Status and Perspectives of Maasai Women in Ngorongoro Conservation Area, Tanzania

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Abstract

The UNESCO World Heritage Site Ngorongoro Conservation Area (NCA) in Tanzania is a well-known example of the challenges of managing a conservation area for multiple goals including meeting the needs of residents within the conservation area. The NCA seeks to achieve multiple goals including protecting biodiversity, providing tourism opportunities, improving resident Maasai livelihoods, and conserving Maasai culture. Within and beyond the NCA, most analysis and projects focus on Maasai men, who are cattle herders and heads of multi-household families. In this paper, we describe livelihoods and well-being, as affected by the protected area, from the perspective of the Maasai women. Recognizing that well-being (and poverty) is multi-dimensional, we examine how different factors correlate with self-reported life satisfaction and we apply the framework of the UN Sustainable Development Goals (SDGs). For each of the SDGs, we report the available evidence from documentation and from surveys of village leaders, female heads of household, and a small supplementary sample of male heads of the polygamous families. We administered the surveys in all 23 Maasai villages in the NCA. The survey results confirm that poverty is widespread, but with substantial variation in the depth of poverty and in access to essentials including water, food, and fuel. Reported life satisfaction of Maasai women is correlated with food security, clothing quality, and access to markets and social services, but not with family ownership of cattle, which is the most used metric of Maasai wealth. Our findings suggest potential improvement in NCA programs and provide a baseline to analyze the effects of any such changes in those programs from the perspective Maasai women.

Keywords: biodiversity conservation; gender; pastoralists; protected areas; Maasai; Sustainable Development Goals (SDGs); people and parks

JEL Codes:

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I. Introduction

Historically, protected areas (PAs) were created to preserve natural habitats for wildlife and recreation, but the importance of incorporating the needs of local people has been recognized since the 1982 World Congress on National Parks (McNeely and Miller 1984). A diverse literature considers the impact of PAs on local communities, with discussions of conflict, economic burden, and economic benefits (Sills and Jones, 2018; Oldekop et al. 2016; Pullin et al. 2013; Boone et al., 2002; Goodman, 2002; Boone et al., 2006; Homewood et al. 2012). Recognition of the relationship between locals' needs and PA management has spurred research on the social impacts of protected areas (Oldekop et al., 2016; Pullin et al., 2013). With the growing consensus that "fortress conservation" versions of parks can burden local populations and lead to conflict that is counter-productive to conservation, new forms of PAs have emerged with the goal of protecting wildlife and ecosystem services at the same time as supporting people's livelihood needs, including PAs that permit people to live within them. A much smaller literature considers the impact of the PA on communities living legally within the PA.

Ngorongoro Conservation Area (NCA) in northern Tanzania provides an example of a PA that permits human residents within the area, with Maasai pastoralists comprising most of those residents (Olenasha, 2009) (Figure 1). The NCA Authority (NCAA) manages the area for 3 primary goals – wildlife conservation, resident people's welfare and culture, and tourism benefits. In an attempt to balance these goals, the NCAA places restrictions on Maasai living within the NCA and provides them with certain benefits. As a World Heritage site, the NCA served as host to a 2016 conference at which 40 countries signed a declaration that re-establishes the importance of combined efforts to promote both conservation and sustainable development. The conference and declaration emphasize the role of preserving cultural heritage and promoting involvement of local communities – particularly women and youth – in management toward these joint goals (UNESCO, 2016). In this paper, we provide a description of the status of Maasai pastoralists living in the NCA, with particular emphasis on the aspects of women's lives that reflect progress toward the Sustainable Development Goals.

Toward this end, we examine the status of Maasai living within NCA using descriptive statistics from our unique woman-focused household survey and by using the lens of the Sustainable Development Goals to characterize women's perspectives on their well-being. We begin with a description of the setting and a brief examination of the related literature on women

in pastoralist societies. Thereafter we describe our data collection process. Next, we provide general descriptive statistics and analyses of these data and comment on the general status of Maasai women in the NCA. We briefly discuss a men's survey that was administered to a small sample of Maasai men, some as husbands to surveyed women, in the villages sampled. Last, we consider subsets of our data and stakeholder information to reflect on the status of women through the lens of the United Nations' Sustainable Development Goals (SDGs). Appendix A contains more detailed information including a summary of data from a census completed by Tanzania's National Bureau of Statistics (NBS). Appendix B contains discussion of SDGs 4 and 6-17, which are not the primary focus of this paper.

II. Background

    i.   NCA Establishment and Goals.

    Prior to establishment of the protected area in 1959, the NCA and surrounding areas were traditionally used by semi-nomadic pastoralist Maasai for grazing cattle in the same areas inhabited by a wide range of wildlife species native to the Serengeti-Mara Ecosystem. When Serengeti National Park was established in 1951, the Maasai lost part of their historic grazing range and became more concentrated in the area that would become the NCA. Without particular controls on population growth, the 20,000 semi-nomadic Maasai living within the NCA at its establishment in 1959 grew to 90,000 residents by 2018. The Maasai live in 23 permanent villages since the "villagization" program of the 1970s, with each village having geographically separate sub-villages and with villages grouped into wards containing several villages. Despite these permanent villages, the Maasai population uses much of the NCA for grazing livestock, with some men taking their herds far from the village for several months of the year. The NCA also has important archaeological significance as it contains the Olduvai Gorge, where the footprints of early hominids have been discovered. Because the NCA was established to meet a range of goals – to conserve the natural system, protect and support Maasai pastoralists, and encourage tourism – NCA management through the NCA Authority (NCAA) reflects a multiple-use regime.
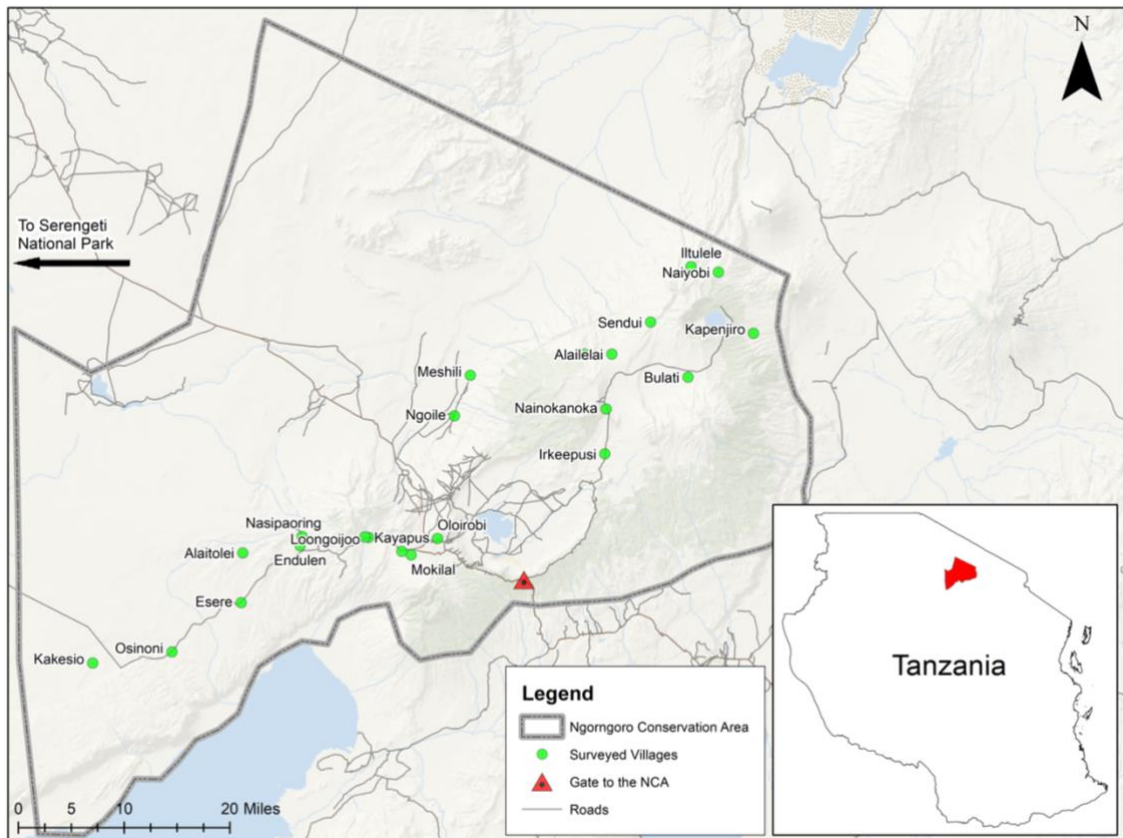
Figure 1. Map of Ngorongoro Conservation Area, villages, main gate, and the location within Tanzania.

ii. Maasai Culture and Women's Role

The Maasai are primarily pastoralists who rely on cattle as their main source of food and income. However, Maasai both within and outside of the NCA have increasingly diversified their livelihoods with employment, for example as security guards. The Maasai patriarchal society contains unique features in that men are often away from the village tending cattle and that men typically have several wives and sub-households. Both factors leave many women as heads of their sub-household or enkaji. Within the polygamous Maasai culture, typically, an older male is the head of his household, enkang, which includes all of his wives' sub-households and his children (Brockington, 2001). Among the Maasai, responsibilities for raising families and herding cattle are sharply differentiated by gender. As in most of sub-Saharan Africa (Peltzer, 2009), women are responsible for feeding their families, including procuring fuelwood and

water, as well as milking cows, with other livestock exclusively managed by men (the traditional Maasai herders). Given this differentiation, Maasai women may emphasize different aspects of their lives in assessing their well-being than Maasai men would.

iii. NCAA-Maasai Resident Interactions, Governance, Restrictions, and Projects

The NCAA is tasked with balancing the goals of conserving wildlife, providing a high-quality tourist experience, and meeting the needs of local residents. Here, we focus on the actions and policies that influence the Maasai residents' well-being.

The Pastoralist Council. The Pastoral Council (PC) was established in 1995 to serve and represent the pastoral residents of the NCA. It consists of a chairman, deputy chairman, secretary, treasurer, deputy treasurer, 1 councilor from each of the wards, the village leader from each village, 6 traditional leaders, 6 representatives of women, 6 representatives of youth, and one representative of NCAA. The PC meets on a quarterly basis and the secretariat of the council meets on a monthly basis. The PC allocates financial support to these meetings, including a transportation allowance for village leaders. Additionally, the PC is usually allowed to hire professionals on a contract basis to facilitate building or provide other services.

Project Funding and the PC. The NCAA hosts over a million visitors per year, which generates entry fee income of $70 million (Slootweg, 2016). The NCAA allocates a fraction of its tourist gate revenues to the PC for various projects, which typically amounts to 500 to 600 million Tanzanian shillings (approximately US$260,000) on an annual basis (Ngorongoro Conservation Area General Management Plan, 2010). Prior to the use of the PC for funding allocation, the NCA invested about 6% of entry fees in community development between 1997 and 2008 (Melita and Medlinger, 2013). The Pastoral Council (PC) allocates funding to specific types of village projects following a process that begins in each village. First, village meetings open to all residents – forming a village assembly – develop a list of priority needs for the village and vote on the specific project to request. Second, each ward (typically 2-4 villages) develops a plan to select which of its villages will receive a project's funding in a given year, typically based on need and often rotating one funded project per year among the villages. Prior to the PC selecting one to many project-ward pairs for funding based on that year's funding level, the PC and the

NCAA review all projects proposed by the wards to ensure that the projects conform to NCAA and PC rules and priorities. For example, the NCAA and PC will not approve projects to develop businesses or other such investments. Acceptable projects provide services that are in the public domain but are not being effectively delivered by the government, such as public water taps; primary and secondary classrooms, schools, teacher salaries, and teacher housing; health facilities; and cattle dips. Similar types of projects are also undertaken by other civil society and charitable organizations in Maasai communities both inside and outside the NCA in a less regular and sometimes less participatory manner. For example, VICOBA-Village Community Banks provide funding for women's empowerment groups through a rotational savings and credit group. Still, the use of tourism receipts to fund public goods projects for NCA villages through the PC forms the central mechanism for the NCAA to provide benefits to villagers. The PC-projects at the village level are the primary mechanism through which NCA residents capture a portion of the international public good that the NCA provides.

Transportation. The NCAA maintains roads (both paved and unpaved) and bridges throughout the NCA, which facilitates both tourism and Maasai movements especially in and out of the NCA. In some circumstances, the NCAA provides transportation services between NCA villages and Karatu—a large market town outside the main gate.

Restrictions. To achieve tourism and conservation goals, the NCAA imposes restrictions on the activities of the NCA village residents. Restrictions include: no concrete building structures, no vehicle ownership or use, entry/exit time limits, no connections to the electricity grid system, limits on the types of materials that can be brought into the NCA, no direct interactions with tourists outside of cultural *bomas*, immigration restrictions, prohibitions on collecting forest products and grazing livestock in some areas – particularly craters and forests, no live tree harvest, and no cultivation of crops. No villages and no livelihood activities are permitted in craters, including the Ngorongoro Crater, which is the center of tourism through game drives and hotels on its rim. Tourists can visit cultural bomas and villages that have special permits but are not permitted in the villages themselves. Most tourists spend little time in the NCA beyond the Ngorongoro Crater, roads to Arusha and Serengeti National Park, Oldavai Gorge, and cultural bomas.

Although traditionally semi-nomadic pastoralists, current NCA Maasai residents have demonstrated an interest in growing crops, especially as they have become less nomadic through villagization. Most Maasai living outside of the NCA in Tanzania cultivate crops in addition to managing their livestock. Following periods of more permissiveness toward agriculture (Galvin, et al, 2015), the Wildlife Conservation Act of 2009 banned cultivation of crops in the NCA to protect habitat and reduce conflict with wildlife that are attracted to farms.

Grain Program. In response to concern over food security, the NCAA distributes grain to all villages within the NCA, and village leaders allocate the grain across households. Each village maintains a list of all women with households – capturing all separate households of one man -- in each village, and each such household is eligible to buy up to 20kg of grain at a subsidized price every four months. The subsidized grain is intended to compensate for the restriction on cultivation and other restrictions.

Other Benefits. Because the NCA's Maasai livelihood depends largely on livestock keeping, NCA residents indirectly benefit from environmental conservation activities that maintain pasture and water for cattle. In addition, the ban on cultivation means that Maasai herders within the NCA do not face the conflict with producers of agricultural products that Maasai herders outside of the NCA face. In addition, some livelihoods depend directly on nature, including for construction materials, fuelwood, water, and income sources such as selling honey and forest medicines. Some inhabitants of the NCA receive opportunities to benefit directly from tourism through an application process to participate in tourism activities at cultural *boma*s or to receive permits to allow tourists to camp in villages and trek with village guides.

iv. General information from the NBS Census

The Tanzanian National Bureau of Statistics (NBS) conducted a population and livestock census in Ngorongoro in 2017 (NBS, 2017). As a census, this effort reached the majority of people dwelling within the NCA, including people from villages that are not Maasai and individuals such as teachers and health officials who live in the NCA but under different conditions – including different housing and electricity access - than most Maasai in the NCA. The census

found a population of 93,136, of whom only one percent were not born in or near Ngorongoro District. The population has a relatively young age structure, with approximately half the population below 15 years old. The census finds high rates of illiteracy, particularly among women (72 %), and finds that 67.5% of the population has not attended school. Forty-six percent of households are headed by women, with an average household size of 4.5. Although 45% of households have access to piped water, especially from public taps, only 5% of households have access to cooking energy sources other than firewood. Most respondents (63%) are engaged in livestock rearing as a main activity. Almost 98% of the population buy their food and only 0.8% produce their own food. Although our survey focuses on Maasai women, our results are consistent with these census statistics (further census data is presented in Appendix A).

III. Related Literature

Several decades of studies consider the impact of PAs on local communities in low-income countries using both qualitative and quantitative approaches (Sills and Jones, 2018; Oldekop et al. 2016). Across these studies, findings of the impact on local poverty vary, with some aspects providing positive outcomes for some subgroups such as through eco-tourism's impact on employment and wages (Robalino and Villalobos-Fiatt, 2015; Clements et al., 2014; Beauchamp et al. 2018). Still, the bulk of this literature does not consider the impact of PA policies on PA inhabitants. With the Convention on Biodiversity signatories committing to ongoing expansion of PA systems, PAs that permit human uses and human residents within PAs are a potential avenue to produce improvements in both conservation and well-being outcomes. Our analysis is grounded in the previous literatures on people-park interactions, Maasai women, well-being in pastoralist societies, dynamics between people and park managers, and the relatively new priorities established by the Sustainable Development Goals.

While an extensive literature describes metrics of poverty, the typical metrics – including Tanzania's Poverty Probability Index – do not apply well to NCA Maasai women, which led to our inclusion of direct life satisfaction questions in our survey instrument. Most descriptions of Maasai household wealth rely on some livestock metric, which reflects that Maasai culture and economics relies on livestock (e.g., Homewood et al., 2012; Burnsilver, 2016; Nkedianye et al., 2019; Molina-Flores et al., 2020). Maasai women's involvement with livestock consists primarily of milking cows for home consumption or sale (Molina-Flores et al. 2020). Our survey

and descriptive analysis of Maasai women in the NCA are broadly consistent with other recent work on the priorities and well-being of Maasai women in Tanzania. Two recent studies identify factors that contribute to the well-being of Maasai women, albeit those outside of the NCA. First, Kalavar et al. (2014) find that women consistently ranked children and livestock as most important for their well-being. Natural resources were also ranked in the top four measures of well-being, which Kalavar et al. (2014) argue is because "the availability and proximity of [water and firewood] affects women's well-being." Second, Woodhouse and McCabe (2018) find that women placed great importance on having male children and on education of both male and female children. Women also cited livestock as an important asset, principally as a source of milk to feed their children. In that study, women emphasized access to healthcare (dispensaries and clinics in the villages and the ability to get to a hospital), water resources, and having a warm house as important to their well-being. While these studies employed focus groups to identify the factors that Maasai women and men believe contribute to their well-being, we identified similar factors through rapid rural appraisal methods such as discussions with key informants. Thus, our survey and descriptive analysis covers similar factors, including food security, access to health care and schools, and accessibility of fuelwood and water.

Our focus on women also reflects the unique role Maasai women play as heads of their sub-households. Westervelt (2018) finds that Kenyan Maasai men are increasingly away from the village for longer periods of time in search of work or better grazing land. This finding is consistent with our interviews with NCA Maasai men and women. Yet, as a positive, this absence of men often presents women with an opportunity for greater independence. As the primary food providers in the household, women are troubled by climatic conditions that decrease the availability of food and increase the time needed to gather water and firewood. Westervelt (2018) find that, compared to 10 years ago, "97% of women and 87% of men said their lives were harder." Traditionally, selling milk in exchange for grain has been viewed as a marker of poor economic conditions, but as access to markets increases, such sales have become a way for women to earn their own income, potentially elevating their role in Maasai society (Brockington, 2001; Westervelt, 2018). Since restrictions on cultivation in the NCA in 2009, women are selling more medicines and fuelwood gathered from forests to meet their financial needs (Melubo & Lovelock, 2019).

The Sustainable Development Goals (SDGs) are a set of interrelated targets agreed upon by US member nations. However, the goals are weighted differently in different contexts, including more macro or country level contexts versus more micro or localized contexts (Nillson, Griggs, & Visbeck, 2016; Barbier and Burgess, 2019; Costanza, et al., 2016). In many contexts, one SDG can only be met at the expense of another (Barbier and Burgess, 2019). For example, Nilsson et al. (2016) find that, in Sub-Saharan Africa, Zero Hunger (SDG 2) is a complement with 'No Poverty' (SDG 1), 'Good Health and Well Being' (SDG 3) and 'Quality Education' (SDG4). However, they also find that SDG 1 is a substitute for 'Affordable and Clean Energy' (SDG 7) and 'Life on Land' (SDG 15). With the goals of both conservation and Maasai wellbeing in the NCA setting, we are particularly interested in the interactions between SDGs that support environmental goals and SDGs that support human development. In our case, we focus on the SDGs that are recognized by Maasai women as important to their well-being. Even poverty indices specific to Tanzania, such as the Poverty Probability Index (PPI), incorporate weights defined at the national level and are not necessarily suitable for every cultural group. Further, there may be specific patterns of substitution and complementarity among SDGs in a local context such as the NCA. As the NCA exists to support a number of different goals for wildlife and people, understanding tradeoffs between the goals is important for developing strategies and understanding possibilities of achieving the SDGs.

