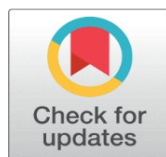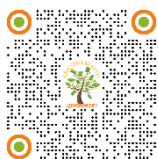# SOCIO - ECONOMIC IMPACTS OF HUMAN - WILDLIFE CONFLICTS IN KIENI SUB - COUNTY, KENYA

Godhard Muiruri Kariuki [1] ✉ iD

[1] Department of Environmental Studies and Community Development, Kenyatta University P.O. Box 43844-00100, Nairobi, Kenya

ABSTRACT

Humans and wildlife share resources in natural habitats resulting to increased human-wildlife conflicts both in frequency and severity across the world. HWC are serious in where ecosystem services are shared between humans and wildlife animals, exceptionally around areas that are protected. The objective of the study was to investigate the socio-economic impacts of human-wildlife conflicts in Kieni Sub-County, Kenya. A descriptive survey design was used in this study. Data collection was done using questionnaires administered to 71 households that were selected using simple random sampling technique. Participant field observations, interview schedules together with focus group discussions were also used. Analysis of data was done by use of descriptive statistics in form of frequencies and percentages. Information gathered from key informants was analyzed thematically. Results of the study revealed that human-wildlife conflicts resulted to both social and economic consequences including safety among the local communities, livestock predation, disease transmission and damage of property. The study concludes that human-wildlife conflicts had a substantial social and economic impact on the local communities of Kieni Sub-County through loss of crops, loss of animals, loss of income as a result of disease control and treatment, human injuries and inconveniences while protecting both crops and livestock not to be attacked by the wild animals.

Keywords: Hidden Costs, Human-Wildlife Conflicts, Kieni Sub-County

1. INTRODUCTION

Human-wildlife conflicts (HWC) are on the rise globally posing one of the greatest challenges to both conservation and livelihoods. However, its forms and impacts varies in terms of space and time. The International Union for Conservation of Nature (IUCN) acknowledges that human-wildlife conflicts affect crops and livestock productions, revenues as well as safety of humans IUCN-WCC (2020). Additionally, IUCN-WCC recognizes that human-wildlife conflicts threatens security of food, hinder attainment of the sustainable goals of development and financial growth IUCN-WCC (2020). Subsequently, HWC is still an encounter in the world both to the society and their livelihoods. HWC has both direct or visible costs and

indirect costs to the affected societies. Direct costs include crop damage, livestock predation, injuries as well as deaths to humans Zakayo (2014), Mashalla and Ringo (2015), Dai et al. (2019) whereas costs that are hidden comprise of societal and mental effects which cannot be quantified such as anxiety and losing sleep Hoare (2001).

Crop raiding is an example of a direct impact of human-wildlife conflicts which is a common challenge to many farmers globally. For instance, between the year 2015 and 2019 in both eastern as well as southern parts of the USA, it is estimated that soybeans and corn worth US$323.9 million and US$194.0 million respectively was lost to different wildlife species Mckee et al. (2021). Additionally, in Brazil, it was noted that there were 2611 cases as a result of animals being crashed by vehicles every year. About 8.5% of those incidences resulted to either to injuries to the humans or loss of lives Abra et al. (2019). Moreover, Abra et al. (2019) approximated the yearly cost of US$ 25,144,794 by the people owing to collision of vehicles with different wild animal species for example lowland tapir and capybara. Furthermore, nine people died while five were injured in Qinghai Province China by the brown bear between the year 2014 and 2017.

In Africa where humans and wild animals share space, the direct effects of human-wildlife conflicts are different. For example, in Tanzania, according to Tanzania Wildlife Management Authority (2019), spotted hyena were reported to have killed 14 people in addition to injuring 24 others between year 2016 and 2018. Likewise, in Laikipia and Kajiado Counties which are in Kenya, human-wildlife conflicts analysis indicated that 64.09 hectares of crops were destroyed by different wild animal species from 2010 to 2018 Manoa et al. (2020). During the similar time, Manoa et al. (2020) observed that Kajiado County (Kenya) had a loss of livestock valued at KSH 1,785,000 (US $ 16,780.53) whereas Laikipia County loss was valued at KSH 407,000 (US $ 3826.15).

