TRADITIONAL ENVIRONMENTAL KNOWLEDGE SYSTEMS AND THE MANAGEMENT OF VULNERABLE AREAS IN NORTH EASTERN TANZANIA

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Abstract

This article aims to contributing to the current debate on the role of traditional environmental knowledge systems (TEKS) on land and land use systems conservation and management for sustainable development. The conceptual frameworks around which most of the TEKS analyses hinge over time are narrated. It is conceived that TEKS have demonstrated synergetic relationship between the land and land use systems in so much as they support millions of people in developing countries. The methodology employed in analysis of TEKS, land resources and land use systems at household and community levels included PRA approaches and a questionnaire. Kainam people living in a vulnerable ecosystem in Northeastern Tanzania, as individuals and as a community applied TEKS for classification of land and the use to which it is put employing soil-water-slope criteria. Specific land utilization types were found to be suited only to particular ecological and management conditions as tested over the years. This was evidenced by dynamically stable arablelands, pasturelands, forestlands and water source resources use systems. Further, TEKS was found to be guided and strengthened by flexible local institutions. There is evidence that, the Kainam community is ready to adopt new technologies and evaluate them scientifically before being put into practice. It is recommended that, a study be conducted on the future of TEKS and how it can be integrated with MEKS, under the globalization pressures with respect to land and land use management for the sustainable human development both locally and globally.

Key Terms: Traditional Environmental Knowledge Systems; Modern Environmental Knowledge Systems; Land use systems; Vulnerability; Management.

Introduction

The dusk of the Twentieth Century witnessed exciting initiatives in revitilising technologies owned by local resource users in Developing Countries. On the 18th December 1992, for instance, the United Nations Resolution 164 declared 1993 the 'International Year of the World's Indigenous People'. This was aimed at strengthening

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international cooperation, in order to address the problems faced by the indigenous communities, in such fields as human rights, the environment, development, education and health. But indigenous awareness concerning the resource management is assured following the World Commission on Environment and Development (WCED, 1987) which advised that indigenous communities are "repositories of accumulated traditional knowledge and experience hereafter known as Traditional Environment Knowledge Systems (TEKS), which large society could learn from managing complex ecological systems." These are essentially land use systems, which support various livelihoods.

Further, the Commission on Development and Global Change of 1995 issued a report titled: "For Earth's Sake". The report listed, *inter alia*, areas of research interest, which are of the highest priority if solutions to national and international environmental problems are to be found. One such area concerns TEKS in conservation measures, where the commission for "approaches to rescuing and revaluing TEKS about natural resources and their management formed the centre-stage" (Deborah, 1997:123). It is within this context that TEKS and resource management systems (RMS) have been identified as research themes that, when studied critically, constitute an important and timely area of environmental research for sustaining land, land use systems and the land user.

It is worth noting here that in the second half of the 1990s, TEKS have entered the mainstream of activities and initiatives undertaken by developing countries and by the international donor community, UN Agencies, and most recently the World Bank (1998). TEKS are on the agenda of the first conference devoted to the Global Knowledge for development (GK 97), held in Toronto, Canada, and even more prominently on the agenda of the second conference (GK II), held in Kuala Lumpar, Malaysia in 2000. The final action plan of the GK II Action Summit and Forum includes a strong endorsement of the TEKS programme and specifically calls for the identification, development and dissemination of local knowledge in various forms including local languages. It also calls for developing strategies for using TEKS in development.

Recently, there has been a growing interest and appreciation among scientists in traditional knowledge systems. The body of scientific publications grew over the last decade and no doubt underlies the recommendation of the UNESCO - World Conference on Science (Budapest, 1999) that traditional knowledge be integrated into the mainstream science. It is in this context that Agenda 21 seeks to address these initiatives by re-examining and applying TEKS techniques, as opposed to the wholesome importation of Modern Environmental Knowledge Systems (MEKS). The ultimate goal is to attain the optimum combination of the best practices from TEKS and MEKS, that illustrate the good use of indigenous knowledge and developing cost-effective and sustainable survival strategies for wealth creation and income generation. In asserting control and direction over their lives in order to safeguard their social structures, Africans applying informal science have utilized knowledge, practices, skills

and tools that their societies have developed in the course of centuries (Rugumamu, 2003). As observed by Lane (1996), traditional knowledge is sum of experience and knowledge within a given group, which forms the basis for decision-making related to familiar and unfamiliar problems and challenges.

Nevertheless, formal knowledge - knowledge generated in schools, universities, research institutes and industrial firms still dominates development thinking. This knowledge gradually spreads over the developing world as the dominant system shaping politics, values and careers - a system that put great emphasis on the contribution of MEKS to development. In this context TEKS were considered inferior and were denied a role in the development process as a consequence, they were classified as non-scientific and treated as contrasting with MEKS. Fortunately the situation is changing as decision makers in developing countries are seeing more and more examples of how TEKS can be put to good use. They are beginning to realize that TEKS is the largest single resource not yet mobilized for the developing enterprise. It is a powerful asset that many developing countries posses. As reflected in October conference in Tanzania whereby the World Bank tabled the paper on the role of TEKS for development.

