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Full Length Research Paper

Local and Indigenous Knowledge Systems for Sustainable Development: Case of Ewaso Narok Wetland, Laikipia Kenya

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Abstract

Local and Indigenous Knowledge systems (LINKS) has allowed communities to sustainably live in harmony with their environment. This research aimed to document the LINKS and validate the impact it has on the use and conservation of Ewaso Narok wetland. Household survey data, Plots of (10X10) M, and (1X1) Mtransect, and comparison of land-use scenarios of 2002, 2010, and 2017. Quantitative data was subjected to X^2 test-using SPSS, R for ecological data and Erdas for satellite imagery. The majority of the respondents (84%) used at least one form of LINK practices and varied significantly depending on the village the farmers came from (P=0.016). Acquisition and dissemination of IK were informal and oral through active participation in the task. The village with the least LINKs (25.8%) practices had dissimilar plant species in PCA. The land-use scenarios of 2002, 2010, and 2017 show an increase in cropland and fallow land by a 34% increase of graminoids by 10% and decrease of papyrus zone by 3%. The peoples' behavior is influenced by the knowledge they possess and their practices influence species distribution and diversity. Therefore, documentation and promotion of good local and IK practices is recommended, for it is an enabler to sustainable development.

Keywords: Local and Indigenous Knowledge Systems, Land use driver, Wetland conservation, Sustainable development

INTRODUCTION

LINKS can generally be defined as the expertise that an indigenous (local)community accumulates over generations of living in a particular environment. This definitionincludes all forms of practices and beliefs, technologies and expertise skills that make it possiblefor a community to achieve steady livelihoods in their environment (Ryser 2011).

Wetlands are species-rich highly productive ecosystems that perform many functions that maintain the ecological integrity of the systems and provide goods and services (Costanza *et al*.,1997;Schyut 2005; Zedler 2005; Russi *et al*., 2012). However, due to a lack of effective management mechanisms and proper appreciation of their value they have been degraded through unsustainable activities.

Plant communities play a major role in the important ecosystem functions (Cardinale *et al.,* 2012; Turnbull *et al.,* 2016) and values that wetland provides such as water filtration, wildlife habitat, flood protection among others and can be used as indicators of wetland health. Flora composition is increasingly threatened by human modification of the landscape (Newbold *et al.,* 2016) through activities such as cultivation. The effects of the exploitation of the wetland resources by the adjacent communities can be indirectly quantified by assessing the status of the plant communities.

Human impacts have a strong and interdependent effect on species diversity and ecosystem functioning, which must be managed together (Worm *et al*.,2002). Ewaso Narok swamp is faced with many pressures from both subsistence farmers and pastoralists as it is a haven within a semi-arid zone. The wetlands form a suitable area for farming due to the presence of water all year round, leading to settlements adjacent to the swamp (Thenya, 2001). Persistent drought

has also made pastoral farmers open up many swamp areas for dry season grazing (Handa, 2011)

The Pastoral communities who are mainly the Maasai, Samburu, and Turkana have indigenous knowledge on how to utilize the wetland by bringing the cattle to feed in the wetland on a rotational basis, giving the swamp time to rejuvenate. The subsistence farmers, on the other hand, practiced mixed cropping and cultivation of indigenous species such as the indigenous vegetables which are considered as high-value crops.

The increased water abstraction from rivers that are feeding to Ewaso Narok wetland has led to increased competition for water resources and critically impacted the downstream users in the low-lying areas of the County, which include small-scale farmers, pastoralists and wildlife that the tourism industry depends on (Wiesmann, 2000).

The LINKS are important in sustainable environmental management and enhanced local livelihoods, but this knowledge system and technologies are being marginalized and even getting lost without proper documentation. Local and Indigenous Knowledge is not owned by one person, it is mostly fragmented in the society with different age set or gender having their unique information. It is transferred in the regular practices and relations among a community, therefore the need to document the interactions of the agriculture and the pastoral community and the effect of the LINKS shared between the farming and pastoralist communities over time. The communities which have migrated to Ewaso Narok wetland also have the indigenous knowledge of where they come from and it will influence the use and utilization of Ewaso Narok wetland.

