



# Pastoralists' use of income diversification as a strategy for adapting to social-ecological change in Samburu, Kenya

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Received: 6 October 2018 / Accepted: 27 January 2020 / Published online: 17 February 2020  
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## Abstract

Pastoralists in the Samburu region of Kenya, like many pastoralists around the world, have endured significant effects of social-ecological change. Improvements in infrastructure, access to education, roads, and cellular networks, combined with changing land tenure systems and impacts from more frequent extreme weather events place Samburu herders squarely in the middle of substantial change. In our study, we interviewed 100 pastoralists to determine how income sources changed over the past 20 years, following an extreme drought in 1998, as a measure of adapting to change. Questions about livestock holdings, income sources, and household demographics were used to conduct a cluster analysis and group comparisons that indicated Samburu pastoralists have chosen one of three primary paths in the past 20 years: increased herd size and retained pastoralism as a primary income source; reduced herd size but retained livestock herding as the primary income source, while adding other modest sources of income; and substantially reduced herd size and pursued non-herding options as a primary income source. Our results show a number of differences among Samburu pastoralists, and the extent to which paths were chosen primarily to alleviate adverse impacts from social-ecological change is unclear, as community members provided numerous explanations for changing herd size.

**Keywords** Samburu · Pastoralism · Income diversification · Kenya

## Introduction

The Samburu region in northern Kenya, like many pastoral areas around the globe, has endured significant social and

environmental change over the past 20 years. Climate has become less predictable in the region including three periods of extreme drought since 1995 (Opiyo et al. 2015), as well as massive floods that contributed to significant erosion and land degradation in 2010 and 2018. The county government instigated a shift in land tenure, from community land to privatization, and fences and similar barriers that lead to fragmentation have followed (Fratkin and Roth 2005). Community conservancies, of which there are 39 that cover more than 42,000 km<sup>2</sup> in northern Kenya, are locally driven efforts to protect rangeland health for both wildlife and pastoralists, and require herders to abide by regulations about where and when they can bring their livestock during a given year within conservancy lands, particularly during dry season grazing (Bedelian and Ogutu 2017). Greater social value placed on primary and secondary education has prompted a need to adjust division of labor within households and herding patterns in order to gain and maintain access to schools (Little et al. 2008). Collectively, these changes may have led to greater competition for an increasingly limited supply of healthy rangelands, which is further linked to a subsequent uptick in tribal conflict and violence (Khisia et al. 2016).

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Communicated by Shuaib Lwasa

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Much of this change has contributed to tremendous hardship on Samburu pastoralists, exacerbated by the realities that pastoralists are known to be among the most marginalized groups in regions around the world (Nori et al. 2005). In areas such as Samburu, where food security, poverty, degraded rangelands, and historic marginalization by the State have persisted, events such as extreme drought are endured more acutely than other regions of the world.

Conversely, over the same period, the region experienced tremendous improvement in road infrastructure and cellular network coverage, contributing to the creation of numerous new market-based opportunities. Deeply corrugated and damaged roads have been replaced by well-constructed tarmac, significantly reducing the travel time to access larger towns and creating markets for new goods. Mobile communication has become more affordable, including Internet-capable phones and data. Basic human rights are increasingly extended to women, bringing pathways for women to access formal education, jobs, and property ownership.

These collective changes propagate through Samburu's social-ecological system in many ways, creating substantial uncertainty within Samburu livelihoods, along with opportunities. Flexible livelihood strategies define many traditional pastoralist groups, the Samburu among them. Yet in the current system, flexibility, adaptation, or simply livelihood change may now include engaging with the market economy brought by the developing infrastructure, such as in education or small business, as well as expanding and diversifying livestock holdings. It is yet unclear whether, how, and why Samburu livelihoods are changing within the current system.

## Study purpose

In the wake of environmental challenges and the infrastructure and social change improvements, we aimed to investigate how pastoral households have shifted their income sources since 1997. We chose 1997 because the following year (1998), the area endured a year-long extreme drought, one of the worst in recent memory, causing many households to reconsider and re-strategize how they meet their needs. In addition, projected increase in climatic variability together with ongoing social and economic changes suggests an uncertain future for Samburu. A better understanding of pastoralists' coping in the context of recent change helps reduce future uncertainty, along with the potential to support household adaptation from various scales of intervention.

