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Effects of Changes in Use of Indigenous Knowledge Systems on Land Cover in Teso Busia County, Kenya

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This paper introduces indigenous land knowledge conservation systems as a significant resource which would contribute to the increased efficiency and effectiveness in the management of land and land based resources among rural communities. Despite their critical role in the conservation of the land based resources, these knowledge systems and technologies are being marginalized or even forgotten among rural communities. This paper discusses Teso community indigenous land conservation systems and the effects of their level of application/adoption on land use/land cover status trends from the time of Kenya's pre-independence to the 2000s era. Data was collected using a variety of social science research methods such as structured questionnaires, in-depth face-to-face interviews, focussed group discussions, content analysis of literature and environmental check lists. The status of the bio-physical environment was tracked using GIS techniques. The common Teso community indigenous land conservation systems included mixed farming, traditional terracing, use of grass-strips, agro-forestry and fallowing. Results showed that adherence to the key Teso community indigenous land management systems have been on the decline since the 1960s. This has negatively impacted on the state of the biophysical environment by increasing land area under rain-fed agriculture by 11.2% and a decline in land under seasonal swamps by 21% between 1973 and 2010. Land size under wetlands dropped by about 33% between 1973 and 2000. These changes were indicative of the negative impact of the decline in level of application of indigenous land conservation systems in the protection and conservation of these resources.. In view of the above, it is recommended that rekindling, recording and preservation of indigenous land-based best practices among local communities such as the Teso for sustainable land management must be integrated into conventional environmental management plans.

Key words: Indigenous knowledge systems, land cover, land use, conservation, Teso, Kenya.

INTRODUCTION

Since time immemorial, Indigenous Knowledge Systems (IKSs) have been used in Africa and in many other parts of the world for a number of purposes as determined by the needs of the society concerned. They include knowledge forms that have remained despite the effects of colonialism, western imperialism and ignorance

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(Cobb, 2011).

Chikaire et al. (2012) referred to these knowledge systems as, “a body of knowledge, or bodies of knowledge of the indigenous people of particular geographical areas that have survived on for a very long period of time”.

Such knowledge is also referred to as the local knowledge that is unique to a culture or society. This knowledge is passed from generation to generation, usually by word of mouth and cultural rituals, and has been the basis for agriculture, food preparation, health care, education, natural resource conservation and for a wide range of other activities that sustain societies in many parts of the world.

A study by Tanga (2013) however reveals that in the recent decades an increasing number of case studies from across the planet have provided evidence of rapid TEK degradation. In view of this, Maffi and Woodley (2010) have argued that due to the critical role that TEK plays in shaping natural resource management strategies, its rapid degradation can have substantial implications on the quality of land based resources.

Indigenous Land Conservation Systems (ILCs) in the context of this paper refers to all traditional cultivation practices which were used to conserve soil, enhance vegetation cover protectwater resources and increase soil fertility for increased crop production.

This study sought to establish the Teso community indigenous land conservation systems and ascertain the effects of the trend in the level of use of these knowledge systems on the status on the biophysical enevironment in the study area.

Lireature review

Combert et al. (2016) note that historically, land based resources among people in most parts of the world formed the basis on which socio-economic, political, cultural and religion were founded and organized. This attachment led to the perception of sacredness of land and land based resources . In view of this Awuah-Nyamakye (2014) points out that the sacred nature of land in turn called for responsible exploitation of its resource which necessitated various ethnic groups to devise different methods and practices for its conservation. Such measures were accordingly tested over time and eventually constituted part of indigenous technical environmental knowledge systems for natural resources conservation.

Hilhorst et al. (2015) submit that these knowledge systems are better understood as practical, personal and contextual units which cannot be detached from an individual, their community, or the environment (both physical and spiritual).

Zeimbicki et al. (2013) noted that most of the indigenous land management systems began with the onset of the activities of land clearing and cultivation. According to the authors above, simple tools were used which in most cases consisted of tools that were not capable of cutting big trees or clearing large trucks of land easily and such were less destructive. Such tools included curved iron blades with long handles used to clear shrubs and grass and the planting hoes that were not capable of opening up large trucks of land or deep layers.

The use of these tools meant that large trees and forests were left largely untouched and erosion was controlled due to minimum tillage, where only the top soil was disturbed. The most common practice involved first slashing land and thereafter burning the resultant debris. This method despite leading to the deterioration of soil nutrients and living organisms, helped to control disease vectors for both human and livestock thereby enabling farmers to cut down on the cost using expensive pesticides.

A study by UNEP (2008) focusing on indigenous knowledge pertaining to disaster management in Kenya, Tanzania, Swaziland and South Africa, similarly reveals that communities in these countries practiced slash-and-burn, shifting cultivation and intercropping, as well as a number of other technologies and practices to optimise food production under varying environmental conditions. Roy et al. (2012) concur that the practice of shifting cultivation (which is an agricultural system in which plots of land are cultivated temporarily, then abandoned and allowed to revert to their natural vegetation while the cultivator moves on to another plot) has been common among rural communities in different parts of the world. Van Vliet et at. (2012) noted that the period of cultivation is usually terminated when the soil shows signs of exhaustion or, more commonly, when the field is overrun by weeds.