Tradeoffs between goals for wildlife conservation and goals for human wellbeing in the NCA setting have centered on the role of cultivation and livestock herding on wildlife and wellbeing. Several studies have found that the declining livestock to human ratio within the NCA contributes to increasing malnutrition rates (Brockington, 2001; Goodman, 2002; McCabe et al., 1992; Westervelt, 2018). In contrast, Galvin et al. (2006) suggest that this ratio declined when cultivation of up to one acre per household was permitted and people moved into the NCA for its rich soil and the benefits provided by the NCAA, such as subsidized grain (Galvin et al. 2006). While significant expansion of the cultivated area in the NCA could lead to declines in both cattle and wildlife populations (Boone et al. 2002), Boone et al. (2006) argue that doubling the area cultivated would greatly benefit the local people and not detrimentally affect wildlife. On the other hand, some ecologists argue that the presence of roads, humans, and cattle in the NCA even without cultivation of crops negatively affects the wildlife and threatens the ecological system (Estes et al. 2006). Outside of the NCA, crops attract wildlife and NCA ecologists

suggest that this behavior leads to human-wildlife conflict that can end in human or wildlife deaths. Still, there are no recent studies that assess food security in the NCA or evaluate the tradeoffs between limited cultivation and wildlife in the NCA.

NCAA's restrictions may have a significant impact on financial well-being. Homewood, et al. (2006) find that non-NCA Maasai have diversified their livelihoods beyond cattle, with 26% of households having other income sources. The NCAA's restrictions prevent most businesses and farming within the NCA, which may impose a significant barrier to economic diversification. However, the same study notes that poorer pastoralists are more likely to resort to non-pastoral activities such as gathering and selling firewood, medicinal plants, and honey. Thus, increased economic diversification may also signal financial hardship within the non-NCA Maasai population.

With limited exceptions (Robalino and Villalobos-Fiatt, 2015; Mariki 2016), research connecting PA management and local people's wellbeing examines effects on households without differentiating the types or magnitudes of effects on different household members. Effects on women are especially likely to be invisible in contexts such as pastoralist societies where men are the primary livestock owners and hold most decision-making power over agricultural land and livestock (Woodhouse and McCabe 2018). In fact, much less research characterizes pastoralist women than pastoralist men, which means that little research focuses on the impact of PAs on women and particularly on women pastoralists such as the Maasai in NCA. Given their role as heads of households with responsibility for the welfare of children and the elderly, Maasai women represent a large fraction of Maasai population within the NCA, increasing the importance of understanding how the PA contributes to women's well-being. We contribute to the body of knowledge on interactions between people and conservation within this unique multiple use conservation area in Tanzania by focusing specifically on the perspectives of women on progress towards the sustainable development goals.

IV. Data and Methods

In 2018, Environment for Development-Tanzania and the University of Wyoming (UW) partnered on a women-focused survey in the Ngorongoro Conservation Area (NCA), following IRB approval from UW (Protocol #20180718JA02047). The NCA has a total of 25 villages; however, two villages were ruled out of the survey because they were predominantly Datoga

rather than Maasai. Unlike the Maasai, the Datoga incorporate fish in their diet and have multiple wives living under a common roof rather than in separate dwellings. The research team conducted stakeholder and key informant interviews with NCA residents and NCAA employees to develop a basis for defining both a semi-structured village level interview and a structured survey questionnaire. The structured survey questionnaire included a variety of questions about household possessions, income, daily activities, preferences, and thoughts about the Ngorongoro Conservation Area Authority. Approximately 20 households per village were randomly sampled in each of the 23 Maasai villages within the NCA, resulting in 458 women respondents.

Sampling methods and protocol

Village Assessment. Some members of the research team, the "village assessment" team, conducted semi-structured interviews to collect data in a specific village on the first day of a two-day survey. This team met with the village head, members of the village council as available, a woman, a Maasai youth when available, and representatives from health and school facilities to gain village-specific information. The village assessment included obtaining a list of households eligible for subsidized grain. The team then used that list as a sampling frame to generate a systematic random sample stratified by sub-village to select survey respondents. With a target of 20 interviews per village, the number of households surveyed per sub-village was determined based on the proportion of village households in each sub-village which in turn was based on the number of households on the grain distribution list. To select households from the grain list, we divided the total number of sub-village households by the number of households to be surveyed and rounded down to get the number of households to be interviewed, X. Each village leader was asked to select a random number, Y, between 1 and X. The team then selected the Yth household as a starting point on the list and sampled every Xth household from there until the end of the list was reached. This process is depicted in Table 1.

	Sub-village A	Sub-village B	Village
Population	350	550	900
Sample Size	7.8	12.2	20
Rounded Sample	8	12	20
X	43	45	

Table 1. Sub-village Household Sampling Process, Example

In the above case, the village leader was asked to pick a number between 1 and 43 for Sub-village A and between 1 and 45 for Sub-village B. Table 2 is an example of the first four household IDs selected based on the village leader picking the number 5.

	Sub-village A	Sub-village B
Household IDs Sampled	Y, Y+X, Y+2X, Y+3X…	Y, Y+X, Y+2X, Y+3X…
Household IDs Sampled	5, 48, 91, 134…	5, 50, 95, 140
Total # of Household Sampled	8	12

Table 2. Household ID Selection Process, Example

After the selection of households, we consulted with the village leader whether each woman on the list would be home on the following day. If the woman was known to be traveling (e.g., to a regional market), we then asked about the ID-1 (ID number minus 1) household. If the women in that household would not be at home, we asked about the ID+1 household, then ID-2, and then ID+2 households. Both ID numbers and names were recorded for every women to be interviewed. Additionally, of all the women sampled in a village, a subset of 3-4 husbands of these women was then chosen to answer a men's survey. The aim of the men's survey was to serve as a comparison to the women's survey. The village assessment team provided the enumeration team with the households to be surveyed and the information collected in the village assessment in the evening following the assessment and prior to the day the survey was undertaken.

Conducting the Women's and Men's surveys . On the second day of data collection in each village, the team of enumerators divided the list of survey respondents among the enumerators. The protocol stated that if the enumerator found no one at home, they went to the nearest neighbor and interviewed them instead. If this person happened to be a co-wife of the original person that was supposed to be interviewed, that information was recorded in the survey. This survey procedure generated 458 observations across 23 villages (*Figure 2.* Map of the 23 surveyed villages, approximate respondent locations, the NCA gate, and NCA roads.Figure 2)
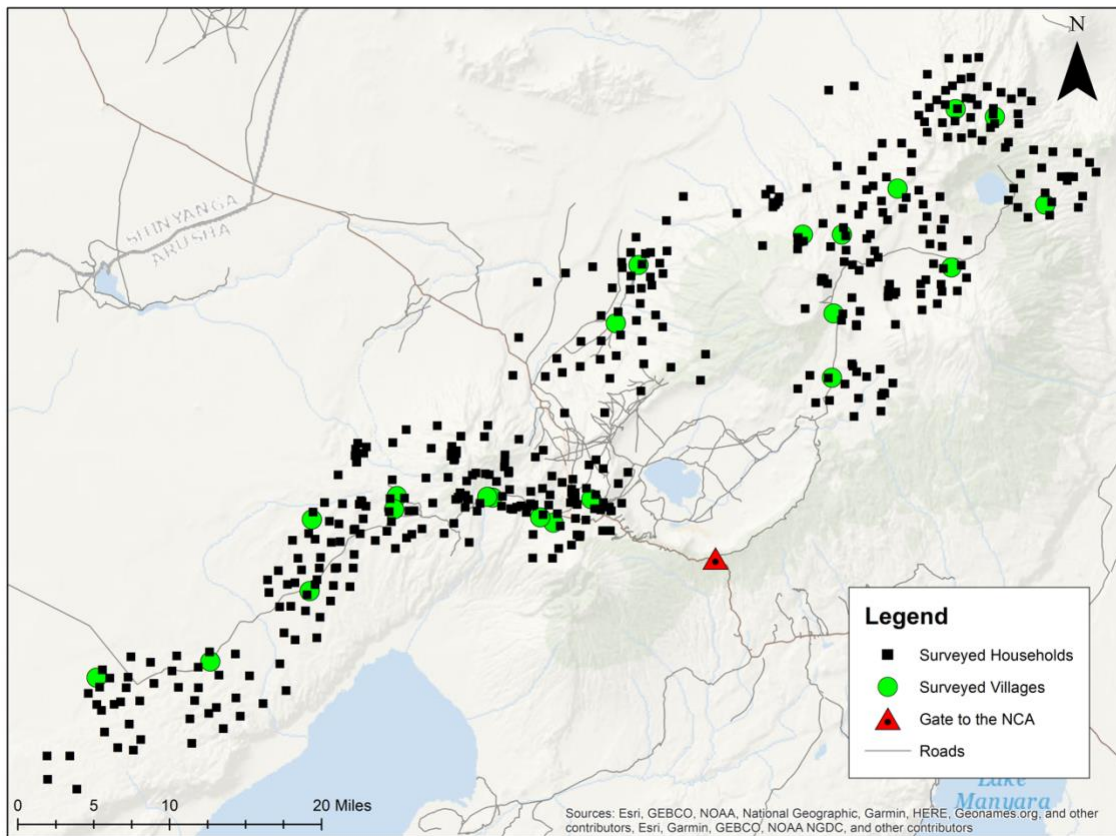
Figure 2. Map of the 23 surveyed villages, approximate respondent locations, the NCA gate, and NCA roads. Surveyed household locations were moved slightly and randomly to protect the privacy of respondents. Therefore, this map provides a general sense of the household respondents' distribution across the NCA and across village proximity.

Survey Instrument

We constructed a survey instrument with several categories of questions. First, we collected basic information about the respondent and the respondent's household members. Second, we identified primary sources of income and quantified ownership of livestock. Third, we asked respondents to describe their activities on a typical day while dividing the day based on Maasai patterns of activities described in preliminary stakeholder interviews. The fourth section focused on fuelwood and water collection activities. The fifth section elicited data on livelihood activities of family members. The sixth section asked questions about food security, health service access, and school programs. The seventh and eighth sections collected information about village projects. These sections included a series of discrete choice questions designed to assess the

perceived value of different projects funded by the NCA relative to grain. The ninth section enquired about market access, availability, and interaction. The tenth section posed questions about community involvement and perspectives. The final section centers on experiences of natural disasters such as the drought that occurred just prior to the interviews.

Data management and cleaning

The data were collected using ODK Collect on Samsung tablets. The data were downloaded from the server, de-identified as per our IRB approved protocol, and shared on a restricted-access Google Teams Drive. Data cleaning and reshaping was done in Stata and R.

Defining Relevant Wealth Metrics for the Community

Tanzania's Poverty Probability Index (or PPI) depict poverty likelihood and has a relatively recent scorecard for the country (2011). For our setting, however, this index has a major drawback in that households are awarded no "points" for cattle if they do not also have crops. Given that crop production is illegal in the NCA, and that livestock are a major source of income and wealth among Maasai, the PPI does not reflect fundamental characteristics of the NCA population. In addition, the PPI contains other categories such as materials used for the dwelling that do not vary across our respondents' households due to restrictions on building materials in the NCA. Still, we calculate PPI for our sample using the formula that reflects PPI components and corresponding points but with minor modifications for our setting (such as students leaving school at a lower age).

1. Number of household members (changed from 18 in the PPI to 17), age of household members (younger than PPI) (0 to 28 points)
2. School attendance of members listed as age 6 to 17 (rather than 6-18 as in the PPI) (0 to 5 points)
3. Building materials of the walls of the house - 0 to 13
4. Building materials of the roof of the house- 0 to 6
5. Main cooking fuel - 0 to 9
6. TVs - 0 to 15
7. Radios, cassette/tape recorders, or hi-fi systems - 0 to 4
8. Lanterns - 0 to 4

9. Tables - 0 to 4

10. If the household cultivated any crops in the last 12 months, does it currently own any bulls, cows, steers, heifers, male calves, female calves, or oxen? Points were awarded as follows:

       A. No crops and no cattle – 0

       B. No crops and cattle – 0

       C. Crops and no cattle – 5

       D. Crops and cattle – 12

The PPI value attained from this formula is identified in a PPI "look up" table to determine the probability that the household falls below a poverty line. For example, a PPI of less than 9 falls below the international poverty line of $1.90/day 100% of the time while a PPI of 25 or 50 falls below that poverty line approximately 71% or 20% of the time, respectively (IPA, 2011).

The literature and the stakeholder interviews suggest that the Maasai measure wealth by number of cattle and children. However, the Maasai also own and value other types of livestock, such as goats and chickens. For that reason, we calculate Tropical Livestock Units, or TLUs, as a wealth measure based on the number of animals owned by the respondent's household, although some respondents have limited information about these holdings. Using the FAO's conversion factors, the numbers of various animals that people owned were converted into the corresponding TLU scores (FAO, 2011).

TLU points awarded per animal:

1. Cow =0.7
2. Bulls =0.7
3. Goats =0.1
4. Sheep =0.1
5. Chicken =0.01

Given this analysis' focus on Maasai pastoralist women in the NCA and NCA restrictions, the PPI has limitations because it lacks a value for cattle in the absence of crops while the TLU has limitations due to women's lack of involvement in and awareness of household livestock

holdings. Because we do not have prior information on the assets valued by women, we instead asked women directly about their life satisfaction, with responses measured on a scale of 0 to 10 to create another measure of well-being for women in our sample.[2] Using a combination of these metrics, we are able to get a picture of the overall well-being of Maasai women living within the NCA.

V. Descriptive Analysis

In this section we outline the findings of the survey. We begin with descriptive statistics at the village level from both the village assessment interviews and from survey respondents; provide descriptive statistics from the women's survey; examine statistics regarding wealth and life satisfaction; provide an analysis of women's reported daily activities; and briefly discuss the men's survey.

i. *Characteristics of villages: village assessment and infrastructure*

Like the NBS census data, the village assessment of the 23 Maasai villages in NCA found an average village population of about 4488 with approximately 1102 households (Table 3; see the appendix Table A2 for further information). The village assessment found that a typical man in the NCA owns 17 cattle, 27 goats, and 26 sheep (Table 3). Given cultivation restrictions in the NCA, the Pastoral council (PC) and the NCAA distribute subsidized grain four times a year. In 17.39% of villages the amount of grain varies by household size, while in all villages there is no seasonal variation in the quantity of grain available. Additionally, 56.52% of villages reported that the grain sometimes or always arrives late. Over half of the Maasai villages (52.63%) have dispensaries with a sample-wide average of 4 nurses, but 30% of the dispensaries have no rural medical officers. A small proportion of medical personnel are paid a hardship allowance or have transportation. Village leaders report a high prevalence of wildlife attacks. The village assessment found that 86.36% of villages have either a primary or secondary school, with an average of 9 teachers in each primary school and electricity in 63.16% of schools. All schools have a school feeding program, but many schools provide only porridge and less than half have enough food throughout the year (Table 5). Although most villages (91.4%) have piped or tap water, most of those taps are public wells in one sub-village, with few households having tap water and some sub-villages having no piped water (Table 4).

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[2] The specific question asked was: How satisfied are you with your life, all things considered? 0 – 10 scale.

Village demographics	Mean (Std. dev.)
Village population	4487.7
	(1980.3)
Total number of households	1101.8
	(421.4)
Grain program	
Average grain amount per household per distribution (Kgs)	20.7 (6.2)
Frequency of grain distribution per year	3.7
	(0.6)
Amount of grain varies by size of the household	17.4%
Amount of grain varies by season	0%
Milling grains in village	4.4%
Grains late	56.5%
Health	
Availability of dispensary	52.6%
Availability of rural medical officer	70%
Average number of Nurses	4.3
	(5.9)
Hardship allowance to medical personnel	18.2%
Transport available to medical personnel	20%
Electricity in dispensary	91%
Wildlife attack on village members	95.2%
Average number of wildlife attacks	6.3
	(10.8)
Education	
Availability of primary or secondary school	86.4%
Number of teachers in primary school	8.9
	(2.9)
School feeding program available in village	100
	(0.0)
Number of students sponsored	22.4
	(28.0)
Electricity available in school	63.16%
Livestock	
Average number of cattle owned by a typical man	17.5
	(15.5)
Average number of goats owned by a typical man	27.3
	(26.3)
Average number of sheep owned by a typical man	25.7
	(21.6)
Food Prices	
Average price of maize in village (per 1 debe≈20 Kgs)	22,313 (9,768.6)
Average price of maize outside village in NCA (per 1 debe≈20 Kgs)	19,029 (19,375.4)
Average price of maize outside NCA (per 1 debe≈20 Kgs)	16,412.8 (4,137.9)
Average price of calf	20,7391.2 (50,990)

Average price of goat	53,333.2
	(15,125.9)
Average price of sheep	52,710
	(13,884.4)
Average price of cow	30,8405.7
	(77,237)
Average price of castrated bull	566,521.6
	(158,437.8)
Average price of bull	467,101.3
	(121,436.5)
Average price of common vegetables	942.8
	(685.5)
Observations	**23**

Table 3. Village Assessment summary statistics.

Infrastructure	% of villages
Health center	56.5%
Daily Market	8.6%
Weekly Market	39%
Tap water	91.4%
Cattle Dip	73.8%
Number of Infrastructure Projects per village	8.5
Average distance from the Main Gate (km)	38.7
Wood Collection (average hours per week)	13.6
Water Collection (average hours per week)	14.4

Table 4. Village Assessment overview statistics on infrastructure and access.

School Food Program	%
Households where children are fed at school	71.2
Received 1 meal per day	66.3
Received 2+ meals per day	30.7
Are there vegetables in school meals?	3.7
Meals covered by the program	**%**
Porridge	53
Lunch	26.1
Porridge and lunch	20.9
How often the school does not have enough food for the meals	**%**
Always	21.3
Sometimes	36.7
Never	42

Table 5. Village Assessment information on school food programs

ii.   Characteristics of respondents to the women's survey

As expected in Maasai villages, 99.6% of the survey respondents are Maasai (Table 6). The average household size is about 5 individuals, with an average of 3.5 children (children are defined as 17 or younger). Most households (88%) have one or two children who are too young to go to school. Maasai use multi-year periods to describe age, which means that we have data on

age groups for adults (Table 6). The age distribution fits an expansive population pyramid, which is indicative of high birth rates and low life expectancy. Most respondents are married or widowed, with all the men in our men's survey being married because they were selected as the spouse of a randomly selected surveyed woman. Because every woman on the grain list is a household head, all survey respondents are household heads, but, due to polygamy in Maasai culture, several households share one male, and the survey collected information about the wife number of each women head of household.

Over 73% of the women respondents in our sample report having no education and only 6% have education beyond primary school. Women report that they eat meat infrequently (Table 11). Women skip more meals than their children, with women and children skipping more meals and eating less meat during the dry season. Even during the rainy season, 53% of respondent women, and 47% of their children, skip at least one meal per week.

