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Traditional Ecological Knowledge in Management of Dryland Ecosystems among the Maasai Pastoralists in Kiteto District, Tanzania

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Abstract

Understanding the way the Maasai pastoralists' Traditional Ecological Knowledge (TEK) affects management of natural resources in dry lands is of practical importance, failure to recognize its contribution in resources management and use can result into mismatch of varied land uses leading to loss of biodiversity and deterioration of livelihood conditions. The study was done in Kiteto district (Maasai Steppe), data was collected using Participatory Rural Appraisal (PRA), Focus Group Discussions and key informants interviews. Statistical Package for Social Sciences (SPSS) was used to analyze quantitative data, PRA data was analyzed by the help of communities and content analysis was used to analyze qualitative data. Findings show that socio-economic factors; sex, age, education level, income from livestock, household size and time spent in keeping livestock influenced the perceived usefulness of TEK. Practices such as herd splitting, grazing patterns, livestock mobility, co-existence of wildlife and livestock, water sources management and construction of settlement played role in management. TEK thus, enables pastoralists to control and manage rangeland resources by regulating access to users and sanctioning abusers. Using medicinal plants to treat some diseases and ailments instead of conventional medication could be due to high costs or availability of drugs and proximity to health centers. Government and actors should work on policies that undermine pastoral ways of life and range ecologists should design a TEK model to be used in dry lands ecosystems management.

Keywords
Ecological knowledge; Dry land ecosystems; Maasai pastoralists; Kiteto; Tanzania

Introduction

Understanding the way the Maasai Pastoralists' Traditional Ecological Knowledge affects (positively or negatively) the management of natural resources in the dry lands is of practical importance for maintaining ecosystem function and resource availability.

Failure to recognize the contribution of this traditional knowledge in resources management and use to enhance biodiversity and the livelihood of people can result into a mismatch of varied land uses that may lead to loss of biodiversity and deterioration of people's livelihood conditions.

The TEK as a system of understanding the environment based on observations and experience built over generations because of people being dependent on the land for their food materials [1] is one of the central contributions of indigenous people to conservation. Hesse et al. [2] stipulated that, pastoralists are highly specialized livestock herders and breeders and have skills and indigenous knowledge of direct national value.

They rely on scarce natural resources under shifting conditions, demanding considerable knowledge of animal husbandry, sustainable rangeland management and informal livestock markets. Traditional knowledge is described by Pierotti et al. [3] as the knowledge, innovations and practices of indigenous and local communities around the world developed from past experiences gained over centuries and adapted to local culture and environment.

Traditional knowledge is transmitted orally from generation to generation and is collectively owned by members of a particular indigenous community taking the form of stories, songs, folklore, proverbs, cultural values, beliefs, rituals, community laws, local language, crop and animal husbandry practices including development of plant species and animal breeds (Ibid). According to Whyte [4], the concept of TEK is better explored in terms of the role it plays in facilitating or discouraging cross-cultural and cross-situational collaboration among actors working for indigenous and non-indigenous institutions of environmental governance, such as tribal natural resources departments, federal agencies working with tribes, and co-management boards.

Local people have a very good understanding of ecological zones representing a system of interactions among plants, animals, soils and the people themselves [5]. Also, Searle [6] reported that species preferred by villagers for forestation are those wood species which are indigenous to the area out of which some species are scientifically identified but other species may have vernacular names. According to Niamir [7], local people can identify more species and varieties of plants than well qualified botanists, probably due to the fact that they have had more time to search and find all the plants in their area. This cuts across most societies whose livelihood is dependent upon the natural resource base for survival; the pastoralists fall in this category.

Pastoralism is analyzed as a way of life depending primarily on livestock keeping or an extensive system of livestock production that involves different degrees of movements (mobility), and where families depend on livestock and their

by-products for a substantial level of their subsistence and income by over 50 per cent [8,9].

Pastoralism is defined as a mode of production which depends on natural forage and pastoralists are found in many parts of the African continent from North to South and from West to East and mostly live in arid or semi-arid lands [10]. There is undeniable fact that pastoralists have been involved in farmer-herder conflicts in Tanzania and elsewhere in Africa. Of recent, clashes between the parties in Kilosa, Kiteto, Kilindi, Kilombero and Bagamoyo are an example of escalation of resource use conflicts in the country. Eviction of pastoralists in some parts of the country to pave way for agriculture expansion, state-backed investment and conservation such as in Ihefu, Mbarali and Loliondo are the signs of demise of pastoralism and that can lead to further conflicts between the two. Mwamfupe [11] argued that pastoralists have lost considerable amount of their land due to lack of security of tenure.

Despite the role played by pastoralists in management of rangelands, the modern science of range management has often neglected pastoralists' participation, largely due to the perception of official resource managers that herder knowledge lacks objectivity [12].

Furthermore, though the Maasai pastoralists have a longtime experience on the use of dry land ecosystems, the management of the rangelands is expert-based and part played by traditional knowledge is not given proper attention for sustainability.

The study thus aimed to describe well the role played by this ecological knowledge of the Maasai in management of dry lands and to argue on a highly charged criticism from ecologists that all pastoral systems contributed greatly to destruction of environments. Research findings will help to inform policy makers at different levels on potential role of pastoralists' TEK on dry lands conservation, management and improvement of land use planning process in Kiteto and elsewhere in the country. Findings will thus serve as input when preparing strategies to address challenges of dry land ecosystem management. Also, the findings will help to bridge the gap between scientific conservation methods and indigenous conservation practices of Maasai Pastoralists.

