

RESEARCH ARTICLE

Implications of human-nature interactions for livelihoods and conservation in Kasungu, Malawi

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Abstract

1. Effective conservation strategies require a comprehensive understanding of human-nature relationships, including the factors driving these interactions. Without this context, interventions risk being impractical or ineffective, potentially leaving both people and nature worse off.
2. We used mixed methods to understand human-nature interactions in Kasungu, Malawi. We specifically examined people's use of natural resources and perceptions of wildlife conservation and their implications for livelihoods and conservation.
3. Over 90% of participants reported collecting natural resources such as firewood, grass, medicinal plants and fruits to support their livelihoods. While most resources were collected for household use, some served both income generation and domestic purposes. Kasungu National Park plays a critical role in providing resources, though harvesting is illegal, alongside neighbouring farms and community forests. Households near the park, women and those of lower economic status were more likely to rely on the park for resources. Additionally, crop and livestock loss experiences were linked to higher resource collection rates.
4. Participants generally expressed positive attitudes towards wildlife and conservation. However, certain factors including proximity to the park, women, food insecurity, and crop and livestock loss were linked to negative attitudes.
5. Our findings offer valuable insights for the design and implementation of conservation initiatives and policies, particularly in communities heavily dependent on natural resources for their livelihoods. Conservation programmes and policies around protected areas should capitalise on the existing positive attitudes towards nature by fostering better community engagement. Locally led, inclusive and nature-positive programmes could simultaneously benefit conservation efforts and improve livelihoods.

KEYWORDS

conservation, food security, livelihoods, Malawi, natural resources use, people's perceptions

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1 | INTRODUCTION

The complex interactions between people and nature have been conceptualised as “nature's contributions to people” (NCP), (Díaz et al., 2015; Pascual et al., 2017). People have diverse perceptions on how nature contributes to their wellbeing, which may relate particularly to their use of natural resources (Fedele et al., 2021; Isbell et al., 2017; Pascual et al., 2017). Understanding these relationships is critical to developing practical, inclusive and effective biodiversity conservation policies and interventions, especially in rural areas where people and nature share landscapes (as in most African countries). Although the evidence may be limited on which aspects of nature contribute to people's well-being (Pett et al., 2016), as it is context-dependent (L'Roe et al., 2023; Sibanda, Van Der Meer, Hughes, et al., 2020; Vedeld et al., 2007), people's relationships with nature are complex and multifaceted.

People's actions, particularly those whose livelihoods depend on natural resources, may sometimes not align with conservation efforts (Karanth et al., 2019; Karanth & Ranganathan, 2018; Salerno et al., 2020). For example, for communities living close to conservation areas, the lack of benefits from conservation and human-wildlife conflicts that destroy property, including agricultural produce and livestock, are often associated with poor attitudes towards conservation and limited participation in nature conservation efforts (Htay et al., 2022; Meyer & Börner, 2022). These interactions influence people's decisions and actions and may lead to behaviours that conflict with conservation efforts, such as retaliatory killing of wildlife, protected area encroachment, noncompliance to rules and regulations and over-extraction of natural resources (Felix et al., 2022; Ihemezie et al., 2021; Jędrzejewski et al., 2017; Violaz et al., 2021).

Despite being one of the poorest countries in the world, Malawi has high levels of biodiversity endemism, and its agricultural-based economy heavily depends on rainfed agriculture (Davis et al., 2021, 2023; Kamanga et al., 2009; Kpienbaareh et al., 2022; van Velden et al., 2020). Expanding farmlands into conservation areas supports the country's food security needs and economic development but is a key concern for natural resource conservation (Phalan et al., 2011; Williams et al., 2021).

We used individual and key informant interviews and focus group discussions to examine human-nature interactions and the implications of such interactions for people's livelihoods and wildlife conservation in Kasungu, Malawi. Specifically, we looked at (i) people's use of natural resources as part of their livelihoods, and what factors influence this use; and (ii) people's perceptions towards wildlife and nature conservation, and factors associated with these perceptions. We defined perceptions as how a person observes, interprets and evaluates an experience, which is essential to understand because perceptions can influence how individuals assess the value of wildlife species and of conservation interventions (Boso et al., 2021; Sibanda, van der Meer, Johnson, et al., 2020).

1.1 | Theoretical framework: Nature's contribution to people

Nature's contribution to people (NCP), defined as “all the contributions, both positive and negative of living nature and their associated ecological and evolutionary processes, to people's quality of life (Figure 1)”, is a framework that is used to understand and communicate how ongoing biodiversity decline may affect the complex relationships between people and nature (Díaz et al., 2015; Peterson et al., 2018). NCP provides generalised and context-specific perspectives and analytical tools to represent nature-people interactions for different scales, audiences and decision-makers. It also recognises the complex interactions between human activities and decisions, such as land and resource use and land management, and nature's ability to support people's well-being and emphasises the importance of cultural context as a cross-cutting factor shaping human perceptions of nature (Bruley et al., 2021; Díaz et al., 2015; Managi et al., 2022). Understanding NCP can improve people's ability to manage ecosystems effectively, equitably and sustainably (Dressel et al., 2018; Managi et al., 2022). The framework has been applied in various studies (e.g. Cimatti et al., 2023; Dean et al., 2021; Martín-López et al., 2019; Smith et al., 2021). Its context-specific perspective highlights the diversity of framing of natural resources across different communities and geographies worldwide (Peterson et al., 2018).

This research focussed on perceptions and diverse uses of nature in Kasungu landscape in Malawi and sought to identify factors that influence these dynamics. Understanding factors affecting NCP is particularly important in highly biodiverse, low-income countries with high levels of nature dependence, as these countries urgently need to achieve development targets but are at high risk of unsustainable development projects that harm biodiversity and nature-dependent livelihoods (Pascual et al., 2017).

2 | METHODS

2.1 | Study system

Ranked as the second-largest district in Malawi, Kasungu is located in the country's central region and covers an area of 7878 km². The district has a population of 842,953, with an annual growth rate of 2.9% and a population density of 105 people per square kilometre (Davis et al., 2023). As an agricultural district, major crops include tobacco, maize, soybeans and groundnuts. The district has biodiversity-rich areas, including Kasungu National Park (Figure 2; Kpienbaareh et al., 2022). The park is a legally protected area covering 29% of the district's land (2316 sq. km) and is managed by the Government of Malawi (van Velden et al., 2020). It is designated an Important Bird Area and hosts over 380 elephants (*Loxodonta Africana*; Davis et al., 2023).

The park is bordered by communal land on the Malawian and Zambian sides, primarily used for subsistence and commercial farming.

