

Full Length Research Paper

Role of indigenous knowledge systems in the conservation of the bio-physical environment among the Teso community in Busia County-Kenya

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Received 5 August, 2016; Accepted 11 October, 2016

The indigenous knowledge systems are a significant resource which would contribute to the increased efficiency, effectiveness and sustainability in environmental conservation among rural communities of developing countries in particular. They form the basis for community-level decision making in areas pertaining to food security, human and animal health, education and more important in natural resource management. However, despite their critical role in the conservation of the bio-physical environment, these practices and technologies are being marginalized or even forgotten among rural communities in different parts of the world. To ascertain the role played by these traditional practises on the bio-physical environment, this paper identified and established the Teso community indigenous environmental practices and assessed changes in these knowledge systems from the time of Kenya's pre-independence to the 2000s era. Data were collected using various social science methods such as the questionnaire and focused group discussions. The results showed that the use of totems, protection of sacred places, prohibitions and gender and age restraints declined by 41.3, 68, 41.8 and 38.2%, respectively. The evident decline in the use of the indigenous environmental knowledge systems has negatively impacted on the state of the bio-physical environment exemplified by the Chi-square Pearson (P) values of 0.00 between decline in the use of age and gender restraints and the deterioration in land fertility and only a few elders using the knowledge systems and reduction in the number of rivers, streams and wetlands as exemplified by the Chi-square Pearson (P) value of 0.02. In view of the above, it is recommended that rekindling, recording and preservation of indigenous environmental best practices among local communities such as the Teso for sustainable natural resources management be re-invigorated and integrated in conventional environmental management plans. This also calls for participatory decision-making between policy makers, implementers and actual resource users.

Key words: Indigenous knowledge systems, conservation, bio-physical environment.

INTRODUCTION

This study addresses the role of the indigenous knowledge systems in managing the bio-physical

environment among local communities in developing countries using Teso community in Busia County in

Kenya as a case study area. It tracks the effects of changes in the use of different types indigenous knowledge systems used by the members of the Teso community on the bio-physical environment from pre-independent Kenya to the 2000s era. It argues that in spite of indigenous knowledge systems often being dismissed as unsystematic and consequently not being captured and stored in a systematic way with the implicit danger being its extinction, some aspects of indigenous knowledge and practices are still critical in the management of the bio-physical environment among local communities such as the Teso of Busia County.

Since time immemorial, various forms of indigenous knowledge systems (IKSs) have been used by societies in Africa and the rest of the World for many different purposes as determined by the needs of the society in question (Chikaire et al., 2012). The study reiterates that the above skills, knowledge and attitudes when harnessed and appropriately applied are capable of sustaining communities and can enhance development in areas such as natural resource management, education, healing and management of diseases, nutrition, wealth/income/business, entertainment, politics among others (Mutasa, 2015).

Current day literature uses different definitions of indigenous knowledge with the World Bank broadly defining it as “a complex set of knowledge and technologies existing and developed around specific conditions of populations and communities indigenous to a particular geographic locality” (Parrotta and Trosper, 2012). The <http://www.sedac.cisen.columbia.edu> web site defines indigenous knowledge as “a local knowledge that is unique to a given culture or society”. It is further viewed as a body of knowledge, or bodies of knowledge of the indigenous/local people of a particular geographical area that have survived on for a very long time. These knowledge systems are developed through a process of acculturation and through kinship relationships that social groups form and are handed down to the posterity through oral tradition and cultural practices such as ritual and rites (Chikaire et al., 2012; Kala, 2012). Such forms of knowledge are also known by other names among them are: Indigenous ways of knowing, local/traditional/folk knowledge/ethno science and is thus a dynamic archive of the sum total of knowledge, skills and attitudes belonging to and practiced by a community over generations, and is expressed in the form of action, objects and sign language for sharing. This form of knowledge has continued to thrive in beliefs, medicine, disaster management, community development, art and craft, education, communication and entertainment,

farming practices (soil conservation, intercropping, farm rotation, and food technology among other uses. (Wasongo et al., 2011; Hilhorst, 2015).

