Journal of the Geographical Association of Tanzania, Vol. 43, No. 1: 17–40

Human-wildlife Interactions and Community Livelihoods: The Case of Villages Around the Selous Game Reserve, Morogoro District, Tanzania

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Abstract

In developing nations, particularly in Africa, interactions between humans and animals (HWIs) are widespread as local populations heavily rely on natural resources such as forests, which serve as habitats for flora and fauna. This paper draws from a study which investigated human-wildlife interactions (HWIs) in four villages—Mvuha, Mbwade, Milengwelengwe, and Kisaki Gomero—surrounding the Selous Game Reserve (SGR). A mixed methods approach was adopted to aid data capturing from 312 households and 11 key informants. Spatial analysis was employed to depict land use and land cover changes around the SGR over time due to human influence. The results indicated that HWIs were influenced by changes in water and pasture availability caused by two elements of weather: temperature and rainfall. People in WMA-designated villages complained about the lack of employment and unfair distribution of benefits, whereby the main concern of non-WMA-designated villages was on the need for policy review, with emphasis on the holistic conservation approach. Nonetheless, bush lands have increased in recent decades at the expense of woodland due to the proliferation of human interference. The paper concludes that the intersection of community livelihoods and wildlife ecology was the most common HWI pattern observed. However, typical forms of interaction were often hostile and instigated human-wildlife conflicts.

Keywords: *human-wildlife interaction, Selous Game Reserve, community livelihoods*

1. Introduction

Human-wildlife interactions (HWI) are common phenomena in developing countries, especially in Africa, where people depend on natural resources for their livelihoods (Acharya et al., 2016). The HWI is primarily caused by human population expansion, climate change and variability, including land use change intensifying competition for land resource utilization (Graham et al., 2005; Distefano, 2011). Climate change is a crucial—but often overlooked—factor that worsens human-wildlife conflict by intensifying the scarcity of resources, changing the behaviour and distribution of animals and humans, and increasing the frequency of encounters between the two (Abrahams et al., 2023). Prolonged droughts lead to less water, and thus, wild animals often leave national parks and game reserves to look for water elsewhere (Wambugu et al., 2017; IUCN,

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2020). In other cases, an increase in wildlife population and re-colonization increase the likelihood of human-wildlife interactions (Madden, 2004; FAO, 2007; Haingura, 2019). When wild animals are overpopulated in a park, they commonly venture out of their natural habitats into human settlements (Songer, 2018; Castrein & Pillai, 2011). In contrast, human population growth entails development activities threatening animal habitats (Woodroffe et al., 2005).

As the human population grows and natural habitats shrink, people and animals compete for limited space, food and other economic resources (Distefano, 2011; Redpath et al., 2013 & Acharya et al., 2016). Such situations increase the likelihood of human-wildlife conflicts, which can result in human fatalities and property destruction for households living near wildlife resources (Gandiwa et al., 2013; Mayengo et al., 2017). Conflicts between humans and wildlife occur when both populations compete for natural resources (Carl et al., 2015). Some studies show that conflicts are intensified because people do not benefit from wild animals, even though such wild animals cause the destruction of properties (Karanth, 2013). The literature demonstrates that human-wildlife interactions are spatially different and influenced by several factors, with climate change constituting an additional aggravating element (Okello, 2006; Carl et al., 2015; Philip, 2016). However, outcomes of being designated as wildlife management areas (WMA) or non-WMA areas are not well specified in the existing body of knowledge to address the magnitude of interaction through coexistence.

Some studies describe such phenomena as interactions and, in some cases, as conflicts; with less consideration of the determinants causing HWIs. Therefore, it was on these grounds that this paper was conducted mainly to examine the effect of HWIs, and its implications on the livelihoods of communities in the selected villages surrounding the Selous Game Reserve (SGR).

2. Theoretical Framework

Two theories were used as the foundation for this research: the carrying capacity theory (CCT) by Del Monte-Luna et. al. 2004, as cited by Parker et al. (2007); and the coexistence theory (CT) by Chesson (2000), Letten et al. (2017), and Saavedra et al. (2017). These theories provide insights into the factors that drive human-wildlife interactions.

2.1 Carrying Capacity Theory (CCT)

This theory states that the maximum number of individuals—i.e., the maximum population size of a biological species in a particular habitat—can be sustained or supported without degrading an environment, given available food, habitat, water and other resources; and that if these needs are not met, the population will decrease until the resources rebound (Chapman et al., 2001). Exceeding the environment's carrying capacity implies impairing the environment's ability to sustain the desired quality of life over the long-term. In protected areas, exceeding environmental carrying capacity automatically pushes wildlife outside their natural habitats as water, food and space for breeding are limited. Land resource issues such as fodder and water-points are important determinants of carrying capacity: these face increasing pressure from environmental change, potentially affecting their availability (Acharya et al., 2016).

2.2 Coexistence Theory (CT)

The coexistence theory addresses the coexistence of species as an interaction between two opposing forces, where fitness differences between such species drive the best-adapted population that outcompete others within a particular ecological region. Thus, two competing species may coexist effectively when both populations are healthy, while one species may displace the second if a chance event weakens it. This framework provides a straightforward interpretation of coexistence resulting from a balance between stabilization and differences in species' overall competitive abilities (Chesson, 2000). The theory further helps practitioners to explore the best mechanisms to conserve rare and endangered species in protected areas, while co-existing with human beings.

3. Context and Methods

3.1 Study Site

The paper draws data from a survey that was conducted in the communities surrounding the Selous Game Reserve (SGR) in Morogoro District, Tanzania. The study selected villages that are classified as wildlife management areas (WMA) near the SGR, and non-WMA-designated villages that are located far from the SGR. Using purposive sampling, the study chose three villages—Mbwade, Milengwelengwe, and Kisaki-Gomero—as WMA-designated. In contrast, Mvuha village is a non-WMA-designated village (Figure 1).

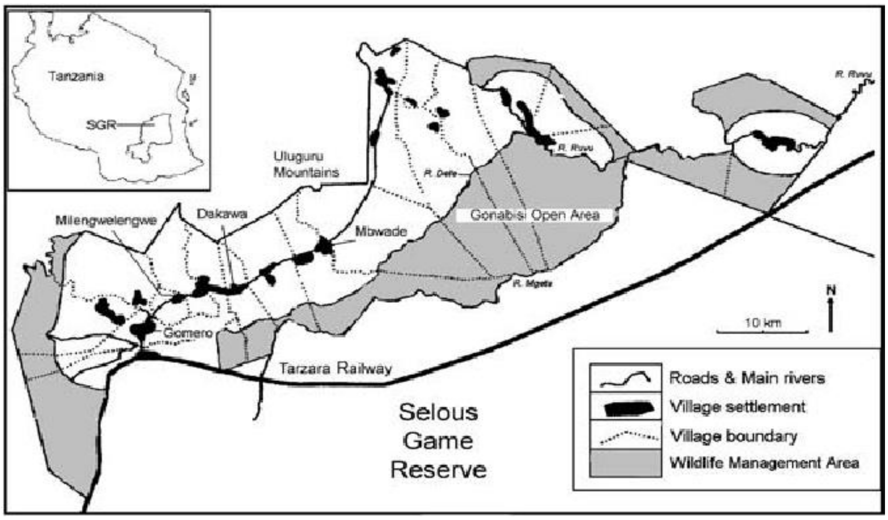

Figure 1: Selous Game Reserve: Mbwade, Milengwelengwe and Gomero villages (Source: Authors, 2022**)**

2.2 Design

This paper employs data that were generated from a cross-sectional research design and mixed-methods research approach to examine the effects of human-wildlife interactions on community livelihoods (Kothari, 2004; Junyong et al., 2017; DESASD, 2005).