In this study, the theoretical underpinning is that there is a complex relationship between and among individuals, local communities, Mother Nature components and land use systems in the whole process of earning livelihoods. The intricate linkages in a given ecosystem and the underlying sound resource conservation and management for sustainable development. There are several concepts used in the analysis of TEKS but none can stand on its own given the linkages between them. Traditional environmental knowledge systems are embedded in places and lives of the people. TEKS may be considered as an integral part of the local knowledge, classification systems and social interaction with the environment. However, social interactions provide the rules for relations and management systems. Therefore TEKS have restrictive application which is locational specific but might also be applied to develop concepts such as conservation of particular land. Vlaenderen (2000) for instance, defines TEKS as local knowledge that has been captured and systematized by the users.

TEKS is analyzed in four different levels. Firstly, traditional knowledge of land resources i.e. arable land, pastureland, forestland and water resources. This level includes the knowledge of plants, animals, soils, water and landscapes. Secondly, the land resources conservation and management systems (adoption of practices), which include users of environmental knowledge and appropriate set of practice, tools and techniques. This is the level whereby the local people seek the mutual and harmonious relationship with their environment. It is a stage that requires an understanding of ecological processes to sustain their daily livelihoods. Thirdly, social institutions, which include a set of rules and code of social relationships that, govern human behaviour. The fourth is the improved productivity of the land resources, which shapes the traditional perceptions, giving meanings to observations of the practical practice experienced.

From thence, the successful TEKS are disseminated to the whole community to be practised to improve the productivity of land resources and human population over time and space. The four levels of TEKS analysis are summarized in figure 1.

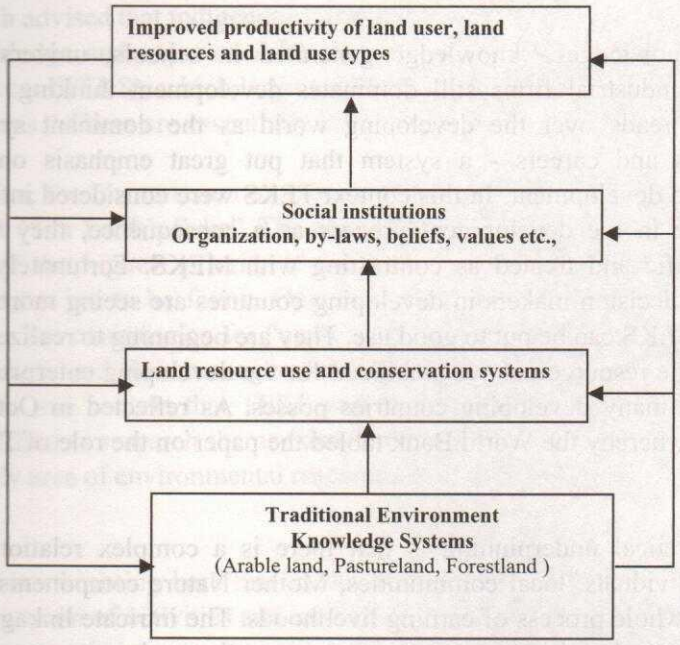


Figure 1. Level of Analysis in TEKS

Source: Modified from Berkes (1999:3)

In rural areas, the survival of local communities is predominantly dependent on utilizing land resources for their livelihoods. In some cases, production does not meet the needs (Rugumamu 2003). Most of the technical solutions that have been implemented to address land resources conservation for increased production in rural areas have failed because they did not take into account the culture, particularly community preferences, skills and knowledge. Given this state of affairs, there is need to find ways to improve production and productivity. One way is through the application of existing TEKS based on the land users capacity to manage the environment and improving on what is already known and practised.

The specific objective of the study is to contribute to a growing debate on the role of TEKS in managing natural resources and improving the quality of life of rural communities. More importantly, it inventorises TEKS and contributes to the databank on land resources management for promoting the quality of life and improving the productivity of land resources for the present and future generations. Subsequently, it triggers positive change by introducing new ideas for enhancing environmental productivity.

Since ecosystems are dynamic, knowledge of the past has very significant implications for current management principles and practices. This study seeks to fill a gap in TEKS information on land resources management activities for the present and future development.

