



Pastoral coping and adaptation climate change strategies: Implications for women's well-being

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ABSTRACT

Pastoral women in the semi-arid rangelands of East Africa are significantly burdened by the vulnerability to and responsibility for responding to changing climates. Consequently, understanding how adaptation and coping strategies impact pastoral women's well-being is critical for supporting the climate resilience of communities and the landscapes on which they rely. We used a household survey, guided by a multi-dimensional framework of well-being, to investigate how the use of drought-related coping and adaptation strategies by Samburu households influenced livestock loss and women's well-being in northern Kenya. Coping and adaptation strategies predicted numerous social-cognitive components of well-being, although not livestock loss. We conjecture these results are a product of a gendered division of labor within households and the community. We argue that interventions aimed at supporting drought resilience must consider the gendered implications of climate response strategies, multiple indicators for evaluation, and the influence of community and place.

1. Introduction

There are significant inequities in the distribution of the impacts of and responsibility for the climate crisis. Specifically, a small number of high-income countries are responsible for the majority of CO₂ emissions driving global climate change. At the same time, low-income countries who are least responsible for CO₂ emissions are affected greatly by impacts (Althor et al., 2016), particularly communities where livelihoods are heavily and directly reliant on natural resources (Thomas and Twyman, 2005). As a result, supporting climate resilience in these communities is an important priority. Pastoral communities in the semi-arid regions of East Africa are one group facing such intense impacts (Field, 2014), yet carry little to no responsibility for the current climate crisis.

Pastoral women are at the very center of this inequitable paradox. They shoulder a significant portion of the household burden for responding to climate change (Anbacha and Kjosavik, 2019b; Balehey et al., 2018) and simultaneously face multiple gendered barriers (e.g., lack of access to credit, land tenure rights, gendered violence) that make it difficult to do so (Anbacha and Kjosavik, 2019a; Balehey et al., 2018; Venkatasubramanian and Ramnarain, 2018). Understanding how pastoral households respond to drought, and the gendered impact of these

responses, is critical for identifying potential strategies and interventions aimed at supporting the climate resilience of pastoral women and their communities. Furthermore, the resilience of communities is inherently connected with rangeland health (Fernández-Giménez et al., 2018). Understanding the gendered impacts of drought responses in more depth, especially livestock related responses, has important implications for predicting both the positive and negative consequences of community climate resilience interventions on local rangelands.

Past research focused on the gendered impact of climate change in pastoral regions has been limited in two important ways. First, studies have yet to compare the gendered impacts across different types of response strategies (i.e., coping versus adaptation; see Balehey et al., 2018; Opiyo et al., 2015). Second, drought impacts are frequently measured by livestock loss (see Goldman and Riosmena, 2013; Nke-dianye et al., 2011). Livestock loss is an obvious and relevant indicator, particularly when thinking about rangeland impacts, but tells an incomplete narrative. Our study overcomes these limitations by specifically comparing the gendered impacts of households' use of two distinct types of response strategies: coping and adaptation. We also include subjective measures of well-being in addition to livestock loss, in our investigation of drought impacts.

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1.1. Pastoral drought response

Pastoralism is a livelihood strategy dependent on the raising of livestock for achieving income and food security. In most pastoral societies, livestock also carry significant cultural value (Dyson-Hudson and Dyson-Hudson, 1980). In the arid and semi-arid regions of East Africa, changes in climate have had significant negative impacts on pastoral livelihoods. Specifically, the increasing occurrence and intensity of drought events have resulted in a reduction in the predictability and quantity of pasture and water points (Brown et al., 2017), both of which are imperative natural resources for pastoralists.

Pastoralists in northern Kenya have historically relied on mobility as their primary strategy for responding to drought (Dyson-Hudson and Dyson-Hudson, 1980). However, recent institutional and socio-economic trends, such as land privatization, insecurity and anti-pastoral government policies, undermine pastoral grazing and limit mobility (Dabasso et al., 2019; Goldman and Riosmena, 2013). Subsequently, pastoralists rely on other strategies such as diversifying livelihoods, importing fodder, and changing herd composition to further respond to drought (Opiyo et al., 2015; Wako et al., 2017). Factors such as access to credit, formal education, gender, age, wealth and geographic location can influence whether a household is able to adopt such strategies (Opiyo et al., 2014).

Literature exploring community and household response strategies to climate change have categorized responses as either *coping* or *adaptation* strategies (Eriksen and Kelly, 2007; Gebeyehu et al., 2021). Morton (2007) stresses the distinction between coping and adaptation: adaptation strategies reduce long-term vulnerability to climate shocks while coping strategies manage and reduce the impact of shocks which are already occurring. This distinction is particularly salient in literature focused on pastoral livelihoods (see Morton, 2007; Opiyo et al., 2015; Venkatasubramanian and Ramnarain, 2018).

Coping strategies can further be defined as temporary adjustments that tend to be reactive and aimed at restoring or maintaining a previous state (Opiyo et al., 2015; Eriksen and Kelly, 2007; Venkatasubramanian and Ramnarain, 2018). This may include changing herd size numbers, increased reliance on bush products, or supplementing additional fodder (Opiyo et al., 2015; Venkatasubramanian and Ramnarain, 2018). In contrast, *adaptation strategies* are long-term proactive adjustments to current and future stressors, (Eriksen and Kelly, 2007), and include strategies such as livelihood diversification, shifts in livestock grazing regimes, and changes in herd composition (Opiyo et al., 2015; Venkatasubramanian and Ramnarain, 2018). Studies that have applied this coping/adaptation distinction highlight the complexity of studying coping and adaptation strategies, as evidence suggests that many pastoral households engage in both types of strategies simultaneously (Venkatasubramanian and Ramnarain, 2018; Opiyo et al., 2015).