2.3 Methods

2.3.1 Sampling

Each village administration office provided a complete household list to sample the population. The sample size was determined using a simple formula (Yamane, 1967), by which every member of a target population's household had an equal chance of being in the sample using simple random sampling (Kaswamila, 2009; Singh & Masuku, 2014). The respective village executive officers (VEOs) assisted in choosing fair samples of families. Three hundred and twelve (312) respondents were randomly chosen from 1,426 families in all four communities (Table 1). Each chosen household furnished one adult over 18 years old for interviews (Marrying, 2000; Phellas et al., 2011). Key informants—three (3) game wardens and eight (8) VEOs from the studied villages—were selected through purposive/ judgmental sampling to share their scientific expertise or experiences (Bernard, 2002; Lewis & Sheppard, 2006; Garcia, 2006). Also, purposive sampling was employed to choose the research area (Polit et al., 2001).

Table 1: Total Number of Households and Sampled Households

Wards	Village	Total Households (N)	Sample Size	Percentage
Bwakira Chini	Mbwade	342	75	5.26
Mngazi	Milengwelengwe	329	72	5.05
Kisaki	Gomero	415	91	6.38
Mvuha	Mvuha	340	74	5.19
Total		**1426**	**312**	**21.88**

Source: Morogoro District Council Planning Office

2.3.2 Data Collection

Primary data were gathered through participatory methods, including focus group discussions (FGDs), unstructured and structured interviews, personal field observations, and a review of records from the (Tanzania) Ministry of Natural Resources (Berkes, 2006; Bennett et al., 2016). The questions examined community livelihoods, patterns of HWI, wildlife management areas (WMAs), and cohabitation.

Closed-ended questionnaires were administered to capture key information regarding the respondents' socio-economic and demographic characteristics, and livelihood activities (Okello, 2006). *Focus group discussions (FGDs)* were undertaken to validate the data collected from individual respondents. A total of 12 FGDs were conducted in this study with four to twelve participants per group, which included farmers, livestock keepers, fishers, and village elders (Kumar, 1989). *In-depth interviews* were administered to key informants such SGR park wardens, and VEOs: a total of 11 key informants were interviewed to determine areas with the highest incidences of HWIs; and their causes and effects on the livelihoods of communities.

The selection of satellite images considered seasonality, cloud cover, and phonological effects, with images from the dry season and 10% cloud cover chosen to avoid seasonal differences. Landsat images were used to analyse land use and cover changes, and US Geological Survey images were obtained through the Google Earth Engine Code Editor. Other Landsat sensors were also used, including the Thematic Mapper (1990s), and the Operation Land Imager (2020s) (Zweig, 2015).

Secondary data was sought from previous studies carried out on HWIs at global, regional and local levels. Such information was retrieved from published sources such as books, journals, SGR brochures, district development plans, theses and other relevant documents.

2.3.3 Data Analysis

Qualitative data were analysed using content analysis (Marying, 2000), employing the analytical method. The data that were collected through questionnaires, key informants and FGDs were coded, cleaned and analysed descriptively into both descriptive (frequencies, percentages and means), and inferential (Chi-square test, spearman correlation and F-test) presentations (Kothari, 2004; Junyong et al., 2017). The quantitative data were analysed and processed using the Statistical Package for Social Scientists (SPSS) software, version 25.0 (IBM Corp., 2017).

The quantity of LULCC for each category was analysed in terms of relative changes, gross gains, and gross losses. The classified land cover layers (bare soil, bush land, agriculture, natural forest, grassland, water, woodland, settlements) for the years 1991, 2006 and 2021 were used. The change maps were developed using the intersect function of ArcGIS spatial analysis, using two consecutive LULC maps (Dewan, 2009).

3. Results

3.1 Pattern of Human-Wildlife Interaction

As mentioned earlier, this paper sought to establish the nature and factors contributing to human-wildlife interaction. According to the results, 41.4 percent of households said that roads are one of the most important types of development that go into wildlife habitats. Hence, 20.5 percent of households reported that motorcycles and cars going to-and-from tourist centres in the game reserve often scare away wild animals. Likewise, farmers who use tractors for agriculture

(21.8%) and tree felling for charcoal-making inside wildlife habitats (16.5%) cause disturbances to wildlife (Figure 2). Respondents also acknowledged the borderline between wildlife habitats and village areas such that human-wildlife interactions are associated with human encroachments into wildlife habitats. However, the proportion of households that reported advancement of human activities into wildlife areas is statistically insignificant ($p > 0.05$), implying the absence of a statistical difference in the proportion of households that reported the situation for all surveyed villages (Figure 2).

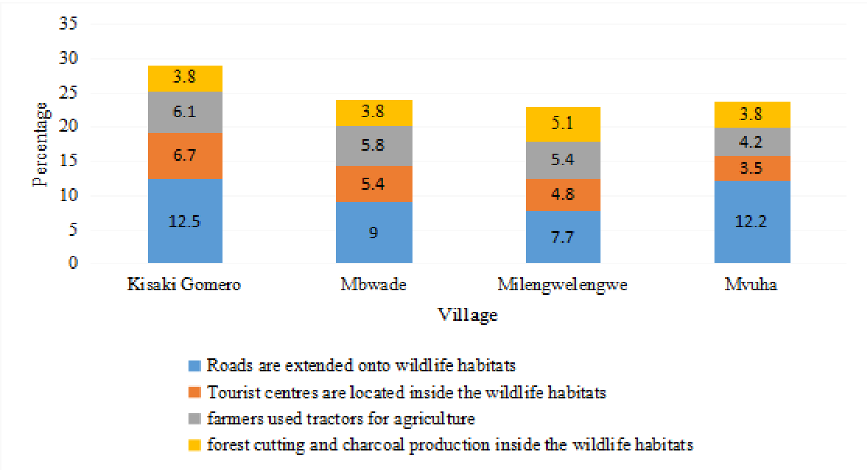

Figure 2: Means of Humans Encroachment into Wildlife Habitats
Source: Authors (2022)

Such interactions between people and wildlife seem to have effects on both sides, and have been seen to threaten wildlife range areas. On the livelihood side, household assets and activities are often destroyed by range wild animals within their natural habitats. The ultimate end of such intersections is manifested through forms presented in subsequent sub-sections.

3.2 Effects of Human-Wildlife Interaction on Community Livelihoods

3.2.1 Wildlife Raids into Human Settlements

Wildlife raids into human settlements were reported to be 168 cases during dry seasons, and 70 cases during wet seasons (Table 2) in all the surveyed villages. Mbwade and Milengwelengwe villages had the most significant number of cases, while Kisaki Gomero and Mvuha had the fewest (Table 2). There is a significant difference in dry season observations ($p = 0.045<0.05$), and no significant difference in wet season observations ($p = 0.374>0.05$); all measured at the $p = 0.05$ significance level. More households reported that wild animals got into their villages during the dry season than during the wet season. This can be linked to the decline of fodder and water in the dry season. Given climatic variability, severe dryness can trigger an invasion by wild animals.

