

Article

Does the Community Conservancy Model Work for Pastoralists? Insights from Naibunga Conservancy in Northern Kenya

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Abstract: Community conservancies are increasingly being established across African pastoral rangelands to help bolster wildlife conservation and livelihoods. Enhancing the effectiveness and sustainability of such conservancies requires better understanding of local community participation and perceptions of their socioeconomic outcomes. Working in Naibunga Community Conservancy in northern Kenya, we evaluated: (1) local community members' perceptions of conservancy-related socioeconomic outcomes; (2) their involvement in conservancy management and conservation activities; and (3) association between these factors (perceptions and involvement) and various demographic factors. We conducted surveys in 358 households, selected using multi-stage sampling, and additionally interviewed key informants. Large proportions (65–90%) respondents perceived conservancy-related improvements in their overall socioeconomic status, security, household income, livestock numbers, and accessibility to grazing resources, schools, and health facilities. Over 75% of respondents indicated that they were involved in conservancy management and conservation activities. Involvement in these activities was positively associated with perception of socioeconomic improvements. In addition, various demographic factors shaped both perceptions of socioeconomic changes and involvement in conservancy activities. Our findings suggest that community conservancies can improve local pastoralists' socioeconomic wellbeing. Such conservancies can achieve far greater outcomes with greater focus on maximizing socioeconomic benefits for local pastoralists and enhancing their participation in conservancy activities.

Keywords: African savanna rangelands; biodiversity conservation; community-based conservation; community conservancy; land degradation; pastoralists' livelihoods; pastoralism; sustainable land management practices



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1. Introduction

Despite a twofold global increase in government-protected conservation areas over the past five decades, such protected areas are considered too small and highly isolated to support viable populations of wildlife [1,2]. Consequently, large proportions of the world's wildlife are found outside government-protected areas [2,3]. In East Africa, for example, it is estimated that 70% of wildlife populations are dispersed outside government-protected areas, mostly on community and private lands [4–6]. However, wildlife populations have been rapidly dwindling in these areas [1], partly due to increased land degradation, habitat loss, and increased human–wildlife conflicts.

The continued decline in wildlife populations has made it necessary for national and international support towards engaging communities and private landowners who live with wildlife in efforts to sustainably conserve biodiversity and support community livelihoods [7,8]. This engagement typically encompasses the involvement of local communities in conservation (community-based conservation) as an alternative approach to wildlife conservation in recognition of the costs the communities living with wildlife suffer [9]. In particular, considerable efforts have been directed towards promoting and facilitating the

establishment of community conservancies to bolster conservation of wildlife on communal pastoral lands [8,9]. Consequently, many pastoral rangelands have been transformed into community conservancies where pastoralism and biodiversity conservation are jointly pursued through collaborative, decentralized arrangements for managing communal lands and natural resources [10]. Such conservancies are thought to act as a catalyst for wildlife conservation, environmental rehabilitation, resource conflict resolution, and sustainable livelihood development for local pastoralist communities [6,8,11–14].

In northern Kenya, a community conservancy typically develops a natural resource management plan that encompasses participatory land zoning, designating zones for core conservation, livestock grazing, and human settlement [6]. Under this plan, sustainable land and grazing management practices such as planned grazing and rangeland restoration activities are implemented [10,12]. In addition, pastoralists often trade off some of their traditional pastoral practices for management practices that incorporate wildlife conservation and wildlife-based tourism [13]. For example, the creation of conservation zones under the conservancy model reduces livestock grazing areas and restricts access to areas that pastoralists once relied on for livestock forage [14]. Additionally, many pastoralists and agro-pastoralists have had to contend with heightened human–wildlife conflicts in various forms, including increased livestock depredation by carnivores, injuries to humans inflicted by wildlife, crop-raiding by wild herbivores, competition for pasture and water, and transmission of zoonotic parasites and diseases [15].

From the foregoing, community conservancies can have potentially significant socioeconomic implications for local pastoralists' socioeconomic wellbeing as well as for the conservation of natural resources. However, the actual implications of such conservancies on the socioeconomic wellbeing of the local pastoralist communities remain poorly understood. Understanding such implications is important for enhancing socioeconomic effectiveness and the sustainable management of community conservancies for biodiversity conservation and livelihoods. In addition, it is important to understand the extent to which local pastoralists are involved in conservancy management and conservation programs because local participation is a key determinant of successful implementation of community-based conservation initiatives [16,17]. In this study, we investigated local perceptions of the socioeconomic outcomes of a community-based conservancy in northern Kenya. We also assessed local participation in conservancy management and conservation activities. Finally, we evaluated the interaction between local community members' perceptions of conservancy-driven socioeconomic outcomes and their involvement in conservancy management and conservation activities, and how each of these factors is shaped by various demographic factors.

2. Materials and Methods

2.1. Study Area

The study was conducted in Naibunga Community Conservancy (hereafter, “Naibunga Conservancy”) located in Laikipia County, Kenya (Figure 1). Naibunga Conservancy lies within longitude 36°5′–37°15′ and latitude 0°20′ N–0°35′ N. The conservancy comprises nine community group ranches: Koiya, Kijabe, Tiamamut, Il Motiok, Nkiloriti, Munishoi, Musul, Il Polei, and Murupusi. It covers a total area of 47,740 hectares of land.

Naibunga Conservancy experiences relief or orographic rainfall due to its altitude and location. It receives 400–700 mm of rainfall annually. Rainfall is typically distributed in two seasons: the long rains, between April and June, and the short rains, between October and December. The annual mean temperature ranges between 16 °C and 26 °C [18].

Naibunga Conservancy is largely characterized by savanna vegetation with varying densities of woody vegetation. The herbaceous layer is comprised of perennial grasses such as *Themeda triandra*, *Eragrostis tenuifolia*, *Cenchrus ciliaris*, *Aristida congesta*, and numerous species of forbs. The woody species layer comprises of trees and shrubs including whistling thorn acacia (*Acacia drepanolobium*), wait-a-bit thorn (*Acacia mellifera*), mgunga (*Acacia etbaica*), prickly thorn (*Acacia brevispica*), and white crossberry (*Grewia tenax*) [19].

Some areas have also been encroached by unpalatable weeds such as *Sansevieria intamida*, *Opuntia* spp., and *Ipomea* spp. which have significantly reduced important grazing areas [20].

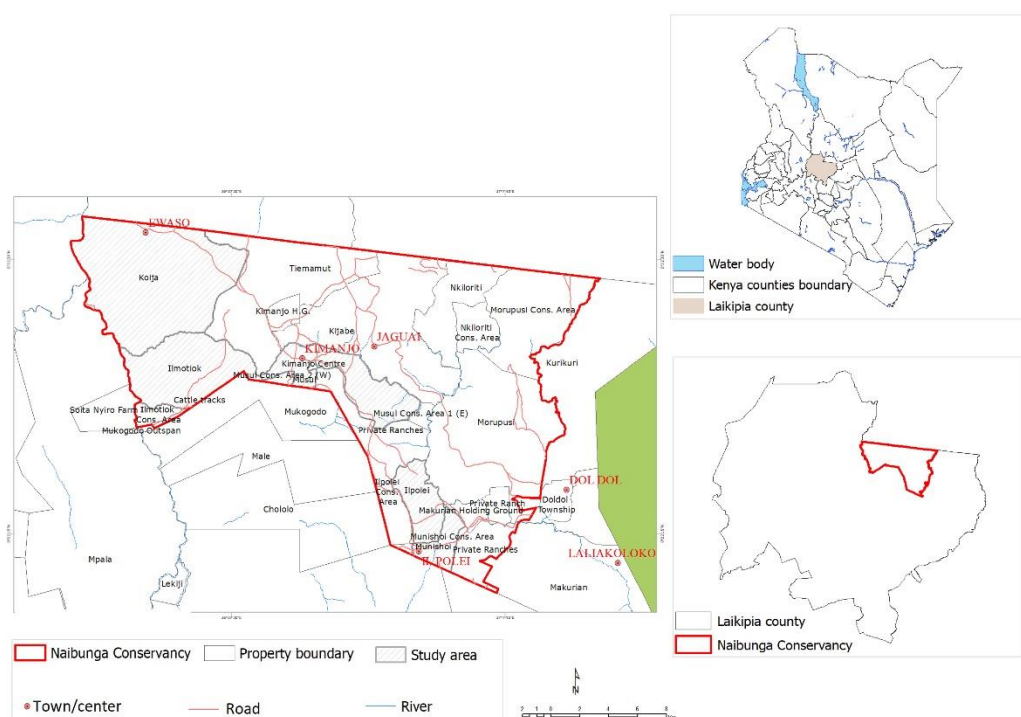


Figure 1. Map of Naibunga Conservancy in Laikipia County, Kenya. Source: This study.

The area is an important home and a migratory corridor for elephants. It also hosts several other wild mammals, including plains zebras, Grevy's zebras, gerenuks, warthogs, dik-diks, impalas, gazelles, hippos, buffaloes, African wild dogs, hyenas, and lions, underscoring the ecological importance of the conservancy [6,21].

Livestock rearing, primarily through pastoralism, and wildlife-based tourism are the major socioeconomic activities in the area. Other socioeconomic activities include charcoal burning, small-scale businesses, sand extraction, subsistence farming, beekeeping, and subsistence hunting [21,22].

2.2. Study Design and Data Collection

We collected data through household surveys and key informant interviews during January–February 2021. For household surveys, we used a multi-stage sampling strategy to select households to be included in the study. First, five out of the nine group ranches that constitute Naibunga Conservancy were randomly selected: Koiya, Il Motiok, Musul, Munishoi, and Murupusi. Transect walks/drives were then conducted in randomly selected settlements areas in each of the selected group ranches with every household encountered selected for the study. A total of 358 households proportionately distributed among the five selected group ranches based on their population size were included in the study. Structured questionnaires were used to collect data from the selected households, with household heads or their suitable adult representatives as the respondents. The questionnaires were administered face-to-face by trained enumerators drawn from the local communities.

