

Research

Socio-demographic factors influencing locals' responses to human-wildlife conflicts in societies living adjacent to Swagaswaga Game Reserve, Tanzania

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Abstract

Understanding the factors that shape local people responses is essential for developing effective strategies to mitigate and manage conflicts between humans and wildlife while safeguarding the well-being of both. This study assessed the factors that influence the locals' responses regarding human wildlife conflicts (HWCs) in villages surrounding Swagaswaga Game Reserve in Tanzania, where human population growth has led to increased competition for natural resources between humans and wildlife. We found a substantial majority (71%) of respondents having experienced HWCs, while others (29%) have not encountered such conflicts. A logistic regression analysis tested various independent variables to determine their significance in predicting locals' responses to HWCs. Our results indicated that the district of residence and the age category of respondents significantly influenced their reactions to HWCs, with district identity being the most significant predictor of these responses. Additionally, the study presents pairwise comparisons of measures taken by local people to mitigate HWCs, showing preferences for non-lethal strategies such as guiding (patrol) and growing alternative crops over lethal control. Moreover, the construction of physical barriers, such as fences and steel bars, was favored over lethal control methods. Unlike previous studies, this research provides targeted guidance for conservation and management strategies that are tailored to the unique needs and preferences of the local communities surrounding Swagaswaga Game Reserve and other areas globally with similar contexts. Therefore, this study extends our understanding of HWC in Tanzania by offering detailed insights into the specific factors that shape local responses and their preferences for mitigation measures.

Keywords Conservation and management strategies · Human wildlife conflicts · Local communities · Non-lethal strategies · Protected areas

1 Introduction

Tanzania is renowned for its remarkable biodiversity, hosting iconic species such as lions, elephants, and rhinos within its protected areas, including national parks and game reserves [1–5]. These protected areas play a pivotal role in conserving these species and their habitats. However, as human populations expand, villages and agricultural activities have intensified interactions between humans and wildlife [2, 6–10]. This interaction often leads to conflicts, as

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wildlife encroaches upon villages, damaging crops and endangering human lives [11–14]. Human-wildlife conflicts (HWCs) have emerged as a significant and complex issue in the rural landscapes surrounding protected areas in Tanzania [2, 3, 15]. These conflicts represent a clash between the conservation of wildlife and the livelihoods of local communities, posing substantial challenges to both biodiversity conservation and rural development efforts [11, 13, 14, 16]. Moreover, retaliatory killings of wildlife by villagers exacerbate the situation, threatening the delicate ecological balance [17–19].

The majority of communities residing near protected areas in Tanzania rely heavily on subsistence agriculture for their livelihoods [4, 20–23]. These communities cultivate crops and rear livestock, making them vulnerable to wildlife incursions that can lead to crop damage and livestock predation [11, 24]. As a result, HWCs in villages surrounding protected areas in Tanzania have profound and direct impacts on the food security and economic stability of these rural communities [14, 16, 21, 25]. These effects are intertwined and contribute to a cycle of challenges that hinder the well-being of the residents [13, 14, 16, 25–30].

Protected areas in Tanzania are interconnected through wildlife corridors and migration routes [10, 24, 31]. These pathways are essential for the movement of wildlife populations, particularly for seasonal migrations. However, the integrity and functionality of these vital conduits face significant challenges, and their preservation is paramount for the conservation of Tanzania's diverse ecosystems and the mitigation of human-wildlife conflicts [24, 31, 32]. HWCs themselves can disrupt wildlife corridors. Communities experiencing conflicts may employ measures like fences and deterrents to protect their crops and livestock, inadvertently obstructing wildlife movement [11]. Additionally, retaliatory killings or captures of problem animals can have severe consequences for the overall population within these corridors [19, 24].