Table 2: Wild Animals Encroaching on Human Settlements In Wet and Dry Seasons

Form of Invasion	Village				Total
	Kisaki Gomero	*Mbwade*	*Milengwe-lengwe*	*Mvuha*	
Wild animals encroach on human settlements during drought periods	87.3% (N=48)	90.0% (N=36)	92.7% (N=51)	86.8% (N=33)	168
Wild animals encroach on human settlements during rainfall and flooding	47.3% (N=36)	30.0% (N=12)	32.7% (N=18)	36.8% (N=14)	70
Total	**55**	**40**	**55**	**38**	**188**

Source: Authors (2022)

3.2.2 Frequency of Wild Animals' Invasion Into Human Settlements

The study further sought to establish the frequency of raids by wild animals on community farms and households. The results showed that 43.9 percent of the respondents reported that wild animals invaded cropland and houses daily during dry and harvest periods; while 46.8 percent reported that wild animals raided for one to three times (Table 3). The frequency of raids by wild animals was high during the dry and harvesting periods. Additionally, 95 percent of the surveyed households from the WMA-designated villages (Mbwade, Kisaki-Gomero and Milengwelengwe) reported crop raids, livestock depredation, diseases, human death, and injury as prevalent events. Occurrences were highly prevalent during the dry season when resources (such as forage and water) were low.

Table 3: Frequency of Wild Animals' Invasion on Farms and Houses

Frequency of wild animals invasion on farms and houses in WMA-designated villages	The proportion of households reporting invasion events (%)
Wild animals invaded farms and houses on a daily basis in dry and harvest periods	43.9
Wild animals invaded farms and houses in one to three days in dry and harvest periods	46.8
Wild animals invaded farms and houses on a daily basis in wet periods	6.3
Wild animals invaded farms and houses in one to three days in wet periods	3.0

Source: Authors (2022)

Respondents reported an increase in the number of human deaths and injuries caused by wildlife outside the park. About 50 injuries and 10 deaths were documented in Kisaki village between 2015 and 2021, whereas 30 injuries and 5 deaths were recorded in Mbwade village. Further, 35 human injuries and 8 deaths were recorded in Milengwelengwe village. In comparison, at least 4 human deaths and 7 injuries were reported in Mvuha village because of minimal interactions between human beings and wildlife. Among the presented cases, elephants, hippopotamuses, lions, and spotted hyenas contributed 70 percent, 10 percent and 5 percent of the total attacks, respectively; while 10 percent was contributed by leopards (Figure 3). The data indicate that the severity of attacks rises as one approaches the SGR. During FGDs, most participants from all studied villages mentioned the presence of injured people.

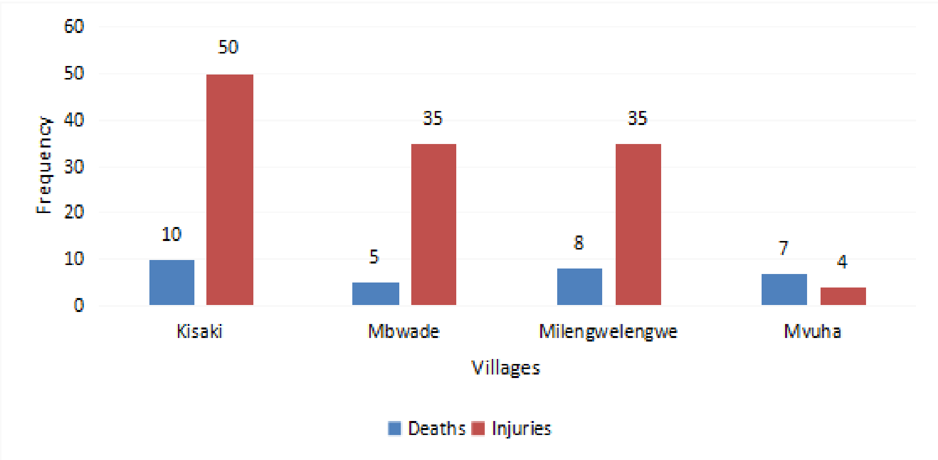

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Figure 3: Frequency and Magnitude of Human Deaths and Injuries in the Study Area

Source: Authors (2022)

3.2.3 Livestock Depredation

The chi-square test revealed a statistically significant distinction between households that keep livestock. According to the household survey, most WMA-designated village households kept animals (Figure 4). Its value was 39.793 (12 df.), and the *p* value was 0.00, measured at a 0.05 significant interval. Since the *p* value is <0.05, there is a significant difference among households. Thus, the number of households keeping livestock varies dramatically between villages, with most households keeping livestock in WMA-designated villages.

Livestock populations are prone to predation by spotted hyenas (39.9% of the surveyed households), followed by African wild pigs (26.1%), baboons (15.1%), lions (13%) and leopards (5.9%) (Figure 5. In addition, 90 percent of the households reported that lions, spotted hyenas, wild pigs, rats, baboons and leopards moved outside the SGR between March 2020 and March 2021; and attacked livestock in the villages (Kisaki, Mbwade, and Milengwelengwe). The study recorded 2,360 deaths of livestock from predation by wild carnivores over the past three years, whereby 700 cases of predation were reported in Mbwade, 750 at Milengwelengwe, 760 at Kisaki-Gomero, and 150 at Mvuha villages.

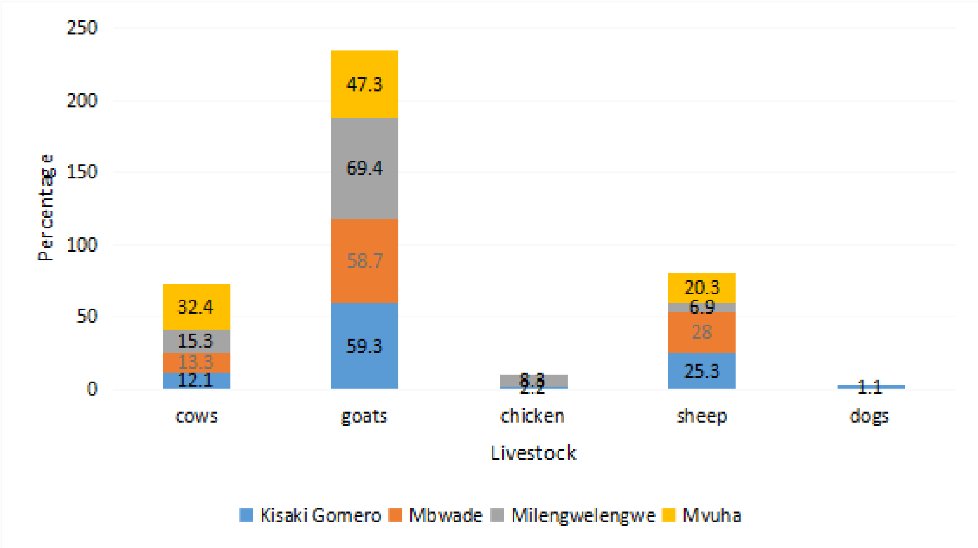

Figure 4: Proportion of Households Keeping Livestock

Source: Authors (2022)

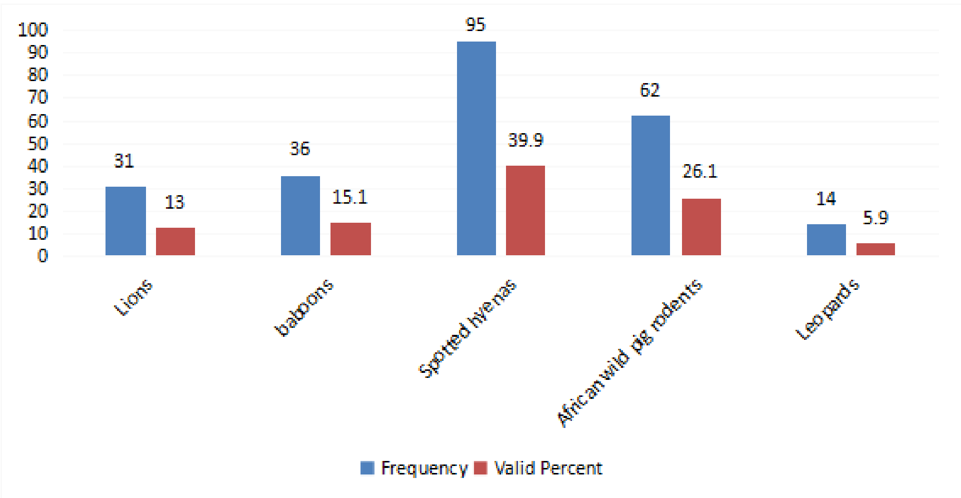

Figure 5: Wild Animals Responsible for Predation

Source: Authors (2022)

