

[39]. Sapkota, S., Aryal, A., Baral, S. R., Hayward, M. W., & Raubenheimer, D. (2014). Economic Analysis of Electric Fencing for Mitigating Human-wildlife C onflict in Nepal. Journal of Resources and Ecology, 5(3), 237–243.

[40]. Saunders, M., Lewis, P., & Thornhill, A. (2009). Research methods for business students. Pearson education.

[41]. Suzuki, K., & Muroyama, Y. (2010). Topic 5: Resolution of Human–Macaque Conflicts: Changing from Top-Down to Community-Based Damage Management. In Primatology Monographs book series (pp. 359–373).

[42]. Tobgay, S., Wangyel, S., & … K. D. (2019). Impacts of crop raiding by wildlife on communities in buffer zone of Sakteng Wildlife Sanctuary, Bhutan. International Journal of Scientific Research and Management, 7(4), 129–135.

[43]. Valeix, M., Hemson, G., Loveridge, A. J., Mills, G., & Macdonald, D. W. (2012). Behavioural adjustments of a large carnivore to access secondary prey in a human-dominated landscape. Journal of Applied Ecology, 49(1), 73–81

[44]. White, P., & Ward, A. (2011). Interdisciplinary approaches for the management of existing and emerging human–wildlife conflicts. Wildlife Research, 37(8), 623–629.

[45]. Widman, M., & Economics, K. E. (2018). Costs of livestock depredation by large carnivores in Sweden 2001 to 2013. Ecological Economics, 143, 188–198.

[46]. Zisadza-Gandiwa, P., Gandiwa, E., & Muboko, N. (2016). Preliminary assessment of human–wildlife conflicts in Maramani Communal Area, Zimbabwe. African Journal of Ecology, 54(4), 500–503.