The loss of crops and livestock, coupled with increased expenditure on protective measures and food purchases, exacerbates poverty and undermines the overall well-being of these communities [16]. Addressing HWCs effectively through sustainable mitigation strategies and community involvement is crucial to improving food security and economic resilience in these areas [33]. The coexistence of humans and wildlife often results in intricate challenges, notably in the villages surrounding these protected areas [15, 22]. HWC have emerged as a critical issue, shaping the lives of both communities and wildlife [26]. Understanding the correlates of these conflicts is pivotal in developing effective strategies for sustainable cohabitation between humans and wildlife in Tanzania.

Despite the extensive biodiversity and the critical role of protected areas in Tanzania, there remains a significant research gap in understanding the complex dynamics of human-wildlife conflicts (HWCs) and the effectiveness of mitigation measures employed by local communities. While many studies have addressed the general aspects of wildlife conservation and the impact of HWCs on agricultural activities, there has been limited focus on the specific socio-demographic factors influencing locals' responses to HWCs in the context of Swagaswaga Game Reserve. Furthermore, few studies have systematically evaluated the various mitigation strategies and their efficacy in reducing conflicts while balancing conservation efforts and community livelihoods. This study aims to fill this gap by providing detailed insights into the socio-demographic determinants of local responses and assessing the preferred mitigation measures, thereby contributing to more targeted and sustainable conflict management strategies in regions experiencing similar challenges.

2 Methods

2.1 Study area

This study was conducted in Swagaswaga Game Reserve (SGR), situated in Kondoa and Chemba districts. Kondoa District is one of the seven districts in the Dodoma Region of Tanzania. It shares its southern border with Dodoma Rural District and its southeast border with Kongwa District. Chemba District was established in 2010, following its separation from Kondoa District (see Fig. 1). The district is bordered to the north by Kondoa District, to the east by Manyara Region, to the south by Chamwino District and Bahi District, and to the west by Singida Region. Swagaswaga Game Reserve also shares its borders with Hanang in Arusha and Singida Districts [34]. The reserve covers an area of approximately 871 km² and connects the former Songa Forest Reserve (187 km²) and the Handa forests (400 km²), along with other adjacent forest areas [35].

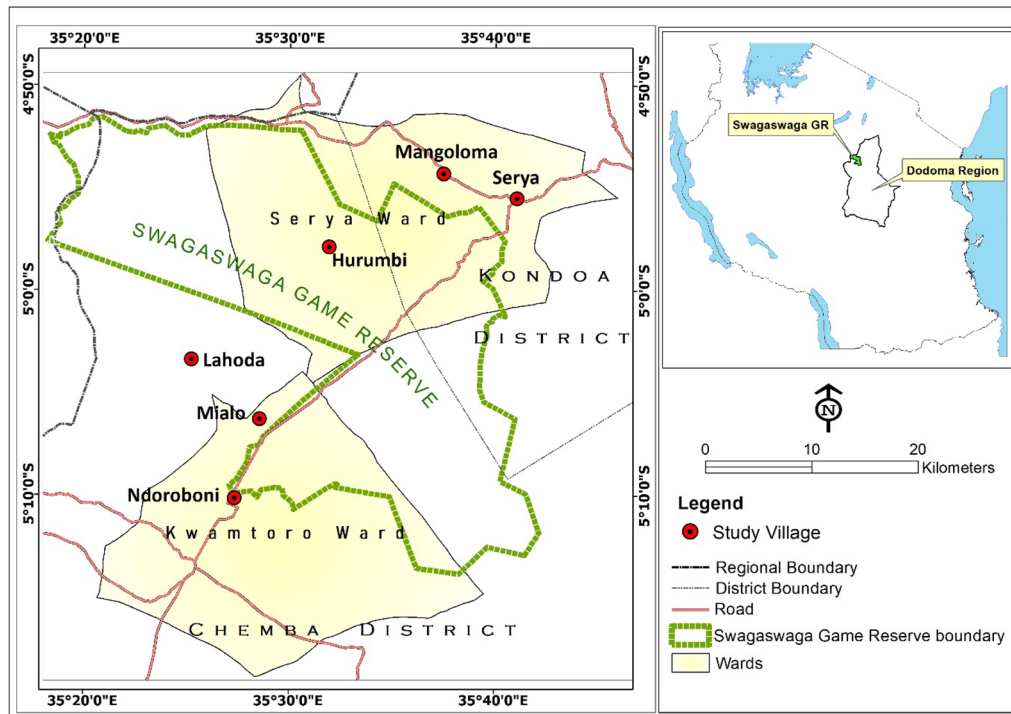


Fig. 1 Map showing the study villages (red dots) surrounding Swagaswaga Game Reserve in Tanzania