The UN Conference on Environment and Development in 1992 catalyzed the interest in the contribution of indigenous knowledge aimed at bettering the understanding of sustainable development. It highlighted the urgent need for developing mechanisms to protect the earth’s biological diversity through local knowledge. The agenda 21 of the UNCED conference emphasized on the need for governments to work towards incorporating indigenous environmental management knowledge systems into contemporary socio-economic development programmes in order to attain sustainable development (Helvetas, 2011; Gaillard and Mercer, 2012))

Studies have shown that throughout the world and especially in the developing countries, indigenous/local people have formed “a science” by engaging in annual cycles of subsistence activities that have evolved into knowledge systems and technologies useful in maintaining and preserving the bio-physical environment within such a community. Thus, over the years, local communities have studied and known a great deal about the flora and fauna, and developed their own classification systems as well as versions of meteorology, astronomy, pharmacology, physics, biology, botany and the sacred commonly referred to as the inner world (IPCC, 2014).

Accordingly, thus, natural resource conservation has been in the traditions of local communities and has been expressed variously in the beliefs and practices used in their management and utilization. A study by Eneji (2012) indicate that the indigenous natural resource management practices evolved through the historical interaction of communities and their environment thereby giving rise to practices and cultural landscapes such as sacred forests and groves, sacred corridors and a variety of ethno forestry practices.

Thus, arising from the above were conservation practices that combined water, soil, flora and fauna. Indeed, these nature-society interactions lead to socio-cultural beliefs as institutional frameworks for managing the resultant practices that arose out of the application of the developed indigenous knowledge systems. Consequently, on the basis of the above the attitude of respect towards the earth as “mother” was widespread among indigenous communities worldwide and especially among people in the developing countries of Africa, Asia and Latin America.

Among these communities the ancient studies made

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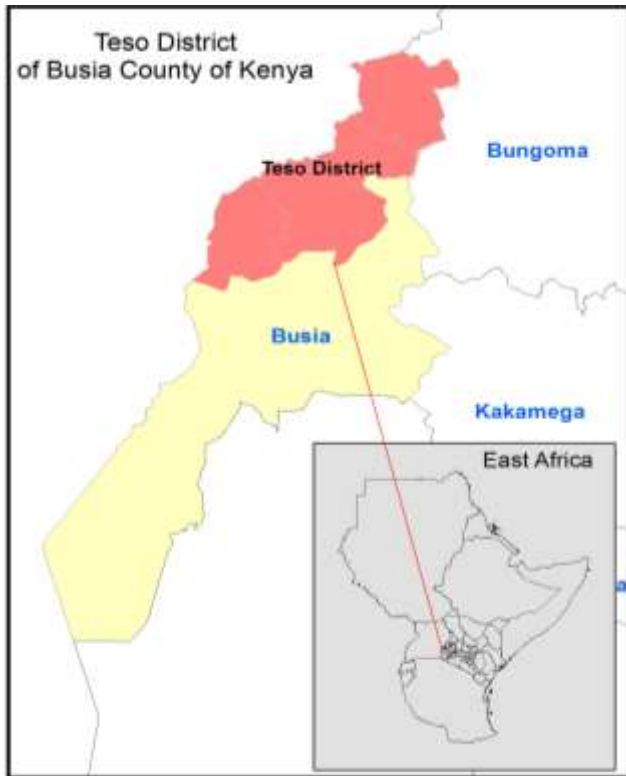


Figure 1. Study area.

