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Continuity and change within the social-ecological and political landscape of the Maasai Mara, Kenya

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Abstract

Traditional livestock management has historically been blamed for the mismanagement of rangelands, but there is a growing recognition of the importance of extensive herding strategies and the local knowledge embedded in these practices. Here, we apply the lens of continuity and change to understand how local herders interpret environmental change. By exploring traditional rangeland indicators as used by Maasai herders, we highlight some of the forces of change that appear to constrain the application of local knowledge of rangeland health. Fieldwork was conducted from January to August 2013 in the Mara Division, Narok County, Kenya, employing semi-structured interviews, transect walks, focus groups, participatory mapping and participant observation. Findings suggest that continuity exists in many of the traditional methods of observing land and livestock. However, various obstructions are surfacing in a political landscape in which local knowledge holders are not always able to put their knowledge and observations into practice. These obstructions of knowledge, practices and skills occurred through three broad forces involving acculturation, prohibition and applicability. As possible consequences of a system in transition, these forces illustrate the unbalanced nature of overlap between heterogeneous users, conflicting interests and power differentials. In order to facilitate continued importance and growth of local knowledge, we conclude that resource and protected area managers must recognize local knowledge holders and ensure such knowledge is considered as more than anecdotal or strategic. By encouraging hybrid knowledge co-production in management decisions, the decision-making frame can be broadened to include herders for more inclusive decision-making.

Keywords: Continuity and change, Traditional ecological knowledge, Local knowledge, Pastoralism, Knowledge co-production, East Africa

Background

> *"I was looking after the cows the day before yesterday, I tried to take them to the place where we can usually find these species* [desirable graminoids], *but I can't find them. It has changed to enyoil* [undesirable species]. *According to me, the population* [people] *is rising up, and maybe in the future the whole area is going to become enyoil." Mzee S.*

> *"Everything created by God is good, there is no bad that comes from him, erosion and degradation is therefore caused by people." Mzee L.*

Traditional livestock management strategies have been blamed across the world for perceived trends in land degradation, expanding desertification and the general mismanagement of rangeland resources (Behnke 1994; Niamir-Fuller 1998; Reynolds and Stafford-Smith 2002). Even as Hardin's treatise falters under the weight of widespread critique (Ellis and Swift 1988; Scoones 1999; Western 2004), the popular rhetoric of expansive degradation in East Africa's rangelands continues pervasively on the ground. Here, we apply the lens of continuity and change to understand how local actors' frame environmental change. By exploring traditional rangeland indicators used by Maasai herders in the Mara District of Kenya, we highlight some of the forces of change that appear to interrupt folk knowledge of rangeland health. The Background section first introduces the

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pairing of continuity and change, followed by a contextualization of change in the study area, and finishes with the vision of the paper's analysis.

A synthesis of continuity and change

Knowledge as a process (Berkes 2012) inevitably entails some tension between traditionally accumulated ways of understanding environmental phenomenon and structuring social behaviour, and new sources of knowledge acquired through learning, experimentation and sharing.

'Continuity and change' is a dynamic pairing often applied in the context of cultural transition, which pastoral systems are evidently undergoing (Galvin 2009; Catley et al. 2013). In a broad sense, debate exists as to whether pastoralism as a mode of human activity is in its last throes of existence in the face of systematic change (Devereux and Scoones 2008) or whether the essential elements of a pastoral way of life continue, only adapting to an ever-changing environment (Galvin 2009). In any case, continuity and change is characteristic of the push and pull evident in pastoral systems, be it in the context of livelihood diversification (Burnsilver 2009), the commodification of livestock and products (Yeh and Gaenang 2010) or livestock management systems (Xiaogang 2005). The pairing arguably emerged from different theoretical bodies, one of which is resilience thinking (Gunderson and Holling 2002, Chapin et al. 2009), which explores the role institutions play in governing social-ecological change at a systems level (Herrfahrdt-Pahle and Pahl-wostl 2012). Through an evaluation of the relative balance between institutional continuity and change, social-ecological systems may be typified in a state of persistence (continuity > change), adaptation (continuity ~ change) or transformation (continuity < change) (Herrfahrdt-Pahle and Pahl-wostl 2012).

Under a resilience lens, continuity, or the maintenance of key institutions (i.e. customs, traditions and belief systems), retention of social memory, and provisioning of a clear process of reform, can render systems brittle (too much continuity may spur surprise and crisis), or if too little, leave systems vulnerable to memory loss. It is this 'moving target' between conservation of societal traditions and innovation-through-learning that defines institutional resilience and which in part informs social-ecological systems (SES) resilience.

There is a parallel stream of thought having emerged from social scientists' interest in cultural change, where investigating continuity and change at a local scale, rather than systems-level (as in resilience), magnifies tensions inherent in the process of discovering 'new' ways of living. The interest here is how traditional knowledge, or cumulated knowledge, practices and beliefs (Berkes et al. 2000), interfaces with the trend of individuals and communities who increasingly embrace influences from development, globalization and modernity (Sillitoe et al. 2002). We employ continuity and change in the precise context of knowledge, in particular concerning the institutions of production of knowledge and its application. This paper pulls from the interest in institutional structures found in complex systems understanding of continuity and change, and the learning and knowledge elements forthcoming in the analyses of cultural change. A third theoretical piece critical to our argument is that of political ecology, which provides a lens to explore the impediments and disruptions shaping knowledge continuity, erosion and subversion (Leff 2012).

Contextualizing change

A brief characterization of the changes in the Mara is warranted, although more thorough treatment can be found elsewhere (Jandreau 2015; Galvin 2009; Butt 2011; Homewood et al. 2009; Reid 2012). The highly productive savannah ecosystem of East Africa has supported nomadic herding communities and vast wildlife populations for millennia (Ogutu et al. 2011; Norton-Griffiths et al. 1975). Systematic transformation in land tenure regimes, occurring all across Maasailand, has left uncertain the sustainability of both pastoral livelihoods and wildlife (Seno and Shaw 2002). In the Mara, wildlife populations have declined by up to 75 % in the last several decades (Ogutu et al. 2011), blamed largely on large-scale cultivation (Norton-Griffiths et al. 2008; Serneels et al. 2001; Thompson and Homewood 2002), in-migration from outside communities (Homewood et al. 2001), sedentarization (Serneels et al. 2001; Waithaka 2009), climate change and increasing drought (Ogutu et al. 2008, 2009), poaching (Waithaka 2009) and settlement expansion (Lamprey and Reid 2004). In a similar vein, pastoralism as a way of life is increasingly threatened by these land use changes (Homewood et al. 2001) as competition for land intensifies and resilience of mobile forms of livestock production diminishes (Waithaka 2009). In addition to recent shifts in herd composition from cattle to a preference of small stock (goats and sheep), per capita livestock has also declined, threatening economic hardship and food security issues in these pastoral communities (Lamprey and Reid 2004).