The oral and rural disposition of indigenous knowledge has made it disguised in the development of communities and modern science. LINK has often been rejected as disorganized and hence it has not been documented and stored systematically with the implicit danger it may become inexistent. Documentation of the available indigenous knowledge and the influence it has on sustainable use of Ewaso Narok wetland will enhance understanding and encourage its dissemination to the younger generation.A people's culture helps in building resiliency by ensuring that they are creative and innovative during conflicts and disasters (UNESCO 2010).

METHODS

Ewaso Narok swamp is located in Rumuruti- Laikipia plateau at longitude 36 º 12' 17''to 36 º 45' 16'' E and latitude 0 º 28' 51'' N and 0 º 7' 28'' S with height of 1,811 m a.s.l. It is characterized by a semi-arid climate (Alvarez *et al*., 2012). The wetland extends over a length of 19 km long and average width of 2 km on the lee-ward side of the Aberdare range. (Figure 1) It is mainly served by the Eng'are Narok and Pesi rivers.

Several other seasonal streams drain into the swamp making

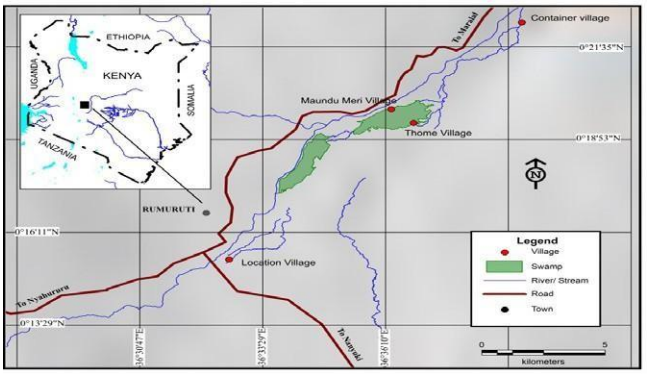

Figure 1: Ewaso Narok wetland.

it permanently flooded except for the portions drained for agriculture (Handa, 2011).

Household survey, observation of people's activities were the methods used to collect data and Fisher *et al.,* formula to calculate the sample size as described by (Mugenda & Mugenda, (2003)

$$N = z^2pq/d^2$$

where

N = sample size, **z** = standard normal distribution as at 95 confidence level (z = 1.96)

p = people with proportional of interest (HH with indigenous knowledge) - not know

q = people without the attribute of interest, **d** = absolute precession (0.05)

There were approximately 557 households in the study site

Adjustment using finite population correction formula for a population of fewer than ten thousand people.

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

The total area sampled around the swamp for vegetation analysis was 0.32ha, nested plots of 10mx10m representing the two vegetation types namely Pristine papyrus zone and grassland grazing zone. Species diversity and richness within these plots were established by randomly selecting four 1m x 1m in each of the plots. The herbaceous vegetation diversity is best captured by the 1m x 1m quadrat while the general 10m x 10 m plot was used to enumerate the species that were not encountered in the 1m x 1m quadrat, an approach ensuring that all the species in the area were included. Standard herbarium procedure was used to collect plants for identification (Foreman & Bridson, 1992). Trends in conservation status were established through the use of three Landsat images of March; 2002, 2010, and 2017 to cover 15 years.

SPSS was used to tabulate and analyze both qualitative and quantitative data. (Leech et al. 2013) Species distribution

patterns were analyzed using R software (R Core Team. 2017). The supervised (isocluster) method using Erdas 8.4 software was used to determine the classification of image data into various thematic classes. vegetationchanges in the various habitats were established by the use of remote sensing techniques while ground-truthing was achieved by getting the specific GPS points in the field.

RESULTS

Mechanism of acquiring, disseminating Local and IK for sustainable use of Ewaso Narok Swamp resources

Communities have a range of mechanisms for gaining knowledge and the means through which new ideas and innovations are customized, disseminated, and put into practice. Acquisition of the Indigenous knowledge is mainly through observation and active participation from more knowledgeable people (Figure 2), in most cases, the parents are the ones who teach their children.

The young generation acquires knowledge at an early age through practice. In the case of farmers and

Pastoralists, they engage their children in assisting with farm activities at an early stage.