The purpose of this study was to characterize income diversification and pastoralism changes between 1997 and 2017, and to identify characteristics that contribute to household decisions to diversify their income sources or remain primarily focused on pastoralism as the primary and/or only household income source.

## Review of literature

Prior research is abundant on the topic of pastoralists' adaptation to change, though there are varying definitions in the abundance of studies about what constitutes adaptation to change. For this study, we use Smit and Pilifosova's (2001) definition: "an adjustment in ecological, social, or economic systems in response to observed or expected changes in environmental stimuli and their effects and impacts in order to alleviate adverse impacts" (p. 881). The rationale for our selection is based on the latter part of the definition, "to alleviate adverse impacts". As described earlier, our study area endured a number of extreme droughts over the past 20 years, and therefore, this definition of adaptation to change fits the context of our study area well, as droughts have challenged household capacities to alleviate adverse impacts.

A Web of Science literature search produced more than 800 peer-reviewed articles published since 2000 using the keywords "pastoral\* AND adapt\*," and more than 100 specifically on the topic of income diversification (using search terms "pastoral\* AND income AND "divers\*"), with more than half of the latter published since 2014. Overall, the effectiveness of income diversification is reasonably well supported in research (see Achiba 2018; Homewood et al. 2006; McPeak et al. 2012). However, there are some articles that challenge the finding that income diversification, particularly into non-pastoral alternatives, is positive (e.g., Watete et al. 2016). Some scholars noted that non-pastoralism income diversification in East Africa is not a viable long-term strategy and pastoralists will eventually return to herding animals (see Homewood et al. 2009) or that diversification can contribute to dropping out of pastoralism and into less stable income options (see Bonneau 2013). Conversely, others argued that, in some regions, rangelands are so deteriorated that pastoralists should look to only non-herding options (see Blackwell 2010), as rangelands can become degraded to a point where they essentially cannot be restored.

In a 2009 policy brief by Little and written on behalf the Common Market for Eastern and Southern Africa (COMESA), the authors challenged the notion that all income diversification for pastoralists is good (in the long run), and they further recommended practitioners avoid a "one size fits all" mentality when considering how to support livestock herders as they adapt to social-ecological change. In the authors' analysis of income diversification in Eastern Africa, they concluded that income diversification that remains within a context of pastoralism (e.g., dairy production, selling hides, and skins) was more viable than unrelated (and sometimes ecologically destructive) options such as agriculture or charcoal production. The COMESA brief further suggested that wealthier households are better equipped to adapt to more lucrative income-earning alternatives and can also invest in formal education for family members, which can result in

higher paying and salaried positions. Poorer households, on the other hand, often adapted through less lucrative and less stable unskilled labor jobs, causing income insecurity and income inequality within a region to persist (see also Little et al. 2008).

Income diversification and herd composition are just two variables for consideration when determining vulnerability and adaptive capacity of pastoralists. Extensive literature discusses livelihood responses common among pastoral households with low to no additional income, particular in times of drought (Doss 2001; Oba 2013). Household size (Opiyo et al. 2014; Wan et al. 2016), characteristics of head of household such as gender and formal education levels (Opiyo et al. 2014), social capital (Miller et al. 2014; Ng'ang'a et al., 2013), and access to information and extension services (Opiyo et al. 2015; Sewando et al. 2016) are among many other factors addressed by previous research.

Closer to our study site, Opiyo et al.'s (2014) study of the vulnerability of more than 300 households in northwestern Kenya in a region adjacent to our site noted that households lacking non-pastoral income sources (to complement livestock herding), and households with fewer and less diverse livestock herds, were more vulnerable during drought, floods, disease outbreak, and similar shock events. A second study in 2015 using the same dataset revealed that investment in formal education (typically driven by the belief that it leads to steady employment) and income diversification were among the most practiced adaptation strategies by households in the region during shock events (Opiyo et al. 2015). Similarly, income diversification is advocated for, or at least noted as a common strategy, in research conclusions in other areas of East Africa, including northern Tanzania (Sewando et al. 2016) and Ethiopia (Dinku 2018), and more broadly in studies from other pastoral regions of the world such as the Andean Mountains in South America (López-i-Gelats et al. 2015) and the Hindu Kush Himalayan region of Asia (Ning et al. 2014).