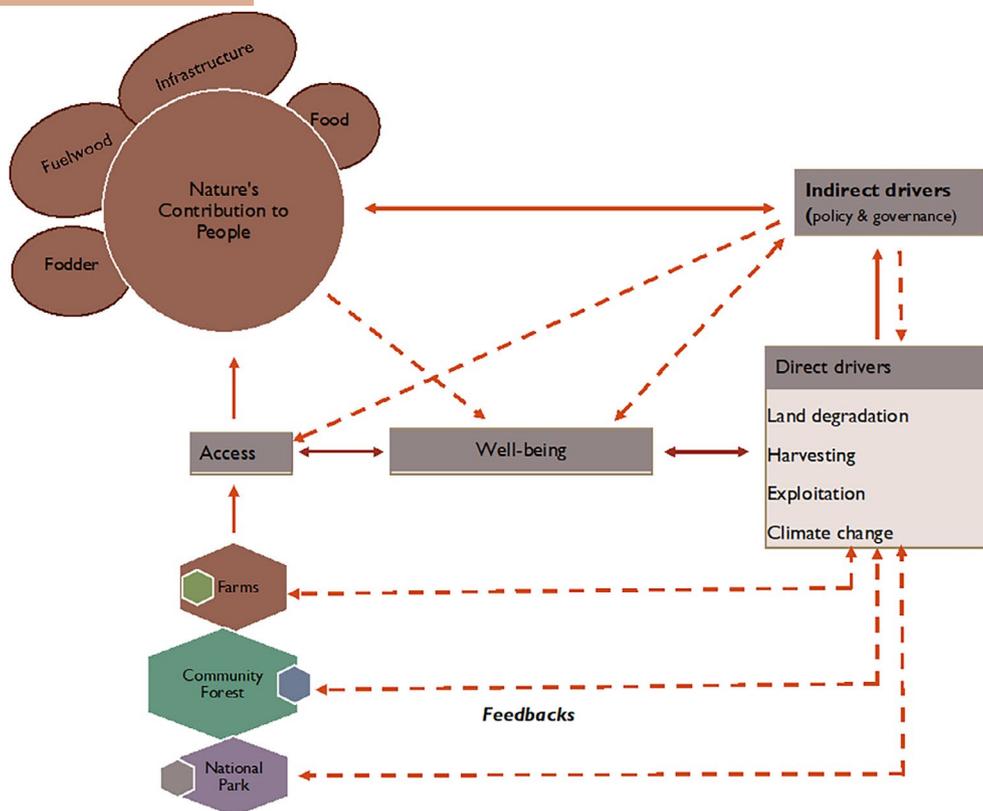


FIGURE 1 A modified framework for nature's contribution to people for Kasungu Landscape adapted from (IPBES, 2019). The dotted lines represent the feedback, and the solid lines and arrows represent the direct links. Nature contributes to the good quality of people's lives by providing beneficial NCP, including material, regulating and non-material contributions. Good quality of life includes access to basic materials, health, good social relationships, security and freedom of choice. Direct drivers of change are internal pressures of the system that alter the state of nature and people's quality of life. Anthropogenic direct drivers of change include land-use changes, which include agricultural expansion, climate change, species introductions and overexploitation of resources. Indirect drivers of change refer to those underlying causes of changes external to the social-ecological system, such as changes in the economy, demography, culture or lifestyles.

Over the years, communities have slowly occupied the park's buffer zone (the area between the park and settlements); hence, agricultural expansion is considered a significant threat to wildlife resources in the park (Davis et al., 2023). Due to reduced habitat availability and the park being mostly unfenced (only 67.5km of the Eastern boundary is fenced to mitigate crop-raiding by elephants), human-wildlife conflicts have been rising (Davis et al., 2023). As the study villages were located on the east side of the national park, and there was no entrance for tourists, the communities did not actively participate in tourism activities.

2.2 | Sampling and data collection

We selected the study villages based on their proximity to the park, accessibility and safety for the research team to test our hypotheses about how NCP vary according to a range of contextual factors (Table 1). To ensure the study reflected diverse perspective of NCP, we used mixed methods, applying a combination of semi-structured household interviews ($n=231$), key informant interviews ($n=18$), and focus group discussions

($n=16$) in eight villages. We targeted households that farm close to (within 5 km) and away from (5-15 km) the national park boundary and interviewed male and female household heads (aged 18-70) to get a representative sample. Participation in the study was entirely voluntary, with informed consent.

While we purposively sampled participants for the focus group discussions and key informant interviews based on their location, position in the community and gender, the participants for the household surveys were randomly selected by generating a household list for a particular village and choosing households using a random number generator. We conducted two focus group discussions in each village, one involving men only and the other women only, so each gender group could freely express themselves. We ensured community leaders were not part of the focus group discussions to reduce socio-cultural and power relations. We conducted women's focus group discussions in the afternoons, and men's in the morning so we would not interfere with their farming and household activities. Each focus group constituted about six to ten people to ensure thorough participation by everyone involved. Key informants included community leaders, National Park staff, farmers and agricultural extension officers.

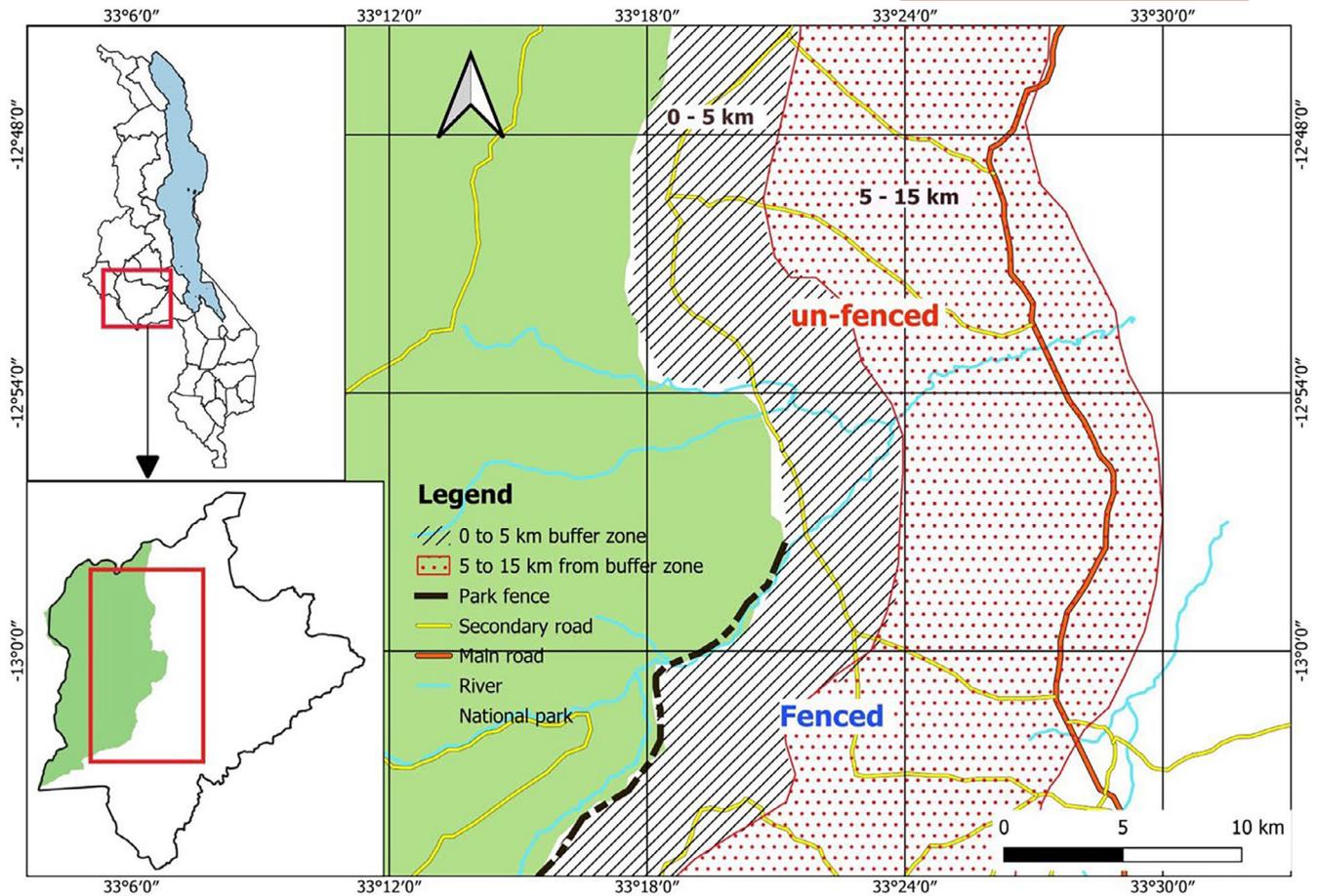


FIGURE 2 Map of Kasungu National Park. Study villages are not shown to preserve the anonymity of the respondents. However, we selected eight villages for study within four zones: (buffer zone 0 to 5 km from the park and away from the buffer zone between 5 to 15 km, next to both fenced and unfenced areas of the park).