The study area is situated between latitude $-4^{\circ} 54' 0.00''$ S and longitude $35^{\circ} 46' 59.99''$ E. It is characterized by a lengthy dry season from April to December and a short-wet season from December to April. The average rainfall varies between 400 mm in the plateau areas and 1000 mm in the highlands. The temperature ranges between 15 and 20 °C. Kondoa District has a total population of 210,682 people, consisting of 107,341 males and 103,341 females. Additionally, Chemba District has a population of 235,711, with 117,585 males and 118,126 females [36]. Data collection encompassed six villages bordering Swagaswaga Game Reserve: Serya, Mongoroma, and Hurumbi in Kondoa District, and three villages which are Mjalo, Ndoroboni, and Lahoda both in Chemba District.

2.2 Data collection

This study employed a cross-sectional research design to examine the correlates of human-wildlife conflicts in six study villages. We used a questionnaire (Supplementary file) with 30 questions, which was randomly distributed to 248 households, representing 5% of the total households in the area. The questionnaire included closed-ended questions designed to address the research objectives and capture respondents' insights. The questions focused on human-wildlife conflicts arising from wildlife in the game reserve. The major questions included: (1) the socio-demographic status of the people, (2) the causes and effects of human-wildlife interactions, and (3) mitigation measures for human-wildlife conflicts. For more details, please refer to the Supplementary file. Interviews were conducted with heads of households (either male or female), or resident adults aged over 30 years.

2.3 Data analysis

Data collected through questionnaires were organized, coded, and analyzed using IBM SPSS version 27. Descriptive statistics were employed to analyze categorical data, providing an overview of respondents' characteristics. For inferential statistics, the chi-square and Kruskal Wallis tests were used. Additionally, a binary logistic regression model was executed at a significance level of $p < 0.05$. This model aimed to demonstrate the associations between

the dependent and independent variables and to quantify the extent to which the outcomes (conflicts) were linked to the correlates of conflicts. In this study, the outcome variables were conflicts (0 = No, 1 = Yes). The independent variables included the district of residence (Chemba or Kondoia), respondents' gender (male or female), age (youth, adult, or elder), level of education (informal, primary, or secondary), and residency status (native or migrant). By differentiating responses based on district helps to tailor interventions to address the unique challenges and characteristics of each area. Gender-specific responses provide insights into how men and women, influenced by their roles in agriculture, livestock rearing, and household responsibilities, experience HWCs differently. Age categories capture generational perspectives, recognizing that youth, adults, and elders have distinct experiences, knowledge levels, and attitudes towards wildlife. Educational background influences awareness and understanding of wildlife conservation, with those having higher education levels potentially more receptive to scientific approaches. Residency status distinguishes between natives, who may have deeper understanding and long-term experience with local wildlife, and migrants, who might bring different perspectives.

3 Results

3.1 Socio-demographic characteristics of respondents

In Chemba District, a relatively higher proportion (40.3%, $n = 50$) of respondents do not experience HWC compared to Kondoia District (17.7%, $n = 22$). In contrast, Kondoia District has a higher percentage (82.3%, $n = 102$) of respondents who reported experiencing HWC, indicating that the conflict with wildlife is a more pervasive problem in this district. Hurumbi Village had the highest percentage (96.7%, $n = 58$) of respondents who reported experiencing HWC, indicating that the conflict with wildlife is highly prevalent in this village. Lahoda Village has the highest percentage (54.5%, $n = 30$) of respondents who reported not experiencing HWC, suggesting that HWC is less common in this village. Serya Village and Mialo Village have relatively equal proportions of residents who do and do not experience HWC, with approximately (57.1%, $n = 16$) and (55.0%, $n = 11$) of respondents, respectively, reporting experiencing it.