In Blackwell's (2010) article about livelihood strategies in northern Kenya, the author concluded that the future of pastoralism in the region is austere, and pastoralists should forego herding altogether given the uncertain effects of climate change and increasing frequency of tribal conflict as a result of unstable livestock-based livelihoods. The author suggested that humanitarian organizations shift their focus to training pastoralists in non-livestock livelihood options rather than livestock husbandry strategies. In this instance, the author's position is less about income diversification to complement pastoralism; rather, the author advocated foregoing pastoralism altogether.

An alternative or complementary strategy to income diversification for pastoralists is destocking (i.e., reducing herd size through selling livestock), but not abandoning pastoralism altogether. In a study of more than 600 households in arid and semi-arid regions of Kenya, Silverstri et al. (2012) noted

that destocking was among the most common response by households during climate shock events and was practiced more frequently among poorer households. However, destocking was less likely among households located farther from large markets and settlements, a characteristic that places pastoral households at more risk in general (Opiyo et al. 2014). Further, Homewood et al. (2009) noted that some Maasai pastoralists in Tanzania are reluctant to sell any livestock at all during drought or similar climate shock events, and others even seek to accumulate livestock as a response to threat, though Ng'ang'a et al. (2013) found only weak evidence to support acquisition as an effective strategy in their study in Samburu, Kenya, the same area as our research. Overall, the literature is mixed on the effectiveness of destocking as an effective adaptation strategy.

Many of the articles we examined were supportive of income diversification in their discussions and conclusions, but few included measures related to assessing if income diversification actually influenced desirable well-being outcomes (this is true of our own study, as well). Woodhouse and McCabe (2018) measured constructs such as security, autonomy, and social unity among Maasai pastoralists in northern Tanzania. Despite their specific outcomes of interest, one of the study's major conclusions emphasized the ineffectiveness of thinking of pastoralists as a homogenous group; the authors noted that households defined well-being in vastly different ways. Further, Östberg et al. (2018) studied well-being outcomes in a similar region of Tanzania and discovered that income diversification achieved through farming resulted in a diversity of benefits related to housing security, schooling for children, and year-round self-sufficiency.

Previous literature suggests that we should have expected to see some level of livelihood diversification in our study. Indeed, diversification of rural livelihoods, including income sources, across sub-Saharan Africa has increased over our period of study (Davis et al. 2010; Ellis 2000; Loison 2015). As a rule, rural people experience variation in the constraints they face, which shapes different income strategies in different households and in different regions, making generalizations regarding the benefits of diversification is challenging (Barrett et al. 2001). Moreover, as with the pastoralist literature reviewed above, research on diversification debates the impacts on well-being and the sustainability of evolving diversified livelihood strategies (e.g., Bryceson 2007; Östberg et al. 2018). Therefore, although we expect to observe evidence of diversification measures such as destocking and accessing formal education, the questions remain of who among the Samburu diversify their livelihoods and for what reasons. We aimed to characterize income diversification of households in Samburu, Kenya, since 1997, and to further analyze the differences between households that chose to diversify and those that did not.

## Methods

### Study area

Samburu County lies in north central Kenya with a population of approximately 300,000 people (see Fig. 1; Samburu County Government 2017-18). It covers more than 21,000 km<sup>2</sup> of land, land that is a rugged scrub and rangeland landscape that supports tens of thousands of livestock and wildlife individuals, though the increase in non-cattle livestock and a simultaneous decrease in populations of all wildlife species in the past 40 years are stark (Ogutu et al. 2016). Average annual precipitation is 200 to 250 mm, which typically falls between a long rain season of March through May and a shorter season between November and December.

However, as noted earlier, rainfall has become less predictable, and northern Kenya has endured three extreme and two moderate droughts since 1995 (as determined by rainfall data; see Opiyo et al. 2015). During the most extreme droughts in 1998 and 2009, the region experienced no rainfall for more than 9 months in both years. As a result, perennial water sources dried, rangeland condition deteriorated to periods rated severe by Kenya's National Drought Management Authority, and wildlife and livestock populations suffered tremendous loss due to lack of food and water. Pastoralists suffered as well, due not only to the stress on (and loss of) livestock which adversely impacted provision of milk, blood, and meat but also due to sharp declines in livestock prices,

increased distances needed to travel to water sources and similar challenges. These impacts were true in the specific region of our study, in the Samburu East District of Samburu County. This district consists of a land area of 10,049 km<sup>2</sup> (Kenya National Bureau of Statistics 2009; Ng'ang'a et al. 2016; see Fig. 1).