We developed a semi-structured questionnaire in English based on information from the scoping study conducted before data collection and translated it into “Chichewa”, the local language. We piloted the questionnaire in one of the participating villages, ensuring that no one in the pilot was included in the study. We obtained permits and ethical clearance before undertaking the research. The Oxford University Research Ethics Committee (CUREC) (R79246/RE002) approved the study. The Malawi Department of National Parks and Wildlife issued a research permit (Ref: DNPW 10/10/14).

2.3 | Data analysis

We used R (V 4.1.2), (R Core Team, 2021) and the NVivo software packages (1.7.1) to analyse individual household questionnaires and identify themes in the data obtained from focus group discussions and key informant interviews, respectively. Following Braun and Clarke’s (2012) recommendations, we used inductive and deductive coding to develop themes and patterns and conduct thematic analysis. We developed codes based on the

research questions and emerging issues in the dataset. We then systematically collated the codes to develop themes we used to map our analysis.

The two broad outcome variables within the statistical analyses were natural resource use and positive perceptions towards conservation. The focal determinants of resource use and positive attitudes were, among others, proximity to the national park, gender, household wealth, and food insecurity (encompassing food-sufficient experiences as a continuum from worrying about not having enough to eat to reducing food consumption). These variables (Table 1) were determined by the literature of previous studies conducted and our knowledge of the study area during the scoping study conducted from February to March 2022. We used the Food Insecurity Experience Scale (FIES) developed by the Food and Agricultural Organization (FAO) to create a food insecurity variable. This is an experience-based metric of the severity of food insecurity that relies on people’s direct responses to a series of questions regarding their access to adequate food (Ballard et al., 2013; Pienkowski et al., 2023). We adjusted it to estimate peoples’ food insecurity experience over a farming season (12 months).

TABLE 1 The hypothesised associations between natural resource use, perceptions of wildlife and conservation, and explanatory variables in the regression analyses and their prior hypothesised effects.

| Explanatory variable | Predicted association | | |
|------------------------------|---|---|--|
| | Resource use | People's perception of wildlife/ conservation | Variable explanation |
| Age | No prior expectation. | Positive association. As age increases, one is more likely to have positive perceptions (Merz et al., 2023) | Age was recorded as the number of years of a person since birth. Continuous variable recorded as (years) |
| Gender | Women are more likely to collect resources from nature (Beyene et al., 2020; Karanth & Ranganathan, 2018). | Women are less likely to have positive perceptions towards wildlife and conservation (Carter & Allendorf, 2016; Merz et al., 2023) | Either Male or Female, (binary) |
| Location | People living close to nature collect and use more resources for their livelihoods (Angelsen et al., 2014; Nguyen et al., 2015) | People living close to nature have more positive perceptions towards nature because of the benefits obtained (Htay et al., 2022) | Distance from the household to the park boundary categorised as close (0–5 km), and away (5–10 km), (binary) |
| Education | No prior expectation | More education will be associated with more positive perceptions towards nature (Carter & Allendorf, 2016; Karanth et al., 2019) | The respondent's highest level of education, (ordinal) |
| Fence | No prior expectation. | People living on the fenced side are more likely to have positive perceptions due to having less human wildlife conflict (Beyene et al., 2020; Merz et al., 2023) | Location of the study village whether on the fenced or the unfenced park boundary, (binary) |
| Household wealth | Better-off households will collect fewer resources (Beyene et al., 2020; L'Roe et al., 2023) | Better-off households are more likely to have positive perceptions towards nature (Htay et al., 2022; Mogomotsi et al., 2020) | An asset index (continuous variable) |
| Food insecurity | People with high food insecurity scale will more likely collect natural resources (Barbier, 2010; Beyene et al., 2020; Fedele et al., 2021) | People with high food insecurity scale will more likely have negative perceptions towards nature due to crop raiding by wildlife (Htay et al., 2022) | Continuous variable derived from the Food Insecurity Experience (FIES) Scale |
| Farm size | Households with large farms will collect fewer resources (Meyer & Börner, 2022) | Households with large farms will have more positive perceptions towards nature (Fedele et al., 2021; Meyer et al., 2022) | Relative household farming size in acres |
| Crop loss from wildlife | High levels of crop loss will lead to high collection of natural resources (Angelsen et al., 2014; Börner et al., 2015) | High levels of crop loss will lead to negative perceptions towards nature (Htay et al., 2022; Meyer & Börner, 2022) | Quantity of crop produce lost in kilograms |
| Livestock loss from wildlife | Loss of livestock will lead to high collection of resources (Meyer & Börner, 2022) | High numbers of livestock loss will lead to negative perceptions towards nature (Htay et al., 2022) | Quantity of livestock loss in numbers |
| Livestock owned | Households with high numbers of livestock will be less likely collect resources from the park (Beyene et al., 2020; Meyer et al., 2022) | High number of livestock will be associated with positive perceptions towards nature (Htay et al., 2022; Meyer & Börner, 2022) | Quantity of livestock owned in numbers |

Note: For natural resource use, we examined three key resources in which there was variability in household use: Grass, firewood and fruits. Predictions are based on previous findings in the literature.

Asset ownership indicates household economic status (Hughes et al., 2020). We used the list of 20 common household assets to create an asset index, which we used as a proxy for household economic wealth. We used principal components analysis (PCA) to

reduce the dimensionality of the input variables and identify major factors related to household wealth (e.g. in Hughes et al., 2020; Nguyen et al., 2015). We weighted the assets based on average market prices to construct the PCA measures and assessed their

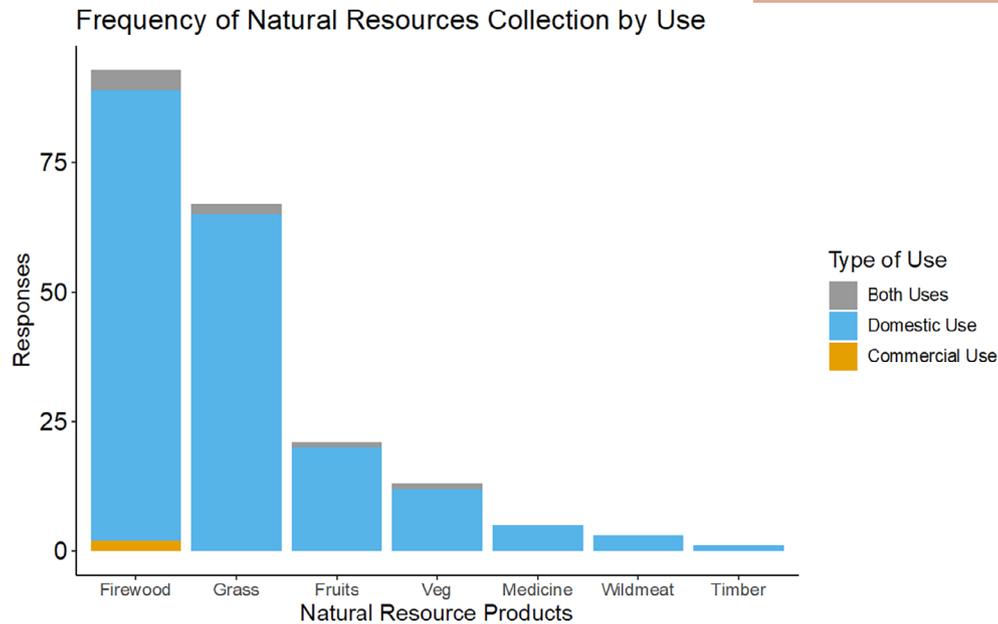


FIGURE 3 Resources used by study participants as measured by frequency of natural resource collection from the national park. The response number indicates households, which collect resources from the park, and the colours of the bars indicate the use of the resources. Blue indicates resources collected for domestic use, yellow indicates commercial use and grey indicates household and commercial uses. The word 'veg' in the natural resources products is shortened for vegetables.