Methodology

Kainam Study Village Setting

The Kainam village is located in Mbulu district in Manyara region. It approximately lies between 350 30^0 and 350 40^0 East and 30 50^0 and 40 00^0 South (Figure 2). The village has an area of approximately 19200ha. It is located 12km Southeast of Mbulu town. Its selection for study has been due to three interrelated factors (Hambati 2003). Firstly, the area is the heartland of the Iraqw people. The most striking differences and indeed of interest between the Iraqw core (meaning Kainam) and expansion areas is the unique cultivation and cattle keeping practices that have since sustained each other in Kainam. Secondly, as a place where the Iraqw first settled before they migrated to other areas like Karatu, Babati, and Hanang districts, the areas' land resources appear more integrated than those found in the new settlements (Loiske, 1995). And thirdly, Kainam village is ecologically a vulnerable ecosystem. Its vulnerability is characterized by highly dissected landscapes with steep slopes in the Mbulu highlands, which range from 1500 to 2300m above mean sea (MSL) level. This nature of the landscape being a natural barrier to invaders may have enabled the community to maintain their traditional cultural values in land resource conservation and management. Further, it experiences a semi-arid environment with rainfall between 700 and 800mm per year and temperatures varying from 100C during the rainy season to 150C during the dry season. Occasionally, a drought disaster strikes the area. This village therefore may be classified as one of the vulnerable ecosystems in Tanzania and renders itself appropriate for a study on TEKS.

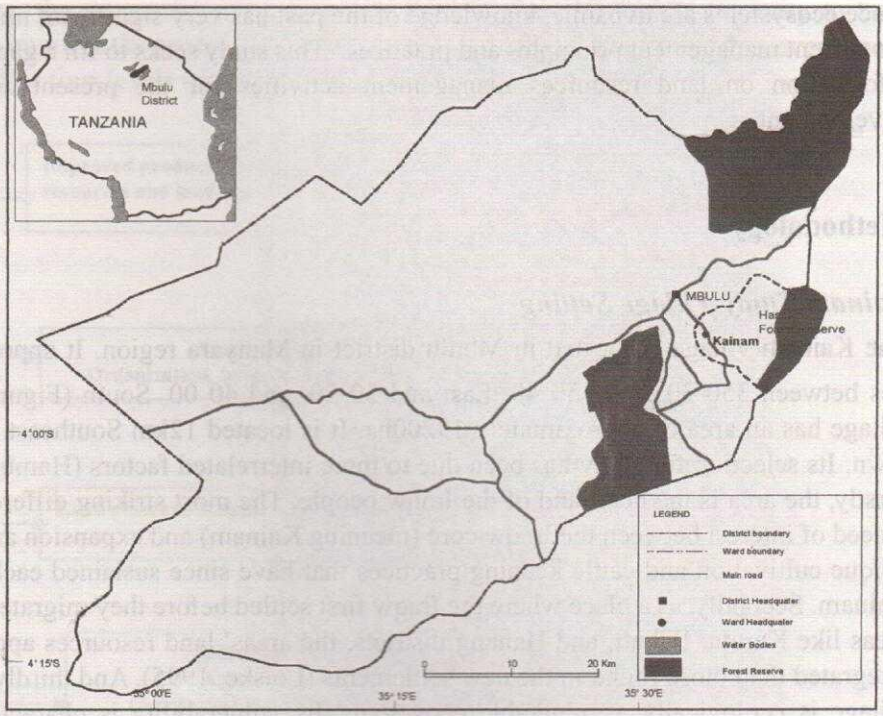


Figure 2: Location of Study Area

A stratified sampling of the village landscape was carried out based on the soil-water-slope interaction in order to get the village land units, i.e. interfluves, slopes, and the valleys (Conacher and Darymple 1977). In each of these land units, random sample has been drawn in order to get interviewees in each land unit. Again with the help of the village leadership, the number of sub-village leaders (i.e. Mwenyekiti wa Kitongoji) were identified, and from their sub-village, a sample was taken purposefully in order to include the relevant different land users. Kothari (1990), argues that, for a sample to be representative enough for statistical analysis, it is recommended that at least a total of 10% of the entire population be taken for study. In this study, a sample of 15% of all the households (650) in the village, was involved.

In this context, data and information collection for the study constituted three main operations. These were the pre-field work, fieldwork and post fieldwork. Pre-field work involved the collection of secondary information before embarking on the actual data collection. Generally, a variety of tools were employed in data and information collection. These data included the spatial, temporal, socio-economic, institutional and technical variables.

Secondary data were obtained for the purpose of familiarizing with the area. These data about the area were gathered before the beginning of fieldwork whose main sources were published and unpublished reports, topographical maps and the aerial photographs which were used to identify the land units, land use and land cover. These data enabled

the PRA team, especially the facilitator, to gain an overview of the state of art and the community members to better understand the study area as the planning and management entity (a holistic unit).

The study employed Participatory Rural Appraisal (PRA) in identifying and analyzing TEKS on agropastoral land resources management and devising better measures to promote equity and sustainability. PRA is capable of capturing the dynamic qualities of environment and the community in general (Rugumamu 1999). It includes; public meeting, personal observation, focus group discussion, structured and unstructured interviews, questionnaire monitoring and participatory resource mapping. All these methods have strengths and weaknesses, therefore a combination of the methods mentioned have been used in this study in order to complement each other.