Pastoralism has dominated as a livelihood in the region for hundreds of years (Spencer 1965). Herders primarily raise cattle, goats, and sheep, and to a lesser extent, camels and donkeys. Livestock not only serves as an income source and livelihood but livestock also carries cultural significance to many tribes in northern Kenya and serves as an indicator of status. The region is populated with members of many tribes, including the Samburu, Turkana, Rendille, Borana, and others, though this study focused only on the Samburu tribe.

### Sample

Participants in the study were recruited through a combined snowball and convenience sampling approach. Randomized sampling was not feasible due to geographic and practical constraints, such as the lack of a viable sampling frame and the difficult terrain for both identifying and accessing some households. In addition, many pastoralists rarely stay in one place for long periods of time, particularly during drier periods (which was the time period during our study).

A Samburu researcher determined, using word of mouth with networks of pastoralists, the general location of recent temporary villages (i.e., convenience sampling). On a given day, the researcher drove along the main highway (a defacto baseline), turned, and proceeded to look for one of the identified villages as the day's starting point. This route to a village became a defacto transect. Our researcher continued until coming upon a village, which was typically within 1 to 1 km of the highway. Villages traditionally are comprised of up to a dozen housing structures supporting members of one family, usually up to 25 or so family members. Upon arrival, the researcher approached an elder to explain the purpose of the project and requested to interview one individual from the village, using inclusion criteria that they needed to be knowledgeable about a household's livelihoods and herd composition in 1997. Typically, the first adult who met the researcher also was the one to participate in the interview.

After completing the interview, our researcher continued driving along the same direction/transect, to the extent possible given limitations of terrain, away from the main highway, using advice from the interviewee to confirm likely village locations, and consulting with people along the way as he drove (i.e., snowball sampling). He continued until reaching another village, which needed to be at least 2 km from the prior interview location to maximize the likelihood of reaching an unrelated family than the previous interview, repeated the interview protocol, and continued in the same



Fig. 1 Samburu County, Kenya

direction/transects to identify the next village, up to 40 km away. On the next interview day, our researcher traveled in the opposite direction from the highway to identify village locations and conduct interviews.

Despite the inherent limitations of conducting household interviews in this region, we are confident that our sampling strategy produced a representative sample because households generally do not differ in relevant characteristics based on distance to highway, and the word of mouth communication with our researcher spanned various local social networks.

Interviews continued until 50 interviews were completed within 10 km of the nearest large town (i.e., Archer's post), and 50 interviews completed with individuals who lived greater than 10 km from the town. This approach enabled the researchers to differentiate livestock holdings and income diversification based on distance to settlements, which literature suggests should be a notable comparison point.

The primary researcher for this project is native to the area, with many years of herding animals in his own experience. The local Samburu language, *Maa*, is his first language and his surname is known to many people in the region. This background helped establish rapport quickly with most interviewees.

## Instrument

Structured questionnaires were used to collect data during face-to-face interviews. The interviews were conducted in the native Samburu language by a member of our research team from the region. Responses were recorded and later translated to English. For each respondent, household demographic information was collected, including age and sex of the survey participant, and number of people in the household. We asked questions about livestock holdings in 1997 and 2017, including numbers of specific livestock species. Income source information was asked, including what the respondent considered to be the household's primary income sources (later categorized as "pastoral" or "non-pastoral"), as well as a list of all income sources in 1997 and 2017. Finally, we asked questions about sufficiency of access to grazing lands in 1997 and 2017. While the use of recall introduces opportunities for error or recall bias, it can be minimized through standardized data collection, a well-structured survey or interview protocol, extending sufficient time for responses and other strategies (Hassan 2005).

## Analysis

A two-step cluster analysis was run to identify subgroups within the sample. This approach was used because of the option to analyze categorical and continuous data together, and results indicate the strength of specific variables in distinguishing the clusters; these are two of the primary

advantages of the two-step cluster analysis (Tkaczynski 2017). In this study, our analysis started with 15 variables related to household characteristics (e.g., distance from nearest town, number of people in household), overall income source measures (e.g., number of income sources, changes in number of income sources between 1997 and 2017, pastoralism as an income source), livestock holdings (e.g., number of cattle, goats and sheep, and camels; total number of livestock species), and grazing characteristics (e.g., current sufficiency of grazing land, accessibility of grazing land), all asked in terms of 1997 and again in 2017.