1.2. The gendered nature of drought

Several studies have investigated how climate change impacts, specifically drought, affect pastoral women (Anbacha and Kjosavik, 2019b; Ongoro and Ogara, 2012). Pastoral women in East Africa face “double marginalization” due to the intersection of their identities as *women* and *pastoralists* (Eneyew and Mengistu, 2013). This marginalization influences their vulnerability to climate change, the capacity to respond, and the impacts of those responses (Balehey et al., 2018; Eneyew and Mengistu, 2013; Ongoro and Ogara, 2012). More specifically, marginalization limits pastoral women’s ability to own land and livestock, access formal education, and acquire non-pastoral employment, all of which would otherwise increase an individual’s capacity to cope or adapt to climate stressors (Gurmu, 2018). Women’s limited access to these opportunities is intensified by the increase in “women’s work” associated with climate shocks. Tasks such as collecting water and firewood, taking care of sick livestock, and herding small livestock become increasingly labor intensive during a drought (Gurmu, 2018).

Additionally, gendered marginalization and increases in the labor demands of women’s work is occurring at the same time as shifts in pastoral gender roles. These shifts are illustrated by increases in women’s responsibility over livestock and livelihood diversification, both of which are important climate shock responses for pastoral households (Anbacha and Kjosavik, 2019).

While this literature documents gendered differences in the impacts of and capacities critical for responding to climate change, there remains a significant gap in our understanding of how gender interacts with specific response strategies. This study seeks to fill this gap by centering the perspective of pastoral women as we investigate the impacts of coping and adaptation strategies.

1.3. Conceptual framework: resilience and well-being

Social-ecological systems theory defines resilience as the capacity of a system to tolerate disturbance without collapsing into a qualitatively different state (Adger, 2000). Resilience theory provides a holistic understanding of the impacts on and responses by social-ecological systems to disturbance and has become an increasingly important construct in the context of climate change (Bahadur et al., 2010). Proponents of resilience theory argue for its utility in looking beyond the immediate impact of a disturbance (e.g., livestock loss), to include the processes and actors within a system use to respond to a disturbance (Berkes, 2017). Scholars have further argued that resilience should not be the ultimate goal of interventions but rather an intermediate step to achieving more long-term goals such as well-being (Armitage et al., 2012; Béné et al., 2012).

In this study, we rely on a multi-dimensional framework developed by the Economic and Social Research Council’s Working Group on Well-being in Developing Countries (WeD) that defines well-being as the “state of being with others and the natural environment that arises where human needs are met, where individuals and groups can act meaningfully to pursue their goals, and where they are satisfied with their way of life” (Armitage et al., 2012; adapted from McGregor, 2008). The WeD framework posits that well-being is comprised of three dimensions: (1) what a person has (material), (2) what they can do with what they have (relational), and (3) how they think about what they have and can do (subjective) (Gough and McGregor, 2007). We chose to apply the WeD framework because it was designed explicitly for use in contexts where community livelihoods are dependent on natural resources (Britton and Coulthard, 2013), but has yet to be applied to investigate drought impacts and response strategies of pastoral communities. In this study, we used the WeD framework to guide our investigation of how households’ use of coping and adaptation strategies in response to drought, impact pastoral women’s well-being. We also investigate differences between livestock loss and socio-cognitive well-being as indicators of drought impact.

2. Materials and methods

2.1. Study area and the community

2.1.1. Climate and rangeland ecology

The semi-arid landscape of the Waso East district of Samburu County, Kenya, is approximately 4950 km². The climate is characterized by a bimodal precipitation pattern, with a cumulative average of 350 mm of annual rainfall and temperatures typically ranging from 18 to 30 °C. Recent increases in unpredictable precipitation patterns, specifically drought, are more frequent and thought to be a result of climate change (Opiyo et al., 2014).

In addition to shifts in climate, the regional landscape is experiencing several ecological threats. Both community members and previous literature describe the loss of perennial grasses and an increase in shrub and bush habitats over the last several decades, specifically the spread of small tree species such as *Acacia reficiens* and *Commiphora spp.* (Kimiti

et al., 2016). Research in the area has also documented parallel losses in the biodiversity and abundance of wildlife (Ogutu, 2016). These threats to overall rangeland health are further compounded by increased land fragmentation and intensified sedentary grazing of livestock (Vågen and Winowiecki, 2014). The interaction between these ecological disturbances and the impacts of climate change have resulted in decreased primary productivity of the rangelands, ultimately increasing the vulnerability of local pastoral livelihoods, as well as local flora and fauna (Ogutu et al., 2016).