Human-wildlife conflicts hidden costs are losses which are not compensated for, delayed temporarily, or are psycho-social Ogra and Badola (2008), Barua et al. (2013). These costs include health, transaction as well as opportunity costs. According to Barua et al. (2013) transaction costs are incurred as a result of bureaucratic failures and delays which are associated with compensation of those involved in human-wildlife conflicts. Compensation scheme is meant to compensate people the monetary losses as a result of human injuries and death, loss of crops and livestock, property damage among other things so as to enhance their coexistence with the wild animals Treves et al. (2009). However, those who are directly affected by human-wildlife conflict, especially in the developing countries encounter experience challenges in getting their reimbursement.

A study by Winemann (2018) in Taita-Taveta County, Kenya revealed that 92% of the participants reported that crop raids by the elephant's crop had made them to suffer both emotionally and mentally. Other places in Kenya includes Kitui County, where it was reported that residents lived in fear due to a lion that had strayed from Kora National Park killing two cows in their village. Efforts by the Kenya Wildlife Service (KWS) to seize and control the lion took a very long time. Resident also indicated that children who were attending were in fear since the lion could attack them Musangi (2020). Elsewhere in Lenkisem village, Kajiado County, an elephant attacked a group of school-going children that lead to death of one of them Koech (2021)while leaving others with fear making them unable to attend school sessions.

According to Fauna and Flora International (2014), opportunity cost is a loss suffered by taking a certain action in opposition to human-wildlife conflicts rather

than other more favoured and valuable alternatives. Opportunity costs are among the societal problems encountered by communities that live near the areas for conservation of wild animals Manoa (2020). Mariki (2016) for instance, noted that water pipes damage by elephants in West Kilimanjaro (Tanzania) was as a result of people walking for long distances looking for water instead of engaging themselves into other chores that are social and economic. Manoa and Mwaura (2016) further noted that pastoral communities who had not embraced kraals which are resilient to predators in the Amboseli region of Kenya usually spent most of their nights protecting their livestock from predator attacks.

Past studies in Kieni Sub-County have documented different forms of human-wildlife conflicts experience by the local communities and varied strategies used in the management of human-wildlife conflicts. For instance, a study conducted by Kariuki (2018) in the study area revealed that different problems were caused by wild animal species. However, the study did not look at the socio-economic impacts of human-wildlife conflicts in the study area. This study therefore aimed at filling this gap by focusing on the socio and economic impacts of HWC in Kieni Sub-County, Kenya.

2. MATERIALS AND METHODS
2.1. STUDY AREA

This study was conducted in Kieni Sub-County which was purposively sampled owing to occurrence of human-wildlife conflicts. Three sub-locations Amboni, Bondeni and Njeng'u were then purposively sampled due to high prevalence of human-wildlife conflicts. In terms of administration, Kieni Sub-County has 5 locations which includes: Mweiga, Endarasha, Gatarakwa, Mwiyogo and Mugunda which covers an area of 1,230 Km^2. Kieni Sub-County is in Nyeri County covering 623Km^2 and is located between longitude $36^040''$ East and $37^0 20''$ East. It also lies between the equator (0°) and latitude 0° 38'' South. Kieni West Sub-County lies from 3076 meters to 5188 meters above sea level. The average temperatures in a month range between 12.8^0 C and 20.8^0 C whereas the average rainfall in a month is from 500 mm to 2400mm in a year. Most of the people in the Sub-County are low-income earners who are distributed sparsely all over the study area.

2.2. SAMPLE SIZE AND SAMPLING PROCEDURE

Kieni Sub-County is made up of 5 locations with a population of approximately 88,525 people (KNBS, 2019). This study had a target population which was obtained from three sub-locations in the Sub-County, and they included: Amboni, Bondeni and Njeng'u from Mweiga location. The target population consisted of 2837 households (Amboni 1525, Bondeni 384 and Njeng'u 928 households) (Table 1). The respondents comprised of small-scale farmers, officers from the Kenya Wildlife Service (KWS), Agricultural and Veterinary officers as well as local leaders. The sample size (n) was arrived at using a formula by Colton (1963) cited in Dongol (2007).