Multiple measures were used to assess acceptability of the two-step cluster analysis solution: an overall positive (i.e., > 0) silhouette score (Norusis 2008, 2011), a silhouette score of at least 0.60 (Sarstedt and Mooi 2014), and predictive importance of individual retained variables of at least 0.40 (Martic-Kehl and Folkers 2015). Only variables that met or contributed to these metrics were retained, a process borrowed from Tkaczynski (2017). Finally, group comparisons of the clusters were run via one-way ANOVAs and paired-sample *t* tests to examine intra- and inter-group differences (which also validates the two-step cluster solution) and reveal the importance of individual variables to specific groupings (Norusis 2008, 2011). Where applicable, we used a statistical significance value of  $p < 0.05$ . All analyses were run in the Statistical Program for the Social Sciences, Version 25.

## Results

The two-step cluster analysis resulted in three distinct clusters. We labeled the three groups as "traditional" ( $n = 10$ ) which illustrated a high level of livestock ownership and pastoralism as the primary income source, "transitioning" ( $n = 57$ ) which illustrated lower levels of livestock ownership but pastoralism remained as the primary income source, and "diversified" ( $n = 33$ ) which represented the lowest levels of livestock ownership, and a non-pastoral primary income source. While the difference in the size of the groups was greater than what is preferable, and the smallest cluster included only 10 cases, we retained them because of the important distinctions between all three groups on a number of dependent variables, and the high degree to which the groupings resonated with people in the community in our follow-up discussions.

The groupings were based on four (of 15) retained variables from the two-step cluster analysis: number of cattle in 2017, number of camels in 2017, number of sheep and goats in 2017, and primary income source in 2017 as pastoral or non-pastoral, resulting in a silhouette score of 0.80 and predictive importance scores of at least 0.67 for each of the four retained variables (see Tables 1 and 2).

We conducted a paired-sample *t* test to compare livestock ownership of all three groups between 1997 and 2017. For this

**Table 1** Two-step cluster groupings of Samburu pastoralists<sup>a</sup>

Cluster	Number of Observations
1: Traditional Pastoralists	10
2: Transitioning Pastoralists	57
3: Diversified Pastoralists	33
Total	100

<sup>a</sup> cluster strength = 0.80

analysis, we adapted a singular measure of total livestock ownership initially developed by Schwartz et al. (1991) based on estimates of one livestock unit as the equivalent of 1.0 cows, 0.7 camels, 10 sheep, and 11 goats. In conversations with and to honor the input of elders in this community-based project, we adjusted this calculation to be 12 for both sheep and goats, and other estimates remained the same. Table 3 illustrates an increase (more than double) in the number of livestock units for traditional pastoralists, and a decrease for both transitioning, and diversified pastoralists ( $p \leq 0.01$  for all three groups; see Table 3).

We examined specific livestock holdings within each of the three groups to measure the extent to which herd composition changed between 1997 and 2017. For all three groups, the percentage of the herd comprised of sheep and goats increased, the percentage of cattle decreased, and the percentage of camels remained relatively unchanged. Nearly all 1997 and 2017 intragroup comparisons were statistically significant (see Table 4).

We further examined differences between the three groups based on eight dependent variables of interest using the Scheffe option for post hoc group comparisons in the one-way ANOVA. In each instance except for “Total Livestock Units in 1997,” we found statistically significant differences ( $p \leq .03$ ). In five of seven variables with statistical significance, the significant difference existed between the traditional and diversified groups, and transitioning differed from neither group.

For “Total Livestock Units in 2017,” traditional differed significantly from transitioning and diversified, and for “kilometers to town,” traditional and transitioning differed from diversified. See Table 5 for a summary of ANOVA results.

Finally, we examined the different non-livestock sources of income for each of the three groups in 2017. Results indicated that the traditional group had the lowest participation in non-livestock sources and the lowest mix of overall non-livestock sources, with only one or two individuals involved in various options. The transitioning group had more participation, primarily in casual labor (22.8%, e.g., unskilled labor, temporary jobs) and family remits or government assistance (47.4%). The diversified group showed the highest participation in non-pastoral income sources, and across the greatest variety of options including tourism-based income (15.2%), salaried positions (21.2%), charcoal or murrum sales (36.4%), family remits and government assistance (42.4%), among others (see Table 6).