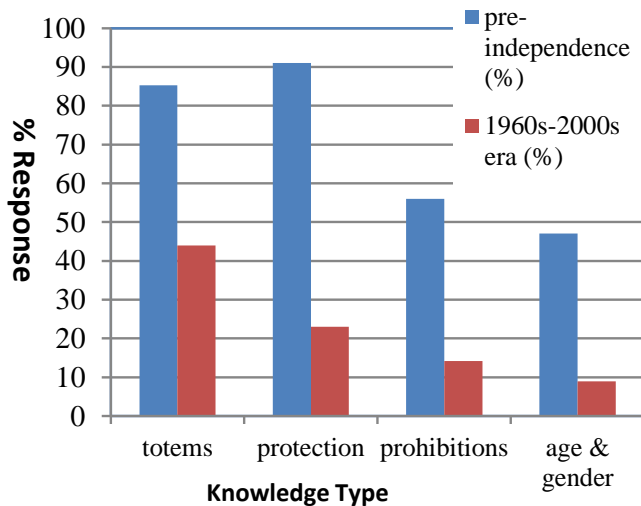


Figure 2. Trends in adherence to Teso Community indigenous environmental management systems.

explicit references to how forests and other natural resources were to be treated and utilized. Africa as a continent is richly endowed with highly diverse biological resources. This paper establishes the Teso community

indigenous environmental knowledge systems and explores its contribution in the protection of the bio-physical environment for sustainable development. It tracks changes in the community's use and adherence to the indigenous environmental knowledge systems from the 1960s to the 2000s era and evaluates the effects of these changes on the quality of the bio-physical environment.

The study sought to establish the role played by the Teso community indigenous knowledge systems on environmental conservation and analyze effects of the changes/trend in the use of these knowledge systems on some selected elements of the bio-physical environment from Kenya's independence to the 2000s era.

The study focused on the geographic area covered by two administrative divisions, namely Ang'urai and Chakol Divisions of Teso District in Busia County. 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 0°36'25.2"N, and longitude 34°16'33.6"E. Teso District is divided into four administrative divisions, namely Amagoro, Angurai, Chakol and Amukura, and covers a total land area of 558.5 km² (Figure 1).

The district's altitude ranges from 1,300 m above sea level in the south to an average of 1,500 m in the central and northern parts. Granite and other rocks are more pronounced in the landscape at Amukura and Chelelemuk areas. Some areas of the District are well watered by springs while others avail water through wells and boreholes. The District is also served by two main rivers –that is to say rivers Malakisi to extreme north and Malaba to the northern entry of the central region.

Teso District Location

Most parts of the District receive between 800 and 1,700 mm mean annual rainfall while other parts receive an evenly distributed rainfall of up to 2,000 mm. Temperatures for the whole District are fairly homogeneous with the mean maximum ranging between 26 and 30°C while the mean minimum range between 14 and 22°C. The land is fairly fertile with soils ranging from sandy soils in some areas such as Amagoro to the black-cotton clay soils that are more pronounced on the southern part of the District (Figure 2).

Teso is a rural District where subsistence agriculture is the dominant activity carried out by the majority of the inhabitants (Republic of Kenya, 2013-2017).

METHODOLOGY

A descriptive cross-sectional design was used in this study. Both quantitative and qualitative approaches of data collection and analysis were used. Quantitative approach was employed to

quantify social phenomena by collecting, analyzing and interpreting numerical data focusing on links among a smaller number of attributes across many cases.

Qualitative approach, on the other hand, which is concerned with the phenomena relating to or involving quality or kind is usually conducted in natural settings. Qualitative approach was particularly useful in addressing issues on the Teso community indigenous environmental knowledge systems and the effects of changes in IEKS on the bio-physical environment from the time of Kenya's independence to 2000 s.

The target population for this study was drawn from selected members of the Teso community, top government representatives of different relevant departments in Teso District and top representatives of Non-Governmental and Private sector organizations whose operations have a bearing on environment and natural resource management in the District.

There was a special category of respondents consisting of the elderly (Sages) aged seventy (70) years and above who were purposely included in the study sample to help the researcher track the socio-economic and environmental trends in Teso District during the pre-independence and post-independence of Kenya. Both male and female respondents were included in the study sample. A total sample size of 384 respondents was selected based on Fischer's formula (Bryman (2012) and Bruce (2011).

Data collection

This research used several methods to collect data. These included the following tools; Research administered questionnaires were used to collect data from 249 household heads who were randomly selected in order to establish the Teso community indigenous knowledge systems and assess effects of the changes in indigenous knowledge systems on the bio-physical environment through time.