Age of the respondent	%
18-30 years young adult	34.7
31-45 years adult	33.2
46-60 years older adult	25.3
60+ years senior	6.8
Education	%
No education	73.6
Primary school	20.3
Secondary school	5.5
University/Technical school	0.7
Primary livelihood (women -most time spent)	%
Livestock keeping (including milking)	65.5
In-house business	4.8
Selling firewood	3.7
Laborer	2.8
Are you part of the Maasai tribe?	99.6 %
Variable	**Mean (Std. Dev)**
Are you part of the Maasai tribe	99.6% -
Household size	4.8 (1.9)
Children (school age)	1.9 (1.3)
Total children	3.5 (1.7)
Tropical Livestock Unit	5.0 (6.55)
Poverty probability index	20.9 (9.9)

Water trip time	2.3
	(2.2)
Water collection (times/week)	7.4
	(4.5)
Fuelwood trip time	4.1
	(2.5)
Fuelwood collection (times/week)	3.6
	(2.1)

Table 6. Women's survey summary statistics

iii. Metrics and Drivers of Wealth and Life Satisfaction

We calculated several metrics to characterize the wealth, well-being, and life satisfaction of Maasai women in the NCA: Poverty Probability Indicator (PPI), Tropical Livestock Units (TLU), household assets, and stated life satisfaction. The PPI reveals a high probability of households falling below the international poverty line ($1.90/day) across all respondents in our sample, with some variation across villages and some well-off outliers within villages (Figure 3). This PPI information indicates that most households within the NCA are quite poor and often fall below the international poverty line. Even the outliers in our sample have a 50% probability of falling below a $4/day (approximately twice the international poverty line).
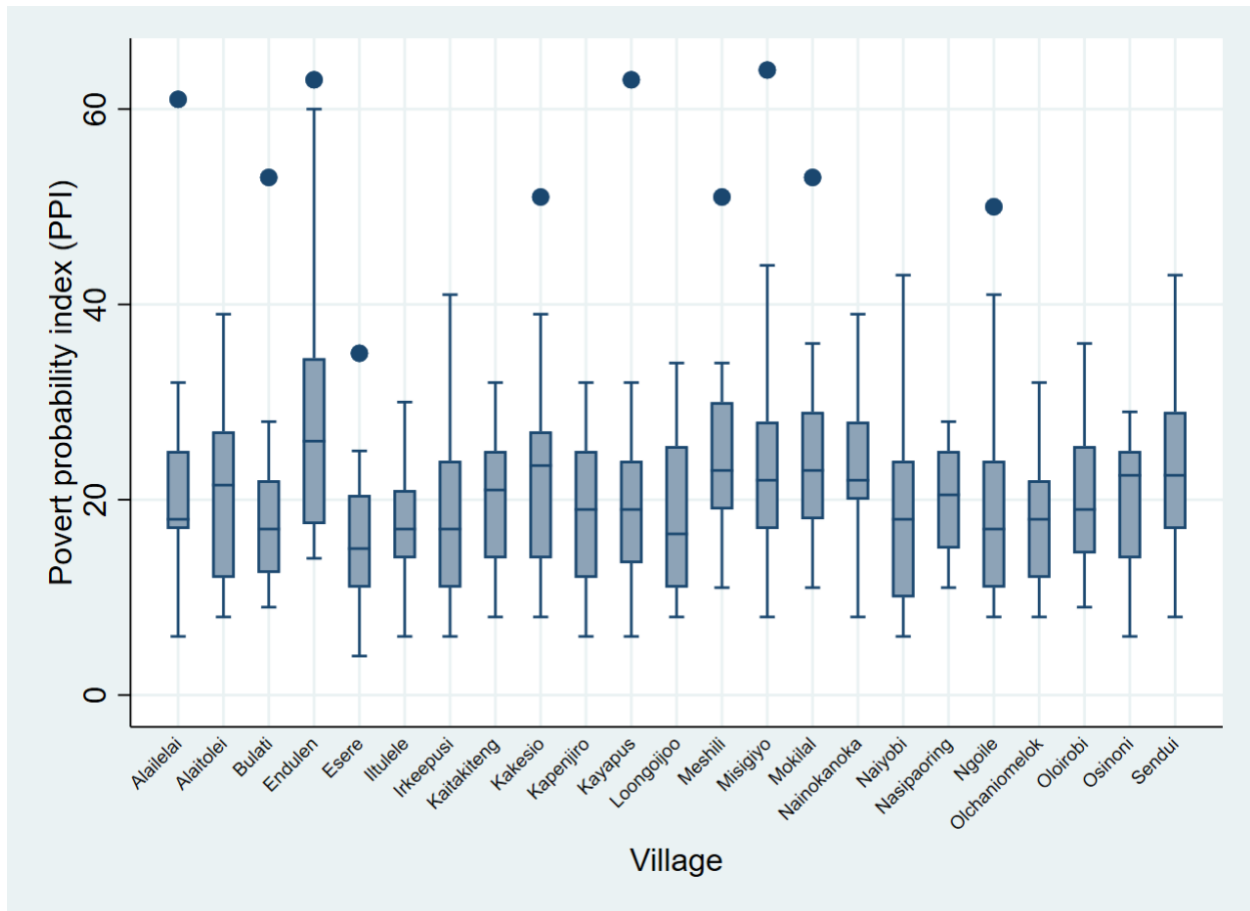
Figure 3. PPI per village with averages, dark circles indicate outliers

Due to the emphasis of Maasai wealth metrics on cattle and the difficulties with assigning PPIs to households with cattle but no agriculture, we also calculated the TLU of our respondents' households (Figure 4). Other literature relates TLU to wealth categories, with low (<10 TLU), medium (10-20 TLU) and high (>20 TLU) as categories, and a TLU of 4.5 per capita as a poverty line for pastoralists (Mburu, et al. 2016). The average TLU in all villages in the NCA falls into the low wealth category according to this classification, and almost all households fall below the per capita TLU poverty line. Again, this wealth metric demonstrates variability across both households and across village averages, with some high TLU wealth households in many villages.
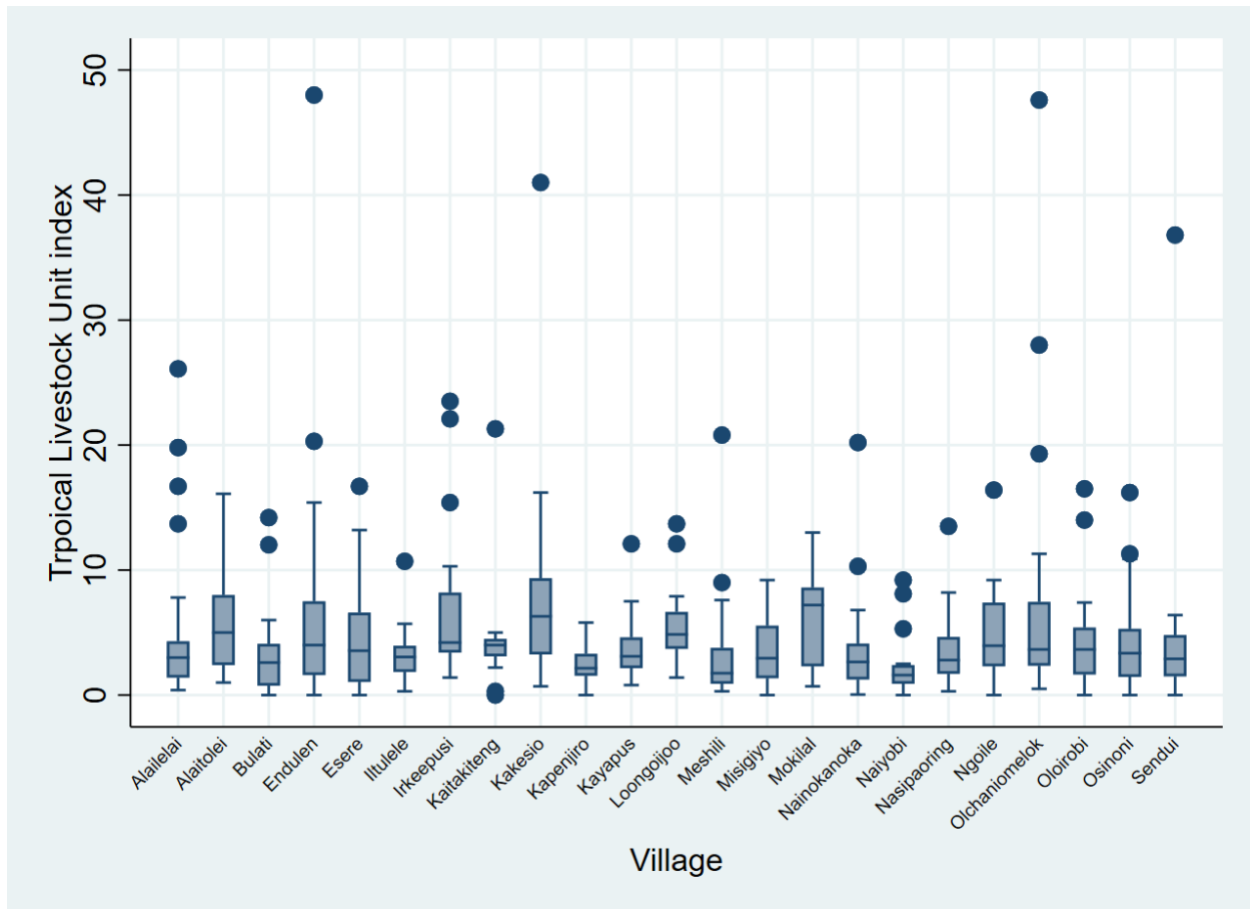
Figure 4. TLU per village with averages, dark circles indicate outliers

We explored the relationships across these well-being and wealth metrics, in addition to some other measures of wealth of importance to women and rural households (Table 7 and Figure 5). Those additional metrics include kitchen assets (an index that represents the household's number of cups, pots and water containers), remittances per year from all household members living outside of the NCA for most of the year, and the number of special outfits that the woman owns. The correlations between our 3 primary well-being metrics are positive but not large. Life satisfaction positively correlates with TLU at a correlation coefficient of 0.176 and with PPI at a correlation coefficient of 0.103, while PPI and TLU have a positive correlation coefficient of 0.219. Women's life satisfaction correlates at a higher level with their number of special outfits (0.323) and kitchen assets (0.287), with those asset measures strongly correlated as well (0.586). Debate remains as to the most appropriate metrics to assess Maasai women's wealth, income, and well-being. The use of TLU poses issues because women in our sample are not always aware of the household's TLU. Relying on PPI poses difficulties for characterizing NCA households

due to the NCA restriction on agricultural activities that impact the way cattle are included in the PPI. Similarly, life satisfaction does not always correlate well with income measures in other rural settings and recent analysis links life satisfaction to relative income rather than actual income (Ball & Chernova, 2008; Boyce et al., 2010; Grimes & Reinhardt, 2015). With those caveats, using the set of three metrics provides a basis for assessing well-being.

Observations = 398	Tropical Livestock Unit	Poverty probability index	Women's kitchen assets	Life Satisfaction	Remittances	# of special outfits
Tropical Livestock Unit	1.000					
Poverty probability index	0.219	1.000				
Women's kitchen assets	0.289	0.314	1.000			
Life Satisfaction	0.176	0.103	0.287	1.000		
Remittances	0.046	0.040	0.041	-0.003	1.000	
# of special outfits	0.161	0.310	0.586	0.323	-0.005	1.000

Table 7. Correlations among wealth and well-being metrics.
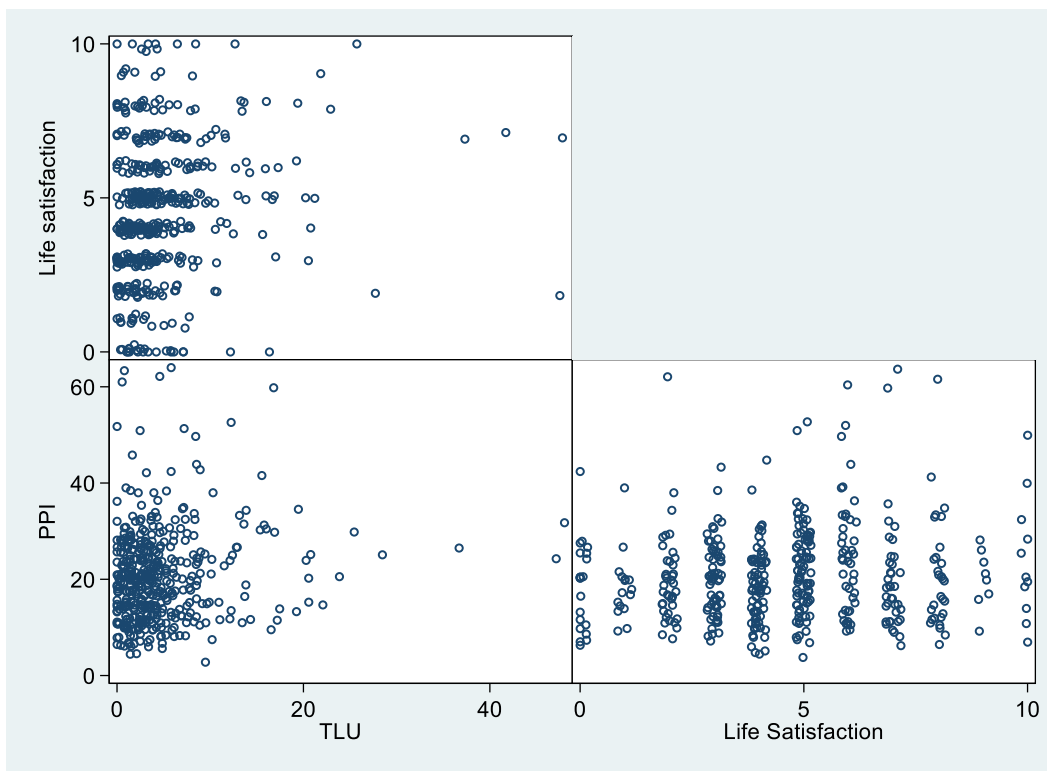
Figure 5. The matrix graph shows a scatter plot of the Tropical Livestock Unit (TLU) index, Poverty probability index (PPI) and perceived life satisfaction. The axis units represent the range of each index.

These well-being metrics tell a story of poverty among Maasai households within the NCA. To explore potential drivers of these metrics, we estimate some simple regressions to determine what household and village characteristics correlate with Life Satisfaction and with TLU. Using the literature on pastoralists and our stakeholder interviews as a guide, we considered the correlations and drivers of women's life satisfaction in a simple regression with and without village dummy variables (Table 8). From the Maasai pastoralist literature, we would expect that TLU and number of children would correlate positively with life satisfaction because those are the metrics that Maasai men state as defining their wealth. From the rural development economics literature focused on women and from stakeholder interviews, we would expect that remittances, education, assets specific to women (kitchen, clothing), schooling for children, availability of resources (fuel and water), health care and health of the family to be strong drivers of women's life satisfaction. Based on stakeholder interviews and aspects of living within a conservation area, we would expect conflict with wild animals and restricted access to resources to negatively correlate with life satisfaction and for concerns about restrictions on growing food in the NCA to also push metrics of food security to the front as factors determining life satisfaction.

We find that Maasai women's life satisfaction does *not* appear to correlate with TLU (Table 8). The emphasis in the pastoralist literature and specifically within the Maasai culture on cattle as a measure of wealth appears misplaced when evaluating the status of Maasai women within our sample. In addition, variables describing age, education level, resource access times and restrictions, and number of children all proved insignificant in this regression. Still, women appear focused on aspects of their children's wellbeing, with assets such as clothing for women and children and access to health care and an ability to handle health issues being significant positive correlates with life satisfaction. However, an unexpected result is that women who have been sick for a month in the previous year have higher life satisfaction, perhaps because they are finally healthy again. In addition to several village dummies, the most significant variables in determining the women's life satisfaction centered on food. Women whose children are fed at school and who eat meat regularly have higher life satisfaction. Women whose regular activities include long trips to markets and to school have lower life satisfaction. Similarly, women who primarily collect water from streams or ponds have lower life satisfaction, which may reflect that that activity is unpleasant and dangerous, or that those water sources are of lower quality than

piped water. Although water availability is a "main challenge" for many women in our sample, and the average woman in our sample spends 2 hours per day collecting water, variables around water source and tap water availability are not robust across specifications; in the regression with village dummies, both tap water availability, and a stream or pond water source are negatively correlated with life satisfaction.

Dependent Variable: Life Satisfaction	Model: Ordered Logit	
Variables	**Base**	**Village Dummies**
Tropical Livestock Unit (TLU)	-0.018	-0.017
	(0.013)	(0.014)
Women's kitchen assets index	0.096	0.131
	(0.097)	(0.120)
Remittances	-0.000	-0.000
	(0.000)	(0.000)
Age - 18-30 years (base level)		
31-45 years	0.541	0.556
	(0.415)	(0.451)
46-60 years	0.683	0.650
	(0.457)	(0.490)
60+ years	-0.161	-0.241
	(0.669)	(0.694)
Education Level – No school (base level)		
Primary school	0.144	0.054
	(0.330)	(0.347)
Secondary school	0.135	0.025
	(0.358)	(0.427)
University/Technical school	0.097	-1.138
	0.144	0.054
Total children	0.062	0.061
	(0.070)	(0.089)
Male children ratio	-0.326	-0.590
	(0.468)	(0.475)
Children in school ratio	0.177	0.107
	(0.271)	(0.286)
School age female children	-0.250	-0.263
	(0.180)	(0.206)
Meals skipped per week	-0.008***	-0.008***
	(0.001)	(0.002)
Children are fed at school	0.765**	1.046***
	(0.329)	(0.365)
Meat/week consumed in dry season	0.599***	0.651***
	(0.133)	(0.145)
Market Distance	-0.022***	-0.021***
	(0.005)	(0.006)
School trip time	-0.130	-0.187*
	(0.092)	(0.107)
# of special outfits	0.021	0.017
	(0.068)	(0.068)
Satisfaction of their children's amount of clothing – Completely dissatisfied (Base)		

Somewhat dissatisfied	0.525	0.310
	(0.327)	(0.383)
Neither satisfied nor dissatisfied	0.446	0.425
	(0.322)	(0.362)
Somewhat satisfied	1.041**	0.780
	(0.430)	(0.483)
Completely satisfied	2.355***	2.479***
	(0.549)	(0.524)
Sick days last year – None (base level)		
Less than a week	0.351	0.328
	(0.218)	(0.235)
1 to 2 weeks	0.183	0.208
	(0.360)	(0.402)
2 weeks to 1 month	0.417	0.453
	(0.331)	(0.356)
More than one month	0.952**	0.831**
	(0.376)	(0.407)
Dispensary distance	-0.003	-0.017
	(0.005)	(0.034)
Cope with unexpected illness in your household – Completely unable (base level)		
Somewhat unable	-0.656	-0.480
	(0.413)	(0.463)
Neither able nor unable	0.990	0.947
	(0.608)	(0.724)
Somewhat able	1.062***	1.150***
	(0.390)	(0.439)
Completely able	-0.389	-0.539
	(0.477)	(0.533)
Owns a solar panel	0.403	0.368
	(0.384)	(0.387)
Tap/piped water available	-0.146	-2.107**
	(0.314)	(0.883)
Limit of how much water you can collect in dry season	-0.072	-0.160
	(0.369)	(0.432)
Water source - Common faucet or well, or neighbor's well in both seasons (Base level)		
Stream, river, pond in both seasons	-0.603*	-0.847**
	(0.345)	(0.397)
Stream, river, pond in any season	-0.083	-0.501
	(0.498)	(0.604)
No Stream, river, pond use	-0.107	-0.236
	(0.439)	(0.626)
Borehole in both seasons	-0.557	-0.435
	(0.418)	(0.610)
Wild animals menace when collecting (%)	0.304	0.443
	(0.234)	(0.272)
Times per week collecting fuelwood	0.070	0.080
	(0.072)	(0.082)
Fuelwood collection trip time	0.059	0.092
	(0.150)	(0.140)
Times/week # Trip time to collect fuelwood	-0.022	-0.029
	(0.023)	(0.022)
Village Dummy - Alailelai (Base)		
Alaitolei		-1.796**
		(0.724)
Bulati		2.604
		(2.978)

Endulen	1.134	
	(1.430)	
Esere	1.120***	
	(0.369)	
Iltulele	-0.330	
	(1.114)	
Irkeepusi	1.737***	
	(0.552)	
Kaitakiteng	0.258	
	(0.618)	
Kakesio	-0.742	
	(0.911)	
Kapenjiro	-1.120	
	(0.866)	
Kayapus	2.037***	
	(0.390)	
Loongoijoo	1.958***	
	(0.436)	
Meshili	1.293**	
	(0.603)	
Misigiyo	0.758*	
	(0.433)	
Mokilal	1.159	
	(1.701)	
Nainokanoka	1.315	
	(2.093)	
Naiyobi	1.294**	
	(0.598)	
Nasporioong	2.255	
	(2.625)	
Ngoile	1.045*	
	(0.571)	
Olchamiolock	1.121**	
	(0.508)	
Oloirobi	1.228***	
	(0.410)	
Osinoni	-	
Sendui	-	
N	**291**	**291**

Table 8. Determinants of life satisfaction. Ordered logit results. Robust standard errors in parentheses and clustered at the village level in both models. *** p<0.01, ** p<0.05, * p<0.1.