Within the Mara ecosystem, where the tourism 'product' demands international acclaim, a new conservation model has emerged under the premise of wildlife conservation and community empowerment/prosperity. Having been experimented elsewhere in Kenya (e.g. Laikipia) and more broadly (e.g. Namibia), this new model, termed a conservancy, can be defined as a commons institution (Hoole and Berkes 2010) whereby individual landowners or communal resource users pool lands to create a singular trust where benefits from wildlife and

tourism development are shared by participants (Sorlie 2008). In the Mara, this model has resulted in a leasing arrangement whereby Maasai landowners agree to limit resource use by physically moving off the land, restricting grazing and cultivation activities and adjusting other land uses that may conflict with wildlife conservation. The landowners then partner with local, national and/or international tourism operators, who pay for exclusive access within the conservancy boundary and all tourism infrastructures. Rather than a commons resource institution, the Mara conservancy model appears more like a business partnership, where Maasai landowners are directly linked to private enterprise. They agree to vacate portions of their land and forego grazing rights in key conservation areas in exchange for monthly, guaranteed payments by leasing ecotourism operators, independent of tourist volume. The emergence of conservancies in the Mara, a story unto itself, largely falls within three distinct drivers as interpreted by research participants: (1) the historical failures to protect user rights and redistribute tourism rents to adjacent communities (e.g. wildlife associations); (2) the emergence of new business and/or profit-seeking interventions and opportunities that improve the quality of tourist experiences in a period of overused, aesthetically degraded national parks (e.g. demand to 'save' the tourism industry from overcrowded mass tourism); and (3) a growing sense within domestic and international discourses of the urgency to conserve un-fragmented landscapes for the conservation of charismatic mega fauna (e.g. the sense that after privatization, as in other areas of Maasailand, rangelands are divided, fenced, turned to crops, and otherwise undesirable for wildlife and associated tourism).

Arguably, at the root of these drivers is the subject of land privatization. In the Mara, as in all Maasailand, land was traditionally managed communally, allowing for the transhumant pastoral lifestyle characteristic of the Maasai (Homewood et al. 2001). However, due to a wide array of socio-political pressures, the communal tenure system has shifted towards individual ownership (Seno and Shaw 2002). This change in tenure has enabled development of new institutions, such as the conservancy model, which is proposed to maintain open lands for wildlife while generating new income avenues for local people under a privatized land tenure system. The intent here is not to review the Maasailand privatization movement, which can be found elsewhere (Reid 2012; Jandreau 2015; Galaty 1994). But it is essential to touch upon the underlying importance of land tenure change in the Mara, which has shaped land use, the emergence of a partnership-style conservancy model, and ultimately informs the obstructions of knowledge we further develop in subsequent sections.

In addition to the potential to improve local livelihoods by diversifying income sources, rapid land use change, as observed in the Mara ecosystem, risks leaving resource users and landowners scrambling to adapt. These changes include the development of ecotourism and conservation enterprises, trade, cultivation, land grabs, and as well as resource competition, harassment/displacement and harvest of wildlife, conversion of communal lands to private and corporate tenure, expansion of settlements and fences, and human population growth (Ogutu et al. 2009). Although there has been progress in detailing the effects of these changes on wildlife (Ogutu et al. 2009, 2011; Reid et al. 2003), pastoralism (Lamprey and Reid 2004) and livelihood development (Thompson and Homewood 2002), the long-term effects of intensified ecotourism operations from conservancies, expanding settlements and global climate change have been theorized (Courtney 2009; Bedelian 2012), but not thoroughly defined.

The responses to observations of a changing environment are derived from accumulated experience from intimate human-environment relationships; however, new structural contradictions have been exposed in this system, inhibiting traditional responses. This paper attempts to identify some of these structural contradictions, all the while acknowledging a much broader, and more complex, context of change. For instance, if we simply consider the multiplicity of actors involved in this system, be they shepherds, herd owners and their households, Maasai elders, local elite including highly educated leaders, guides, younger Maasai scholars, Western land managers, tourism partners, camp managers, wardens, scouts and rangers, tourists, domestic and international researchers, local, park, county and federal officials, international conservation groups, among others, we might begin to see how the drivers of change are hard to untangle. Our goal is to draw attention to the agents of influence that directly shape how folk knowledge of environmental conditions meets these diverse influences and are reformed in the process.

It is within this context we argue that change in the political (e.g. protected area boundaries), social (e.g. loosening of reciprocal relationships) and ecological (e.g. fluctuations in rainfall timing and intensity) system may have severed the linkage between ecosystem feedback and applied behavioural responses by herders on the land. We have organized the following Results and Discussion with three objectives in mind: (1) employing both existing literature and primary data, we introduce the qualitative indicators used by Maasai herdsman as part of their evaluation of rangeland health; (2) we aim to evaluate the use of these indicators under the lens of socio-cultural change, offering some hypotheses, what

we term obstructions, to explain the perceived disruptions in applying this knowledge to land-management decisions; and (3) we attempt to explore the space between herder knowledge of rangeland monitoring and those of Western-oriented managers who increasingly command land management in contemporary Kenya. In doing so, the third objective attempts to identify points of contact, or hybridization, between methods of rangeland observation used historically versus contemporary, so as to inform shared ideas of rangeland stewardship in a changing environment.

The thesis is this: in Kenya's Maasai Mara, tension exists between the continuity of traditional methods for interpreting rangeland conditions and changing structures impinging upon actors' response to this knowledge, leading to a degree of vulnerability in the social-ecological system.

Study area

The Greater Mara Ecosystem (GME) encompasses the northern range of the 30,000-km^2 Mara-Serengeti ecosystem spanning the international boundary of Kenya and Tanzania, confined by the Rift Valley in the east and the Siria Escarpment in the west. The Maasai Mara National Reserve (NMNR) occupies the southern area of the ecosystem to the Tanzanian border, totaling 1,530 km^2 of protected land under the jurisdiction of local governments. The fieldwork was conducted in the surrounding rangelands (formerly communal, now subdivided), which act as extensive dispersal areas for wildlife. Current land use in the area includes wildlife conservation, livestock grazing, maize and other crop cultivation, tourism enterprise, settlement expansion and other land uses (Seno and Shaw 2002; Ogutu et al. 2011). The 30,000-km^2 dispersal area is occupied and owned by the Maasai, a semi-transhumant pastoral society (Homewood et al. 2001; Ogutu et al. 2005; Waithaka 2009).