The post fieldworks were the activities done after the fieldwork was completed. Compiled or collected information from the field using the different methods, for instance those already mentioned, were analyzed and evaluated. This operation dealt with the two major activities, these were: the organization of problems and opportunities, that was to put in place organized data and information for the participants to discuss and authenticate. Also to rank the problems and opportunities, that enable the researcher and the village community to discuss and agree upon the priorities and increase community awareness of the importance of the land resources conservation and management on their basic needs and aspirations. Importantly, it has empowered the community and formed the basis for formulating a plan of action on how to integrate the TEKS and MEKS to have appropriate technology for the land resources conservation and management (Scoones et al 1994). Data and information acquired from the field, which have been proved and verified by the PRA team and the researcher, were coded electronically to facilitate the analysis and evaluation.

The statistical Package for Social science (SPSS) software was used in the coding and later processing of data to derive table of frequencies, percentages, and means. Later on cross-tabulation was done to establish relationships between the research objectives and questions as well as the goal of the study. Data and information were analyzed and presented using percentages and visual presentation like tables, and graphs (bar).

Evidence of Sustainability of the Land User and Land use Systems Under Teks

TEKS on Land Management

The community in the study area has knowledge of classifying the land quality according to the position of the land unit and the nature of the slope on a landscape. Figure 3 shows the traditional land classifications along transect during the field study. The land uses are classified according to the nature of the slope, drainage systems, and

vegetation. Land resource conservation measures vary from one land unit to another, though they might be of the same land use. The evidence on TEKS per major land units, slopes in degrees, farmers soil description, drainage, vegetation, land use and resources management measures in the village are as summarized in the transect model (figure 3). Relations between and among people under TEKS.

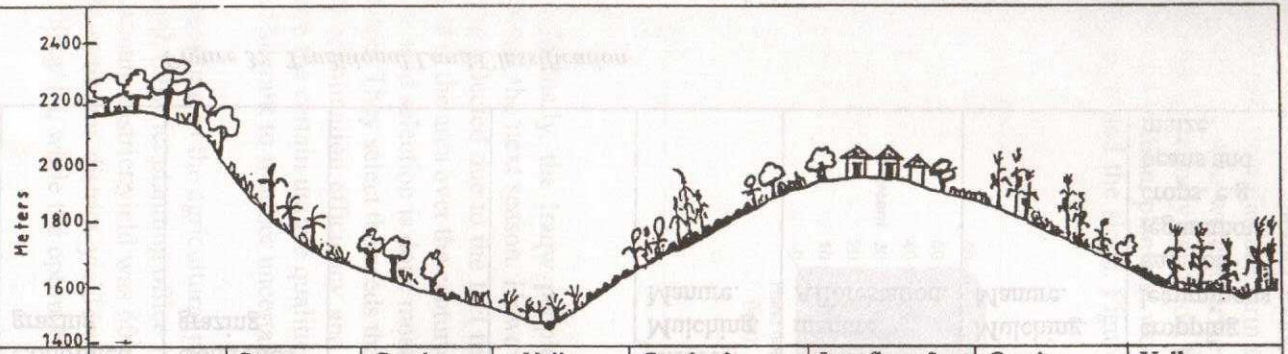
People's capacity to organize themselves for managing the land resource is the key to enhancing TEKS. According to Iraqw traditions, the first man to occupy a new land and build a house is known, as kahamusmo and becomes the owner of the land. He has the authority to allocate land to those who follow. He settles land disputes and punishes those who are found guilty. Therefore, the Iraqw security of tenure depended on the leadership qualities of the kahamusmo. There is strict adherence to his procedures of land allocation and arbitration or fines in case of conflicts.

TEKS on Arable Land

The agricultural fields in the study area are found in patches due to the nature of the landscape (Figure 3). According to the PRA survey team, the average total farmed land in Kainam village is 1.4 hectares per household. Table 1 below shows the range and average farm sizes in particular land units.

Table 1: Farm Size.

Land unit	Farm size in hectares (ha)	
	Range	Average
Interfluve	0.3-0.5	0.4
Mid-slopes	0.3-0.8	0.5
Valley bottoms	0.8-1.5	1.4



Land unit	Interfluvel (Narrow)	Steep slope (Narrow)	Gentle slope 1 (Narrow)	Valley bottom 1 (Narrow)	Gentle slope 2a (Eastern Slope), (Wide)	Interfluve 2 (Wide)	Gentle slope 2b (Western slope)	Valley bottom 2 (Wide)
Slope in degrees	$<2^0$	8^0-15^0	2^0-7^0	1^0-2^0	2^0-6^0	$<3^0$	2^0-4^0	$<1^0$
Farmer's soil description	Stony and gravel.	Shallow soils with outcrops here and there. Stony and gravel.	Shallow soils with local bedrock exposure (gravelly).	Very deep, black soils with abundant mica flakes.	Deep dark greyish brown sand-clay soils.	Very deep dark reddish brown clays with thick top soils.	Deep and very deep, very dark greyish brown clay-loam soils.	Very deep, dark grey, or black clays, commonly with numerous mica flakes.
Drainage	Well, to somewhat excessively drained.	Surface runoff, to somewhat excessively drained.	Well, to somewhat excessively drained	Poorly-drained.	Well-drained	Well-drained	Well-drained	Well-drained

Contd.

