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Indigenous Knowledge in Drought-Induced Human-Carnivore Conflict Management among Maasai Pastoralists in Olkiramatian and Shompole Conservancies, Kenya

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A B S T R A C T

Drought is increasingly recognized as a major driver of human-carnivore conflict (HCC) in pastoral ecosystems. In Kenya's arid and semi-arid lands, prolonged drought reduces pasture, water, and prey availability, forcing wildlife and livestock into closer contact and increasing conflict risks. Although Indigenous Knowledge (IK) has historically guided pastoralist adaptation and conflict management, its contribution remains insufficiently documented in formal carnivore conservation policy. A quantitative cross-sectional survey was conducted among 153 households in Olkiramatian and Shompole conservancies in Kajiado County, Kenya. Data were collected using structured questionnaires administered in December 2024. Descriptive statistics, regression analysis, correlation analysis, principal component analysis (PCA), cluster analysis, and Partial Least Squares Structural Equation Modelling (PLS-SEM) were employed to examine relationships between drought-induced HCC, Indigenous Knowledge application, management effectiveness, and policy integration. All respondents identified at least one Indigenous Knowledge-based trigger of drought-induced HCC, while 94.8% reported using Indigenous Knowledge management practices. Carnivore proximity (n=245), human encroachment (n=172), pasture loss (n=119), and water scarcity (n=97) emerged as major conflict triggers. Indigenous Knowledge application significantly improved perceived HCC management effectiveness (β=0.54, $p<0.001$) and positively influenced support for policy integration (β=0.27, $p<0.001$). Traditional drought indicators including weather patterns, plant phenology, and animal behavior were widely used for drought forecasting. Most respondents (63.4%) preferred Indigenous Knowledge over conventional approaches, while 25.5% supported integrated Indigenous-Conventional Knowledge systems. Indigenous Knowledge remains a critical component of drought-induced HCC management among Maasai pastoralists. Strengthening the integration of Indigenous Knowledge within formal conservation and drought governance frameworks could enhance resilience, improve conflict mitigation, and promote sustainable human-carnivore coexistence.

Keywords: Indigenous Knowledge; Human-carnivore conflict; Drought; Maasai pastoralists; Conservation; scarce resources, traditional practices, justice, environmental stewardship, co-creation

1.0 Introduction

Drought is among the most severe climate-related hazards affecting ecosystems and livelihoods globally. Unlike rapid-onset disasters such as floods and storms, drought develops gradually, making its onset and impacts difficult to detect and manage (IPCC, 2021). In East Africa, increasing drought frequency and intensity have significantly affected pastoral livelihoods and biodiversity conservation.

Pastoral communities depend heavily on natural resources, particularly water and pasture. During drought periods, reduced forage availability and declining wildlife prey populations force carnivores to move closer to livestock and human settlements. Consequently, livestock depredation increases, resulting in heightened human-carnivore conflict (Treves and Karanth, 2003).

The Maasai pastoralists of southern Kenya have historically coexisted with wildlife through Indigenous Knowledge systems that guide resource management, drought adaptation, and conflict resolution. Indigenous Knowledge encompasses ecological observations, customary institutions, seasonal grazing practices, and traditional dispute resolution mechanisms developed through generations of interaction with the environment (Berkes, 2012).

Despite increasing recognition of Indigenous Knowledge in climate adaptation discourse, its role in managing drought-induced HCC remains inadequately documented. Conservation interventions frequently prioritize scientific approaches while overlooking locally developed systems that enjoy greater cultural legitimacy and community acceptance.

This study examined Indigenous Knowledge used by Maasai pastoralists in Olkiramatian and Shompole conservancies to manage drought-induced HCC.

The specific objectives were to:

1. Document Indigenous Knowledge on triggers of drought-induced HCC.
2. Identify Indigenous Knowledge-based management measures.
3. Examine the application of Indigenous Knowledge in HCC management.
4. Assess opportunities for integrating Indigenous Knowledge into formal conservation policy.

2.0 Materials and Methods

2.1 Study Area

This study was conducted in Olkiramatian and Shompole community conservancies located in Kajiado County, Kenya, within the South Rift Valley ecosystem. The two conservancies collectively cover approximately 890 km² and constitute an important wildlife dispersal landscape that supports both pastoral livelihoods and biodiversity conservation. The area is characterized by semi-arid climatic conditions, with annual rainfall ranging between 200 and 600 mm, and experiences recurrent droughts that significantly affect both livestock production and wildlife populations.

The Ewaso Nyiro River serves as the primary permanent water source within the ecosystem and plays a critical role in sustaining livestock, wildlife, and local communities during prolonged dry periods. The conservancies host diverse wildlife species, including large carnivores such as lions (Panthera leo), spotted hyenas (Crocuta crocuta), leopards (Panthera pardus), and cheetahs (Acinonyx jubatus), which frequently interact with livestock. Pastoralism is the dominant livelihood activity in the study area, with more than 90% of households depending primarily on livestock production for food security and income generation. The dependence on natural resources, coupled with increasing climate variability, makes the area particularly vulnerable to drought-induced human-carnivore conflict (HCC).