Methodology

Study area description

Kiteto District, one of the five administrative districts of Manyara Region in Northern Tanzania, lies between 6°7'16"S, and 36°37'30"E shown in Figure 1. Although there are remarkable variations in the amount of precipitation, the district receives an average of 350 mm to 700 mm of rainfall annually and there is one rainfall season (Uni-modal) between the months of January and May. The dry months are August, September, October and November and it is considered to be semi-arid to arid.

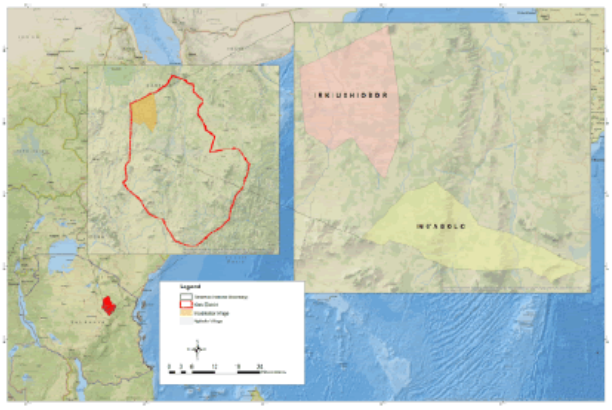

Figure 1 Map of Tanzania showing Kiteto District and the two study villages.

As defined by Kothari [13], a research design is the arrangement of conditions for the collection and analysis of data in a manner that aims at combating relevance to the research purpose and economy in procedure. The research design for this study was cross-sectional whereby data were collected in single point in time, combining qualitative and quantitative approaches.

Sampling procedure

Makami Division was purposively selected out of 7 divisions of Kiteto District because it is located in the dry lands and inhabited by the Maasai pastoralists. All the two wards of Makami Division which are Makami and Ndedo, were used for the study.

From the two wards, stratification was developed to select the village with pastoralists only and those with agropastoralists. Then, from each stratum one village was randomly selected using random numbers developed using excel computer program and Irkiushioibor and Irng'abolo villages were selected.

Households for questionnaire survey were selected randomly using random numbers developed from excel computer programme, and the head of household was the respondent. Focus group discussion (FGD) involved eight to twelve members composed of knowledgeable Maasai elders who are custodians of traditional practices, herders who perform the role of daily livestock grazing and women who are responsible for Manyatta (huts) construction and collection of fuel wood. District Agriculture and Livestock Development Officer (DALDO), District Forest officer (DFO), District land Officer (LO) and two leaders from NGOs involved in land use planning were the key informants for this study.

Sample size

According to Saunders et al. [14] sample size depends on the nature of study, time and available resources. In this study, number of households for enumeration was obtained using a formula by Bartlett et al. [15] such that:

Where: n is the required (adjusted) sample size, N is the population size; n0 is the sample size as calculated by Cochran's [16] formula:

Where: p is the proportion of respondent that will give you information of interest (the proportion confirming), q viz (1-p) is the proportion not giving you information of interest (proportion defective), and p*q is the estimate of variance (which is maximum when p=0.50 and q=0.50). The maximum population variance of 0.25 will give the maximum sample size. Based on the information above, Lusambo [17] modified the sample size formula as:

Where n is the sample size of finite population, and N is the population size.

Data collection

Both primary and secondary data were collected for this study. Secondary data included information about the study area and research topic.

Primary data included a list of TEK practices, role of TEK practices in management of natural resources available, local institutions guiding the use of pasture and water, grazing patterns used in the area, drought coping strategies and various plant species' uses including those with medicinal values. These were collected by using various methods which included Participatory rural appraisal (PRA), household questionnaire survey, focus group discussion and key informants interviews.

Data analysis

Statistical Package for Social Sciences (SPSS) version 19 was used to analyze quantitative data. Descriptive statistics such as frequency, means, standard deviations, percentages and charts were used to give information on respondents' characteristics and identifying TEK practices. Binary logistic regression model was used to determine the perceived usefulness of TEK when managing natural resources (rangelands, water sources and forests). The Binary logistic regression model equation is given by:

Where: p is the probability of Perceived usefulness of TEK (Dependent variable), Xs=independent variables (socialeconomic factors)

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(Table 1), α is the Y intercept, βs are regression coefficients and e is an error term.

Variable	Description
Y	Perceived usefulness of TEK in managing dry land ecosystem in the area
X1	(0=Not useful, 1=Useful)
	Sex (0=Female, 1=Male)
X2	Age (years)
X3	Education level (0=no formal education, 1=formal education)
X4	Household size
X5	Length of time one lived in the area (number of years)
X6	Number of local cows
X7	Number of goats
X8	Number of sheep
X9	Length of time in keeping livestock (number of years)
X10	Total income from sales of cattle
X11	Total income from sales of goats
X12	Total income from sales of sheep

Table 1: Variables used in the binary regression equation.

For data collected using likert scale, chi-square test was used to test the effectiveness of the medicinal plants in curing both livestock and human diseases in the study area.