Vegetation	Woodland trees of various Spp.(10-15m high) Indigenous spp.	Woodland trees of various Spp.(10-15m high) Indigenous spp.	Bushland. Short trees spp. (1-10m high) Indigenous spp.	Grasses and scattered trees like wild date palm.	Various tree spp. both exotic and indigenous spp.	Agroforestry.	Various tree spp. both exotic and indigenous spp	Crops, Grassland and scattered trees. (Wild date palm)
Land use	Forest	Forest Fire wood extraction.	Bushland Distant grazing area.	Wetlands. Grasses used as roofing materials. Natural wells.	Sorghum, Finger millet, sweet potatoes and Irish potatoes.	Settlement, homestead garden (tobacco and fruits). Homestead grazing	Maize, Beans, and Wheat. Fallow grazing.	Maize inter-cropped with Beans. Grazing. Streams.
Resources conservation measures.	Controlled firewood extraction, Controlled grazing.	Controlled firewood extraction, Controlled grazing.	Controlled grazing.	Local beliefs. By-laws.	Ridging farming. Local terraces. Mulching. Manure.	Mulching. Application of household wastes and manure. Afforestation.	Crop rotation. Local terraces. Mulching. Manure.	Mulching, application of manure. Inter-cropping leguminous and non-leguminous crops. e.g. beans and maize.

Figure 3: Traditional Land Classification

Farm inputs are another evidence of the success of TEKS. Craftsmen within Iraqw community manufacture farm tools to improve production and productivity. All of the respondents who were interviewed have reported that, they are using traditional farm implements namely hand hoe, bush knife, axe. These hand tools are commonly used in farm preparation, planting, weeding and harvesting and are suited to the nature of the landscape and the slope. Figure 4 shows traditional farm implements mostly used by farmers.

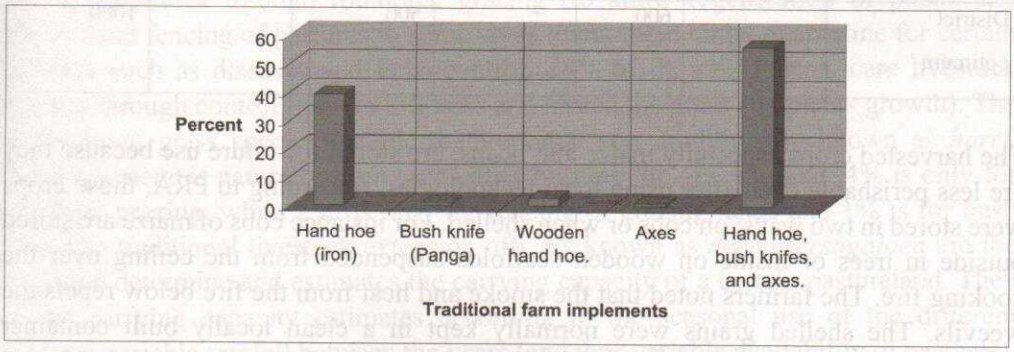


Figure 4: Traditional Farm Implements

Traditionally, the Iraqw people have their own knowledge of selecting seeds to be planted the next season. However, in the study area, maize, beans and sweet potatoes were selected due to the fact that these are the major stable food crops that have been used in the area over the centuries and TEKS is mostly applied in their production cycle. The seed selection is done mostly by the mother or the father, soon after the harvesting period. They select the seeds that have performed well in the past season by considering the germination efficiency and its productivity in the past year. These selected seeds have the certain unique qualities. These qualities include taste, resistances to pests and are tolerant to weather uncertainties.

According to the agricultural planning document for Mbulu district for the year 1995-2000, (District planning office 1995) the target for maize yield was 800kg/ ha, while the optimum district yield was 600kg/ha. The target for beans yield was 600kg/ ha, while the optimum district yield was 500kg/ha. The target for sweet potatoes yield was 1500kg/ ha, while the optimum district yield was 1000kg/ha, as shown in the table 2.

Table 2: Yields of Maize, Beans, and Sweet Potatoes

Land unit	Maize yield Kg/ha		Beans yield Kg/ha		Sweet potatoes yield Kg/ha	
	Range	mean	Range	mean	Range	mean
Interfluve	150-600	400	150-500	200		
Mid-slope	100-600	400	100-300	200	250-2000	800
Valley bottom	200-1000	600	150-600	400		
District optimum		600		500		1000

The harvested crops especially maize and beans, are stored for future use because they are less perishable even after using local technologies. According to PRA, those crops were stored in two ways; on cobs or when shelled. For instance cobs of maize are stored outside in trees or inside on wooden scaffolds suspended from the ceiling over the cooking fire. The farmers noted that the smoke and heat from the fire below repels the weevils. The shelled grains were normally kept in a clean locally built container through use of wet cow dung known as *'kunti'*. Then the shelled grain stored in *kunti* is mixed with sand, burned animal dung, and ashes; all contribute to reducing insect damage in stored grain. Sand occupies air spaces between grains, exclude air, and suffocates grain weevils. It also scratches their skins and this causes dehydration and eventual death, especially if the grain is very dry. This system has been used over the years and it has proved that, insects were killed and rodents were excluded without use of any other chemical substances.