The area is characterized by a bi-modal wet and dry seasonality. The long rains occur from March to June, followed by the dry season from July to October. The short rains fall during November to December, although this pattern is increasingly irregular (Ogutu et al. 2008). A significant rainfall gradient is evident in the Mara, with mean annual rainfall less in the southeast (877 mm), increasing towards the north-west (1341 mm). Temperature averages 18 °C, with monthly variation between 14.7 °C and 30 °C (Waithaka 2009). Drought is a recurrent disturbance in the landscape, due in part to El Nino-Southern Oscillation (Nicholson and Kim 1997) as well as the Indian Ocean Dipole (Webster et al., 1999). The landscape is composed primarily of savanna grasslands, with interspersed pockets of wood and shrublands along waterways and escarpments.

Methods

Fieldwork was conducted from January to August 2013 in the Mara Division, Narok County, Kenya. This work was part of a broader research effort looking at the development of a relatively new ecotourism model called the conservancy and the subsequent negotiation process among multi-stakeholder groups. Sources of data include semi-structured interviews conducted with 130 residents, transect walks with two expert herders, a focus group discussion with six expert herders, validation interviews with two *wazee* (highly respected elders, plural), two participatory mapping exercises and with additional contributions from lengthy participant observation. Expert herders were selected based on trusted community informants, who have embedded knowledge of their community leaders. Transect walks were conducted in a relatively structured manner, where a transect was delineated along a continuum of use, starting at the elder's village (heavy use) following a straight trajectory to within the conservancy boundary (lower use). During the transect walk, both generalized questions about traditional rangeland assessment as well as more specific questions related to features observed during the walk were discussed, with the help of a translator. Types of indicators used for analysis during the walks, focus groups and interviews included any observational data relating to livestock husbandry and management, pasture management, wildlife and livestock interactions, floral and faunal knowledge and herding strategies, among others. Indicators gleaned from the data collection methods were ranked and verified by expert herders.

Results and discussion

Continuity of traditional indicators as a body of TEK

Traditional ecological indicators arise from accumulated experience in which feedback from an ecosystem are applied to future behaviours and use (Berkes 2007). This can lead to long-term monitoring of trends and conditions where such indicators expose environmental change. Due to the holistic nature of observations, in which multiple indicators are employed to characterize resource conditions, the inferential scope is much wider versus the conventional methods of selecting relatively few indicators and scrutinizing them in detail (Kislalioglu et al. 1996). In addition, there are no formalized generalizations that dictate cause and effect as with Western science, providing a more flexible stratagem for interpreting change (Berkes 2007).

In East Africa's Maasailand, there have been efforts made to document tools herders use to gauge landscape health and suitability for livestock. Authors including Goldman (2007), Dabasso et al. (2012), Kipuri and Ridgewell (2008) and others have explored methods of rangeland observation from traditional herding perspectives, identifying key monitoring indicators such as presence/absence, condition and distribution of woody and herbaceous plant species, and animal condition (Fernandez-Gimenez 2000; Wasonga et al. 2003; Oba et al. 2000; Mapinduzi et al. 2003). The Maasai have an extensive knowledge in areas of ethnosciences, including ethnobotany, ethnopharmacy and ethnotoxicity, in addition to animal husbandry and veterinary medicine (Ole-Lengisugi 1994; Minja 1999). Landscapes are classified according to their grazing suitability, which is livestock-species dependent, and determined based on plant composition, erosion potential, seasonality, free-water access and other conditions (Oba and Kotile 2001; Western and Dunne 1979).

For the Maasai of Tanzania, rangelands are classified into upland (*Osopuko*), dry valley bottomlands (*Olpurkel*) and valley slopes (*Oldoinyo*) (Oba and Kaitira 2006). These patchy landscape classifications help determine seasonally dependent grazing patterns which are adapted to variability and unpredictability (Niamir-Fuller 1998) and inform a well-documented grazing reserve system employed by Maasai to cope with climate uncertainty (Mwilawa et al. 1996). Paired with robust knowledge of range plants, Maasai are able to select pastures based on vegetation compositions most favoured by livestock while avoiding areas less desirable (Sindiga 1994). Rangeland health is often assessed via indicators of body condition, productivity and health of livestock. For instance, pastoralists across Kenya's rangelands judge pasture conditions based on livestock attributes (rumen-fill, coat condition, milk production, weight gain, etc.), while grazing suitability is based on environmental factors such as forage availability, water access, predator risk, disease and parasite loads (Kipuri 1996; Wasonga et al. 2003). This knowledge helps to prescribe decision-making on whether and when to move herds to better pasture, introduce fire or split the herds to distribute risk. Maasai also use wildlife to aid in selecting grazing areas (Goldman 2007). For instance, wildebeest are especially important as indicators for rainfall patterns but also dictate suitable pastures during the wildebeest calving season when the deadly malignant catarrh fever can be transmitted to cattle and when large grass reserves are finished by migrating animals (Butt 2011). Other pastoral groups throughout Africa share similar methods of environmental monitoring, interpreting indicators of plant and animal interaction, fire ecology and cultural queues (Oba et al. 2008; Niamir-Fuller 1998).

Rangeland indicators used by Maasai herders

In this section, a short synopsis of some of the main indicators identified by participant herders is provided as part of their body of environmental knowledge. Relative to the literature, both novel and familiar indicators were discussed by participant herders (Table 1). For instance, identifying key forage species as a widely used measure of rangeland health confirms previous reporting on traditional monitoring methods (Oba et al. 2008), while other indicators such as foraging behaviour were less described in literature.

Vegetation indicators

Herders identify the presence and/or absence of key forage species, which partly informs their assessment of grazing suitability for particular livestock species. In the Mara, grass species including *operesi orasha*, *irikarro* and *emunuwa* (local names) are consistently identified as the most desirable forage for cattle, while species such as *enyoil*, *intuleli* and *porori siet* are considered less desirable. Shoats (sheep and goats, together) prefer species such as *oltutu* and *enyoil* but are generally considered less selective overall. During transect walks, plant species were often identified based on the most abundant, or dominant, species in a plant community. For instance, upon inspecting a patch of graminoids, where an ecologist might catalogue four grass species, a Maasai herder will often identify the dominant one or two, grouping the additional species under those named. The functional diversity of species is a type and quality of forage more relevant to the needs of livestock, rather than simply a measure of biodiversity.