Among male respondents, a higher percentage (70.6%, $n = 132$) reported experiencing HWC, while a lower percentage (29.4%, $n = 55$) indicated that they do not experience HWC in their villages. Among female respondents, an even higher percentage (72.1%, $n = 44$) reported experiencing HWC, while a lower percentage (27.9%, $n = 17$) stated that they do not experience HWC in their villages. Among youth respondents, a higher percentage (92.0%, $n = 23$) reported experiencing HWC, while a lower percentage (8.0%, $n = 2$) indicated that they do not experience HWC in their villages. Among adult respondents, a majority (69.5%, $n = 98$) reported experiencing HWC, with a minority (30.5%, $n = 43$) stating that they do not experience HWC in their villages. Among elder respondents, a significant majority (67.1%, $n = 55$) reported experiencing HWC, while a minority (32.9%, $n = 27$) did not experience HWC in their villages.

Among individuals with informal education, (100.0%, $n = 4$) reported experiencing HWC, with none indicating that they do not experience HWC in their villages. Among individuals with primary education, a significant majority (70.2%, $n = 118$) reported experiencing HWC, while a minority (29.8%, $n = 50$) stated that they do not experience HWC in their villages. Among individuals with secondary education, (100.0%, $n = 4$) reported experiencing HWC, with none indicating that they do not experience HWC in their villages. Finally, among native residents, a majority (64.7%, $n = 55$) reported experiencing HWC, while a minority (35.3%, $n = 30$) indicated that they do not experience HWC in their villages. Among migrant residents, an even higher percentage (74.2%, $n = 121$) reported experiencing HWC, with a smaller percentage (25.8%, $n = 42$) stating that they do not experience HWC in their villages.

3.2 Factors influencing the locals' responses regarding human wildlife conflicts

Respondents were asked if they had experienced any HWCs in the study area. Our findings showed that most of them (71%) acknowledged having experienced HWCs. In contrast, only few respondents (29%) reported to have not experienced any human-wildlife conflicts. We found that the district in which residents live ($p \leq 0.001$) and their age category ($p = 0.028$) significantly influenced the local community responses to HWCs, while gender, level of education, and residency status did not have statistically significant effects (Table 1).

Table 1 Factors influencing the locals' responses regarding human wildlife conflicts on the question "Do you experience HWC in your village?—Yes or No"

Independent variables	<i>B</i>	<i>S.E</i>	Wald	<i>P</i> ≤
District	1.116	0.308	13.091	0.001***
Gender	0.08	0.346	0.001	0.981
Age category	−0.511	0.260	3.848	0.05*
Level of education	−0.030	0.300	0.010	0.921
Residency status	0.266	0.305	0.764	0.382

P* < 0.05, *P* < 0.01, ****P* < 0.001**Table 2** Pairwise comparisons of what measures local people take to mitigate human wildlife conflicts on the measures taken by local communities to mitigate HWC conflicts

Factors comparison	Test statistic	Std. error	<i>P</i> ≤
Lethal control vs. construction of barriers such as fences and steel bars	3.937	16.604	0.813
Lethal control vs. guiding (patrol)	−47.055	15.720	0.003**
Lethal control vs. growing alternatives crops	55.955	17.123	0.001***
Construction of barriers such as fences and steel bars vs. guiding (patrol)	−43.118	9.694	0.001***
Construction of barriers such as fences and steel bars vs. growing alternatives crops	−52.018	11.833	0.001***
Guiding (patrol) vs. growing alternatives crops	8.900	10.558	0.399