TEKS on Pastureland

According to the PRA, the study area pastureland is identified according to landforms, topographic location, soils and the vegetation type in relation to land units, such as interfluves, mid-slopes, and the valley bottoms. The work of identifying pastureland is done traditionally by the group of old wise men known as *barisersagaloen* whose age ranges between 46-64 years, and have been trained since their youth by the former *barisersagaloen.* According to focus group discussion with the *barisersagaloen,* there are four types of grazing lands, and these are:

Hill grazing land traditionally known as *tlomma.* This is the land unit specified for distant grazing during the afternoon and it is communally owned. The major dominating trees here are traditionally known as *narrey* or shrubs especially solanum species and brackens (Pteridium acquilibrium). Interfluve traditionally knowns as *dindirmo,* is the area near by homesteads, whereby every household own an area less than 0.5ha for grazing, which is traditionally known as *hindiwi.* Grazing on homesteads is normally during the morning. This is also a special grazing land for the weak animals and lactating or pregnant cows. Mid-slopes grazing land is traditionally known as *geay.*

This is a communally owned area along the mid-slopes between (40-80) and it is left uncultivated for grazing purposes.

Valley bottom grazing land traditionally known *khatsa,* is the area whereby normally livestock normally get water, and therafter spend a few hours resting. The *khatsa* is divided into three parts, which are: the area where cattle rest after drinking water, protected wetlands for collecting grass for livestock and thatching houses and fields for dry season cultivation.

According to the households interviewed, 65% of the respondents have cared for their livestock pastures through rotational grazing (to allow regeneration of plants and grasses) and fencing of pastures in some areas to put them under quarantine for certain purposes such as diseases and ticks control. 28% of the respondents care livestock pastures through control fires (to kill ticks and hasten the grass and plants growth). The most known grass species include, heteropogon spp, traditionally known as *harri*, which regenerates naturally from seeds after burning the grazing land. 4% is only for rotational grazing, while 2% is only for fencing of grazing lands and 1% is for bush fires. The traditional livestock extension officers known as *deemusersagaloen* are the ones who determine and estimates the carrying capacity of a certain pastureland. They do the carrying capacity estimates according to the seasonal use of the different pastures, variable rainfall between the years (and thus variable availability of pastures), the importance of available trees and shrubs fodder as well as the water availability for the area. Crop residues are not included in the carrying capacity estimates as they were used as supplement feed to weak animals and lactating or pregnant cows. The carrying capacity of a grazing area is a measure of the land's potential to support the livestock.

According to the PRA, the community egages in livestock keeping due to the important roles which they play in their daily livelihoods. These include the subsistence provisioning of food such as milk and meat and traditional form of capital for most economic transactions such as purchase of food, clothing, medicines and schooling. Supplying manure for fertilizing the soil and security against drought and plant diseases as well as cultural functions such as rituals, marriage, and circumcision. According to the household interviews, 79% of the respondents benefit from food, manure, and the income coming from livestock keeping, while 21% benefit food, manure income, dowry, and prestige. 62% get milk less than two litres per day while 38% get milk between two to three litres per day. According to the PRA team, the milk is enough for their household needs.

The Interaction of TEKS and MEKS on Pastureland

Pastureland as arable land, there is an interaction of TEKS and MEKS in conservation and management of the pastureland resources. This interaction has been seen in new species of fodder, introduction of the dairy cows, and the caring of the livestock and pastures.

Leaves and stems from the banana plant are said to be the most important fodder. This is the new plant grown on the contour lines in between the fields, where also other plants, for example elephant (Pennisetum purpreum) and guatemala (Tripsacum laxum) grasses are grown to provide cattle fodder. The livestock are fed on the collected fodder at the homestead especially during the dry season. The elephant and guatemala grasses were introduced by the British, but growing them on the contour-lines, was an established practice.

The introduction of crossbreed and exotic cattle in the village is a means of intensifying animal production, controlling animal numbers, and their mobility, and consequently improving the environment. The local and modern way of caring livestock also has been observed in the study area.