2.2 Research Design

The study employed a quantitative cross-sectional research design to assess community perceptions of drought-induced human-carnivore conflict and the role of Indigenous Knowledge (IK) in conflict management. A cross-sectional approach was considered appropriate because it enabled the collection of data from respondents at a single point in time, allowing for the examination of prevailing drought experiences, conflict patterns, Indigenous Knowledge systems, and management practices within the conservancies.

The design facilitated the generation of quantitative data suitable for statistical analysis and enabled comparisons between communities in Olkiramatian and Shompole conservancies. Additionally, the approach provided an opportunity to evaluate relationships among drought conditions, conflict triggers, Indigenous Knowledge

application, management effectiveness, and support for policy integration.

2.3 Sampling Procedure and Sample Size

The study targeted households residing within Olkiramatian and Shompole conservancies. A total sample of 153 households was selected for participation, comprising 72 households from Olkiramatian Conservancy and 81 households from Shompole Conservancy.

A systematic sampling technique was used to select respondents. Households were identified using a predetermined 1-3-5 interval sampling approach to ensure broad spatial coverage across the conservancies while minimizing selection bias. The sampling procedure enabled the inclusion of households with varying experiences of drought and human-carnivore conflict, thereby enhancing the representativeness of the study findings.

The household head or an adult household member knowledgeable about livestock management, drought experiences, and wildlife interactions was selected as the respondent during each interview.

2.4 Data Collection

Primary data were collected in December 2024 through structured household questionnaires administered using face-to-face interviews. The interviews were conducted by trained Maasai research assistants who were familiar with local cultural practices, language, and ecological conditions, thereby enhancing respondent understanding and the reliability of information collected.

The questionnaire was designed to capture information on several key thematic areas relevant to the study objectives. These included socio-demographic characteristics of respondents, livelihood activities, experiences and perceptions of drought, human-carnivore conflict experiences, Indigenous Knowledge systems used for drought prediction and conflict management, conflict mitigation measures, institutional involvement in conflict resolution, and preferences regarding Indigenous and conventional knowledge systems.

Data collection focused on identifying community perceptions of drought-induced HCC triggers, documenting Indigenous Knowledge-based adaptation and mitigation strategies, evaluating the effectiveness of conflict management measures, and assessing support for integrating Indigenous Knowledge into formal conservation and governance frameworks.

2.5 Ethical Considerations

Ethical approval for the study was obtained from South Eastern Kenya University (SEKU) prior to field data collection. Permission to conduct the research was also obtained from relevant local authorities and conservancy management institutions.

Participation in the study was voluntary, and informed consent was obtained from all respondents before interviews were conducted. Respondents were informed about the purpose of the study, the nature of their participation, and their right to withdraw from the interview at any stage without penalty. Confidentiality and anonymity were maintained throughout the research process by ensuring that personal identifiers were not included in the final dataset or subsequent reporting of results.

2.6 Data Analysis

Data were entered, cleaned, coded, and analyzed using R statistical software version 4.3. Both descriptive and inferential statistical techniques were employed to address the study objectives.

Descriptive statistics, including frequencies, percentages, means, and summary measures, were used to characterize respondents' socio-demographic attributes, drought experiences, human-carnivore conflict patterns, Indigenous Knowledge practices, and management measures. Results were presented using tables, figures, and graphical visualizations where appropriate.

Several multivariate statistical approaches were employed to investigate relationships among study variables. Multinomial logistic regression was used to examine factors influencing categorical conflict-related outcomes, while binary logistic regression was applied to analyze dichotomous response variables.

Poisson regression was used to model count-based variables associated with conflict experiences and management practices. Ordinal regression was employed to analyze ordered response variables related to perceptions and attitudes.

To explore patterns within the dataset and reduce dimensionality, Principal Component Analysis (PCA) was conducted, followed by K-means cluster analysis to identify groups of respondents with similar characteristics and perceptions. Correlation analysis was performed to examine associations among Indigenous Knowledge application, drought-induced conflict triggers, management effectiveness, and policy integration variables.

In addition, Partial Least Squares Structural Equation Modelling (PLS-SEM) was used to explore the relationships between latent constructs representing Indigenous Knowledge application and conflict management outcomes. The PLS-SEM approach was selected because of its suitability for exploratory modelling and its ability to accommodate complex relationships among variables measured using multiple indicators.

All statistical tests were evaluated at a significance level of $\alpha = 0.05$. Results were interpreted based on statistical significance, effect sizes, and their relevance to drought-induced human-carnivore conflict management and Indigenous Knowledge systems within the study area.

3.0 Results and Discussion

3.1 Socio-Demographic and Livelihood Profile

A total of 153 respondents were surveyed, 72 from Olkiramatian and 81 from Shompole conservancies. Gender distribution was relatively balanced, with a slight male majority (58.3% in Olkiramatian; 59.3% in Shompole). Education levels were generally low, with a significant disparity between the conservancies. In Olkiramatian, 37.5% of respondents had no formal education compared to 66.7% in Shompole. Tertiary education was rare in both areas (12.5% and 7.4%, respectively).

Age distribution was similar, with the majority in both conservancies falling within the productive age group of 36-60 years (37.5% in Olkiramatian; 43.2% in Shompole). Residency was long-term for most households: more than two-thirds had lived in the area for at least six years.