Questionnaires containing both closed and open-ended questions enabled the researcher gain useful and up to date information regarding the status trends in the use of the Teso community indigenous environmental knowledge systems from pre-independence to the 2000s era.

Key informant interviews

Changes in the Teso community indigenous environmental knowledge systems through time were investigated by use of in-depth interviews targeting 50 sages and follow-up discussions targeting 30 sages who were purposely selected from the two administrative Divisions of Teso District. Besides, interviews were also carried out with 15 heads of different government departments and representatives of related NGOs and private sector organizations to gain a deeper understanding of how indigenous knowledge systems are perceived and treated by different government representatives.

PRA and focus group discussions

Focus group discussions and follow-up discussions in a workshop based set-up were carried out with 40 household heads were used to cross-check the validity of the responses and brainstorm on emerging issues regarding trend in use of indigenous environmental knowledge systems and perceived effects on the state of the bio-physical environment.

Again, the transect walks in the two Divisions of data collection enabled the researcher obtain first-hand information on the state of

the various elements of the bio-physical environment. Through structured observation, the researcher was able to witness the clearance of bushes and trees for charcoal burning purposes, silting in river banks, eroded riverbanks and hilly slopes, among other forms of environmental damage.

Secondary data

Extra data were obtained from secondary sources such as textbooks, newspapers, relevant journals and electronic sources such as the internet.

Data analysis methods

All questionnaire-based data were cleaned, coded and entered into SPSS for analysis. Analysis centred on cross-tabulation and correlation in order to ascertain the perceived relationship between the level of adherence to indigenous environmental knowledge systems and the status of some selected environmental descriptors.

Interview-based data were analysed qualitatively with narrative correlation being used in corroborating the results with questionnaire data in order to assess the relationship between changes in the use of indigenous knowledge systems and the status of certain selected elements of the bio-physical environment. PRA and FGD data were transcribed and typed into word with themes and sub-themes based on the study objectives created.

RESULTS AND DISCUSSION

Up to 98% of the respondents confirmed that there existed Teso community indigenous environmental knowledge systems. Totems, protection of sacred places, prohibitions as well as age and gender restraints were the most commonly applied norms in the conservation of the various elements of the bio-physical environment.

The study found out that the use of all the Teso community indigenous environmental knowledge systems had declined over time. The use of totems had declined by 73%, prohibition 86%, age and gender restraints 85% and protection of sacred places by 90%. This is presented in Figure 1.

Totems and the preservation of floral and faunal resources

The results from this study showed that during the years preceding Kenya's independence, different clans and sub-clans within Teso District highly upheld totemism. The Teso community members had a complexity of varied ideas and ways of behaviour based on the world view drawn from nature. The above in the views of Eneji et al., (2012) included ideological, emotional, reverent, and genealogical relationships of social groups or specific persons with animals or natural objects. Such animals and objects according to the Teso community members were viewed as companions, relative, protector,

progenitor, or helper and were usually ascribed supernatural powers and abilities and were offered a combination of respect, veneration, awe and fear. Among the members of the Teso people of Busia County, (the African Mourning Dove, the Half-Collared Kingfisher, the Nubian Nightjar and the Barn Swallow) locally known as *Akabalutu*, *Amuruon*, *Asulwenyi* and *Emelete*, for instance were highly respected prior to Kenya's independence since such birds were treated as symbols for different clans and were also associated with good luck and wealth.

In gratitude, none of the people of the Iteso heritage whose ancestors treated the above as totems could kill, hurt or eat such birds. Furthermore, there were certain tree species that were never felled due to some beliefs that such were associated with water sources, having medicinal properties, associated with bad omen, ancestor or were associated with luck and wealth. The fig tree locally known as *Ebule* for instance was associated with spirituality and where traditionally community members used to worship under could never be tampered with.

Likewise, the *Kigelia Africana* tree locally known as *Edodoi* that was believed to be an effective cure for mumps where by the patient only needed to visit it very early in the morning (earlier than anybody else) and go rubbing the infected chicks around the plant several times was never carelessly felled.