TEKS on Forestland

PRA team noted that the community classifies the forests or trees according to their locations and uses. According to the focus group discussion with the Barisersagaloen, there were three types of forests found in the study area. These are: The forests/trees found along the interfluves nearby homesteads. These are tree spp. like Olea Capensis, traditionally known as *sahati* and Prunus Africana traditionally known as *gwaami*. They are used mostly for firewood (branches), building, timber, and medicine (barks); they are owned by family. The forests/ trees found along the mid-slopes. These are tree spp. like Podocarpus falcatus and some acacia spp. These are mostly used as fodder for the cattle, bee-keeping as they provide nectar for *bees* and protect the surface runoff, thus soil erosion protection along the mid-slopes, they are owned communally. The forests/ tree found along the valley bottoms, these are the tree spp. that normally preserve water. These are spp. like *tiita* (Ficus Thonningii), Harrii and thaanthi (wild date palm spp.), these spp. are never cut or used for any purpose as they are considered to be protecting water spp. in valley bottoms. Village government owns them. The forest ownership varied from household, individual level to government, as figure 5 shows.

Figure 5: Forest Ownership in the Village

The Interaction of TEKS and MEKS on Forestland

Forestland as an arable land and pastureland, there is an interaction of TEKS and MEKS in the village. TEKS and MEKS have been integrated in forest management and conservation, through the introduction of agroforestry and afforestation. There are several types of trees planted in the plots. Agroforestry includes fruit trees, forestry trees, and leguminous trees. The later (e.g. Leucaena) is used for fodder or soil improvement purposes. According to the households interviewed, the exotic plant species raised are mainly: black wattle (46%), grevillea (28%), and eucalyptus (26%).

The community in Kainam treats certain forest areas as sacred sites for traditional worshipping, especially when there is a severe stress such as drought and diseases for both plants and animals. Some tree species such as Ficus, traditionally known as *Tiita* is considered spiritual, and are never cut by the local people. The Forests are catchment areas for streams in the study area. The community protects the forests as they said that, forests are sources of rainfall and water sources in the village. Therefore the forests reserves in the study area were protected as important water sources. There was a strong belief that, trees should remain as natural as possible as a place where their gods rest and give blessings.

The Future of Teks

In their efforts to assert control and direction over their lives and to safeguard their social structures, Africa's rural people have traditionally utilized the knowledge, skills, and tools that their societies have developed in the course of centuries. TEKS is an important aspect of a society's culture. According to Dewes (1993), traditional knowledge is characterized as the sum of experience and knowledge within a given group, which forms the basis for decision-making related to familiar and unfamiliar challenges. They are the challenges of an individual, group, community or society, which drive TEKS at a particular moment in time.

Rugumamu, (2002) observed that conservation and management technologies in the community are aimed at preserving natural resources for future production of goods and services and is essential for survival of certain groups of people over a given time and space. In the study area, the community has traditional ways of classifying land use depending on the nature of the landscape in terms of slope angle, aspect and length. Like Sikina, (1994) in the northern province of Zambia, the rural farmers have their own ways of identifying local soil and land types for agricultural uses. The main criteria used by farmers to classify soils were colour of the top soil layer, texture, consistency, and organic matter content. The same criteria were also observed in Kainam village. For example, black soils are considered to be rich in organic matter, and are often found in valley bottoms and farmers normally plant maize and beans, the staple food.

Traditional ways of conserving fertility and productivity of soil practised by the community include manure application in all farming systems, which are collected and processed in different ways. As noted by Tengo and Andersson (2000), to maintain soil

productivity on permanent fields, it is necessary to compensate for the loss of nutrients gained by the crop and lost through leaches by a constant input. The importance of livestock as manure producers is well recognized by the farmers of Kainam and this is said to be the main reason for keeping cattle.

As Smaling and Braun (1996), noted elsewhere, beans rotated with cereals out-yield inter-cropping practices. Nitrogen fixation by beans provides nutrient soil input. This is also supported by the results in the study area, whereby beans are used as the most common nitrogen fixation crop. Through the use of beans in inter-cropping and crop rotation systems, an input of nitrogen is therefore, automated in the fields. As noted by Tengo (1999), wild nitrogen fixating plants, such as Fabaceae spp. are found on fallow and in the grazing areas. Nitrogen fixation is one of the processes that restore nitrogen to the arable land during a fallow period and to pasture land.

The crop fields in the study area are found at different land units, with different slope degrees, length and aspect. The traditional land classification that has been conducted over the years revealed that different land units with different land uses or same use require different land management systems. FAO (1983) notes that management practices on different areas within one land utilization type are not necessarily the same. For example, land utilization type may consist of mixed farming with part of the land under arable use and part allocated to grazing, such differences may arise from variation in the land, requirements in land use type, from requirements of the management system or all of them. This concept was supported by the results in the study area whereby fields were prepared and organized differently in accordance with the cropping patterns in different land units with different traditional land management systems.

TEKS practices applied to different plots in different land units have resulted in gradual increase in yields over time and space in the village. For instance, in the mid-slopes; the plots vary in size from 0.3-0.8 ha, and the yield per hectare ranges from five to six bags of maize, while in valley bottoms the same area produces five to eight bags. This variation in produce is partly due to the fact that some nutrients are transported from the mid-slopes and interfluves to the valley bottoms hence enriching the soil in the valley bottom fields. On the other hand, the proximity of mid-slope fields to the homesteads contributed these fields being more fertile because some farmers throw household waste directly to the fields near the house. This may explain why the yields between those land units are not very significantly different.