2.1.2. Pastoralism and changing livelihoods

The greater Archer's Post community is the largest permanent settlement in Waso East, and home to approximately 6000 people (Samburu County Government, 2020). Historically transhumant pastoral groups including the Samburu migrated across this region in search of water and pasture (Spencer, 1965). However, the interaction of broad drivers including but not limited to colonialism, globalization, and post-colonial government policies have resulted in a shift toward more sedentary communities. As a result, alternative livelihoods such as small business and tourism enterprises have become increasingly common (Lenaiyasa et al., 2020). Despite these shifts, livestock and livestock-related livelihoods remain a primary livelihood strategy for many households in the area (Lenaiyasa et al., 2020).

2.1.3. Gender

The structure of Samburu communities is strongly influenced by gender and age. Traditionally, older men were considered community-decision makers, younger men were responsible for security and livestock, and women were responsible for domestic tasks such as caretaking, cooking, cleaning, and fetching water and firewood (Spencer, 1965). However, changes in culture and livelihood practices have shifted these roles, one of the most notable being the role and responsibilities of pastoral women. Examples of the shifting roles of women have been documented in several pastoral communities in East Africa and include increasing responsibilities for small scale livestock, non-livestock related livelihood activities and enrollment of children in school (Anbacha and Kjosavik, 2019a; Gurm, 2018; Karmebäck et al., 2015).

In addition, young men responsible for herding livestock are forced to move further away and for longer periods of time in search of healthy pasture for livestock, especially cattle. Simultaneously, sheep and goat husbandry has increased, and available herding labor has decreased as more children attend school. Subsequently, women's livestock-related responsibilities have increased significantly. These responsibilities have become more burdensome as quality pasture near settled areas has decreased.

The increase in women's livestock responsibilities has occurred alongside dynamic cultural practices and beliefs around polygyny, child marriage, female genital mutilation, domestic violence, and property rights that continue to limit the agency and well-being of women (Mwakio, 2017). These practices of gender marginalization are occurring at the same time as pastoral women and girls are experiencing increased access to education (Syomwene and Kindiki, 2015), improved agency over alternative livelihoods (Ongoro and Ogara, 2012) and increased representation in political leadership (UNDP, 2020). Samburu women are experiencing important gains in gender equity yet still experience gender-based barriers that limit opportunities to take advantage of such gains.

2.2. Research ethics

We received permission to conduct this research from local elders and community leaders, and the Institutional Review Board at Colorado State University (ID: 18-7927H). We used a community-based research approach (Minkler, 2004) to guide our research. Our research question was determined after interviewing community members to determine

local priorities for research. The study design was developed collaboratively with our local research team and community advisors. Data were collected by female team members from the local area and preliminary results and implications were discussed with study participants during several community meetings.

2.3. Data collection

Data were collected via a household survey in two communities within the greater Archer's Post region. The selected communities were chosen specifically because they represent a significant contrast in pastoral practices and lifestyle. Community A is located approximately 3 km (3 km) from Archer's Post town center and home to ~500 households. Community B is approximately 15 km from Archer's Post town center and home to ~240 households. Comparatively, Community A has significantly easier access to basic services (e.g., healthcare, schools, markets) than community B. However, Community B is home to larger livestock herds, has access to more unrestricted acreage for grazing, and members tend to practice a more traditional pastoral way of life, all of which can lead to differences between the communities including, but not limited to, gender roles, participation in formal education, and migration.

The survey was administered face to face between October and December of 2019. Our goal was to census each household in both communities. Our local team members visited each village in both communities and invited one woman (18+ years) from each household to participate in the study. In households where multiple women resided, the decision of who was going to participate was left to the household. This resulted in 125 participants from Community A and 75 from Community B.

2.3.1. Survey instrument

The survey was co-designed with our local research team and an advisory board and based on our previous work (Walker et al. 2021a, 2021b) which investigated Samburu women's well-being and impacts of the 2017 drought. The survey consisted of three sections and a combination of close- and open-ended questions. The first section focused on demographics of participants and their households. The second section focused on participants' self-assessment of their well-being, specifically their material, relational and subjective well-being (see Gough and McGregor, 2008). The third section focused on the coping and adaptation strategies households used in response to the 2017 drought, as well as reported livestock loss.

Our team used a collaborative and iterative approach (see Douglas and Craig, 2007) for translating the survey. The survey was originally written in English and then translated into Samburu by our local team members. Two local team members translated the survey individually, compared translations and collaboratively addressed any differences. A third team member checked the final translation, and the team of three addressed any final concerns.

Once translated, the survey was piloted with pastoral women from two villages in the region ($n = 40$) and minor adjustments were made. Local team members facilitated the administration of the final survey. Facilitators read the questions aloud to participants, and captured responses on an electronic tablet. The survey software, KoBo Toolbox, was programmed with both Samburu and English translations of all survey questions and responses to allow the non-local members of our team to review data in English.

2.3.2. Outcome variables

Our study focused on four key outcome variables. First, we asked women about livestock loss from the 2017 drought. We asked about the number of shoats [sheep (*Ovis aries*), and goats (*Capra aegagrus hircus*)] lost to the 2017 drought, using the 2017 drought as a notable event to anchor participants' recall (Kumar, 2002). We converted these numbers into a percentage loss for each household. We asked women about shoat

loss rather than total livestock loss because young male warriors herd cattle significant distances from Samburu settlements, often not returning home for the entirety of a drought event or dry season. Shoats, on the other hand, are more likely to stay with the settled household, and be herded by women or children. Consequently, women would have a better recall of shoaat loss, as well as the coping and adaptation strategies used by the household to mitigate the impacts of drought on shoaat herds.