## Discussion

In our study, 100 pastoralists generally did not differ (statistically) in 1997, though 20 years later, there were many differences among the measured variables related to livestock holdings and livestock-based income sources. This was revealed by the type of variables retained in the cluster analysis and the group comparisons that followed. In the 20 years between 1997 and 2017, 90 of the 100 pastoralists destocked substantially and picked up non-livestock income sources, and the remaining 10 increased their herd size considerably and added minimal non-livestock income sources. In fact, the “transitioning” pastoralist had the most livestock units of all three groups in 1997, yet they were not the group that increased their herd size; it was the traditional group that grew their herds the most between 1997 and 2017.

**Table 2** Values of retained variables in Samburu pastoral cluster groupings

Variable	Group		
	Traditional	Transitioning	Diversified
Primary 2017 income source is herding <sup>a</sup>	90%	100%	0%
Mean number of goats/sheep in 2017 <sup>b</sup>	349	56	30
Mean number of cattle in 2017 <sup>c</sup>	44	6	4
Mean number of camels in 2017 <sup>d</sup>	11	1	<1

<sup>a</sup> predictive importance = 1.0

<sup>b</sup> predictive importance = 0.97

<sup>c</sup> predictive importance = 0.87

<sup>d</sup> predictive importance = 0.67

**Table 3** Livestock unit comparisons between 1997 and 2017 for three Samburu pastoral groups

	1997 Livestock Units		2017 Livestock Units		<i>t</i> -value	<i>p</i> -value
Traditional	41.6		88.6		3.03	0.01
Transitioning	45.3		12.2		3.91	< 0.01
Diversified	24.7		6.8		2.96	< 0.01

Many of the specific characteristics of the traditional, transitioning, and diversified groups are consistent with prior literature. The traditional group generally has larger herds and fewer income sources, lives farther from towns, and has generally kept more a more diverse livestock herd than their transitioning and diversified peers. Their larger household sizes provide greater capacity to tend to the large herd sizes (see Opiyo et al. 2014), and locations farther from towns can provide access to healthier rangelands for their livestock since they may be grazed less intensively. Given the big herd sizes, it is also unsurprising that traditional pastoralists have fewer income sources and more diverse livestock herds, given they appear to adhere to pastoralism as the primary, if not only, income strategy. Opiyo et al. (2014) would likely consider this a risky approach, and Ng'ang'a et al. (2013) found weak evidence for increasing a herd size as a viable response to system threats.

Each of the three groups increased the number of household income sources between 1997 and 2017, with the diversified group, on average, adding the most of the three groups. The diversified group also showed the greatest mix of income sources, with at least 15% of diversified individuals participating in any one of the eight options reported in this study. By contrast, the traditional group reported two individuals at most receiving non-pastoral income sources, which is unsurprising given this is the group that has retained livestock the most for income.

Interestingly, family remits and government assistance were reported by 47% of households in the transitioning group and 42% diversified households. While our study did not address issues around financial security, food security, and related concepts, the high number receiving this income raises questions about whether a movement toward non-pastoral income aligns with issues of insecurity. Our study did not

address the relationship between this potential insecurity and livestock holdings (e.g., which one preceded the other), and it would be an area of interest for future research in this study. Was their instability or insecurity in raising livestock that led to a shift to non-pastoral income sources or was the shift due to other drivers?

These changes follow a number of improvements in the region during the 20 year period that was the focus of our study, including the completion of a tarmac highway in 2014 that replaced a notoriously corrugated and rough road. In 1997, leaving the general region was rare; vehicles were few and the journey to larger cities and markets involved considerable time, expense, and discomfort. Today, the area is served frequently each day by large busses traveling north to Ethiopia and south to Nairobi; smaller public busses (i.e., matatus) pass through the region multiple times per day to closer-by towns, and the area is accessible by non-4WD vehicles that bring a diversity of produce and household goods that were previously unavailable. As a result, the number of small shops (i.e., dukas) has increased tremendously.

The capital improvements have also led to a number of temporary and permanent job opportunities, often in unskilled labor such as road construction, gravel and sand mining, ditch digging, and similar jobs. A service industry has emerged with the addition of small restaurants and guest hostels, as well, given the greater availability of supplies and food, and the overnight or stopover stays of lorry drivers, adventuring tourists, and government and NGO staff. Regional NGOs have worked with women's groups to help women launch small businesses, including the production of beadwork for tourist markets throughout Kenya.