The dissemination of the new knowledge in developing countries is communicated informally through storytelling, village meetings and in this study, active participation played a major role in the dissemination of the knowledge. The farmers emulate good farming practices from other successful farmers. Any new knowledge learned from fellow farmers seem to be more credible as it has been tried and well tested. This informal way of communicating information forms the building block for the adoption of new and sustainable farming practices. Learning through repeated practice on a task took prominence over simply observing and replicating. Personal communication was a key source of knowledge in wetland use.The learning process is divided into a simple and complex task, the complex task is further subdivided into separate procedures which can be repeated until they are well mastered.The pastoralists initiate their children in livestock practices at a very early age, the head of the family will accompany the boys as they herd, passing on the knowledge as they practice.The well to do families do not engage their children in various tasks since they can afford to hire a laborer instead. This is one of the factors contributing to the loss of IK.

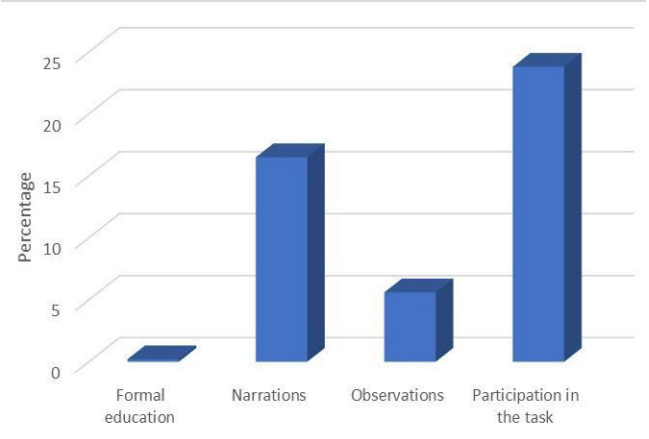

Figure 2*:* Method used in disseminating IK.

The differences of Indigenous Knowledge possessed across the 4 villages

There was a relationship between the knowledge one possessed with the village they came from, the p-value of 0.016 tested at a significance level of 0.05. (Table 1). The IK systems usually promote the soil and water conservation that ensures the biodiversity is intact. The knowledge systems slowly disappear due to the changing needs and interests, thereby introducing modernize farming technologies that change the landscape and biodiversity of an area.

This research also wanted to ascertain if there were any differences in the IK possessed vis a vis the number of years one has lived in the village. The people who had lived less than ten years had relatively similar knowledge to the people who had lived 40 years and above. The number of years one has lived in the village as shown in (Table 2) had no significant difference regarding the Indigenous knowledge they possess P=0.838. This could be due to the locals despite the indigenous knowledge they own from where they are coming from when they settle in an area, they tend to copy what they see the farmers adjacent to them are doing

Table 1: Cross-tabulation of the village one comes from against IK possessed.

Possession of indigenous knowledge practices (n=229)			
VILLAGE	**YES***	**NO***	**TOTAL+**
Container	58 (93.5%)	4 (6.5%)	62 (27.1%)
Location	43(89.6%)	5(10.4%)	48(21.0%)
Maundu meri	49(86.0%)	8(14.0%)	57(24.9%)
Thome	46(74.2%)	16(25.8%)	62(27.1%)
Total	196(85.6%)	33(14.4%)	229(100.0%)

Key; * =row percentage and + =column percentage, Chi-square test=0.016

Table 2: Cross-tabulation of how long one has lived in the villages against the indigenous knowledge possessed

Length of time lived in the village	**Yes ***	**No ***	**Total+**
<10 years	33(82.5%)	7(17.5%)	40 (17.5%)
11-20 years	50(84.7%)	9(15.3%)	59(25.7%)
21-30 years	63(86.3%)	10(13.7%)	73(31.9%)
31-40 years	32(88.9%)	4(11.1%)	36(15.8%)
41-50 years	12(80%)	3(20%)	15(6.5%)
>51 years	6(100%)	0(0%)	6(2.6%)
Total	196(85.6%)	33(14.4%)	229(100%)

Key; * =row percentage and + =column percentage

Contribution of IK in Ewaso Narok wetland utilization as perceived by the Respondents

The household survey data showed that 93% of the respondents agree that IK practices on the utilization of the wetland had a positive impact. (Table 3). The IK practices such as crop rotation, mulching,mixed cropping were mainly practiced to conserve soil and water and to prevent soil degradation. Improved soil fertility and reduced soil erosion were mentioned as some of the positive contributions. With only 7% of the respondents could not link the contribution of IK to the wetland.IK that is practiced in the area has led to increased income from selling crops and use of the wetland resources such as the papyrus. There is minimized water pollution due to the reduction of the use of pesticides and fertilizers replaced by practices such as crop rotation and mulching. Controlled grazing in the swamp has reduced the conflicts between the farmers and the pastoralists, the burning and clearing of the *Cyperus papyrus* create an open field which farmers use as a means to keep off the wildlife from their farms thus reducing the human-wildlife conflicts though this practice leads to vegetation loss.