Livelihoods were dominated by livestock keeping (84.7% in Olkiramatian; 96.3% in Shompole). Crop farming (33.3%) and business (20.8%) were more common in Olkiramatian than in Shompole (11.1% and 16%, respectively). Livestock ownership was nearly universal, with Shompole households holding larger herds of cattle, sheep, and goats, while donkey ownership was higher in Olkiramatian.

Most respondents reported experiencing fewer than ten droughts over the past 20 years (65.3% in Olkiramatian; 61.7% in Shompole). However, drought patterns differed: short-term droughts were more common in Olkiramatian (68.1%), whereas long-term droughts predominated in Shompole (58%).

Across both sites, a majority observed that human–carnivore conflicts (HCC) have intensified over the last decade (63.9% in Olkiramatian; 65.4% in Shompole).

3.2 Indigenous Knowledge on Triggers of Drought-Induced Human-Carnivore Conflict

All respondents (100%) identified at least one Indigenous Knowledge (IK)-based trigger of drought-induced human-carnivore conflict (HCC), demonstrating widespread local ecological understanding of conflict dynamics. Five major trigger categories were identified (Table 2). Carnivore proximity was the most frequently reported trigger (n = 245), followed by human encroachment (n = 172), pasture loss (n = 119), water scarcity (n = 97), and prey shifts (n = 73).

These results indicated that respondents recognized both ecological and anthropogenic drivers of conflict.

3.3 Indigenous Knowledge-Based Management Measures

A majority of respondents (94.8%) reported using at least one Indigenous Knowledge-based HCC management strategy. Respondents reported an average of five management measures, indicating reliance on multiple complementary interventions.

Deterrence was the most commonly reported management strategy (n = 156), followed by livestock guarding (n = 122), collaboration with conventional authorities (n = 119), use of dogs (n = 109), and carnivore tracking (n = 94). Boma improvement (n = 65) and retaliatory killing (n = 44) were less frequently reported (Table 3).

Table.1 Socio-demographic Characteristics, Livelihood Activities, and Drought-Conflict Experiences of Respondents in Olkiramatian and Shompole Conservancies

Conservancy	Variable / Level	Percentage
Olkiramatian	Gender: Female	41.7%
Olkiramatian	Gender: Male	58.3%
Olkiramatian	Education: College or university	12.5%
Olkiramatian	Education: No formal education	37.5%
Olkiramatian	Education: Primary school	26.4%
Olkiramatian	Education: Secondary School	23.6%
Olkiramatian	Age: 18–35	36.1%
Olkiramatian	Age: 36–60	37.5%
Olkiramatian	Age: Above 60	26.4%
Olkiramatian	Time Spent: 1–5 years	23.6%
Olkiramatian	Time Spent: 11–20 years	9.7%
Olkiramatian	Time Spent: 6–10 years	30.6%
Olkiramatian	Time Spent: More than 20 years	20.8%
Olkiramatian	Time Spent: Less than 1 year	15.3%
Olkiramatian	Livelihood: Livestock keeping	84.7%
Olkiramatian	Livelihood: Crop farming	33.3%
Olkiramatian	Livelihood: Business	20.8%
Olkiramatian	Livelihood: Employed	12.5%
Olkiramatian	Livestock Ownership: Cattle	65.3%
Olkiramatian	Livestock Ownership: Sheep	65.3%
Olkiramatian	Livestock Ownership: Goats	63.9%
Olkiramatian	Livestock Ownership: Donkeys	34.7%
Olkiramatian	Drought Type: Long-term	31.9%
Olkiramatian	Drought Type: Short-term	68.1%
Olkiramatian	Droughts in 20 Years: Less than 10	65.3%
Olkiramatian	Droughts in 20 Years: More than 10	23.6%
Olkiramatian	Droughts in 20 Years: None	11.1%
Olkiramatian	HCC History: First 10 years	16.7%
Olkiramatian	HCC History: Last 10 years	63.9%
Olkiramatian	HCC History: None	19.4%

Conservancy	Variable / Level	Percentage
Shompole	Gender: Female	40.7%
Shompole	Gender: Male	59.3%
Shompole	Education: College or university	7.4%
Shompole	Education: No formal education	66.7%
Shompole	Education: Primary school	17.3%
Shompole	Education: Secondary School	8.6%
Shompole	Age: 18–35	32.1%

Shompole	Age: 36–60	43.2%
Shompole	Age: Above 60	24.7%
Shompole	Time Spent: 1–5 years	21%
Shompole	Time Spent: 11–20 years	13.6%
Shompole	Time Spent: 6–10 years	38.3%
Shompole	Time Spent: More than 20 years	18.5%
Shompole	Time Spent: Less than 1 year	8.6%
Shompole	Livelihood: Livestock keeping	96.3%
Shompole	Livelihood: Crop farming	11.1%
Shompole	Livelihood: Business	16%
Shompole	Livelihood: Employed	4.9%
Shompole	Livestock Ownership: Cattle	93.8%
Shompole	Livestock Ownership: Sheep	86.4%
Shompole	Livestock Ownership: Goats	82.7%
Shompole	Livestock Ownership: Donkeys	64.2%
Shompole	Drought Type: Long-term	58%
Shompole	Drought Type: Short-term	42%
Shompole	Droughts in 20 Years: Less than 10	61.7%
Shompole	Droughts in 20 Years: More than 10	19.8%
Shompole	Droughts in 20 Years: None	18.5%
Shompole	HCC History: First 10 years	9.9%
Shompole	HCC History: Last 10 years	65.4%
Shompole	HCC History: None	24.7%