Besides, the length of time that a field is cultivated is usually shorter than the period over which the land is allowed to regenerate by lying fallow. Inter-cropping and mixed farming were reported to have also been commonly adopted by indigenous communities in many parts of the world. Intercropping is the cultivation of two or more crops simultaneously on the same field. It also means the growing of two or more crops on the same field with the planting of the second crop after the first one has completed its development.

Within such a system, leguminous plants that included alfalfa, peas, beans and peanuts were intercropped with non-leguminous plants including maize and cassava. The practice consisted of planting leguminous plants that compete only slightly with non-legumes crops for nutrient and which in some cases even supplied nitrogen to adjacent plants via leakage and root decomposition (fine roots grow and die rapidly within the season, even in healthy plants) as noted by Sileshi et al. (2011).

These leguminous plants within the intercropped system did not only act as cover crops but also do have

modules that house Bradyhizobium bacteria that act as nitrogen fixers to the soil.

Mixed farming on the other hand is a system of farming in which a farmer conducts different types of agricultural practices together on a single farm in view of maintaining soil fertility, increasing his income through different sources as well as increasing food production. An example of mixed farming includes keeping of poultry, dairy, animals for meat, bee keeping, goat and sheep rearing, piggery and agro forestry (Bell et al., 2014).

The resultant crop production and animal rearing in this mixed system of indigenous agricultural practices enabled communities to take advantage of the ability of the cropping systems to reuse their own nutrients and the tendency of certain crops to enrich the soil with organic matter.

The above finding agrees with the observation by Lemaire et al. (2014) who note that mixed farming maintains soil biodiversity, minimizes soil erosion, helps to conserve water, and maintain the vegetation cover that provided a suitable habitat for birds, animals and insects. Besides, this system also makes the best use of crop residues and animal waste. When crop residues are not used as feed, stalks may be incorporated directly into the soil where they act as mulches and upon decomposing enriched the soil with organic matter.

Neufeldt et al. (2012) noted that another common indigenous land management practice was the tropical agro-forestry system which involved the planting of coffee under shade trees common in countries such as Uganda and Ethiopia (Inga SSP; Erytrina SSP). In such systems there was evident ample compensation of nitrogen loss at harvest with a subsidy from the shade trees litter thereby maintaining the soil nutrients (Leakey, 2010).

Mahapatra (2011) provides an example of another traditional land management system referred to as the tropical corn/bean/squash polyculture system. This system suffered less frequent attacks by caterpillars, leafhoppers, thrips and other pests, due to its capability to hinder a great numbers of parasitic wasps and by providing alternative hosts for predators and parasites.

Eskandari and Kazeni (2011) present another land management practice, known as the traditional intercropping system, common among indigenous communities especially in developing countries. This practice was capable of preventing competition from weeds due to the large crop leaf area of their complex canopies that prevented direct sunlight from reaching sunlight receptive weed species. Certain associated crops also inhibited weed germination or growth by releasing toxic substances into the environment becoming a more preferred option to the use of dangerous and expensive chemicals (Leakey, 2010)

Bell et al. (2014) observed that the traditional practice of integrating animals such as cattle, goats, sheep, swine and poultry into farming that was common among rural communities in different parts of the world, besides providing sufficient food for the communities, contributed greatly to soil fertility as animals recycled the plant content and transform it into manure that enriched soil fertility.

Based on the above literature, indigenous farming systems and technologies had certain elements of land conservation that enhanced the control of soil degradation.

However in spite of the importance of TEK in on the conservation of land, findings of a global survey by Rufei and Gavin (2016) on a classification of threats to TEK that was undertaken in 48 countries and regions between 2010-2012 found out that the degradation of TEK was widespread. The outcome from the literature sources reviewed and questionnaires indicated that TEK degradation was by far the most trend- (89%) in literature; (87%) of the questinnaires respondents (Ruifei and Gavin, 2016). Tang (2013) attributes the evident degradation government policy and legislation, contact with other cultural groups, colonization, marginalization by dominant groups, economic development pressures among other reasons.

In view of the above, this study sought to establish the Teso community indigenous land conservation systems with the view to assessing the effects of changes in the use of these knowledge systems on the land use/land cover and soil fertility within the study area in Busia County, Kenya.

METHODOLOGY

Area of study

This study sought to establish the effects of the trend in used of TEKs on the land cover in Teso, in Busia County, Kenya. It focused on the geographic area covered by two administrative divisions; Ang'urai and Chakol Divisions of Teso district in Busia County. Teso community is relatively small in size and has been dominated by the large Luhya ethic groups leading to the former's cultural beliefs and practices being marginalized and eventually getting extinct (Ayaa and Waswa, 2016)

The two Divisions were purposely selected since they marked the two extreme ends of the district-that is to say Angurai to the North and Chakol to the south and also due to the fact that the two have evidenced adverse natural resource degradation (Republic of Kenya, 2014 to 2018).

Besides, the two are home to the Teso community cultural centers and educational institutins where various cultural events and education are carried out especially by the elderly members of the community (Republic of Kenya, 2013 to 2017).

The District borders Bungoma District to the North and East, Busia District to the south and the Republic of Uganda to the West. It lies between latitude O° 20 North and O° 32 North and longitudes 34° 01 and 34° 07 East. Teso District is divided into four administrative divisions; Amagoro, Angurai, Chakol and Amukura. It covers a total land area of 558.5 km^2 (Figure 1).

