Pastoralism and climate change:
preliminary investigations to assess vulnerability and drivers of rangeland degradation

Silvia L. Ceppi*, Giorgio Colombo*, Gerson Mollel**, Angel Mkindi** and Fabrizio Orsini*

* Istituto Oikos, Milan, Italy; ** Oikos East Africa, Arusha, Tanzania

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Introduction

The rangelands bordering the western slopes of the Mount Meru, in the Southern Acacia-Commiphora bush lands and thickets eco-region (Burgess et al., 2004), are a key ecological corridor and provide for a range of ecosystem services that entirely support the livelihoods of Maasai pastoralists and their herds.

Climate change effects, including unpredictable rainfall patterns and long periods of drought that drive water scarcity and erosion of topsoil, are conducive to economical and food insecurity. A contraction of available and good quality grazing lands, exacerbated by increased population and livestock, has forced pastoralists to revert to unsustainable practices as exit strategies to reduce their economical insecurity. These include migration, charcoal production and livestock destocking.

We present here descriptive results of an analysis of current livelihood strategies, the perception of climate change, and the coping mechanisms adopted by selected representatives of pastoralist communities, thus facilitating the design of appropriate and effective response mechanisms to alleviate people and ecosystems' vulnerabilities.

Material and methods

This research targets the pastoralist communities of the Ward of Oldonyosambu and the subvillage of Mkuru in Arumeru District, Arusha Region, Tanzania, counting approximately 8000 people distributed across 235.6 Km^2.

A pool of indicators adapted from Coulibaly et al. (2015) was collected with the aim to identify: 1) the existing pressure on the rangelands; 2) the most relevant critical vulnerabilities; 3) present coping strategies.

The word *boma* is used in this research to identify a unique pastoralist settlement composed by one or more houses protected in the same enclosure (Fig. 1). The research instruments include a semi-structured individual household questionnaire and the photo-interpretation of satellite imagery. The questionnaire was administered to 151 randomly selected males and women representing one *boma* each. A pilot of 20 questionnaires helped the verify the effectiveness of the questions. The final version contained 53 questions and lasted circa 1h. Answers were recorded in a custom OpenDataKit form (www.opendatakit.org) on tablets. Questionnaires were uploaded as soon as completed, when network was available, and subsequently cleaned and elaborated. Respondents belonged to each village and subvillage in the target area in numbers proportional to the pastoralist population. The existing pressure on the rangelands was measured through proxy indicators (density of *boma*, livestock numbers), assuming such pressure is dependent on the livestock daily movements from and to the *boma* and is proportional to livestock numbers. The distribution, shape and density of the homestead was using satellite images from Google Earth in compliance with their term of service.

In 2015 the administrative boundaries for Oldonyosambu Ward changed and there is disagreement on the exact new location. This work refers to the official boundaries pre-2015 subdivision.

Fig. 1. With 44 huts and ten livestock enclosures this was the largest *boma* in Engutukoit village.

Results

Boma distribution

Oldonyosambu Ward hosts a total of 1948 *boma*, 339 (17%) have been measured and digitised. Their distribution is strongly clustered - 13% of the land (31.6 Km^2) hosts 68.5% of the *boma*. The area of the sampled *boma* ranges between 200-20,000 m^2. The density of *boma* ranges between 0-90/Km^2 (see fig. 1).

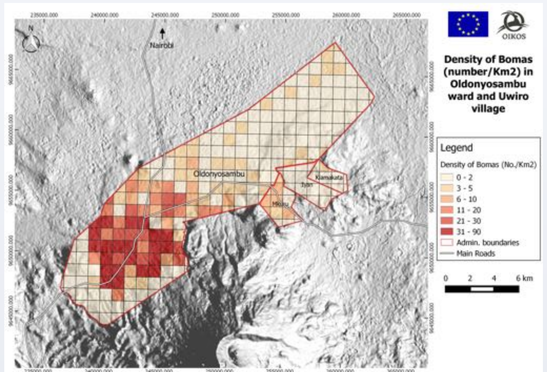

Fig 1. Density of *boma*/km^2 in the target area.

Livestock: numbers, species composition and water accessibility

Pastoralists lives entirely depend upon livestock productivity. Herd composition and numbers provide key information on the pressure these exercise on the rangelands, and the economical security of the respondents. Our sample represents circa 8% of the total population, here we recorded more than 7,000 cattle and 26,000 shoats (see Tab 1).

Inequalities of livestock ownership are evident. The maximum number of cows/respondent recorded is 1,000 but 50% of the respondents **own 10 or less cows** (see Tab. 1), against an average of 48 cows/respondents, confirming the findings of Homewood et al., 2009. Pastoralists with low numbers of livestock have to rely on other sources of income: 80% of the respondents farm to integrate their income; moreover, 46% of the respondents do not vaccinate their livestock suggesting high vulnerability to livestock diseases.

	Cow	Dairy cow	Goat	Sheep	Donkey	Chicken
MEDIAN	10	-	17	15	2	3
MAX	1,000	3	2,000	5,000	300	100
MIN	0	0	0	0	0	0
AVERAGE	48	0	71	107	7	6
TOTAL	7,214	19	10,715	16,203	1,013	931

Tab. 1. Livestock distribution and species composition.

Pastoralists rely on water for livestock and presence of pastures for their survival; the data collected show that 4 months/year, from July to November, 60% or more respondents are unable to find water for livestock within Oldonyosambu. Instead, when water for livestock is available, livestock is watered on average 4.6 times/week (median 4). In a bimodal rainfall pattern, October and November are typically wet months, yet, respondents experience a shortage of water in both months, implicating that rainfall is not reliable (see figure 2).