Table.2 Indigenous Knowledge-Based Triggers of Drought-Induced HCC

Trigger Category	Frequency
Carnivore proximity	245
Human encroachment	172
Pasture loss	119
Water scarcity	97
Prey shifts	73

Table.3 Indigenous Knowledge-Based HCC Management Measures

Management Measure	Frequency
Deterrence	156
Livestock guarding	122
Conventional authorities	119
Dogs	109
Tracking	94
Boma improvement	65
Retaliatory killing	44

3.4 Thematic Representation of Indigenous Knowledge Narratives

Word cloud analysis revealed recurring themes related to drought-induced HCC and Indigenous Knowledge management systems (Figure 1). Frequently occurring terms included *carnivore*, *livestock*, *conservation*, *Indigenous Knowledge*, *pastoral*, *migration*, *water scarcity*, *leadership*, and *authority*. The themes reflected the interconnected ecological, livelihood, institutional, and conservation dimensions of HCC management.

3.5 Indigenous Knowledge and Drought Assessment

Traditional weather patterns, plant indicators, and animal behavior were the most commonly used drought assessment tools in both conservancies. Traditional weather indicators were reported by 36.1% of respondents in Olkiramatian and 40.1% in Shompole. Fewer than 20% relied primarily on meteorological information, while less than 6% reported no use of forecasting methods.

3.6 Drought-Induced Conflict and Community Responses

Respondents directly linked drought conditions to increased HCC. Human migration (26.9%) was the most frequently reported drought-related driver of conflict, followed by pasture loss (24.9%), water scarcity (19.0%), livestock migration (15.9%), and carnivore migration (13.3%).

To mitigate drought impacts, communities adopted several adaptive strategies including livestock migration, engagement with conservancy authorities, livelihood diversification, hay storage, and use of livestock guarding dogs.

3.7 Perceived Effectiveness of HCC Management Strategies

As shown in figure 3 below, indigenous Knowledge was perceived as the most effective HCC management approach (32.2%), followed by technology-based deterrents (22.6%), employment of guards (20.5%), and conventional legal systems (18.0%). Protective enclosures were perceived as the least effective strategy (5.9%).

3.8 Indigenous Knowledge Systems and Institutional Roles

Traditional HCC management methods included trapping carnivores (35.3%), indigenous courts (30.7%), and poisoning (24.3%). Local leaders (42.3%) emerged as the most influential actors in HCC resolution, followed by conservation authorities (37.8%) and community land officials (19.9%).

3.9 Community Perceptions of Indigenous Knowledge

Respondents identified sustainability (33.7%), efficiency (29.2%), and affordability (28.5%) as key strengths of Indigenous Knowledge systems. Major challenges included poor transmission to younger generations (35.1%) and limited recognition within formal legal systems (28.3%). Most respondents preferred Indigenous Knowledge (63.4%) over Conventional Knowledge (11.1%), while 25.5% preferred integrated Indigenous-Conventional Knowledge approaches.

3.10 Relationships between Indigenous Knowledge Application, Management Effectiveness and Policy Integration

The inferential analyses were consistent with the descriptive findings, which indicated widespread recognition and application of Indigenous Knowledge (IK) in drought-induced human-carnivore conflict (HCC) management. To further examine the relationships among IK application, management effectiveness, and policy integration, multiple linear regression models with robust standard errors were fitted.

The first model assessed the influence of Indigenous Knowledge application and drought-induced HCC triggers on perceived management effectiveness. The results showed that Indigenous Knowledge application was positively and significantly associated with management effectiveness ($\beta = 0.54$, $p < 0.001$). Respondents reporting greater use of Indigenous Knowledge practices were more likely to perceive HCC management measures as effective. In contrast, drought-induced HCC triggers were negatively associated with management effectiveness ($\beta = -0.32$, $p = 0.007$), indicating that increasing ecological pressures reduced the perceived effectiveness of conflict mitigation measures. Together, Indigenous Knowledge application

and drought-related conflict triggers explained 15.3% of the variation in perceived management effectiveness (R^2 = 0.153).

A second regression model examined factors associated with support for the integration of Indigenous Knowledge into formal conservation and wildlife management policies. Indigenous Knowledge application had a significant positive effect on policy integration (β = 0.27, $p < 0.001$), suggesting that respondents who actively applied Indigenous Knowledge were more likely to support its incorporation into formal governance frameworks. However, perceived management effectiveness was not a statistically significant predictor of policy integration ($p = 0.058$). The model explained 6.9% of the variation in policy integration ($R^2 = 0.069$).

The correlation analysis further supported these findings (Figure 4). Indigenous Knowledge application showed a positive association with management effectiveness (r = 0.32) and policy integration (r = 0.22). A stronger positive relationship was observed between Indigenous Knowledge application and drought-related conflict triggers (r = 0.69), suggesting that communities experiencing greater drought-induced conflict pressures were more likely to apply Indigenous Knowledge-based strategies. In contrast, the relationship between management effectiveness and policy integration was weak (r = -0.06), indicating that support for policy integration may be influenced by factors beyond perceived effectiveness of management interventions.