Using TLU as a wealth metric, as in much of the analysis of pastoralist communities, we examine what household characteristics act as inputs to, or correlate with, the household TLU. Regressions (Table 9) with and without village dummy variables explain little of the TLU variation and have few significant variables. As in most studies of wealth, the household head having primary school education correlates positively with TLU. Of the inputs to cattle management and sales – male children, distance to gate or market, access to a cattle dip, or veterinary costs – only the veterinary costs variable produces a significant result, albeit with a small coefficient. Several village dummies prove significant – with positive and negative

coefficients –suggesting that it would be fruitful to examine village characteristics as drivers of TLU. The lack of explanatory power in this regression could result from the women respondents' lack of information about their household's TLU, given their lack of involvement with that production process and marketing. Taken together, the lack of significance of TLU for women's life satisfaction and the lack of power in the TLU regression demonstrates that the literature's focus on TLU type metrics for evaluating pastoralists' households does not adequately describe pastoralist women's experience and wellbeing.

Dependent variable: TLU	Model: OLS	
	Base	Village
Household size	0.018	0.075
	(0.239)	(0.239)
Education Level of the head of the household– No school (base level)		
Primary school	1.970**	1.695*
	(0.918)	(0.880)
Secondary school	3.123	2.800
	(2.117)	(2.232)
University/Technical school	1.803	0.717
	(1.641)	(1.912)
Total male children	0.815	0.462
	(1.154)	(1.099)
Ratio of male children	-2.010	-0.990
	(3.103)	(3.076)
Distance to gate	-0.001	0.013
	(0.031)	(0.042)
Market distance	-0.000	0.004
	(0.009)	(0.007)
Remittances	0.000	0.000
	(0.000)	(0.000)
Primary livelihood: Keeping livestock	0.122	-0.135
	(0.689)	(0.775)
Cattle dip available	0.032	0.032
	(0.691)	(0.477)
Veterinary input costs	0.000*	0.000*
	(0.000)	(0.000)
Village Dummy - Alailelai (Base)		
Alaitolei		1.299**
		(0.467)
Bulati		-1.126**
		(0.472)
Endulen		2.833***
		(0.407)
Esere		-2.189***
		(0.596)
Iltulele		-1.325
		(0.827)
Irkeepusi		1.459*
		(0.832)
Kaitakiteng		0.582
		(0.817)
Kakesio		3.120**
		(1.258)

Kapenjiro		-2.181***
		(0.392)
Kayapus		-0.402
		(0.763)
Loongoijoo		0.592
		(1.038)
Meshili		-1.318***
		(0.304)
Misigiyo		-0.022
		(0.900)
Mokilal		0.418
		(0.833)
Nainokanoka		-0.906**
		(0.419)
Naiyobi		-2.663***
		(0.850)
Nasporioong		-0.683
		(0.476)
Ngoile		-0.666
		(0.546)
Olchamiolock		3.671***
		(0.654)
Oloirobi		0.984
		(1.286)
Osinoni		-
Sendui		-
Constant	3.230*	2.601
	(1.872)	(2.275)
R²	**0.07**	**0.145**
N	**370**	**370**

Table 9. OLS regression: TLU drivers. Robust standard errors in parentheses and clustered at the village level in both models. *** p<0.01, ** p<0.05, * p<0.1.

iv.   Daily schedules

Women allocate their time to a range of daily activities (Table 4 and Figure 6). Women spend over 2 hours per day collecting water and nearly 2 hours a day collecting fuelwood, on average. Many women are responsible for milking cows, although some women allocate that responsibility to female children. Cooking and chores require nearly 1.5 hours each per day. After accounting for household time spent on household activities, most women (65%) spend most of their potential income-generating time on cattle-related activities, especially milking cows.
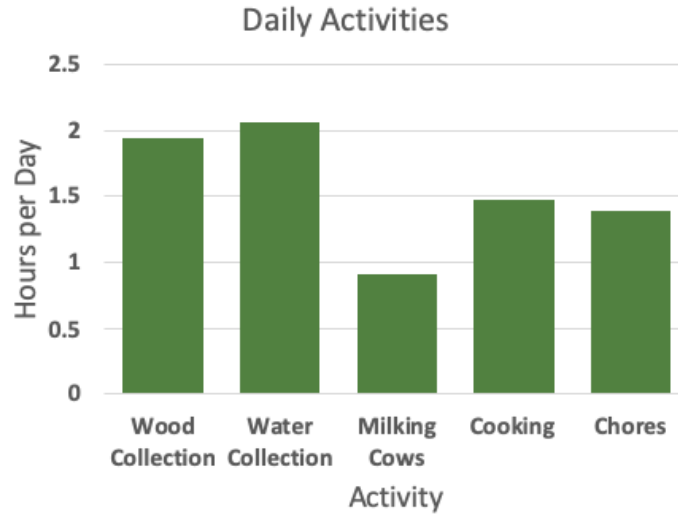
Figure 6. Women's daily activities.

v.   *Men's survey*

With few men present in the villages due to long trips to prime grazing grounds, the survey was administered to just 68 men, all of whom were married to a sampled woman. This sampling over-represents men who are located in the village during a time when many men were away with cattle, such as non-herders, the elderly or ill, and laborers. Most men have primary education (66%), which represents a higher level of education than that of the women. Fewer than 30% of the men have only one wife. Most surveyed men spend most of their time in (56%), and receive most of their cash income from (60%), livestock related activities (Table 10). These men report TLUs of 7.6, which includes livestock from all of their households.

	Women Survey	Men Survey
Marital Status	%	%
Married	79.5	100
Widowed	18.6	0
Single/Other	1.9	0
Education	%	%
no school	73.6	14.7
partial primary	2.2	1.5
primary	18.1	66.2
partial ordinary secondary school	1.8	5.9
ordinary secondary school	3.5	5.9
partial advanced secondary school	0.2	
technical school	0.4	

university	0.2	4.4
Number of Wives	%	%
1	24.7	29.4
2	30.0	38.2
3	23.9	10.3
4+	21.4	22.1
Main challenge facing now	%	%
Not enough food or money for food	48.7	
Water Availability	23.4	38.2
Unable to grow Food	6.3	
Other	21.6	48.5
Primary livelihood (most time spent)	%	%
Livestock keeping	65.5	55.9
In-house business	4.8	0
Selling firewood	3.7	0
Laborer		14.7
Primary source of cash income	%	%
Livestock keeping	21	60.3
In-house business	14	0
Selling firewood	5.5	0
Laborer	0	10.3
Tropical Livestock Unit	4.98	7.6

Table 10. Men's survey findings compared to women's survey, household characteristics

Comparison between the men's and women's surveys reveals different responses across household food consumption, including a widespread perception by men that their children rarely skip meals (Table 11).

	Women Survey			Men Survey*
How many days did your household consume in the last week (rainy season)	**Vegetables (%)**	**Rice (%)**	**Meat (%)**	**Vegetables (%)**
None	7	34.9	51.5	7.3
Once per week	6	38.2	34.7	17.7
2-3 times per week	33.7	22.5	5.5	48.5
4-5 times per week	13.5	0.9	0.7	0
7+ times per week	39.31	1.1	0.7	26.5
How many days did your household consume in the last week (dry season)	**Vegetables (%)**	**Rice (%)**	**Meat (%)**	**Vegetables (%)**
None	28	30.1	66.2	11.8
Once per week	29.7	45.6	23.6	32.4
2-3 times per week	34.1	19.7	4.4	47.1
4-5 times per week	1.1	1.1	0.2	0
7+ times per week	6.4	2	0.4	8.8
			Women Survey	**Men Survey**
Households that typically buy all the subsidized grain offered by the NCA			90.2 %	-
How many meals a day does your family eat on average? (rainy season)			**%**	**%**
1			0.9	2.9
2			33	48.5
3+			66.1	48.5
Meals the interviewee skipped in a week (rainy season)			**%**	**%**
0			47.1	83.8
1			16.5	14.7
2			21	1.5
3+			15.38	0
Meals your children skipped in a week (rainy season)			**%**	**%**
0			62.5	92.7
1			13.3	7.3
2+			24.1	0
How many meals a day does your family eat on average? (dry season)			**%**	**%**
1			0.9	0
2			46.5	45.6
3			52.6	54.4
Meals the interviewee skipped in a week (dry season)			**%**	**%**
0			36.6	83.8
1			16.6	14.7
2			23.5	1.5
3+			9.2	0
Meals your children skipped in a week (dry season)			**%**	**%**
0			54.4	95.6
1			16.2	4.4
2			15.5	0
3			13.9	0

*Table 11. Men's survey responses compared to women, food security. *Men were only asked about vegetable consumption while women were asked about rice, meat, and vegetable consumption.*

vi. Challenges facing NCA Maasai

Because of the challenge in defining metrics of well-being for NCA's Maasai community, we collected data about respondents' perception of and opinions about aspects of living within the

NCA. We asked both women and men to state the primary challenge they face while living in the NCA. Men were more likely than women to mention constraints on income-generating activities. Within food security categories, nearly 50% of women and only 25% of men listed "not enough food" as the primary challenge, while another 13% of men addressed NCA's restriction on food (Table 12). Taken together, both men and women cite food security as a critical challenge, which dovetails with the life satisfaction regressions that find food-related variables to be important. Women (23%) and men (40%) identify water availability as their primary challenge – with stakeholder discussions revealing that women emphasize the time and effort taken to collect water even from village taps while men emphasize the struggle to find water sources for cattle. Women also mention fuelwood challenges (4%) and medical care access (45%), while the fourth greatest challenge for men is the lack of road access.

Primary challenge facing your community	Women (%)	Men (%)
Not enough food/money for food	48.7	25.0
Water availability	23.4	39.7
Unable to grow food	6.3	13.2
Need better medical access (dispensary/hospital/ambulance)	4.4	1.5
Fuelwood	3.7	-
Road access	3.3	8.8
Education - lack of access to schools	2.6	2.9
Need more employment opportunities	2.6	2.9
Education- too costly/need scholarships	0.9	-
Other(specify)	3.7	5.9
Don't know	0.4	-
Observations	458	68

Table 12. Men's and women's responses to "primary challenge."

From the women's survey at the village level, food insecurity was identified as the main challenge in 17 villages (Table 13). Water was the most commonly reported primary challenge in 6 villages of which 3 do not have any water projects or piped water. Road access was the primary challenge for the village of Kaitakiteng, which does not have even a seasonal dirt road for access by vehicle.

	Main challenge category (Frequency)						
	Food	Water	Medical	Fuelwood	Road access	Education	Employment
Alailelai	17	0	0	3	0	0	1
Alaitolei	11	6	0	0	0	1	2
Bulati	15	1	2	2	0	0	0
Endulen	11	2	0	2	0	2	3
Esere	7	6	2	0	0	3	2

Village							
Iltulele	4	11	1	0	2	2	0
Irkeepusi	16	0	0	1	0	0	0
Kaitakiteng	0	4	2	0	9	3	0
Kakesio	3	13	0	0	0	1	0
Kapenjiro	7	10	2	1	0	0	0
Kayapus	13	1	0	1	0	2	0
Loongoijoo	16	2	0	0	0	2	0
Meshili	14	3	1	0	0	0	0
Misigiyo	16	1	0	0	1	0	1
Mokilal	16	0	1	1	0	0	1
Nainokanoka	15	1	0	1	0	0	0
Naiyobi	16	1	0	1	0	0	0
Nasporioong	8	10	0	1	0	0	0
Ngoile	10	7	3	0	0	0	0
Olchamiolock	6	9	1	0	3	0	0
Oloirobi	14	2	0	3	0	0	1
Osinoni	8	6	5	0	0	0	1
Sendui	9	11	0	0	0	0	0
Total	252	107	20	17	15	16	12

Table 13. Women's data – primary challenge by village.

Given that the two main challenges facing households in the NCA are availability of food and water, we calculated the PPI of individuals within a village that cited food or water availability as their main challenge and compare the individuals' PPI to the village's average PPI (Table 14). In most (16 of 17) of the villages in which food availability is cited most often as the main challenge, the individuals citing food availability as their main challenge had a lower PPI than the average PPI for that village. In contrast, we found no consistent relationship with village-level PPI when water was identified as the main challenge.

	Average PPI by "Main Challenge"		
	Main challenge: Food availability	Main challenge: Water availability	Village Average PPI
Alailelai	20.5	.	21.8
Alaitolei	19.3	25.2	20.8
Bulati	16.9	15.0	18.7
Endulen	29.2	22.0	29.4
Esere	19.1	14.7	16.4
Iltulele	13.0	19.4	17.4
Irkeepusi	17.8	.	18.4
Kaitakiteng	.	24.8	19.5
Kakesio	16.0	22.7	22.6
Kapenjiro	17.7	18.7	19.0
Kayapus	21.8	21.0	20.7
Loongoijoo	19.3	16.0	18.5
Meshili	24.2	23.3	24.7

Misigiyo	22.5	64.0	24.7
Mokilal	25.0	.	24.2
Nainokanoka	22.4	24.0	22.7
Naiyobi	17.6	22.0	18.6
Nasporioong	22.0	16.4	19.7
Ngoile	18.5	24.3	20.6
Olchamiolock	16.7	19.1	18.1
Oloirobi	19.4	24.0	20.4
Osinoni	21.0	21.3	20.0
Sendui	24.3	23.2	23.6
Total	20.6	21.2	20.9

Table 14. PPI by respondents' identified main challenge , averaged at the village level

VI. Discussion

Although much of the literature characterizing the status of the Maasai finds similar results in terms of poverty, our focus on the well-being of Maasai women reveals different determinants of that well-being than suggested by the existing male- and livestock-focused Maasai and pastoralist analyses. One challenge to using TLU as a well-being metric is that women were not sure of how much cattle their household owned because women are not the primary livestock caretakers. In addition, many households lost significant cattle holdings in a recent drought, which casts more uncertainty on the women's statements about TLU levels. Ongoing research using the men's survey and the NBS census data (see Appendix A, Table A1 for summary statistics) will provide more understanding of what drives TLU in the NCA. Still, our analysis suggests that women pastoralist Maasai in the NCA are much less focused on livestock than the literature on Maasai and other pastoralist communities suggests. That lack of focus and knowledge of TLU by Maasai women implies that policies aimed at improving women and children's well-being should not assume that TLU is a driver or an indicator of women's well-being.

Our analyses of women's life satisfaction and main challenges confirm the information obtained from stakeholder meetings that food and water availability within the NCA present significant challenges to Maasai residents. While the NCA, PC, and other organizations have provided water taps in many villages, women describe long wait times for water collection. Likely affecting men, relatively few villages have consistent water sources for cattle across the NCA, a problem heightened by drought in the years just prior to this survey.

To partially compensate for the restriction on growing crops in the NCA, the NCAA and PC provide subsidized grain to NCA households. Despite that program, women and men

consistently state that access to food is a problem throughout the NCA. The history of the NCA restriction on crops reveals perceived conflict by the NCA between growing crops and protecting wildlife in the NCA, particularly when wildlife is attracted to human settlements due to the crops. Access to food is a critical issue for the NCA to address to meet its dual goals of Maasai well-being and cultural preservation and of wildlife conservation. In addition, given women's limited voice in village and PC meetings and decisions and that women are likely to have more complete information about meals and food in the household, the fact that men commonly view food security as less critical than do women means that policy for food security is likely underprioritized. These data suggest that few NCA residents would agree that the current level of grain programs, market access, and crop restrictions enables households to achieve food security within the NCA.

Through careful description of Maasai women's activities and wellbeing, this paper lays the groundwork for future analyses (and possibly future data collection) that will be grounded in the household production framework and models of labor allocation tradeoffs in semi-subsistence settings (e.g. Singh, Squire, and Strauss, 1986; Udry 1996; Taylor and Adelman, 2003; Smith, 2015; Kristjanson et al. 2014; Boru et al., 2014). This modeling framework integrates non-market activities, such as fuelwood and water collection that are often the responsibility of women, and agricultural production. However, the framework is less developed for the NCA setting of Maasai pastoralist households in polygamous families with no crop production (Thornton, Galvin, and Boone, 2003; Fratkin and Smith, 1995). In particular, there has been little empirical work on the role of women in livestock-focused production systems despite increasing acknowledgement of the importance of their role (Thornton, Galvin, and Boone, 2003; Kristjanson et al. 2014). The descriptive information presented here will inform future analysis that reflects women's decisions, activities, and perceptions in a livestock-focused pastoralist household production system without access to agriculture and with time-costs for market access.

VII. Sustainable Development Goals (SDGs)

In 2015 during an historic UN summit, world leaders agreed to strive towards a common goal of protecting the earth while encouraging sustainable development for people's welfare. They established 17 Sustainable Development Goals (SDGs) for every country to work toward. The

common features of the SDGs are integrated and balance the three dimensions of sustainable development – economic, social, and environmental (UN, 2017). Each goal contributes to the achievement of a major aspect of sustainable development. Moreover, the SDG agenda emphasizes the importance of monitoring global and country progress on the sustainable development goals using a set of indicators. Country and locality specific evaluations can also contribute to the debate on the achievement of SDG targets and lead to adjustments aimed at achieving these milestones. Because the NCA was established to achieve a similar balance between economic, social, and environmental progress, in this section, we use the Sustainable Development Goals as a lens through which to present and interpret the data collected from households within the NCA. There are seventeen SDGs: (1) No Poverty, (2) Zero Hunger, (3) Good Health and Well-being, (4) Quality Education, (5) Gender Equality, (6) Clean Water and Sanitation, (7) Affordable and Clean Energy, (8) Decent Work and Economic Growth, (9) Industry, Innovation, and Infrastructure, (10) Reduced Inequality, (11) Sustainable Cities and Communities, (12) Responsible Consumption and Production, (13) Climate Action, (14) Life Below Water, (15) Life on Land, (16) Peace, Justice and Strong Institutions, and (17) Partnerships to achieve the Goals. Here, we describe the status of Maasai people living within the NCA in relation to SDGs 1,2,3, 5, and 6. Brief discussions of the remaining SDGs is contained in Appendix B.

i. Zero Poverty—SDG 1

As above, we constructed several metrics to capture income or wealth. The poverty probability index (PPI) includes household size, family members in school, housing materials, cooking fuel, household assets, and livestock ownership. Using the PPI, the NCA sample's poverty rate is twice the national poverty rate (in 2011) of 28.2%. The Tropical Livestock units (TLU) index measures all type of livestock depending on the context and the use of the livestock. With this metric, 90% of the sample is in poverty. Of the 60% of respondents who answered questions about their husband's income, 25% reported that their husband had no income. From the survey, approximately 50% of husbands make less than the average of TS 337,000. A quarter of the women report receiving remittances, with 75% of them receiving less than the sample average of TS 183,000. Finally, most of the respondents place themselves below the average

cattle holdings, which indicates a pessimistic view of their relative wealth or a cultural tradition of not viewing oneself as better than others.

Maasai women in the NCA have few opportunities and limited time for generating cash income. The main productive activities from which women earn cash income are milking cows and other livestock activities, in-house businesses, and selling firewood. An "in-house business" is the main source of cash for 3 out of every 20 respondents, but only 1 of those 3 report that they spend most of their time on this activity. Respondents spend most of their time on activities that further the household production function, such as fuel and water collection, chores, and milking cows for home consumption.

Overall, our interviews and data suggest that the Maasai in the NCA face high levels of poverty as measured in several ways (further information can be found in Table A2 in Appendix A) and the NCA restrictions limit the ways that households can improve their economic status.