However, when the dominant grass type changes, as in a heavily grazed area, herders perceive these changes. Herders appear to pay particular attention to changes in functional diversity:

> "*Every year, the land changes a little bit, but before the conservancy and demarcation it was mostly operesi orasha* [red oat grass] *and very tall. A new plant has come here, it is called orkikoi* [small unknown forb]. *The shoats graze it, but it is increasing.*" Mzee S.

Similarly, grass height is used to measure relative intensity-of-use and is dependent on livestock species (Table 1). The concept of *erashe* (Maasai word for grass stubble) denotes both a visual measure of grass height as well as a traditional method of pasture management. As a measure of height, *erashe* may refer to tall, decadent grass that has fallen over, as in a wheat field after the harvest. Here, herders observed that new shoots would emerge after the rains from seed sources, rather than the old root-mass. *Erashe* can also refer to the patches of a range left unburned by fire, pockets of old grass stands

Table 1 Indicators, or signs, used by expert herders to evaluate rangeland condition and inform folk management decisions (only indicators with majority agreement among elders (>3) or appeared in verification interviews are shown)

Indicator class	Indicator	Description/quotation
Forage/ vegetation	Key forage species (including increasers/decreasers)	Identifies trends in the presence/absence and/or relative abundance of important fodder species for livestock.
		"*It is the best for cows, opareshi, irikarro, and emunuwa, as well as empalakai*"…"*These are the best for us as Maasai.*"
		"*A new plant has come here, it is called orkikoi. The shoats graze it, but it is increasing.*"
	Grass height	A qualitative estimate of relative grass height, often clumped categorically: this includes identifiers such as '*touchable*' (accessible to sheep/goats) and '*erashe*' (a measure of forage stubble)
	Grass colour/condition	An observation of '*greenness*', indicating moisture (*wetness*) and nutrient (*fatness*) content.
		"*When it is wet season, you can be able to identify the color of the grass, you can get the yellowish or green grasses. The only grass that is pure green is emuruwa* [boma grass] *and empalakai (found in fig tree forests). In the wet season, the whole area is green, but if you look in detail, you can see the variation in greenness. Emuruwa is perfect* [for livestock] *when it is green, but empalekai is not good for cows.*"
		Herders use grass colour to age the fodder:
		Black; unusable, (fire), but will soon be a green flush and highly desirable
		Green; fresh shoots very desirable
		Brown; unburned, old, dirty, full of ticks and disease
		"*Fresh grass has no germs, but old grass has malaria and disease. It is the same with humans- if you drink stagnant water, you get malaria, but if you drink clean flowing water, no disease.*" Mzee T
	Forest condition	Presence of particular species and overall canopy cover (relative to memory)
Soil	Colour	Provides information on suitability of grazing and sensitivity to erosion and helps in locating homestead sites: classified as black, red and white soils
		"*If God sees narok* [black] *soils, it rains. God doesn't like to see that color- everything will become fat if they go to those areas just burned.*" Interview participant
		"*The black soil- if you drive through it, or drive cattle through, they sink into and grass can't grow.*" Interview participant
	Texture	A secondary classification that is used to identify salt licks and soil quality (smooth and rough)
	Bare patches	Areas of exposed soil with no vegetation: often differentiated between human (livestock) induced versus nonhuman-induced (soil characteristics, divine influence)
Livestock	Rumen fill	Visual measure of forage intake, indicating forage quantity/availability and livestock health
	Forage behaviour	Inspection of how livestock forage - providing insights on quantity and quality of roughage.
		"*I can't rest under a tree to watch the cows, I must be in the cows, watching how they are grazing, seeing if they are grazing in a good manner, to see if they are getting enough grass. If not I drive them to another area. We can see if the grass is enough depending on if they graze with their teeth, or with their tongue. If they graze with their tongue then you know they are getting enough grass.*" Transect Walk participant
	Posture behaviour	Indicates range condition based on particular cattle behaviours, such as when cattle lower their head to the ground the shepherd takes note of the interval (timing) between lowering the head to feed and raising the head to chew and swallow. If the cow takes a 'long' time between forage and swallow, the range can be interpreted as in poorer shape.
	Small stock presence/density	Shoats (sheep and goats) often exclude cattle indicate different range conditions
		"*The land is healthy here, but shoats can't let the grass to grow.*" Interview participant
	Health/performance: (milk yield, fur quality, mating frequency)	Used to determine the forage condition, where cattle health correlates with milk production (amount of milk collected from heifers)
		Suggests forage is healthy with increasing mating frequency, cows tired (not sleeping) indicates a night of mating a common indicator of disease or unhealthy livestock; fur stiff and erect - unhealthy; flat and smooth - healthy
		"*As Maasai, we look to the fur to see if it is standing upright, to know if the area we are grazing is not good for cows. So first we see the fur in the morning and evening and if the belly is full or not.*"

Table 1 Indicators, or signs, used by expert herders to evaluate rangeland condition and inform folk management decisions (only indicators with majority agreement among elders (>3) or appeared in verification interviews are shown) *(Continued)*

		"We see the cows are getting enough grass, but still not good milk. We must move from here because its not a good place. This area is cold for our livestock; the species of grass growing right there is not good for cows. Maybe the grass is tall, but its cold."
Environmental	Wildlife presence/use	Informs herders of predation risk, risk of disease (MCF) and grass condition
		Herders are conscious of how cattle relate to the 'smell' of grass, often indicating the presence of a predator (lion) or disease.
	Cattle trails	Indicates the level of use by livestock in a given area
		"Cattle trails cause soil erosion, it washes the good soil away and takes two years to grow back."
	Disease	Certain diseases can indicate poor range conditions, especially diseases relating to ticks.
	Drought severity/season	Morning dew, orange sunsets: indicates moisture in the air, suggesting the dry season has not come yet suggests a drought season is coming and rain is far away
	Landscape classification	Defines important, seasonal grazing movement patterns classified as highlands (*osopuko*), lowlands (*olpurkel*), marshes (*agarata* or *oyarata*), plains (*ongata*), riparian (*ewaso*), rocky outcrops (*shenai opir*)
		"The reason grass stays longer in a mountain area is because the grass grows between the stones, and its very difficult for cattle to uproot them. They will just graze the tops, but they can't uproot it. In the plains, the grass can be uprooted. Also the rocks don't allow the cows to step on the grass. And in the forest, there is more shade, which allows the grass to last longer."
	Water access/quality	Determines the movement of livestock. Water is surveyed for quality (turbidity, colour and smell) and quantity (qualified differently for cattle and shoats).
Socio-political	*Boma* density/population	Indicator of use - also helps to consider and rate forage potential - a resource-rich hotspot, specific species composition and history of place
	PA boundaries	Determines movement and routes taken by herders and livestock; monitor ranger behaviour/leniency and other herders' behaviour

amidst fresh green shoots. Applied to traditional management, *erashe* describes the stems deliberately left ungrazed after livestock are introduced on a pasture. The stubble would be left to permit forbs and grasses a shorter recovery period between grazing and the arrival of rain. Grass height provides an estimate of how intense an area has been grazed and whether or not there is sufficient forage for livestock. This indicator is evaluated differently for different species, where sheep favour short, fresh grass while cattle prefer taller, more mature forage. For instance, by referring to grass as 'touchable', herders are noting a measure of suitability for sheep on pastures grazed short, in effect reachable by the small stock while unusable by cattle.