Sample size (n) = $\dfrac{(N \times Z^2 \times P (1-P))}{(N \times d^2 + Z^2 \times P (1-P))}$ (1)

Where,

N = total household's number

Z = standard variation at 95% confidence level (1.96)

P = estimated population (0.05)

d = limit error of 5% (0.05)

Table 1

Table 1 Number of Households and Sampled Households		
Sub-locations	Households (N)	Sampled Households
Amboni	1525	38
Bondeni	384	10
Njeng'u	928	23
Totals	2,837	71

Source Kenya National Bureau of Statistics (2019)

2.3. DATA COLLECTION AND ANALYSIS

Data collection was by use of structured questionnaires, focus group discussions, interviews conducted with key informants and participant field observations. The structured questionnaires were administered randomly by the researcher to households that were affected by human-wildlife conflicts in the three sampled sub-locations. There were three FGDs that were involved in the study where each came from the three sub-location and consisted of 8 members from the local community. Key informants' interviews were also carried out with agricultural and veterinary officers, officers of the Kenya Wildlife Service as well as local opinion leaders. Participant observations were conducted so as to appreciate the nature of the conflicts that occurred between humans and wild animals on both fields that were affected and those that were non-affected. The study used primary and secondary data. The study yielded both qualitative and quantitative data where qualitative data was obtained from the open-ended questions in the structured questionnaires, focus group discussions and Key Informant Interviews (KIIs). Quantitative data analysis was done by way of descriptive statistics in form of frequencies and percentages. Data presentation was done using frequency tables and percentages.

3. RESULTS AND DISCUSSION
3.1. SAFETY OF THE LOCAL COMMUNITIES

The findings from the survey revealed that human-wildlife conflicts instilled fear to the local communities. Marauding elephants, buffaloes and leopards were identified as the main species that instilled fear to the local communities. However, baboons were also mentioned to instill fear to humans especially women. This threatened the safety of the local communities in the area making them unable to conduct their economic and social activities especially at night. The perceived danger also restricted school going children from attending school affecting their educational development. Wild animals were said to move out of the protected areas and at night they would move around in the local community causing panic to the community members. This finding agrees with Nyhus (2016) who observes that human-wildlife conflict is a major source of insecurity for people and communities who live within or nearby protected areas. Nyamwaro et al. (2006) opines that there are other less noticeable but equally important impacts of human-wildlife conflicts. For example, in Transmara Sub-County of Kenya, people were afraid to conduct their socioeconomic activities due to the presence of elephants in their localities.

However, less people in the community were injured by the wild animal species as a result of chance contact with them to and from dwelling or a water source. This is in congruence with Kariuki (2018) who pointed out that 3% of human-wildlife conflict that occurred in Kieni Sub-County were human injuries/threats. People could also be injured when walking at night or chasing away the wild animals from their crop lands or homesteads. Injuries reported by the local community members were said to be catastrophic at the family and village level though at national level they had little consequence. Most of the local community members depended on manual jobs which required their physical well-being and injuries to them could cause the family and the community at large a lot of problems. For example, the families would not get food, shelter, and other basic needs especially when the bread winner was injured. This would also affect the family in terms of children losing opportunity to receive education and eventually their future. The survey findings denoted that there is a high level of awareness within the local community of the dangers posed by the wild animal species.

3.2. HUMAN-WILDLIFE CONFLICTS AND FOOD SECURITY

The survey results show that human-wildlife conflicts threatened food security in the local communities where the communities largely depended on subsistence crop farming and selling of livestock Moalf (2016). Even though nationally the loss of crops and livestock meant nothing, to the concerned family, it meant loss of supply of food for the family, and this caused much problem to the local community at large. Discussions with the Focused Groups (FGDs) pointed out that the incidences of crop raiding especially by monkeys in the area had increased over the recent years. The increased level of conflict could be attributed to increased number of monkeys in the area which the local communities claim they were brought by the Kenya Wildlife Service (KWS) from other areas, dry spells experienced due to climate variability and lack of food for the wild animals. Human-monkey conflict was an issue of concern, with no sign of abating.