Data collected by use of PRA was analyzed by help of communities. Tools such as participatory resource mapping were used and analysis of the data was done at the site with the help of communities. To validate information collected from PRA, feedback meetings were organized. Content analysis was used to analyze qualitative data whereby chunks of words were coded and categorized into themes and meaningful textual units.

Both the quantitative and qualitative data were synthesized to establish the reality of the role played by traditional ecological knowledge in the management of dry lands ecosystems. Plant specimens given in vernacular were identified by using field keys and assistance of other expertise. These provided information on socio-economic importance of plant species used in the study area, mostly medicinal values.

Study limitations

Given the nature of the study area and the time the study was undertaken, some limitations were encountered. Firstly, the study was undertaken in November and December, the time which pastoralists become busy in the peak of a dry spell of the year.

During this time, watering of livestock becomes challenging because water table goes down and most water sources go dry and scarcity of water is experienced.

Due to this reason, pastoralists use most of their time looking for water for their precious livestock. To deal with this situation, researchers had to conduct some interviews during evening hours depending on the availability of the respondents.

The other limitation faced was the fact that the pastoral settlements were both scattered and remote.

It took some time to travel from one hamlet to another to meet respondents, and to solve this, village authorities were requested to gather respondents from the distant hamlets at the village center to ease the interviewing process. This helped to meet them without wasting time of both parties.

Results and Discussion

Demographic characteristics of respondents

Table 2 presents sex, marital status and education of respondents. As shown in the table, illiteracy level was so high, about 68.3% of respondents had no basic education. And, although the number of males interviewed (65.8%) exceeded that of females (34.2%, widows, 22.5%), the study ensured that both sexes participated

Attribute	Frequency	Percent
Sex of respondent		
Male	79	65.8
Female	41	34.2
Marital status		
Married (single wife)	40	33.3
Married (multiple wives)	53	44.2
Widow/widower	27	22.5
Education level		
No formal education	82	68.3
Primary	31	25.8
Secondary level	7	5.8

Table 2: Characteristics of respondents (n=120)

This was important because females participate in both livestock keeping activities and domestic chores that involve resource use. Also, findings show that 44.2% of respondents had multiple wives.

Socio-economic factors that influence adherence of TEK practices

Age class: The age classes of the Maasai pastoralists were an important group in the study because Maasai pastoralists are transhumant and livestock keeping being the main economic activity was performed based on age set system whereby each group participated in one or several activities.

Ndaskoi [18] described that the organization of the Maasai men starts right after initiation and that, the system is based on age set, Olporro.

Under this system all the boys, on attaining the age of sixteen or thereabout, are circumcised and accepted into a particular age-set, a unit possessing a single name Table 3 and a sense of unity.

S/No	Age group	Age	Role played
1	Il Mertien	8-25	Livestock herders
			Had understanding of availability of pasture resources
2	Il Mirihi	26-40	Protected land against grabbers and intruders
			Undertook scouting to search new pastures and water *(Eleenore)*
			Moved livestock to access distant pastures and water, *(Ronjo)*
			They perform the duty of watering livestock throughout the dry season *(Eokore)*
3	Il Kimunyak	41-60	Provided advice on suitability of landscapes for grazing
			Owned water sources by virtue of their Sections/kinship (Clan heads)
			Provided directives to herders on grazing duties
4	Il Kishumu & Iseuri	>60	Owned water sources on behalf of their kin. Put in place grazing patterns (Alalili) that are observed by village and non-village members. Performed cleansing of water sources (Orkeju) at the beginning of dry season. Preserved traditional practices and historical knowledge of events. Provided advice to other age groups on resources management

Table 3: Role of Maasai age groups in management of dry land ecosystems

It is further stated that among the Maasai people there are no rulers but there are leaders. For every sub-tribe each age group had a leader, Alaigwanani (singular), Ilaigwanak (plural) elected by the largest possible assembly of the members of the group. There is also a deputy leader Engopiro (singular), Ingopir, (plural).

Sex of respondents

(Among the Maasai pastoralists, men perform livestock activities such as watering, pasture scouting and grazing, temporary camping, Ronjo, treatment as well as selling. Women do not do much of these activities as compared to men.

Young ladies could go to take care of livestock (grazing) in absence of boys, and during the study, it was noted that the girls were not scorned as boys in case livestock were lost.

Although women and young girls performed most of the household chores including construction of huts, Manyatta and milking, they had knowledge on resource use and medicinal plants. About 34.2% of women participated in the study.

Household size

Findings in Table 4 show that average household size (N=120) in the study area was about 9 people. Household size in a pastoralist setting means more labour to work on livestock related activities.

S/No	Age group	Age	Role played
1	Il Mertien	8-25	Livestock herders
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Table 4: Descriptive statistics on demographic characteristics

While young boys could go to herd livestock and calves, the two are normally not mixed during the day, warriors would do watering specifically during the dry season and looking for pastures, women will undertake milking and later separate calves from adult cattle.

Level of education

Findings show that the level of illiteracy was so high, 68.3% because most respondents had no primary education.

This could be associated with the reasons for keeping livestock as there are reduced chances of other economic opportunities given the fact that area is dry to allow for crop cultivation.

This being the business, practices that favour livestock keeping while conserving environment will likely be observed by them.

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This being the business, practices that favour livestock keeping while conserving environment will likely be observed by them.