Through the household surveys, we collected data on the respondents' perception of conservancy-related changes in their overall socioeconomic status and various other socioeconomic indicators, namely, average household income, ownership and herd size of different livestock types, security situation, status of roads, and accessibility to grazing resources, water, health facilities, schools, and electricity. The indicators were adopted from the World Bank Poverty Framework, which views socioeconomic status as a com-

plex product of the opportunities available to a household, the security under which such opportunities are exploited, and the empowerment level a household or community possess [23]. We also sought to find out whether, and to what extent (number of hours per week), respondents were involved in the management and conservation activities implemented by the conservancy. In addition, we collected data on various demographic factors including gender, formal education, household size (i.e., number of individuals per household), occupation, main source of livelihood, ownership of different livestock types (cattle, sheep and goats (combined), camels, and donkeys), and livestock herd size (i.e., number of animals by livestock type). The levels of the various factors assessed during household surveys are detailed in Table A1.

We employed key informant interviews to collect qualitative data. The key informants included the chairpersons of the five selected group ranches (one per group ranch) and four leaders of the conservancy's land management committees. The key informants were interviewed on the conservancy's socioeconomic development, management and conservation strategies, initiatives, and programs. In addition, we sought key informants' opinions on conservancy-related socioeconomic outcomes for local community members, with emphasis on local livelihoods, security situation, and accessibility to water, forage resources, schools, and health facilities.

2.3. Data Analysis

We analyzed quantitative data using Statistical Package for Social Sciences (SPSS) statistical software version 26 [24]. We used descriptive statistics (percentages and counts) to summarize these data. Chi-square tests were used to test for association between various categorical variables. Specifically, we tested for association between local perceptions of conservancy-related socioeconomic outcomes and involvement in conservancy management and conservation activities. We also tested for association between gender and education. In addition, we tested for association between each of selected demographic attributes (gender, education, household size, livestock ownership, and herd size) and respondents': (1) perception of conservancy-related socioeconomic outcomes; and (2) involvement in conservancy management and conservation activities. For multi-level factors, we sometimes combined levels for better interpretation or when doing so was necessary to satisfy the Chi-square test of association's assumption of at least 80% of cells having expected count values not lower than 5 [25]. The levels of each factor used in these Chi-square tests are specified in Table A1. We accepted statistical significance at $p < 0.05$.

We analyzed qualitative data from key informant interviews using thematic analysis. Specifically, we grouped and summarized qualitative data under three main themes: (1) the conservancy's strategies to enhance the socioeconomic wellbeing of local community members; (2) the conservancy's strategies and initiatives for local community participation in conservancy management and conservation activities; and (3) the socioeconomic outcomes of the conservancy's socioeconomic development and conservation strategies, initiatives, and programs.

3. Results

3.1. Demographics

A majority (61.2%) of the respondents were males (Figure 2a). Overall, a slight majority (54%) of the respondents had no formal education (Figure 2a). Of those who had formal education, the majority (61.3%) had primary education, whereas 25.8% and 12.9% had secondary and tertiary education, respectively. Notably, there was a significant association between education level and gender, with males generally being more educated than females ($\chi^2 = 11.9$, $p = 0.008$; Figure 2a).

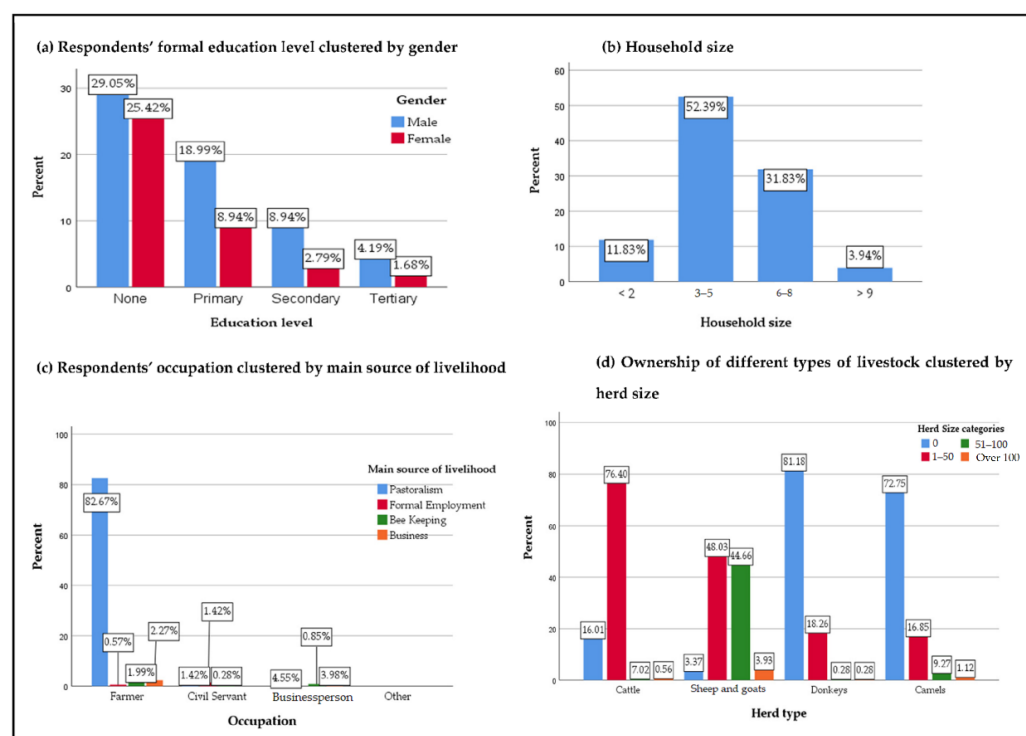


Figure 2. Respondents' various demographic attributes.

In terms of household size, slightly more than one half of the sampled households had 3–5 individuals, whereas 31.8%, 11.8%, and 3.9% of the households were comprised of 6–8, <3, and >9 individuals, respectively (Figure 2b). Farming was the main occupation; 87.7% of the respondents reported that they were farmers (Figure 2c). All other respondents not involved in farming were either businesspersons (9.2%) or civil servants (3.1%) (Figure 2c). An overwhelming majority (82.4%) of the respondents who indicated that they were farmers practiced pastoralism as their main source of livelihood (Figure 2c). Most (76.4%) of the sampled households owned 50 or fewer cattle (Figure 2d). In addition, 48% and 44.7% of them owned 1–50 and 51–100 small stock (sheep and goats), respectively (Figure 2d). Donkeys and camels were relatively less common as more than 72% of the sampled households owned neither of these livestock types (Figure 2d).

3.2. Conservancy-Related Socioeconomic Outcomes

Nearly 90% of the respondents perceived that the conservancy had improved their overall socioeconomic status (Table 1). Analysis of other socioeconomic attributes revealed that the security situation, accessibility to grazing resources, household income, and accessibility to schools improved the most, with more than 72% of the respondents perceiving improvements in these attributes. In the second tier were improvements in accessibility to health facilities and livestock numbers, with 66.1% and 65.3% of the respondents perceiving improvements in these attributes, respectively (Table 1). Moderate proportions (52.9% and 53.5%) of the respondents perceived improvements in the status of roads and accessibility to water, whereas only slightly more than 25% of the respondents perceived improved accessibility to electricity (Table 1). Based on livestock type, high proportions (67–70%) of respondents perceived increases in the number of cattle and sheep and goats, whereas only 22.1% and 8.1% of respondents perceived increases in camel and donkey numbers, respectively (Table 1).

Table 1. Respondents' perceptions of conservancy-related changes in various socioeconomic indicators.

	Increased/ Improved		No Change		Decreased/ Deteriorated	
	Freq.	%	Freq.	%	Freq.	%
How socioeconomic status changed generally	293	89.6	28	8.6	6	1.8
How livestock numbers changed	233	65.3	93	26.1	31	8.7
How cattle numbers changed	250	70.0	75	21.0	32	9.0
How goat/sheep numbers changed	240	67.2	62	17.4	55	15.4
How camel numbers changed	79	22.1	261	73.1	17	4.8
How donkey numbers changed	29	8.1	292	81.8	36	10.1
How the average household income changed	269	75.4	35	9.8	53	14.8
How accessibility to water changed	189	52.9	101	28.3	67	18.8
How accessibility to health facility changed	236	66.1	106	29.7	15	4.2
How accessibility to schools changed	258	72.3	92	25.8	7	2.0
How status of roads changed	191	53.5	103	28.9	63	17.6
How accessibility to grazing resources changed	275	77.0	29	8.1	53	14.8
How accessibility to electricity changed	92	25.8	252	70.6	13	3.6
How security status changed	293	82.1	13	3.6	51	14.3

Key informant interviews revealed increased employment opportunities for local community members under the community conservancy setting. For example, through collaboration between the community conservancy and the Northern Rangelands Trust (NRT), an umbrella membership organization for community conservancies in the region, local community members get employed as conservancy managers, community scouts (rangers), and grazing coordinators. Key informants also indicated that through partnership with NRT and other stakeholders, members of the conservancy benefit from improved access to livestock markets through initiatives such as “Livestock to Market” (LTM) and “livestockWORKS” [26,27]. They further noted that these initiatives have helped minimize reliance on exploitative middlemen, thereby enabling local pastoralists to maximize profits from livestock sales. In addition, the key informants revealed that through partnership with various stakeholders, the conservancy has improved market access for local women's handicraft products. The key informants further revealed that under the conservancy, various youth groups are usually trained on financial management prior to accessing credit facilities such as savings and credit co-operatives (SACCO) loans for entrepreneurship. Further, the key informants indicated that local conservancy members benefit from increased livestock productivity due to conservancy-related improvements in ecological conditions coupled with increased access to grazing resources.