The most vulnerable crops to raiding by wild animals in the area was maize and bananas. This finding corroborates with Kariuki (2018) who observed that different crops were damaged by wild animals in Kieni Sub-County with maize being significantly damaged at 45%. Other crops like bananas, potatoes, beans, and vegetables were also damaged by the wild animals at 18%, 11%, 13% and 9% respectively. Maize which is a staple food in the area was significantly damaged because it is grown by most farmers. Most of the crops were destroyed at the mature stage of growth causing substantial loss to the households and to the local community as indicated in the Table 2.

Table 2

Table 2 Stage of Growth When Crops Were Damaged		
Stage of growth	**Frequency (N)**	**Percentage (%)**
Young	9	13
Average	16	22
Mature	46	65
Total	**71**	**100**

Source Field Survey

According to views from focus group discussions, the most responsible animal species for crop damage were monkeys, baboons, and elephants. Instances where crops were damaged by the monkeys and baboons were the most serious than the

elephant's raids due to the fact that monkeys visited their farms throughout the year. Elephants though they rarely raided the farms had adverse impact to crops as they destroyed large fields of land in a very short period of time. Crop destruction by monkeys and baboons was not quantified due to the fact that crop damage by monkeys and baboons are not considered for compensation. These crop damages reduced the yields by a significant percentage resulting to the individual households and the local community to be food insecure.

Farmers also indicated that they harvested immature crops such as maize and potatoes since they were attacked by the wild animals before they matured. Poor storage of these crops and sheathing of maize led to them rotting due to their water contents. Harvesting of immature crops led to low yields since crops were not given ample time to mature. This posed a threat to food security in the local communities. Harvesting of immature crops especially maize was done in an attempt to save them from raid primary by elephants, monkeys, antelopes but also by porcupines. Yields were affected throughout the year since there were farmers who did farming through irrigation by the help of water from the nearby rivers and also wild animals especially primates, rodents and birds frequented the farms throughout the year.

From the survey results, human-wildlife conflicts in the local community, caused crop damage and destruction which had forced some of the farmers, especially those bordering the forest to abandon their traditionally cultivated pieces of land while other farmers planted Napier grass for their livestock (Figure 1). Other farmers utilized their portions of land for grazing while others planted onions as a non-palatable crop which when damaged they did not feel much impact since it did not have much of economic value as compared to crops like maize, beans, potatoes, fruits, and vegetables, which people depended on due to their economic and nutritional value. This led to decreased crop yields since some parts of the crop land were not utilized for crop grow yields from the farms resulted to farmers buying staple food for their consumption from the local markets. A similar study conducted by Maiga and Marchand (1999) in Mali pointed out that in some areas, damages from human-wildlife conflicts compelled the families affected to abandon their farm fields that they traditionally cultivated. Elsewhere, Saj et al. (2001) indicated that farmers in Entebbe, Uganda changed what they grew in their farms so as to plant crops that were less susceptible to raids by vervet monkeys.

Figure 1

Figure 1 A Portion of Land Bordering the ANP that has Been Abandoned by a Farmer

Predators like wild dogs and hyenas were also reported to kill several domestic animals for example cattle, sheep, and goats among others in the local

communities and this devastated households' food security (Table 3). The loss of the family's small herds effectively destroyed the family's' income and their livelihood. For the local community, domestic animals were used both as a resource by means of producing manure, milk, meat as well as source of wealth. Tjaronda (2007) pointed out that in the Kanamub area of Namibian Sesfontein Conservancy, farmers lost between three and four animals in a month to wild animals such as cheetahs, leopards, lions, and hyenas.

Table 3

Table 3 Livestock Predation		
Type of livestock	**Frequency (N)**	**Percentage (%)**
Goats & sheep	40	57
Cattle	14	19
Poultry	17	24
Totals	**71**	**100**

Source Field Survey

3.3. ECONOMIC AND SOCIAL LOSSES

The result findings further show those respondents in the local communities incurred economic and social costs as a result of conflicts between people and wildlife animals in the area. The local communities incurred both direct and indirect costs which affected the local communities a great deal. Crop damage and livestock predation led to direct economic costs while the communities incurred a variety of additional costs as people living alongside wild animals had to do a lot of investment in strategies such as human vigilance, herding of livestock herding as well as control of predators. However, these indirect costs were harder to quantify, but were substantial.