Impact of Local and IK to speciesdistribution

The standard deviations for component 1 and component 2 aredisplayed in (Figure 3). Each site was unique on their own but Thome was visually unique compared to the others as shown by the length and direction of the arrows due to dissimilar species. There were 117 species, which were similar in all the sites hence, the crowding at the center. *Cynodon nlemfuensis* Vanderyst and *Cyperus rotundus* L. are present in Container village whereas *Cyperus exaltatus*Retz. And*Leersia hexandra*Sw. which are mainly weedy species were common in Thome village. This difference was due to

Table 3: Contribution of IK on the utilization of the wetland.

Contribution of IK to the wetland utilization (n=229)	Frequency*	%
Increased conservation efforts	61	13.1
None	32	6.9
Increased utilization of the wetland	25	5.4
Improved irrigation system	21	4.5
Increased income from selling papyrus and sedge, fodder	21	4.5
Increased income through farming	13	2.8
Controlled grazing in the swamp	10	2.1
Improved soil fertility	8	1.7
Reduced soil erosion	5	1.1
Reduced flooding	3	0.6
Reduced fertilization uses hence minimized water pollution	2	0.4
Increased income by reducing crop damage by animals	1	0.2
Reduced conflicts and land grabbing	1	0.2
Reduced pest multiplication through rotational farming	1	0.2
Total	467	100

*Table represent open-ended question from the quantitative survey on the impact of IK on the wetland

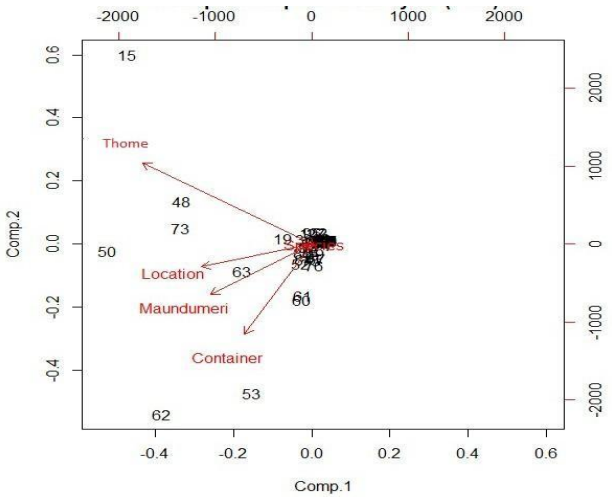

Figure 3*:* Principal Component Analysis on species diversity.

the excessive land use, leaving a thin strip of intact Cyperus papyrus, *Cyperus exaltatus* Retz, with a large area covered by *Cynodon nlemfuensis* Vanderyst and *Digitaria abyssinica* (Hochst. ex A. Rich.) Stapf. The PCA data assents with data in Table (1) where Thome had the highest number of respondents who did not have any IK practices.

Land Use

Indigenous Knowledge comes from the land through the relationships Indigenous Peoples develop and foster with the essential forces of nature. When you destroy the land, Indigenous knowledge is lost. There were seven land-use classes in Ewaso Narok wetland namely; Cyperus papyrus zone, *Cyperusexaltatus/rigidifolia* zone, *Cynodon/Digitaria* zone, Fallow/bare land zone. Cropland, water, and built-up zones

The three satellite images of the swamp were analyzed to show the percentage of cover vegetation changes as well as the current information of the size and to determine the sustainability of the current utilization trends of the swamp.

The land-use scenarios of 2002, 2010, and 2017 show an increase in cropland and fallow land by 34%, an increase in the area covered by graminoids by 10%, and a decrease in the papyrus zone by 3%. As shown in (Figure 5). Cropland, fallow and bare land is the major land use around Thome village. Data from these Landsat images concur with the ground-truthing data about the species distribution as represented in PCA (Figure 3).

DISCUSSION

Laikipia county is bordered by Baringo to the west, Meru and Nyeri to the South, Nyandarua to the Southwest, Samburu to the North and Isiolo to the Northeast. These six Counties have both pastoral and agricultural communities,this diversity is evident along Ewaso Narok Swamp as it is surrounded by multi-ethnic communities who are either pastoralists or agricultural farmers.