Interview results unveiled that slightly over half of households reported goats (58.7%), followed by sheep (20.5%) and cows (17.9%) were attacked by predators. Predation rates varied, depending on the number of animals inhabiting a village. Those near wildlife habitats saw more significant livestock predation than villages further away. As expected, predation positively correlated with livestock numbers ($r^2 = 0.87$, $p<0.05$); and wild prey abundance ($r^2 = 0.96$, $p< 0.05$) (Figure 6).

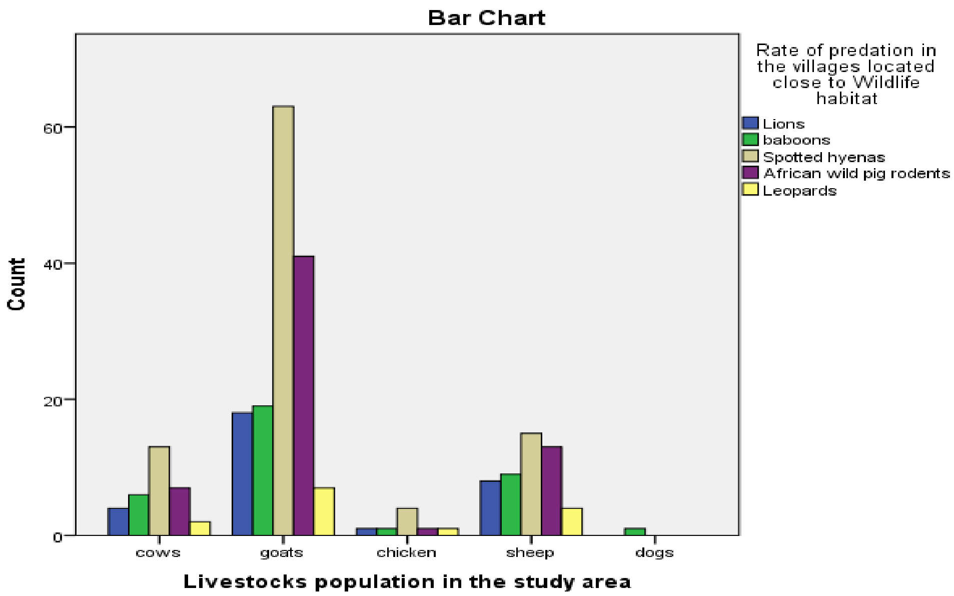

Figure 6: Rate of Predation in Villages Located close to the WMA
Source: Authors (2022)

Interview results highlighted factors causing human-wildlife conflicts to include climate change, infrastructure expansion, household location, and grazing on wildlife habitats. The predation rate was determined by comparing villages adjacent to the WMA-designated villages with infrastructure development and human activities in wildlife habitats (Figures 7 and 8). The chi-square value for the test was 11.103 at 12 degrees of freedom. The corresponding *p* value was 0.52 > 0.05, indicating no statistically significant difference in the proportion of households reporting predation tendency in villages near the WMA, versus expansion of infrastructure and human activities onto wildlife habitats.

A chi-square test was also conducted to examine the association between predation and villages close to the WMA. Its value was 6,120 (8 df), and its *p* value was 0.634; showing no statistically significant difference between households reporting predation and grazing in WMA-designated villages since the value is more than the significance threshold of 0.05. In Mvuha village (non-WMA), households reported predation, and the chi-square test result was 28.360 (8 df). The *p* value was 0.05, indicating a relationship between household locations and predation in the examined villages. Thus, the proportion of households that reported predation events near wildlife resources significantly differs among WMA-designated villages rather than those not forming the WMA. As a result, predation becomes more likely as one gets closer to the core of wildlife resources.

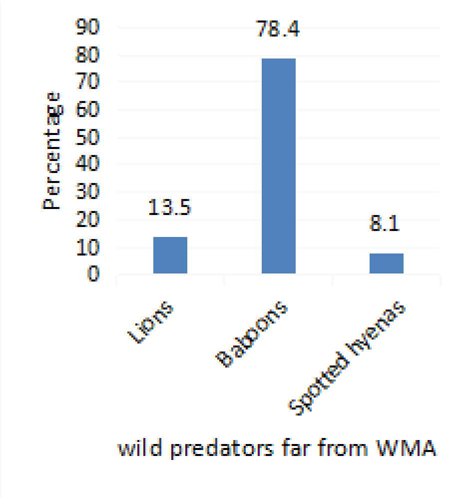

Figure 7: Predation in Villages Distant from WMAs

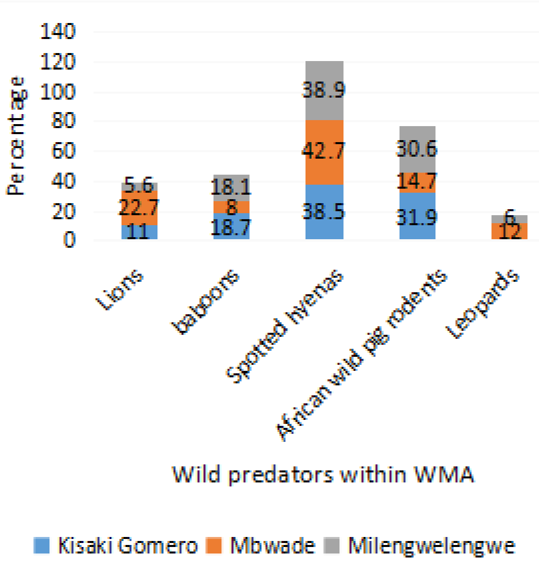

Figure 8: Predation in Villages Forming WMAs

Source: Authors (2022)

Interview results with SGR officers pointed to grazing activities conducted inside protected land and buffer zones as heavily contributing to predation, especially during rainfall and flooding seasons. Also, surrounding communities have cleared part of the forest land around the SGR; hence, inviting wild animals to move into nearby farms, including water sources; leading into conflicts.

Illegal hunting threatens wildlife as human activities increase in and near the SGR. There were very few instances of recorded poaching. The majority originated in distant communities from the SGR. About 60 percent of the respondents from Mvuha village revealed that they go, from time to time, to villages close to wildlife habitats for bush meat and engage in the skin trade. They emphasized the need for their village to be designated as a WMA to enjoy the WMA benefits. This result conveys two important messages: first, villages not forming WMAs and those with WMA do not feel ownership of the wildlife resources and, therefore, are more likely to pull out of conservation initiatives. Second, villages that are not WMAs can be proxies for poaching activities, and even if WMA villages would do so, they can blame non-WMA villages.