From the findings, it is estimated that in the local community's economic loss from crop damage was reported was US $ 22,101 from elephants alone (Table 4). This was a great economic loss to the individual households and the local community at large. The findings also indicated that crop damage by baboons and monkeys was not quantified since they were not considered for compensation. This implies that the economic loss as a result of crop damage would be more than this.

Table 4

Table 4 Estimated Economic Loss of Crops from Elephants Raids			
Crop Loss range in US $	**Households affected (N)**	**Percentage**	**Average crop loss in**
		(%)	**US $**
20-49	11	29.29	1000
49-99	9	26.26	1923
99-197	4	10.1	1497
197-296	3	8.08	1972
296-493	5	13.13	5127
493-986	3	9.09	6656
986 and above	1	4.04	3944
Total	**36**	**100**	**22,101**

Source Field Survey

A big number of farmers in the area of study are small stockholders with livestock between 10 and 15 animals per household, so that the relative impact of livestock predation is high. The wild dogs were responsible for most of the livestock predation. A study conducted by Kariuki (2018) reported that 31% of the livestock attacks were by wild dogs. Other livestock attacks were by leopards (27%), hyenas (23%), elephants (18%) and baboons (11%). The cost of conflicts between humans and wild animals at the household level in the area was estimated to be at US $ 1469 per annum. This caused a significant impact on the livelihoods of the local community. An estimate cost of livestock for compensation was done using the market value at that time though no compensation has been done so far to the local communities. Wang and Mackdonald (2006) noted that depredation can have a substantial economic effect on the owners concerned. For example, a level of only 2% stock loss to depredation resulted to households in Bhutan losing 18% of their per capita cash earnings while depredation by snow leopards (*uncia uncia*) and wolves cost villagers in Nepal approximately half of their average yearly per capita income Mishra (1997).

Livestock that were injured, killed, or contracted diseases from wild animals, lost their economic value since they could not be sold at the same price as when they were before wildlife attacks. For example, there were 34 cases that were reported as a result of disease transmission to the livestock for a period of one year. From the reported cases, 61% (n=21) revealed that livestock were cases of East Coast Fever (ECF) disease whereas 39% (n=13) were diagnosed with trypanosomiasis disease (Table 5). When livestock were sold in that condition, they fetched low prices in the local markets. Livestock attacks by wild animals also affected the livestock's milk production leading to farmers incurring more losses especially for cattle and goats. Mature livestock were said to have more economic loss that the young ones. For example, the cost of mature cattle was estimated to be more than, US$ 493, mature goat at US $ 39 and a mature sheep at US $ 49. This cost of livestock went down drastically whenever a livestock was injured by wild animals or contracted disease from the wildlife.

Dogs were also frequently injured, and others killed though their economic value was difficult to quantify due to the economic value attached to them. Hamisson and di Silvestre (2008) reported that in Niger, the economic losses that were incurred from the year 2000 to 2006 in the W transboundary Park were estimated to be approximately US $ 149 530. This loss is equivalent to an annual average of US $ 138 per individual.

Table 5

Table 5 Diseases Transmission		
Disease Transmitted	**Frequency (N)**	**Percentage (%)**
East Coast Fever	21	61
Trypanosomiasis	13	39
Total	**34**	**100**

Source Field Survey

The study further established that farmers also incurred other additional costs which took varying forms such as fencing and construction of livestock enclosures to protect their crops and livestock (Table 6). Fencing was used to guard both crops and livestock from wild animal attacks notably at night. However, enclosures such as cow sheds and calf pens guarded only livestock from the attacks. EcoPost (2020) approximated that fencing an acre of farm in Amboseli Ecosystem and Mount Kenya

Ecosystem it would require about KES 40,000 (US$ 366.97) to cater for 2 barbered wire rolls, 102 posts, 3.5kgs of nails in addition to labor. Elsewhere Kissui et al. (2019) indicated that there was use of traditional fences in Tanzania. However, he further noted that predator-proof bomas were more effective compared to the traditional fences.