Overall, the inferential results demonstrate that Indigenous Knowledge application plays a significant role in shaping perceptions of HCC management effectiveness and support for policy integration. However, the relatively modest R^2 values suggest that additional ecological, social, institutional, and governance factors contribute to community perceptions and policy preferences regarding drought-induced human-carnivore conflict management.

3.11 Indigenous Knowledge as a Foundation for Understanding Drought-Induced Human-Carnivore Conflict

The finding that all respondents identified at least one Indigenous Knowledge (IK)-based trigger of drought-induced human-carnivore conflict (HCC) demonstrates the depth of ecological knowledge possessed by Maasai pastoralists. The prominence of carnivore proximity, human encroachment, pasture loss, and water scarcity indicates that local communities possess a sophisticated understanding of the ecological and social processes that shape conflict occurrence.

These findings reinforce the argument that Indigenous Knowledge is generated through continuous observation of environmental conditions and wildlife behavior over long periods of interaction with local ecosystems (Berkes, 2012). Rather than viewing conflict solely as a wildlife problem, respondents recognized the interaction between ecological pressures and human activities, suggesting a systems-based understanding of conflict dynamics.

The prominence of carnivore proximity as the leading trigger suggests that local communities interpret conflict through direct observations of changing carnivore movement patterns and resource use. This observation is consistent with growing evidence that environmental stress and climate variability alter wildlife distributions and increase contact between people, livestock, and carnivores (Abrahms *et al.,* 2023). However, unlike studies that primarily emphasize ecological drivers, the present findings demonstrate that communities simultaneously identify human encroachment as a major contributor to conflict. This indicates that Maasai communities do not attribute conflict exclusively to wildlife but recognize the role of human-induced landscape changes in shaping conflict patterns. The findings therefore extend previous research by demonstrating that Indigenous Knowledge encompasses not only environmental observations but also critical reflections on human activities that influence ecosystem functioning (Kideghesho, 2016). Such perspectives are particularly important in contemporary conservation debates where conflict is increasingly recognized as a socio-ecological rather than purely ecological phenomenon.

3.12 Drought as a Conflict Multiplier in Pastoral Landscapes

The results suggest that drought functions as a conflict multiplier by intensifying competition for scarce resources rather than acting as a direct cause of conflict. Respondents consistently linked drought-induced HCC to pasture loss, water scarcity, and the migration of people, livestock, and wildlife.