Livestock indicators

Forage behaviour by cattle also clue herders on the health of the range. For instance, when forage is insufficient, cattle use their teeth to clip grass shoots, breathe irregularly and feed in an erratic and interrupted pattern. When the forage is good, cattle will use their tongues, lips and teeth to harvest grass, and their breathing is heavier, mostly through their nostrils. Herders are listening and watching *how* their cattle forage in addition to *what* they forage on in order to gauge the quality of the pasture (Table 1).

Soil and environmental indicators

Soil type provides information for herders as well, often discussed as *hot* or *cold* soils, and differentiated by colour and less commonly texture. The concept of warm and cold, applied to different signals of suitability, translates differently than an explicit gauge of temperature. Roba and Oba (2009) found similar usage of warm and cold to translate environmental conditions - where warm corresponds with good, or 'of quality, or suitable', whereas cold refers to bad, unhealthy or unsuitable.

> *"I have been living in different areas, Olulunga, Mara, Naroksura; but the most suitable area for cattle is in Olkiyumbo* [referring to before the 1990's, as today Olkiyumbo is part of MMNR]. *The grass is very warm for our livestock. The moment they graze there they get milk. For the first thing, there is a time we say the bulls are very warm, like they are ready to breed. When cows go to graze in Olkiyumbo, they don't sleep because they were breeding the whole night. They breed so much when they go to Olkiyumbo. But now, what I have realized, things are changing."* Mzee S.

The *wazee* agreed soil has a role to play in rangeland health, but the importance of it as an indicator was less transparent. For instance, black cotton soil is found in *orpurkel* landscapes where some of the most favoured

grasses are also found, but the black is known as a 'stealer' of water and nutrients from other plants:

> "*The black soil we call olkinkoi, or oltorobo* [the hunter]. *All he does is eat. It's just stealing the resources, eating the grass and drinking the water.*" Mzee T.

Within riparian forests, the soil is less desirable for cattle:

> "*In the fig tree forests along Talek, there is enough grass, but if cows focus here, they can't have enough milk and are unhealthy. If you observe in detail, the soils don't have much nutrients there, so the grass isn't good for cows. If you try to see, even if there is enough grass, maybe the soil has something wrong with it.*" Mzee S.

The sandy, white soils among the Mara's hills and escarpments are found to be less nutrient-rich and dry out more quickly, yet the grass stays longer in these soils due to the inner-mixing of forest canopy and relative inaccessibility to livestock:

> "*The reason grass stays longer in a mountain area is because the grass grows between the stones, and its very difficult for cattle to uproot them. They will just graze the tops, but they can't uproot it. In the plains, the grass can be uprooted. Also the rocks don't allow the cows to step on the grass. And in the forest, there is more shade, which allows the grass to last longer.*" Mzee S.

Landscape types were challenging to elicit during conversations but emerged as important elements determining traditional readings of land use and health, corroborating Mapinduzi et al.'s (2003) findings. Landscapes play a key role in determining livestock movements traditionally, with key identifiers placed on macro landscapes such as highlands (*osopuko*) and dry lowlands (*olpurkel*), as well as micro landscapes including rocky outcrops (*shenai opir*), forests, waterways (*ewaso*, or a 'place with big waters'), marshes (*agarata* or *oyarata*), hills *(oldoinyo*) and plains (*ongata*). Supporting Mapinduzi and colleagues, landscape type is used as an indicator informing other rangeland cues. For example, *olpurkel* is associated with highly nutritious grass species but which tends to desiccate faster than *osupoko*, and therefore is susceptible to heavy grazing pressure and a different suitability computation. It is the landscape type that qualifies a herder's response to and judgment of other indicators.

Water is a key element to semi-arid pastoral production, and when standing water becomes limiting, major changes to the system are warranted, often including large-scale movement of livestock. Therefore, herders monitor both water quantity and quality, the interpretations of which vary by livestock species. Cattle, for example, consume larger quantities of water, thus requiring a more substantial source as compared to sheep. When the water is '*dirty*', livestock are often moved or, in the case of small milk or *olekeri* herds, supplemented with water hauled by women or men on motorbikes.

Cattle trails are used as an indicator of use and, when present, are often interpreted as overuse. While livestock trails are viewed as problematic in terms of forage quality and erosion potential, herders also mentioned that trails are necessarily part of an ecosystem with concentrated resources (the trails to a watering hole or a salt lick, for instance, or perhaps those to a grazing zone inside the conservancy).

> "*It is not too bad, the cow trail might be the way to access the water or the salt lick, or the access to a grazing zone. There is no grass that grows inside the trail due to erosion. It is very important to have one trail though, rather than many, so not to destroy the environment with many trails. The more trails you have, the more grass you loose!*" Interview participant

Obstacles confronting traditional knowledge in the Mara

It is fair to conclude continuity exists in many of the traditional methods of observing land and livestock by many herders, but can we also assume continuity exists in the translation of this knowledge into decisions, or feedback, on the land? Perhaps more explicitly, are traditional ways of observing land being used and indeed remain useful, considering the significant socio-economic and cultural changes occurring in the Mara? As researchers move past the idea of traditional ecological knowledge (TEK) as locked in a static state (Ruttan 1999; Agrawal and Gibson 1999), perhaps the more relevant question pertains not to the body of knowledge itself, but the obstacles faced in applying, adapting and owning the learning process in the face of modernity (Gómez-Baggethun and Reyes-García 2013). Here, we turn to the various obstructions surfacing in a political landscape where local knowledge holders do not always express freedom, want or ability to apply their observations into action. Fully aware of their interdependence, and by no means comprehensive, we have assembled these obstructions of knowledge, practices, techniques and skills into three broad forces: (1) acculturation, (2) prohibition and (3) applicability. As possible side effects of the broader system in transition, these forces exude to

a greater or lessor degree the nature of overlap between heterogeneous users, interests and power differentials.