The remaining three outcome variables focused on women's well-being at the time of the survey (approximately 1.5–2 years after the 2017 drought). The well-being indicators used in the survey were based on previous research with the same communities and designed to establish a culturally relevant and gender-specific framework for well-being. We chose one tangible indicator from each of the three dimensions from the WeD framework (i.e., material, relation, and subjective) based on variables that women highlighted as salient (Walker et al., 2021a). From the material dimension, we asked women about their food security, specifically asking them to estimate how many meals they skipped in the last month due to a lack of food. For the relational dimension, we asked about participants' sense of their ability to provide for their children, measured on a Likert scale of (1 = not at all, 5 = very much). From the subjective dimension, we asked women about their hope for the future, also measured on a Likert scale of (1 = not at all hopeful, 5 = very hopeful).

Previous literature has shown that traditional Likert scales can be difficult to use in populations with low literacy rates and across cultures (Flaskerud, 1988). To address this issue, participants were asked to respond to Likert-type questions using an image of a bar graph. Facilitators explained that the smallest bar represented "not at all" and the largest bar represented "very much." Each bar in-between was described using a different Samburu word that represented the spectrum of responses in between "not at all" and "very much." Participants were asked to place a rock on the bar that represented their answer. To familiarize participants with this system and increase the accuracy of their responses, each participant practiced using the bar graph by answering practice questions such as "how tired are you right now?"

2.3.3. Predictor variables

Predictor variables included the number of coping strategies and number of adaptation strategies each household used in response to the 2017 drought. The list of strategies was created based on preliminary interviews with women in the area, colleagues' prior research in the area, and relevant literature (e.g., Ongoro and Ogara, 2012; Opiyo et al., 2015).

The coping strategies measured in our survey included migration (with livestock) via walking, migration via truck, and supplementary feeding. Additionally, selling and buying livestock during the drought were also categorized as coping strategies, based on interviews and previous research in the community that indicated buying and selling are often a reactionary, temporary strategy with households returning to typical herd size once they can afford to do so.

Adaptation strategies included changing herd composition, participation in community rangeland planning, use of veterinary medicine vaccinations, and livelihood diversification (e.g., non-livestock sources of income). These strategies were categorized as adaptations because they reduce a household's vulnerability to current as well as future drought impacts and require significant investment.

Table 1 lists each strategy and the corresponding description and classification. Participants were asked if they engaged in any of the nine strategies during the drought of 2017. Participants were asked to think specifically about their shoaat herds when responding to livestock related strategies. Using this list of nine strategies, we created two predictor variables, created by summing the total number of coping strategies and the total number of adaptation strategies used by each household.

Table 1

List of coping and adaptation strategies.

Coping Strategies (5)	
Strategy Name	Strategy description
Migration via walking	Walking livestock more than a day's walk away from primary settlement to access pasture
Migration via truck	Moving livestock by truck to access pasture
Supplementary feeding	Buying non-pasture food sources such as vegetable scraps to feed livestock
Buying livestock	Buying livestock to increase herd size
Selling livestock	Selling livestock to reduce herd size
Adaptation Strategies (4)	
Strategy Name	Strategy description
Community rangeland planning	Working with community members and/or organizations to determine where and when to graze
Changing herd composition	Changing the species of livestock in herd
Using veterinary medicine	Providing livestock with medicine such as vaccines to prevent illness
Livelihood diversification	Investing resources in non-livestock related livelihoods

2.3.4. Control variables

Household demographic data were also collected. We decided on these variables based on previous literature and conversations with our local research team. These variables included: gender of head of household (e.g., Opiyo et al., 2014), formal education experience (e.g., Eneyew and Bekele, 2012), household size (e.g. Eneyew and Bekele, 2012; Opiyo et al., 2014), community, level of income diversification prior to drought (e.g. Opiyo et al., 2014) and herd size prior to drought (e.g. Opiyo et al., 2014).

Gender of head of household. This categorical variable describes whether the head of household is male or female. This was determined by first assessing if the participant was married, and then, if her husband routinely lived in her home. We asked this question because our advisory board indicated that a significant number of women in the Archer's Post region live as single mothers but identify as married. Some have been widowed while others have separated from their husbands and as a result, act as primary day-to-day household decision-makers.

Formal education of all adults in household. Participants described the composition of their household and provided the years of formal education for each member. The number of years for each adult were summed to create a single variable for the entire household. We measured the collective education experience of the adults in a household rather than the participant's individual formal education experience to reflect the collective nature of household decisions.

Household size. This variable is defined as the number of people that regularly eat and sleep in the home.

Community. Community A is less than 5 km from the town center while Community B is approximately 15 km away. This variable was included based on the expertise of the local research team members, as the adherence to traditional Samburu cultural practices such as gender roles, migration practices and the access to basic services varies widely in Samburu. For example, households in Community B have less access to wells or treated water, livestock markets, healthcare facilities, and schools, but have better grazing access. Community B is a more traditional and more rural Samburu community in comparison to Community A by local people. Please refer to the data collection sub section above for more context regarding the two communities.