Data collection proceedure

Both quantitative and qualitative approaches of data collection and analysis were used. The quantitative approach was employed to

Figure 1. Teso district location by grids (Source: Kenya Survey Maps).

quantify social phenomena, by collecting, analyzing and interpreting numerical data. This approach was also useful in quantifying and mapping the status of some selected elements of the biophysical environment during pre-and post- independent Kenya.

The qualitative approach was useful in addressing issues related to the Teso community ILCs and the effects that changes in the use of these systems have had on the bio-physical environmental status from the time of Kenya's independence up to the 2000s.

The study sample was drawn from selected members of the Teso community, government officials from the ministries of environment and natural resource management as well as representatives from Non-governmental and Private sector organizations in the district using different sampling techniques using fischer's formula.

Due to the study focus on ILCs, the researcher, despite being conscious of the role of the youth in environmental conservation, targeted only those respondents from the community who were household heads, due to their wealth of knowledge in norms and cultural issues as related to environmental conservation.

A special category of respondents consisting of the elderly (Sages) aged 70 years and above who were also included in the study sample helped the researcher track the trends in the use of indigenous land conservation systems and land use-land cover status in Teso District during the pre-independence and post-independence of Kenya. Both male and female respondents were included in the study sample.

In view of the above, a total sample size of 384 respondents was drawn for the study. From the above sample, 289 consisted of house hold heads who were randomly selected from the two administrative Divisions of Teso district. Of the remaining, 80 respondents consisted of the Teso community elders (Sages) while the 15 respondents were selected from government, Non-governmental and private sector organization within the District who were purposively selected.

The 249 household heads formed the first category of respondents who responded to questionnaires administered by researcher assisited by research assistants while the remaining 40 household heads formed a second category of respondents that were involved in the focus group discussions (four focus group discussions of between 6-10 people each-two from each of the two divisions).

Of the remaining, 50 respondents consisted of the Teso community elders (sages) 25 drawn from each of the two divisions through snow-ball technique and they formed part of the key informants in the study. Besides, another group of 30 elders from the two divisions were purposively selected and were involved in a follow up discussion on indigenous Teso community norms and environmental management systems.

The remaining 15 respondents who were also categorized as key informants were purposively selected from the top government district representatives of relevant departments as well as Non-

governmental and private sector organizations whose operations have a bearing on environment and natural resource management.

Data collection methods

Several methods of collecting data were used:

Interviews and focus group discussion

Changes in the use of the Teso community indigenous land conservation systems through time were investigated by the use of in-depth interviews targeting the Sages from the two administrative divisions of the Teso District. From the study's key respondents, the researcher was able to gain historical and current information related to the community's indigenous land conservation systems and their status trends from pre-independence to the 2000s era. This information assisted in supplementing and validating information obtained through the questionnaire surveys conducted with the household heads in the two Divisions.

Similarly, from the interviews conducted with the heads of different government departments and representatives from NGOs and private sector organizations in Teso, the researcher was able to attain a clearer understanding of how ILCs are perceived and treated by different government representatives.

Questionnaires

To assess the effects of the changes in use of the indigenous land conservation systems on the land use/land cover, through time, structured questionnaires interviews were administered by the research assistants targeting individual household heads. Questionnaires containing both closed and open-ended questions enabled the researcher to gain useful and up to date information regarding the status trends in the use of the Teso community indigenous land conservation systems from pre-independence to the 2000s era. This research tool also made it possible to establish the Teso community community indigenous land management systems and analyse the perceived effects of changes in these systems on the land use/land cover through time.

Participatory observation and focus group discussions

The focus group discussions that were carried out with the household heads and the follow-up discussion with the Teso sages generated detailed past and current information regarding trends in use of ILCs and effect of this trend on the status of the bio-physical environment. Varying views, opinions, perceptions, attitudes, beliefs and experiences, on Teso community indigenous land conservation systems and their usefulness in the conservation of land based resources were generated. Trough observation, the researcher was able to deduce the clearance of bushes and trees for charcoal burning purposes, silting up of river banks, eroded riverbanks and hilly slopes, among other forms of land damage.

Geographic Information System (GIS) Tool

To ascertain changes in the land use/land cover status trends, the GIS software was used. Analysis of GIS data involved acquisition of satellite images for Teso District for the years 1973, 1986, 2000 and 2010 (for which satellite images for District were available/ found) and processing them using GIS standard procedure. Geographic information system and Remote sensing/mapping techniques were used to track and obtain accurate, current and detailed information on how the status of the bio-physical environment has changed over- time in Teso District.

The tools used were Erad 9.1 Arc View GIs 3.2 and Arc Map software

The final output was maps and a table of quantities of changes in the amount of land under rain-fed agriculture, seasonal swamps, wetland vegetation, shrub land and settlement.

Secondary data

Additional data was obtained from secondary sources such as: textbooks, newspapers, journals and electronic sources including the internet.

Data analysis methods

All questionnaire-based data was cleaned, coded and entered into statistical package for social sciences (SPSS) for analysis.

PRA and FGD data were transcribed and typed into Microsoft Word. Themes and sub-themes were created based on the study objectives of establishing the trend in the use of Teso community indigenous land management systems and analyzing the effects of changes in indigenous land conservation systems on the land cover. Coding, cutting and pasting of relevant information into the sub-themes was done. This information was later described to provide meaning in line with the objectives addressed by the study.