Acculturation: Obstructions of knowledge transmission

Acculturation and integration are often separated in the literature, as the former denotes a broader change in language, schooling and/or values, while the latter indicates learning new skills, values and behaviours specific to market participation (Godoy et al. 2005). Here, we treat economic integration as but one element informing the process of acculturation rather than in isolation with the other forces outlined above. In arguing that Maasai folk knowledge is undergoing acculturation, it may first seem contrary to claim that traditional ecological knowledge concerning rangeland health is still in practice, that rather knowledge and practice are indeed 'being lost'. Instead, we begin here for the purposes of displaying some of the mechanisms for knowledge transmission that may be eroding, rather than knowledge itself. Informal conversations with elder herders and youth indicate a diminishing role of storytelling, of 'morning chats' and of loosening institutional learning platforms (such as the *ol manyatta*) which corroborated expert herders' feelings elicited in interviews of a shrinking space for sharing their knowledge. An illustrative example of this is the warming fire, where elders and herders (often sons) would assemble by a fire to discuss, in a two-way exchange, the day-to-day herding strategies. As one elder describes:

> "*Before, we had a warming fire in the middle of the boma* [Kiswahili for homestead]. *When the cows come in the evening all the shepherds have to come with the elders. The shepherds would narrate the story about what the grass looked like, where they took the cows, and even in the early morning, while the women milked the cows, they go back to the fire:* [They asked…] *Who is going to look after the cows today? Where do you prefer to go? How does the grass look like where we want to go? So the elders know the cows will go directly to the grass and we know they will go where it is best because we have advised the shepherds. In the past, people don't have other jobs to go to, so they only concentrate on their livestock. This is the only school or job that they have. Now I have three sons, and all of them they are working. So I remain only, with the hired shepherds.*" Mzee S.

This daily routine institutionalizes knowledge transmission among elders and younger herders, who learn to hone skills of observation. Today, this occurs to some extent between the herd owner and his hired shepherd(s), but it features much less as a collective exercise, with possible consequences to the proficiency of cattle husbandry and ultimately the continuity of pastoral knowledge itself:

> "*Nowadays, you have to hire the shepherds because the school has been introduced, and we are sending our children to school. The way we hire the shepherds, he can't look at your cows the way you want. It is very different between how today's shepherd looks at the cow versus me as the owner. The only thing the shepherd is interested in is his salary.*" Mzee S.

In another example, *wazee* spoke of the *ol manyatta*, or the 'Maasai school', as a gathering of all age sets for the purposes of teaching young men and women the roles and 'ways of being Maasai'. This gathering, ceremony and learning institution is eroding, if not already disappeared:

> "*In the Ol Manyatta, it is our university of Maasai… old men come from all the tribes…the young generation settles here, and they are told stories. Everybody comes to listen, if you go to these places then you know the past, but if not, then you don't know the stories of the past. Nowadays the children are going to school, they write. But we as elders have all that is in our heads.*" Mzee T.

Following Davidson-Hunt and Berkes (2003), the trend of an increasing disconnect between herders and land may have sharp repercussions on land management. Memories require a knowledge holder, the culturally informed context or place of encounter, and the novice willing and able to experience such memories. These interchanges appear to be increasingly isolated from each other. On occasion, a young participant would admit to feeling ignorant of his past and, in a frustrated realization, explain that '*we don't go to visit the wazee under a tree anymore*'. The places of exchange, whether the *ol manyatta*, *orpul* (a gathering in the bush for the purposes of healing, regeneration and storytelling) or simply the refugia of a shade tree, are becoming less and less a feature of growing up Maasai. If we understand memory as knowledge developed by experience on the land, the richness of time spent in the 'bush' versus in the classroom, in tourism lodges, in off-road vehicles or in town seems to be reversing. As one junior elder explained:

> "*The younger generation won't survive in the bush. One month in the bush and that would be like killing them!*" [My assistant as a representative of 'the younger generation' shakes his head in humoured agreement] Mzee J.

The period of apprenticeship, in which youth learn to navigate the bush, read livestock behaviour, interpret environmental queues and observe change has been increasingly displaced.

Of equal interest, herd owners themselves spend less time with the cattle, instead frequenting town centres, conducting other businesses and/or hiring out day-to-day duties. It is difficult to fully predict the repercussions, but it may be fair to conclude fewer skilled experts are 'on the land' interpreting human-land exchanges. If we take folk or 'traditional ecological knowledge to refer to the culturally shared body of knowledge of the environment held by people that interact with the environment' (Godoy et al. 2005), continuity in the methods of interaction is intricately associated with the continuity of the knowledge itself (Grice and Hodgkinson 2002).

Some have predicted acculturation is correlated with a diminished body of traditional ecological knowledge (Sternberg 1997), and others have found evidence in support of this hypothesis (Godoy et al. 2005). Although this paper does not explicitly measure usage of folk knowledge, there are grounds for concern that investments into folk knowledge are lessening and, paired with other forces, may threaten the flexibility of traditional management systems (Godoy et al. 2005).

The erosion of social institutions and informal ways of knowledge transmission may simply reflect value shifts within a society in transition (Reyes-García et al. 2010). The diminished value of traditional knowledge is not a new arena in knowledge disciplines, as we can point to an extensive array of examples where local, traditional ecological knowledge is devalued by external, expert, interventionist knowledge of science and policy (Nadasdy 2003; Goldman 2003). What may be less clear is how knowledge is questioned and valued intergenerationally, from within a community of interest. Observations reflecting long-standing experiences and traditional practices are being reviewed and perhaps re-evaluated internally, i.e. by a younger generation of herd owners. As education becomes a primary facet of growing up in the Mara, educational curriculum emphasizing Kenya's culturally dominant agro-culture has infiltrated decision-making. The expanse of the church has also marked changes in the culture of the Maasai:

> "*The church came many years ago but the Maasai community, they used to not go to church, they followed their traditions. They know God is there but they do their things their own way. But recently especially here in the Maasailand, we have seen many churches come, people going to church and these people who are going to the church they are the ones who are saying this culture is bad…These other people who still believe in Maasai culture like a women or a man who is older than you should respect and you should have a distance, but now people don't do that, people are just like, for example the way the American people, and that is not good according to our culture.*"
> Focus Group Participant

Increasing interactions between pastoralists and tourists have impacted values and behaviours, especially of the younger generation who are beginning to exercise household decision-making power. There are new role models in the community, often those who have attended university, or who have become wealthy via tourism enterprise. New ideals have emerged: of permanent brick and tin-roof housing, land cruisers, television sets, secondary and university education for your children and property boundaries without the interference of a council of elders. This is leading to economic stratification within the Maa community, with an increasing spirit of competition and lessening communal and traditional obligations (to land and neighbour or clan member).