3.2.4 Disease Transmission

Wild animals transmit zoonotic diseases to livestock and humans. During FGDs, 40 percent of household heads reported that elephants, hippopotamuses and buffaloes often spread pathogens like anthrax and spores to livestock. Thirty percent of the respondents reported that elephants also carry diseases like rabies and East Coast fever (ECF), as well as ticks that carry those diseases. Moreover, 10 percent of the respondents mentioned that spotted hyenas, baboons, hippopotamuses, and elephants are carriers for diseases like rabies and ECV, and harbour disease-bearing ticks.

3.3 Factors Contributing to Human-Wildlife Interaction

Interview results show that more households reported that wild animals raided their villages during the dry season than during the wet season (Table 4). Accordingly, this suggests that under prolonged drought circumstances, when land resources are low and nearly depleted, there is an increased risk of enhanced frequency and magnitude of raiding events that can be catastrophic to human life and property.

Data on changes in precipitation and temperature patterns over the past three decades shed light on alterations in important climatic parameters (Figures 9 and 10). Such changes could influence the area's food and water availability (Shaghude, 2005). During the rainy season, water and food are often abundant in the SGR, resulting in a decline in animal raids, partly explaining a few animal invasions during the wet season. The reserve has less water and food during the dry season; thus, wild animals must leave the reserve to obtain food and water elsewhere outside the reserve.

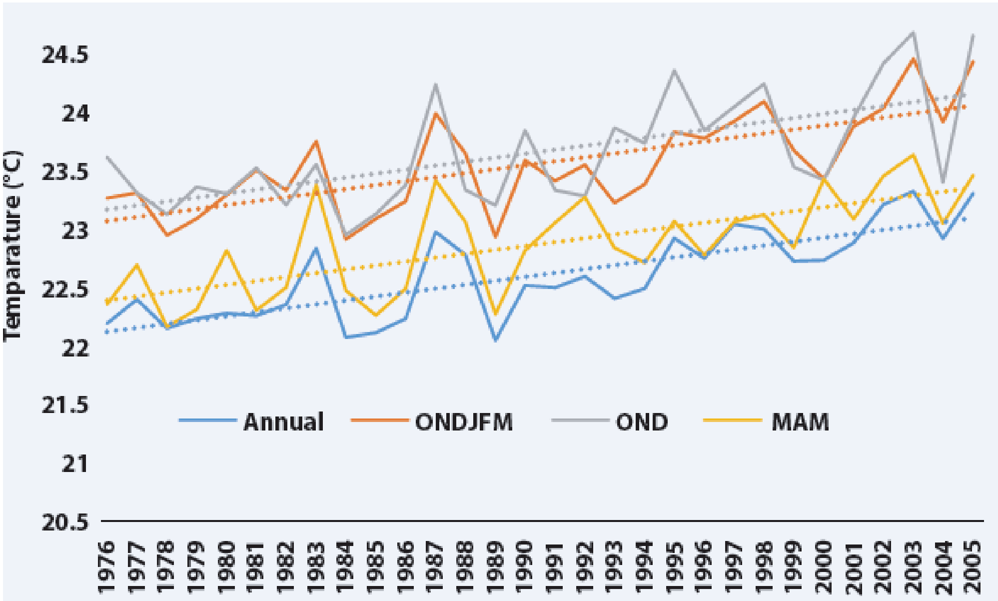

Figure 9: Precipitation and Temperature Patterns Over the Past Three Decades

Source: Future Climate for Africa (2017)

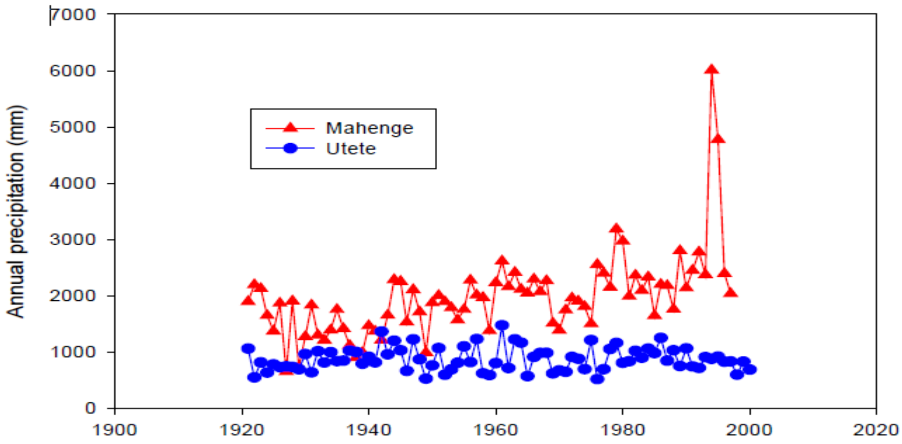

Figure 10: Rainfall Trends Recorded at Mahenge and Utete Meteorological Stations

Source: Shaghude (2005).

Socioeconomic information offers additional support for the meteorological data. Approximately 70 percent of the respondents indicated that seasonal variations in precipitation have a substantial effect on human-wildlife interactions. During the rainy season, lions, baboons, and spotted hyenas feed on goats and cows. In contrast, elephants and hippos move into farms and water sources during droughts, presenting a hazard to adjacent communities (Table 4). Thus, there is a substantial relationship between climate fluctuation and predation intensity.

Table 4: Wildlife Species that Encroach on Human Settlements

During Dry Season		During Rainy Season	
Wildlife Species	***Respondents (%)***	***Wildlife Species***	***Respondents (%)***
Elephants	53.80	Spotted Hyenas	32.40
Hippopotamus	33.70	Baboons	33.00
Ungulates	11.20	Lions	22.40
Buffalos	01.30	Wild pigs	12.20
Total	**100.00**		**100.00**

Apparently, under drought situations, the frequency and magnitude of raiding events can be catastrophic to human lives and properties. For instance, the droughts that persisted in the study area from 1990 to 1992 resulted to wild herbivores invasions and subsequently crops damages; leading into clashes between wild animals and human beings that resulted into human deaths and injuries. Similarly, the results in this paper show that from 1993 to 1994 there were colder temperatures and less rainfall, which resulted into wild carnivores invasions; and subsequently livestock attacks in the study area (Table 5).

Table 5: Timeline of Human-Wildlife Interactions Concerning Climate Variations in the Studied Villages

Year	Climate status	Incidence	Impact
1990–1992	• Excessive hot weather, heat waves, drought	• Wild herbivores invasion on human areas	• Crop damage, livestock depredation • Human death and injuries • Diseases transmission
1993–1994	• Colder temperature • Flooding	• ·Wild carnivores invasion on human areas	• Livestock depredation • Human death and injuries
1995–1996	• Precipitation • Flooding	• Wild carnivores invasion on human areas	• Livestock depredation • Human death and injuries
1997–1998	• Colder temperature	• No wildlife invasion	
1999–2000	• Excessive hot weather, heat waves, drought	• Wild herbivores invasion on human areas	• Crop damage • Livestock depredation • Human death and injuries
2001–2002	• Excessive hot weather, heat waves, drought	• Wild herbivores invasion on human areas	• Crop damage • Livestock depredation

Source: Morogoro District Profile (2016)

Discussions and interviews revealed that during dry and extreme heat at night, wild species—particularly elephants, hippos and ungulates—leave their habitats and move onto farms, water supplies, and residential areas; destroying grain storage bins and consuming grains. Thus, such scenarios deteriorate local communities' livelihoods. Further, the respondents mentioned spotted hyenas, wild pigs, rodents and lions as the key predators attacking goats, sheep and cows during seasonal rains and floodings. Also, as a result of polluted and destroyed water sources, populations and livestock face water scarcity and conflicts. According to the respondents, climate variability is responsible for the irregular flow of the Kisaki River. As a result, small streams channelled from the Kisaki River are collapsing, degrading the quality and quantity of forage, thereby forcing the migration of wild animals into human areas in search of water and pasture.