P* < 0.05, *P* < 0.01, ****P* < 0.001

3.3 Measures local people take to mitigate human wildlife conflicts

The presented results (Table 2), show pairwise comparisons between different measures taken by local people to mitigate human-wildlife conflicts (HWCs). Lethal control vs. guiding (patrol) ($p = 0.003$), indicated a statistically significant difference between the use of lethal control and guiding (patrol) as measures to mitigate HWCs (Table 2). Lethal control vs. growing alternative crops ($p < 0.001$), suggested a significant difference between the use of lethal control and growing alternative crops as mitigation measures. Construction of barriers such as fences and steel bars vs. guiding (patrol) ($p < 0.001$), also indicated a statistically significant difference. Finally, construction of barriers vs. growing alternative crops ($p < 0.001$), indicated a significant difference (Table 2).

4 Discussion

According to the Tanzania National Bureau of Statistics (2022), the populations of Chemba and Kondoa Districts have been increasing significantly. For instance, while the population of Kondoa was 210,682 in 2012, it reached 259,963 in 2022. Similarly, Chemba's population was 235,711 in 2012, but by 2022, it had reached 293,619. With the population growing at this rate, it is expected that more agricultural land will be converted to settlements, thereby reducing wild animals' dispersal areas. Consequently, human population growth and the transformation of natural landscapes into cultivated village land have brought humans and wildlife into closer proximity, leading to increased competition for natural resources such as land [10, 22, 32]. This population growth and land use change have exacerbated human-wildlife conflicts (HWCs), as both humans and wildlife vie for the same resources. Our findings suggest that the rise in HWCs is closely linked to the expanding human population and the consequent encroachment on wildlife habitats. Therefore, effective management and mitigation strategies must address the root causes of these conflicts, focusing on sustainable land use planning and community-based conservation efforts to balance the needs of both humans and wildlife.

This scenario aligns with the findings of Nyhus and Tilson [37], where population growth coincides with an increasing demand for resources like land for agricultural activities. A notable example is Hurumbi village, which has been encroached upon by villagers from Hanang, despite being located inside the game reserve. As the population continues to grow, farmers are compelled to cultivate within animals' migratory corridors, causing animals to destroy

crops as they pass through. This crop raiding undermines food security for local communities, and the absence of compensation for crop losses and domestic animal killings has made these communities less tolerant of wildlife, resulting in the widespread killing of wild animals [11, 16, 19]. This situation was also observed by Mbise and Røskaft [38], who stated that an increase in human populations is linked to an increased use of natural resources and habitats, thereby forcing wildlife to reside in close proximity to humans. Additionally, population growth is associated with habitat destruction, further diminishing wild animals' homes. Habitat disturbance in the study area is a combination of settlements in and around the reserve, overgrazing, bush encroachment, as well as tree cutting for charcoal production and house construction [34, 39]. Similarly, a study conducted by Mukeka et al., [40] in Kenya documented that human population growth and habitat fragmentation were the most significant contributing factors to human-wildlife conflicts (HWCs), as people require space to cultivate food.

Understanding the factors that shape residents' responses is essential for developing effective strategies to mitigate and manage conflicts between humans and wildlife while safeguarding the well-being of both [2, 11, 22, 27]. Our study findings provide valuable insights into the complexity of human-wildlife conflicts in the study area. The need for conservation efforts and strategies to mitigate HWC in both districts, with particular attention required in Kondoa District where a larger proportion of residents are impacted by these conflicts, is very important [35]. The influence of district highlights the need for targeted interventions and policies that consider regional variations when addressing HWCs. The specific geographical location within the study area has a substantial impact on how residents perceive and respond to human-wildlife conflicts. This indicates that factors related to district-level characteristics, such as proximity to protected areas or wildlife habitats, may play a crucial role in shaping residents' experiences and attitudes towards HWCs [24, 31]. Moreover, the reported conflicts varied based on the age category of the respondents, highlighting the need to consider generational perspectives when addressing HWCs. This indicates that different age groups of residents have varying responses to HWCs [11]. That means, it is essential to delve deeper into these age-related differences to understand how generational perspectives and experiences may influence residents' reactions to human-wildlife conflicts. The importance of addressing HWC across all age groups and tailoring mitigation and conservation efforts is very important to consider the perspectives and challenges faced by residents of different ages [27]. Therefore, community engagement and awareness campaigns should be inclusive of youth, adults, and elders to effectively manage and reduce HWC [11, 22, 24, 27, 41].