Measures of income	Average
Average poverty rate % (from PPI)	57.8
Average poverty rate % (from TLU)	90.0
Assets index (range -2.5 to 13)	0
Husbands reported income (Shillings)	337,249
Remittances (Shillings)	183,702
Cow loss past year (%)	55
Perception of relative cattle to avg. male in village (Mode)	Less than average
Number of Houses	2.5

Table 15. Different measures of income reported in the survey

ii. Zero Hunger—SDG2

SDG2 aims to address food security by fostering mechanisms to ensure zero hunger by year 2030, with various sub-objectives (UN, 2015). Stakeholder interviews and survey questions indicate that food security is of particular concern among Maasai women in the NCA. Typical mechanisms for improving food security, such as augmenting food production, are not possible due to the NCA restrictions on crop cultivation (Lawou, Mbasa and Mnyawi, 2014). With crop restrictions imposed to protect habitat and wildlife, the NCA's management goals around SDG 15 – conservation of Life on Land – conflict with NCA management goals around Maasai well-being and SDG2 on hunger. The subsidized grain distribution program seeks to offset the burden of this restriction on Maasai households facing food insecurity and limit the negative impact of the pursuit of SDG15 on SDG2 among NCA residents. Still, more than half of the sample do not

consume meat at all, contrary to the common documentation of Maasai reliance on livestock products for food. Vegetables and grains are consumed more than meat. The source of vegetables and grains are mainly through the grain distribution program in the NCA, markets both in and outside NCA, and farms owned or rented outside NCA.

SDG2 aims at ensuring food access all year round for all people by the year 2030 (UN, 2015). Our survey indicates seasonal variation in food consumption and security, likely driven by limited production opportunities, long distances to markets, and a reliance on livestock that imposes seasonal changes and weather vulnerabilities on income flows. More families consume three or more meals in the rainy season than in the dry season, yet their consumption level is below the national average of approximately 62.4% nation-wide and 55% in rural areas, as recorded in demographic and health surveys (Demographics, T., 2016). Similarly, approximately 37% and 47% of respondents did not skip meals in dry and rainy seasons, respectively. This level is again below the national average of 57% and the rural area average of 52.7% of people who report to never experience trouble satisfying food needs in the past year (Demographics, T, 2016). People in the NCA skip more meals in dry seasons than rainy seasons and parents skip more meals than children. 3 out of 4 children receive food in school, although it is often porridge and it is not a constant supply over the year. Village Assessment data indicate that the grain distribution program supplies an average of 21 kgs of grains four times a year (for 3 months) to households in NCA. This distribution program does not vary with season and does not vary with household size in 83% of villages.

To ensure access to food all year round, a more seasonally-focused school food program and household grain distribution might target times of particular need. Improvements in roads and frequency of markets in the NCA would also promote food security. Overall, our stakeholder interviews and survey data confirm that Maasai women in the NCA face considerable food insecurity.

In addition to food security, SDG2 also aims at improving agricultural productivity and incomes of small-scale food producers, including women and pastoralist, by 2030, as well as sustainability of food production systems (UN, 2015). This emphasis includes secure and equal access to land, other productive resources, and inputs. Livestock-keeping remains the main economic activity of the NCA community, which falls under SDG2's agricultural production considerations. In the NCA, the village administration demarcates land for various purposes,

including grazing of adult cattle and containing young and injured livestock. Calves are usually grazed in agreed-upon areas near the village while grazing areas vary by season, for the rest of the livestock. The long travel to locate grazing land and water for livestock, especially in the dry season, can negatively affect Maasai wellbeing by increasing livestock mortality and fecundity (Swanson, 2007). In the sample examined in Lawou, Mbasa and Mnyawi (2014), 66%, of respondents identified problems of inadequate land for grazing, 84% highlighted inadequate land for pasture, and 82% cited lack of water for livestock. Wildlife attacks on livestock are also common and a unique challenge for the Maasai in the NCA. In keeping with SDG2's promotion of agricultural (including livestock) production, NCA programs provide some veterinary services, cattle dips, and livestock water sources. The ban on cultivation and grazing restrictions in particular locations that limit NCA Maasai households' ability to achieve SDG2, (zero hunger), are in place to achieve the goals of SDG15 , demonstrating a micro-level tradeoff between these SDGs in this multiple use conservation area.

iii. Health and well-being—SDG3

SDG 3 aims at promoting good health and wellbeing of people by ensuring universal health coverage including insurance, access to quality and affordable essentials, and vaccines for all (UN, 2015). Tanzania's National Health Policy 2007 and National Health Policy 2017 incorporated this goal by advocating availability and accessibility of good quality basic health services (MoHCDEC, 2017). Moreover, the primary Health Care Services Development Program (2007-2017) outlined a strategy to ensure that there is a dispensary in each village and a health center in each ward. The NCA does not meet these goals of accessibility of basic health services, with only 3 out of 5 surveyed households having a dispensary in their village. Almost all the dispensaries have electricity financed through the government as well as NCAA donor programs, and basket funding. Most dispensaries are financed by the government or by a cost-sharing system. Despite these attempts to increase access, the sub-villages in the NCA are scattered and this leads to long travel times to dispensaries. Our survey shows that the average time to reach a dispensary is 8 hours. These travel times likely reflect poor road conditions between sub-villages and villages, in addition to the lack of vehicle ownership. Respondents in 83% of surveyed villages highlighted poor road conditions and roads that are not passable during the rainy season as a constraint to reach at least one sub-village.

SDG 3 also encourages recruitment, development, training, and retention of a health services workforce in developing countries (UN, 2015). This goal is essential for the NCA given that it is located in a remote rural area with various restrictive regulations, which make jobs there less attractive for many professional healthcare workers. Only 1 health center and 10 dispensaries serve the 23 NCA Maasai villages. Only 5 dispensaries have rural medical officers available and a total of 43 nurses cover the NCA population of 103,216 people. Hardship and transport allowances are usually paid to encourage retention of health workers in rural areas, but only 20% of NCA health staff receive a hardship and transport allowance. The demand for health workers in the NCA is high. The reported average wait time for a doctor is 10 hours and an average annual number of household visits to a dispensary around 3. Still, villages self-report an average of 6 on a health and household health satisfaction scale from 1 to 10. Overall, the NCA's healthcare infrastructure and staffing fall below the standards in Tanzania and below those required to attain SDG 3.

NCA communities face both typical and unusual rural health challenges. One of the unique health challenges facing NCA Maasai communities is wildlife attacks. Respondents in about 95% of surveyed villages indicated that a village member has been attacked by wildlife in the two years prior the survey, with a total of about 145 attacks and 37 deaths. Our village dispensary assessments indicated that the primary health concerns include diarrhea, pneumonia, skin infections, malnutrition, upper respiratory infections, eye diseases, sexually transmitted infections, worms, and fever. This list consists of many preventable diseases. Other health concerns reported include poor reproductive health literacy; sanitation, including building and using toilets at home; absence of staff housing, inpatient services, and proper childbirth delivery sections; home delivery, poor ventilation in houses, traditional cultural practices, and a lack of a good water supply. These findings suggest that development of infrastructure, improvement of service delivery, and promotion of health literary are priorities to promote health in the NCA.

	Women's Survey (%)
Households with a dispensary in their village	61.1
Households in villages that pay hardship allowance for dispensary staff	18.2
Households in villages with transport allowance for dispensary staff	20.1
Electricity at the dispensary	90.4

	Average
Wait time for a doctor/nurse (hours)	10
Time to reach the place where they are treated (hours)	8.2
Household visits to the dispensary in the last year	2.6
Own Health satisfaction (10-point scale)	5.7
Household health satisfaction	5.9
Dispensary costs financing source	Government / Cost sharing
Infant deaths in the last year	8
Child deaths in the last year	30

Table 16. Access to health

iv. Gender equality—SDG 5

SDG 5 calls for gender equality and empowering all women and girls, with specific targets including ending all forms of discrimination against women and girls everywhere, recognizing and valuing unpaid care and domestic work, and ensuring women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic, and public life. We find evidence of substantial variation in the degree of agency or empowerment of Maasai women across the NCA. For example, about a fifth of women reported that they were involved in a women's group, with the most common purpose of those groups being to foster entrepreneurship or secure financial support. Most (77.5%) women reported that they retain control over any income that they earn directly, but 18% of women do not control even income that they earned.

To capture empowerment, we asked whether the respondent was consulted when her husband sells a cow (18% nearly always, 29% rarely) and whether her opinion is heard in the village development process (19% fully or somewhat heard, 6% fully or somewhat ignored).

	Women Survey
Are you asked for your opinion when your husband sells a cow?	%
Nearly Always	18.2
Often	25.4
Sometimes	23.5
Rarely	28.5
Refused/Do not know	4.4
Involved in a women's group	20.3
What are the other purposes of this group?	%
Financial support	31.1

Childcare	2.1
Entrepreneurship	35.5
Any other type of assistance	30.2
Do you feel your opinion is being heard in the village development process?	%
Fully heard	3.9
Somewhat heard	15.5
Neither heard nor ignored	14.6
Somewhat ignored	2.4
Fully ignored	3.9
Do not know	25.6
N/A	9.2
Women have the ability to keep and use income earned	77.5%
How does cash typically come into your household?	%
Ask husband for a certain amount	25.1
Have a weekly allowance	5.5
Sell livestock	14.6
Not available/ None	21.8
Other	33.0
How able are you to pursue your goals? (For instance, opening a shop or starting a business)	%
Completely unable	27.1
Somewhat unable	13.1
Neither able nor unable	6.3
Somewhat able	16.4
Completely able	37.2
First ranked Items that should be funded by the PC	%
Water Access	58.9
Dispensary	11.8
Education provisional of scholarships	9.4
Cheaper grains	9.1

Table 17. Gender equality

Although NCA and PC documents encourage participation of women in village and PC decisions, less than 20% of our sample said they typically participate in village meetings. Most researcher-observed meetings in the NCA were predominately men with very few women present, despite 50% of the households in the NCA being female headed. Twenty percent of women in the sample have no cash income but almost half of respondents receive cash from their husband when he sells cows. More than half of respondents feel that they can pursue their goals, but 27 percent of respondents feel completely unable to pursue any life goal. For women, the most important projects that the PC or NCAA should fund are water access projects, dispensaries, scholarships and cheaper food. Of the projects that are commonly funded, women view scholarships and dispensaries as more valuable than cattle dips and village offices.

v. Water and sanitation—SDG 6

SDG 6 focuses on clean water and sanitation. Within the NCA, water sources include water from taps, wells, and lakes and streams, with considerable heterogeneity in these sources across villages, but more homogeneity within villages, especially where public tap water pipes are installed. Among the water sources, we found that a similar number of trips were taken to reach all water sources, about once a day on average. The number of trips was slightly higher for those using a common faucet or well. However, the total trip time was an hour less on average for those sources compared to the others, indicating that it is easier for the women to access water from taps/wells frequently, as needed. Still, many women reported that their main challenge is water availability.

Women also face potential obstacles in collecting water, such as wild animals. People often mentioned that women could not go to specific places alone, or at all, during certain seasons due to potential wildlife interactions. Nearly half of all women are concerned about wildlife interactions when they collect water (Table 18). Creating water sources with reduced potential for these interactions could reduce this fear and the costly avoidance activities of accessing more distant water sources.

Water Source	% of households	Numbers of trips per week	Trip time (hours)	Main challenge: Water availability (%)	Wild animals menace when collecting (%)
Common faucet or well, or neighbor's well	51.6	7.7	1.8	17	45
Stream, river, pond	41.7	7.2	2.9	28	30
Borehole	5.1	7.2	2.8	36	57
Other	1.6	5.1	4.3	14	63
Total	**100**	**7.4**	**2.3**	**23**	**45**

Table 18. Water availability

For the sanitation aspect of this SDG, in recent years NCAA has pushed to make sure all households are using a private or shared latrine, although our data suggest that that goal has not been achieved. While 95.5 percent of our sample used a pit latrine, 76.7 percent were sharing this latrine with other families and only 46.1 percent of our sample had access to a safe water source. Six villages do not have piped water. In eight villages most residents collect water from a stream or river. Most of our sample have access to some type of latrine, but some households use alternative places as toilets, creating challenges such as disease spread. Indeed, during our fieldwork nearby non-NCA villages faced a cholera outbreak. Soap mitigates the spread of these

diseases. When comparing peoples' use of different toilet facilities to rates of households owning soap, we found that households with individual latrines were the most likely to own soap, while individuals with no latrine access do not own soap. Improved toilet facilities and soap are crucial to preventing the spread of transmissible diseases. However, our sample reflected heterogeneity in both facilities and soap use, with many households across many villages facing obstacles to appropriate sanitation.

What is the main type of toilet facility used by this household?	Freq.	Percent of each group owning soap
Own pit latrine (not flushed with water)	85	51.8
Shared (between families) pit latrine	351	33.3
Stream, river, pond, field, forest	14	0.0

Table 19. Toilet availability

Women Survey	Average
Water collection (times per week)	7.4
Time for water collection (hours)	2.3
Comparison of time for water collection 5 years ago	**%**
It used to be less	14.8
Same amount	51.4
It used to be more	32.7
Collected water for another household in the past year	78.5 %
Households with limits to water collection in dry season	46.8 %

Table 20. Water access

Water Source	%	Average Trips per week	Average Trip time	Main challenge: Water availability (%)
Common faucet or well, or neighbor's well in both seasons	41.9	7.8	1.5	0.4
Stream, river, pond in both seasons	39.4	7.4	2.8	0.6
Stream, river, pond in rainy season but common faucet or well, or neighbor's well in dry season	8.6	6.6	3.7	0.8
Borehole in both seasons	3.5	5.7	3.4	0.9
Borehole in the dry season and river, stream, pond in the rainy season	1.6	10.4	1.5	0.6
Other	5.1	6.1	3.3	0.7
Total	100	7.4	2.3	0.6

Table 21. Water collection by access type

What is the main type of toilet facility used by this household?	%	Household owns soap (%)
Shared (between families) pit latrine (not flushed with water)	76.6	33.3
Own pit latrine (not flushed with water)	18.6	51.8

Stream, river, pond, field, forest	3.1	0.0
Other	1.3	14.3
Refused to answer	0.4	35.0
Total	100	37.3

Table 22. Soap access and toilet facility

VIII. Conclusion

This paper presents data and discussion to form a description of the status of Maasai women living in the Ngorongoro Conservation Area (NCA) in northern Tanzania. As a multiple-use area, the NCA's management goals include conserving wildlife and biodiversity, catering for tourism, and promoting the Maasai culture and the well-being of resident Maasai. With these goals, the NCA Authority (NCAA) restricts certain livelihood activities of its residents and provides partial compensatory programs to residents. Overall, the data on the NCA's Maasai women depict evidence of widespread poverty and food insecurity throughout the NCA, large time commitments for gathering water and fuelwood by women, lack of water availability, lack of access to electricity, restricted access to markets and job security, and a lack of reliance on livestock for life satisfaction, which is not conveyed by the literature.

We use the Sustainable Development Goals (SDGs) as a lens through which to view the status of Maasai women living in this conservation area. Some SDGs conflict with each other in the NCA setting. For example, the NCAA prohibits cultivating crops to protect wildlife which is the goal of SDG 15. However, that restriction leads directly to increased hunger and food insecurity that is only partially offset by the current subsidized grain program. This is a challenge for achieving SDG 2 in the NCA. Other NCA restrictions on electricity, fuelwood collection, and buildings also promote SDG 15's ecosystem conservation targets but work against achievement of SDG 1 on poverty alleviation, 7 on sustainable energy, 9 on infrastructure, and 11 on sustainable communities.

Approaches that may address food and water access outside of the NCA – such as more water infrastructure and sustainable agriculture – lead to conflict with other NCA goals and the SDGs. Unique and innovative methods to resolve chronic food and water availability issues are necessary for the NCA to achieve its dual goals of promoting Maasai well-being and conserving

ecosystems and wildlife. In addition, exploring opportunities to promote more than one SDG within the NCA could be beneficial. For example, promoting fuel efficient stoves or non-wood based stoves for households within the NCA would address SDG 3 by improving women's health by reducing smoke, SDG 7 by providing sustainable energy, SDG 13 by reducing greenhouse gas emissions to protect the climate, and SDG 15 by reducing pressure on forests for fuelwood sources. In addition, more of women's time could be allocated to productive or enjoyable activities with the reduction in fuelwood collection time. While tradeoffs across SDGs are common and expected in a multiple-use conservation area, future policy emphasis to mitigate the burdens on people of some more ecologically focused SDGs may improve more development focused SDG outcomes. In particular, our status description reveals that the main challenges facing NCA residents are food security and water availability, yet these issues are challenging to solve given the NCA's emphasis on the conservation activities related to SDG 15. Overall, examining the SDGs and the status of women within the NCA provides insight to inform policies that balance the needs of people and the needs of ecosystems.

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Appendix A

This appendix contains further summary statistics from the NBS census and our surveys.

NBS Survey Summary (Table A1)

A census of all NCA residents provides further background information about this population. This table reports some of the central summary statistics from that survey (NBS 2017).

Variable	Freq.	Percent
Sex of the household head		
Male	11210	53.7
Female	9657	46.3
Age of the Household Head		
Children (Less than 18 years)	166	0.8
Young Adults (18 to 30 years)	5910	28.3
Adults (30 to 45 years)	8238	39.5
Senior Adults (46 to 60)	4209	20.2
Old (above 60 years)	2343	11.2
Marital Status		
Not married	1010	4.9
Married	15929	76.6
Living together	1430	6.9
Divorced	116	0.6
Separated	207	1.0
Widow/Widower	2099	10.1
Refused	11	0.1
In the past twelve months, has any member being involved in tourism?		
Yes	1043	5.0
No	19822	95.0
What is the main source of Income in this household?		
Agriculture	29	0.1
Livestock Keeping	19528	93.6
Fishing	17	0.1
Minerals	1	0.0
Tourism activities	99	0.5
Government Employee	221	1.1
Public parastatal employee	141	0.7
Private company employee	309	1.5
NGO employee	41	0.2

	Freq.	Percent
Self-employed (Not in agriculture/livestock)	120	0.6
Self-employed (agriculture/livestock)	136	0.7
Transfers	223	1.1

During the last 12 months, did you or any member of your household receive assistance or gifts from a relative or friend who is living outside Ngorongoro Division?	**Freq.**	**Percent**
Yes	1114	5.3
No	19751	94.7

What is the main source of drinking water for your household?

piped water into dwelling	1679	8.1
piped water into yard/plot	133	0.6
public tap	7530	36.1
pumped well	134	0.6
covered well	316	1.5
uncovered well	1643	7.9
protected spring	712	3.4
unprotected spring	4612	22.1
rainwater	234	1.1
bottled water	8	0.0
cart	9	0.0
tanker truck	104	0.5
river/dam/lake/pond	3750	18.0

What is the main source of energy for cooking for this household?

electricity	82	0.4
solar power	62	0.3
generator source (private)	15	0.1
industrial gas	281	1.4
electricity (biogas)	10	0.1
electricity (wind)	8	0.0
kerosene lamp	33	0.2
coal	1	0.0
charcoal	115	0.6
firewood	19865	95.2
wood/cotton residuals	16	0.1
dung	249	1.2
not applicable	127	0.6

What is the main source of energy for lighting for this household?

electricity	322	1.5
solar power	1678	8.0
generator source (private)	56	0.3
industrial gas	1	0.0

	electricity (biogas)	2	0.0
	electricity (wind)	2	0.0
	kerosene lamp	816	3.9
	candle	29	0.1
	firewood	6506	31.2
	torch/chinese lamp	11365	54.5
	other source	87	0.4
Do you/your household own a television inside Ngorongoro Division			
	Yes	528	2.5
	No	20336	97.5
Do you/your household own a television outside Ngorongoro Division			
	Yes	372	1.8
	No	20492	98.2
Do you/your household own a phone inside Ngorongoro Division			
	Yes	81	0.4
	No	20783	99.6
Do you/your household own a phone outside Ngorongoro Division			
	Yes	43	0.2
	No	20821	99.8
Do you/your household own a telephone inside Ngorongoro Division			
	Yes	5583	26.8
	No	15281	73.2
Do you/your household own a telephone outside Ngorongoro Division			
	Yes	416	2.0
	No	20448	98.0
Do you/your household own a bicycle outside Ngorongoro Division			
	Yes	72	0.4
	No	20792	99.7
Do you/your household own a bicycle outside Ngorongoro Division			
	Yes	74	0.4
	No	20790	99.7
Do you/your household own a car inside Ngorongoro Division			
	Yes	142	0.7
	No	20722	99.3
Do you/your household own a car outside Ngorongoro Division			
	Yes	90	0.4
	No	20774	99.6
Do you/your household own a radio inside Ngorongoro Division			
	Yes	1470	7.1
	No	19394	93.0
Do you/your household own a radio outside Ngorongoro Division			

Yes	343	1.6
No	20521	98.4

Do you/your household own solar power inside Ngorongoro Division

Yes	986	4.7
No	19878	95.3

Do you/your household own solar power outside Ngorongoro Division

Yes	130	0.6
No	20734	99.4

In the past 30 days, has your household ate few meals than usual?