Regarding security, the key informants revealed that through partnership with NRT, the conservancy has employed community scouts, who conduct community patrols to help maintain security. In addition, the key informants indicated that the conservancy has a functional conflict resolution committee, which “has immensely contributed to timely response in case of attacks by cattle rustlers, and mediation of any misunderstanding”. Explaining the impact of insecurity, one key informant said, “Insecurity has been costing us our livestock and grazing resources. We have frequently suffered incursions from Isiolo and Samburu. When they attack one area of the conservancy, there is always a shift in (grazing) pressure from the insecure areas to secure areas. For example, the current insecurity situation in Tiamamut has shifted (grazing) pressure into Musul, Koiya, and Il Motiok leading to scarce grazing resources in those areas”.

However, the key informants indicated that the security situation has generally improved across the conservancy due to conservancy-led security enhancement efforts. The key informant further observed, “however, the situation is not as bad as it was before, we now have improved security and with improved security, we at least have enough grazing resources for ourselves as our community patrol teams on many occasions have foiled such attacks before they happen. In addition, National Police Reservists have helped a lot as they collaborate with Administration Police to respond timely to any insecurity situation”.

Concerning accessibility to water, the key informants indicated that although the conservancy has helped increase the number of water pans across the landscape, accessibility to water remains a challenge because such water pans dry up almost immediately when the dry season sets in. They also noted that water scarcity is one of the biggest problems facing local community members, who are often forced to walk for long distances in search of water. One of the key informants opined, “water is not enough as we share the same with our livestock and wildlife, particularly elephants”. However, the key informants indicated that the conservancy currently has a water committee charged with managing and rehabilitating existing water points.

The key informants indicated that one way in which the conservancy enhances accessibility to schools is providing bursaries to needy students. Regarding accessibility to health facilities, the key informers revealed that the conservancy from time to time helps offset hospital bills for needy community members.

3.3. Local Community Involvement in Conservancy Management and Conservation Activities

Slightly more than 75% of the respondents reported that they were involved in conservancy management and conservation activities (Figure 3). An overwhelming majority (82.2%) of them reported an involvement level of 1–10 h per week, whereas only 10.8% and 7.1% reported involvement levels of 11–20 h and over 20 h, respectively (Figure 3).

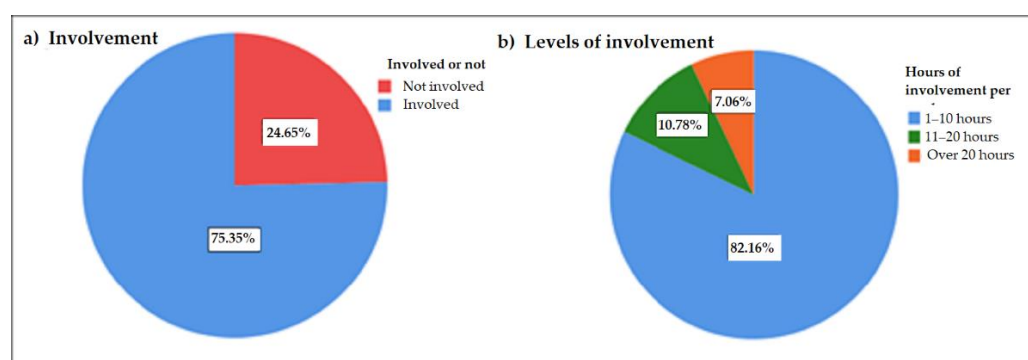


Figure 3. Respondents' involvement in community conservancy management and conservation activities.

Key informants listed various rangeland management programs that community members were involved in, namely, holistic management (community-based planned rotational grazing), rehabilitation of water points, soil erosion control, grass reseeding, control of invasive species such as *Opuntia* and *Sansevieria* spp., and participatory land zoning programs. The key informants further indicated that most of these activities are carried out in collaboration with NRT and other organizations in the region. For instance, through partnership with NRT, the community conservancy established various green houses across communal group ranches from which a *Cochineal* fungus, used as a biological control of the invasive plant *Opuntia* spp. is cultured.

According to key informant interviews, community members also participate in conservancy management and conservation programs in various other ways including active participation in management decision-making through various committees such as business, grazing and water committees, and through conservancy annual meetings. Key informants also indicated that local participation in these committees is important for ensuring that conservancy members influence management decisions. In addition, they revealed that under the community conservancy setting, community members are regularly trained to strengthen their capacity to participate more effectively in conservancy management and conservation activities.

3.4. Associations between Perceived Socioeconomic Outcomes, Involvement in Conservancy Management and Conservation Activities, and Demographic Factors

Respondents' perception of conservancy-driven change in their overall socioeconomic status was significantly associated with their involvement in conservancy management and conservation activities ($\chi^2 = 83.5, p < 0.001$; Table 2). Specifically, a higher-than-expected proportion of respondents who perceived improvement in their overall socioeconomic status were involved in these activities (Table 2). Conversely, lower than expected proportions of respondents who perceived either no change or a decrease in their overall socioeconomic status were involved in these activities (Table 3). These patterns were similar for nearly all other socioeconomic indicators (all $\chi^2 > 6.1, p < 0.048$; Table 2). The only exception was that respondents' perception of conservancy-related change in donkey numbers was not significantly associated with their involvement in conservancy management and conservation activities ($\chi^2 = 2.9, p = 0.232$; Table 2).

Perception of conservancy-related change in socioeconomic status was also associated with various demographic factors, namely, household size, cattle ownership, camel ownership, and sheep and goat herd size (all $\chi^2 > 9.5, p < 0.016$; Table 3). Specifically, a higher-than-expected proportion of respondents from households with fewer (1–5) members perceived that their socioeconomic status had improved since conservancy establishment, and vice versa (Table 3). Similarly, higher than expected proportions of respondents with cattle, those with camel and those with no more than 50 sheep and goats reported conservancy-related socioeconomic status improvement, and vice versa. However, perception of overall socioeconomic status change was associated with neither gender nor formal education ($\chi^2 < 0.3, p > 0.178$; Table 3).

Analyses of association between specific socioeconomic indicators and demographic factors revealed mixed results (Appendix A Tables A2–A10). Of note, there was an association between gender and perception of change in accessibility to grazing resources; a higher-than-expected proportion of female respondents perceived improved accessibility to these resources, whereas the reverse was the case for male respondents ($\chi^2 = 15.7, p < 0.001$; Table A2). Of further note, both cattle ownership and camel ownership were positively associated with perceptions of improvements in security status, livestock numbers, household income, and accessibility to health facilities (all $\chi^2 > 7.0, p < 0.03$; Tables A5 and A8). We noted similar association patterns for ownership of sheep and goats, but these results did not meet one of the requisite assumptions of the Chi-square test (Table A6). Camel ownership also associated positively with perception of improved access to forage resources ($\chi^2 = 6.7, p = 0.035$; Table A8). Conversely, cattle ownership was negatively associated with perceived improvements in accessibility to water and status of roads ($\chi^2 = 6.5, p = 0.038$; Table A5). However, cattle herd size was not significantly associated with any of the socioeconomic indicators (all $\chi^2 < 3.2, p > 0.192$; Table A9).

Local involvement in conservancy management and conservation activities was associated with several demographic factors (all $\chi^2 > 4.5, p < 0.034$; Table 4). Specifically, higher than expected proportions of female respondents, respondents with formal education, and those from households with fewer (1–5) individuals reported that they were involved in these activities (Table 4). Conversely, lower than expected proportions of male respondents, respondents with no formal education, and respondents from larger households were involved in these activities (Table 4). In addition, higher than expected proportions of respondents who owned cattle, those who owned camels, and those with no more than 50 sheep and goats indicated that they were involved in conservancy management and conservation activities (Table 4). In contrast, lower than expected proportions of respondents with no cattle, those with no camels, and those with more than 50 sheep and goats, were involved in these activities (Table 4).

Table 2. Chi-square tests for association between respondents' perceptions of conservancy-related socioeconomic outcomes and their involvement in conservancy management and conservation activities. Values in parentheses are expected counts.