The measures employed by local people to mitigate HWCs show distinct preferences [16, 26, 27, 42]. Notably, local residents exhibited a preference for non-lethal strategies, as evidenced by their favoring of guiding (patrol) and the cultivation of alternative crops over resorting to lethal control methods. Additionally, the construction of physical barriers, such as fences and steel bars, was also preferred over lethal control, underlining the perceived effectiveness of these barriers in preventing HWCs. Our findings underscore the significance of community-centered conservation approaches that align with the preferences of local communities, promote non-lethal strategies, and invest in physical barriers as effective tools for HWC mitigation, all while safeguarding the interests of both human communities and wildlife. Solutions aimed at mitigating HWCs may include, but are not limited to, community engagement, awareness campaigns, and the development of effective conflict mitigation measures designed to reduce the adverse impacts of HWCs on both local communities and wildlife. By actively involving local communities, identifying functional mitigation strategies, and initiating conservation efforts, all of these initiatives can be adapted to address the unique needs of each village, ultimately diminishing the impact of HWCs on both the well-being of local communities and the preservation of wildlife. Unlike previous studies [40, 43–48], our study provides targeted guidance for conservation and management strategies that are tailored to the unique needs and preferences of the local communities surrounding Swagaswaga Game Reserve and other areas globally with similar contexts. Therefore, this study extends our understanding of human-wildlife conflicts (HWC) in Tanzania by offering detailed insights into the specific factors that shape local responses and their preferences for mitigation measures.

4.1 Major conclusions

The study highlights critical issues surrounding human-wildlife conflicts (HWCs) in Chemba and Kondoa Districts of Tanzania, driven by significant population growth. These conflicts result in challenges such as crop raiding, food insecurity, and increased human-wildlife intolerance, leading to the killing of wild animals and habitat destruction. Our study underscores the importance of understanding the factors influencing residents' responses to HWCs, with findings indicating that district and age significantly impact these responses. The preference for non-lethal mitigation measures suggests

that strategies aligning with local community preferences are essential. Our research bridges the gap between general knowledge of HWCs and specific, actionable recommendations, providing insights applicable to similar global contexts.

4.2 Recommendations

Our study recommends community-centered conservation efforts, non-lethal mitigation strategies, and the use of physical barriers to effectively manage HWCs while protecting both local communities and wildlife. Proposed solutions include community engagement, awareness campaigns, and adaptable conflict mitigation measures tailored to each village's unique needs. Addressing HWCs in Chemba and Kondoa Districts requires a holistic, targeted approach that recognizes the complexity of the issue and the necessity of community-driven solutions, thereby ensuring the coexistence of humans and wildlife and safeguarding the well-being of both.

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Author contributions N.F.S. conceptualized the study idea and collected the data. F.P.M. and N.F.S. analyzed the data and wrote the paper.

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Data availability The datasets for this study will be made available upon reasonable request, in adherence to privacy considerations and in alignment with the regulations set forth by the government of Tanzania. We are committed to ensuring that data sharing is conducted in a manner that respects privacy and complies with applicable regulations (Data Sharing and Exchange Guidelines, Document Number: eGA/EXT/ITA/002).

Declarations

Ethics approval and consent to participate This research complied with the Declaration of Helsinki guidelines and was endorsed by the University of Dodoma's Ethics Committee, under approval number UDOM/261/69/41. Participants provided verbal consent after being thoroughly informed about the study and its objectives.

Competing interests The authors declare no competing interests.

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