2026 Volume: 02 Issue: 01 www.ijrpa.com ISSN 2456-9995 Research Article

International Journal Research Publication Analysis

Page: 01-14

# LOCAL COMMUNITIES' EFFECTIVENESS IN MITIGATING HUMAN–WILDLIFE CONFLICT IN EASTERN KILIMANJARO, TANZANIA

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**Article Received: 22 December 2025**
**Article Revised: 10 January 2026**
**Published on: 30 January 2026**

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DOI: https://doi-doi.org/101555/ijrpa.6321

## ABSTRACT

*Human–wildlife conflict (HWC) continues to undermine biodiversity conservation and rural livelihoods in developing countries, particularly in communities bordering protected areas. This study evaluates the effectiveness, adoption, and perceived performance of community-based human–wildlife conflict mitigation strategies in Msaranga and Mahorosha villages, located along the eastern boundary of Kilimanjaro National Park (KINAPA), Tanzania. A mixed-methods research design was employed, integrating household surveys (n = 60), key informant interviews, focus group discussions, direct observation, and physical site visits. The findings indicate that local communities employ a range of mitigation measures, including physical barriers (trenches, stone walls, thorn hedges), chilli pepper fences and guiding fields, scaring and chasing, visual deterrents, and guard dogs. Physical barriers were perceived as the most effective intervention (41.7%), followed by Mauritius thorn hedges (37.9%), scaring and chasing (21.7%), chilli-based deterrents (15.3%), visual deterrents (5%), and electric or natural fences (4.3%). Although electric fencing was widely perceived as effective, it was rarely adopted due to high installation and maintenance costs. The study concludes that while local communities demonstrate substantial adaptive capacity in mitigating HWC, the effectiveness and sustainability of these measures are constrained by financial limitations, labour intensity, ecological pressures, and weak institutional support. Strengthened collaboration between conservation authorities and local communities, enhanced conservation education, and targeted technical and financial assistance are*

*essential for promoting sustainable human–wildlife coexistence in the eastern Kilimanjaro landscape.*

***KEYWORDS:*** *Human–wildlife conflict; community-based mitigation; crop raiding; conservation governance; Kilimanjaro National Park; Tanzania.*

## 1. INTRODUCTION

Human–wildlife conflict (HWC) is a pervasive challenge in conservation landscapes worldwide, particularly where protected areas interface with densely populated rural communities. HWC arises when wildlife activities negatively affect human livelihoods through crop damage, livestock depredation, property destruction, or threats to human safety or when human activities undermine wildlife survival and habitat integrity (Dickman, 2008; Treves, 2009). In sub-Saharan Africa, the incidence and intensity of HWC have increased in recent decades due to population growth, land-use change, habitat fragmentation, and climate variability (Salerno et al., 2015; Senkondo et al., 2024).

In Tanzania, protected areas occupy approximately one-third of the national territory and play a critical role in biodiversity conservation and the national economy through tourism and ecosystem services. However, communities living adjacent to these protected areas often bear disproportionate conservation costs while receiving limited and uneven benefits (Newmark et al., 1994; Kegamba et al., 2024). As a result, persistent HWCs have contributed to negative community attitudes toward wildlife, weakened support for conservation initiatives, and increased risks of retaliatory actions against wildlife.

Local communities constitute the frontline actors in HWC mitigation. In many rural settings, households rely on self-initiated, low-cost deterrent measures due to limited institutional presence or delayed response from wildlife authorities. Empirical evidence from East Africa suggests that community-based, non-lethal mitigation strategies such as chilli pepper fences, thorn hedges, beehive fences, and active guarding can reduce conflict intensity when they are locally appropriate and supported by effective governance arrangements (Montero-Botey et al., 2022; Hariohay et al., 2024). Nevertheless, the effectiveness and sustainability of these measures vary widely depending on socio-economic conditions, ecological context, and the level of institutional support.