The population trend in the area is highly variable according to the national population and housing census, leading to the expansion of agricultural and construction activities up to the buffer zone near the SGR. Rapid in-migration has also led to the encroachment of people on wildlife habitats for grazing and shifting agriculture; which has additionally led to the obstruction of wildlife migration corridors. FGDs further confirmed the effects of population growth on HWIs: the majority (90%) of the participants confirmed that people expand their territories and farms adjacent to the SGR, thus spurring HWIs.

3.4 Land-Use Types and HWC

Satellite imagery from 1991, 2006, and 2021 showed land-cover change, with bushland and cultivated land increasing at the expense of woodland. Cultivated land expanded from around 20,000ha in 1990 to about 30,000ha in 2021, whereas bushland area increased from approximately 35,000ha in 1990 to about 100,000ha in 2021. In contrast, woodland decreased from 140,000ha in 1990 to 75,000ha in 2021. Some other areas were converted into either urbanisation or reverted to barren land (Figures 11,12, 13 & 14).

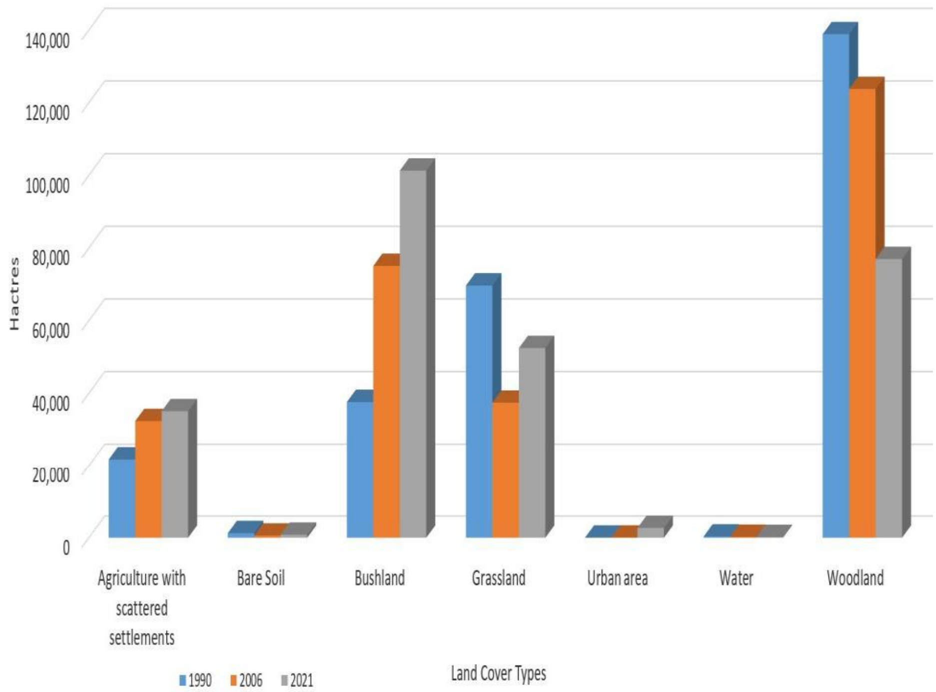

Figure 11: Land Use Cover Change in the Studied Villages
Source: Authors (2022)

Figure 12 shows that the vegetation cover was thick, and yellow patches were quite low. On the other hand, in Figure 13 the natural vegetation cover was decreasing, with an increase in yellow patches as a result of human encroachments. Similarly, Figure 14 shows that the natural vegetation cover was disappearing, again at the expense of human activities.

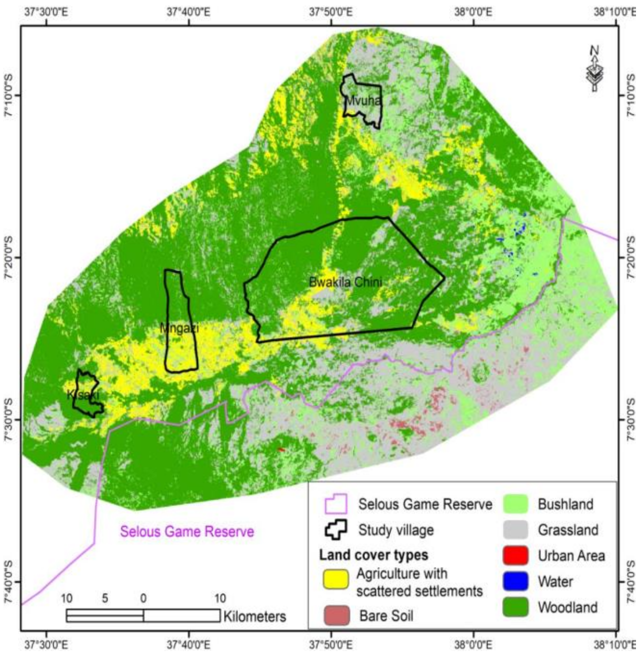

Figure 12: Land-cover Map in 1991 at Mvuha, Mbwade (Bwakila Chini), Milengwelengwe (Mngazi) and Kasaki Villages

Source: GIS Landsat image, 1991

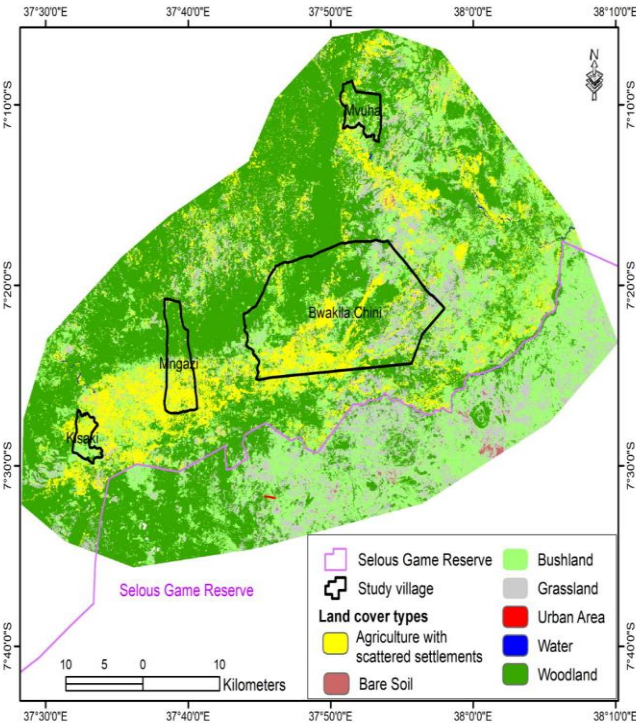

Figure 13: Land-cover Map in 1991 at Mvuha, Mbwade (Bwakila Chini), Milengwelengwe (Mngazi) and Kasaki Villages

Source: GIS Landsat Image, 2006

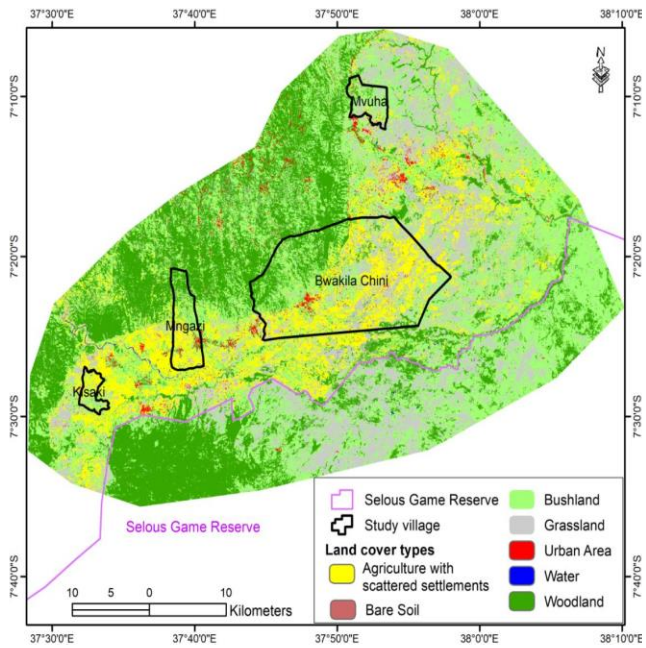

Figure 14: **Land-cover Map in 1991 at Mvuha, Mbwade (Bwakila Chini), Milengwelengwe (Mngazi) and Kasaki Villages**

Source: GIS Landsat Image, 2021

3.5 Location of Households and Livelihood Choices

Figure 10 depicts residences at varying distances from wildlife areas, and inhabitants engaged in various economic pursuits.