Time spent in the village

Average number of years spent by respondents in the study villages was about 37. Given the nature of the area (dry lands), the Maasai opted to keep livestock and any practices that influenced livestock keeping in the area will be adhered to.

Nyinondi [19] put that Maasai lived in the Maasai Steppe for centuries and grazed their livestock in the area, so have acquired knowledge to develop a well-defined grazing system and codes to govern resource use in the landscape [12].

Binary regression equation model was used to test whether socio-economic factors noted influenced the perceived usefulness of TEK in managing dry lands ecosystems in the study area.

The regression equation model used to test whether socioeconomic factors influenced the perceived usefulness of TEK in managing dry lands ecosystems indicated that the model fits very well as indicated by Hosmer and Lemeshow Test being above 0.05 (p=0.97).

Results from the binary logistic equation indicate that the variables influencing the perception of usefulness of TEK contributed from 11.1% to 29.6% as explained by Cox and Snell R2 and Nagelkerke R2 values.

All the predictors contributed equally to the model because they had probabilities greater than 0.05. Table 5 shows that Wald's statistics are non-zero values, and according to Powers and Xie [20], the non-zero Wald's statistics values indicate the presence of relationships between the dependent and explanatory (independent) variables.

Parameter	N	Min.	Max.	Mean	Std. Dev.
Age of respondent (years)	120	27	78	48.43	10.35
Number of respondents with multiple wives	53	1	6	3	0.97
House hold size (total composition)	120	2	30	9	5.33
Number of years lived in villages	114	1	60	36.65	14.82

Table 5: Socio-economic factors influencing overall perceived usefulness of TEK in managing dry land ecosystems

Thus, on the basis of the results of this study the null hypothesis was rejected in favour of the alternative hypothesis that, socio-economic factors influenced the perceived usefulness of TEK in managing dry land ecosystems in the area at 5% level of significance.

In Table 5, sex has a negative regression coefficient (b) of -0.509 and the odds ratio (Exp b) of 0.601. This implies that a unit decrease in this variable, which was statistically insignificantly at probability of 5% (p=0.545) decreases influencing by a factor of 0.739.

Sex may influence the role of TEK in natural resources management depending on ownership of resources at the household level such as land and livestock, all of which are important in determining the role played by TEK.

Age has a positive regression coefficient (b) of 0.135 and the odds ratio (Exp b) of 1.144. This implies that an increase in age, which was statistically insignificantly at probability of 5% (p=0.192), increases adherence to TEK practices by a factor of 1.033.

In this study, the mean age of respondents was 48 years as noted previously, and age influences knowledge of various things in a place, this is vital in explaining experiences and benefits of various TEK practices that have been undertaken in the area for many years.

Education level has a negative regression coefficient (b) of -1.252 and the odds ratio (Exp b) of 0.286.

This implies that a unit increase in this variable, which was statistically insignificantly at probability of 5% (p=0.156), decreases the rate of adhering to TEK practices by a factor of 4.516.

In a pastoralist setting, people who are educated would like to keep livestock differently, say for example the ranching systems and neglect the usefulness of TEK practices.

Household size has a negative regression coefficient (b) of -0.111 and the odds ratio (Exp b) of 0.895.

This implies that a unit decrease in this variable, which was statistically significant at probability of 0.05 (p=0.048), influenced negatively the role played by TEK by a factor of 0.726. Household size in a pastoralist setting influences a number of factors.

Large household size may influence income earnings and expenditure; it may influence the level of labour force and may as well increase livestock activities concentration and diversification.

Total income earning per year has a positive regression coefficient (b) of 0.0001 and the odds ratio (Exp b) of 1.000.

This implies that a unit increase in this variable, which was statistically insignificantly at probability of 5% (p=0.690), increases perceived usefulness of TEK by a factor of 1.000. Income influences a number of factors.

People with high earnings from livestock and their products would prefer to keep more livestock and adhere to TEK practices that favour pastoralism in their locality.

Natural vegetation and wildlife species observed in the study areas indicated that pastoralists' TEK practices influenced the management of these natural resources.

TEK practices existing in the study villages

Results from focus group discussions in the two study villages revealed several TEK practices. The practices in Table 6 were based on livestock keeping as a major economic activity and the management of natural resources that this activity relied upon.

Type of NR	TEK Practice	Traditional name	Description	Usefulness in dry land management
Grazing land	Herd splitting	*Iloho, Alaram and Irmongi*	Separating calves from adult cattle;	To control breeding
				Easy feeding, avoid physical injuries to young and weak animals.
Grazing land	Set aside portions of grazing areas	*Alalili*	For young and weak animals	Avoid overgrazing
			For different seasons of the year	Reserving pasture for the dry season
Grazing land	Moving livestock to access water and pasture away for a specific period	*Ronjo*	Seasonal movement to feed livestock away from permanent	Reserving dry season pasture
			Settlement	Fatten livestock
Grazing land	Herd diversity;	*Iltimito*	Keeping varieties of livestock herds such as cattle, goats, sheep and donkeys.	Each herd feeds differently on available type of vegetation.
				Reserve in case of severe drought or disease
Water sources	Water sources owned by clan heads;	*Engishomi*	Hand dug wells owned by kinship	Every water source has someone to take care of.
Water sources	Prohibition to cut down trees/establish settlement close to water sources.		No specific distance given.	To avoid drying the water sources and siltation