Despite growing recognition of community-based approaches, empirical studies evaluating how effective local communities are in adopting, implementing, and sustaining mitigation measures remain limited, particularly in the eastern Kilimanjaro landscape. This study addresses this gap by assessing the effectiveness, adoption, and perceived performance of community-led HWC mitigation strategies in Msaranga and Mahorosha villages, with the aim of informing more inclusive and sustainable conservation practice.

## 2. Literature Review

### 2.1 Theoretical Review

This study is grounded in three complementary theoretical perspectives: Human–Wildlife Conflict Theory, Human Dimensions of Wildlife Management, and Community-Based Natural Resource Management (CBNRM).

Human–Wildlife Conflict Theory conceptualizes HWC as a product of competition over space and resources at the human–wildlife interface (Dickman, 2008; Treves, 2009). The theory emphasizes that HWCs are not solely ecological phenomena but are shaped by human vulnerability, perceptions of risk, tolerance thresholds, and institutional responses. In agrarian societies, even small-scale crop losses can have disproportionate livelihood impacts, thereby intensifying negative perceptions of wildlife and conservation authorities.

Human Dimensions of Wildlife Management theory highlights the central role of social values, attitudes, beliefs, and behaviours in shaping wildlife management outcomes (Decker et al., 2001). According to this framework, mitigation strategies that fail to align with local perceptions and capacities are unlikely to be sustained, regardless of their technical effectiveness. Understanding community perceptions of effectiveness is therefore critical to designing viable HWC interventions.

CBNRM theory posits that conservation outcomes improve when local communities actively participate in resource governance and derive tangible benefits from conservation initiatives (Baldus, 2005; Kideghesho et al., 2005). However, where benefit-sharing mechanisms are weak or inequitable, and where decision-making authority remains centralised, community motivation to invest in mitigation efforts may decline (Kegamba et al., 2024).

## 2.2 Empirical Review

Empirical studies across East Africa consistently identify crop raiding and livestock depredation as the most prevalent forms of HWC in smallholder farming systems (Newmark et al., 1994; Ogada et al., 2003; Salerno et al., 2015). Elephants, buffaloes, baboons, and bush pigs are frequently cited as the most destructive species, causing substantial economic losses at household level and undermining food security.

A wide range of mitigation strategies has been documented, including physical barriers (trenches, walls, fences), chilli-based deterrents, guard animals, visual deterrents, and electric fencing (FAO, 2005; Lamarque et al., 2009). While electric fencing has demonstrated high effectiveness in reducing wildlife incursions, its high installation and maintenance costs limit adoption among rural households (O'Connell-Rodwell et al., 2000). In contrast, low-cost and locally available interventions such as thorn hedges and chilli fences are more widely adopted, although their effectiveness varies across ecological contexts (Montero-Botey et al., 2022).

Recent studies emphasise the importance of community perceptions in determining the adoption and sustainability of mitigation strategies. Where interventions are perceived as effective, affordable, and compatible with existing livelihood systems, uptake and maintenance are higher (Salerno et al., 2015; Senkondo et al., 2024). Conversely, interventions perceived as labour-intensive, risky, or costly are often abandoned despite their potential technical effectiveness.

## 2.3 Research and Knowledge Gap

Despite extensive scholarship on HWC, several gaps remain. First, few village-level studies systematically evaluate mitigation effectiveness from the perspective of local communities, which is critical for long-term adoption. Second, limited research examines the constraints influencing adoption, including financial capacity, labour availability, and institutional support. Third, the eastern Kilimanjaro–Tsavo transboundary landscape remains underrepresented in empirical HWC research. This study addresses these gaps by providing a community-centred evaluation of mitigation strategies in Msaranga and Mahorosha villages.

## 2.4 Conceptual Framework

The study conceptualises community effectiveness in mitigating HWC as an outcome of interactions among ecological pressure (wildlife frequency and species type), socio-economic

capacity (income, labour availability, landholding size), and institutional support (technical assistance, financial support, conservation education). These factors influence the adoption and perceived effectiveness of mitigation strategies, which in turn shape conflict intensity and community attitudes toward conservation.