inter-item correlation ($\alpha=0.73$). We included the first principal component (capturing 61% of the variance) in the logistic regression models as a wealth index.

Resource use data were recorded in ordinal categories (high and low); therefore, we used an ordinal regression model to determine the relationship between resource use and explanatory variables. We explored this for resources with high variation in use between respondents, such as firewood, grass and fruits.

To measure people's perceptions towards wildlife and conservation, we developed a set of nine questions on a 5-point Likert scale (strongly disagree=1 to strongly agree=5). We then selected six questions that showed high response variability. Having checked that they were congruent (Cronbach $\alpha=0.7$), we created a 'positive perceptions' index. As this was a continuous variable, we used it as the dependent variable in a general linear model (GLM). We tested the dependent variables for collinearity using variance inflation factors (VIF), and factors were not correlated (VIFs between 1 and 2). We used stepwise backward elimination and Akaike's information criterion (AICc) for model selection to check the models were not overfitted (Appendices A1–A3).

3 | RESULTS

3.1 | Sample characteristics

The mean age of study participants was 45, with males constituting 55% of the sample. Eighty per cent of the participants were married; the rest were widowed, divorced or separated. Female-headed households constituted 15% of the sample. Sixty per cent of the

participants lived in the buffer zone, and 52% in the fenced part of the park. The level of education varied between genders; men had attended more years of formal education than women. Most participants were Chewa ethnicity (83%), with other ethnic groups including Tumbuka (11.3%) and a mix of Yao, Ngoni and Lomwe (5.7%). Agriculture was the main livelihood activity, and the principal crops (in order of importance) were maize, soy, groundnuts and tobacco. Common livestock included chickens, owned by 47% of respondents, goats (22%) and pigs (20%). Other livestock included pigeons, rabbits and cattle, ducks and guinea fowls (11%).

3.2 | Natural resource use

Study participants used diverse natural resources such as firewood (46%), grass (33%), food including bushmeat, fruits and vegetables (19%), and medicinal plants (2%) to sustain their daily lives (Figure 3). These resources are collected from various places, including farms, community forests, household compounds and the national park. While firewood is used for their daily cooking, heating and other energy needs, the grass is used for grazing animals and constructing bathrooms, vegetable gardens and temporary dwelling houses in their farms (to live in when they guard their crops against wildlife during farming season). Timber is used for charcoal and brick production (for the kiln) and construction. When we asked participants about the collection of resources from the park, two people had the following to say.

The national park is the closest place to get herbs because that is where the ancestral trees with healing

TABLE 2 The resource collection best-fit model coefficients of variables tested with significant p -values for each selected resource. They include factors associated with people collecting firewood, grass and fruit from the national park.

| Variables | Grass use model | | | | Firewood use model | | | | Fruit use model | | | |
|-----------------------|---------------------|--------------|--------------|-------------|---------------------|--------------|-------------|-------------|---------------------|--------------|-------------|-------------|
| | Confidence interval | | | | Confidence interval | | | | Confidence interval | | | |
| | Estimate | Low | High | p -value | Estimate | Low | High | p -value | Estimate | Low | High | p -value |
| O 1 | 9.91 | 0.76 | 19.05 | 0.03 | 4.83 | 0.66 | 9.00 | 0.02 | 3.81 | -0.98 | 8.59 | 0.12 |
| Age | -0.03 | -0.08 | 0.02 | 0.26 | -0.01 | -0.04 | 0.02 | 0.53 | 0.04 | -0.01 | 0.08 | 0.13 |
| Gender [Male] | 0.59 | -0.66 | 1.85 | 0.36 | -0.08 | -1.01 | 0.85 | 0.87 | -1.08 | -2.35 | 0.19 | 0.09 |
| Location [Close] | 2.56 | 0.88 | 4.25 | 0.00 | -0.41 | -1.36 | 0.55 | 0.40 | 0.03 | -1.15 | 1.21 | 0.96 |
| Fence [Unfenced] | -1.38 | -2.73 | -0.03 | 0.05 | 0.51 | -0.45 | 1.46 | 0.30 | 0.26 | -1.03 | 1.55 | 0.69 |
| Education [Primary] | 0.42 | -2.88 | 3.73 | 0.80 | 3.04 | -0.18 | 6.27 | 0.06 | -0.99 | -2.84 | 0.86 | 0.29 |
| Education [Secondary] | -0.80 | -4.67 | 3.08 | 0.69 | 3.24 | -0.15 | 6.64 | 0.06 | -0.30 | -2.68 | 2.07 | 0.80 |
| Maize loss | 2.86 | 0.78 | 4.94 | 0.01 | 0.10 | -1.52 | 1.71 | 0.91 | 1.49 | -0.51 | 3.49 | 0.14 |
| Soybeans loss | 1.03 | -1.15 | 3.21 | 0.35 | 0.26 | -1.60 | 2.12 | 0.78 | -0.31 | -2.09 | 1.47 | 0.73 |
| Groundnuts loss | 3.00 | 0.90 | 5.11 | 0.01 | 0.54 | -1.54 | 2.62 | 0.61 | -0.94 | -2.68 | 0.79 | 0.29 |
| Livestock loss | 2.22 | 0.86 | 3.59 | 0.00 | -0.84 | -1.84 | 0.15 | 0.10 | -0.35 | -1.55 | 0.84 | 0.56 |
| Food insecurity | -0.03 | -0.25 | 0.19 | 0.81 | 0.03 | -0.13 | 0.19 | 0.71 | 0.00 | -0.20 | 0.20 | 0.98 |
| Wealth index | -0.08 | -0.24 | 0.09 | 0.35 | 0.00 | 0.00 | 0.00 | 0.64 | 0.00 | -0.03 | 0.02 | 0.69 |
| Other resources | 4.21 | 2.84 | 5.57 | 0.00 | 5.74 | 3.58 | 7.91 | 0.00 | 1.55 | 0.89 | 2.22 | 0.00 |
| Livestock owned | -0.67 | -1.58 | 0.25 | 0.15 | 0.06 | -0.50 | 0.63 | 0.83 | -0.43 | -1.29 | 0.44 | 0.34 |
| Farm size [Medium] | 0.14 | -3.31 | 3.59 | 0.94 | 0.43 | -2.40 | 3.27 | 0.76 | -1.47 | -4.08 | 1.14 | 0.27 |
| Farm size [Small] | -0.32 | -3.59 | 2.94 | 0.85 | 0.67 | -2.05 | 3.39 | 0.63 | -1.12 | -3.50 | 1.26 | 0.36 |

Note: Significant levels are denoted by '0.1' for very low, 0.01 for intermediate level and '0.001' for high level. Variables with relative importance are in bold, red font indicates a negative correlation, and blue indicates a positive correlation factor.

powers are. Even if I want to go to the modern hospitals, I cannot afford it since it requires a lot of money to get to town to seek medical attention from the government hospitals. It is worse to leave this place during the rainy season because most rivers are full. Even children stop going to school because it is too dangerous to cross the rivers.