Study Area

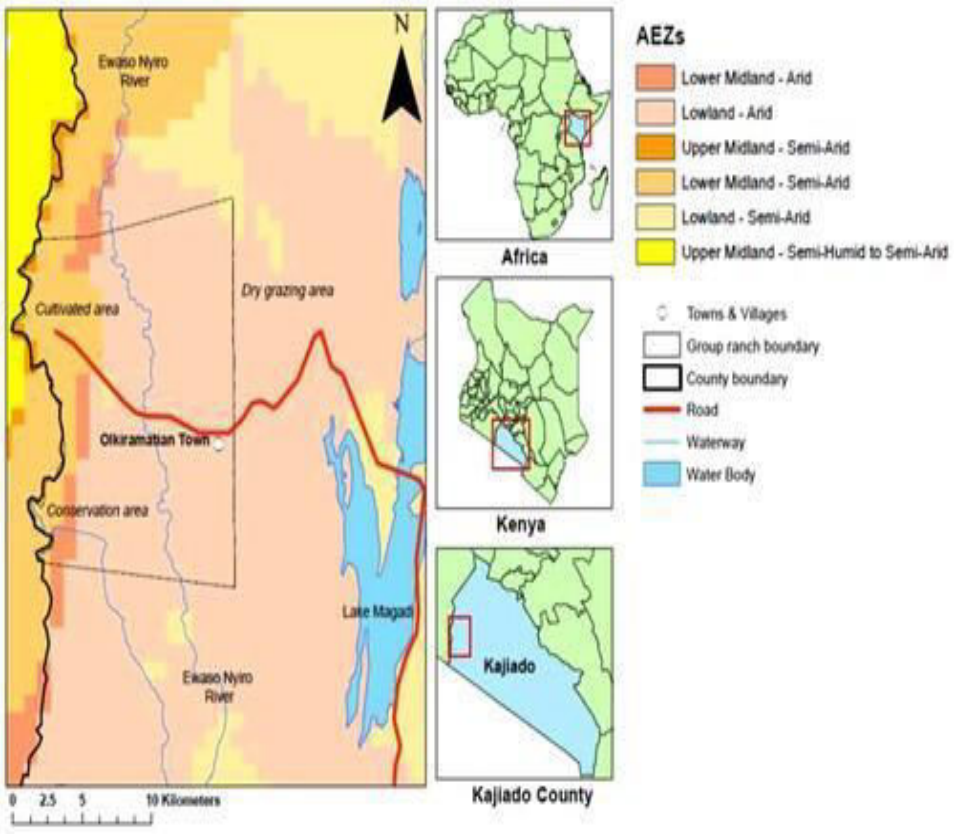


Figure.1 Thematic word cloud narratives

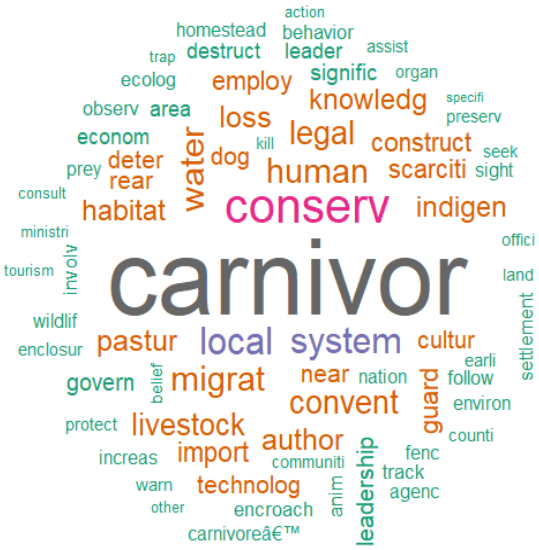


Figure.2 Drought-Induced Conflict and Community Responses

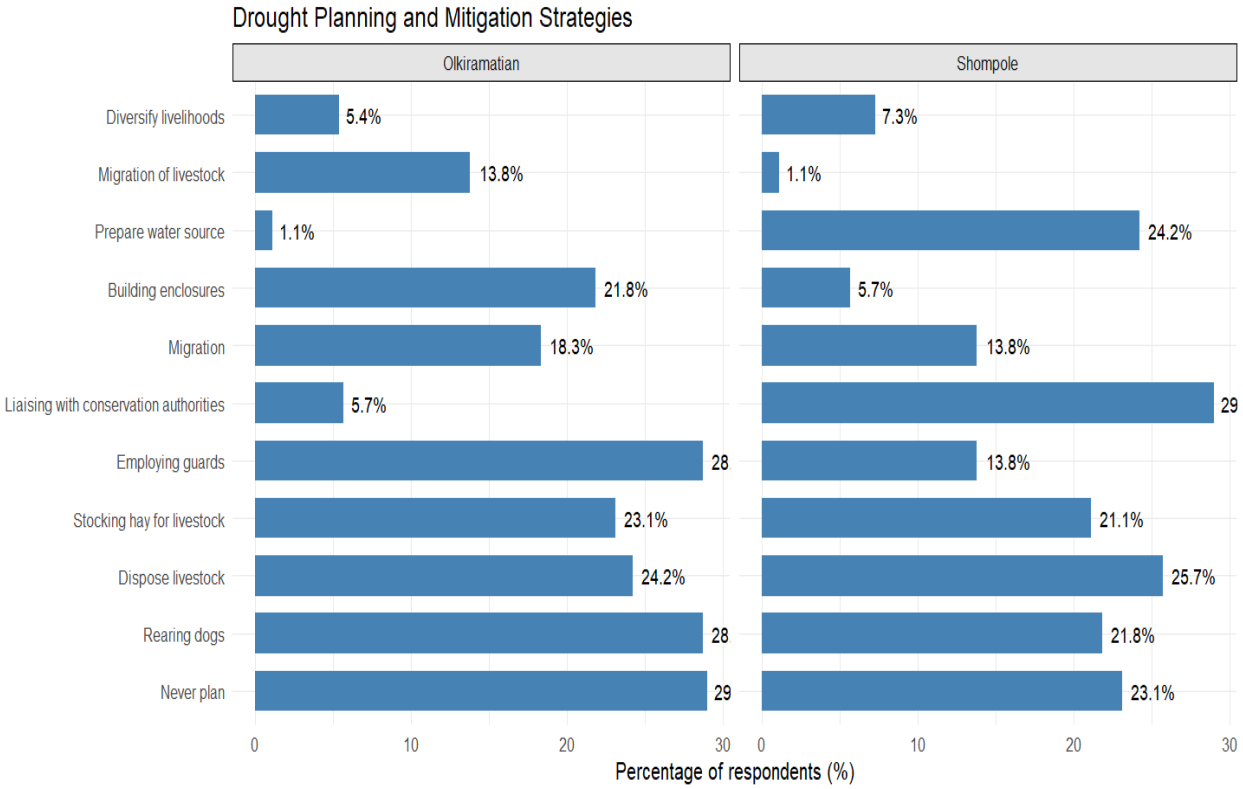


Figure.3 Respondents Perceived Effectiveness of HCC Management Strategies

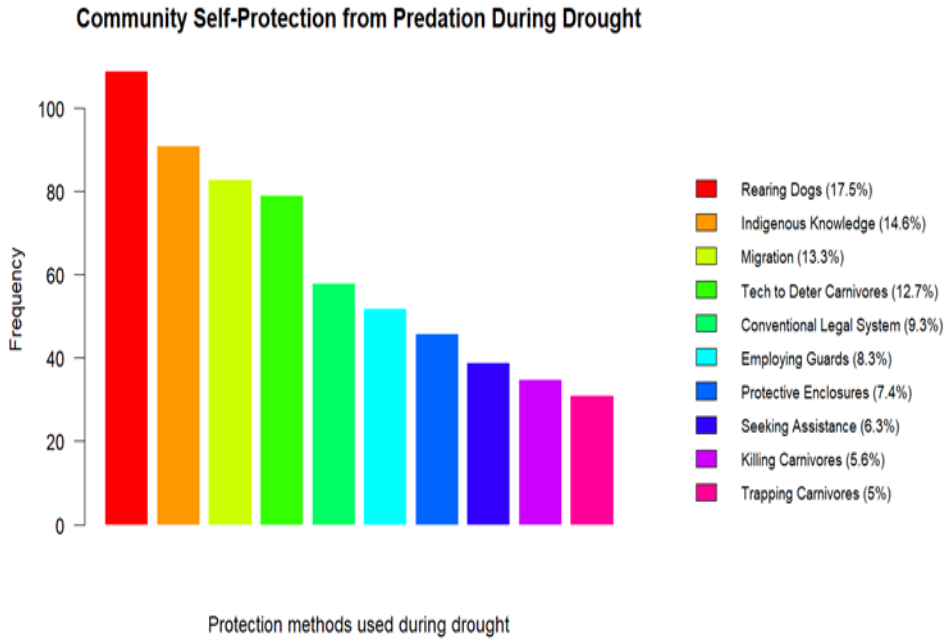
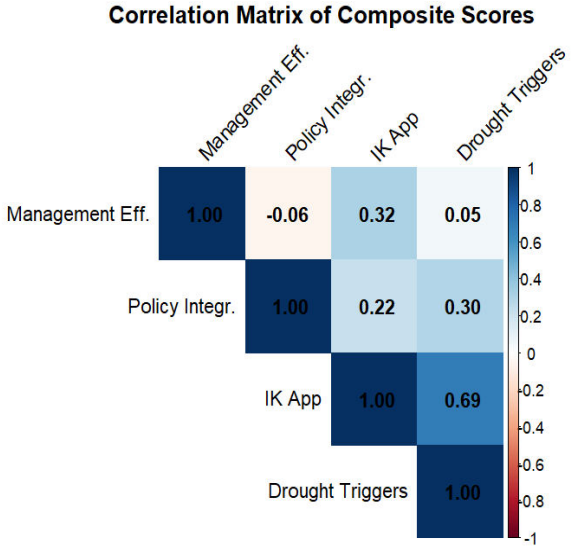


Figure.4 Correlation Analysis Results



This finding aligns with ecological studies demonstrating that prolonged drought alters resource distribution, forcing wildlife and human populations into closer proximity (Abrahms *et al.,* 2023).

However, the present study provides additional insight by revealing how local communities interpret these processes. Respondents did not perceive drought as an isolated climatic event but rather as a catalyst that triggers a cascade of ecological and social changes that ultimately increase conflict risk.

The high frequency of reported livestock predation and human safety concerns further indicates that drought-induced HCC extends beyond ecological impacts to affect livelihoods, well-being, and community attitudes toward conservation.

This observation supports arguments that human-carnivore conflict should be viewed not merely in terms of economic losses but also in relation to psychological, social, and governance dimensions (Brehony *et al.,* 2020).

Importantly, the findings suggest that interventions focused solely on reducing carnivore attacks may fail to address the underlying drivers of conflict if broader drought-related pressures remain unresolved. Effective conflict management therefore requires addressing both immediate conflict incidents and the environmental conditions that contribute to their occurrence.

3.13 Indigenous Knowledge-Based Adaptation and Conflict Management

The widespread use of deterrence measures, livestock guarding, tracking, dogs, and engagement with local authorities demonstrates that Indigenous Knowledge remains a practical and adaptive management system rather than a static body of traditional practices.

