UNIVERSITY OF NAIROBI

THE ROLE OF INDIGENOUS KNOWLEDGE IN AGRO-PASTROL SYSTEMS; USE, SPECIES DIVERSITY AND CONSERVATION OF EWASO NAROK WETLAND, LAIKIPIA KENYA

BY

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DECLARATION

I declare that this thesis is my original work and has not been submitted elsewhere for examination or award of a degree. Where other people's work has been used, this has been properly acknowledged and referenced in according with the University of Nairobi's requirements.

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DEDICATION

This work is dedicated to God almighty through Him all things are possible. My husband Joseph and our children Brigit and Emmanuel, whose support has been endless.

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ABSTRACT

The Indigenous Knowledge has allowed communities to live in harmony with their environment for a long time. However, the oral nature of this knowledge has made it invisible and hence is often ignored or dismissed during the development of communities and by modern science, The aim of this research was to document the Indigenous Knowledge Systems and validate the impact it has on the use and conservation of Ewaso Narok wetland. The methods used were a comparison of land-use scenarios of 2002, 2010 and 2017, Household survey, Participatory Rural Appraisal and transects of (10X10) m in Papyrus zone and (1X1) m for the grassland in four selected wetland villages. Household survey data was subjected to X^2 test using SPSS, R was used for ecological data and Erdas for satellite imagery. There were 137 species belonging to 35 families having diversity indices of 2.71 ±1.95 and the species evenness index of 0.64±0.58, Species richness of 7.69±3.23. A total of 37 useful plant species were recorded around Ewaso Narok wetland with the Cyperaceae (11%) and Fabaceae (11%) highest-ranking families. The majority of the respondents (84%) used at least one form of IK practices and these varied significantly depending on the village the farmers came from (P=0.016). Acquisition and dissemination of IK was informal and oral through active participation in the task. Thome village had the highest number of people recorded with least IK practices (25.8%). The Principal Component Analysis showed Thome with dissimilar species from the other three villages. This difference was due to the excessive land use, leaving a thin strip of intact *Cyperus papyrus*, *Cyperus exaltatus*, with a large area covered by *Cynodon nlemfuensis* and *Digitaria abyssinica*. There was a new distribution range recorded for *Rorippa palustris*, which had previously been recorded in Ethiopia. This species could have been dispersed through the Palaearctic-African bird migration systems or the livestock trade from Ethiopia to Nanyuki. There was no significant difference in the IK possessed in relation to the time one has lived in the village $P<0.05$ (P=0.838). This is because when farmers settle in an area, they tend to copy what the others adjacent to them are practicing. The land-use scenarios of 2002, 2010 and 2017 show an increase in

cropland and fallow land by a 34% increase in the area covered by graminoids by 10% and decrease in the papyrus zone by 3%. This research confirms a correlation between IK practices which determine the utilization and the species composition present. The integrity of the wetland is impacted by the plant species composition, which influences the ecosystem services and conservation. The promotion of IK practices in wetland use and conservation is recommended when designing the management plan for shared resources.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
CBD	Convention on Biological Diversity
EMCA	Environmental Management and Coordination Act
FGD	Focus Group Discussion
FTEA	Flora of Tropical East Africa
GISP	Global Invasive Species Programme
GIS	Geographic Information System
GoK	Government of Kenya
GPS	Global Positioning System
IK	Indigenous Knowledge
IKS	Indigenous Knowledge System
INRM	Integrated Natural Resource Management
IUCN	International Union for Conservation of Nature
PRA	Participatory rural appraisal
SDGs	Sustainable Development Goals
SPSS	Statistical Packages for Social Sciences
UNCED	United Nations Conference on Environment and Development
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNSDG	United Nations Sustainable Development Goals
WRMA	Water Resources Management Authority
WWF	World Wide Fund

CHAPTER ONE: INTRODUCTION

1.1 Background Information

Wetlands are species-rich highly productive ecosystems, which perform many functions that maintain the ecological integrity of the systems and provide goods and services (Costanza *et al.,* 1997; 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.
The role of indigenous and local communities in biodiversity conservation is recognized in the preamble of the Convention on Biological Diversity on the value of maintaining the indigenous knowledge and practices relevant to the conservation and sustainable use.