Table 6

Table 6 Physical Barriers		
Physical barrier	**Frequency (N)**	**Percentage (%)**
Fences	19	41
Enclosures	27	59
Total	**46**	**100**

Source Field Survey

Dogs used in guarding the livestock from predation required to be taken care of in terms of diet, immunization, and veterinary care so as to be able to do effective guarding. Encounters with wild animals, exposure to diseases and physical injuries caused a high financial cost to the individual and the local community in the form of medical treatment. Other farmers who did not have family members to guard their farms employed people to guard their animals from predators at a cost of US $ 2 per day having economic strain to the farmers (approximately US $ 59 per month and US $ 710 per annum). Manoa et al. (2021) found out that Dogs were employed to protect livestock and crops both in Amboseli Ecosystem and Mount Kenya Ecosystem especially in alerting households of wildlife attacks and scaring away birds and small mammals. The people in Amboseli Ecosystem and Mount Kenya Ecosystem largely depend on ordinary dogs who are untrained and their cost was from ranged KES 1900 to 2200 (US$ 17.43 - 20.18) for each dog when compared to the Anatolian Shepherd trained dog whose costs was from US$ 1000 in Tanzania Ruaha Carnivore Project (2020) to US$ 2780 in Namibia as well as South Africa (Rust et al., 2013).

Dogs have been recognized as affective in guarding sheep against wild animals such as cheetah together with other small carnivores. However, studies point out that they are related to some ecological expenses that are unknown. For instance, Drouilly et al. (2020) revelled that from his analysis of 183 scats from six dogs that were guarding livestock in South Africa, 10 different wild mammals were preyed on by dogs. Elsewhere, Korir (2015) documented that in Narok County (Kenya), soya beans farmers resulted to employing not less than three workers to protect their farms from gazelles and zebras' raids. Consequently, each farmer spent about KES 18,000 (US $ 165.14) on average monthly on wages.

3.4. HUMAN-WILDLIFE CONFLICTS OPPORTUNITY COSTS

Other *'opportunity costs'* were also incurred by the local communities due to conflicts between people and wild animal species. The pressure of wild animals since the time that was required for guarding livestock limited the period of time that could be used in other potential activities for example attending school or even assisting in harvesting of crops. Some of the schools going children were used during the weekdays and over the weekends denying them a chance to attend school, do their school assignments, their playing time which contributes their physical and mental development. This affected their academic performance and eventually their future. Namara (2006) observed that a common coping strategy includes the deployment of children like crop guards during the day and older

family members at deployed at night, while crops mature and ripen. Some households consequently have to deny children opportunities in education so as to provide the much-required labour of crop guarding, further making them unable to break out of poverty.

Local farmers also indicated that they incurred cost in terms of time spent when guarding crops from elephants at night and from baboons, monkeys, and birds during the day. Farmers guarded their farms from 6am-6pm and in turns denying them time to do other productive activities that could supplement their income and hence influence their livelihoods. The task of guarding at night was done by men while during the day the responsibility of guarding was done by children. This finding is consistent with a study conducted by Musyoki (2014) who noted that farmers in Mahiga "B" village of Kieni, spent significant amount of time protecting their crops from wild animal attacks. Guarding at night was reported to cause social disruption of family units as men and young boys spent more time at night guarding the fields during the cropping season. This affected their sleep and subsequent productivity of the people involved in guarding. This also led to school dropouts by some young boys as they spent more time in the field herding cattle during the day while others were employed to do herding of livestock. However, this was not reported as a major problem in the local communities. According to Barua et al. (2013)spending of time while protecting both their livestock and crops have numerous social and economic consequences to the people. First, guarding at night prevents people from getting an opportunity to take part in other activities that can generate revenue during the day as a result of lack of sleep. Secondly, protecting against threatening and feared wild animal species for example elephants is linked to tiredness as well as abuse of alcohol for relieve of anxiety among adults Barua et al. (2013).