Yes	10108	52.5
No	9141	47.5

How many times in the last 12 months, did your household experienced shortage of food?

never	1383	6.6
rarely	6909	33.1
sometimes	1400	6.7
frequently	10185	48.8
always	987	4.7

Which type of food is most favored by your household?

Mixed food (milk and maize)	1899	9.1
Stiff porridge (ugali)	9725	46.6
Rice	2482	11.9
Cooked maize (makande)	921	4.4
Meat	628	3.0
Porridge	5087	24.4
Other (specify)	122	0.6
How is this food obtained?	Freq.	Percent
Bought	20417	97.9
Self-production	173	0.8
Government assistance	25	0.1
NGO assistance	186	0.9
Assistance from relatives/friends	63	0.3

In general, how do you perceive about this year's economic situation of a household and that of last year?

Very bad	12980	62.2
Bad	3522	16.9
The same	3179	15.2
Better off now	1109	5.3
Very better	74	0.4

In general, how do you perceive about this year's economic situation of this area and that of last year?

Very bad	11480	55.0

	Bad	4037	19.4
	The same	4273	20.5
	Better off now	1014	4.9
	Very better	60	0.3
In general, how do you perceive about this years' economic situation of your household and other households in this area?			
	Very bad	8867	42.5
	Bad	3189	15.3
	The same	7349	35.2
	Better off now	1353	6.5
	Very better	106	0.5

Source: Authors computation from NCAA data collected by National Bureau of Statistics (NBS, 2017)

Table A1. Summary of NBS data

Table A2. Summary Statistics by Village

This table contains summary statistics of household characteristics from our survey by village.

Village	Variable	Kakesio	Kaitakite	Irkeepusi	Iltulele	Esere	Endulen	Bulati	Alaitolei	Alailelai
						Mean				
	Household size	4.6	4.3	4.9	5.2	5.3	5.4	4.9	5.5	4.2
	Children in school age	1.9	1.7	2.1	2	2.2	2.2	2	2.1	1.2
	Total children	3.4	2.9	3.5	3.7	3.9	3.6	3.5	3.7	3
	Tropical Livestock Unit	8.02	4.41	7.12	3.24	4.78	10.73	3.3	5.79	5.67
	Poverty probability index	22.6	19.5	18.4	17.4	16.4	29.4	18.7	20.8	21.8
	Water trip time	2.4	3	0.6	3.9	2.4	1.6	1.7	2.8	1.6
	Water collection (times/week)	7.1	7.5	8.1	7.7	8.4	11.7	6.9	6.8	8
	Fuelwood trip time	2.5	2.8	4.2	4.1	2.7	3.4	6.7	3.1	7.7
	Fuelwood collection (times/week)	3.8	4.7	3.7	4.6	3.1	3.4	2.6	3.6	2.5
	Age					%				
	18-30 years young adult	40	42	21	5	20	20	25	15	52
	31-45 years adult	35	26	42	50	50	35	30	40	33
	46-60 years older adult	20	26	21	30	30	30	35	35	14
	60+ years senior	5	5	16	15	0	15	10	10	0
	Education					%				
	No education	55	84	79	90	65	80	70	65	81
	Primary school	25	16	21	10	35	15	20	30	10
	Secondary school	20	0	0	0	0	5	10	5	10
	University/Technical school	0	0	0	0	0	0	0	0	0
	Primary livelihood (most time spent)					%				
	Livestock keeping	55	63	89	65	60	60	65	70	76
	In-house business	10	5	0	0	5	0	5	10	0
	Selling firewood	0	0	5	0	10	5	5	0	0
	Laborer	5	0	0	0	5	5	5	0	0

Table A2. Summary Statistics by village

Source: Data collected by authors

	Sendui	Osinoni	Oloirobi	Olchamio	Ngoile	Nasporio	Naiyobi	Nainokan	Mokilal	Misigiyo	Meshili	Loongoij	Kayapus	Kapenjir
Mean														
	4.2	5.1	4.7	5.2	4.9	5.3	5	4.7	4.7	3.9	4.6	5.1	4.9	5
	1.5	2.1	1.6	2.1	2.4	2	1.8	1.8	2	1.5	1.7	2.4	1.7	1.7
	2.8	3.9	3.3	4	3.5	3.8	3.6	3.2	3.3	2.8	3.5	3.9	3.4	3.8
	4.73	4.39	4.49	8.17	4.9	3.64	2.26	3.79	6.01	3.4	3.6	5.64	3.91	2.6
	23.6	20	20.4	18.1	20.6	19.7	18.6	22.7	24.2	24.7	24.7	18.5	20.7	19
	6.5	2.5	1.6	2.9	2.3	1.9	2.1	1.5	1.1	1	1.5	1.1	2.3	5.2
	5.1	7.6	8.5	6.1	7.4	8.7	5.8	7.9	8.7	8.3	6.4	8.3	6.2	4.1
	4.7	3.8	6.2	4.7	2.8	4.2	3.2	5.8	4.2	3.1	3	3.4	3.9	2.6
	3.5	4.9	3.5	3.5	4.2	3.3	4.1	2.7	3.9	2.9	2.8	3.9	3.6	5.1
%														
	50	40	50	40	15	20	37	55	55	40	45	15	40	55
	25	25	20	60	40	30	21	20	20	25	25	60	30	20
	20	25	15	0	45	40	37	25	20	25	25	20	25	20
	5	10	15	0	0	10	5	0	5	10	5	5	5	5
%														
	90	70	70	65	70	95	74	80	55	75	65	60	75	80
	10	20	25	30	15	5	21	15	35	15	25	30	25	15
	0	10	5	5	10	0	5	5	10	5	10	5	0	5
	0	0	0	0	5	0	0	0	0	5	0	5	0	0
%														
	65	70	60	80	80	70	63	55	70	55	65	60	55	55
	0	5	0	10	5	5	11	0	5	0	10	15	0	10
	5	5	5	5	0	0	5	5	10	0	5	5	10	0
	0	0	0	0	5	5	5	10	5	5	0	5	5	0

Table A2. Summary Statistics by village

Source: Data collected by authors

58

	PPI		Poverty rate (PPI)		TLU		Women's Kitchen assets	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Alailelai	21.8	11.1	55.4	20.2	5.7	7.2	-0.1	1.3
Alaitolei	20.8	9.8	60.3	26.5	5.8	4.0	0.2	1.6
Bulati	18.7	9.8	63.5	20.8	3.3	3.8	0.1	1.2
Endulen	29.4	15.2	40.8	23.1	10.7	18.8	0.8	1.4
Esere	16.4	7.1	66.5	21.2	4.8	4.6	0.0	1.6
Iltulele	17.4	5.8	63.8	18.6	3.2	2.3	-0.2	2.0
Irkeepusi	18.4	9.4	64.2	24.7	7.1	6.4	-0.5	1.0
Kaitakiteng	19.5	7.7	60.0	21.9	4.4	4.3	-0.2	1.1
Kakesio	22.6	10.6	56.1	25.2	8.0	8.7	-0.2	1.5
Kapenjiro	19.0	7.8	61.7	21.0	2.6	1.7	0.0	0.9
Kayapus	20.7	12.2	59.1	24.2	3.9	2.7	0.0	0.8
Loongoijoo	18.5	8.3	64.0	22.2	5.6	3.1	0.2	1.5
Meshili	24.7	9.3	48.5	18.2	3.6	4.8	1.1	2.9
Misigiyo	24.7	13.1	50.8	25.8	3.4	2.7	-0.5	1.0
Mokilal	24.2	9.7	49.5	20.0	6.0	3.9	-0.1	1.0
Nainokanoka	22.7	8.3	52.5	21.1	3.8	4.5	0.3	2.0
Naiyobi	18.6	9.4	63.4	24.6	2.3	2.6	0.1	1.5
Nasporioong	19.7	5.9	57.1	14.9	3.6	3.0	-0.6	0.6
Ngoile	20.6	11.9	60.4	27.8	4.9	3.9	0.0	1.3
Olchamiolock	18.1	6.1	64.0	17.3	8.2	11.4	0.0	1.0
Oloirobi	20.4	8.1	57.5	21.2	4.5	4.3	0.3	1.2
Osinoni	20.0	7.1	58.9	20.1	4.4	4.2	-0.3	1.0
Sendui	23.6	10.1	50.7	22.5	4.7	7.8	-0.5	1.1
Total	20.9	9.9	57.8	22.5	4.99	6.6	0.00	1.43
Observations	436.0		436.0		458.0		430.0	

Table A3. Measures of income by village

	Husband rep. income		Remittances		Cow loss past year		Relative cattle perception	Life Satisfaction (1 worst to 10 best)	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mode	Mean	Std Dev
Alailelai	286429	383939	65238	261182	49%	0.3	Less than avg.	4.3	2.6
Alaitolei	578333	1008517	165000	402159	72%	0.2	Same as avg.	4.4	2.7
Bulati	68333	121867	5000	18209	41%	0.3	Less than avg.	4.5	1.8
Endulen	808500	761206	21000	50461	59%	0.3	Same as avg.	4.8	2.1
Esere	380083	456887	24000	57619	67%	0.2	Less than avg.	4.6	1.7
Iltulele	218846	605489	63000	267957	43%	0.3	Less than avg.	4.4	2.6
Irkeepusi	239167	369600	68056	145694	54%	0.2	Same as avg.	5.1	2.7
Kaitakiteng	374583	847782	28684	59438	61%	0.2	Same as avg.	5.1	2.4
Kakesio	445385	865791	16000	35116	54%	0.2	Less than avg.	4.6	2.0
Kapenjiro	410667	799339	16500	56408	42%	0.3	Less than avg.	3.9	2.2
Kayapus	131250	251225	16500	56408	64%	0.2	Less than avg.	5.5	2.5
Loongoijoo	381667	685590	21500	60548	58%	0.2	Same as avg.	5.9	1.7
Meshili	118889	156241	4000	12732	53%	0.2	Same as avg.	4.6	2.0
Misigiyo	305000	331128	18850	30212	67%	0.3	Same as avg.	4.1	1.8
Mokilal	397700	636834	76667	295615	52%	0.2	Less than avg.	4.7	1.6
Nainokanoka	271250	572602	1500	6708	39%	0.2	Less than avg.	3.8	2.0
Naiyobi	359000	741038	13684	42323	36%	0.3	Less than avg.	4.5	2.4
Nasporioong	64545	90925	96150	323775	71%	0.2	Same as avg.	4.7	2.2

Ngoile	230000	410934	22632	73473	62%	0.2	Same as avg.	4.8	2.6
Olchamiolock	105538 5	2417539	3500	15652	47%	0.2	Less than avg.	4.6	2.1
Oloirobi	219444	198816	89500	178428	63%	0.2	Less than avg.	4.1	2.8
Osinoni	315750	461878	115250	281750	55%	0.4	Less than avg.	4.3	2.2
Sendui	136750	204311	17500	33541	45%	0.3	Less than avg.	3.5	2.6
Total	337249	771205	42081	170203	55%	0.3	Less than avg.	4.5	2.3
Observations	265		454		374		298	453.0	

Table A3. Measures of income by village cont.

Appendix B

This Appendix contains our evaluation of SDGs 4 and 6-17.

SDG 4: Quality education

Most NCA households have access to a nearby primary school but all students attending secondary school must travel to the few secondary schools within the NCA villages. On average, students make a trip of 1.5 hours to get to school. Scholarships, school structures, teacher salaries, and teacher housing constitute a large fraction of the PC-funded projects in the NCA villages. Stakeholders including NCAA officials, parents, and village leaders consistently emphasize the importance of education.

NCAA officials are investigating the idea of building a boarding school for secondary school students outside of the NCA rather than building more secondary schools within the NCA. Stakeholder discussions suggest that the reasoning behind this plan is that it would improve conservation goals, such as SDG 15, by limiting construction within the NCA and would provide safe education, SDG 4, and food for students, SDG 2. Our data and discussions with women in the NCA describe the reliance of women on their daughters for various household activities such as milking, childcare, and cooking. Similarly, households rely on male children to graze livestock, especially sick or pregnant cattle and small animals such as goats. Any plan to move secondary education outside of the NCA would likely affect the number of students enrolled in secondary education based on the fees for the boarding school, reductions in household labor, and lower household food costs while children board at school.

Women Survey/ Village Assessment	%
Ability to charge a device in the village	73.6
Households local access to primary school	86.5
Households with access to schools with electricity	63.1
	Average
Sponsored students per village	22.4
Trip time to go to school (hours)	1.47
Teachers in primary schools	8.9
Who pays their salaries/allowances?	Government

Table B1. Education Quality

SDG 7: Affordable and clean energy

SDG 7 calls for universal access to affordable, reliable, sustainable, and modern energy. Like much of sub-Saharan Africa, most (99%) Maasai households in the NCA rely on firewood for a three-stone stove which is their primary method of cooking. Women collect firewood an average 3.6 times a week, spending an average of 4 hours each day. Time allocation responses show that collecting firewood and water are the two primary activities for women during the middle of the day. Many households reported that they also collected firewood for at least one other household in the past year. These time allocations reflect high opportunity costs despite the "affordability" of collecting fuel in terms of cash outlay. In addition, fuelwood is not a clean energy source. While firewood is clearly the traditional cooking fuel, 28.6% of respondents stated that they would prefer a stove using modern fuels (such as LPG) and 28.8% that they would prefer an improved cookstove.

Women Survey	Average
Fuelwood collection (times per week)	3.6
Time for fuelwood collection (hours)	4.04
Time for fuelwood collection 5 years ago	**%**
It used to be less	26
Same amount	54.1
It used to be more	17.7
Three stone fire as primary method of cooking	98.7%
Preferred type of cookstove	**%**
Three stone / Traditional	27.9
Improved cookstove	28.8
Stove with modern fuel (LPG, electric, etc.)	28.6
Other/Do not know	14.6
Collected fuelwood for another household in the past year	60.5%

Table B2. Women's cooking and fuel types

SDG 8: Decent work and economic growth

Women in our sample work primarily in their household and spend, on average, 3 hours per day doing chores. Although protected areas often generate employment as guards, guides, and hotel workers, in Tanzania, those positions require a secondary school education while local women – and many local men – have less education. Few (5.7%) respondents identified a household member who has ever held a tourism-related job in the NCA. Although many women believe that tourism intrudes on their culture, they agree that tourism has the potential to generate employment opportunities – although it has not – and could bring development projects to the

NCA – such as the examples of tourists making charitable donations of school supplies and stoves.

Women's Survey	
Time spent doing chores (hours per day)	2.9
Tourism related job in the household	5.7 %
Village Assessment	**%**
Tourism generates culture interference	100
Agree that tourism generates employment opportunities	73.6
Agree that tourism brings development projects	34.6
Agree that tourism generates more deaths from car accidents	12.9
Best parts of living in the NCA?	**%**
Support livestock	78
Living peacefully	38.8
NCA facilitates development	26.1

Table B3. Women's attitudes about the NCA

SDG 9: Industry, innovation, infrastructure

Most infrastructure and development projects are funded by the NCAA or various levels of the government. Management plans emphasize improved roads and bridges to facilitate tourists' movements throughout the NCA, and do not prioritize roads between and within villages beyond the area near the main crater. Villages within the NCA are prohibited from connecting to the electricity grid but hotels use electricity and generators. Given the emphasis on livestock for livelihoods, NCAA and PC projects have led to more than half of households having a cattle dip available. More than 80% of households have access to a grain storage facility and a milling machine.

Women Survey	
Main source of funding for projects	**%**
NGO	4.4
Society	26.2
Pastoral Council	8.7
NCA	25.6
Government	30.8
Households with a cattle dip available	56.6%
Households that use a grain storage facility	82.5%
Households with access to milling machine in village	87.1%

Table B4. Women's access to village projects

SDG 10: Reduced inequality

Here we discuss inequality in various ways including gender inequality, inequality across NCA households, and inequality measured against Tanzanian households. Inequality can occur in several dimensions such as economic (income, wealth, and assets (productive)), social (education and health outcomes and opportunities), and environmental where environmental shocks affect people and groups differently. In this study, inequality in income (or rather expenditure), asset ownership, education and health outcomes will be investigated across social groups (by gender, employment status, and age group). Two variables are considered regarding asset ownership: TLU, kitchen assets, and other assets related to women's activities.

Tropical Livestock Units

TLU varies markedly across and within villages. For instance, while Bulati has an average of 10.73 TLU, Kapenjiro village has an average of 2.6 TLU. Within villages, while Bulati has the highest average TLU, the minimum is zero and the maximum is 76 with a standard deviation of 18. TLU demonstrates significant variability that represents inequality within and across villages.

Village Name	Frequency	Mean	Standard Deviation	Minimum	Maximum
Alailelai	21	5.7	7.2	0.4	26.1
Alaitolei	20	5.8	4.0	1.0	16.1
Bulati	20	3.3	3.8	0.0	14.2
Endulen	20	10.7	18.8	0.0	76.0
Esere	20	4.8	4.6	0.0	16.7
Iltulele	20	3.2	2.3	0.3	10.7
Irkeepusi	19	7.1	6.4	1.4	23.5
Kaitakiteng	19	4.4	4.3	0.0	21.3
Kakesio	20	8.0	8.7	0.7	41.0
Kapenjiro	20	2.6	1.7	0.0	5.8
Kayapus	20	3.9	2.7	0.8	12.1
Loongoijoo	20	5.6	3.1	1.4	13.7
Meshili	20	3.6	4.8	0.3	20.8
Misigiyo	20	3.4	2.7	0.0	9.2
Mokilal	20	6.0	3.9	0.7	13.0
Nainokanoka	20	3.8	4.5	0.0	20.2
Naiyobi	19	2.3	2.6	0.0	9.2
Nasporioong	20	3.6	3.0	0.3	13.5
Ngoile	20	4.9	3.9	0.0	16.4
Olchamiolock	20	8.2	11.5	0.5	47.6
Oloirobi	20	4.5	4.3	0.0	16.5
Osinoni	20	4.4	4.2	0.0	16.2
Sendui	20	4.7	7.8	0.0	36.8
Total	458	4.981	5.24	0	76

Table B5:Summary Statistics of Tropical Livestock Units by Village

Variation in TLU across age groups may denote some age inequality. Although variation across wards within a particular age group is observed, seniors and older adults within a village or ward have fewer endowments of TLU compared to adults and young adults, which might threaten their ability to meet their needs. Average TLU increases with level of education, except for university education. In particular, women with no education have a low level of TLU. Overall, the variability of livestock endowment across and within villages shows inequality across households and across villages in TLU (Figure B4).
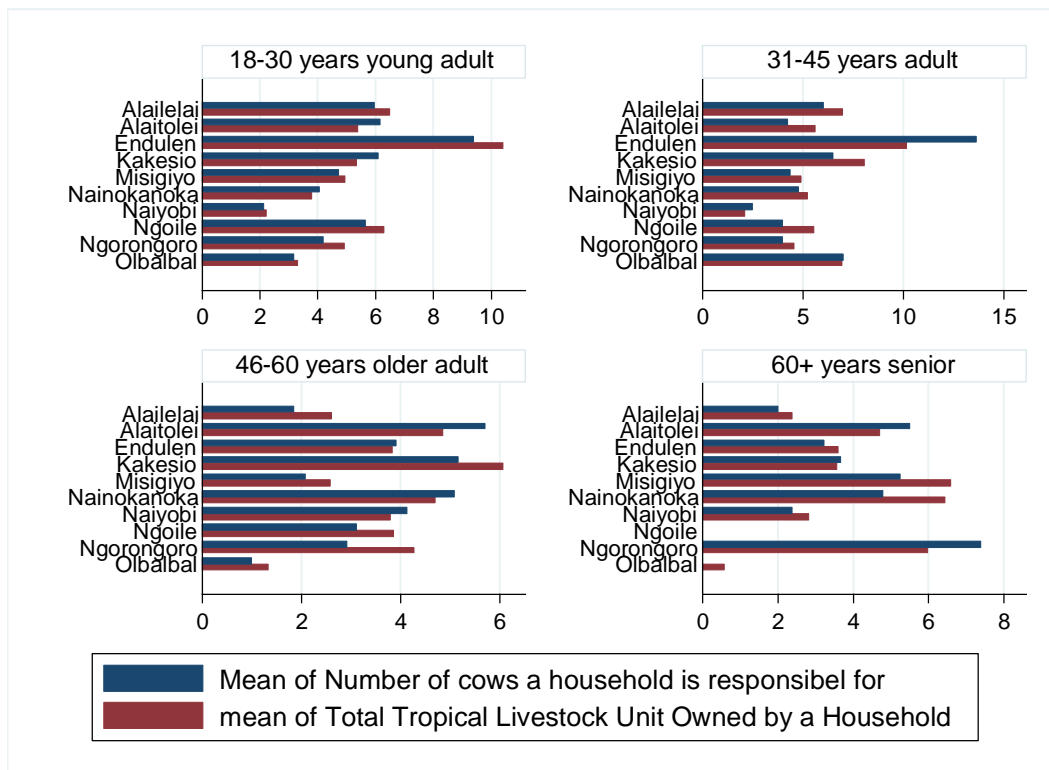