As an example of diminished value of folk knowledge, consider the detailed knowledge *wazee* exhibit concerning the various compositions, prescriptions and uses of natural salt licks. One *mzee* (respected elder, singular) spoke at great length about his cumulated knowledge of salt licks; their place names, locations, textures, smells, compositions, the proper seasonal uses and health benefits for livestock including deworming properties; and the merits of natural salt over salt from the market. Alternatively, many herd owners today buy salt, deworm with over-the-counter veterinary medicines and, of particular interest, view salt licks as unessential or 'the old way'. Admittedly, part of this spawns from the relative difficulty of accessing salt licks (see 'outlawed' below), but there is an increasing acceptance that natural salt licks are not an essential part of livestock rearing relative to water and forage access, that instead 'buying' salt has now become an acceptable part of the costs of production. Aside from concerns of access (discussed below), this trend seems to indicate a lessening value of natural salt licks and the knowledge wrapped up in its traditional utilization.

> "*There are many types of salt licks: soil-only* [no water] *salt licks called emboliay; there is a salt lick of water and soil which are not good for animals in the dry season because it is too salty; then there is another water and soil lick* [mostly water] *when the river floods it washes it anew and makes is clean again making it good in the wet season.*

There are differences between the health of the cows in these areas, and the most important thing is to have a salt lick, but not the buying salt, the natural salt. The cows using the natural salt lick are very health in kilo versus *those using buying-salts. And this is why we use de-worming from the chemist, if you have access to the salt lick, you do not have to deworm. Some, they buy because they like it. They say, let me try it' just to experiment, but it is not the best; the natural de-wormer is the best."* Mzee S.

Prohibition: The fences, laws, policies and tenure reform obstructing knowledge

"*We are facing problems- there is no place to go without the worry of fines- we've already adapted and we are at a tipping point, we will just sell our cattle and take up cultivation."* Mzee S.

Herders are increasingly constrained by a fragmenting landscape of physical and socially constructed barriers (Galaty 2011). Often these are in the form of property boundaries, conservation and agricultural enterprises or protected areas, although they might also include new laws and regulations (e.g. grazing policies inside the Maasai Mara National Reserve). This has led to a real challenge in observing seasonal use of landscapes, which provide essential resources for pastoralists at different times of the year. As described above, landscape types are used for foddering livestock across seasons depending on rainfall patterns, wildlife and disease movements and overall range condition. However, as territorialization roots itself across the Mara, the flexibility and access of these intermittent resources become challenging labyrinths ripe with fines, fences and conflict (Butt 2012).

"*Long ago, there was a huge space, but now we only have this small space. If you burn Olare Orok, you live in Nkoilale, then you move back after the grass returns. There were so many options! Now, the reserve is the only place to graze!*" Mzee T.

"*It used to be the reason to move in the wet season is to follow healthy grass- now we just go where there is green grass."* Mzee K.

The loss of options and selectivity in forage signifies among other concerns a lessening ability to sufficiently meet livestock needs (Fernandez-Gimenez and Febre 2006). The options for dry season refuge are of particular concern. The integral knowledge and historical use of micro and macro landscape features has been superseded by interests not always compatible with the temporal variability necessary for dryland pastoralism. Tourism lodges occupy and deny access to key water points, salt licks and important high-elevation refugia; private property boundaries are now fencing in similarly valuable keystone features on the landscape; loosening familial/kinship ties leave others without the necessary relationships to call upon in times of need. In addition, cultivation has expanded into both wet and dry pastures, growth of town centres adds to diminishing grazing lands, and more recently, expansion of conservation areas are increasingly constraining lands outside protected areas.

The Mara, like other semi-arid rangelands, occupies a mosaic of different suitability profiles for livestock, and it is the flexibility of embedded knowledge that has retained both robust livelihoods alongside rich flora and fauna. It simply cannot be assumed that under land subdivision, every landowner will be provisioned with the necessary essentials for viable livestock production, let alone those who do not hold title to land.

New forms of territorialization, or the 'attempt by an individual or group to affect, influence, or control people, phenomena, and relationships by delimiting and asserting control over a geographic area' (Vandergeest and Peluso 1995), have resulted from the emergence of new and conflicting justifications for uses of limited space (Leff 2012). Territoriality has emerged at various scales, including the homestead (e.g. erupting conflict among brothers, wives and sons after the death of the household head), parcel (border disputes among neighbours and friends), conservancy (exclusionary membership) and group ranch (exclusionary membership and the prevention of in-migration from outside areas) scale. Resource scarcity, especially outside protected areas, is driving territorial behaviour among neighbours, who often expressed the need to fence and police lands to prevent others from taking advantage when 'one's back is turned'.

Applicability: The incompatibilities between knowledge and practice

"*When I talk with elders, they say it's terrible* [this new life]. *It is up to you guys* [the younger generation] *now, the Maasai way of living has completely changed, everything now depends on money."* Interview participant

One could argue the advanced degree of change in the social-ecological system of the Mara has left traditional ecological knowledge and local approaches to land stewardship in question, and perhaps reflecting a breached threshold of stability, or as Plummer and Armitage (2007) would call a system flip. Societal and cultural

change is occurring at a dramatic and increasingly rapid rate, influenced by a flood of westernized positions of development. Concepts such as livestock ranching, Holistic Rangeland Management, banking and financial services, novel indicators of wealth, education and a Western notion of conservation are but a handful of factors contributing to a changed state-of-being in the Mara. These factors interact and reform pastoralism as a 'way of life'. Within the adaptation literature, scholars have argued pastoralism is redefining itself (Catley et al. 2013) but in what capacity remains contested. The ability, and desire, to move livestock long distances has diminished. The loss of mobility has resulted in lands being grazed consecutively across wet and dry seasons, reducing the period of rest. To continue to exploit these lands, many households are investing in sheep:

> "*There are less options to graze cattle, so we shift to shoats* [sheep and goats]. *Any rain we get benefits the shoats. Yes…increasing shoats cause overgrazing but we don't have any other areas for cattle.*" Mzee L.

> "*You send people to research the hills to see if there is enough grass in the hills for cows, and send others to research the plains for sheep. This is called lale'nok. Nowadays, there is no such thing as lale'nok, you just graze wherever you want as long as it's on your land.*" Interview participant

Herders contend sheep only require flushes of short, green grass throughout the year, while cattle require waist-high forage to maintain body health. Additionally, sheep are '*hospitals*' for Maasai women particularly during post-pregnancies, they are easy to slaughter, provide quick cash in the market, offer shorter birthing intervals and survive on less water and forage. However, many herders themselves, as well as some outside researchers and Western land managers, are concerned with the decreasing quality of grazing lands, and this shift in herd composition appears to be acting as part of a negative feedback loop encouraging further grazing pressure. With many of the traditional institutions for group decision-making increasingly displaced by imported systems of governance and/or individual decision-making, traditional land management is becoming incompatible.