Milking time of the dairy cattle was also affected leading to loss of milk which most of the farmers depended on and hence affecting their livelihood. The farmers did not have preservation facilities that could have helped them to store their milk and the distance covered to the diary centres was long. Farmers got an average of 10 litters of milk per day at an average cost of US $ 0.3 per litter (approximately US $ 89 per month and US $ 1065 per annum). This had economic implications and especially at the household level where the local community derived their means of living from the milk sales (Figure 2).

Figure 2

Figure 2 A Farmers' Co-Operative Vehicle Delivering Milk

Repairs of damaged properties like fences, water pipes, gates, water tanks and other reservoirs, livestock enclosures and other structures destroyed by the

elephants, incurred some additional and unplanned costs to the local communities. However, property damage by the wild animals was not common and also went unreported. This is supported by Long et al. (2020) who reported that a national human-wildlife conflict data analysis between the year 2005 and year 2016 in Kenya, revealed that that damage of property amounted to merely 4% of the 29,647 human-wildlife conflict incidences that were reported.

4. CONCLUSION

Based on the survey findings that the local communities are faced with various consequences as a result of human-wildlife conflicts, the study concludes that human-wildlife conflicts have a significant social and economic impacts on the local communities through loss of crops, loss of animals, loss of income to diseases control and treatment, human injuries and inconveniences caused during protection of crops and livestock. The study also concludes that the livelihoods of the local communities were adversely affected by human-wildlife conflicts in the study area.

CONFLICT OF INTERESTS

ACKNOWLEDGMENTS

REFERENCES

Abra, F.D., Granziera, B.M., Huijser, M.P., Ferraz, K.M.P.M.D.B., Haddad, C.M., and Paolino, R.M., (2019). Pay or Prevent? Human Safety, Costs To Society And Legal Perspectives on Animal-Vehicle Collisions in Sao Paulo State, Brazil. Plos One 14 (4), 0215-152. https://doi.org/10.1371/journal.pone.0215152.

Barua, M., Bhagwat, S.A., and Jadhav, S. (2013). The Hidden Dimensions of Human-Wildlife Conflict : Health Impacts, Opportunity, and Transaction Costs. Biological Conservation. 15, 309-316. https://doi.org/10.1016/j.biocon.2012.07.014.

Dai, Y., Hacker, C.E., Zhang, Y., Li, W., Li, J., Zhang, Y., and Li, D., (2019). Identifying The Risk Regions Of House Break-Ins Caused by Tibetan Brown Bears (Ursus Arctos Pruinosus) in the Sanjiangyuan Region, China. Ecol. Evol. 9 (24), 13979-13990. https://doi.org/10.1002/ece3.5835.

Drouilly, M., Kelly, C., Cristescu, B., Teichman, K.J., and O'rian, J.M., (2020). Investigating The Hidden Costs Of Livestock Guarding Dogs: A Case Study in Namaqualand, South Africa. J. Verterb Biol.200033. https://doi.org/10.25225/jvb.20033.

EcoPost (2020). Ecopost Estimate Calculator.

Huaping, L., Mojo, D., Fu, C., Wang, G., and Kanga, E. (2020). Patterns of Human-Wildlife Conflict and Management Implications in Kenya : A National Perspective. Hum. Dimens. Wildl. 25 (1). https://doi.org/10.1080/10871209.2019.1695984.

IUCN-WCC (2020). Addressing Human-Wildlife Conflict: Fostering A Safe and Beneficial Coexistence of People and Wildlife, International Union For Conservation of Nature.

Kariuki, G. M. (2018). Typology of Human-Wildlife Conflicts Encountered by the Local Communities in Kieni West Sub-County, Kenya. International Journal of Scientific and Research Publications (IJSRP), 8(12), 160-169. http://dx.doi.org/10.29322/IJSRP.8.12.2018.p8422.

Kenya National Bureau of Statistics (2019). The 2019 Kenya Population and Housing Census. Government of Kenya, Nairobi.

Kimega, G.M., (2003). Unresolved Human/Wildlife Conflict in Kenya : The Source of Misery and Poverty. Ecofiles. Lusaka, Zambia.