		Involvement				χ^2	<i>p</i> -Value
		Involved		Not Involved			
		Freq.	%	Freq.	%		
How socioeconomic status changed generally	Increased/Improved	243 (221.3)	82.9	50 (71.7)	17.1	84.1	<0.001
	No change	4 (21.1)	14.3	24 (6.9)	85.7		
	Decreased/Deteriorated	0 (4.5)	0.0	6 (6.0)	100.0		
How livestock numbers changed	Increased/Improved	204 (179.5)	87.6	29 (53.5)	12.4	41.0	<0.001
	No change	53 (71.6)	57.0	40 (21.4)	43.0		
	Decreased/Deteriorated	18 (23.9)	58.1	13 (7.1)	41.9		
How cattle numbers changed	Increased/Improved	218 (192.6)	87.2	32 (57.4)	12.8	51.0	<0.001
	No change	37 (57.8)	49.3	38 (17.2)	50.7		
	Decreased/Deteriorated	20 (24.6)	62.5	12 (7.40)	37.5		
How goat/sheep numbers changed	Increased/Improved	203 (184.9)	84.6	37 (55.1)	15.4	31.0	<0.001
	No change	32 (47.8)	51.6	30 (14.2)	48.4		
	Decreased/Deteriorated	40 (42.4)	72.7	15 (12.6)	27.3		
How camel numbers changed	Increased/Improved	78 (60.9)	98.7	1 (18.1)	1.3	28.5	<0.001
	No change	187 (201.1)	71.6	74 (59.9)	28.4		
	Decreased/Deteriorated	10 (13.1)	58.8	7 (3.9)	41.2		
How donkey numbers changed	Increased/Improved	26 (22.3)	89.7	3 (6.7)	10.3	2.9	0.232
	No change	221 (224.9)	75.7	71 (67.1)	24.3		
	Decreased/Deteriorated	28 (27.7)	77.8	8 (8.3)	22.2		
How the average household income changed	Increased/Improved	236 (207.2)	87.7	33 (61.8)	12.3	78.7	<0.001
	No change	21 (27.0)	60.0	14 (8.0)	40.0		
	Decreased/Deteriorated	18 (40.8)	34.0	35 (12.2)	66.0		
How accessibility to water changed	Increased/Improved	155 (145.6)	82.0	34 (43.4)	18.0	6.1	0.047
	No change	74 (77.8)	73.3	27 (23.2)	26.7		
	Decreased/Deteriorated	46 (51.6)	68.7	21 (15.4)	31.3		
How accessibility to health facility changed	Increased/Improved	198 (181.8)	83.9	38 (54.2)	16.1	27.1	<0.001
	No change	63 (81.7)	59.4	43 (24.3)	40.6		
	Decreased/Deteriorated	14 (11.6)	93.3	1 (3.4)	6.7		
How accessibility to schools changed	Increased/Improved	220 (198.7)	85.3	38 (59.3)	14.7	39.6	<0.001
	No change	49 (70.9)	53.3	43 (21.1)	46.7		
	Decreased/Deteriorated	6 (5.4)	85.7	1 (1.6)	14.3		
How status of roads changed	Increased/Improved	175 (147.1)	91.6	16 (43.9)	8.4	49.4	<0.001
	No change	62 (79.3)	60.2	41 (23.7)	39.8		
	Decreased/Deteriorated	38 (48.5)	60.3	25 (14.5)	39.7		
How accessibility to grazing resources changed	Increased/Improved	226 (211.8)	82.2	49 (63.2)	17.8	24.5	<0.001
	No change	22 (22.3)	75.9	7 (6.7)	24.1		
	Decreased/Deteriorated	27 (40.8)	50.9	26 (12.2)	49.1		
How accessibility to electricity changed	Increased/Improved	87 (70.9)	94.6	5 (21.1)	5.4	28.1	<0.001
	No change	175 (194.1)	69.4	77 (57.9)	30.6		
	Decreased/Deteriorated	13 (10.0)	100.0	0 (3.0)	0.0		
How security status changed	Increased/Improved	244 (225.7)	83.3	49 (67.3)	16.7	43.5	<0.001
	No change	10 (10.0)	76.9	3 (3.0)	23.1		
	Decreased/Deteriorated	21 (39.3)	41.2	30 (11.7)	58.8		

Table 3. Chi-square tests of association between respondents' perceptions of conservancy-related socioeconomic outcomes and various demographic factors. Values in parentheses are expected counts.

		Changes in Overall Socioeconomic Status					
		Improved		Not Improved		χ^2	<i>p</i> -Value
		Freq.	%	Freq.	%		
Gender	Male	178 (179.2)	89.0	22 (20.8)	11.0	0.2	0.654
	Female	115 (113.8)	90.6	12 (13.2)	9.4		
Education level	No formal education	154 (157.7)	87.5	22 (18.3)	12.5	1.8	0.179
	Formal education	139 (135.3)	92.1	12 (15.7)	7.9		
Household size	1–5	192 (184.4)	93.2	14 (21.6)	6.8	8.2	0.004
	6 and above	98 (105.6)	83.1	20 (12.4)	16.9		
Own cattle?	Yes	258 (245.4)	94.2	16 (28.6)	5.8	38.7	<0.001
	No	34 (46.6)	65.4	18 (5.4)	34.6		
Own sheep and goats?	Yes	286 (283.0)	90.5	30 (33.0)	9.5	9.7	0.002
	No	6 (9.0)	60.0	4 (1.0)	40.0		
Own donkeys?	Yes	55 (55.5)	88.7	7 (6.5)	11.3	0.1	0.805
	No	237 (236.5)	89.8	27 (27.5)	10.2		
Own camels?	Yes	91 (81.5)	100.0	0 (9.5)	0.0	14.7	<0.001
	No	201 (210.5)	85.5	34 (24.5)	14.5		
Number of cattle	1–50	236 (236.3)	94.0	15 (14.7)	6.0	0.1	0.750
	51 and above	22 (21.7)	95.7	1 (1.3)	4.3		
Number of sheep and goats	1–50	142 (139.4)	92.2	12 (14.6)	7.8	1.0	0.314
	51 and above	144 (146.6)	88.9	18 (15.4)	11.1		

Table 4. Chi-square tests of association between respondents' involvement in conservancy management and conservation programs and various demographic factors. Values in parentheses are expected counts.

		Involvement					
		Involved		Not Involved		χ^2	<i>p</i> -Value
		Freq.	%	Freq.	%		
Gender	Male	160 (168.7)	73.1	59 (50.3)	26.9	5.1	0.025
	Female	115 (106.3)	83.3	23 (31.7)	16.7		
Education level	No formal education	141 (149.4)	72.7	53 (44.6)	27.3	4.6	0.033
	Formal education	134 (125.6)	82.2	29 (37.4)	17.8		
Household size	1–5	191 (175.7)	84.1	36 (51.3)	15.9	16.4	<0.001
	6 and above	83 (98.3)	65.4	44 (28.7)	34.6		
Own cattle?	Yes	239 (230.1)	79.9	60 (68.9)	20.1	9.3	0.002
	No	35 (43.9)	61.4	22 (13.1)	38.6		
Own sheep and goats?	Yes	263 (264.8)	76.5	81 (79.2)	23.5	1.5	0.219
	No	11 (9.2)	91.7	1 (2.8)	8.3		
Own donkeys	Yes	46 (51.6)	68.7	21 (15.4)	31.3	3.2	0.073
	No	228 (222.4)	78.9	61 (66.6)	21.1		
Own camels?	Yes	88 (74.7)	90.7	9 (22.3)	9.3	14.2	<0.001
	No	186 (199.3)	71.8	73 (59.7)	28.2		
Number of cattle	1–50	215 (217.4)	79.0	57 (54.6)	21.0%	1.5	0.224
	51 and above	24 (21.6)	88.9	3 (5.4)	11.1%		
Number of sheep and goats	1–50	140 (130.7)	81.9	31 (40.3)	18.1%	5.5	0.019
	51 and above	123 (132.3)	71.1%	50 (40.7)	28.9%		

4. Discussion

4.1. Conservancy-Related Socioeconomic Outcomes

Socioeconomic outcomes are important in determining the success or failure of community-based conservation initiatives because local community members will likely support initiatives that improve their socioeconomic wellbeing and shun those that they deem non-beneficial to them [28–31]. In the present study, we found that a vast majority (~90%) of local community members perceived improvement in their socioeconomic status following conservancy establishment. We also found that large proportions (>65%) of community members perceived conservancy-related improvements in several other socioeconomic indicators, namely, security situation, access to grazing resources, household income, access to educational and health facilities, and livestock numbers. These findings generally suggest that the community conservancy model, as applied in our study region, can improve the socio-economic wellbeing of local pastoralists.

The observed high proportion of respondents reporting perceived improvement in security situation is consistent with a recent evaluation in northern Kenya indicating that nearly eight-tenths of conservancy members felt safer due to security enhancement and peace-building efforts undertaken by conservancies [26]. In our study region and similar pastoralist settings across sub-Saharan Africa, local communities commonly suffer from various forms of insecurity including livestock theft (e.g., through cattle raiding), wildlife poaching, banditry, invasions and illegal grazing, and conflict over natural resources [12,32–34]. Persistent insecurity threatens pastoralists' socioeconomic wellbeing by impairing their ability to participate more effectively in income generating activities [35,36]. We attribute improved security to better coordination and enhanced peace building and conflict resolution efforts under the community conservancy framework. Community conservancies in our study region often invest in community policing to complement efforts by local and national government agencies and non-governmental organizations [26,27,33]. Specifically, the conservancies work closely with the Northern Rangelands Trust (NRT), Kenya's National Police Service (NPS), the Kenya Wildlife Service (KWS), and county governments to provide a community-driven approach to tackling security and reducing conflict. Our key informant interviews revealed that similar security enhancement efforts are implemented in Naibunga Conservancy.

In our study, we found that local perception of improved security was positively associated with cattle ownership and camel ownership, suggesting that enhancing security is particularly important for livestock owners. Although we noted a similar association between security perception and ownership of sheep and goats, this particular finding should be interpreted with caution because it was not statistically valid (i.e., less than 80% of cells had expected frequency values equal to or greater than 5). Livestock (especially cattle, sheep, goats, and camels) are highly valued and are a major source of livelihoods for pastoral communities in Kenya's arid and semiarid regions [36,37]. Therefore, pastoralists may be particularly concerned about the security of their livestock. Our findings suggest that enhancing security benefits for local pastoralists can increase their support for community-based conservation initiatives. Therefore, community conservancies should prioritize security enhancement for local communities for better socioeconomic and wildlife conservation outcomes.

At face value, the observed perceived improvements in accessibility to grazing resources and livestock numbers may appear somewhat surprising. Under the community conservancy framework in our study region, local pastoralists typically make a trade off by setting aside portions of their communal land for wildlife conservation [1,6,10], which should reduce the area available for grazing their livestock. However, local community members are usually allowed to graze their livestock in these areas during the dry season [38], thereby partly mitigating the impact of this trade off. The fact that large proportions of respondents noted these improvements suggests that it is possible to achieve a win-win outcome for both biodiversity conservation and livestock production under the community conservancy framework.