The above is comparable to the findings by Adu-Gyamfi (2011), Eneji et al. (2012) and Awuah-Nyamekye (2014) who content that among most African indigenous communities, totemic objects and materials vary significantly over tribes and clans. They give examples of totem animals that include mere mammals (Leopards, Lions, Elephants, Monkeys, Buffalo), and birds such as the (Falcon, Raven, snake, parrot) among others. Similarly, turtles, crocodiles, snakes (python), scorpions, crabs and fishes. They note that all the communities surveyed had a belief that there existed a relationship between the totem object or material and the tribe or clan. In this regard members of a particular tribe or clan did not eat, kill or trap these animals and birds thus naturally enhancing their population.

Protection of sacred places, floral, faunal and water resources conservation

The study found out that prior to Kenya's independence the practice of ensuring that certain culturally defined and designated spots and territories was highly upheld by the Teso Community members. These included burial sites, places for ceremonies such as oath-taking, appeasing of evil spirits, cleansing of members infected by diseases considered contagious or members believed to have committed serious crimes such as murder and adultery, places inhabited by clan gods or spirits of once respected

clan elders and medicine men which were protected by respective clans. Among the Teso community members activities such as farming, grazing of animals or even settlements were prohibited from such protected areas.

The Teso community members had various beliefs and practices related to both the dead and the living that had some links to the conservation of the environment. For instance, since time immemorial, members have had a belief that the dead and long buried relatives had their spirits continuously haunting the living family members to free them from the graves. Thus, to appease these departed relatives, there was a common practice of exhuming the remains of the same from the graves that were at least ten years old for preservation. This ceremony that is locally known as *Ekutet /Epunyas* was carried out by a special group of elderly men and women from the community and was done in the absence of children and foreigners.

Accordingly, once all the remains had been recovered from the grave, special baskets were used to transfer the same to some special central site where such remains were stored in places that were strictly being protected and only occasionally visited by the elderly who carried an assortment of traditional foods and drinks for appeasing the evil spirits. Accordingly, no human activity of any kind is carried out in such an area as it was believed that the spirits would not take it kind with anybody disturbing the peace of the dead or the spirits themselves. The area thus remained a very thick forest habiting a number of species or different organisms.

Such sites and places were considered sacred and were thus protected from any internal or external interference thereby encouraging natural growth of the vegetation that later turned out to be dense forests that formed important habitats for a variety of flora and fauna.

Besides, the Teso community members greatly recognized the importance of rivers, marshes and swamps as important dwellings places for ancestors and "God's creatures" (biodiversity) since various species of plants and animals thrived in them.

Thus, the conservation of water courses, streams, water pans and wells as well as the associated vegetation was protected through rules that ensured their sustainability. More important were the shrines, caves and the forests covering the springs which were never interfered with because of the belief that ancestors or evil spirits dwelt in such places. Again, reptiles such as snakes, frogs and toads that inhabited ponds, rivers and wells were protected from any harm due to the belief that they helped maintain / sustain the lives of these important water points. Also, the community members highly recognized and appreciated the importance of wells and rivers as crucial sources of water for livestock and human beings as well as a source of fish.

Therefore, in order to conserve these resources, there were strong rules and beliefs that protected such

elements of the bio-physical environment. For instance, some forests were protected by taboos that forbade people from entering them and some trees were declared sacred and thus felling them constituted a breach of taboo with violators being fined some quantity of food or live animals as determined and directed by the village authority. In some instances, folklore and stories such as those claiming that witches were patronizing some forests, rivers, caves, shrines and wells at certain times or seasons to practice their trade and store their tools of trade helped instil fear of violating the rules.

Accordingly, therefore the effectiveness of the traditional Teso community sanctions prior to Kenya's independence was shown by the fact that forest reserves existed for generations and were important havens for biodiversity as they provided a sanctuary for plants, animals, birds until recently when such were cleared to pave way for modern agricultural activities.