## 3. RESEARCH METHODOLOGY

### 3.1 Study Area

The study was conducted in Msaranga and Mahorosha villages, Kisale–Masaranga Ward, Rombo District, northern Tanzania. The villages are located along the eastern boundary of Kilimanjaro National Park and are influenced by transboundary wildlife movements from Kenya's Tsavo ecosystem. Livelihoods are predominantly based on smallholder agriculture, including banana, maize, beans, and root crops, with coffee as a key cash crop (Newmark, 1991).

### 3.2 Research Design

This study adopted a descriptive case study design using a mixed-methods approach, integrating quantitative and qualitative techniques. The design was appropriate for capturing both measurable patterns of human–wildlife conflict mitigation and the lived experiences, perceptions, and adaptive practices of local communities. Mixed methods enabled triangulation of data sources and enhanced the depth and credibility of the findings (Decker et al., 2001; Treves, 2009).

### 3.3 Study Population

The study population comprised all households residing in Msaranga and Mahorosha villages in Kisale–Masaranga Ward, Rombo District, Tanzania. These villages are located immediately adjacent to the eastern boundary of Kilimanjaro National Park and are therefore directly exposed to frequent human–wildlife interactions.

The population also included key institutional stakeholders, such as village leaders, ward executive officers, conservation officers from Kilimanjaro National Park (KINAPA), and district natural resource officers, who possess specialised knowledge regarding wildlife management and conflict mitigation in the area.

### 3.4 Sample Size and Sampling Techniques

A total sample of 60 households (30 from each village) was selected for the household survey. The sample size was considered adequate for an in-depth village-level case study, particularly when complemented by qualitative data from focus group discussions and key informant interviews. This sample size aligns with recommendations for social science explainable field studies where intensive engagement and triangulation are prioritised over large-scale generalisation.

Simple random sampling was used to select household respondents from village household registers. Random numbers were generated to ensure that each household had an equal probability of selection, thereby reducing selection bias.

Purposive sampling was employed to select key informants, including village leaders, conservation officers, and district officials, based on their roles, experience, and relevance to human–wildlife conflict management.

Focus group discussions (FGDs) were formed using purposive and stratified selection to ensure representation across gender, age groups, and livelihood categories, particularly farmers who had experienced wildlife-related losses.

This combination of sampling techniques enhanced representativeness while ensuring access to rich, context-specific insights.

### 3.5 Data Collection

Sixty households (30 per village) were selected using simple random sampling from village registers. Purposive sampling was used to select key informants, including village leaders, wildlife officers, and district natural resource officials. Data were collected through structured household questionnaires, key informant interviews, focus group discussions, and direct field observation.

### 3.4 Data Analysis

Quantitative data were analysed using descriptive statistics in IBM SPSS (version 27), while qualitative data were analysed thematically to contextualise and explain quantitative findings.

### 3.5 Validity and Reliability

To ensure validity, multiple strategies were employed:

Triangulation of methods (household surveys, interviews, FGDs, observation, and document review) was used to cross-verify information obtained from different sources.
Content validity was enhanced by designing research instruments based on established literature on human–wildlife conflict and community-based conservation.

Pilot testing of the household questionnaire was conducted in a nearby village with similar characteristics to refine question clarity, relevance, and sequencing before full deployment.

Reliability was ensured through:
Consistent use of the same structured questionnaire across all sampled households.
Training of research assistants on interview techniques and ethical conduct to minimise interviewer bias.
Use of standardised data coding and entry procedures during quantitative data processing.
Repeated probing during qualitative interviews to confirm consistency of responses.
Together, these measures enhanced the accuracy, consistency, and trustworthiness of the study findings.

### 3.6 Ethical Considerations

Ethical standards were strictly observed throughout the study. Prior to data collection, permission to conduct the research was obtained from relevant district and village authorities.