(Female respondent, buffer zone, unfenced)

Because we have increased in numbers, the demand for firewood has also increased, and most of the trees we had are gone. It is only now that we are planting trees because our sources of firewood are dwindling, and the punishment when found harvesting firewood from the park has also increased.

(Male responded, non-buffer zone, unfenced)

Respondents reiterated that resource collection from the park is decreasing because the national park authorities have introduced an anonymous informant system for people to get compensation for reporting illegal harvests from the park.

Nowadays, when you are caught harvesting bushmeat, you either pay 12 million kwacha [approx. USD

7000] or spend 36 years in jail. Imagine, for example, if I go to jail for harvesting an animal as small as a pangolin that will take me less than a week to finish, then I have to spend 30 years in jail. My children will grow and marry without me and even have their own children while I am away. So, it is not worth the trouble, although other people are still risking it.

(Male respondent, buffer zone, fenced)

Using any resource significantly correlated with using another natural resource (Table 2). For example, if people collect firewood ($p < 0.00$, 95% CI: 3.6–7.9), they were likely to use the same opportunity to collect fruits ($p < 0.00$, 95% CI: 0.9–2.2), grass ($p < 0.00$, 95% CI: 2.8–5.6) and other resources. While males were less likely to collect fruits ($p < 0.01$, 95% CI: -2.4–0.2), older people were more likely to collect fruits than others ($p < 0.01$, 95% CI: -0.0–0.1).

People who lived close to the national park ($p < 0.00$, 95% CI: 0.9–4.3) and who had experienced crop ($p < 0.1$, 95% CI: 0.8–4.9) and livestock loss ($p < 0.00$, 95% CI: 0.9–3.6) collected grasses more than others. Livestock ownership ($p < 0.1$, 95% CI: -1.6–0.25) and household wealth ($p < 0.1$, 95% CI: 0.1–0.4) showed a negative correlation with grass collection, indicating that economically well-off people are less likely to collect these resources. People with formal education were more likely to collect firewood than others ($p < 0.1$, 95% CI: -0.18–6.27).

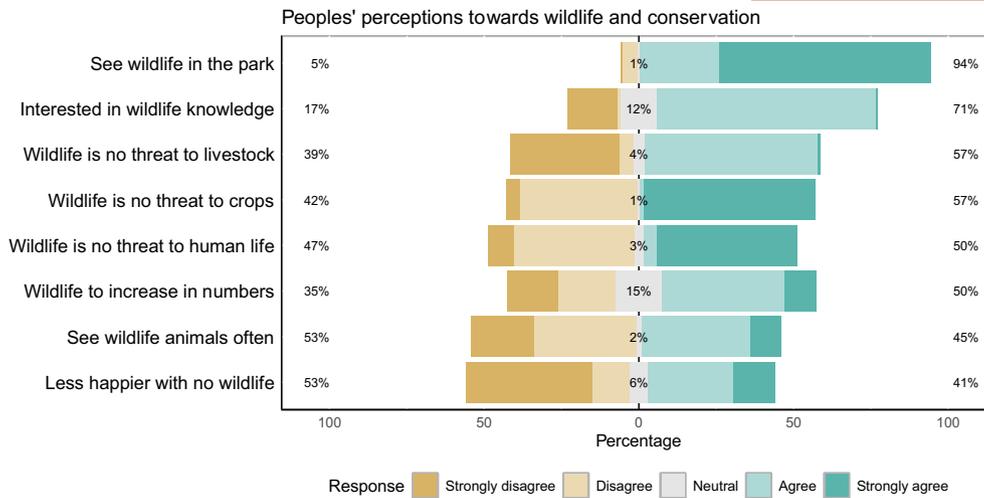


FIGURE 4 Graph summarising people's attitudes towards wildlife and conservation in the participating villages. The right green side shows the positive attitudes, and the left yellow side shows the negative attitudes. The white middle part indicates neutral.

3.3 | People's perceptions of wildlife and conservation

We observed overall positive perceptions towards wildlife and conservation among the communities. For example, over 90% of participants were interested in seeing animals in the national park, and 71% were interested in gaining wildlife knowledge (Figure 4). Two of them had the following to say.

It would be great to see the wildlife inside their natural habitat, not only when they have come to our village, and people are either chasing or running from them.

(Male respondent, away from the park, unfenced)

Most times when we are offered to go see animals in the national park, we are asked to pay very high bus fares and arrange food, which becomes very expensive since we have to use the main gate, which is very far. So, seeing wildlife in the park would be wonderful.

(Female respondent, away from the park, fenced)

Positivity towards an increase in wildlife numbers and interest in seeing wildlife more often were relatively balanced between respondents. Fifty-seven per cent of households agreed that wildlife was a threat to their livestock, but interestingly, respondents from focus group discussions had balanced views on this topic:

As much as they bring forex [Foreign revenues] in the country, these animals, especially elephants, are very dangerous. I am glad to see them occasionally, but not

often. When they want to eat your crops, they can finish the whole farm in one night.

(Female respondent, away from the park, fenced)

I am not sure if I want the animals to increase in their numbers because, as it is, we only harvest what is left after the elephants, bush pigs, and monkeys have taken what they can. Now I no longer use that land, I have decided to rent a farm in the neighbouring village.

(Female respondent, buffer zone unfenced)

Attitudes varied based on gender, location, resource use and food insecurity experience (Figure 5). For example, men showed more positive attitudes than women ($p < 0.1$, 95% CI: 0.0–0.2), and collecting natural resources from the park was linked to positive attitudes ($p < 0.1$, 95% CI: –0.0–0.1). Living close to the park ($p < 0.00$, 95% CI: –0.3–(–0.1)), experiencing food insecurity ($p < 0.01$, 95% CI: –0.0–(–0.1)), and losing crops ($p < 0.01$, 95% CI: –0.2–(–0.0)) and livestock ($p < 0.1$, 95% CI: –0.1–0.01) were associated with negative attitudes.

Discussions of solutions to protect crops and livestock from wildlife depredation revealed varied responses. For example, a focus group discussion with communities close to the park suggested that the fence be extended along the boundary to cover the rest of the eastern boundary where most communities farm. There was, however, worry for some people that the fence would restrict their access to resources in the park. We could not assess the balance of opinion due to the nature of the discussion and that resource extraction is illegal.