We partly attribute improvements in accessibility to grazing resources and livestock numbers to the various conservancy-driven land and grazing management initiatives that were revealed by our key informants. As our key informants attested, these initiatives may have improved rangeland condition and forage availability for both livestock and wildlife, consistent with previous findings in our region [12,39,40]. Further, we relate these improvements to improved security under the community conservancy setting. Specifically, we posit that improved security reduces livestock losses to theft, thereby contributing to overall increases in livestock numbers across the landscape. In addition, we propose that improved security minimizes incursion grazing and conflicts over resources, thereby increasing forage availability for local community members' livestock. These arguments are supported by the views of our key informants, who pointed out the negative impacts of insecurity on livestock and grazing resources. As our key informants observed, insecurity reduces accessibility to grazing resources because pastoralists tend to avoid herding their livestock in areas they consider insecure. Consequently, their high concentrations in areas considered safer leads to overgrazing and subsequent degradation of forage resources in these areas. We recommend that in addition to allowing pastoralists' livestock to periodically access conservation areas, community conservancies can enhance socioeconomic and conservation outcomes by increasing efforts towards implementing community-based sustainable land and grazing management practices and enhancing security for local pastoralists and their livestock.

We relate the observed perceived conservancy-driven improvement in average household income to increased profitability of livestock rearing, based on the fact that an overwhelming majority of community members in our study region are pastoralists. In addition, the observed positive association between perception of increase in household income and ownership of livestock suggests that livestock keeping is a major driver of household income improvement. Under the community conservancy framework, local pastoralists can derive enhanced benefits from livestock through multiple pathways. One such pathway is the improved profitability of livestock sales through the various conservancy-driven livestock market access enhancement initiatives that were identified by our key informants. As pointed out by the key informants, such initiatives enable local pastoralists to maximize profits by selling their livestock at more competitive prices. Consistent with our findings, it was recently reported that cattle sales by pastoralists from community conservancies in northern Kenya improved by nearly 50% over a one-year period due to such livestock market enhancement initiatives [26]. Our findings underscore the important role that such conservancy-driven livestock market access initiatives play in improving local livelihoods.

In addition to improved livestock markets, increased pastoralists' household income could also be related to increased livestock productivity triggered by conservancy-driven improved availability of forage resources [12,39]. Furthermore, we posit that the improved security situation creates an enabling environment for better livestock rearing and productivity, thereby leading to improved household income for local pastoralists. Improvement in local household income can additionally be related to employment and business opportunities created by the conservancy, based on the information obtained from key informant interviews. The creation of such opportunities appears to be vital in helping local community members diversify their income streams, leading to increased local household incomes.

Our findings on perceived changes in accessibility to schools and health facilities resonate with information obtained from our key informants and the conservancy's current strategic plan [21]. Specifically, the conservancy strives to improve accessibility to schools in various ways including expanding education facilities to include adult education and boarding schools, lobbying community members to increase school enrolment, and awarding bursaries to needy students. In terms of health, the conservancy prioritizes the construction of health facilities to cover as many settlements as possible, enhancing mobile clinic and ambulance services, and the training of community health workers. The observed perceived improvements in accessibility to schools and health facilities generally

suggest that the conservancy is making some progress on these fronts. However, based on our findings that the majority of local community members had no formal education, and that just one out of ten members had post-primary education, more efforts need to be directed towards enhancing accessibility to educational facilities. Notably, the observed positive association between formal education and involvement in conservancy activities suggests that expanding education opportunities for local community members will be beneficial to local community members while also contributing towards desirable outcomes for conservancy management and conservation programs.

In addition, the positive association between livestock ownership and local perception of improvement in access to both schools and health facilities suggests that livestock owners may have better access to these facilities, likely because of higher household income. This argument is consistent with the positive association between perception of improved household income and livestock ownership that was observed in this study. In addition, there is evidence that pastoralists in this region sell their livestock to pay school fees for their children [41], further underscoring the role of livestock in enhancing accessibility to schools. Therefore, community conservancies should redouble their efforts to create a favorable environment for livestock rearing as a strategy to enhance local household incomes and accessibility to these facilities. In addition, based on the observed gender disparity in formal education (females were less educated than males), community conservancies should further direct their efforts towards enhancing girl-child education to address this disparity.

The conservancy also focuses on improving road networks and improving accessibility to water by renovating water points and constructing water pans [21]. However, the fact that only moderate proportions (~53%) of respondents perceived improvements in these facilities indicates that much more needs to be done on these fronts. Our finding on local perceptions of change in water accessibility is consistent with information from our key informants. Whereas the key informants indicated that the conservancy attempted to increase accessibility to water, they also indicated that water scarcity remains a big challenge for local community members. As opined by our key informants, water scarcity heightens conflicts among people as well as between people and wildlife. The observed negative association between the perception of improved accessibility to water and cattle ownership suggests that available water sources are insufficient not only for people but also for livestock and wildlife. Therefore, to better enhance conservation and socioeconomic outcomes, community conservancies should focus on developing more effective strategies to improve water availability for pastoralists, their livestock, and wildlife.

The fact that an overwhelming majority (more than seven-tenths) of respondents did not note improvement in accessibility to electricity may be due to difficulties in distributing mains electricity in such vast and sparsely populated landscapes. This could be one of the reasons why improving accessibility to electricity has not been prioritized, based on the conservancy's current strategic plan [21]. We propose that community conservancies in such pastoral landscapes should direct more efforts towards improving local accessibility to alternative energy sources, especially solar power, if they are to better enhance the socioeconomic wellbeing of local pastoralists. Such an intervention could importantly bolster the local economy by enhancing domestic lighting, accessibility to water through solar-powered water pumps, and the use of mobile phones, which is fast expanding in these pastoral regions [42]. In addition, improving local accessibility to solar power could contribute towards better mitigation of human–wildlife conflicts through the use of solar-powered light-emitting diode (LED) flashlights to reduce livestock depredation by lions [43].

4.2. Local Participation in Conservancy Management and Conservation Activities

Local participation has been identified as a key determinant of socioeconomic and conservation outcomes of community-based conservation projects [16,17,31,32]. In our study, key informants revealed several ways in which local community members were

involved in conservancy management and conservation activities, including rangeland rehabilitation and restoration, community-based grazing management, participation in management committees, and capacity building. The observed overwhelming majority (nearly eight-tenths) of respondents reporting involvement in these activities demonstrates a considerably high level of support for the conservancy and its programs among local community members. We associate the observed high level of local community participation in conservancy activities with the observed equally high levels of local community perceptions of socioeconomic improvements. This proposition is consistent with the fact that local community members' involvement in these activities was positively associated with their perceptions of conservancy-related socioeconomic improvements. These findings resonate with other studies showing that local perceptions of socioeconomic benefits of community-based conservation initiatives play a pivotal role in increasing local participation in such initiatives [44,45]. The observed overwhelming majority (approximately eight-tenths) of respondents reporting to be involved for not more than 10 h per week suggests that this is the participation level that best balances engagement in individual activities with engagement in conservancy activities.

The observed positive association between possession of formal education and respondents' participation in conservancy management and conservation activities underscores the importance of education in enhancing local participation in conservancy programs. Education has been identified as a key factor in improving local participation in conservation [46]. Specifically, formal education importantly prepares people to participate in activities that require the application of skills and knowledge and improves their self-confidence [47]. The observed higher than expected proportion of females reporting involvement in conservancy management and conservation activities suggests that females can play a pivotal role in community-based initiatives, as has also been reported elsewhere [37,48]. It is noteworthy that this gender disparity in local participation in conservancy activities was observed despite the fact that females were generally less educated than males, yet education positively influenced local participation. While what drove gender disparity in local participation is unclear, we posit that the observed gender disparity in the perception of conservancy-related improvement in accessibility to grazing resources could be responsible. In addition, in our study region, adult males largely take care of cattle, which usually require more forage and water, and are normally herded in far-flung areas away from homesteads [41]. Therefore, males engaged in cattle herding may have little time to participate in conservancy management and conservation activities.

The observed positive association between livestock ownership and local community members' participation in conservancy activities can be attributed to the fact that livestock ownership was also positively associated with perception of conservancy-related socioeconomic improvements, a major determinant of local participation. Livestock owners appear to be more motivated to participate in these activities as a way of ensuring better livestock productivity and profitability. The observed negative relationship between sheep and goat herd size and involvement in conservancy activities could be due to the possibility that households with larger herd sizes have less time available to participate in conservancies as they have more animals to look after.

Based on the foregoing findings, we suggest that community conservancies should focus on addressing individual-level differences in involvement in conservancy management and conservation activities if they are to better achieve broad-based, equitable, and sustainable participation in these activities by local community members. In particular, the conservancies should prioritize identifying and addressing the disparities in local participation related to educational, gender, and livestock ownership and herd size differences among local community members.

5. Conclusions

Increasing food security with minimal negative impacts on biodiversity continues to be one of the most pressing global challenges [49]. Community-based conservation aims to

address this challenge by producing both conservation and socioeconomic benefits [38]. In this study of Naibunga Conservancy in northern Kenya, we found that a vast majority (nine-tenths) of local community members perceived that their overall socioeconomic status had improved since the establishment of the conservancy. In addition, large proportions of local community members perceived conservancy-related improvements in various other socioeconomic attributes including security situation, household income, livestock numbers, and accessibility to grazing resources, schools, and health facilities. These socioeconomic improvements were related to various initiatives implemented by the conservancy, including peace and security enhancement, community-based rangeland restoration and grazing management, enhancement of access to livestock markets, enhancing employment and small business opportunities, and provision of educational bursaries. However, only low to moderate proportions of community members perceived improvements in the status of roads and accessibility to water and electricity, suggesting slower progress in addressing the challenges associated with these socioeconomic attributes. We also found that a large proportion (nearly eight-tenths) of community members were involved in conservancy management and conservation activities. Our study further showed that local participation in these activities was positively influenced by perceptions of conservancy-related positive socioeconomic outcomes, as well as by possession of formal education. In addition, we observed a gender disparity in local participation in conservancy activities, with a higher proportion of females reporting participation compared to males.