Level of income diversification prior to drought. Participants were asked to indicate the proportion of their income that came from livestock (e.g., selling of livestock, selling of milk or hides) and non-livestock (e.g., owning a small shop, selling charcoal or firewood) activities prior to the drought. Participants were given 10 rocks and asked to separate the rocks into two groups to represent income that came from livestock versus income that came from non-livestock activities. The number of rocks given to non-livestock related activities was then divided by 10 to

determine a percentage.

Herd size prior to drought. Participants were asked to indicate the number of shoats, cows and camels (*Camelus dromedarius*) their household owned prior to the drought. We added the various species counts to create a total herd size variable. Due to the significant differences in the market value of shoats, cows and camels, we used average market prices of each species to create a conversion ratio so that one (1) unit was equal to one cow (cow = 1, shoat = 0.12, camel = 2). A total livestock unit approach is common in research focused on livestock and pastoralism (see Boru et al., 2014; Opiyo et al., 2015). This variable is a proxy for wealth, as livestock are both a form of savings and income for pastoral families. However, this approach has limitations as a measure of wealth for families who rely more on diversified income strategies.

2.4. Data analysis

To analyze the influence of adaptation versus coping strategies, a series of forced-entry multiple linear regressions were run using R statistical software. A model was conducted for each of the four outcome variables (i.e., livestock loss, food security, ability to provide for children, and hope) and included the following independent variables: number of adaptation strategies, number of coping strategies, gender of head of household, education, household size, community, income diversification, and herd size.

After analyzing descriptive statistics, we conducted t-tests, Wilcoxon rank sum tests, correlation analysis and chi-square tests to explore relationships between the nine independent variables as well as the relationship between the independent variables and dependent variables (see appendix). We then centered the numerical independent and key predictor variables (adaptation, coping, education, household size, income diversification and herd size) at the mean to ease the interpretation of regression coefficients. For each outcome variable (livestock loss, food security, provide for children, and hope) we ran the following multiple linear regression model and checked for violations of regression assumptions.

$$Y = \beta_0 + \beta_1 \text{Adaptation} + \beta_2 \text{Coping} + \beta_3 \text{Gender} + \beta_4 \text{Education} + \beta_5 \text{Household size} + \beta_6 \text{Community} + \beta_7 \text{Income Diversification} + \beta_8 \text{Herd Size}$$

Food security as an outcome variable was poorly predicted by the model ($R^2 < 0.05$, $p = 0.32$) and violated multiple linear regression assumptions. As a result, it was dropped from further analyses and our analysis is limited to the relational and subjective components of well-being. We also added an interaction term, community, to adjust for a violated linear relationship assumption in the model predicting ability to provide for children.

3. Results

Given our research goals related to livestock-related coping and adaptation, prior to running regression models we filtered our original data set ($n = 200$) to remove households which did not have livestock prior to the 2017 drought. We also removed households that estimated a loss of greater than 100% of their livestock which indicated inaccurate estimates by the participant ($n = 9$). The final sample size in our analysis was 165 households.

All 165 respondents were women, ranging in age from approximately 18 to 75 years. Fifty-one percent (51%, $n = 84$) of respondents reported a woman as the head of household, of which 42 percent ($n = 35$) were unmarried while the remaining 58 percent ($n = 49$) were married but their husbands no longer lived in their homes (participants explained that this was either due to death or separation). The average cumulative years of formal education of adults in the household was 3.41 ($SD = 6.37$) and the average household size was 5.29 ($SD = 1.95$). The average proportion of income that came from non-pastoral activities prior to the drought was 54% ($SD = 21\%$), and average pre-drought herd size was 5.64 ($SD = 8.8$). Approximately 60% ($n = 99$) of households

were from community A and the 40% ($n = 66$) from community B (see Table 2). Table 3 presents results of community comparisons by outcome variables scores, while Table 4 compares communities across control variables.

3.1. Regression analysis

Results of the regression analysis indicated the model significantly predicted livestock loss, ability to provide for children, and hope. As stated previously, the food security model was dropped from this analysis. Table 5 presents the model summary statistics, regression coefficients and standard errors for each predictor in the model.

3.1.1. Livestock loss

The model significantly predicted livestock loss ($R^2 = 0.23$). Years of education ($p < 0.01$) and community ($p < 0.01$) were significant predictors. Neither adaptation nor coping were significant predictors of livestock loss.

3.1.2. Ability to provide for children

The model also significantly predicted ability to provide for children ($R^2 = 0.39$). Community was a significant predictor ($p < 0.01$), as was the interaction between adaptation and community ($p < 0.01$). After finding evidence of heteroscedasticity, we calculated robust standard errors, which are included in Table 5. Using the robust standard errors did not change the conclusions of the model, indicating the violation of homoscedasticity did not have a large impact on our model.

3.1.3. Hope

Our model was also able to significantly predict hope scores ($R^2 = 0.22$). The coping variable was a statistically significant predictor ($p < 0.05$). Additionally, the gender of the head of household, ($p < 0.01$), and community ($p < 0.001$), were also statistically significant predictors. After finding evidence of heteroscedasticity, we again calculated robust standard errors, which are included in Table 5. Using the robust standard errors did not change the conclusions of the model, indicating the violation of homoscedasticity did not have a large impact on this model.

3.1.4. Food security

The model did not significantly predict food security scores ($R^2 = 0.05$). None of the variables in the model were statistically significant predictors (See Table 5).