This observation is consistent with that report by Ogbuagu (2011) who notes that sacred sites among different indigenous and local communities are highly protected places since they are considered to be of special significance to and play a vital role in the overall well-being of the of Indigenous and local communities. Such sites according to Bhagwat et al. (2011) and Rutte (2011) are viewed as naturally constructed places where cosmic energies are at confluence to enable communication with ancestors, special places for learning and practicing spirituality, philosophy and science; technologies and arts of the indigenous people. Many such sites are thus an expression of World views in which nature is animated; human values are attributed to nature and its elements. Such sites are internationally defined as "areas of land or water having special spiritual significance to peoples and communities" and are recognized as the oldest conserved areas in the World.

Further, UNESCO (2011) says that among other indigenous communities such places were considered sites of fascination, attraction, connectedness, danger, ordeal, healing, ritual, meaning, identity, revelation, and/or transformation. Accordingly, some of these sites were found in dense forests, thick vegetation, in water logged places, swamps and marshes, caves, hills, rocks, particular mountains, soils, water falls, ponds, among other spots.

The above concurs with the findings by Byers et al. (2001) who observed that among the Shona of Zambezi valley there exists a wide range of objects, sites which different community members consider as sacred and they include; trees, rivers, pools and mountain ranges as sacred. Accordingly their concept of sacred (*inoera*) connotes something that is life sustaining and linked to rain and land fertility. They view a sacred place (*nzvimboinoera*) as where spirits dwell and associated with it are rules of access as well as behaviours that are not allowed (taboos).

The above confirms the findings by Risiro et al. (2013) and Matsika (2012) who observed that among communities studied, deforestation was less than 50% in sacred forests than in their secular counterparts. They further observed that close to 133 species of native plants occurred in the sacred forests whereas they were variously, threatened endangered, extirpated elsewhere in Zimbabwe. The above studies thus concluded that strategies for biodiversity conservation that link culture and nature are more effective than those imposed from the top by government or /and agencies and that ignore the traditional beliefs, values, institutions, and practices of local societies.

Prohibitions and the conservation of floral resources

Members of the Teso community practised prohibitions which entailed restricting its members from acting or behaving in some certain unacceptable manner that contributed to the conservation of the various elements of the bio-physical environment. The study found out that among the Iteso people, members mandated to harvest medicinal plants for instance were encouraged to administer some treatment on the harvested part through practices such as the application of cow dung so as to accelerate the callus formation as well as the re-growth of the cambium layer of the affected tree. There were norms that prohibited young children as well as women (especially menstruating women) from harvesting medicinal plants because of the belief that such medicine would lose its medicinal value or healing power.

Likewise, the harvesting of young plants for medicinal use was prohibited and thus there were strict rules that only allowed the harvesting of mature plants for medicinal purposes.

Similarly, the digging of only secondary roots rather than the main (tap) root of the medicinal plants was also allowed so as to protect these plants from any form of damage. Besides, community members were encouraged to plant medicinal plants near homesteads especially as strips between or separating different land parcels for ease of access as well as for protection from outsiders.

It was common to find that felling or uprooting of the above was restricted to only those portion/ parts and quantities needed such as branches, leaves or roots being harvested. In particular, root tuber crops such as cassava and sweet potatoes were protected by harvesting only large roots or tubers through a process known as "milking,"-that is to say, only harvesting large and harvestable roots and tubers which assured the survival of the crop thereby enabling the conservation of these plants. Again, there were traditional claims which stated that some medicinal plants could only be harvested or reached after wearing special clothes, leaving special treated coins under the plant at night

before harvesting or making a special prayer before collecting the roots, bark or leaves of certain tree species that helped the conservation of medicinal plants.

Likewise, taboos and restrictions on gathering of medicinal plants and the nature of tools used for harvesting by Teso community members which in most cases consisted of blunt knives helped to limit the volume of tree products harvested. Again, the Teso culture never permitted women to engage in any kind of construction activities and thus acts of clearing land or vegetation for whatever reason was a male activity. Also, the fetching of firewood entailed cutting or picking dead wood or only those tree branches that could be reached from the ground or cutting shrubs and not young trees.