Taken together, our findings suggest that the community conservancy model as applied in our study region can improve the socioeconomic wellbeing of local pastoralists, and consequently contribute to tackling the global challenge of balancing socioeconomic development interests with wildlife conservation interests. For greater socioeconomic and environmental outcomes, community conservancies should prioritize multi-pronged strategies that maximize socioeconomic benefits for local community members, in combination with strategies to ensure that biodiversity values are also protected. In particular, because the vast majority of members of such conservancies are pastoralists who primarily rely on livestock for survival, strategies that enhance the security of pastoralists and their livestock, rangeland, and livestock productivity and accessibility to water should be given utmost priority.

In addition, such community conservancies should focus on increasing accessibility to educational facilities to address low literacy levels among local community members, especially girls. Further, the conservancies should focus on improving infrastructure and explore ways of enhancing local accessibility to alternative energy sources, especially solar power, to further spur socioeconomic growth and development in such remote landscapes. Finally, to further enhance their socioeconomic and conservation outcomes, such conservancies should devise and implement strategies aimed at enhancing and entrenching local community participation in conservancy programs. In particular, the conservancies should pay greater attention to identifying and addressing the major barriers to behavior change and equitable local participation in conservancy activities, including barriers to educational and gender equity.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by Egerton University Research Ethics Review Committee (EUREC) on 30th November 2020 (Approval number EUREC/APP/108/2020).

Informed Consent Statement: Informed consent was obtained from all respondents involved in the study.

Data Availability Statement: The datasets generated and used by this study are available at figshare at <https://figshare.com/s/d96524133a6f82bc0a78> or <https://doi.org/10.6084/m9.figshare.14825034>.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Various variables and their levels as used in original (household survey) assessments and Chi-square tests of association.

Variable	Original Level Assessed	Levels Used for Chi-Square Tests
Socioeconomic indicators	Increased/Improved, No change, Decreased/Deteriorated	Increased/Improved, No change/decreased or deteriorated
Involvement	Involved, Not involved	Involved, Not involved
Involvement levels (hours per week)	0, 1–10, 11–20, >20	Not used in Chi-square tests
Gender	Male, female	Male, female
Education level	None, primary, secondary, tertiary	None, primary, secondary, tertiary (for association test with gender)
	None, primary, secondary, tertiary	No formal education, formal education (for association test with variables other than gender)
Household size	<2, 3–5, 6–8, >9	1–5, >6
Occupation	Farmer, civil servant, businessperson, others	Not used in Chi-square tests
Main source of livelihood	Pastoralism, formal employment, beekeeping, other	Not used in Chi-square tests
Livestock type	Cattle, sheep and goats, camels, donkeys	Not used in Chi-square tests
Cattle ownership	Yes, no	Yes, no
Sheep and goat ownership	Yes, no	Yes, no
Camel ownership	Yes, no	Yes, no
Donkey ownership	Yes, no	Yes, no
Cattle herd size	0, 1–50, 51–100, >100	1–50, >50
Sheep and goat herd size	0, 1–50, 51–100, >100	1–50, >50
Camel herd size	0, 1–50, 51–100, >100	Not used in Chi-square tests

Table A2. Chi-square tests of association between respondents' gender and their perceptions of conservancy-related changes in various socioeconomic indicators. Values in parentheses are expected counts.

		Gender				χ^2	<i>p</i> -Value
		Male		Female			
		Freq.	%	Freq.	%		
How livestock numbers changed	Increased/Improved	147(142.9)	67.1	86 (90.1)	62.3	3.76	0.152
	No change	58 (57.1)	26.5	35 (35.9)	25.4		
	Decreased/Deteriorated	14 (19.0)	6.4	17 (12.0)	12.3		
How the average household income changed	Increased/Improved	168 (165.0)	76.7	101 (104.0)	73.2	5.015	0.081
	No change	25 (21.5)	11.4	10 (13.5)	7.2		
	Decreased/Deteriorated	26 (32.5)	11.9	27 (20.5)	19.6		
How accessibility to water changed	Increased/Improved	118 (115.9)	53.9	71 (73.1)	51.4	3.12	0.210
	No change	66 (62.0)	30.1	35 (39.0)	25.4		
	Decreased/Deteriorated	35 (41.1)	16.0	32 (25.9)	23.2		
How accessibility to health facility changed	Increased/Improved	152 (144.8)	69.4	84 (91.2)	60.9	3.30	0.192
	No change	60 (65.0)	27.4	46(41.0)	33.3		
	Decreased/Deteriorated	7 (9.2)	3.2	8 (5.8)	5.8		
How accessibility to schools changed	Increased/Improved	157 (158.3)	71.7	101 (99.7)	73.2	1.34	0.513
	No change	59 (56.4)	26.9	33 (35.6)	23.9		
	Decreased/Deteriorated	3 (4.3)	1.4	4 (2.7)	2.9		
How status of roads changed	Increased/Improved	122 (117.2)	55.7	69 (73.8)	50.0	3.00	0.223
	No change	56 (63.2)	25.6	47 (39.8)	34.1		
	Decreased/Deteriorated	41 (38.6)	18.7	22 (24.4)	15.9		
How accessibility to grazing resources changed	Increased/Improved	160 (168.7)	73.1	115 (106.3)	83.3	15.66	<0.001
	No change	14 (17.8)	6.4	15 (11.2)	10.9		
	Decreased/Deteriorated	45 (32.5)	20.5	8 (20.5)	5.8		
How accessibility to electricity changed	Increased/Improved	53 (56.4)	24.2	39 (35.6)	28.3	6.59	0.037
	No change	162 (154.6)	74.0	90 (97.4)	65.2		
	Decreased/Deteriorated	4 (8.0)	1.8	9 (5.0)	6.5		
How security status changed	Increased/Improved	182 (179.7)	83.1	111 (113.3)	80.4	0.506	0.777
	No change	8 (8.0)	3.7	5 (5.0)	3.6		
	Decreased/Deteriorated	29 (31.3)	13.2	22 (19.7)	15.9		

Table A3. Chi-square tests of association between household size and respondents' perceptions of conservancy-related changes in various socioeconomic indicators. Values in parentheses are expected counts.

		Household Size					
		1–5		6 and Above		χ^2	<i>p</i> -Value
		Freq.	%	Freq.	%		
How livestock numbers changed	Increased/Improved	153 (148.1)	67.4	78 (82.9)	61.4	4.83	0.089
	No change	51 (59.0)	22.5	41 (33.0)	32.3		
	Decreased/Deteriorated	23 (19.9)	10.1	8 (11.1)	6.3		
How the average household income changed	Increased/Improved	177 (170.6)	78.0	89 (95.4)	70.1	4.72	0.95
	No change	23 (22.4)	10.1	12 (12.6)	9.4		
	Decreased/Deteriorated	27 (34.0)	11.9	26 (19.0)	20.5		
How accessibility to water changed	Increased/Improved	119 (120.6)	52.4	69 (67.4)	54.3	0.530	0.767
	No change	67 (64.1)	29.5	33 (35.9)	26.0		
	Decreased/Deteriorated	41 (42.3)	18.1	25 (23.7)	19.7		
How accessibility to health facility changed	Increased/Improved	152 (150.7)	67.0	83 (84.3)	65.4	0.193	0.908
	No change	65 (66.7)	28.6	39 (37.3)	30.7		
	Decreased/Deteriorated	10 (9.6)	4.4	5 (5.4)	3.9		
How accessibility to schools changed	Increased/Improved	172 (164.2)	75.8	84 (91.8)	66.1	4.54	0.103
	No change	50 (58.4)	22.0	41 (32.6)	32.3		
	Decreased/Deteriorated	5 (4.5)	2.2	2 (2.5)	1.6		
How status of roads changed	Increased/Improved	128 (121.2)	56.4	61 (67.8)	48.0	2.45	0.125
	No change	63 (66.0)	27.8	40 (37.0)	31.5		
	Decreased/Deteriorated	36 (39.8)	15.9	26 (22.2)	20.5		
How accessibility to grazing resources changed	Increased/Improved	179 (174.4)	78.9	93 (97.6)	73.2	5.20	0.074
	No change	21 (18.6)	9.3	8 (10.4)	6.3		
	Decreased/Deteriorated	27 (34.0)	11.9	26 (19.0)	20.5		
How accessibility to electricity changed	Increased/Improved	61 (58.4)	26.9	30 (32.6)	23.6	1.58	0.453
	No change	156 (160.3)	68.7	94 (89.7)	74.0		
	Decreased/Deteriorated	10 (8.3)	4.4	3 (4.7)	2.4		
How security status changed	Increased/Improved	193 (186.0)	85.0	97 (104.0)	76.4	11.14	0.004
	No change	11 (8.3)	4.8	2 (4.7)	1.6		
	Decreased/Deteriorated	23 (32.7)	10.1	28 (18.3)	22.0		

Table A4. Chi-square tests of association between respondents' formal education level and their perceptions of conservancy-related changes in various socioeconomic indicators. Values in parentheses are expected counts.