4. Discussion

Our results point to the importance of using multiple indicators to evaluate the impacts of drought, and the diversity of interventions that could improve the resilience of the communities in this study. Economic measures (i.e., livestock loss) and culturally specific well-being measures are valuable indicators of drought impact and resilience to such

Table 2
Descriptive statistics of demographic variables.

Variable	Mean	SD	Median	Min	Max
Years of education of adults in household	3.41	6.37	0.00	0.00	26.00
Years of education of respondent	2.02	3.94	0.00	0.00	14.00
Household size	5.29	1.95	5.00	1.00	13.00
Proportion of income from non-pastoral activities	0.54	0.21	0.50	0.00	1.00
Herd size (1 = 1 cow)	5.68	8.80	2.40	0.12	59.20
Age of respondents	~18–30 years		~31–45 years		~45+ years
	34.55% (n = 57)		36.36% (n = 60)		29.09% (n = 48)
Gender of head of household	Woman		Man		
	50.90% (n = 84)		49.09% (n = 81)		

Table 3
Comparison of outcome variable scores by community.

	Community A	Community B	Test Statistic
Livestock Loss	<i>M</i> = 0.62	<i>M</i> = 0.40	<i>t</i> = 5.50 <i>p</i> < 0.001
Food Security	<i>Mdn</i> = 1	<i>Mdn</i> = 1	<i>W</i> = 3293.50 <i>p</i> = 0.93
Provide for Children	<i>Mdn</i> = 5	<i>Mdn</i> = 4	<i>W</i> = 4955.50 <i>p</i> < 0.001
Hope	<i>Mdn</i> = 5	<i>Mdn</i> = 4	<i>W</i> = 4533.00 <i>p</i> < 0.001

Table 4
Comparison of control variable scores by community.

	Community A	Community B	Test Statistic
Education	<i>M</i> = 5.08	<i>M</i> = 0.91	<i>t</i> = 4.90 <i>p</i> < 0.001
Household size	<i>M</i> = 5.03	<i>M</i> = 5.68	<i>t</i> = -2.14 <i>p</i> < 0.05
Income diversification	<i>M</i> = 0.54	<i>M</i> = 0.53	<i>t</i> = 0.33 <i>p</i> = 0.74
Herd Size	<i>Mdn</i> = 1.2	<i>Mdn</i> = 6.0	<i>W</i> = 1412.00 <i>p</i> < 0.001
Gender of HH	Woman = 65 Man = 34	Woman = 19 Man = 47	<i>χ</i> ² = 7.34 <i>p</i> < 0.001

impacts (Béné et al., 2012). However, neither of these measures, when used alone, tell a complete narrative. On average, households in our sample reported losing 53% of their shoat herds during the drought, a severe impact. On the other hand, the well-being data indicated that one and a half years after the drought, participants, on average, could provide for their children and felt hopeful for the future, and were relatively food secure. By combining these indicators, we get a picture of communities that suffered significant material losses because of the drought, but also reported relatively high levels of well-being 18 months later.

In addition to differences in our model’s significance in predicting livestock loss and two aspects of well-being, our results support previous literature’s distinction between coping and adaptation strategies (Eriksen and Kelly, 2007; Opiyo et al., 2015; Venkatasubramanian and Ramnarain, 2018). The number of long-term adaptation strategies used by a household significantly predicted a woman’s ability to provide for her children, but not her hope for the future. Conversely, the number of short-term coping strategies predicted participant’s hope for the future, but not the ability to provide for their children. These results can be explained by the fundamental differences between coping and adaptation strategies, and the subsequent implications these differences have for Samburu women’s experience responding to drought.

4.1. Predicting women’s ability to provide for their children

Many of the adaptation strategies reported in our study create labor

Table 5
Model summary statistics and regression coefficients for each outcome variable.

	Livestock loss		Provide for children		Hope		Food security	
<i>R</i> ²	0.23		0.39		0.22		0.05	
<i>df</i>	7		7		7		7	
<i>F</i> -value	5.79**		9.91**		5.58**		1.18	
	<i>β</i>	<i>Std. Error</i>	<i>β</i>	<i>Std. Error</i>	<i>β</i>	<i>Std. Error</i>	<i>β</i>	<i>Std. Error</i>
Intercept	0.63***	0.03	4.68***	0.079	4.55***	0.10	3.17**	0.55
# Coping strategies	0.00	0.17	0.06	0.060	0.17**	0.05	0.08	0.32
# Adaptation strategies	0.01	0.02	-0.09	0.086	0.01	0.06	-0.34	0.40
Education	-0.01**	0.003	-0.01	0.014	-0.01	0.01	-0.02	0.06
Gender of HH	0.01	0.04	0.03	0.154	0.28*	0.13	-1.32	0.79
Community	-0.25***	0.05	-1.04***	0.181	-0.64***	0.15	-1.16	0.87
Household size	-0.01	0.01	-0.001	0.034	-0.07	0.04	-0.06	0.19
Income diversification	0.19	0.10	-0.11	0.325	0.28	0.27	-1.12	1.80
Herd size	0.000	0.002	-0.01	0.011	-0.01	0.01	0.04	0.05
Community x coping			0.03	0.125				
Community x adaptation			0.73***	0.146				