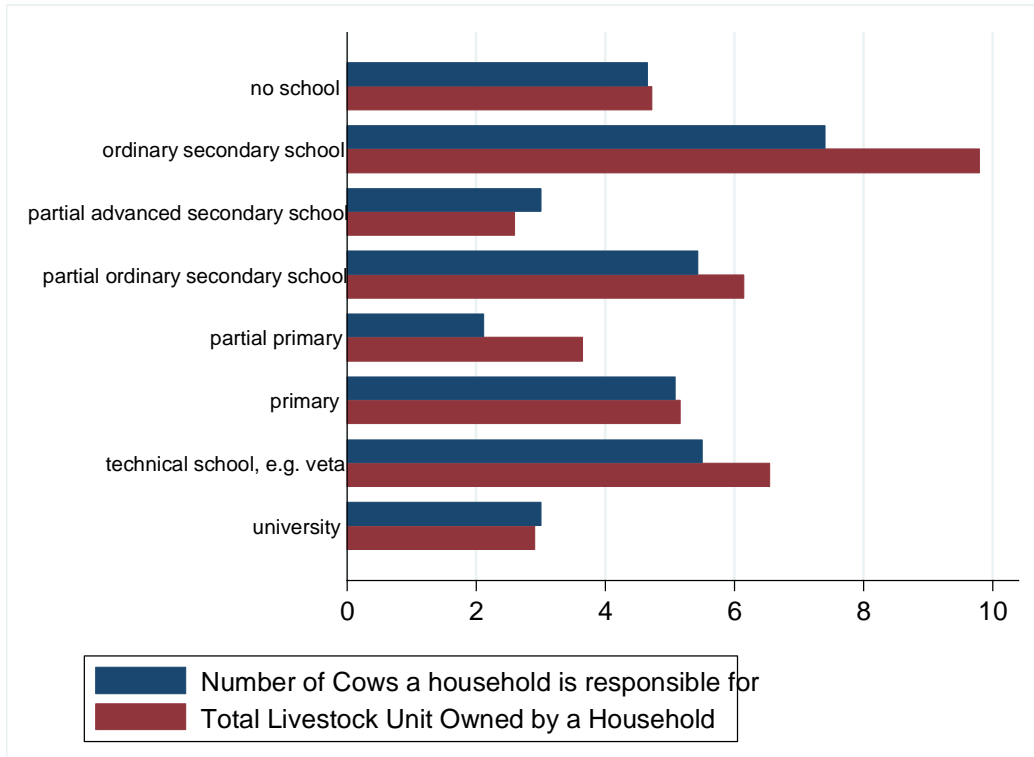*Figure B1: Distribution of Tropical Livestock Units by Age group and Ward*

Figure B2: Distribution mean of Total TLU and Number of Cows Owned by household by education Level
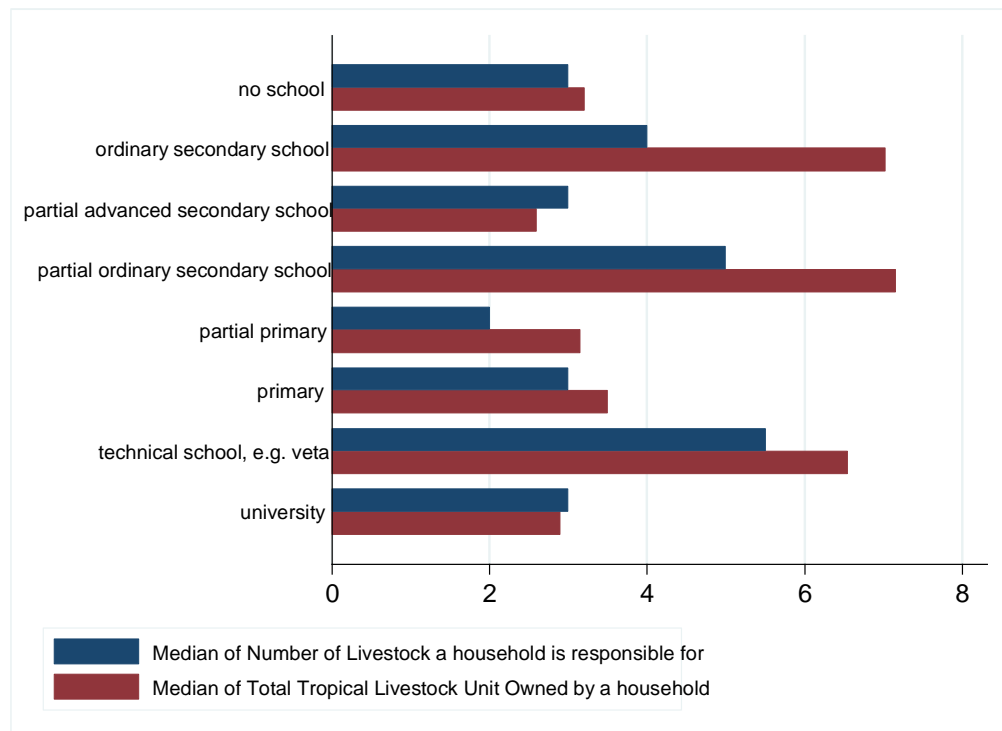
Figure B3. Distribution median of Total TLU and Number of Cows Owned by household by education Level
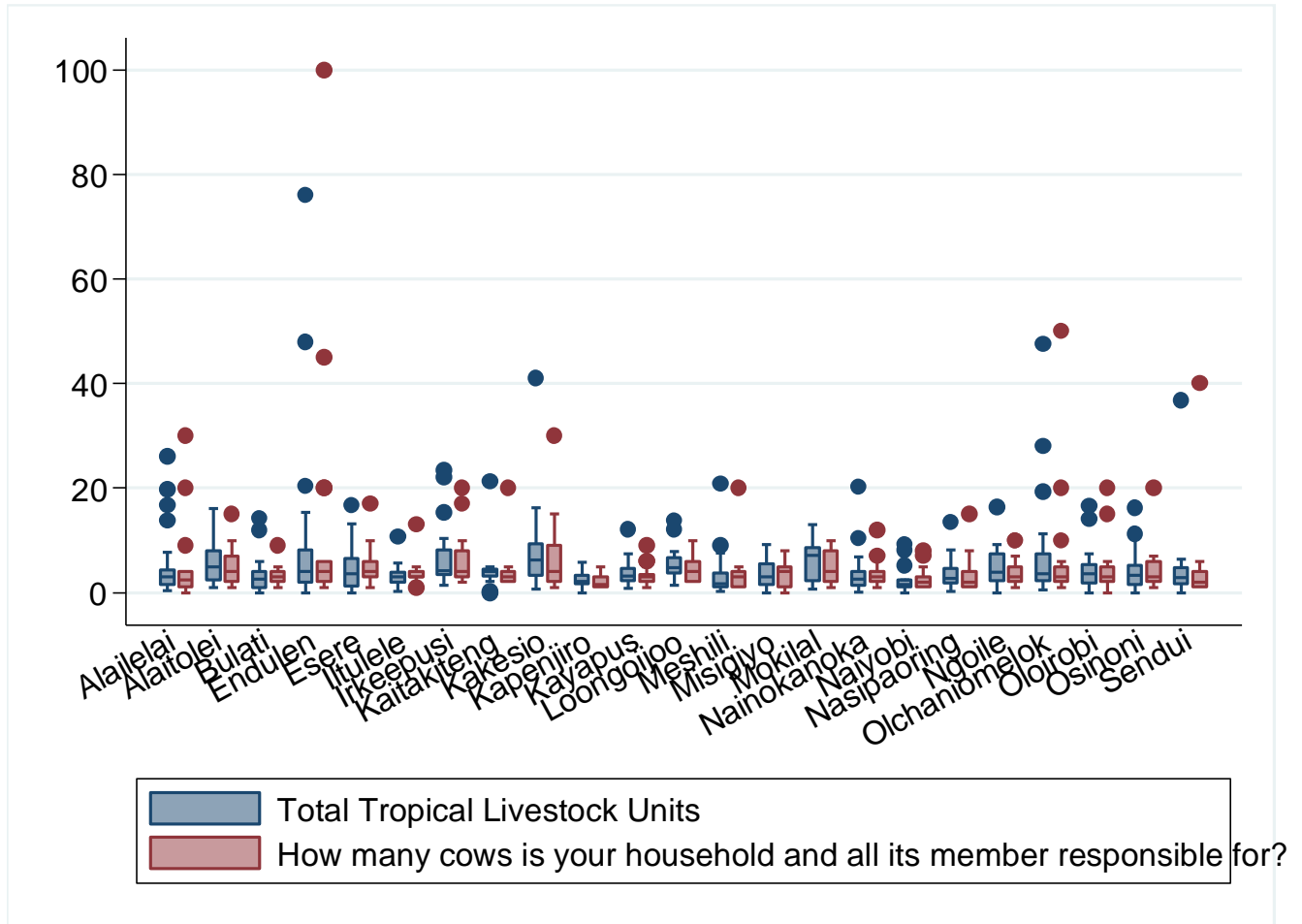
Figure B4. Variability in Households' Livestock Endowment across and within Villages

Kitchen Assets and Clothes

Because this study focuses on women, data was collected on ownership of kitchen/household assets as a metric of women's wealth, such as cups, pots, water collection equipment. Data on ownership of clothes (ordinary and special outfits) was also collected. These data indicate disparities across, as well as within, villages.

Cups and pots. While households at Endulen and Meshili have the highest number of cups per household, on average 10 cups, the average ownership at Iltulele and Nasporiong is 4.4 cups. These data suggest some inequality of assets across and within villages (Table B6). The number of pots owned across villages on average ranges from 2.8 pots to 5 pots but with a high standard deviation, suggesting some inequality within villages (Table B6). The number of cups

and pots owned by households/women increases with an increase in a woman's education level (Table B7). Within group variability decreases with age for number of cups owned and increases for number of pots owned. This variability suggest inequality within and across groups by age and education, in addition to within and across villages.

Village Name		Number of cups		Number of Pots	
	Frequency	Mean	Standard deviation	Mean	Standard Deviation
Alailelai	21	6.3	4.3	4.0	2.4
Alaitolei	20	7.6	6.5	4.2	2.0
Bulati	20	6.4	3.8	3.7	1.9
Endulen	20	10.7	6.5	5.0	2.1
Esere	20	6.1	3.9	3.6	1.5
Iltulele	20	4.9	4.0	3.8	5.4
Irkeepusi	19	5.4	2.6	2.8	1.4
Kaitakiteng	19	6.4	5.1	3.3	1.2
Kakesio	20	6.7	6.1	4.1	2.2
Kapenjiro	20	6.3	3.1	3.3	1.0
Kayapus	20	7.5	3.4	4.1	1.5
Loongoijoo	20	6.5	4.0	4.4	1.7
Meshili	20	10.9	11.9	4.3	2.1
Misigiyo	20	5.9	4.1	3.2	1.7
Mokilal	20	7.5	4.4	3.9	1.8
Nainokanoka	20	7.5	6.0	4.1	2.9
Naiyobi	19	7.6	6.9	3.9	1.3
Nasporioong	20	4.4	1.6	3.2	1.3
Ngoile	20	6.2	4.9	4.0	2.0
Olchamiolock	20	5.6	2.4	3.7	1.9
Oloirobi	20	8.2	5.3	4.3	1.5
Osinoni	20	5.8	4.5	3.5	1.5
Sendui	20	5.6	6.2	2.9	1.4

Table B6. Distribution of Number of Kitchen Equipment by Village
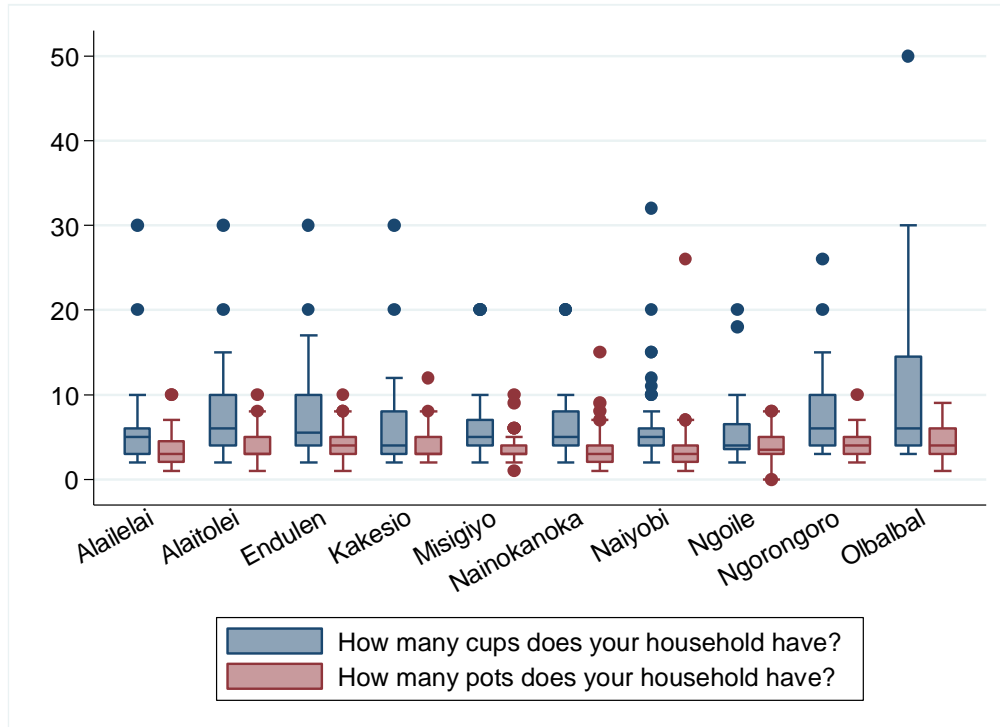
Figure B5. Variability of Kitchen Equipment by Village

What was your highest level of education reached?		Number of Cups		Number of Pots	
	Frequency	Mean	Standard Deviation	Mean	Standard Deviation
no school	337	5.98	4.2	3.54	2.02
Primary	93	7.47	5.33	4.03	2
Secondary	25	14.71	10.81	5.92	2.43
Tertiary	3	7.33	2.31	4.5	.71

Table B7. Distribution of Kitchen Equipment by Education Level

How old are you?		Number of cups		Number of Pots	
	Frequency	Mean	Standard Deviation	Mean	Standard Deviation
18-30 years young adult	159	7.64	6.93	3.83	1.9
31-45 years adult	152	6.85	4.95	3.74	1.96
46-60 years older adult	116	5.61	3.03	3.7	2.48
60+ years senior	31	6.17	3.9	3.84	2.3

Table B8. Distribution of Kitchen Equipment by Age

Water collection equipment

Pastoralist women in the NCA also require water collection equipment but these data show little difference across villages for ownership of both 10 and 20 liter water collection equipment, except for Meshili and Alaitole, and limited within village variation (Table B9). Highly educated women tend to own more water collection equipment, as shown in Figure B7.

Village Name		10 litres water collection bucket		20 litres water collection bucket	
	Frequency	Mean	Standard Deviation	Mean	Standard Deviation
Alailelai	21	3.15	1.79	2	1.87
Alaitolei	20	3.58	2.22	2.85	2.35
Bulati	20	4.53	2.57	2.44	1.9
Endulen	20	4.05	2.84	3.85	2.83
Esere	20	4.5	4.45	3.56	4.58
Iltulele	20	3.58	4.18	1.54	.97
Irkeepusi	19	2.94	2.43	3	2.45
Kaitakiteng	19	3.32	1.7	2.07	1.33
Kakesio	20	2.11	1.41	6	16.52
Kapenjiro	20	4.26	2.58	2	1.47
Kayapus	20	3.5	1.76	1.7	.92
Loongoijoo	20	3.89	4	2.58	1.57
Meshili	20	6.3	6.59	2.35	1.77
Misigiyo	20	2.3	1.49	2	.84
Mokilal	20	2.65	1.27	2	1.3
Nainokanoka	20	4.22	4.58	2	1.06
Naiyobi	19	3.53	4.15	2.39	1.5
Nasporioong	20	2.39	.85	1.6	.91
Ngoile	20	3.55	1.99	2.31	1.49
Olchamiolock	20	4.37	2.01	1.95	1.61
Oloirobi	20	3.38	1.86	2.06	1.3
Osinoni	20	3	1.59	2.29	1.4
Sendui	20	2.95	1.22	1.38	.96

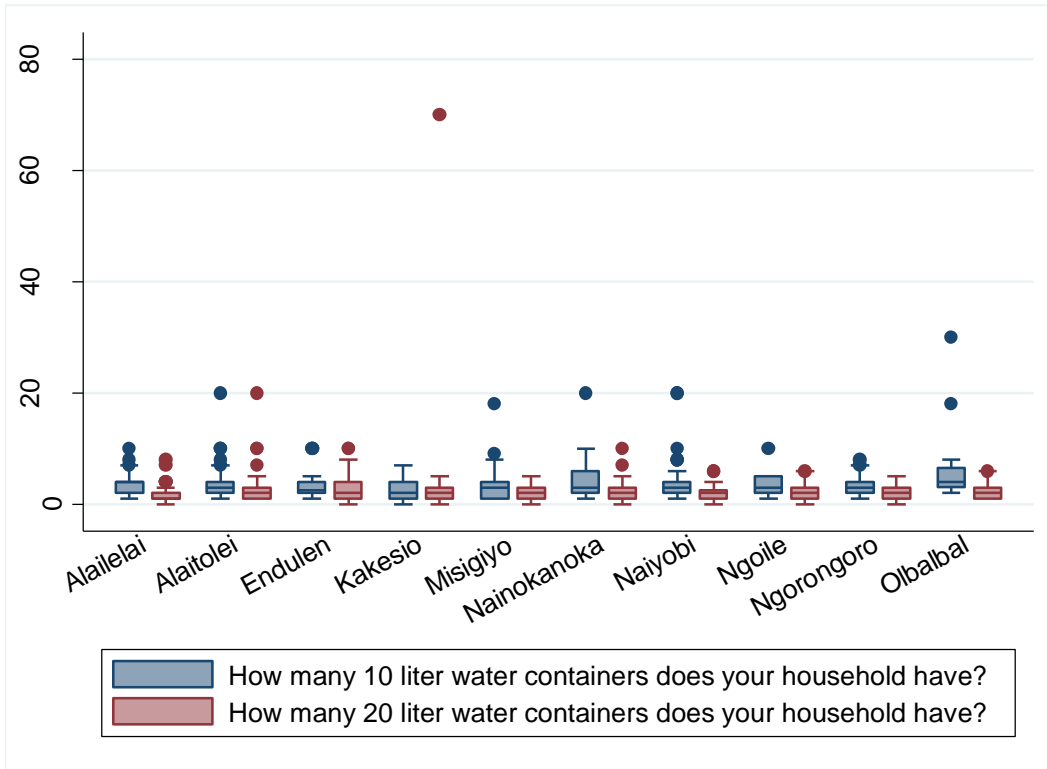*Table B9. Distribution of water collection equipment by village*