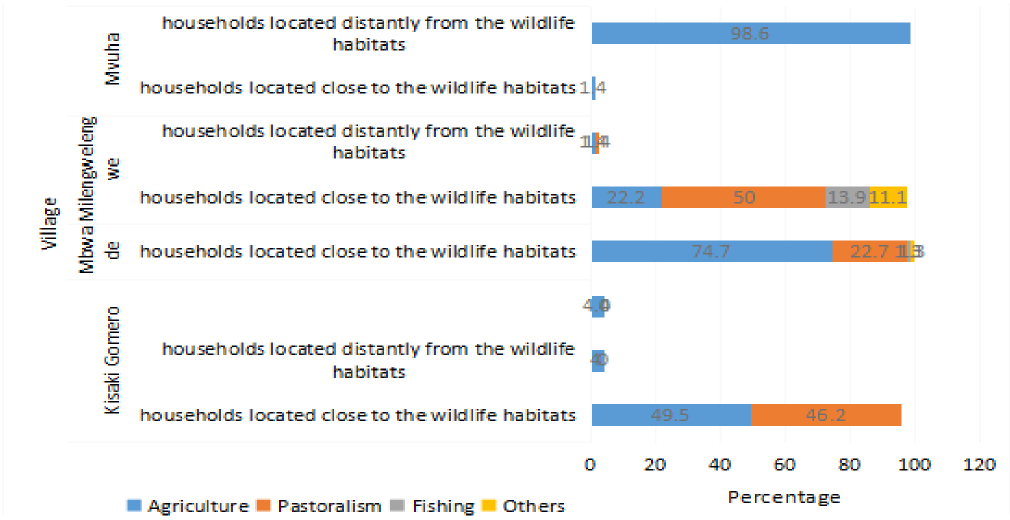

Figure 15: Proportion of Households Conducting Different Activities Relative to Wildlife Habitats

Source: Authors (2022)

The findings, as shown in Figure 15, unveiled that 98.5 percent of the households in Mvuha engage in crop farming, while 74.7 percent of the households at Mbwade are involved in crop farming. A chi-square test was conducted to examine whether the proximity of families to animal areas impacted their choice of livelihood. Its value was 3.586 (1 degree of freedom), whereby the p-value was $0.079>0.05$ when tested at a $p=0.05$ significance level. Hence, there is no association between the proximity of households to wildlife habitats and livelihood choices.

This result implies that proximity to wildlife habitats and vice versa does not influence the choice for livelihood activities. Hence, all households in the area, WMA-designated or not, conduct similar livelihood activities, regardless of their relative proximity to wildlife areas.

3.6 Household Locations Relative to Wildlife Habitats

Most (74.7%) of the interviewed respondents had households in villages close to wildlife habitats, while the rest (25.3%) had homes in villages distant from wildlife habitats (Figure 16). The findings indicate that 94 percent of the respondents in households proximal to wildlife habitats face crop damages by wild animals (Figure 16). Also, the problem persists in households located far from the wildlife habitats, though at a smaller scale (Figure 17). Household variances are statistically significant since the p value is 0.05 and the Chi-square value is 276.276 (3 degrees of freedom). Hence, the chances for contacting wild animals likely increase with proximity to wildlife habitats.

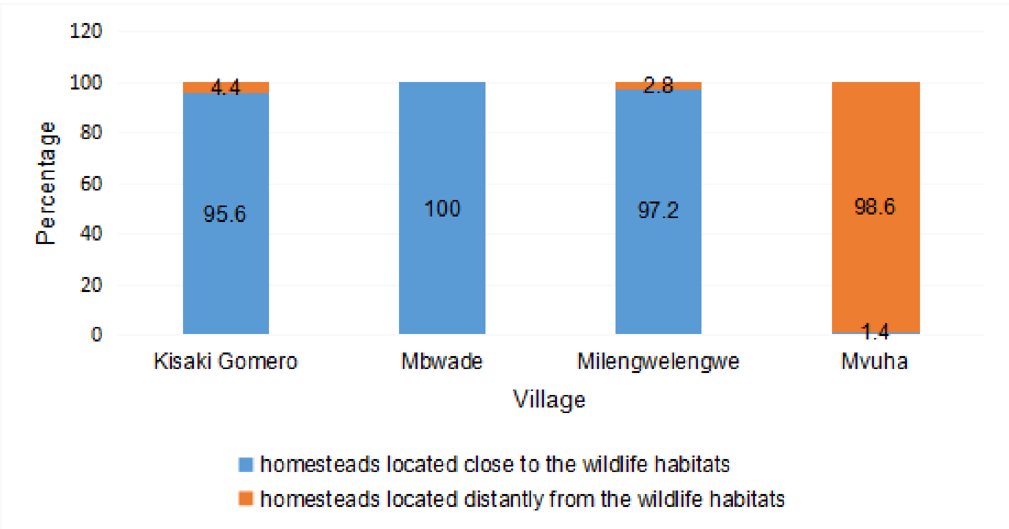

Figure 16: Location of Households in Relation to Wildlife Habitats
Source: Authors (2022)

This paper establishes that the more households are proximal to wildlife habitats, the more they are vulnerable to attacks by wild animals. The results are not far from those of a study conducted by Baird (2013) in eight (8) villages in the eastern part of the Tarangire National Park. According to the findings of this research, those who live closer to national parks are at a greater risk of wildlife-related problems than those who live further away (ibid.).