All participants were fully informed about the purpose of the study, the voluntary nature of participation, and their right to withdraw at any stage without penalty. Informed consent was obtained verbally from all respondents before interviews and discussions commenced.

Confidentiality and anonymity were ensured by avoiding the use of personal identifiers in questionnaires and reports. Data collected were used solely for academic purposes and securely stored to prevent unauthorised access.

The study adhered to ethical principles of respect, beneficence, and non-maleficence, ensuring that participation did not expose respondents to physical, psychological, or social harm.

## 4. Presentation of Results

This section presents the empirical findings of the study in a descriptive and objective manner. Interpretation of results is reserved for the subsequent discussion section.

### 4.1 Socio-Demographic Characteristics of Respondents

A total of 60 household heads participated in the study, with equal representation from Msaranga and Mahorosha villages (30 respondents each). The socio-demographic characteristics of respondents are summarised in Table 1.

**Table 1: Socio-demographic characteristics of respondents (N = 60)**

| Variable | Category | Frequency | Percentage (%) |
|---|---|---|---|
| Gender | Male | 39 | 65.0 |
| | Female | 21 | 35.0 |
| Education level | Primary education | 51 | 85.0 |
| | Secondary education | 7 | 11.7 |
| | Tertiary education | 2 | 3.3 |
| Main occupation | Farming | 47 | 78.3 |
| | Formal employment | 5 | 8.3 |
| | Trading/business | 6 | 10.0 |
| | Other | 2 | 3.4 |
| Landholding size | 0.5–1 ha | 13 | 21.7 |
| | 1.5–2 ha | 39 | 65.0 |
| | Above 2 ha | 8 | 13.3 |

### 4.2 Mitigation Measures Used by Local Communities

Respondents reported using multiple mitigation measures to protect crops and property from wildlife. The distribution of mitigation measures is presented in Table 2.

**Table 2: Human–wildlife conflict mitigation measures used by households. (N = 60)**

| Mitigation method | Frequency | Percentage (%) |
|---|---|---|
| Physical barriers (trenches, stone walls, fences) | 35 | 58.3 |
| Mauritius thorn hedges | 22 | 36.7 |
| Scaring and chasing | 13 | 21.7 |
| Chilli pepper fences and guiding fields | 9 | 15.3 |
| Visual deterrents | 7 | 11.7 |
| Electric / natural fences | 2 | 3.3 |

### 4.3 Perceived Effectiveness of Mitigation Measures

Respondents were asked to rate the effectiveness of each mitigation method on a three-point scale: very effective, fairly effective, and not effective. The results are presented in Table 3.

**Table 3: Perceived effectiveness of mitigation measures (N = 60)**

| Mitigation method | Very effective (%) | Fairly effective (%) | Not effective (%) |
|---|---|---|---|
| Physical barriers | 41.7 | 15.0 | 4.0 |
| Mauritius thorn hedges | 37.9 | 21.0 | 7.0 |
| Scaring and chasing | 21.7 | 19.0 | 4.0 |
| Chilli pepper fences | 15.3 | 12.0 | – |
| Visual deterrents | 5.0 | 32.0 | 1.0 |
| Electric / natural fences | 4.3 | 4.0 | – |

### 4.4 Adoption Levels of Mitigation Measures

The extent to which households had adopted different mitigation measures is presented in Table 4.

**Table 4: Adoption of mitigation measures by households (N = 60)**

| Mitigation method | Adopted (Yes) | Adopted (%) | Not adopted (%) |
|---|---|---|---|
| Physical barriers | 57 | 95.0 | 5.0 |
| Scaring and chasing | 51 | 85.0 | 15.0 |
| Mauritius thorn hedges | 48 | 80.0 | 20.0 |
| Chilli pepper fences | 41 | 68.3 | 31.7 |
| Visual deterrents | 36 | 60.0 | 40.0 |
| Electric fencing | 0 | 0.0 | 100.0 |

### 4.5 Institutional Response to Human–Wildlife Conflict

Respondents were asked to assess the responsiveness of conservation authorities during conflict incidents. Results are summarised in Table 5.