		Education Level				χ^2 <i>p</i> -Value	
		No Formal Education		Formal Education			
		Freq.	%	Freq.	%		
How livestock numbers changed	Increased/Improved	127 (126.6)	65.5	106 (106.4)	65.0	0.018	0.991
	No change	50 (50.5)	25.8	43 (42.5)	26.4		
	Decreased/Deteriorated	17 (16.8)	8.8	14 (14.2)	8.6		
How the average household income changed	Increased/Improved	150 (146.2)	77.3	119 (122.3)	73.0	3.23	0.199
	No change	14 (19.0)	7.2	21 (16.0)	12.9		
	Decreased/Deteriorated	30 (28.8)	15.5	23 (24.2)	14.1		
How accessibility to water changed	Increased/Improved	101 (102.7)	52.1	88 (86.3)	54.0	0.497	0.780
	No change	54 (54.9)	27.8	47 (46.1)	28.8		
	Decreased/Deteriorated	39 (36.4)	20.1	28 (30.6)	17.2		
How accessibility to health facility changed	Increased/Improved	129 (128.2)	66.5	107 (107.8)	65.6	2.90	0.235
	No change	60 (57.6)	30.9	46 (48.4)	28.2		
	Decreased/Deteriorated	5 (8.2)	2.6	10 (6.8)	6.1		
How accessibility to schools changed	Increased/Improved	141 (140.2)	72.7	117 (117.8)	71.8	0.382	0.826
	No change	50 (50.0)	25.8	42 (42.0)	25.8		
	Decreased/Deteriorated	3 (3.8)	1.5	4 (3.2)	2.5		
How status of roads changed	Increased/Improved	86 (103.8)	44.3	105 (87.2)	64.4	15.29	<0.001
	No change	70 (56.0)	36.1	33 (47.0)	20.2		
	Decreased/Deteriorated	38 (34.2)	19.6	25 (28.8)	15.3		
How accessibility to grazing resources changed	Increased/Improved	152 (149.4)	78.4	123 (125.6)	75.5	5.48	0.064
	No change	10 (15.8)	5.2	19 (13.2)	11.7		
	Decreased/Deteriorated	32 (28.8)	16.5	21 (24.2)	12.9		
How accessibility to electricity changed	Increased/Improved	41 (50.0)	21.1	51 (42.0)	31.3	5.51	0.063
	No change	147 (136.9)	75.8	105 (115.1)	64.4		
	Decreased/Deteriorated	6 (7.1)	3.1	7 (5.9)	4.3		
How security status changed	Increased/Improved	157 (159.2)	80.9	136 (133.8)	83.4	0.470	0.791
	No change	8 (7.1)	4.1	5 (5.9)	3.1		
	Decreased/Deteriorated	29 (27.7)	14.9	22 (23.3)	13.5		

Table A5. Chi-square tests of association between cattle ownership and respondents' perceptions of conservancy-related changes in various socioeconomic indicators. Values in parentheses are expected counts.

		Own Cattle					
		Yes		No			
		Freq.	%	Freq.	%	χ ²	p-Value
How livestock numbers changed	Increased/Improved	216 (195.7)	72.2	17 (37.3)	29.8	39.27	<0.001
	No change	64 (77.3)	21.4	28 (14.7)	49.1		
	Decreased/Deteriorated	19 (26.0)	6.4	12 (5.0)	21.1		
How the average household income changed	Increased/Improved	243 (225.9)	81.3	26 (43.1)	45.6	37.25	<0.001
	No change	26 (29.4)	8.7	9 (5.6)	15.8		
	Decreased/Deteriorated	30 (43.7)	10.0	22 (8.3)	38.6		
How accessibility to water changed	Increased/Improved	150 (158.7)	50.2	39 (30.3)	68.4	6.52	0.038
	No change	90 (84.0)	30.1	10 (16.0)	17.5		
	Decreased/Deteriorated	59 (53.6)	19.7	8 (10.7)	14.0		
How accessibility to health facility changed	Increased/Improved	206 (197.4)	68.9	29 (37.6)	50.9	7.09	0.029
	No change	82 (89.0)	27.4	24 (17.0)	42.1		
	Decreased/Deteriorated	11 (12.6)	3.7	4 (2.4)	7.0		
How accessibility to schools changed	Increased/Improved	228 (215.9)	76.3	29 (41.1)	50.9	19.84	<0.001
	No change	64 (77.3)	21.4	28 (14.7)	49.1		
	Decreased/Deteriorated	7 (5.9)	2.3	0 (1.1)	0.0		
How status of roads changed	Increased/Improved	162 (160.4)	54.2	29 (30.6)	50.9	8.38	0.015
	No change	79 (86.5)	26.4	24 (16.5)	42.1		
	Decreased/Deteriorated	58(52.1)	19.4	4 (9.9)	7.0		
How accessibility to grazing resources changed	Increased/Improved	228 (231.0)	76.3	47 (44.0)	82.5	1.118	0.572
	No change	25 (24.4)	8.4	4 (4.6)	7.0		
	Decreased/Deteriorated	46 (43.7)	15.4	6 (8.3)	10.5		
How accessibility to electricity changed	Increased/Improved	74 (77.3)	24.7	18 (14.7)	31.6	1.553	0.460
	No change	214 (211.7)	71.6	38 (40.3)	66.7		
	Decreased/Deteriorated	11 (10.1)	3.7	1 (1.9)	1.8		
How security status changed	Increased/Improved	258 (245.2)	86.3	34 (46.8)	59.6	25.05	<0.001
	No change	10 (10.9)	3.3	3 (2.1)	5.3		
	Decreased/Deteriorated	31 (42.8)	10.4	20 (8.2)	35.1		

Table A6. Chi-square tests of association between sheep and goat ownership and respondents' perceptions of conservancy-related changes in various socioeconomic indicators. Values in parentheses are expected counts. Highlighted statistics indicate unmet Chi-square assumption of at least 80% of cells having expected values ≥ 5 .

		Own Sheep and Goats					
		Yes		No		χ^2 <i>p</i> -Value	
		Freq.	%	Freq.	%		
How livestock numbers changed	Increased/Improved	233 (225.1)	67.7	0 (7.9)	0.0	28.95	<0.001
	No change	81 (88.9)	23.5	11 (3.1)	91.7		
	Decreased/Deteriorated	30 (30.0)	8.7	1 (1.0)	8.3		
How the average household income changed	Increased/Improved	265 (259.9)	77.0	4 (9.1)	33.3	32.98	<0.001
	No change	28 (33.8)	8.1	7 (1.2)	58.3		
	Decreased/Deteriorated	51 (50.1)	14.8	1 (1.8)	8.3		
How accessibility to water changed	Increased/Improved	184 (182.6)	53.5	5 (6.4)	41.7	6.686	0.035
	No change	93 (96.6)	27.0	7 (3.4)	58.3		
	Decreased/Deteriorated	67 (64.7)	19.5	0 (2.3)	0.0		
How accessibility to health facility changed	Increased/Improved	230 (227.1)	66.9	5 (7.9)	41.7	5.040	0.080
	No change	99 (102.4)	28.8	7 (3.6)	58.3		
	Decreased/Deteriorated	15 (14.5)	4.4	0 (0.5)	0.0		
How accessibility to schools changed	Increased/Improved	252 (248.3)	73.3	5 (8.7)	41.7	6.920	0.031
	No change	85 (88.9)	24.7	7 (3.1)	58.3		
	Decreased/Deteriorated	7 (6.8)	2.0	0 (0.2)	0.0		
How status of roads changed	Increased/Improved	183 (184.6)	53.2	8 (6.4)	66.7	2.638	0.267
	No change	99 (99.5)	28.8	4 (3.5)	33.3		
	Decreased/Deteriorated	62 (59.9)	18.0	0 (2.1)	0.0		
How accessibility to grazing resources changed	Increased/Improved	268 (265.7)	77.9	7 (9.3)	58.3	10.581	0.005
	No change	25 (28.0)	7.3	4 (1.0)	33.3		
	Decreased/Deteriorated	51 (50.2)	14.8	1 (1.8)	8.3		
How accessibility to electricity changed	Increased/Improved	90 (88.9)	26.2	2 (3.1)	16.7	1.100	0.577
	No change	242 (243.5)	70.3	10 (8.5)	83.3		
	Decreased/Deteriorated	12 (11.6)	3.5	0 (0.4)	0.0		
How security status changed	Increased/Improved	283 (282.2)	82.3	9 (9.8)	75.0	6.147	0.046
	No change	11 (12.6)	3.2	2 (0.4)	16.7		
	Decreased/Deteriorated	50 (49.3)	14.5	1 (1.7)	8.3		

Table A7. Chi-square tests of association between donkey ownership and respondents' perceptions of conservancy-related changes in various socioeconomic indicators. Values in parentheses are expected counts.

		Own Donkeys				χ^2 <i>p</i> -Value	
		Yes		No			
		Freq.	%	Freq.	%		
How livestock numbers changed	Increased/Improved	43 (43.9)	64.2	190 (189.1)	65.7	2.517	0.284
	No change	15 (17.3)	22.4	77 (74.7)	26.6		
	Decreased/Deteriorated	9 (5.8)	13.4	22 (25.2)	7.6		
How the average household income changed	Increased/Improved	49 (50.6)	73.1	220 (218.4)	76.1	1.835	0.399
	No change	5 (6.6)	7.5	30 (28.4)	10.4		
	Decreased/Deteriorated	13 (9.8)	19.4	39 (42.2)	13.5		
How accessibility to water changed	Increased/Improved	43 (35.6)	64.2	146 (153.4)	50.5	5.203	0.074
	No change	17 (18.8)	25.4	83 (81.2)	28.7		
	Decreased/Deteriorated	7 (12.6)	10.4	60 (54.4)	20.8		
How accessibility to health facility changed	Increased/Improved	46 (44.2)	68.7	189 (190.8)	65.4	0.439	0.803
	No change	19 (19.9)	28.4	87 (86.1)	30.1		
	Decreased/Deteriorated	2 (2.8)	3.0	13 (12.2)	4.5		
How accessibility to schools changed	Increased/Improved	47 (48.4)	70.1	210 (208.6)	72.7	0.517	0.772
	No change	18 (17.3)	26.9	74 (74.7)	25.6		
	Decreased/Deteriorated	2 (1.3)	3.0	5 (5.7)	1.7		
How status of roads changed	Increased/Improved	40 (35.9)	59.7	151 (155.1)	52.2	1.437	0.488
	No change	18 (19.4)	26.9	85 (83.6)	29.4		
	Decreased/Deteriorated	9 (11.7)	13.4	53 (50.3)	18.3		
How accessibility to grazing resources changed	Increased/Improved	49 (51.8)	73.1	226 (223.2)	78.2	0.864	0.649
	No change	6 (5.5)	9.0	23 (23.5)	8.0		
	Decreased/Deteriorated	12 (9.8)	17.9	40 (42.2)	13.8		
How accessibility to electricity changed	Increased/Improved	9 (17.3)	13.4	83 (74.7)	28.7	8.162	0.017
	No change	57 (47.4)	85.1	195 (204.6)	67.5		
	Decreased/Deteriorated	1 (2.3)	1.5	11 (9.7)	3.8		
How security status changed	Increased/Improved	53 (55.0)	79.1	239 (237.0)	82.7	0.926	0.629
	No change	2 (2.4)	3.0	11 (10.6)	3.8		
	Decreased/Deteriorated	12 (9.6)	17.9	39 (41.4)	13.5		

Table A8. Chi-square tests of association between camel ownership and respondents' perception of conservancy-related changes in various socioeconomic indicators. Values in parentheses are expected counts.