Since positive attitudes towards wildlife and conservation were negatively correlated with crop and livestock losses (experienced by 82% and 45% of participants, respectively), we explored factors

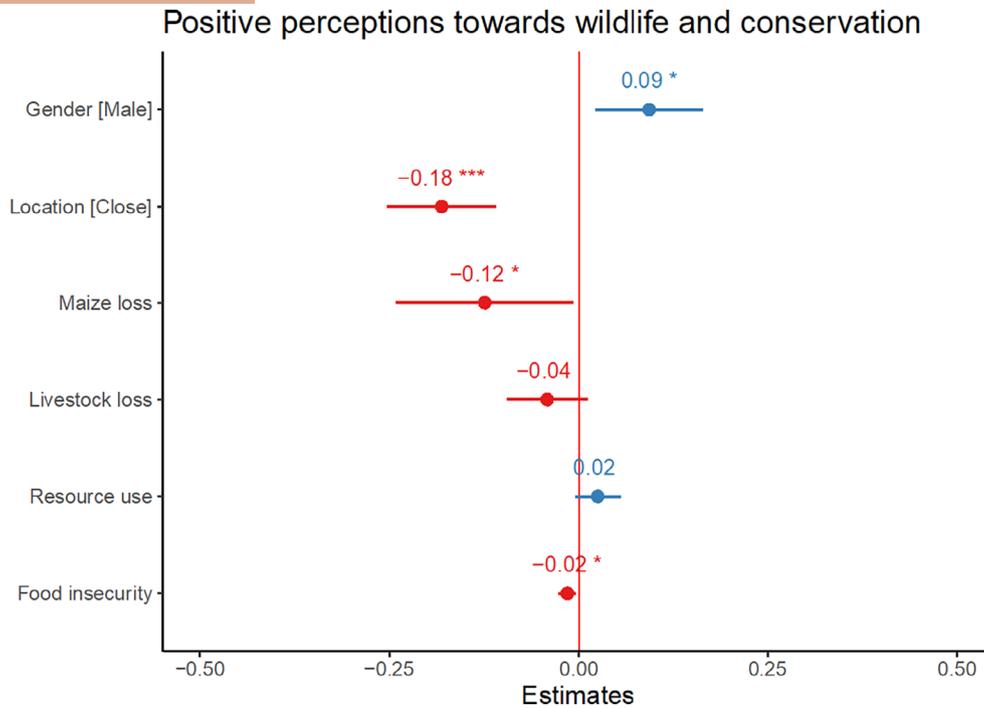


FIGURE 5 Results of a general linear regression model for perceptions towards wildlife and conservation. The red numbers indicate a negative association, the blue numbers indicate a positive association, and the stars indicate a significance level.

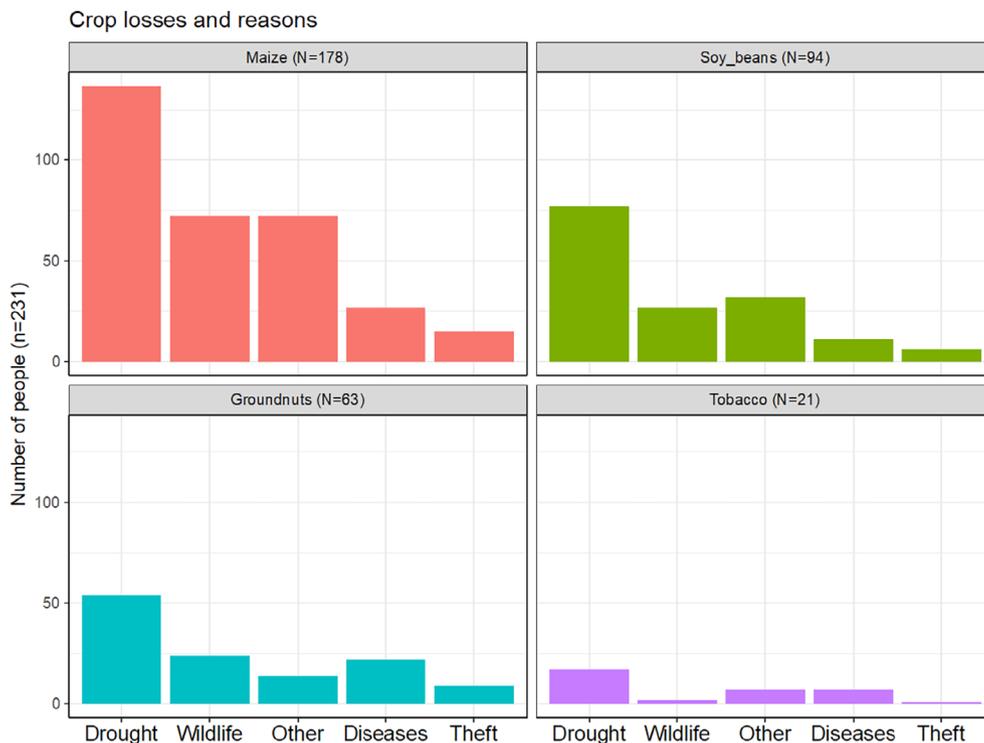


FIGURE 6 Graph showing the number of people (N) reporting crop losses as a result of various factors in the study area. Drought was the main reason for most crop losses, seconded by wildlife and other reasons.

relate to the losses (Figures 6 and 7). Maize was the most affected (indicated by 77% of respondents), followed by soybeans (40%), groundnuts (27%) and tobacco (9%). Crop losses due to drought were high across all crops, followed by wildlife predation, diseases

and theft. Other reasons for crop losses were input-related challenges such as lack of fertiliser.

Loss of chickens were the highest among all livestock (indicated by 83% of the respondents) followed by pigs (26%) and goats (24%).

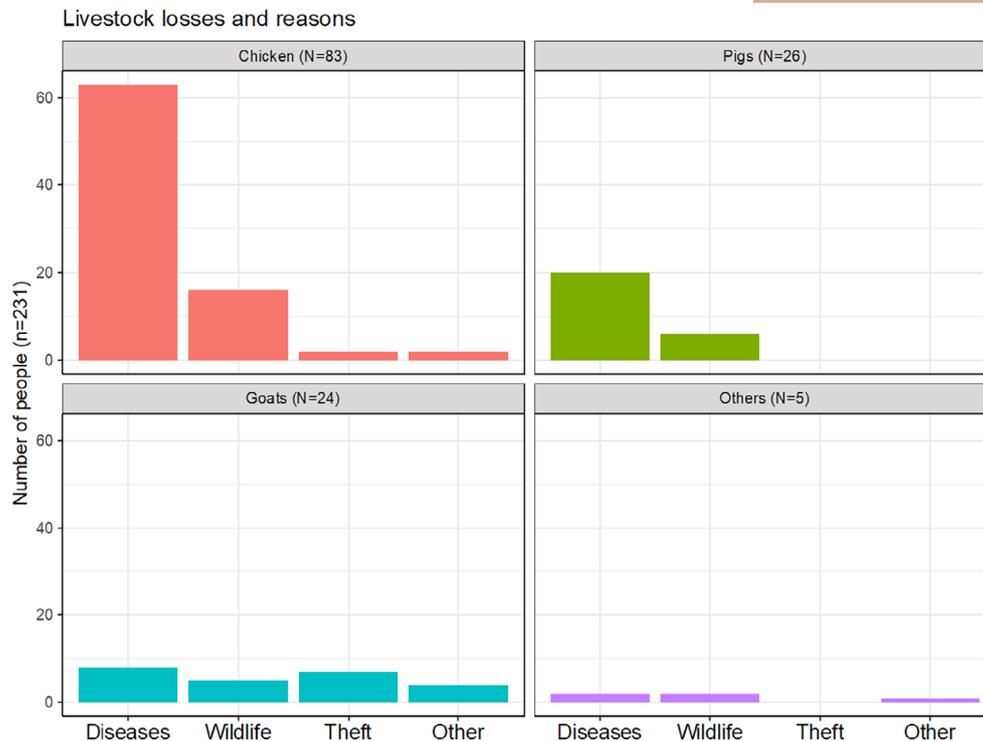


FIGURE 7 Graph showing the number of people (N) reporting livestock losses as a result of various factors. Losses due to diseases were top, followed by wildlife, theft and other reasons, including poisoning.