**Table 5: Perceived responsiveness of conservation authorities (N = 60)**

| Response category | Frequency | Percentage (%) |
|---|---|---|
| No response | 39 | 65.0 |
| Delayed response | 15 | 25.0 |
| Immediate response | 6 | 10.0 |

## 5. Discussion of Findings

This section interprets the results in relation to the study objectives, theoretical framework, and existing literature.

### 5.1 Effectiveness of Community-Based Mitigation Measures

The findings indicate that **physical barriers** and **Mauritius thorn hedges** are the most widely adopted and perceived as effective mitigation strategies. This reflects their affordability, reliance on locally available materials, and compatibility with existing farming practices. These findings align with previous studies which demonstrate that low-cost, locally controlled interventions are more likely to be sustained in rural conservation landscapes (Salerno et al., 2015; Montero-Botey et al., 2022).

However, the limited effectiveness of physical barriers against large mammals, particularly elephants, underscores the ecological limitations of household-level interventions. This finding supports Human–Wildlife Conflict Theory, which emphasises that conflict intensity increases where ecological drivers exceed local coping capacity (Dickman, 2008).

### 5.2 Adoption Constraints and Socio-Economic Factors

Despite high awareness of electric fencing, none of the households had adopted this method. High installation costs, maintenance requirements, and lack of electricity access emerged as key barriers. This confirms earlier findings that technically effective interventions may fail in low-income settings if they are not economically accessible (O'Connell-Rodwell et al., 2000).

The widespread use of scaring and chasing techniques reflects immediate coping behaviour rather than long-term solutions. While effective in the short term, these methods are labour-intensive and pose safety risks, particularly when confronting elephants.

### 5.3 Institutional Support and Governance Implications

The majority of respondents reported either no response or delayed response from conservation authorities. This institutional gap places disproportionate responsibility on communities and weakens trust between local residents and park management. According to the Community-Based Natural Resource Management framework, such weak institutional engagement undermines collective action and long-term conservation despite high local willingness to mitigate conflicts (Kideghesho et al., 2005; Kegamba et al., 2024).

### 5.4 Implications for Sustainable Human–Wildlife Coexistence

The findings demonstrate that local communities possess significant adaptive capacity, but this capacity is constrained without sustained institutional, financial, and technical support.

Integrated mitigation approaches that combine community-led interventions with government-supported infrastructure and education are therefore essential. This reinforces recent calls for multi-level governance approaches to HWC mitigation in transboundary conservation landscapes (Senkondo et al., 2024).

## 5. CONCLUSIONS

This study concludes that local communities in Msaranga and Mahorosha villages possess substantial adaptive capacity in mitigating human–wildlife conflict using locally appropriate strategies. Community-based interventions such as physical barriers, thorn hedges, and chilli-based deterrents play a critical role in reducing crop raiding and enhancing household resilience. However, the effectiveness and sustainability of these measures are limited by financial constraints, labour intensity, ecological pressures, and weak institutional support. Without sustained collaboration between conservation authorities and communities, local mitigation efforts alone are insufficient to address the structural drivers of human–wildlife conflict in the eastern Kilimanjaro landscape.

## 6. RECOMMENDATIONS

1. Strengthen community–authority collaboration: Establish regular dialogue platforms and rapid response mechanisms between KINAPA and surrounding communities.
2. Enhance conservation education and extension services: Improve community awareness of effective mitigation strategies and wildlife behaviour.
3. Provide targeted technical and financial support: Facilitate cost-sharing mechanisms for durable mitigation measures and support locally viable deterrents.
4. Promote collective and landscape-level approaches: Encourage coordinated mitigation efforts across villages and strengthen transboundary collaboration with Kenyan authorities.
5. Integrate livelihood incentives: Support mitigation strategies that generate co-benefits, such as chilli production and beekeeping, to enhance sustainability.

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