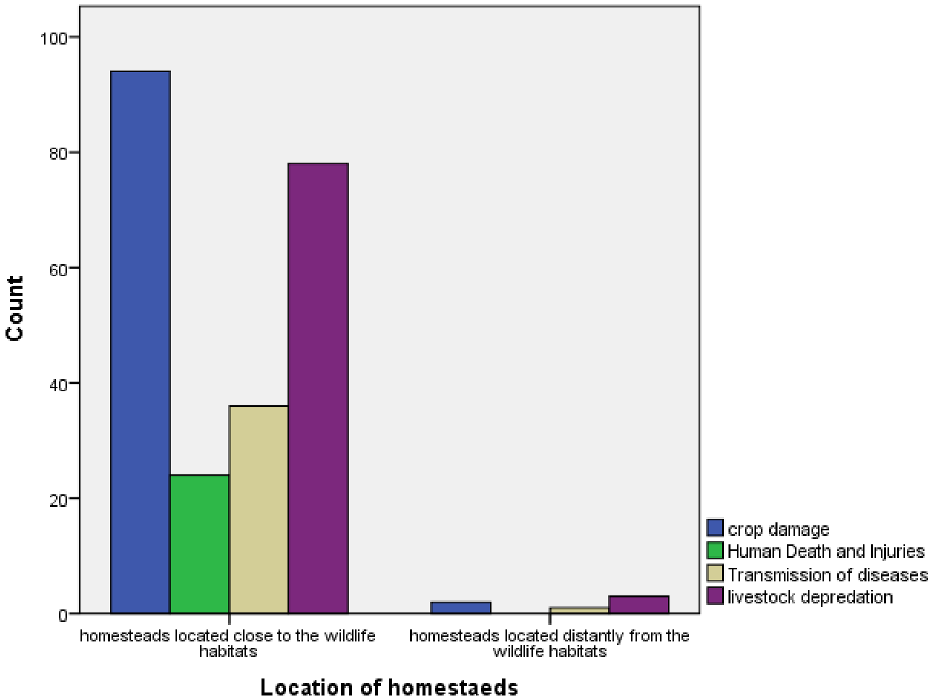

Figure 17: Impacts of Human-Wildlife Interactions on Households' Allocated For Wildlife Habitats
Source: Authors (2022)

With regards to whether, and the extent of, socioeconomic attributes extend into wildlife habitats, results from the discussions and interviews showed that not only do human activities tend to intensify within village lands, but also they tend to expand into wildlife areas. Therefore, wildlife-free-ranging areas are somehow affected by time and space. As wild animals range within their traditional habitats, human activities are likely to interfere in these areas. Interference causes HWIs that affect both WMA and non-WMA-designated villages. Crop damages were reported by 45.1 percent in Kisaki Gomero, 38.3 percent in Mbwade, and 41.7 percent in Milengwelengwe (all WMA-designated villages); whereas it was reported by 60 percent in Mvuha (a non-WMA-designated village) (Figure 13). Also, deaths and injuries were more prevalent in communities not classified as WMAs than in WMAs. In contrast, the transmission of diseases was highly pronounced in WMA-designated villages, and so did livestock predation (Figure 18). There is no significant difference among households reporting these events for all surveyed villages ($p>0.05$). The chi-square value is 5.734.

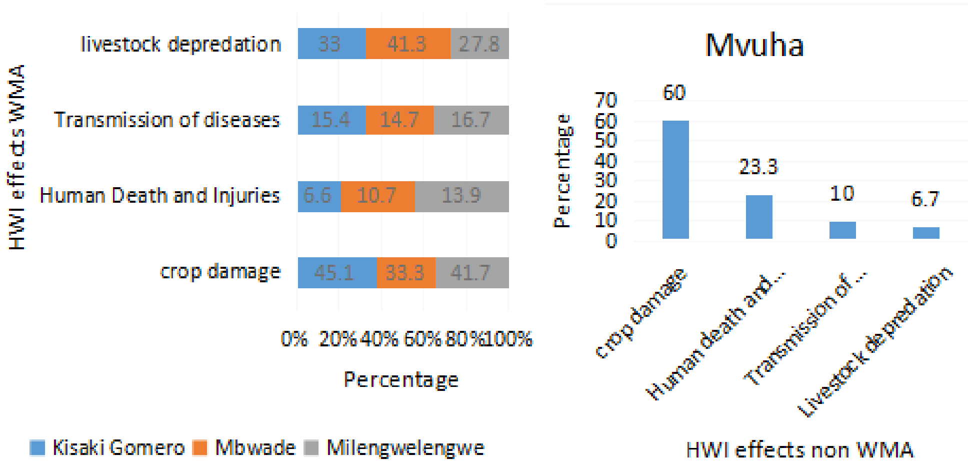

Figure 18: Proportion of Households Reporting Effects of HWI in the Villages with WMA and Village Without WMA

Source: Authors (2022)

4. Discussion

This paper sought to examine the effects of human-wildlife interactions on community livelihoods in villages surrounding the Selous Game Reserve. The results show that factors causing human-wildlife interactions—including climate change and human encroachment on wildlife habitats—are likely influencing the carrying capacity of the natural habitats; which push wild animals outside their ecological habitats. The findings concur with IUCN (2020), which reported that a number of injuries experienced by community members as a result of raids on farms, livestock husbandry, and other means of subsistence by wild animals has fluctuated throughout time (Gandiwa et al., 2013; Mayengo et al., 2017). These incidences are magnified by the enormous developments happening in the SGR, such as infrastructural development, hunting, agricultural activities and tourism.

The frequency of injuries unveiled in this paper increases when water and fodder are inadequate in the park, and animals must seek such resources elsewhere. The number of injuries is likely to increase further when the number of wild animals leaving the park increases. These results align with those of Mc Guiness et al. (2014) and Haingura (2019), who reported that the amount of water and fodder decrease in the reserve during the dry season, forcing wild animals to move out in search for such resources elsewhere within and outside the reserve.

The present study concurs with Lankester et al. (2016) and Philip (2016), who reported that carnivores like leopards, baboons, lions and wild pigs that are unable to hunt tend to move onto human areas attacking livestock. These results also corroborate findings by Kideghesho et al., (2017), who found that predators like lions, leopards, and hyenas, among others, kill and eat livestock in villages surrounding protected areas. The magnitude of predation varies according to the type of wild species (Bruce et al., 2003).

The paper uncovers that human-wildlife interactions have the potential to transmit diseases to humans. These findings are in line with Kideghesho and colleagues (2017), who contended that domestic dogs are popularly known to transmit canine distemper virus and rabies to local communities. Other literatures show that malignant catarrh fever, a viral infection that kills livestock, is associated with wildebeest; and likewise, the foot and mouth disease (Otieno, 2003). Equally, the transmission of pathogens from wild animals (*Bcontinuedn*) to cattle continues to cause conflicts between farmers and conservation initiatives (Kilpatrick et al., 2009).

5. Conclusion

The paper contributes to an understanding of the influence of climate change and variability and land use change on human-wildlife interactions. It has shown that carrying capacity, as a determinant of wildlife resources, is influenced by land resource availability; and tend to vary depending on climate dynamics that push wildlife outside their natural habitats looking for resources. On the other hand, human livelihood activities have been expanding overtime onto the SGR buffer zone, thereby making households enter into wildlife habitats where they contact wild animals. The more human activities spread into wildlife habitats, the less the space for wild animals. This means reducing rangelands, which are vital to herbivores and the ecology. Ultimately, these result into human-wildlife interactions that lead wildlife raids on human villages and fields, ensuing in injuries and human deaths, livestock depredation and diseases transmission from wild animals to human and domesticated animals. Besides, due to weather dynamics, resources such as feed and water are depleted during dry periods, forcing wild animals to leave their biological niches in search of these resources.

The paper observes that unemployment, unfair distribution of benefits, and the lack of community involvement in WMA-designated areas may affect conservation participation. On the other hand, people's interests from non-WMA-designated villages have been left out; thus there is need to revisit the WMA policy because people in such areas also indirectly contribute to conservation. It is recommended that there should be investments in infrastructure development and in other sectors of people's livelihood activities in all villages in the vicinities of the WMA to prevent encroachment. Local people in villages surrounding wildlife resources must be given primary consideration when distributing benefits due to participation in wildlife conservation. This will have far-ranging implications in the management and conservation of WMAs. A comprehensive framework for managing wildlife resources, whilst supporting community livelihoods, is thus imperative in the face of climate and environmental change.

Acknowledgement

This paper is extracted from a PhD study by the first author. We are thankful to the University of Dar es Salaam, SGR game wardens, VEOs and household members from the study villages.

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