RESULTS

The study found out that the use of the five main indigenous land conservation systems which included: mixed farming, agro-forestry, traditional terracing, use of grass-strips and fallowing have been on the decline since the 1960s.

The results showed that, prior to 1963 the time Kenya gained internal self-rule, up to 94% of the respondents upheld the use of traditional mixed farming, 88% agro-forestry, 81% traditional terracing, 84% use of grass strips and 80% observed traditional fallowing/shifting cultivation as a strategy for maintaining the vegetation cover within the study area. However, from the 1960s to the 2000s era, use of mixed farming had declined by 20%, agro-foresty by 46%, traditional terracing by 65%, use of grass-strips 75% and following by 96% as indicated in Figure 2 and Table 1.

DISCUSSION

Mixed farming and environmental conservation

Prio to Kenya's independence when members of the Teso community greately adhered to certain common forms of indigenous beliefs and practices in general and especially those related to land conservation, any form of activities carried out on land such as farming or settlement were controlled or guided by these traditional beliefs or practices.

The common beliefs and practices that were articulated by the houasehold heads who participated in questionnaire interviews and especially the elders who

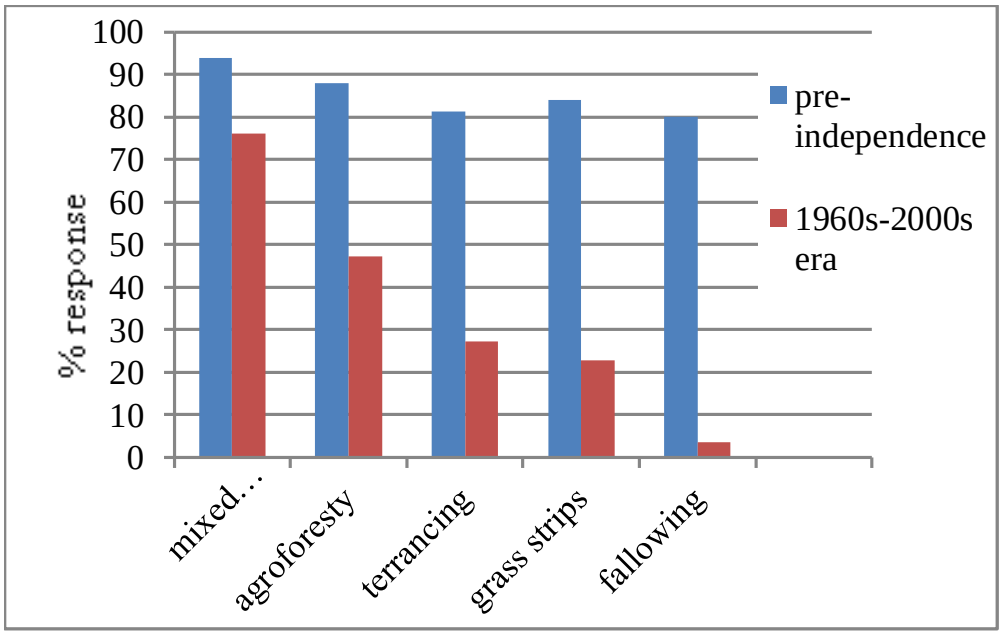

Figure 2. Changes in indigenous land management systems.
Source: GIS Data.

Table 1. Trends in the use of indigenous land conservation systems.

ILCs	Pre-independence (%)	1963-2013(%)	Trend (%)
Mixed farming	94	75	-20.2
Agro-forestry	88	48	-45.5
Traditional terracing	81	28	-65.4
Use of grass strips	84	21	-75
Fallowing	80	3	-96.2

participated in the key informant interviews included use of totems, protection of saced places, prohibitios as well as age and gender restraints.

The results from the key interviews with the Teso community elders showed that mixed farming was one of the most common forms of agriculture practiced by the majority of the Teso community members prior to Kenya's independence in 1963. Mixed cropping, or intercropping of crops such as maize with beans, maize with pumpkins, and maize with potatoes was a common practice throughout the district and had several important land conservation properties.

Most of the household heads who participated in the study revealed that in addition, different varieties of indigenous trees/shrubs were planted in gardens to provide shade, as wind breaks and also to demarcate farmlands and homes. Some of these trees/shrubs had medicinal properties or had cultural importance and were thus protected from any harm. This enabled the existence of large tracks of land under vegetation such as shrubs to increase since the practice of mixed farming was highly upheld by the members of the Teso community.

Interviews with the household heads also revealed that members of the Teso community relied on the indigenous knowledge of the three Ws and one H of indigenous food crop production- that is to say what crop(s) should be planted, when (during which season should it be planted), where (in which ecological location should it be planted depending on the soils and moiture requirements) and how (varying traditional methods of planting for example sowing vegetative cuttings). This practice can be compared to the Satoyama traditional system practised in Japan where different agricultural activities were only undertaken in locations deemed suited to as determined by their nutrient, water and soil requirements.

In this case, the village elders took an active role in giving advice and directing the community on what food crops to plant, when to plant them where to plant them and how to plant them depending on the agro-ecological conditions. This enabled the community members to only

plant food crops that were seen as most suited and could sustainably utilize the available soil and water requirements in given ecological zones.

The results showed that indigenous mixed farming technique had the advantage of enabling a more efficient use of the land using a different crop species combination with different requirements. The crops in such a system tended to provide a complete vegetation canopy of varying heights, thus dissipating heavy rainfall impact, protecting the soil from erosion, as well as controlling weed germination and growth.