		Own Camels					
		Yes		No		χ^2	<i>p</i> -Value
		Freq.	%	Freq.	%		
How livestock numbers changed	Increased/Improved	80 (63.5)	82.5	153 (169.5)	59.1		
	No change	12 (25.1)	12.4	80 (66.9)	30.9		
	Decreased/Deteriorated	5 (8.4)	5.2	26 (22.6)	10.0	17.20	<0.001
How the average household income changed	Increased/Improved	82 (73.3)	84.5	187 (195.7)	72.2		
	No change	11 (9.5)	11.3	24 (25.5)	9.3		
	Decreased/Deteriorated	4 (14.2)	4.1	48 (37.8)	18.5	11.76	0.003
How accessibility to water changed	Increased/Improved	52 (52.5)	53.6	137 (137.5)	52.9		
	No change	32 (27.2)	33.0	68 (72.8)	26.3		
	Decreased/Deteriorated	13 (18.3)	13.4	54 (48.7)	20.8	3.226	0.199
How accessibility to health facility changed	Increased/Improved	86 (64.0)	88.7	149 (171.0)	57.5		
	No change	9 (28.9)	9.3	97 (77.1)	37.5		
	Decreased/Deteriorated	2 (4.1)	2.1	13 (10.9)	5.0	30.638	<0.001
How accessibility to schools changed	Increased/Improved	85 (70.0)	87.6	172 (187.0)	66.4		
	No change	9 (22.5)	9.3	83 (66.9)	32.0		
	Decreased/Deteriorated	3 (1.9)	3.1	4 (5.1)	1.5	19.42	<0.001
How status of roads changed	Increased/Improved	58 (52.0)	59.8	133 (139.0)	51.4		
	No change	21 (28.1)	21.6	82 (74.9)	31.7		
	Decreased/Deteriorated	18 (16.9)	18.6	44 (45.1)	17.0	3.482	0.175
How accessibility to grazing resources changed	Increased/Improved	77 (74.9)	79.4	198 (200.1)	76.4		
	No change	12 (7.9)	12.4	17 (21.1)	6.6		
	Decreased/Deteriorated	8 (14.2)	8.2	44 (37.8)	17.0	6.692	0.035
How accessibility to electricity changed	Increased/Improved	6 (25.1)	6.2	86 (66.9)	33.2		
	No change	88 (68.7)	90.7	164 (183.3)	63.3		
	Decreased/Deteriorated	3 (3.3)	3.1	9 (8.7)	3.5	27.45	<0.001
How security status changed	Increased/Improved	90 (79.6)	92.8	202 (212.4)	78.0		
	No change	6 (3.5)	6.2	7 (9.5)	2.7		
	Decreased/Deteriorated	1 (13.9)	1.0	50 (37.1)	19.3	20.68	<0.001

Table A9. Chi-square tests of association between respondents' cattle herd size and their perceptions of conservancy-related changes in various socioeconomic indicators. Values in parentheses are expected counts. Highlighted statistics indicate unmet Chi-square assumption of at least 80% of cells having expected values ≥ 5 .

		Number of Cattle				χ^2		<i>p</i> -Value
		1–50		51 and Above				
		Count	%	Count	%			
How livestock numbers changed	Increased/Improved	196 (196.5)	72.1	20 (19.5)	74.1			
	No change	61 (58.2)	22.4	3 (5.8)	11.1			
	Decreased/Deteriorated	15 (17.31)	5.5	4 (1.7)	14.8	4.826	0.90	
How the average household income changed	Increased/Improved	219 (221.1)	80.5	24 (21.9)	88.9			
	No change	24 (23.7)	8.8	2 (2.3)	7.4			
	Decreased/Deteriorated	29 (27.3)	10.7	1 (2.7)	3.7	1.454	0.483	
How accessibility to water changed	Increased/Improved	138 ((136.5)	50.7	12 (13.5)	44.4			
	No change	81 (81.9)	29.8	9 (8.1)	33.3			
	Decreased/Deteriorated	53 (53.7)	19.5	6 (5.3)	22.2	0.390	0.823	
How accessibility to health facility changed	Increased/Improved	185 (187.4)	68.0	21 (18.6)	77.8			
	No change	76 (74.6)	27.9	6 (7.4)	22.2			
	Decreased/Deteriorated	11 (10)	4.0	0 (1.0)	0.0	1.725	0.422	
How accessibility to schools changed	Increased/Improved	205 (207.4)	75.4	23 (20.6)	85.2			
	No change	60 (58.2)	22.1	4 (5.8)	14.8			
	Decreased/Deteriorated	7 (6.4)	2.6	0 (0.6)	0.0	1.607	0.448	
How status of roads changed	Increased/Improved	148 (147.4)	54.4	14 (14.6)	51.9			
	No change	70 (71.9)	25.7	9 (7.1)	33.3			
	Decreased/Deteriorated	54 (52.8)	19.9	4 (5.2)	14.8	0.888	0.642	
How accessibility to grazing resources changed	Increased/Improved	204 (207.4)	75.0	24 (20.6)	88.9			
	No change	23 (22.7)	8.5	2 (2.3)	7.4			
	Decreased/Deteriorated	45 (41.8)	16.5	1 (4.2)	3.7	3.286	0.193	
How accessibility to electricity changed	Increased/Improved	70 (67.3)	25.7	4 (6.7)	14.8			
	No change	193 (194.7)	71.0	21 (19.3)	77.8			
	Decreased/Deteriorated	9 (10.0)	3.3	2 (1.0)	7.4	2.465	0.292	
How security status changed	Increased/Improved	235 (234.7)	86.4	23 (23.3)	85.2			
	No change	8 (9.1)	2.9	2 (0.9)	7.4			
	Decreased/Deteriorated	29 (28.2)	10.7	2 (2.8)	7.4	1.720	0.423	

Table A10. Chi-square tests of association between respondents' sheep and goat herd size and their perceptions of conservancy-related changes in various socioeconomic indicators. Values in parentheses are expected counts.

		Number of Sheep and Goats					
		1–50		51 and Above		χ^2 <i>p</i> -Value	
		Count	%	Count	%		
How livestock numbers changed	Increased/Improved	109 (115.9)	63.7	124 (117.2)	71.7	3.396	0.183
	No change	43 (40.3)	25.1	38 (40.7)	22.0		
	Decreased/Deteriorated	19 (14.9)	11.1	11 (15.1)	6.4		
How the average household income changed	Increased/Improved	131 (131.7)	76.6	134 (133.3)	77.5	7.538	0.023
	No change	20 (13.9)	11.7	8 (14.1)	4.6		
	Decreased/Deteriorated	20 (25.4)	11.7	31 (25.6)	17.9		
How accessibility to water changed	Increased/Improved	91 (91.5)	53.2	93 (92.5)	53.8	0.652	0.722
	No change	49 (46.2)	28.7	44 (46.2)	25.4		
	Decreased/Deteriorated	31 (33.3)	18.1	36 (33.3)	20.8		
How accessibility to health facility changed	Increased/Improved	112 (114.3)	65.5	118 (115.7)	68.2	1.822	0.402
	No change	49 (49.2)	28.7	50 (49.8)	28.9		
	Decreased/Deteriorated	10 (7.5)	5.8	5 (7.5)	2.9		
How accessibility to schools changed	Increased/Improved	124 (125.3)	72.5	128 (126.7)	74.0	1.349	0.509
	No change	42 (42.3)	24.6	43 (42.7)	24.9		
	Decreased/Deteriorated	5 (3.5)	2.9	2 (3.5)	1.2		
How status of roads changed	Increased/Improved	100 (91.0)	58.5	83 (92.0)	48.0	4.385	0.112
	No change	46 (49.2)	26.9	53 (49.8)	30.6		
	Decreased/Deteriorated	25 (30.8)	14.6	37 (31.2)	21.4		
How accessibility to grazing resources changed	Increased/Improved	131 (133.2)	76.6	137 (134.8)	79.2	3.853	0.146
	No change	17 (12.4)	9.9	8 (12.6)	4.6		
	Decreased/Deteriorated	23 (25.4)	13.5	28 (225.6)	16.2		
How accessibility to electricity changed	Increased/Improved	50 (44.7)	29.2	40 (45.3)	23.1	3.491	0.175
	No change	113 (120.3)	66.1	129 (121.7)	74.6		
	Decreased/Deteriorated	8 (6.0)	4.7	4 (6.0)	2.3		
How security status changed	Increased/Improved	144 (140.7)	84.2	139 (142.3)	80.3	2.895	0.217
	No change	7 (5.5)	4.1	4 ((5.5)	2.3		
	Decreased/Deteriorated	0 (24.9)	11.7	30 (25.1)	17.3		

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