Water sources	Ritual to cleanse the water sources *(Orkeju)*.	*Emayian*	Prayer is said at the beginning of the dry season *(Alameyu)* as sign of inauguration.	Prior tothis prayer, no one is allowed to utilize the water
Forests	Construction of Kraals *(bomas)*	*Engang'*	It's a circular cluster of dwellings enclosed by a fence	Constructed using tree tops and branches (for boma), withies and poles (for huts)
Forests	Use of medicinal plants	*Olchani*	To cure people and livestock ailments	-
Wildlife	Maasai do not consume game meat	*Ilchang'it*	Beef is considered better than game meat	Wildlife available in rangelands than cultivated areas
Wildlife	Maasai allow wild animals, ungulates, to graze with livestock without killing them	-	Co-existence of livestock and wildlife is common in the rangelands	Rangelands are safer breeding sites for wildlife
Beekeeping	Beekeeping is not a cash earning business	-	Bees honey is used in performing rituals.	Extraction is by using fire that is detrimental
Grazing lands	Burning rangelands	*Embejeto*	Aim is to eliminate ticks and other parasites	This is detrimental to fauna and flora (biodiversity)
			Allows sprouting of new and palatable grass for livestock	

Table 6: TEK practices perceived to promote dry land ecosystems management

The practices constituted the daily routine of pastoralists' life style in taking care of their precious livestock while ensuring the sustainability of the scarce resources in the rangelands.

As pointed out earlier, pastoralism was the dominant mode of livelihood that depended entirely on availability of natural resources such as pasture, water, salt licks and livestock routes to access these resources.

From the study, Alalili was a mechanism used to reserve pasture for young animals and ensure that pasture was available for different seasons. Regarding Ronjo, pastoralists move their livestock to access distant pasture and water. Livestock could not be confined in one point without moving to access pasture and water where it may be available. This is asserted by Fratkin [21] that pastoralists, more than other populations have historically adapted to conditions of low and erratic rainfall, patchy resources, and recurrent drought. Also, Mung'ong'o et al. [22] put that pastoralist transhumant herding patterns have been in tune with the ecological realities of dry land areas where rainfall and grazing are subject to high risk and seasonal variability. They have allowed vegetation to be renewed every year as they resorted to temporary migration and such migration has essentially been a traditional drought-coping strategy and has had positive effects to environment in that it allowed the affected area to recuperate.

TEK practices that promote or hinder management of dry land

Findings showed that TEK practices promoted the management of dry land resources by 92.5% in the study area (Figure 2). However, some pastoralists (7.5%) urged that certain practices were detrimental to the environment and other natural resources.

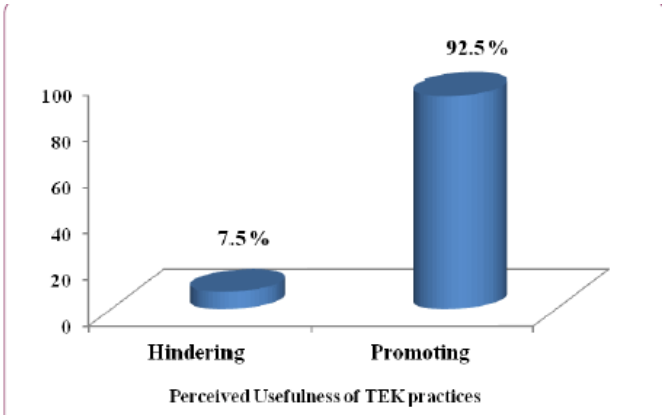

Figure 2 Schematic cross section of passive solar pasteuriser (front view).

This study examined both sets of practices to see their contribution in either promoting or hindering the management of the dry land resources in the study area.

TEK practices perceived to promote dry land ecosystems management

According to Temesgen [23], pastoral systems in Africa are found in the vast arid and semi-arid areas. Pastoralism is uniquely well adapted to dry land environments; as an economic and social system, it operates effectively in highly variable conditions, managing the complex relationship between people and the natural environment. These areas are characterized by marked rainfall variability, and associated uncertainties in the spatial and temporal distribution of water resources and grazing for animals. Interviewed pastoralists perceived that TEK was useful in managing dry land ecosystems in the study area (Table 7). Usefulness is based on the reasons that TEK practices provide guidelines on utilizing and managing land and natural resources available.

Practice identified	Usefulness in the study area
Livestock mobility	Promotes regeneration of new vegetation when degraded environments are left un-grazed
Herd splitting	Reduces trampling on land and suppression of vegetation
Seasonal grazing patterns (Ronjo)	Reserving pasture and water resources for the dry season
Alalili, Sing. Ilalillak, Plural.	Ensures availability of pasture resources for young and weak animals all year round
Herd diversity	Ensures that one type of vegetation was available for at least one herd type (cattle, sheep, goats)
Cleansing of water sources	Preserving water sources for dry season
Rotational watering of livestock	Sustaining the available water for the dry season
Conservation of water sources	To avoid evaporation and drying up of water sources
Prohibit establishing settlement near water sources	To avoid siltation and contamination of water sources
Conservation of forests and wildlife	Ensures that rangelands are safer environments for wildlife
Use of medicinal plants	Ensures sustainable use of plants and avoid cutting down trees unnecessarily
Construct bomas and huts using twigs and poles	Ensures sustainable use of plants for these specific variable use