This finding concurs with earlier observation by Lemaire et al. (2014) who noted that the synergies between cropping and livestock husbandry in mixed farming offers various environmental conservation opportunities including increasing efficiency of resource use and protecting soil from elements of erosion. According to the above, such a system reduces natural resource depletion and environmental fluxes to the atmosphere and hydrosphere, offering more diversified landscapes that favour biodiversity and increase system flexibility to cope with socio-economic and climate variability.

Agro-forestry and the conservation of soil and water bodies

Among the ancient Teso Community members, there was a belief that God penetrated all his creatures with his (sic) presence and as such any of these creatures had to be handled in a sensitive manner with empathy and reverence. In this regard every community member had the natural responsibility to be a steward of the “mother nature” to tend to its trees, valleys, ponds, swamps, rivers and habitation.

Among members of the Teso community traditional agro-forestry has been in use since time immemorial. It involves planting various indigenous trees, grasses and crops on the farm lands and around homesteads, as well as keeping different types of animals and domesticated bird varieties. Certain tree species were planted around seasonal swamps, natural springs or ponds that were considered as dwelling places for ancestors or evil spirits or cultural sites for ceremonies.

This greatly helped in maintaining the area of land under wetlands and forests/shrubland since there was minimal disturbance from external causes. The most preferred indigenous tree varieties included medicinal trees such as *Tamarindus indica apeduru,* whose various parts were believed to treat different human and livestock ailments.

This form of farming practice provided multiple benefits of high productivity and income generation while at the same time maintaining the vegetation cover and soil health. Tree leaves, bark, roots and grasses provided herbal medicine to human beings and domesticated animals.

Trees were also seen as symbols of God’s presence among people. The leaves of the trees, grasses and shrubs as well as crop residues were used for mulching, fodder for livestock and for thatching of traditional Teso houses. The mulching material from agro-forestry practices was regarded important since it helped protect soil from being eroded by heavy rain and drying out from hot sun and winds that could easely be deposited in water bodies such as swamps. The mulch protected the fertile top soil from being swept away by the agents of soil erosion such as wind and water that runs off the surface thereby facilitating the growth of natural vegetation.

Mulching material, besides retaining moisture by reducing evaporation, was also used to suppress weeds by smothering their growth, thereby reducing the work-load of the farmer.

This observation conforms to the earlier findings by Neufeldt et al., (2012) who note that the trees in an agroforestry system provide important ecosystem services including; soil, spring and watershed protection, animal and plant diversity conservation and carbon sequestration as well as storage which are all key in conserving the environment.

Importantly, the study found out that the diversity from trees and other vegetation in traditional agro-forestry besides improving the land vegetative cover also provided other benefits such as: reduction in pest problems, microsite modification to allow plants with varying climatic requirements to be grown in a small area and the production of multiple products including firewood, bio-fuel, timber, food, fodder, building materials, materials for tools, medicine, for subsistence and sale.

This finding concurs with an earlier observation by Frison et al. (2011) who noted that besides being key in solving the problem of food security by encouraging cultivation of a wide range of edible plants and vegetables and shrubs for fodder, the system also enables diversification of household income through the sale of wood products.

Trees in agro-forestry practice also serve as: windbreaks, as ground water management systems, by draining water logged areas, as shade provision for people and domesticated animals and importantly provided habitat for a wide range of fauna. The systems therefore ensured the various elements of the biophysical environment including the vegetation, swamps, natural springs and rivers were left undisturbed for long periods of time.

This confirms the work by Garibaldi et al. (2013) who pointed out that a diversity of trees in farm land support populations of different bird, animal and insect species by providing an alternative habitat thereby enabling conservation.

Also, the vegetative filter strips established in the form of agroforestry or contour grass buffer strips have the potential to improve water quality, wildlife abundance,

biodiversity and aesthetic value. Filter strips of permanent vegetation that reduce the runoff and trap sediments can be used to reduce non-point source (NPS) pollution. Besides, a reduction in runoff helped protect stream, rivers and ponds from silting thereby enabling maintaince of the size of land under these elements. This finding corresponds with the views by Maliki et al. (2012) who hold that the vegetation in an agroforestry practice serves two major purposes: the fine root system holds soil in place thereby reducing soil erosion and secondly, plant stems decrease the flow velocity thus enhancing sedimentation which in turn can enhance the growth of natural vegetation.

Traditional terracing and the conservation of soil and wetlands

The indigenous Teso farmers were known for making traditional ditches locally known as *iperejene* to allow excess water to infiltrate easily and drain out of the cultivated land to the side of an artificial natural water way. A ditch was sometimes dug on the upper side of the cultivated land to act as a cut-off drain to protect the field from run-off coming from higher ground. In this way traditional ditches helped drain excess water from the fields protecting the soil from being eroded and surface runoff generated within the cultivated land area.

This finding confirms the work by Agnoletti et al. (2011) which illustrates the crucial role terracing has played in the conservation of soil, especially in highland areas in many parts of the world. The work demonstrates how small-scale agriculturalist inhabiting much of the highlands in developing countries have continued to embrace the traditional practice of constructing cut-off drains in order to divert the run-off from the upper parts of the hill and mountains before it reaches the farm land. These cut off drains were also often adopted in low laying floodplains in order to protect crops from inundation.