Figure B6. Distribution of Water collection Equipment by Ward
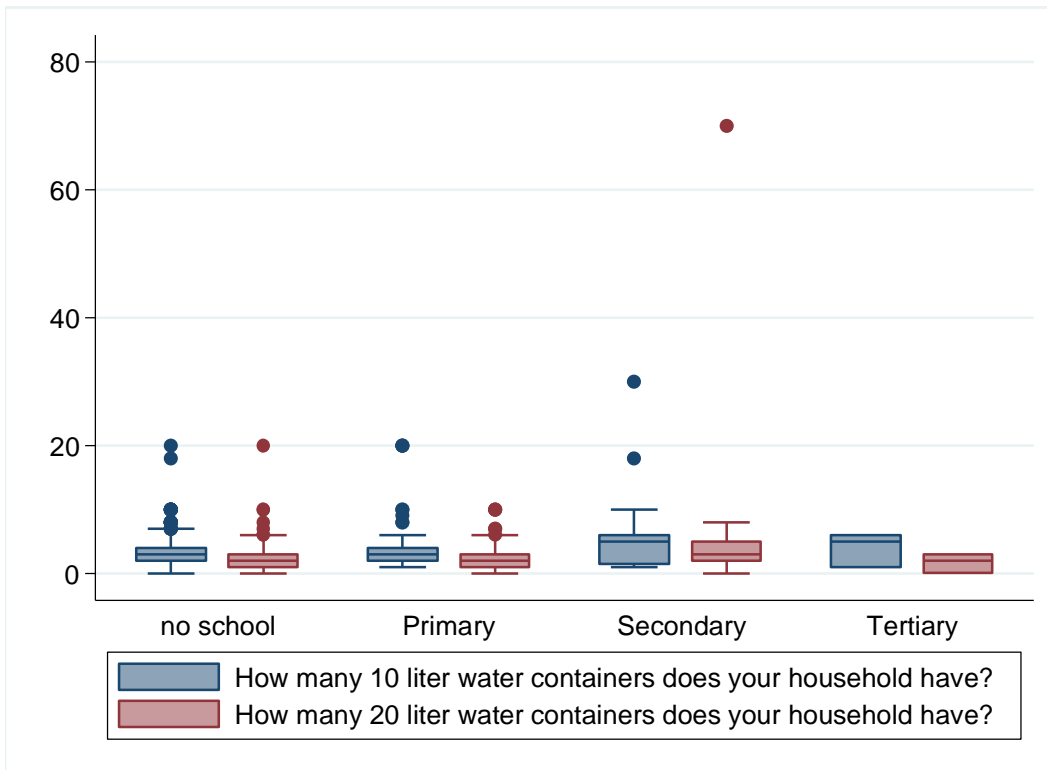

Figure B7. Distribution of water equipment by Level of Education

Clothes (Ordinary and Special outfits)

Women's clothing ownership provides another asset metric. While the average number of respondents who own special and typical outfits in Endulen is five and 3 respectively, at Iltulele, the average is 1.5 and 1, demonstrating some variation and potential inequality across villages. Variability within the villages is substantial. For instance, in Endulen, the mean number of special and ordinary outfits have standard deviations of 3.66 and 2.25 respectively (see Table B10). Across education levels, the number of outfits (both ordinary and special) increases with an increase in a woman's level of education, except for tertiary education, with variation within and across education levels (Table B11). Across age groups, young adults own more special outfits while older adults own more typical clothes, with high variability.

All metrics of women's well-being show variability within and across villages, education level, and age group. This variability may signal some inequality among Maasai women in the NCA.

Village Name	Frequency	Number of Special Outfits		Number of Ordinary or typical outfits	
		Mean	Standard Deviation	Mean	Standard deviation
Alailelai	21	2.76	2.66	2	2.21
Alaitolei	20A	3.2	2.19	1.65	1.09
Bulati	20	3.5	3.07	1.65	1.18
Endulen	20	5.05	3.66	3	2.25
Esere	20	3.05	2.42	1.85	1.14
Iltulele	20	1.55	1.79	1.05	.89
Irkeepusi	19	2.11	2	1.53	.9
Kaitakiteng	19	2.63	2.11	1.63	1.21
Kakesio	20	3.21	2.23	1.85	1.5
Kapenjiro	20	1.75	2.38	1.6	1.57
Kayapus	20	3.55	2.52	2.2	1.2
Loongoijoo	20	2.45	2.33	2.55	2.68
Meshili	20	6.35	12.84	2.05	1.54
Misigiyo	20	2.25	1.65	1.5	1
Mokilal	20	4.2	4.49	2.15	1.76
Nainokanoka	20	1.84	1.5	1.79	1.55
Naiyobi	19	2.68	3.25	1.58	1.3
Nasporioong	20	1.5	1.19	1.5	.95
Ngoile	20	2.53	2.39	1.75	1.07
Olchamiolock	20	2.5	1.96	1.7	1.17
Oloirobi	20	3.05	2.74	1.7	1.08
Osinoni	20	3	2.64	1.8	1.06
Sendui	20	1.8	1.82	1.4	.82

Table B10: Distribution of clothes by Village

		Number of Special Outfits	Number of Typical Outfits

What was your highest level of education reached?	Frequency	Mean	Standard Deviation	Mean	Standard Deviation
no school	337	2.54	2.54	1.72	1.51
Primary	93	3.13	2.41	1.88	1.15
Secondary	25	7.04	11.73	2.64	1.6
Tertiary	3	1.5	.71	1.67	1.15

Table B11: Distribution of Clothes owned by Women by education Level

		Special Outfits		Typical Outfits	
How old are you?	Frequency	Mean	Standard Deviation	Mean	Standard Deviation
18-30 years young adult	159	3.42	5.42	1.82	1.31
31-45 years adult	152	2.72	2.58	1.97	1.67
46-60 years older adult	116	2.49	2	1.64	1.43
60+ years senior	31	2.61	2.54	1.52	.96

Table B12: Distribution of Clothes owned by Women by education Level

SDG 11 *Sustainable cities and communities*

Although SGD 10 emphasizes sustainable cities, some aspects are relevant to community sustainability. A sustainable community refers to a community that promotes sustainable development. A sustainable community uses its resources to achieve its needs without compromising the possibility of future generations achieving their needs (UK 2003 Sustainable Communities Plan). In the NCA context, we assess community sustainability based on the NCA communities' ability to accommodate improving the lives of the current population while preserving the environment (conditions for future generations to achieve their own goals). The relevant indicators here include housing, access to public transport, and vulnerability to disasters. In addition, the study also investigates availability of resources (such as water, energy sources, food) in relation to community needs and extraction of natural resources.

Community sustainability. Because the NCAA restrictions do not allow construction of modern houses, most dwellings in NCA villages are of low quality, albeit with "improved" houses having cement floors and sheet metal walls and roofs. 76% of households use shared toilets without water flushing, followed by unshared pit latrines without water. Prohibitions on connecting to the electricity grid mean that most households are not connected to electricity (87.55 per cent), although about 11 percent use a solar panel. 89.7% of respondents live in buildings with walls made of cow dung, poles, mud and grasses, and floors of cow dung.

Another dimension of sustainability is how well the community is able to pursue development goals and mitigate unforeseen economic shocks. Many individual respondents state that they can pursue their goals (34 %), but 25% are completely unable and about 12% are somewhat unable, which may imply that their broader community is unsustainable. Likewise, about 56 %of women do not think they could cope with the costs and other constraints of unexpected illness while only 11 % think they could. Moreover, about 85% of women state that their incomes have not met their expenses in the past 2 years. In addition, about 53% of women assert that their households' situation has worsened compared to 2 years ago and about 27% state that their access to land in the next ten years is insecure. These are potential indicators of a community's lack of sustainability.

	Freq.	Percent	Cum.
What is the main type of toilet facility used by this household?			
Other(specify)	6	1.31	1.31
Own pit latrine (not flushed with water)	85	18.56	19.87
Refused to answer	2	0.44	20.31
Shared (between families) pit latrine (not flushed with water)	351	76.64	96.94
Stream, river, pond, field, forest	14	3.06	100
Total	458	100	
What kind of electricity access do you have in your household?			
No electricity used	401	87.55	87.55
Other(specify)	4	0.87	88.43
Yes, through paid connection to electrical grid	1	0.22	88.65
Yes, through unpaid village system (mini-generator, mini-hydro, solar-battery system)	2	0.44	89.08
Yes, through use of own solar installed panel stand-alone system	50	10.92	100
Total	458	100	
What is the main building material used for the floor of the main building?			
cement	15	3.28	3.28
dirt	416	90.83	94.1
tiles	2	0.44	94.54
wood	25	5.46	100
Total	458	100	
What is the main building material used for the roof of the main buildings?			

Grass/leaves, mud and leaves, or other	411	89.74	89.74
Iron sheets, tiles, concrete, or asbestos	47	10.26	100
Total	458	100	

What is the main building material used for the walls of the main building?

Baked bricks	13	2.84	2.84
Poles and mud, grass, sun-dried bricks, or other	441	96.29	99.13
Stones, cement bricks, or timber	4	0.87	100
Total	458	100	

Has your household's income over the past two years been sufficient to cover expenses?

Don't know	5	1.09	1.09
No	390	85.15	86.24
Refused to answer	1	0.22	86.46
Yes	62	13.54	100
Total	458	100	

Overall, what is the well-being of your household today compared with the situation compared to two years ago?

About the same	121	26.42	26.42
Better off now	83	18.12	44.54
Don't know	9	1.97	46.51
Other(specify)	2	0.44	46.94
Worse off now	243	53.06	100
Total	458	100	

How secure do you feel that your household will have access to land it currently has?

Completely insecure	127	27.73	27.73
Completely secure	104	22.71	50.44
Don't know	74	16.16	66.59
Neither secure or insecure	32	6.99	73.58
Refused to answer	1	0.22	73.8
Somewhat insecure	47	10.26	84.06
Somewhat secure	73	15.94	100
Total	458	100	

How able are you to cope with unexpected illness in your household (costs/transport)?

Completely able	52	11.35	11.35
Completely unable	258	56.33	67.69
Don't know	9	1.97	69.65
Neither able nor unable	20	4.37	74.02
Refused to answer	3	0.66	74.67
Somewhat able	57	12.45	87.12
Somewhat unable	59	12.88	100

	Total	458	100	

How able are you to pursue your goals (for instance, opening a shop or starting a small business)?

Completely able	159	34.72	34.72
Completely unable	116	25.33	60.04
Don't know	28	6.11	66.16
Neither able nor unable	27	5.9	72.05
Not applicable	1	0.22	72.27
Refused to answer	1	0.22	72.49
Somewhat able	70	15.28	87.77
Somewhat unable	56	12.23	100
Total	458	100	

Table B13: Indicators of community sustainability

Access to Public Transport. Public transport ensures the smooth flow of goods, services, and labor from one place to another. Roads in the NCA are maintained by NCAA in collaboration with the District Council to ensure that villages within NCA are accessible. However, some villages only have seasonal road access and many only have dirt roads. Due to conservation restrictions, public transport is not readily accessible for the NCAA villages and respondents view public transport as unreliable. For instance, 43.23% of respondents state that daily access to the hospital is not accessible on a daily basis from their village by public transport. Likewise, about 69% of respondents report that the regional and district headquarters are not accessible on a daily basis from their villages.

Is it possible to get to Regional Headquarters from this village every day?

No	198	43.23	43.23
Yes	260	56.77	100
Total	458	100	

Is it possible to get to Regional Headquarters from this village every day?

No	318	69.43	69.43
Yes	140	30.57	100
Total	458	100	

Is it possible to get to District Headquarters from this village every day (there and back)?

No	318	69.43	69.43
Yes	140	30.57	100
Total	458	100	

Is it possible to get to pre-primary school from this village every day (there and back), by public transport?			
No	418	91.27	91.27
Yes	40	8.73	100
Total	458	100	
Is it possible to get to primary school from this village every day (there and back), by public transport?			
No	419	91.48	91.48
Yes	39	8.52	100
Total	458	100	
Is it possible to get to secondary school from this village every day (there and back), by public transport?			
No	159	34.72	34.72
Yes	299	65.28	100
Total	458	100	

Table B14: Access to Transport Indicators

Vulnerability to shocks and natural disasters. Natural disasters, like drought, often result in lost assets. To pastoralists, major assets are livestock. A drought in the year prior to our survey led to dramatic reductions in cattle holdings but does not appear to have increased the number of meals skipped by household members (Table B15).

		Number of Dead cows due to disaster		Number of Meals Skipped in the year	
Village Name2	Frequency	Mean	Standard Deviation	Mean	Standard Deviation
Alailelai	21	8.33	19.99	77.24	82.13
Alaitolei	20	22.61	32.74	50.44	58.53
Bulati	20	4	5.2	93.4	97.29
Endulen	20	18.35	20.27	18.74	45.85
Esere	20	16.13	13.39	82.75	75.05
Iltulele	20	7	7.81	122.11	105.36
Irkeepusi	19	12.11	20.94	118.63	119.37
Kaitakiteng	19	11.47	9.15	45.11	43.8
Kakesio	20	13.56	22.22	68.67	66.59
Kapenjiro	20	2.69	4.06	117.78	94.9
Kayapus	20	10.9	23.83	66.2	76.95
Loongoijoo	20	11.68	13.96	51.3	62.88
Meshili	20	5.91	3.96	98.5	99.27
Misigiyo	20	13.75	14.67	67.68	60.63
Mokilal	20	8.5	9.87	59.9	93.75
Nainokanoka	20	2.69	2.36	89.9	88.34
Naiyobi	19	3.14	3.23	72	62.22
Nasporioong	20	15.06	16.92	61.47	62.28
Ngoile	20	8.81	9.1	43.16	50.05
Olchamiolock	20	6.78	8.9	51.8	59.48
Oloirobi	20	8.59	6.77	100	97.86

Osinoni	20	15.62	21.22	47.5	63.56
Sendui	20	3.74	4.59	91	115.49

Table B15: Impact of 2017 disaster to Livestock and meals skipped, by village

SDG 12: Responsible consumption and production

Our data do not directly address responsible consumption and production.

SDG 13: Climate action

Our data do not directly address climate action. Still, most villagers use fuelwood as their primary cooking and heating energy source, which releases carbon. NCAA could pursue programs to reduce the use of fuelwood in the NCA, which would contribute to climate change mitigation through lower carbon releases and less use of forest resources, at the same time as increasing women's health through reduced smoke and women's well-being by reducing fuelwood collection times.

SDG 14: Life Below Water

Our data contains little information about life below water and the NCAA does not actively pursue conservation of water ecosystems beyond restricting access to the lakes within the craters of the NCA.

SDG 15: Life on land

This SDG aims to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss." As a conservation area, NCA's goals address protecting this specific terrestrial ecosystem and conserving the rich biodiversity of the area, including endangered species such as rhino. Because the NCA is a UNESCO World Heritage site, NCAA's success in achieving its goals is assessed regularly. UNESCO's 2019 report finds some challenges for biodiversity conservation related to invasive species and poaching.The report also highlights issues surrounding tourism carrying capacity and the impact of traffic on conservation outcomes. The report urges the NCAA to "enhance its efforts to combat these threats (UNESCO, 2019)". Although UNESCO has some concerns, the report suggests that the NCAA is doing reasonably well in addressing the components of SDG 15 that reflect conservation of ecosystems and biodiversity.

The NCA is a multiple-use conservation area, and thus the NCAA's goals also address sustainable use of ecosystems and forests by NCA resident villagers, related to SDG 15. In this regard, the UNESCO report suggests more stakeholder engagement in management, including local people, and encourages the NCAA to increase resources to support cultural heritage preservation, including efforts to preserve Maasai culture. The report requests that the NCAA "engage local communities … in exploring alternative livelihoods to its current voluntary resettlement scheme." The resettlement scheme encourages NCA's human population to relocate outside of the NCA in support of conservation goals, in line with SDG 15. However, 'sustainable use' and 'sustainably managed forests' are also targets of SDG 15.

The investigation of SDG 7 on energy in this study reveals that most households in our sample use fuelwood as their primary energy source. However, our data do not reflect the degree to which such use is the result of sustainable management. Several forested areas have restricted access and restrictions are enforced by regular patrols, but few data are available from the NCAA to describe the effectiveness of the monitoring and enforcement of those forest use restrictions. Similarly, households are not permitted to harvest "green" wood and must collect only dead wood, but there is little evidence that harvesting of trees is a significant issue within the NCA.

Our data shows some conflict between Maasai households and the wildlife protected within the NCA. Two out of 5 households report interactions with wild animals which have led to changes in their behavior when collecting water. They report few incidences of animals attacking humans but 80% of the attacks end in the death of the people attacked. Wild animals attack livestock in and around many protected areas in Tanzania, however, and 42% of our respondents report such attacks. Broadly speaking, Tanzania's programs for compensating people for wildlife-related livestock and crop losses are not widely used, although compensation is received for death and injury. Given the NCA's restrictions on harming wildlife, most NCA residents adapt their activities to minimize conflict with wildlife by avoiding forests and other locations where wild animals are present and by extracting forest resources in groups.

Women's Survey	%

The presence of wild animals affects where you collect water	44.7	
Households that report wild animals attacking family members	6.1	
Households that report wild animals attacking livestock	42.4	
Households that report family members deaths from wild animal attacks	4.8	
Household extract in groups in response to wild animals	29.9	
Household avoid forests in response to wild animals	55.7	
Household avoid other locations in response to wild animals	64.2	

Table B16. Reported interactions between humans and wildlife

SDG 16: Peace justice and strong institutions

The most common type of meetings where women participate are village meetings, religious gatherings, and village credit groups. However, women do not participate actively in village and religious meetings,. In village credit groups, women are more engaged. Most people disapprove of or are neutral regarding the role of the NCA in achieving its objectives of conservation and social welfare. The Pastoral Council is less distrusted than the central government and the NCA administration (Table B17). Previous bad experiences and the fact that the NCAA enforces conservation practices are possible explanations for greater distrust of the NCAA. Most respondents agree that village projects encourage people to comply with regulations, but they also strongly disagree with the statement that the NCAA is making their lives better.

Participation by type of meetings	Village - % (N=236)	Religious - % (N=116)	Village credit Group - % (N=236)
Rarely	17.4	12.1	6.5
Sometimes	51.7	42.2	32.5
Often	24.2	27/6	29.9
Nearly always	6.8	18.1	29.9
Community meetings attended per year (average)			2.2
Do you agree that NCAA/PC accomplishes the objectives of conservation and social welfare?[3]			%
Completely disagree			36.4
Somewhat disagree			15.2
Neither agree nor disagree			12.1
Somewhat agree			17.9
Completely agree			18.3
Level of trust by institution	Pastoral Council - %	NCAA- %	Government - %
Completely distrust	14.2	49.9	21.2
Somewhat distrust	14.2	8.2	13.1

[3] The NCAA/PC say that they protect wildlife through regulations that prohibit cropping, limit building construction, restrict where cattle can be grazed, and determine what can be collected for fuelwood. They provide benefits for local communities such as subsidized grain, school buildings, and dispensaries, and support for schools including teachers and scholarships. Is this also your understanding of what the NCAA/PC does? (Agree-Disagree)

Neither trust nor distrust	8.7	8.2	15.6
Somewhat trust	28	14.8	27.1
Completely trust	34.8	19	22.9

Do benefits provided by the NCAA, like schools and dispensaries, encourage people to comply with the regulations?	%
Completely disagree	21.2
Somewhat disagree	13.1
Neither agree nor disagree	15.6
Somewhat agree	27.1
Completely agree	22.9
Do the benefits provided by the NCAA/PC make life better for your own family	%
Completely disagree	56.8
Somewhat disagree	15.1
Neither agree nor disagree	6.5
Somewhat agree	13.5
Completely agree	8.1

Table B17. Participation in government and attitudes about NCAA and PC

SDG 17: Partnerships for goals

Our data do not directly consider the use of partnerships to achieve sustainable development goals. Anecdotal evidence suggests that international organizations or individuals provide financial support for some projects to improve NCA resident's livelihoods. In addition, NCA's status as a UNESCO World Heritage Site implies that international partners work directly with the NCAA in developing and implementing management plans.