Table 7: Perceived TEK practices promoting management of dry land ecosystems

Pastoralists expressed that transhumance was important and that it was a kind of coping strategy at adverse climate extremities like scarce vegetation during the dry season. As put by Nkedianye et al. [24], pastoral mobility is a drought coping strategy which historically helped many pastoralists to manage uncertainty and risk in arid lands (also in Selemani [25]. Arid ecosystems are spatially and temporally variable and to a large degree unpredictable, pastoral mobility enables the opportunistic use of these natural resources. In Tanzania, pastoralists reduce risk of livestock mortality by seasonal movement of livestock to the productive and high rainfall areas. Evidence indicates that, pastoral mobility is economically effective (i.e. less costly) because it requires minimal labor and inputs compared to stall feeding system (Ibid). However, in areas where there were both farmers and pastoralists like Irng'abolo village this mode caused conflicts because of intrusion of livestock into crop fields, Selemani [25] opposed this by putting that pastoral mobility serves as symbiotic interaction with farmers, whereas livestock supply manure to the farmers and farmers provide crop residues for livestock feeds.

Regarding wildlife in the rangelands, Maasai pastoralists do not consume wild meat and therefore do not aspire to kill wildlife that grazing close to their livestock. They allow wild animals, especially the ungulates to graze with their animals without any disturbances. The findings collaborate with Msoffe [26], who reported that for millennia, pastoralists have shared landscapes, with wildlife throughout Africa (also Homewood and Rogers, [27]). Conroy [28] echoed by putting that the traditional Maasai system of livestock and land management has also been admired for its tolerance of wildlife. Maasai herds and flocks are locked in the corral each night, leaving the unfenced grazing areas exclusively to the wildlife. Even during the day wildlife can be seen near the herds of cattle and flocks of sheep and goats. Study by Voeten [29] found that throughout the 20th century the co-existence of livestock and wildlife has been in decline as conservation policy excluded people and livestock from protected areas and, expanding agriculture excluded wildlife and livestock use.

Regarding conservation of forests, pastoralists do not cut down trees or clear bushes for the purposes of establishing crop fields. They mostly utilized plants in many ways including performing rituals and constructing their Manyatta (kraal) but only tree tops were used for these purposes, leaving tree trunks standing. Also, when constructing huts, only poles and withies were used and trees left un-cleared. In the study area (dry land), shrub lands, thickets and tall trees were standing despite the reasons that the area is semi-arid, bushes not cleared. Promotion and dissemination of this resource use knowledge and management to youngsters and to the community at large was done by the elderly. It was found that from youthfulness, resource use knowledge and management is implanted to young people and so required to adopt and maintain to the next generation. The findings were similar to those of Mlekwa [30] on elders maintaining and restoring social order in the community, they transmit their accumulated experience related to herding and resource management to the younger generation, they served as spiritual guardians and sponsors of religious ceremonies, passing on cherished traditions and customs of the people to youths and children.

From the study, findings in **Table 8** show information/ perception of pastoralists on how TEK was perceived to restore or protect degraded lands in the villages.

Restoration technique	Frequency	Percent
Mobility allows regeneration of vegetation	65	54.2
Forests and water sources are conserved	6	5
TEK ensures that fragile sites are conserved	9	7.5
Apportioning grazing areas, Alalili, ensures sustainability of pastures	25	20.8
Herd splitting reduces feeding pressure	5	4.2
Seasonal grazing patterns, Ronjo, preserve pastures	10	8.3

Table 8: Perceived responses on how TEK restores degraded sites (n=120).

Results indicate that 54.2% of respondents strongly agreed that mobility promoted regeneration of new plants when the area is left untouched for certain period of time. This was explained to be the reason for pastoralists to have the kind of grazing patterns that enabled them to move from one place to another to allow for regeneration. The results agree with Tenga et al. [8] who described that transhumance (livestock mobility and rotational use of grazing lands) minimizes land overuse and allows vegetation to recover after grazing, thereby protecting marginal lands from degradation. A study by Mapinduzi et al. [31] using indigenous ecological knowledge to assess effects of grazing and cropping on rangeland biodiversity at micro-and macro-landscape scales in Northern Tanzania identified indicator plant species and their associations with micro-landscapes and livestock grazing suitability (i.e. for cattle and small ruminant grazing).

Herd splitting reduced pressure on grazing resources and therefore conserves land against degradation. Livestock were divided into smaller groups based on cohort that could feed with ease and with less suppression on the land cover. The findings are similar to those of Mangara et al. [32] stating that herd splitting was done to reduce competition and allow the disadvantaged animals (small/weak) to graze. Also, herd splitting was a strategy to mitigate inadequate feed supply in dry and drought periods. They have allowed vegetation to be renewed every year as they resorted to temporary migration and such migration has essentially been a traditional droughtcoping strategy and has had positive effects to environment in that it allowed the affected area to recuperate.

TEK practices perceived to hinder dry land ecosystems management

Criticism on the mode of livestock by Maasai and other pastoralist groups is centered on mobility, whereby movement of livestock is claimed to compromise with other land uses and causes the never-ending conflicts. Practices identified to

hinder management of natural resources in the dry lands are shown in Table 9.