Besides protecting soil from the run-off, these farmers also constructed cut-off drains to prevent loss of seeds and fertilizer which can easily be washed away by excessive run off coming from uplands. The said cut- off drains according to the study findings were directed away from water bodies such as traditional wells, natural springs or ponds due to the belief that such water bodies were abodes of the gods and could be used for worship, consultation and appeasement of the gods.

The study found that the indigenous Teso farmers also adopted traditional ridges which were associated with the growing of crops such as: beans, groundnuts, sweet potatoes and cassava, locally known as *emaragwe*, *emaido, achokaa* and *emwogo* that helped increase vegetative cover and protect soil from both rain and wind erosion.

Related to ridging was contour farming which was mostly observed by those communities living at the slopes of Amukura, Ikieng, Chelelemuk and Kolanya hills. Because of the evident soil and gulley erosion in these areas, the inhabitants constructed water channels along hill contours to divert water to the sides of the slopes. Some specific plants with soil retaining root systems such as elephant grass (*Pennisitum purpureum*) and sugar cane (*Saccharum officinarum*), were used to support the channel embankments or dykes so as to prevent them from collapsing.

These greatly helped control soil erosion as well as maintained soil fertility thereby encouraging natural growth of vegetation which attracted a variety of bird species. The above observation concurs with the findings by Mutegi et al. (2008) who have documented the importance of combining Napier grass with leguminous shrubs in contour hedgerows in controlling among small-scale farmers in Central Kenya.

This is comparable to the traditional practice found on the slopes of the Uluguru Mountains in Tanzania whereby traditional terraces are used separately or in combination with other conservation structures including plantation trees such as sisal (*Agave sisalana*), euphorbia (*Euphobia splendens)* and eucalyptus (*Eucalyptus globu*) that were planted along the contour alongside other conservation practices. Kajembe et al. (2010) say that the above practice has been used for several decades as an effective method of controlling gulley erosion as well as for promoting rainfall infiltration among communities inhabiting the mountainous regions of Tanzania.

Grass-strips and conservation of the land

The findings from the study showed that within the traditional Teso community farming systems, the use of grass-strips which entailed leaving pieces of land with traditional vegetation between the main cultivated fields to control soil erosion and conserve biodiversity was common and greatly emphasized prior to Kenya's independence.

The strips locally known as *amang'uria,* consisted of different species of grasses and traditional plants that were planted to separate adjacent farms under different activities.

The trees commonly planted included local tree species such as *Ficus sycomorus*, locally known as *Ebule* which was an indigenous tree species. Grass species such as Spear grass (*Heteropogon contortus*), Napier grass (*Pennisetum purpureum*) and Rhodes grass (*Chloris gayana*) also locally known as *Esere, Eludeka* and *Akalias* were the most preferred.

These plants also served as important sources of medicinal plants and acted as feed for livestock. The above practice also created habitats for different birds, insects and reptiles rodents, etc in-spite of some crop damage caused by these creatures, thereby aiding in the conservation of these elements of the environment. The

practice also helped protect the loose soil particles from being blown away by the wind or water runoff. Such a practice helped to ensure that any top soil blown a way by wind or water runoff was trapped by the vegetation thereby reducing the possibility of silting into ponds, dams, rivers and other water bodies.

Donjadee and Tingsanchali (2013) echoed the above observation by noting that indigenous communities in most parts of the world adopted different types of buffers as an effective way of land conservation. They give examples of buffers as grass-strips, hedgerows, grassed water ways, wind breaks (mostly consisting of rows of trees or bushes) and riparian buffer zones of grass or shrubs adjacent to water courses that helped filter pollution.

They also observe that besides reducing the effects of water and wind erosion, buffers significantly reduce the volume of sedimentation in water bodies such as ponds, dams natural springs and rivers and thus enabling maintance of the size of the area of land under wetlands and wetland vegetation.

Buffers also prevent the drift of pesticides from the fields into water bodies, roads or other areas, thereby reducing incidences of pollution. Further, Donjadee and Tingsanchali (2013) confirm the effectiveness of buffers as wind breaks, which they say have been successfully used to halve the wind speed over a distance equal to twenty times the trees' height and incept the drift of aerial pollution and soil particles.

Zhang et al. (2010) further observe that with time, the above traditional buffers evolved into semi-natural habitats that improved the vegetation cover of a given landscape that enabled such area to host a variety of wildlife on farm land and created a network of corridors for the movement of fauna and flora. They noted that buffers provided commodities which included fruits, wood, fodder among other, thereby contributing to a more diverse production on the farm. The traditional practice of protecting soil erosion through planting grass-strips or use of other buffer materials thus enabled many communities in different parts of the world to sustainably manage land.

Fallowing soil fertility and the protection of water resources

The Indigenous Teso farmers practiced fallowing which meant a resting period for agricultural land between two cropping cycles during which soil fertility is restored. The decline in total nitrogen, organic carbon, potassium, Zinc and the acidification of soils was due to continuous cultivation that resulted to soil exhaustion that necessitated fallowing among members of the Teso community. Two main types of fallowing were upheld by members of the Teso community-that is to say natural fallowing in which the soil was left to the natural vegetation and the improved fallow where leguminous trees, shrubs and or cover crops are planted in the fallow.