Similarly, the cactus and euphorbia trees were seen as medicinal and were thus prohibited from being cut down carelessly. Also, the Meru Oak locally known as (*Eyolokome*) whose leaves were believed to be an effective mosquito repellent was equally prohibited from being felled. Indigenous trees such as *Melia Volkensii* locally known as (*Elirat*) and *Markhamia lutea* (*Eswaat*) besides being medicinal in nature were also associated with good luck and wealth and thus were found planted in nearly all homesteads and were never easily interfered with unless for building purpose.

There were also tree species that were never interfered with because of the Folklore and stories that if the fuel wood from such a tree was used for cooking the resultant smoke would lead to blindness and deafness. Similarly, a house constructed using such trees would be inhabited with evil spirits thereby bringing curses to the occupants. These prohibitions which were closely adhered to enabled the population of such trees to increase which in turn encouraged other associated vegetation to grow. The increase of the population of such trees also encouraged the presence of a wide range of birds and wild animal thereby helping in environmental conservation and ensuring a steady supply of traditional medicine and thus lower levels of morbidity and mortality among members.

The above findings correspond with the observation by Agyarko (2013) and Danquah (2014) who indicate that among the Ashanti of South-Western Ghana for instance, trees which were regarded as housing spirits were not be felled without performing rituals. In this regard, such a custom had a protective effect on trees such as odum (*Chlorophora excelsa*), African mahogany (*Khaya ivorensis*) and tall palm trees as betene (*Elaeis Guineensis*) and shea butter (*Butyrospermum parkii*) and the Dawadawa (*Parkia clappertoniana*) osese (*Funtumia sp.*) species.

Again, animals found in a particular habitat were regarded as sacred and thus were protected from hunting. The above particularly applied to the Black and White colobus (*Colobus polykomos*) and the mona monkey (*Cercopithecus mona*) in the Boabeng-Fiema

wildlife sanctuary of Central Ghana. A similar situation was reported for the bats of Wli in the South Eastern part of the country whereby the overhanging rocks of the mountains that form the border with Togo is known to house an impressive colony of large bats, which are said to be conserved by the local community. In this regard, the Black and White colobus (*Colobus polykomos*) and the mona monkey (*Cercopithecus mona*) found in the Boabeng-Fiema wildlife sanctuary of Central Ghana are in particular protected by prohibitions (Elorm-Donkor, 2012).

Age and gender restraints and land resource conservation

Within the Teso community, different age groups and genders closely respected and upheld rules and guidelines that forbade them acting contrary to what was expected of them by culture. The traditional Teso culture for instance restrained women from climbing a tree for reasons particularly related to women's nature of dressing. Likewise, women and young unmarried boys were restrained from owning land and the accompanying land based resources such as water points and trees by being denied the authority to utilize such resources unless permitted by an elder or the household head. As a result of the said restraints, land-based resources were used sustainably leading to the conservation of the various elements of the bio-physical environment.

Besides, women and children were restrained from certain activities including felling certain types of trees. In particular, women were restrained from felling trees that were viewed as having medicinal properties; fetch firewood from condemned tree varieties such as those perceived as prone to lightening, those whose smoke was perceived as capable of causing blindness or deafness or those believed to attract evil spirits, among others.

Likewise decisions on the location of the home/settlement were a preserve of the clan heads but not any member of the community. This enabled community members to settle in communal villages which led to the formation of homesteads rather than scattered houses thereby reducing pressure on land based resources. The study further, found out that community members were guided by clan elders on the suitable spots for activities such as settlement, farming, grazing, among others, thereby prohibiting them from venturing into areas perceived to be fragile, susceptible to diseases and lightening, among other dangers.

This ensured minimal or no disturbance to certain components of the bio-physical environment. In this regard, Awuah-Nyameke (2014) notes that among African communities institutionalized prohibitions such as taboos were thus designed to develop positive societal

attitudes towards the environment.