Type of NR	TEK Practice	Traditional name	Description	Usefulness in dry land management
Grazing land	Herd splitting	*Iloho, Alaram and Irmongi*	Separating calves from adult cattle;	To control breeding
				Easy feeding, avoid physical injuries to young and weak animals.
Grazing land	Set aside portions of grazing areas	*Alalili*	For young and weak animals	Avoid overgrazing
			For different seasons of the year	Reserving pasture for the dry season
Grazing land	Moving livestock to access water and pasture away for a specific period	*Ronjo*	Seasonal movement to feed livestock away from permanent	Reserving dry season pasture
			Settlement	Fatten livestock
Grazing land	Herd diversity;	*Iltimito*	Keeping varieties of livestock herds such as cattle, goats, sheep and donkeys.	Each herd feeds differently on available type of vegetation.
				Reserve in case of severe drought or disease
Water sources	Water sources owned by clan heads;	*Engishomi*	Hand dug wells owned by kinship	Every water source has someone to take care of.
Water sources	Prohibition to cut down trees/establish settlement close to water sources.		No specific distance given.	To avoid drying the water sources and siltation

Burning up the rangelands for reasons to eliminate ticks and tsetse fly in Irkiushioibor grassland was perceived to be detrimental to environment in the rangelands. Although the intention was to allow for regeneration of new pasture, the practice causes deaths of flora and fauna specifically slowly moving animals. Beekeeping was reported not to be a cash earning activity by the Maasai pastoralist in Irkiushioibor village but bees' honey, Enaiho, was used when performing rituals like initiation and blessings. Despite this, extraction of honey was done entirely by using fire/smoke to deter the bees. This practice was reported detrimental because it wipes away almost all the bees by killing them before getting their honey.

Effectiveness of Medicinal Plants in Curing Livestock and People

Medicinal plants for humans

It was also important to know the common ailments in the area that were cured by using local herbs identified. Table 10 shows that Malaria was the most common disease and was reported by all respondents interviewed (100%), other common diseases and ailments included coughs, stomach disorders, intestinal worms, skin diseases and wounds. The most usable plants were those in their vicinity, unless it was not found in their locality. There was many other plant species mentioned by respondents and observed during data collection but had low frequencies.

Disease	Frequency	Percent
Intestinal worms	80	66.7
Malaria	120	100
Diabetes	4	3.3
Ulcers	22	18.3
Skin diseases	60	50
Coughs	115	95.8
Colds	54	45
Stomach disorders	101	84.2
Wounds	29	24.2

Table 10: Human illnesses cured by using medicinal plants (n=120).

Table 10: Human illnesses cured by using medicinal plants (n=120)

Disease/ Ailment	Effectiveness (%) based on number of respondents	Plant species and part used		
		Vernacular name	Scientific name	Plant part used
Malaria	60	*Ormukutan*	*Albizia anthelmintica*	Bark, roots
		Oloisuki	*Zanthoxylum chalybeum*	Bark, roots
		Endulelei	*Solanum incanum*	Fruits
		Oltirkish	*Unidentified*	Fruits
		Kabuya	*Unidentified*	Fruits
		Orgilai	*Teclea simplicifolia*	Bark
		Oremit	*Salvadora persica*	Roots
Intestinal worms	41.8	*Orkitarwo*	*Croton spp*	Bark
		Orkelelwet	*Croton spp*	Bark
		Osingwai	*Unidentified*	Bark
		Oloiborbenek	*Croton dichogamus*	-
		Ormukutan	*Albizia anthelmintica*	Bark, roots
		Osukuroi lenkiok	*Aloe vera*	Leaves
Ulcers	34.5	*Olkiloriti*	*Acacia nilotica*	Bark
		Orkitarwo	*Croton spp*	Bark
		Alamuriaki	*Carissa edulis*	Bark, fruits
Skin diseases	56.9	*Oltemway*	*Commiphora swynnertonii*	Oil
		Embalwa	-	Roots
		Olchilichili	*Commiphora ssp.*	Oil
Diabetes	70	*Orkokola*	*Rhamnus staddo*	Bark
		Olodwai	-	Fruits
		Oltemway	*Commiphora swynnertonii*	Oil
		Alamuriaki	*Catha edulis*	Bark, fruits
Coughs	52.5	*Arparrarruay*	-	Leaves
		Oloisuki	*Zanthoxylum chalybeum*	Bark, roots
		Olodwai	-	Fruits
		Osukuroi	*Aloe vera*	Leaves
		Orbukoi	*Terminalia brownie*	Bark

Gouts	77.8	*Arparrarruay*	-	Leaves
		Oldarpoi	*Kigelia africana*	Leaves
Colds	48.8	*Alamuriaki*	*Carissa edulis*	Bark, roots
		Endulelei	*Solanum incanum*	Fruits
		Engilelo	-	Roots
		Orkitalaswa	*Myrica salicifolia*	Bark
		Oltemway	*Commiphora swynnertonii*	Oil
Stomach disorders	46.8	*Oiti*	*Acacia melifera*	Bark
		Orkelelwet	*Croton spp*	Bark
		Oloisuki	*Zanthoxylum chalybeum*	Bark, roots, fruits
		Ormukutan	*Albizia anthelmintica*	Bark, roots
		Orpel	*Markahamia lutea*	Roots
		Oling'oswa	*Balanites aegyptiaca*	Roots
		Osingway	-	Bark

Table 11: Plant species used to treat human ailments and their effectiveness.