*** = *p* < 0.001, ** = *p* < 0.01, * = *p* < 0.05.

demands largely considered to be within the domain of pastoral women. For example, herd composition changes in response to drought are often characterized by shifts from large-scale livestock such as cattle to smaller scale livestock, such as sheep and goats. Samburu women are more likely to be responsible for small-scale livestock husbandry, and an increase in shoats translates into an increase in women’s labor and responsibility. Women have also become increasingly responsible for taking care of sick and young stock, so the use of veterinary medicine increasingly falls under the domain of women’s responsibilities (Pickering, 2021; Yasin, A., personal communication, August 24, 2021). Additionally, non-livestock (i.e., diversified) income strategies are considered women’s work (Anbacha and Kjosavik, 2019a; Gurmu, 2018). All three of these adaptation strategies (herd composition changes, veterinary medicine, and livelihood diversification) increase the labor demand and responsibility of Samburu women. As a result, they can increase women’s decision-making power, or agency within their households (Anbacha and Kjosavik, 2019a), which in turn could result in an increase in their sense of being able to provide for their children.

Our previous research indicates that women in this region consider being able to provide for their children to be an integral part of their well-being (citation removed for anonymous review). Gains in household decision-making power driven by increased responsibility for and labor demands of adaptation strategies could explain the positive relationship between adaptation strategies and women’s ability to provide for their children. A woman may feel as if she has more decision-making power in her household because her household’s adaptation strategies are largely her responsibility. This connection between women’s agency, increased capacity for decision-making, and children’s well-being has been documented by studies in other regions of the world (Ortiz Rodríguez et al., 2016; Begum and Sen, 2009).

We did not find this same relationship between coping strategies and ability to provide for children variables, however many of the coping strategies do not create the same labor demands on women; many are the domain of men’s work (e.g. moving livestock by truck, buying and selling livestock). As a result, the use of coping strategies does not lead to as many increases in women’s decision-making power, and the subsequent positive effects of more decision-making, such as how women feel about their ability to provide for children, is unchanged.

It is also important to note that adaptation strategies were only a significant predictor of participants’ ability to provide for children as an interaction variable with community. The impact of adaptation strategies was larger for participants in Community B in comparison to Community A. This might be explained by the differences between these two communities. Community A households have more formal education experience, smaller household sizes, fewer livestock, and are more likely to be headed by a woman. Conversely, community B households have less formal education, bigger households, more livestock and more likely

to be headed by a man. Additionally, conversations with our local team members and advisory group indicate that Community B households generally adhere to more traditional cultural practices in comparison to Community A. With respect to gender roles, this may include greater instances of domestic violence, childhood marriage, and female genital mutilation. These differences between the two communities, may arguably lead to differences in agency or decision-making power of women at the household level, with women in Community B potentially having less agency than Community A. In turn, differences in agency might have created more potential for adaptation strategies to affect *providing for children* scores, via increases in agency, for women in Community B. Additionally, Community A reported significantly higher *provide for children* scores potentially leaving very little room for adaptation strategies to impact their *provide for children* scores.

Several scholars argue that agency plays an important role in increasing adaptive capacity to climate change, as well as resilience and well-being more broadly (Cinner et al., 2018; Rao et al., 2020). However, the specific mechanisms that drive these relationships require further study. Our results point to the importance of better understanding the role pastoral women's agency plays in the relationship between drought response strategies and women's well-being, as well as the significant influence of community and place.

4.2. Predicting women's sense of hope

Our results indicated that the number of *coping strategies* used by a household was a significant predictor of women's *hope for the future*. A possible explanation for this relationship is the role *coping strategies* may play in encouraging women's optimism about the viability and future of pastoralism. In previous work investigating well-being with Samburu women, participants discussed *hope* in the context of the collective future of Samburu culture and community. Despite significant shifts in culture, the practice of pastoralism continues to play an important role in Samburu women's identity and their *hope* for the future was essentially about whether they felt like their community could continue to practice their way of life (Walker et al., 2021a). *Coping strategies* are small, short-term strategies that perhaps encourage optimism about the future potential to maintain pastoralism. *Coping strategies* enable households to engage in immediate strategies to mitigate drought impacts and are familiar or more typical of a traditional pastoral culture (i.e., migration of livestock, supplementary feeding, buying and selling livestock). On the other hand, many *adaptation strategies* require significant, long term divergences from traditional pastoral practices. They might not encourage the same level of optimism about pastoralism's viability, but rather reinforce the need to practice an altered or less familiar form of pastoralism. As a result, we do not see the same relationship between *adaptation strategies* and *hope*.

4.3. Limitations & future research

There are limitations to this study that should be noted. First, our study relies on the assumption that measurements of well-being one and a half years after the drought are a valid indicator of a household's ability to recover from drought. We do not have well-being measures prior to or immediately after the drought to empirically support this assumption, but the expertise of our local research team supports such a hypothesis. The second key limitation is how we measured the use of *adaptation* and *coping* strategies. A high numeric value on both the coping and adaptation variables indicates the use of several different strategies, but not the intensity or the reliance on a strategy. An in-depth focus on the use of each individual strategy and how it may impact well-being is an important area for future research. Such a focus could also comparatively highlight the impact individual response strategies have on both community and rangeland resilience. Third, while the head of household variable serves as a proxy for decision-making power, it has limitations due to the complexity of household structure and gender

dynamics in Samburu culture. The variable does not reflect the presence of other male family members who might have a significant influence in the household. A more nuanced exploration of gender dynamics within households with respect to coping and adaptation decision-making processes is an important focus for future research. Another area for future research is to investigate post-drought recovery in addition to livestock loss to better understand the relationship between livestock recovery and household well-being. Finally, while our study focused solely on the perspective of pastoral women, drought creates stress on many, if not all, members of a household who have a role in subsequent adaptation and coping responses. We acknowledge this collective experience and response within households and communities, and while the scope of our study is focused on women's perspectives, they are nested within relational household and community-level structures.