> "*In the past, the community must come together to access pasture and water, but now I* [the herd owner] *decide. I make my own decisions and I prefer this. If I fence 1 or 2 acres for olekeri no one can question me.*" Mzee O. M.

The conservancies may prove to be a possible intermediary between the traditional management schemes being left behind and the push towards a modern, privatized, but still 'collectively' managed grazing scheme. Some highly educated Maasai leaders have become advocates of the conservancy model for precisely this reason. They believe that while traditional pastoral strategies are inadequate, the value of land amalgamation, of collective action and of resource stewardship that conservancies employ are all newly crafted methods of their old system. Educated Maasai are not alone in their push to find this middle ground, the Food and Agricultural Organization (FAO) is energizing initiatives such as Globally Important Agricultural Heritage Systems (GIAHS) which seeks to balance conservation, adaptation and socio-economic development. They argue that heritage agricultural systems, such as pastoralism, are at risk of disappearance without the transmission of accumulated knowledge and experience married with in situ innovations (FAO 2015). That is, to mitigate against the threats of globalization processes by empowering folk knowledge holders to derive benefits from conservation (FAO 2015). However, the true success of such hybridization will depend on the nature of such partnerships *and* the progression of power-sharing mechanisms within the conservancy format, in the case of the Mara.

Conclusions: Towards revitalizing shared knowledge

> "*The only thing covering peoples' eyes* [from the realization of overgrazing] *is this reserve. The moment the reserve restricts people is the moment they* [Maasai herders] *realize they have to do something different with the land.*" Mzee S.

To attempt to characterize traditional knowledge as fixed is to negate the very nature of how such a dynamic system of learning takes place in response to cultural and environmental queues. Instead, acknowledging and embracing the continuous blending of various sources of knowledge in the face of a changing environment is increasingly recognized as part of a resilient knowledge system (Robinson and Berkes 2011; Reyes-García et al. 2013). This paper contributes to such reasoning by emphasizing the real complexities at work when traditional and modern holders of knowledge meet. By exploring the structured arena of knowledge sharing, we can escape the limitations of knowledge integration and instead focus on what conditions are needed to build a conversation among different knowledge holders or knowledge spaces (Goldman 2007). While arguing for hybridization, it should nevertheless remain very clear *how* knowledge is shared, by whom, for whom and at whose cost? In thinking of knowledge as a process, it is important to consider whose knowledge is subverted or

adopted 'along the way'. In agreeing that 'TEK systems endure only by adopting hybrid types through accommodating new forms of knowledge' (Gómez-Baggethun et al. 2010, p. 72), it is this accommodation of new forms of knowledge that may uncover the unequal power relations within a traditional system in transition.

In the Mara, conservancies offer ripe potential for productive hybridization of approaches to collective land management as a way to adapt to the new societal realities while preserving the biological and productive capacity of the land. The conservancy can provide a substantive buffer to the transforming instruments of privatization and commercialization, as it advocates for large tracts of untilled rangelands while retaining local ownership. This potential makes a significant assumption that scientific and external knowledge agents do not usurp localized ways of knowing, therefore suppressing the ability to expand and apply folk knowledge (Reyes-García et al. 2013). As previously gestured to, one only begins to comprehend the complexity of understanding knowledge influences when we ponder the diversity of actors involved in land management decision-making from Western land managers to international conservation groups to Maasai educated elite. Conflict spawns from the diversity of discourses surfacing within these myriad stakeholder groups, with the power of voice often along a hierarchical spectrum. Traditionally-held institutions are strained by these discourses, whether through coercion or eager acceptance; it is therefore unsurprising that knowledge becomes one arena where societal change is most pronounced.

If we assume hybridization necessitates replacement of some elements of traditional knowledge, what pieces make the traditional system vulnerable to breakdown and which pieces retain flexibility? Perhaps one potential answer among others is to consider whether the decline of some elements of a TEK system, in order to incorporate new knowledge, leads to more or less options for responding to disturbance or variability. As one highly educated Maasai leader relayed to us during an interview, the pastoralism of the future will be a hybrid system where the cultural attachments to cattle and tradition will melt and mould over the scaffold of profit-generation, where increased access to education eradicates sentimental notions of animal husbandry and replaces it with pragmatic solutions to environmental change, yet where the statement 'cows are our lifeway' will still ring true to the heart of Maasai in the Mara even if cattle's day-to-day importance diminishes. Perhaps this position echoes the growing interest in the concept of hybrid knowledge co-production (Armitage et al. 2011) as a way to navigate societies in transition.

In sum, we have argued folk knowledge holders in the Maasai Mara possess and continue to collect environmental knowledge yet through various obstructions often struggle to translate this information into practice. While the obstructions of acculturation, prohibition and applicability answer directly to the disconnect between environmental knowledge and practice, they are but small pieces materializing out of a widespread societal shift with yet unknown ramifications. It is fair to argue these obstructions pose significant threats to the value and application of Maasai folk knowledge. The frustration and concern participants expressed during the course of research as they observe, and take part in, the transformation of the Mara, showcase the tensions of continuity and change at work. As much as we might consider tensions such as these a natural part of transition, there is a tendency to lose sight of those most incongruent with the process and who often have the greatest to lose. Even as we try to predict the fallout of widespread societal change, our focus on knowledge can be one tangible way to help ease the process of conflict between continuity and change (Goldman 2011). To this affect, in facilitating the continued growth and importance of local knowledge, there must be recognition of who those knowledge holders are and to ensure such knowledge is considered as more than anecdotal or strategic. Science and positivism do not necessarily produce the ultimate answer; they are as partial as the system they aim to replace. By encouraging hybrid knowledge co-production, we can lessen the dominance of tourism interests as the primary decision-making frame and open the door for a more inclusive process whereby local knowledge holders are heard. Ultimately, it is the herders who own the land and bear the highest costs (e.g. wildlife, disease and drought) yet as Naimir-Fuller et al. (2012) remind us, so often wield the smallest voice despite the largest representation.

Abbreviations

MCF: malignant catarrhal fever; MMNR: Maasai Mara National Reserve; PA: protected area; TEK: traditional ecological knowledge.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

With CJ taking the lead particularly with respect to the data collection and literature review, both authors (CJ and FB) contributed significantly to the organization, framing and argumentation of the article. Both authors read and approved the final manuscript.

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