Accordingly, this practice did not only allow for the natural rejuvenation of land but also greatly helped to control gully erosion by allowing natural vegetation to reclaim the land. The practice helped reduce the amount of silting into nearby water bodies including rivers, streams, dams traditional wells and ponds. In this regard, the practice of traditional fallowing helped to maintain the quality and size of water bodies among traditional Teso community members.

This practice also enabled avoidance of those land areas that were infested with pests and animal diseases or those viewed to be ecologically fragile or sensitive thereby enabling sustainable utilization of land. In addition, it helped restore soil organic matter and rehabilitate the population of soil organisms that was reduced during the cultivation period.

Effects of changes in the use of ILCs and LULC status

As shown in Figure 2 and Table 3 the use of indigenous land conservation systems showed declining trend through time. Nearly all the study participants noted with much concern that currently in most of Teso community, there is very little respect for the traditionally upheld traditional beliefs and practices that guided members previously in different aspects of life. The elders in particular blamed the above on contact with outside cultures through marriages, rapid population growth, modern church and education systems that have demonized the traditional practices. This curcurs with views by Tang (2013) who has noted that today, as a result of rapid population increase, increased adoption of modern agricultural methods of production among other factors have played a role in the noted trend, thereby leading to marginalization of the previously upheld beliefs that helped conserve various elements of the biophysical environment.

A study by Ayaa and Waswa (2016) on the role of indigenous knowledge on the management of the biophysical environment within the same community for instance revealed that the use of commonly held belief and practices such as totems, protection of sacred places, prohibitions and age and gender restraints declined throughout the period of time covered by the study.

Spatial analysis results

As indicated in Table 2 and Figure 3, Spatial analysis results showed that land use in Teso has changed drastically in favour of rain-fed agriculture and settlement in particular. In this regard, the area of land under rain-

Table 2. Land use land cover quantities in hectares (000 HA).

Land use/Year	1973	1986	2000	2010
Rain-fed Agriculture	35,283	36,583	38,794	39,217
Seasonal Swamps	16,645	15,149	13,208	13,194
Settlement	14	64	84	295
Shrub-Land	3,384	3,614	3,467	2,768
Wetland Vegetation	706	619	476	555

Source: GIS data.

Table 3. Effects of changes in ILCs on land use/land cover trends (000 HA).

Spatial Parameters	1973-1986 (%)	1986-2000 (%)	2000-2010 (%)
Rain-fed agriculture	+3.7	+6.04	+1.1
Seasonal swamps	-8.9	-12.8	-0.11
Settlement	+357	+31.25	+251
shrub land	+6.8	-4.06	-20.2
Wetland vegetation	-12.3	-23.1	+16.6

Source : Gis data.

fed agriculture increased by about 3.7% between 1973 and 1986. In the period between 1986 and the year 2000, the land area under rain-fed agriculture further increased by 6% while in the years between 2000 and 2010; it further increased by 1.0%.

Land used for human settlement increased by 357% between 1973 and 1986 and by about 31% between 1986 and 2000. In the years between 2000 and 2010, the area of land under settlement expanded by 251%.

Although the noted growth in settlement and agriculture could be the cause of the significant decline in the area of land covered by seasonal swamps, shrubs and wetland vegetation, marginalization or low level of adherence to commonly upheld indigenous beliefs and practices in general and traditional land conservation systems in particular may have also contributed to a great extent.

The above corresponds with the findings by Ojomo (2011) who argues that among rural communities in Sub-Saharan Africa Teso included before the onslaught globalization, modern Religion, urbanization,formal education and change in economic trends, there existed certain vibrant traditional beliefs systems that controlled human behaviour and activies that ensured minimal disturbance to the elements of the biophysical environment.

Most members of these communities for instance believed in totensm whereby certain living things such as birds, animals, plants or water bodies were regarded with special awe, reverence and respect and thus could not be harmed. Members of such communities could designate certain places as being sacred. This was exemplified by setting aside patches of forest/shrubland, marshes, natural springs and ponds for sustainable resources use and the preservation of biodiversity as noted by- Awuah-Nyamekye (2014).

The intention in the views of Douglas (2015) was to protect watershed, fragile ecosystems as well as plants and animals of conservation importance to the local community. Despite other factors, the declining trend in the use of indigenous knowledge systems in general and land conservation systems in particular could have contributed significantly to change in the land use-land cover within Teso District during the period of time covered by the study.

It could peharps be as the results of the foregoing that the area under seasonal swamps for instance declined by 8.9% between 1973 and 1986 and further by 12.8% between 1986 to the year 2000. Between the year 2000 and 2010, the amount of land under seasonal swamps only declined marginally by 0.11%. This is in spite of the fact that that in general cropping tends to favor the low lying areas and hence the competition and loss of wetlands.

The study also found out that in- spite of the area under shrubs increased by 6.8% between 1973 and 1986, it declined by 4.1% between 1986 and 2000 and further by 20.2% between 2000 and 2010. The study findings also indicates that land area under wetland vegetation declined by 12.3% between 1973 and 1986 and further by 23.1% between 1986 and 2000. In the years 2000 and 2010, the area under wetlands however increased by 16.6% probably as a result of the government afforestation programme.