4.4. Implications for supporting drought resilience of pastoral women

The results of this study point to the importance of using multiple indicators to investigate drought impact and resilience to such impacts. They also supported previous literature's distinction between *coping* and *adaptation* strategies (Eriksen and Kelly, 2007; Opiyo et al., 2015) and the specific implications of these strategies for pastoral women (Venkatasubramanian and Ramnarain, 2018). From an applied and intervention perspective, understanding the gendered relationship between drought-response strategies and well-being has important implications for supporting pastoral women's resilience to climate change. *Coping* and *adaptation* responses are distinctively different strategies, with unique impacts on pastoral women's well-being, which can be potentially explained by the gendered divisions of labor. Interventions aimed at supporting the climate resilience and well-being of pastoral women, need to consider how gendered divisions of labor might influence the efficacy or impacts of an intervention that encourages or supports specific response strategies. Additionally, the relationship between specific drought response strategies and women's well-being also provides important context for understanding how and why Samburu women make decisions about their livestock in response to drought. As a user group with increasing agency, the ability to accurately predict and respond to these decisions is critical for effective rangeland management.

Our study also demonstrates the importance of holistically evaluating and designing climate resilience interventions. As stand-alone indicators, economic indicators such as livestock loss or socio-cognitive well-being indicators tell different narratives about the drought resilience of pastoral communities. By only looking at livestock loss numbers, one could determine that neither the *coping* nor *adaptation* strategies used by Samburu households were effective at mitigating the effects of drought. However, women's self-reported well-being scores indicated that both *adaptation* and *coping* strategies had unique and important impacts on their socio-cognitive well-being. These results underscore the importance of a multi-level views perspective; including different types of indicators and measuring them at multiple scales (Woodhouse et al., 2015) as well as recognizing the complex and diverse impacts different climate response strategies have on women's well-being (Venkatasubramanian and Ramnarain, 2018). The use of such an approach has important implications for the design, evaluation and adaptation of climate change resilience interventions. More specifically, a holistic framework that includes multiple well-being dimensions has the potential to address the inherent tension between pastoral women's increasing agency and their increasing workload. This tension has been noted by other scholars studying changing gender roles in pastoral systems in the context of climate change (Karmebäck et al., 2015). While a multi-dimensional framework cannot resolve these tensions, it can provide guidance and help ensure that interventions do not simply improve one aspect of women's well-being while negatively affecting another.

Finally, our study also demonstrates the importance of place and

community. Our results highlight the vastly different impacts coping and adaptation strategies had on well-being for communities a mere 10 km apart. As the international discourse around climate resilience continues to grow in relevance and urgency, hyper local contexts must be a focal point of the conversation. Geographic and cultural contexts need to play a critical role in the design of such interventions.

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CRedit authorship contribution statement

Sarah E. Walker: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Supervision, Project administration. **Brett L. Bruyere:** Conceptualization, Methodology, Writing – review & editing, Funding acquisition. **Jennifer N. Solomon:** Conceptualization, Writing – review & editing. **Kathryn A. Powlen:** Formal analysis, Writing – review &

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Table A
Descriptive statistics of outcome variables

	M	SD	Min	Max
Livestock loss	0.53	0.27	0	1
Food security	2.06	4.48	0	30
Ability to provide for children	4.31	1.02	1	5
Hope	4.42	0.84	1	5

Table B
Pearson’s correlations between key predictor variables and continuous covariates

	Number of adaptation strategies used		Number of coping strategies used	
	r	p	r	p
Education capacity of adults	0.11	0.16	-0.06	0.44
Household size	-0.08	0.29	-0.06	0.43
Level of income diversification	0.12	0.13	-0.26	<0.01
Herd size	0.06	0.48	0.20	<0.01

Table C
Comparison of number of coping and adaptation strategies used across categorical covariates

	Number of adaptation strategies used		Number of coping strategies used	
	t(163)	p	t(163)	p
Gender of HH	-0.50	0.61	-0.86	0.39
Community	-1.11	0.27	-1.34	0.18
	$M_{women} = 2.67$	$M_{men} = 2.74$	$M_{women} = 2.35$	$M_{men} = 2.51$
	$M_{comm A} = 2.64$	$M_{comm B} = 2.80$	$M_{comm A} = 2.32$	$M_{comm B} = 2.58$

Table D
Correlations between adaptation and coping strategies and outcome variables

	Number of adaptation strategies used		Number of coping strategies used	
	r	p	r	p
Livestock loss	-0.04	0.64	-0.07	0.36
Food security	-0.07	0.34	-0.01	0.97
Ability to provide for children	0.17	0.03	0.06	0.43
Hope	0.06	0.44	0.17	0.03

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