These findings support evidence from pastoral systems across East Africa showing that local communities often rely on preventive measures that reduce livestock vulnerability while minimizing direct harm to carnivores (Western *et al.,* 2021). The relatively high adoption of preventive approaches and the comparatively lower reliance on retaliatory killing indicate that coexistence-oriented strategies remain central to local conflict management systems.

A particularly important finding is that respondents reported using multiple management measures simultaneously. This suggests that Indigenous Knowledge functions as an integrated management framework rather than a collection of isolated interventions. Such flexibility reflects the adaptive nature of Indigenous Knowledge systems, which continuously evolve in response to changing ecological conditions (Berkes, 2012).

This challenges persistent assumptions that Indigenous Knowledge is outdated or incompatible with

contemporary conservation needs. Instead, the findings indicate that local knowledge systems continue to provide practical solutions to emerging environmental challenges, including those associated with climate variability and increasing human-wildlife interactions.

3.14 Indigenous Knowledge in Drought Forecasting and Early Warning

Traditional weather indicators, plant phenology, and animal behavior emerged as important tools for drought assessment and prediction. The widespread reliance on these indicators suggests that Indigenous forecasting systems continue to play a significant role in pastoral decision-making.

These findings support previous studies demonstrating that Indigenous forecasting systems remain highly relevant in regions where scientific climate information is unavailable, inaccessible, or insufficiently localized. However, the findings also suggest that communities are not necessarily rejecting scientific information. Rather, they appear to prioritize information sources that are context-specific and directly linked to local environmental conditions.

The relatively low reliance on meteorological forecasts may therefore reflect challenges in communication, accessibility, or local applicability rather than a lack of trust in science. This finding highlights the need to move beyond debates that position Indigenous and scientific knowledge systems as competing alternatives.