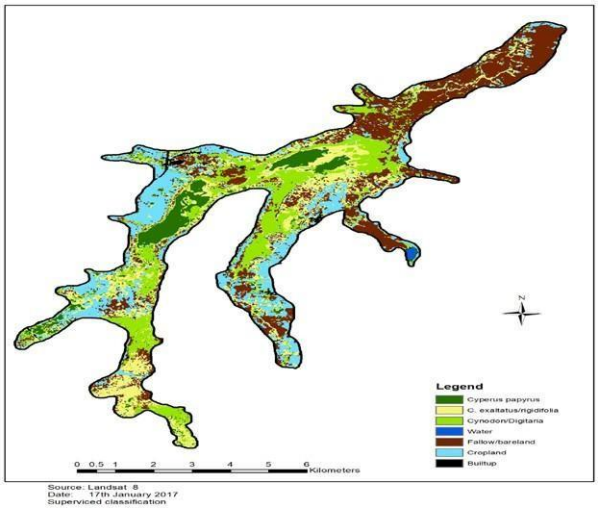

Figure 4: Land use classes in Ewaso Narok wetland.

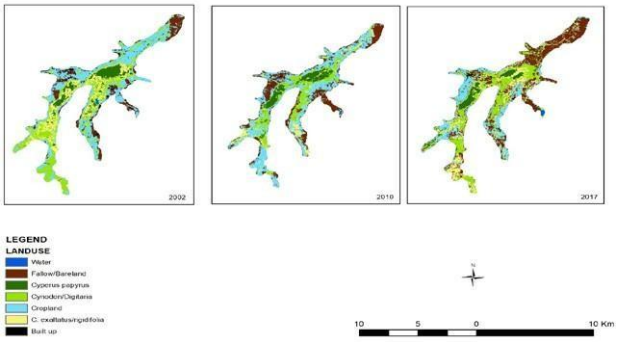

Figure 5: Land use change scenarios.

There was a high level of awareness of the existing local and IK in the wetland. This extant knowledge is an accumulation of practices that the people had before they moved to Ewaso Narok and knowledge that they acquired because of the interaction they have on day-to-day activities. The dissemination of the knowledge in developing countries is communicated informally through storytelling, village meetings and in this study, active participation played a major role in the dissemination of the knowledge. The farmers emulated what they saw other successful farmers did as what they receive from fellow farmers is regarded to be more credible as it has been tried and tested. This informal way of communicating information formed the building block for adoption and sustainability as not all information is shared uniformly across the board (Silitoe, 2017). The study concurred with the Mundy & Compton (1995) topology IK acquisition and channels of dissemination. Learning on how to grow a horticultural crop such as french beans did occur through exogenous and/ or indigenous channels. The information on the name of a medicinal plant and what disease it treats was also shared through exogenous and /or indigenous channels.

The effects of the exploitation of the wetland resources by the adjacent communities can be indirectly quantified by assessing the status of the plant communities.This research has established that there is a direct correlation between the possession of local and IK with the species distribution patterns. Land-use change alters the vegetation type in an area, but if the conversion is done selectively, the negative impacts are minimal. One of the wetland functions is to act as a sponge and cushion the low-lying areas against flooding; this function is compromised when there is an intensive conversion of wetlands into agricultural land (Verhoeven & Setter, 2010).

CONCLUSION

The self-regulatory indigenous practices are acquired and practiced when the resources are limited, in this context, the limiting factors in the swamp are farming land and grazing land. The community has a mechanism on how to acquire land and where to graze, but as for water it has always been there through it fluctuates with seasons.

The ability to recover from the drastic changes in any ecosystem and still be able to provide the ecological services measure the resilience of the area. Keystone species such as the *Cyperus papyrus* when they are eliminated in the wetland ecosystem other species such as *Cyperus exaltatus* and *Cyperus rigidifolius* come in to undertake the cushioning role, in the sense, they complement to the resilience of the ecosystem. When you translate Local and IK into English for documentation purposes, the dynamism, fluidity, and context are lost. Strengthening the oral tradition and teaching the knowledge of the land when the biodiversity is intact enhances effectiveness and longevity. This study established a correlation between Local and IK possessed with resource utilization and ecological data. This information leads to the conclusion that Local and IK plays a major role in the sustainable use, resilience and conservation of the wetland.

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