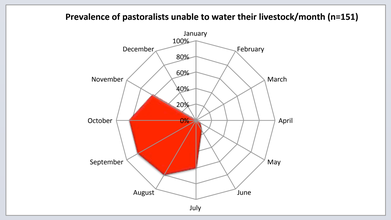

Fig. 2. Distribution of availability water for livestock throughout the year.

Perception of risk

Drought, erratic rainfall, wind, lack of farming and veterinary inputs and pests and diseases jeopardise the livelihoods of pastoralists (Brown and Thorpe, 2008; Homewood, 2004). Respondents ranked the importance of each risk in their experience. Results show that drought is considered the most detrimental risk, whilst pests and diseases and the risk of lack of farming and veterinary inputs are not as feared by the respondents (see fig. 3).

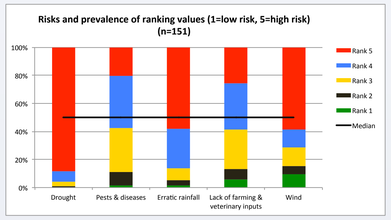

Fig. 3. Respondents' perceived risks and prevalence from a low to high scale. Drought, erratic rainfall and wind are the most prevalent perceived risks.

Shocks and coping strategies

Eighty four percent (n=151) of the respondents experienced drought in the past 5 years. The consequences of drought were ranked from 1 (low intensity) to 5 (high intensity). Food insecurity is the most severe consequence of drought followed by livestock death (Fig. 4). Several coping strategies were adopted: 59% of respondents sold livestock, 19% looked for off farm employment, 18% worked for food, 16% migrated, 14% ate less, 5% borrowed from relatives, 5% requested and received food aid and 2% changed the composition of the herds.

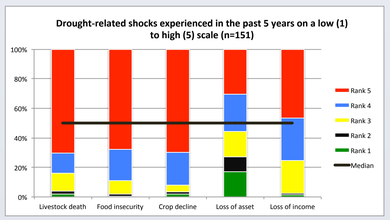

Fig. 4. Livestock death, crop decline and food insecurity are the most prevalent shocks, experienced by 60% of the sampled population.

Alert mechanisms & weather services

At present 63% of the respondents do not receive weather forecast information and relies on personal experience. Results show that only 4% of the respondents would choose government extension agents to specialise in weather information whilst 52% believes it is important to train villagers, 42% thinks the use of local languages would be important. Information from local weather stations is important for 17% of the respondents and reliable communication networks for one out of ten respondents.

Again, 68% of the respondents believes that weather forecasts should be provided by village leaders and radio presenters. Sourcing directly from central weather stations is ideal only for 15% of the respondents and 13% believes NGO should be the weather service providers. Only 3% would rely on friends and relatives and 1% on expert farmers.

Conclusions

Forty kilometers from Arusha city centre, pastoralists fear drought, erratic rainfall and wind, and experience drought-related food insecurity (59%, n=151) and death of livestock (64%, n=151), which could be aggravated by the high number of respondents (46%, n=151) who do not vaccinate their livestock in spite of the relative proximity of veterinary services. Assuming that our sample is representative of the entire population, the total livestock numbers present in Oldonyosambu could reach 90,000 cows and 335,000 shoats over an area of 235.6 km^2.

A shared feeling that 'rains are unreliable' is backed up by the distribution of availability of water for livestock, showing 4 months of water unavailability/year. Drought in rangelands has a negative effect on cattle performance; this worsens when in presence of high stocking rates and poor condition rangeland than on good condition rangeland (Fynn and O'Connor, 2000). When a drought occurred, almost two thirds (59%) of the respondents destocked the herds, whilst only one fifth looked for off farm employment and a mere 2% changed the composition of the herds, indicating a possible missed opportunity to restock with more drought resistant species.

Subsistence pastoralism was typically an economy of sparse settlements, whilst, due to population increase and encroachment, densities in Oldonyosambu reach 90 *boma*/km^2. Although it is safe to assume that the rangelands with high *boma* density receive a higher pressure from livestock, we lack data to measure how these affect neighbouring rangelands.

Effective information and communication strategies may mitigate the experienced unreliability of traditional weather forecast methods but 63% (n=151) of the respondents do not receive any form of weather forecast. Weather services for pastoralists would contribute to prepare for climatic shocks but it emerges that respondents do not wish to rely on government extension services to receive weather information, and would rather relate to trained villagers.

Istituto Oikos and its partners are in the process to establish a 4-years ecological monitoring system which will include the installation of two weather stations. Data collected will contribute to understand the nature of the relationship *boma* density/livestock numbers, and rangeland quality, and assess the status of a key ecological corridor between Mount Meru, Kilimanjaro and Amboseli ecosystems.

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Contacts

Silvia L. Ceppi, Scientific advisor, c/o Oikos East Africa, box 8342 Arusha. E-mail: silviaceppi@gmail.com

Giorgio Colombo, Project Manager, c/o Oikos East Africa, box 8342 Arusha. E-mail: giorgio.colombo@istituto-oikos.org

Gerson Mollel, Assistant PM, Oikos East Africa, box 8342 Arusha. E-mail: rangeland@oikosea.org

Angel Mkindi, Head Community Development Officer, Oikos East Africa, box 8342 Arusha. E-mail: community@oikosea/org

Fabrizio Orsini, GIS expert, c/o Oikos East Africa, box 8342 Arusha. E-mail: F.orsini3@gmail.com