Kissui, B.M., Kiffner, C., Konig, H.J., and Montgomery, R.A., (2019). Patterns of Livestock Depredation and Cost-Effectiveness of Fortified Livestock Enclosures In Northern Tanzania. Ecol. Evol. 9, 11420-11433. https://doi.org/10.1002/ece3.5644.

Koech, G., (2021). Long Wait for Compensation after Wildlife Wreaks Havoc. In : The Star.

Korir, K., (2015). Farmers Count Losses As Wildlife Invade Farms.

Manoa, D.O., Mwaura, F., Thenya, T., and Mukhovi, S. (2020). Comparative Analysis of the Typology, Seasonality and Economic Cost of Human-Wildlife Conflict in Kajiado and Laikipia Counties, Kenya. East African Journal of Science, Technology and Innovation, 1 (4). https://doi.org/10.37425/eajsti.v1i4.188

Manoa, D.O., and Mwaura,F., (2016). Predator-Proof Bomas as a Tool in Mitigating Human-Predator Conflict In Loitoktok Sub-County, Amboseli Region of Kenya. Nat. Res. Forum 7, 28-39. https://doi.org/10.4236/nr.2016.71003

Mariki, S. (2016). Social Impacts of Protected Areas on Gender in West Kilimanajro, Tanzania. Open J. Soc. Sci. 4, 220-235. https://doi.org/10.4236/jss.2016.43028.

Mckee, S.C., Shwiff, S.A., and Anderson, A.M., (2021). Estimation of Wildlife Damage From Federal Crop Insurance Data. Pest Manag. Sci. 77 (1), 406-416. https://doi.org/10.1002/ps.6031.

Mishra, C. (1997). Livestock Depredation by Large Carnivores in the Indian Trans Himalaya : Conflict Perceptions and Conservation Prospects. Environmental Conservation, 24(4), 338-343. https://doi.org/10.1017/S0376892997000441.

Moalf. (2016). Climate Risk Profile for Nyeri. Kenya County Climate Risk Profile Series. The Kenya Ministry of Agriculture, Livestock and Fisheries (Moalf), Nairobi, Kenya.

Murphy, C. (2007). Community-Based Crocodile Management.Travel News Namibia.

Musangi, L., (2020). In : Obuya, P. (Ed.), Villagers Fearful After Stray Lioness Kills Two Cows in Mwingi.

Musyoki, C. (2014). Crop Defense and Coping Strategies: Wildlife Raids in Mahiga "B" Village in Nyeri District, Kenya. African Stud. Monogr. 35 (1).

Namara, A. (2006). From Paternalism to Real Partnership With Local Communities ? Experiences from Bwindi Impenetrable National Park (Uganda). https://doi.org/10.4314/AD.V31I2.

Nyamwaro, S. O., Murilla G.A., Mochabo, M.O.K. and Wanjala, K.B. (2006). Conflict Minimizing Strategies on Natural Resource Management and Use : The Case For Managing And Coping With Conflicts Between Wildlife and Agro-Pastoral Production Resources in Transmara District, Kenya. Policy

Research Conference on Pastoralism and Poverty Reduction in East Africa, Nairobi.

Nyhus, P. J. (2016). Human-Wildlife Conflict and Coexistence. Annu. Rev. Environ. Resour. 41, 143-171. https://doi.org/10.1146/annurev-environ-110615-085634.

Ogra, M., and Badola, R. (2008). Compensating Human-Wildlife Conflict in Protected Area Communities: Ground-Level Perspectives from Uttarakhand,India. Hum. Ecol. 36 (5), 717-729. https://doi.org/10.1007/s10745-008-9189-y

Tanzania Wildlife Management Authority (2019). Progress Report 2019.

Tjaronda, W. (2007). Namibia : Conservancies Suspend Compensation Schemes. New Era (Windhoek, Namibia).

Treves, A., Wallace, R.B., and White, S. (2009). Participatory Planning of Interventions to Mitigate Human-Wildlife Conflicts. Conserv. Biol. 23 (6), 1577-1587.