In this study, it was noticed that pastoralists used plants for many ways including construction of kraals and huts, making clubs, spiritual and traditional rites, but mostly for medicinal values.

Hauff [35] stated that all Maasai pastoralists have medicinal knowledge. In curing ailments, decoction from pieces of bark, roots, or leaves Alchani, was used as medicine, taken without being processed [36] and sometimes added to foods [35]. Certain trees were used for particular ailments [37], studies attributed the low incidences of heart disease among Maasai with cholesterol lowering substances found in bark extracts used by the Maasai in their foods (milk, soup and blood) [38] given the reliance on meat and milk.

Msogoya [39] stated that WHO statistics show that 80% of people in the developing countries use herbal medicines and 60% of people in Tanzania use herbal medicine to cure various diseases and that every village has a provider.

Also, 60% of people in Tanzania mainly in rural areas start to use herbal medicines when they fall sick prior to visiting health centers.

In major cities in Tanzania, The Maasai tribesmen deal with herbal medicines and statistics show that a provider receives ten to twenty (10-20) clients a day with various problems ranging from BP, kidney failure, asthma and stomach ulcers (Ibid).

Medicinal plants for livestock

When interviewed on the types of livestock diseases common in the study area which were treated by using medicinal plants, respondents identified diseases and ailments as shown in Table 12.

Disease	Frequency	Percent
Eye problems	76	63.3
Retaining placenta	97	80.8
Wounds	92	76.7
Ticks and other parasites	94	78.3
Skin diseases	66	55

Table 12: Livestock illnesses treated by medicinal plants (n=120).

The most common problem mentioned was the retention of placenta after the animal has given birth, others included ticks and other parasites which were the causes of deaths of livestock, wounds and eye related problems and injuries.

Effectiveness of medicinal plants in treating livestock illnesses was also examined. Findings in Table 13 show that medicinal plants were effective to about 84.2% when provided orally to livestock that retain placenta after delivery. Also, were effective by 54.2% when applied on livestock skins to remove ticks and other parasites that were the causes of most livestock diseases. A decoction from medicinal plants was used to treat livestock eye problems and injuries and was effective to about 53.5% and when used to treating skin diseases was moderately effective for about 42.9%. The results conform to Fatima et al. [40] who explained that the roots of Carissa spinarum were reported to be of many medicinal uses. They are ground and put into the wounds of cattle to kill worms. It is also used in combination with the roots of some other medicinal plants to treat rheumatism.

Disease/ Ailment	Effectiveness (%) based on number of respondents	Plant species and parts used		
		Vernacular name	Scientific name	Plant part used
Retention of placenta	84.2	*Armame*	*Solanum nigrum*	Roots
		Orkobobit	*Unidentified*	Roots
		Osingwai	*Unidentified*	Roots
Ticks and other parasites	54.2	*Oltemway*	*Commiphora swynnertonii*	Oil/exudates
		Oloisuki	*Zanthoxylum chalybeum*	Bark, roots
Eye problems	53.5	*Oltemway*	*Commiphora swynnertonii*	Oil/exudates
		Orbukoi	*Terminalia brownie*	Bark
Skin diseases	42.9	*Olchilichili*	*Commiphora spp*	Oil/Exudates
		Oltemway	*Commiphora swynnertonii*	Oil/exudates
Wounds	30.9	*Oltemway*	*Commiphora swynnertonii*	Oil/exudates
		Oloisuki	*Zanthoxylum chalybeum*	Bark

Table 13: Plant species used to treat livestock ailments and their effectiveness

Also, a study by Chacha [41] revealed that tick-borne infections resulting from tick infection in livestock are common

veterinary health problem in Tanzania. Tick infections were the cause of reported cattle deaths and were estimated to amount for 68% of the 364 million USD annual total losses resulting from tick-borne diseases in Tanzania.

Conclusion

It is concluded that pastoralism as a livelihood strategy is part and parcel of the Maasai traditions and culture. Socioeconomic factors such as sex, age, number of cows owned had positive coefficients such that males, adults and those with large herds of livestock influenced the usefulness of TEK in managing natural resources. Practices such as herd splitting, setting aside areas of grazing lands for different seasons of the year and for young and weak animals, Ilaliliak, water resources Ilchorroi, being managed traditionally, co-existence of livestock and wildlife in the rangelands, pre-determined and planned transhumance, Ronjo, and conservation of wildlife and forest resources are the TEK practices identified to play key role in management of dry land ecosystems in Kiteto district. There is therefore a positive link of pastoral ways of life and natural resources management.

Medicinal plants have played important roles in the treatment of diseases and ailments (human and livestock) instead of conventional medication in Kiteto. It was further noted that the Maasai used the decoction from pieces of bark, roots, or leaves as medicine, olchani, taken without being processed or added to foods such as milk, soup or fresh blood from cattle and goats. In livestock, the most common diseases were retention of placenta after the animal delivery, wounds and eye problems, removal of ticks and other parasites which were the causes of most livestock deaths. Application was inform of powder (ground bark), crashed leaves or exudates like that of Commiphora swynnertonni, popularly known as Oltemway. The study has therefore shown that TEK has a role to play in management of dry land ecosystems in Kiteto District and other areas with similar ecological characteristics.

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