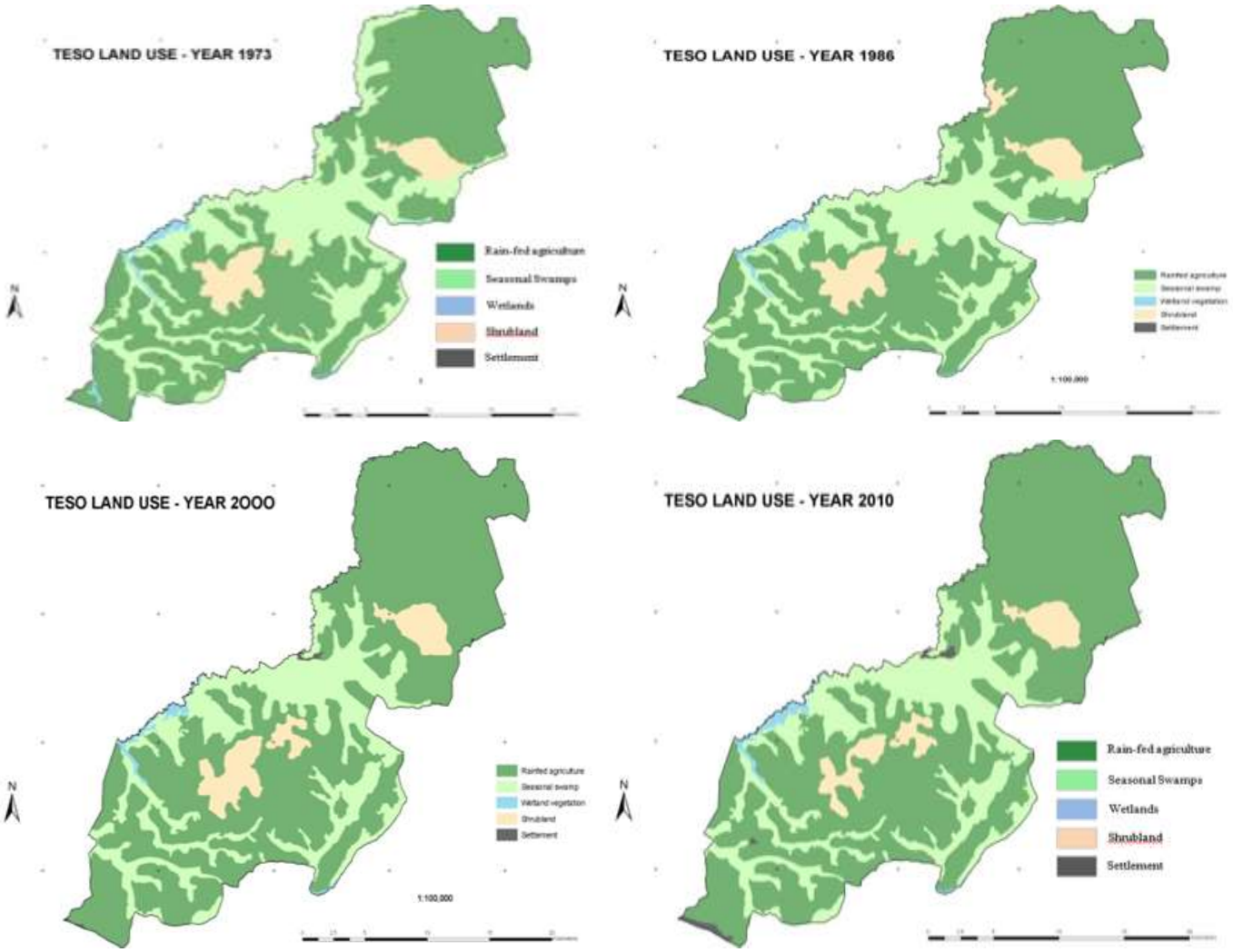

Figure 3. Spatial analysis (LULC) results.
Source: GIS data.

As pointed out earlier, although other factors including expanding population growth and commercialization of agriculture could have caused expansion in amount land under rain-fed agriculture, marginilization of indigenous beliefs systems may have contributed to some extent.

Conclusion

The level of use of tradional ecological knowledge systems is on the decline in parts of the world, Teso community included. Factors responsible for the marginilization of TEK among rural communities such as Teso include increase in population that require more land for farming and settlement, modern agricultural practices, intermarriages, modern religion among others.
The adoption and level of use of tradional ecological land management knowledge systems can contribute to the conservation of certain elements of the biophysical environment including wetland vegetation, shrublands and seasonal swamps. Guided by traditional beliefs such as sacredness, prohibitions and age and gender restraints human activities on land are controlled thereby minimizing disturbance of the said elements of the biophysical environment.

Recommendations

There is need for a long and an ongoing process aimed at assisting local community members to build or improve their collective resources and skills to maintain and /or revitalize their traditional cultural lifestyles.

Efforts should be towards a partnership between relevant governmental agencies, NGOs, private sector organizations, research organizations and other external

partners with a target of conserving TEK and traditional culture.

Community-based TEK conservation activities should be undertaken within the existing cultural sites with the partnership with custodians of TEK (elders) with a target of conserving and revitalizing TEK.

Areas for further research

There is need for further study to investigate the strategies for documenting and disseminating indigenous land conservation systems and a framework and the integration of ICT in the documentation and dissemination of indigenous land conservation systems.

There is also need for a study on the process of designing an appropriate frame work for integrating indigenous best practices into the conventional conservation practices in order to achieve sustainable natural resource management.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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