Prior literature, in our synthesis, tends to frame income diversification, destocking or growing herds, and other strategies, mostly as choices to avoid negative impacts. In

**Table 4** Livestock holdings in 1997 and 2017 for three Samburu pastoral groups

Livestock type	Traditional Group				Transitioning Group				Diversified Group			
	1997	2017	<i>t</i> -ratio	<i>p</i> -value	1997	2017	<i>t</i> -ratio	<i>p</i> -value	1997	2017	<i>t</i> -ratio	<i>p</i> -value
Cattle	24.3	44.1	-1.69	0.13	30.6	6.1	3.91	<0.01	19.7	3.9	2.91	<0.01
Goats & sheep	101.8	349.0	-3.31	<0.01	104.6	56.1	3.19	<0.01	60.0	29.8	2.29	0.03
Camels	6.2	10.8	-2.14	0.06	4.2	1.0	6.57	0.04	0	0.3	1.13	0.27

**Table 5** ANOVA comparisons of three Samburu pastoral groups on key variables<sup>1</sup>

	Groups			<i>F</i> -value	<i>p</i> -value
	Traditional	Transitioning	Diversified		
Total no. of income sources, 2017	1.6 <sup>a</sup>	2.0 <sup>a,b</sup>	2.7 <sup>b</sup>	8.78	<0.01
Change in no. of income sources, 1997-2017	+6 <sup>a</sup>	+9 <sup>a,b</sup>	+1.5 <sup>b</sup>	4.85	0.01
Total livestock units, 1997	41.6 <sup>a</sup>	45.3 <sup>a</sup>	24.7 <sup>a</sup>	1.17	0.31
Total livestock units, 2017	88.6 <sup>a</sup>	12.2 <sup>b</sup>	6.8 <sup>b</sup>	139.97	<0.01
Total livestock species, 1997	2.4 <sup>a</sup>	2.2 <sup>a,b</sup>	1.8 <sup>b</sup>	3.76	0.03
Total livestock species, 2017	2.8 <sup>a</sup>	2.0 <sup>a,b</sup>	1.8 <sup>b</sup>	9.5	<0.01
No. of people in household	10.2 <sup>a</sup>	7.6 <sup>a,b</sup>	6.7 <sup>b</sup>	3.74	0.03
Km to nearest town	20.7 <sup>a</sup>	17.2 <sup>a</sup>	6.9 <sup>b</sup>	12.67	<0.01

many of our follow-up conversations with elders, young people, highly educated (in formal schools), and less educated, most of them acknowledged that reducing risk to livestock can be part of household consideration to adopt non-livestock income sources, but there appeared to also be salience across our conversations that some individuals want to pursue non-pastoral options for other reasons. Sometimes the choice is a simple as a non-livestock opportunity resonates with someone's interests or curiosities. Our question here is centered on the impetus for the adaptive behavior. To what extent is it to avoid adverse impacts (as literature often suggests) versus other catalysts that are not necessarily rooted in coping with risk.

We reviewed our findings informally with a number of individuals in the region and results resonated closely with many of them. Each individual could think of someone they knew that "fit" each of the three groups. Further discussion with them is consistent with one of our thoughts after reviewing and analyzing a shortcoming in the literature: the

shift from one mostly homogenous group in 1997 to three distinct groups in 2017 might not be the result of individuals choosing different strategies for alleviating adverse impacts on livestock and rangelands from social-ecological change. The shift might also be explained by differences in what is available in 2017 compared with 1997 in terms of opportunities, some of which are more appealing to individuals for potentially many reasons.

One young man of approximately 20 years owned no livestock, but owned a small shop, and picked up temporary jobs here and there as his primary income sources. He expressed that herding livestock sounded less appealing than other job options he learned about in school. He also acknowledged that keeping livestock seemed too risky and volatile (mostly due to tribal conflict), so his decision to forego livestock was partially influenced by reducing risk. He described his father as "confused by (the young man's) decision" to sell the few livestock he acquired earlier in adolescence, and the young man assumed that his father, without any formal education

**Table 6** 2017 income sources for three pastoral groups in Samburu Kenya<sup>1,2</sup>

Income Source	Traditional <sup>1</sup>	Transitioning <sup>2</sup>	Diversified <sup>3</sup>	Chi-square	<i>p</i> -value
Livestock	100.0	100.0	33.0	95.9	<.01
Salaried job	10.0	0	21.2	12.8	<.01
Casual-Temporary-Unskilled Labor	10.0	22.8	21.2	0.8	0.66
Small business	10.0	3.5	18.2	5.5	0.06
Tourism	0	10.5	15.2	1.8	0.40
Fuelwood / Charcoal / Murrum	0	3.5	36.4	20.5	<0.01
Rental rooms	10.0	1.8	9.1	3.0	0.23
Transportation	0	1.8	3.0	0.4	0.82
Family remits/Government or NGO assistance	20.0	47.4	42.4	2.6	0.27

<sup>1</sup> Cells in columns of three groups represent percentages<sup>2</sup> 10% of sample<sup>3</sup> 57% of sample<sup>4</sup> 33% of sample

and who had rarely left the immediate area in his lifetime, may not ever really understand the young man's choices.