The TEKS-MEKS interface was demonstrated by 18% of the interviewees who cultivated modern seeds supplied by Farm Africa, an NGO working with rural people in Mbulu district via Village Government. The improved seeds include maize, H 622/32 (Kilima) and beans 85/90 (Lyamungu), which were concurrently used with traditional fertilizers and pesticides, including the hand-hoe for tillage operations. However, the interaction of MEKS and TEKS in the study area have not shown any improvement on the farm yields or production or sustainance of land productivity.

As Rugumamu (1996) observed, traditional pastoralism depends heavily on rotational grazing between different land units, to take advantage of fluctuations in the availability and quality of forage and water. This is also supported by the results in the study area whereby the traditional rotational grazing system is a coping mechanism aimed at ticks control and fallowing to allow for leaves and twigs to decompose and fertilise the land. The findings are also echoed by Tengo and Andersson, (2000) in Hanang.

Further, the study revealed that, there are no reliable veterinary services in the village, hence more dependence to the traditional veterinary atendants. This implies that the traditional livestock healthcare is a dominant system in the village and the livestock practices have lead to the capability of the ecosystem to sustain the present livestock population within the village pastureland resource base. As Ellies and Swift (1988) observed, a pastoralist has detailed knowledge of animals, their characteristics, diseases, and vectors. Tengo and Andersson, (2000) noted that over the years the Kainam community has developed effective ways of ensuring that this knowledge is used for sustainable utilization of environmental resources. The same situation has been observed by Loiske (1995), in Gitting village in Hanang district and Rugumamu (1996) in Busongo and Makomero villages in Shinyanga region.

TEKS practices as observed by Rugumamu (2001), have conserved and managed several species on the forestland in the proximity, especially those that anthropogenic forces easily affected their germination or growth. Kainam community for years has been observing the dynamics of the forest growth and regeneration using TEKS. As observed by Mark et al., (1992), in Indian rural communities whereby the community protects the forest through their beliefs as the source of rainfall and water in the villages. Mbuta (2001) also observed a similar case in Mangula village. This is also supported by the results in the study area whereby there is a strong belief that, trees should remain as natural as possible as a place where their gods rest and give blessings. Based on PRA statement, afforestation, the intercropping of crops and trees has been done since time immemorial. The British government in the late 1930s initiated colonial efforts in this direction, after the indigenous trees were cleared to combat tsetse fly infestation. They introduced new plant species such as wattle (Acacia Mearnsii) the dominant exotic species in the study area. Since then several plants species have been planted at community and individual levels. Currently, there are tree nurseries run by schools, villages, Non- governmental Organizations, and individuals.

Policies in any community greatly influence the form of land resources use and conservation. Officially, land in Tanzania is owned by the state, but in practical sense it is privately owned (Ellis, 1988). Customary laws of land tenure are still propagated in most parts of Tanzania (Pitblado, 1970; Rugumamu 1997; Shivji 1998) the same case has been observed in the study area. Land resources management in rural areas is the concern of many sectoral policies. This influences resource management practices depending on the interest, applicability to community and acceptance with regards to

effectiveness (Mbuta, 2001).
Most of the time the State defines the problems and suggests solutions, without taking into account popular views such as TEKS with regards to resource conservation. For example State intervention in problem solving reveals some contradictory tendencies that raises questions to most of the land users, as they were not effectively involved in the whole process of decision-making.

Conclusion and Recommendations

The findings of the study show that traditional societies have knowledge on their land resources. They know their needs, values, as well as threats and possible alternative solutions. The Kainam community members have traditional systems of landscape classification and a good understanding of the effects of land use on agro-biodiversity. Their landscape assessments were verified by field methods, which would add to the appreciation of their traditional environmental knowledge. The survival strategy of the local community is a clear evidence of the success of TEKS. Indeed, as the study demonstrates, involving local people in resources inventorying in the arable land, pastureland, and forestland resources has been of immense importance for management of resources over time and space. This is due to the fact that the local people have culturally an in-built knowledge, which has been historically accumulated, and used for survival and sustainable land resources utilization in the village ecosystems.

The findings on the interaction of TEKS and MEKS reveal that, during this era of globalization, it is enviable to have MEKS in our environment. Success in development through use of land resources is likely to be achieved when local people are involved in the planning and implementation of development projects and programmes. The concerns should reflect the needs and aspiration of the stakeholders as well as those of the land resources base. Land uses in most rural areas are complementary or even competitive and/or conflicting. The inventory of locally driven solutions to complex issues on land resource conservation and management is, therefore of great importance in developing countries that lack capital investment.

In the light of the preceding results, it is imperative to suggest that a study be conducted on the future of TEKS and how it can be integrated with MEKS, as well as how well the smallholder farmers would fare under the pressures of privatization, liberalisation and capital flows in relation to land resources management for sustainable development.

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