Diseases were the main reason for the losses, followed by wildlife predation, theft and other reasons.

Our results revealed that even though wildlife was an essential cause of crop and wildlife losses, diseases and drought were as pertinent and led to significant losses.

4 | DISCUSSION

4.1 | Factors influencing households' natural resource collection

We demonstrate that, in Kasungu landscape, natural resources are collected mainly for domestic purposes. Although the resources are sourced from various places, Kasungu National Park is an essential source of natural materials for people's social and economic well-being. This is commonly the case with communities close to conservation areas although in some areas access can be restricted (Angelsen et al., 2014; Beyene et al., 2020; Meyer & Börner, 2022; Shackleton & Shackleton, 2006; Vedeld et al., 2007). While previous research highlighted the contribution of income from forest resources (Angelsen et al., 2014; Kamanga et al., 2009; Nguyen et al., 2015; Wunder et al., 2014); in our case, most participants indicated household use except for firewood, grass and fruits, which were used for both household consumption and income. The association between resource dependence and poverty was also reported by L'Roe et al. (2023), Fedele et al. (2021) and Barbier (2010). This suggests that, even though conservation policies restrict people's

access to the national park, it contributes significantly to rural livelihoods. Therefore, it is important that conservation policies consider conserving wildlife while supporting nature's contributions to people's livelihoods (e.g. Díaz et al., 2015).

Collection of resources is highly gendered (Beyene et al., 2020; Karanth & Ranganathan, 2018; Thondhlana et al., 2012), and as predicted, our case was no different, as women were more likely to collect natural resources compared to men. As women are mostly household caretakers with limited access to the market, they tend to rely more on non-market products including natural resources from the park to meet household food security needs (Beyene et al., 2020; Karanth & Ranganathan, 2018).

As predicted (Table 1), better-off people were less likely to collect resources from the park, particularly grass. The implication is that people with a higher wealth index will have various sources of income rather than depending on the park's resources. The linkage of resource use and socioeconomic and demographic factors was also reported by L'Roe et al. (2023), Meyer et al. (2022), Vedeld et al. (2007) and Beyene et al. (2020). Fedele et al. (2021) also characterised highly resource-dependent people as having high poverty rates, limited market access and strong ties to nature.

We found a positive association between resource collection and crop and livestock loss, suggesting that people who have experienced crop and livestock loss were likely to collect resources. Natural resources have been known to provide a safety net to shocks such as low agricultural yield, especially for poor rural households (Angelsen et al., 2014; Börner et al., 2015; Fedele et al., 2021).

4.2 | Factors influencing perceptions of wildlife and conservation

People's perceptions towards wildlife and conservation were generally positive, which is consistent with most studies (e.g. Karanth et al., 2019; Karanth & Ranganathan, 2018; Merz et al., 2023; Mkanda, 1995; Mogomotsi et al., 2020). This suggests that there is room to enhance collaboration between institutions and local people and improve the prospects for conserving wildlife species and reducing habitat loss (Merz et al., 2023). However, having positive attitudes does not guarantee positive behaviour (Biru et al., 2017; Htay et al., 2022; Yosef, 2015), as in this case, people still illegally harvest resources from the park. Factors including gender, closeness to the park, food insecurity experience and crop and livestock loss, among others, influenced attitudes towards wildlife and conservation in the landscape reflecting linkage of various socio-demographics to attitudes towards conservation (Merz et al., 2023; Mogomotsi et al., 2020).

Contrary to our initial prediction, negative perceptions were more likely registered to people living within 5 km for the park. This can be attributed to the cost associated with living in proximity to dangerous wildlife which is higher than the potential benefits (De Boer & Baquete, 1998; Merz et al., 2023). The negative perceptions were also observed among participants who experienced food insecurity, crop and livestock loss, as was previously reported by Htay et al. (2022) and Meyer and Börner (2022). Although harvesting any resource is illegal, people who harvested resources from the park registered positive attitudes towards conservation. This could reflect the benefits of harvesting resources in the park, as observed by Biru et al. (2017), Htay et al. (2022) and Merz et al. (2023).

We were surprised to find no association between household wealth and positive perceptions even though the association of economic well-being and positive perception was previously reported by Ochieng et al. (2021) and Mogomotsi et al. (2020). The premise that better off people potentially have a diversity of income streams and/or savings that can cushion them against the economic shocks from crop and livestock depredation by wildlife may not hold in our study area. This confirms the complex and multifaceted nature of attitudes and perceptions towards nature and conservation.

The contribution of gender to conservation attitudes was significant. As predicted, women were more likely to have negative attitudes as compared to men (Carter & Allendorf, 2016; Karanth et al., 2019; Karanth & Ranganathan, 2018; Merz et al., 2023). Several reasons could explain this. First, studies have suggested that unfavourable attitudes of women towards wildlife could be attributed to a greater apprehension about dangerous species (Carter & Allendorf, 2016). Due to household gender dynamics and responsibilities, women are in constant contact with the environment, which increases the risk of encountering dangerous animals in the landscape (Merz et al., 2023; Ochieng et al., 2021). Second, the kinship system towards land tenure is patriarchal. This means males own land and usually dominate decisions at household and community levels, and these could include involvement in different conservation initiatives (Ochieng et al., 2021). Therefore, power relations

and access to conservation opportunities could affect women's social well-being, leading to low trust in conservation institutions and wildlife conservation.

4.3 | Study limitations

Our study had limitations, which may impact our analysis, interpretations and conclusions. Our analysis was primarily based on information provided by the respondents, with the potential for reporting bias. For example, Malawi's conservation policies, which restrict access to national parks, may have influenced the data collected regarding resource use from the national park. The first author spent substantial time in the village building trust, and we have no reason to think that people were being untruthful, however we recommend that future studies make use of other methods of collecting sensitive data such as indirect questioning methods (Hinsley et al., 2019; Nuno & St. John, 2014).

Recent escalation in human-wildlife conflicts, which have led to tensions between local communities and national park authorities, are likely to have affected people's responses regarding their perceptions of wildlife and conservation (e.g. Davis et al., 2023). Human-nature interactions in Malawi are heavily influenced by seasons due to agricultural seasons and wildlife patterns. Because our study was conducted in one season of the year, it may not have captured the variations across the seasons, limiting our study's broader applicability despite our asking the respondents to consider their interactions with nature broadly and not just in that season. Recognising these limitations, findings from this study are not generalisable to areas with different socio-political and environmental conditions.

4.4 | Local and global implications of the study

Our findings underscore the complex relationship between communities near conservation areas and their surrounding environment, highlighting both the heavy dependence on natural resources and the communities' positive attitudes towards nature and wildlife conservation. This relationship is shaped by several social, ecological and economic variables such as gender, food security and household wealth, which must be considered in conservation strategies.

We have shown that communities around Kasungu national park rely significantly on forest resources, to a larger extent for household hold consumptions and sometimes for income. This underscores the critical role of these resources in sustaining local livelihoods, and current exclusionary policies limiting access to these resources may jeopardise both local livelihoods and long-term conservation goals. For example, the illegality of resource extraction complicates efforts to collect accurate data on usage levels, hindering the design of effective interventions. To address this, it is essential to integrate the contributions of natural resources into Malawi's conservation policy and intervention design (Díaz et al., 2015; Dressel et al., 2018). This includes developing participatory structures tailored to Kasungu's specific

context, informed by social-ecological studies to ensure inclusivity and local support. Although implementing community driven conservation policies has several challenges including power dynamics (as most conservation areas in Malawi including Kasungu National park are managed by the government with support from international organisations), many communities lack financial and technical capacity to effectively manage conservation projects (e.g. Meyer & Börner, 2022); it is important that programmes are put in place to deliberately bridge these gaps while ensuring that external interventions do not undermine local priorities. These complexities underline the need for adaptive and participatory approaches that address the socio-economic and political dynamics of community based conservation.