An elder woman, a transitional pastoralist based on our groupings, with whom we spoke kept a modestly sized herd of goats and sheep, because, she said, herding is what she knows how to do, and she is uncomfortable with the idea of a bank holding her money. She also started selling beadwork about 10 years ago to earn supplemental income and would prefer to grow her beadwork business and have a smaller livestock herd because of the opportunity costs of herding. However, she did not like the idea of completely destocking because of her values around honoring tradition and cultural heritage. She also said she does not expect her children to herd livestock; she realized that they are likely to be interested in other pursuits. Her son, a young adult who completed secondary school, owned no livestock because he does not like the hassles and stresses of finding someone to herd his animals while he works elsewhere.

An elder man, a traditional pastoralist by the definition of our groupings, suggested that his community is simply becoming more diverse in its thinking; he was unsure if destocking or increasing herds were generally to alleviate negative outcomes or instead driven by other sociological factors. He worries, however, that if too many people opt to not keep livestock, the cultural identity of the Samburu tribe will become muddled. Each of his six sons own livestock, though typically two of the sons herd the livestock belonging to the father, his other four sons, and an uncle. The father thought this could be an approach that would retain cultural heritage, since at least two sons were herders and all sons still owned livestock, while still providing opportunities for others to pursue non-herding options.

Our study did not measure if any of our groups were doing better than the other two, whether that be defined by assets, health indicators, access to formal education, or a number of other possible measures. Though as we noted with Woodhouse and McCabe (2018), well-being measures should reflect the priorities of the groups being measured, with consideration given to the heterogeneity that exists within groups. Our findings also resonate with Woodhouse and McCabe's advice for researchers and conservation practitioners to employ a disaggregated approach, in this case for addressing pastoralists' adaptation to change through income diversification, a position emphasized in the COMESA (2009) brief described earlier, as well. There are a multitude of reasons, which our follow-up conversations demonstrated, that might propel a pastoralist to destock, increase their herd, or pursue other income sources, some of which might be related to alleviating adverse impacts from social-ecological change, but might also simply reflect changing times as people have more options available to pursue than before. Future studies in this region could provide insights in why pastoralists add (or not) income sources or change the composition of their herds, and

the extent to which such decisions are motivated by mitigating negative impacts of systematic change in their regions.

In sum, the results of our research, and the ensuing conversations with local people about the results, point to a criticism of some prior literature about pastoralism regarding income diversification: changes by pastoralists in income sources and related herd composition are too often assumed to be driven by a need to avoid adverse impacts, and such decisions are likely more complex and influenced as well by other sociological factors and individual preferences. Barrett et al. (2001) presented these as push and pull factors; risk management and avoiding adversity are push factors into income diversification, while responding to opportunities (adversity aside) are pull factors. Second, as the COMESA (2009) report advocated, there is tremendous diversity within a group of pastoralists, and as such, there is no singular understanding or singular recommendation that accurately applies to the group, in this case, pastoralists in northern Kenya. Practitioners and researchers are urged to keep that diversity firmly in mind as they seek understanding and develop options to support these groups.

## Limitations

Our study did not measure if any of the three groups were better off, as measurable by a number of possible variables related to health, security, fulfillment, and similar measures. There are many options to consult for conducting this type of work, building from the abstract capabilities approach that measures the various capacities of an individual to achieve desired outcomes (see Robeyns 2016), to tangible measures such as material assets and type of housing structure noted by Woodhouse and McCabe (2018) in their work. In addition, our sampling design and research goals did not account for individuals who had left the community entirely. Our groupings and results could change if our sampling accounted for individuals who relocated to other parts of the country.

**Acknowledgments** We thank the 100 pastoralists who contributed their information, perspectives, and time to help us document this work and the changes in their community. Thank you also to the individuals in Samburu with whom we shared our results for their input, contributions, and wisdom.

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