Cross-tabulation and correlation analysis results

Prior to Kenya's independence when the Teso community socio-cultural structures were strong with most members adhering to them, there was some statistical significant relationship between observance of indigenous environmental knowledge systems and the quality of certain elements of the bio-physical environment. This is exemplified by the Pearson Chi-square (P) value of 0.00 at 95% between protection of sacred places and land fertility. Similarly, the results showed a statistically significant relationship between high level observance of protection of sacred places and variety of bird and wildlife as indicated by the Pearson Chi-square (p) value of 0.003 at 95% level of confidence.

Again, cross-tabulation analysis between high level observance of prohibitions as a knowledge system and land fertility as exemplified revealed statically a significant relationship as shown by the Chi-square (p) value of 0.01 at 95% level of confidence. Also, the results revealed a statistically significant relationship between prohibition and land fertility as indicated by the Pearson Chi-square (p) value of 0.01 at 95% level of confidence. From the 1960's to the 2000s era, the study revealed a statistically significant relationship between a decline in the observance of age and gender restraints and deterioration in land fertility as exemplified by the Pearson Chi-square (p) value of 0.000 at 99% level of confidence.

The correlation analysis results showed that prior to Kenya's independence there existed a positive though weak relationship between high level use of prohibitions and age and gender restraints with the vegetation cover which was dense and well distributed as indicated by the Pearson correlation coefficient (R^2) values of 0.032 and 0.037 respectively. Between 1960s to 2000s era however, a decline in the use of totems, protection of sacred places and age and gender restraints adversely affected land fertility, vegetation cover as well as the number and nature of natural springs, rivers and streams as indicated by the Pearson correlation coefficient (R^2) values of 0.219, 0.736, 0.186, 0.125 and 0.463 respectively.

Conclusion

The Teso community members have used various indigenous environmental norms such as prohibitions, protection of sacred places, totems and age and gender restraints in managing different elements of the bio-physical environment with varying successes. This is particularly with regards to protection of sacred places and enhancement of the vegetation cover prior to Kenya's

independence as indicated by the Pearson correlation coefficient (R^2) values of 0.032 and 0.037 respectively.

From the 1960s to the 2000s the level of use of the previously dominant indigenous knowledge systems has declined with only a few elderly people still adhering to these knowledge systems. The drastic decline in the use of the indigenous knowledge systems (Totems 44%, prohibitions 14.2%, restraints 8.9% and protection of sacred places 23%) has negatively impacted on the state of the bio-physical environment including land fertility, the population of birds and wildlife, size of area covered by seasonal swamps as well as shrub-land as evident from the Land use/Land cover analysis as well as the cross tabulation results.

RECOMMENDATIONS

Based on these conclusions, this study makes the following recommendations.

- i) The government through ministries of mineral and natural resources, NEMA, agriculture, forests, relevant NGOs, donor community and private sector should take adequate steps to focus on mainstreaming traditional (indigenous) best practices with proven value/utility into contemporary environmental management systems and enhance the capacity of the community members for its adoption and application in conserving the various elements of the bio-physical environment. Such practices should be identified, classified and documented in a way that they can easily be accessed by community members.
- ii) In view of the above, there is need for collaboration between the above stakeholders and the community sages/ elders to facilitate the acquisition of indigenous best environmental practices held by the latter so as to enable documentation of the same for purposes of the future generations as well as for the current community members' application in the conservation purposes. In this regard, a fund should be set aside to serve as a token of appreciation to encourage and motivate the smooth acquisition of this knowledge from the sages in all the counties in the Country.
- iii) At the individual level, the government with the assistance of NGOs and private sector organizations should sponsor environmental campaigns through electronic media such as video and films shows using local language so as to reach the illiterate community members. Relevant audio and visual educational materials should be developed possibly in the form of village bulletins, sponsored drama and local video shows in the local language so as to create awareness in the community.

Areas for further research

- i) There is need for study on the process of designing a

framework that can integrate indigenous environmental best practices with scientific conservation approaches among rural communities.

ii) A study should be carried out to ascertain the most appropriate and cost-effective method for capturing, documenting and storing indigenous environmental management best practices currently under threat of being forgotten among rural communities.

Conflict of Interests

The authors have not declared any conflict of interests.

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