Instead, the results support growing calls for knowledge co-production approaches that integrate Indigenous forecasting indicators with scientific climate information to improve drought preparedness and adaptive decision-making (Tengö *et al.,* 2017).

3.15 Indigenous Institutions and Community-Based Governance

The prominence of local leaders and indigenous courts in conflict resolution demonstrates the continued legitimacy of customary governance institutions within Maasai communities. Respondents frequently identified these institutions as central actors in addressing conflict and guiding community responses.

These findings are consistent with arguments that Indigenous institutions often possess social legitimacy derived from cultural acceptance, local accountability, and contextual understanding of community challenges (Berkes, 2012). Unlike externally imposed governance arrangements, customary institutions are embedded within local social structures and are therefore often better positioned to facilitate compliance and collective action.

However, respondents also identified limited recognition of Indigenous institutions within formal conservation frameworks. This finding reflects a broader governance challenge in which local institutions continue to play important operational roles while remaining marginal within formal decision-making processes (Kideghesho, 2016).

The coexistence of strong local legitimacy and weak formal recognition suggests a governance mismatch that may limit the effectiveness of conservation interventions. Policies developed without meaningful engagement with customary institutions risk overlooking important sources of local knowledge, authority, and community support.

3.16 Indigenous Knowledge, Management Effectiveness, and Policy Integration

The inferential findings provide quantitative support for the practical value of Indigenous Knowledge in drought-induced HCC management. Indigenous Knowledge application was positively associated with perceived management effectiveness ($\beta = 0.54$, $p < 0.001$), indicating that respondents who reported greater use of Indigenous Knowledge practices were more likely to perceive conflict management measures as effective.

This finding strengthens the descriptive evidence showing widespread adoption of Indigenous Knowledge strategies and suggests that these practices are not merely culturally valued but are associated with positive management outcomes. The results therefore support arguments that Indigenous Knowledge contributes meaningfully to conservation and resource management by providing locally relevant and context-specific solutions (Berkes, 2012).

In contrast, drought-induced HCC triggers were negatively associated with management effectiveness ($\beta = -0.32$, $p = 0.007$), indicating that increasing ecological pressures undermine the effectiveness of management interventions.

This finding suggests that even effective Indigenous Knowledge systems may face limitations under intensifying climate stress and resource scarcity.

The positive relationship between Indigenous Knowledge application and support for policy integration ($\beta = 0.27$, $p < 0.001$) is particularly significant.

Respondents who actively applied Indigenous Knowledge were more likely to support its incorporation into formal conservation policies. This suggests that support for policy integration is grounded in practical experience rather than solely cultural preference.

However, the relatively low explanatory power of the policy integration model ($R^2 = 0.069$) indicates that support for integration is influenced by additional social, institutional, and political factors beyond those examined in this study.

Factors such as trust in conservation agencies, previous experiences with wildlife governance, and participation in decision-making processes may play important roles in shaping attitudes toward policy integration.

Consequently, the findings suggest that integrating Indigenous Knowledge into conservation policy is not merely a technical exercise but also a governance challenge involving questions of legitimacy, representation, and power sharing (Tengö *et al.,* 2017).

4.0 Implications for Conservation Policy and Practice

The findings demonstrate that Indigenous Knowledge should not be viewed as an alternative to scientific approaches but rather as a complementary knowledge system capable of strengthening conservation outcomes.

Policy frameworks should therefore:

- Recognize Indigenous Knowledge as a legitimate knowledge system.
- Strengthen the role of elders and customary institutions in conflict resolution.
- Incorporate Indigenous drought forecasting indicators into early warning systems.
- Promote co-management models integrating Indigenous and scientific knowledge.
- Support intergenerational transmission of Indigenous Knowledge.

4.1 Study Limitations

Several limitations should be acknowledged. First, the study relied largely on self-reported perceptions, which may be influenced by recall bias and subjective interpretation.

Second, the cross-sectional design captured responses at a single point in time and therefore could not assess temporal changes in conflict patterns.

Third, the PLS-SEM model exhibited relatively weak measurement properties, particularly low internal consistency among some indicators, requiring cautious interpretation of structural relationships.

4.2 Future Research

Future studies should employ longitudinal approaches to examine how Indigenous Knowledge adapts to increasing climate variability and changing conservation policies.

Comparative studies across different pastoral ecosystems would also enhance understanding of contextual differences in Indigenous Knowledge application. Further research should additionally explore mechanisms for institutionalizing Indigenous Knowledge within wildlife governance frameworks while preserving its cultural integrity.

5.0 Conclusion

Indigenous Knowledge remains a critical and widely utilized system for managing drought-induced human-carnivore conflict among Maasai pastoralists in Olkiramatian and Shompole Conservancies.

The findings of this study demonstrated that Indigenous Knowledge contributes significantly to drought induced HCC mitigation, drought forecasting, and community-based governance. Integrating Indigenous Knowledge with formal conservation and climate adaptation frameworks offers opportunities to enhance resilience and promote sustainable human-carnivore coexistence.

Future conservation policies should recognize and strengthen Indigenous Knowledge systems as complementary components of effective wildlife governance.

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Conflict of Interest

The authors declare no competing interests.

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