Additionally, given the community's dependence on natural resources, there is a need for initiatives that promote off-farm employment, reduce resource extraction and support alternative livelihoods while managing potential trade-offs for conservation and human-wildlife conflict risks (Fedele et al., 2021; Meyer & Börner, 2022). Gender-sensitive programmes that enhance returns from farming and other livelihood activities are particularly important.

While crop and livestock losses due to depredation were frequently reported, losses from drought and disease were even more significant. With the human population in the area continuing to grow (van Velden et al., 2020), the demand for natural resources is likely to increase unless effective mitigation strategies are implemented. Potential solutions include improving market access for farmers to maximise returns on their produce (Beyene et al., 2020), promoting drought-resistant crops and expanding veterinary services to reduce agricultural losses. Addressing high population growth through family planning initiatives and youth education programmes is another critical priority.

Targeted compensation programmes could provide relief for the most vulnerable community members and, when combined with other strategies, help mitigate negative human-wildlife interactions. Effective engagement with local communities is crucial to leveraging their positive attitudes and fostering locally led conservation initiatives. Simplistic solutions, such as fencing or punitive measures against resource harvesting, may provide short-term relief but are unlikely to promote long-term stewardship of natural resources. Instead, sustainable solutions require re-evaluating and updating current policies to reflect local realities, ensuring they are inclusive, practical and adaptable to changing socioeconomic and environmental conditions.

Our study offers valuable global insights into human-nature interactions and the role of nature in supporting livelihoods. Socioeconomic factors were found to strongly influence both resource use and attitudes towards conservation, emphasising the need for programmes that integrate poverty alleviation and economic incentives (Meyer & Börner, 2022). Additionally, these relationships vary with proximity to protected areas, suggesting that one-size-fits-all conservation strategies are unlikely to succeed. Instead, localised approaches tailored to the unique environmental, social and economic contexts of individual communities are essential.

Conservation policies that restrict resource access risk alienating local communities, leading to negative perceptions and non-compliance. To achieve sustainable conservation and livelihood

outcomes, policies must adopt inclusive approaches that involve local communities in decision-making and acknowledge the essential contributions of nature to their daily lives.

AUTHOR CONTRIBUTIONS

Lessah Mandoloma, Michael Clark, Lauren Coad, Karl Hughes and E. J. MilnerGulland conceptualised ideas and designed the methodology. Lessah Mandoloma collected and analysed the data. Lessah Mandoloma wrote the manuscript which was revised by all co-authors.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

Due to the sensitivity of the information gathered, the interview data are not publicly accessible. Readers seeking further details can reach out to the lead author.

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APPENDIX 1

Appendix A1: Resource use models diagnostics: Goodness-of-fit test

We used McFadden pseudo R-squared value to get insights into the goodness of fit for the resource use models (firewood, grass and fruits). McFadden's framework:

$$R^2 = 1 - \frac{\log - \text{likelihood of full model}}{\log - \text{likelihood of null model}}$$

Firewood model

R-squared value of 0.57 indicated that approximately 57% of the variability in the dependent variable (Fuelwood collection) is explained by the model. This suggests a reasonably good fit for the logistic model, as McFadden pseudo R-squared values

between 0.2 and 0.4 are often considered to represent an excellent fit for categorical or ordinal regression models (McFadden, 1974).

Grass collection model

The R-squared value of 0.71, suggests that the model explains about 70% of the variability in the data. This suggests a great fit for the model.

Fruit collection model

The R-squared value of 0.397, indicated that the model explains approximately 40% of the variability in the response variable. While not as high, this value still reflects a moderate level of explanatory power since a value of around 0.4 suggests that the model captures some meaningful patterns in the data.

APPENDIX A2: LINEAR REGRESSION MODELS FOR POSITIVE PERCEPTIONS TOWARDS WILDLIFE AND CONSERVATION

| Positive perceptions linear regression models | | | | | | | | | | | | |
|---|------------------------|-------------|-----------|------------|---------|--------------|----------------------------|-------------|-----------|------------|---------|--------------|
| Variables | Perceptions full model | | | | | Significance | Perceptions_best_fit_model | | | | | |
| | Estimate | Conf. level | Conf. low | Conf. high | p value | | Estimate | Conf. level | Conf. low | Conf. high | p value | Significance |
| Age | -0.002 | 0.950 | -0.005 | 0.001 | 0.189 | | | | | | | |
| Gender male | 0.094 | 0.950 | 0.019 | 0.170 | 0.013 | * | 0.094 | 0.950 | 0.022 | 0.165 | 0.010 | * |
| Education Primary | -0.068 | 0.950 | -0.218 | 0.078 | 0.363 | | | | | | | |
| Education Secondary | -0.072 | 0.950 | -0.246 | 0.100 | 0.411 | | | | | | | |
| Location close | -0.185 | 0.950 | -0.261 | -0.109 | 0.000 | *** | -0.181 | 0.950 | -0.253 | -0.109 | 0.000 | *** |
| Fence unfenced | -0.037 | 0.950 | -0.113 | 0.040 | 0.344 | | | | | | | |
| HH_size | 0.005 | 0.950 | -0.010 | 0.020 | 0.558 | | | | | | | |
| Farm_size Medium | 0.056 | 0.950 | -0.159 | 0.261 | 0.603 | | | | | | | |
| Farm_size Small | 0.099 | 0.950 | -0.108 | 0.296 | 0.336 | | | | | | | |
| Maize_loss | -0.142 | 0.950 | -0.269 | -0.015 | 0.027 | * | -0.124 | 0.950 | -0.242 | -0.007 | 0.037 | * |
| Soybeans_loss | 0.025 | 0.950 | -0.109 | 0.160 | 0.719 | | | | | | | |
| Gnuts_loss | 0.028 | 0.950 | -0.109 | 0.165 | 0.687 | | | | | | | |
| Livestock_loss | -0.037 | 0.950 | -0.094 | 0.021 | 0.206 | | -0.042 | 0.950 | -0.095 | 0.012 | 0.121 | |
| Livestock_owned | -0.013 | 0.950 | -0.060 | 0.035 | 0.599 | | | | | | | |
| Resource_use | 0.025 | 0.950 | -0.008 | 0.059 | 0.131 | | 0.025 | 0.950 | -0.005 | 0.055 | 0.105 | |
| Wealthindex | 0.000 | 0.950 | 0.000 | 0.000 | 0.477 | | | | | | | |
| Food_insecurity | -0.016 | 0.950 | -0.028 | -0.004 | 0.012 | * | -0.015 | 0.950 | -0.027 | -0.004 | 0.011 | * |

APPENDIX A3: AIC FOR THE POSITIVE PERCEPTION MODELS

| Positive perceptions model selection based on AIC | | | | | | |
|---|-------|--------|------------|--------|--------|---------|
| Models | K | AICc | Delta_AICc | AICcWt | Cum.Wt | LL |
| Positive perceptions (best fit) | 8.00 | 472.97 | 0.00 | 1 | 1 | -228.16 |
| Positive perceptions (full model) | 19.00 | 490.76 | 17.79 | 0.00 | 1.00 | -224.58 |

Lower AIC value indicate better model fit with fewer predictors.