Article 8(j) of the Convention on Biological Diversity (2005) emphasizes on the need to respect, preserve and maintain indigenous knowledge relevant for conservation and sustainable use, at the same time promote the practice with the consent of the holders of the knowledge. There is a need to safeguard and support the customary use of biological resources in agreement with traditional cultural practices that are attuned with conservation or sustainable use (article10(c) CBD, 2005). Kenya is a signatory to CBD and therefore it is bound by its ratification.

Indigenous Knowledge is the local knowledge that is unique to a given culture or community (World Bank 1997, Rÿser 2011) and it accumulates over time. Indigenous Knowledge is the basis for a society and envisaged as the social resource of the poor for it facilitates communication and decision-making.

United Nations Conference on Environment and Development (UNCED) emphasized the crucial requirement for developing systems to safeguard the earth's biological diversity by using local knowledge, hence many of the documents endorsed at UNCED underscores the urgency to conserve the knowledge of the environment that is disappearing within communities (IUCN/UNED/WWF, 1991). The 2030 agenda for the Sustainable Development Goal 15 seeks to "protect, restore and promote sustainable use of terrestrial ecosystems sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss" (UNSDG, 2015). In the context of this study, the term Indigenous knowledge is used to represent the local perspective of the people utilizing the Ewaso Narok wetland and not necessarily the definition of indigenous in an anthropological sense.

Resource management practices based on indigenous knowledge are not necessarily sustainable, a practice that was once sustainable can shift to be unsustainable when socio-economic or environmental changes occur at a faster rate than the rate at which a community can develop their indigenous knowledge to cope with the change (Dixon 2005). Adaptive capacity is intrinsically linked to the acquisition of new knowledge though this does not automatically guarantee the sustainability of natural resource management.

New knowledge may be inappropriate given that it is being developed under a different set of socio-cultural and environmental conditions. The current introduction of the high yielding crop varieties as an example has sometimes led to total crop failure when certain conditions such as low rainfall and diseases are experienced. The wise use concept according to Ramsar convention needs to be applied in the management of Ewaso Narok wetland, making sure that as much as the communities are making use of the ecosystem services provided by the wetland, the health and integrity of the wetland remains intact. (Ramsar, 2010).

1.2Significance of wetlands

Wetlands are known to be of great importance wherever they occur; they carry out important functions and provide key products and services to the community and the environment. These services are divided into two;

a)Ecological services

i. When there is heavy rainfall the wetlands absorb the excess water and this controls flooding and soil erosion
ii. The water that settles in the wetlands later helps in the recharge and discharge of surface and underground runoff
iii. water purification through the absorption of nutrients and toxic substances
iv. They are carbon sinks which help on the mitigation of climate change
v. They are biodiversity hotspots for both fauna and flora.
vi. Provide a buffer zone between saline and freshwater

b)Socioeconomic importance

i. Source of wetland products such as food and water
ii. Religious and cultural importance

iii. Tourism

iv. Hydropower

v. Aesthetic value among others.

1.3 Wetlands and the SDG

The Sustainable development goals aims at eradicating poverty and achieving sustainable development by the year 2030. In their own unique way, the wetlands contribute to each goal as shown in figure 1.

Figure 1: Contribution of wetlands towards the achievement of SDGs

Source: Ramsar 2018a

1.4 Problems facing wetlands

Wetlands are reducing at a very fast rate, about 35% since 1970 of the global wetland areas have been lost (Ramsar, 2018a). This has put the wetland plants and animals at risk of extinction. The lack of proper inventories of biodiversity and the water quality and quantities has worsened the problem Zedler &Kercher (2005) The EMCA (1999) emphasizes conservation and sustainable use of the wetlands.)

1.5 Overview of Ewaso Narok wetland

The Ewaso Narok swamp is within the Engare Narok River, which ends in Lorian swamp in the county of Wajir. Several tributaries flowing into Engare Narok River, Lake Ol'Bolossat and the Nyandarua ranges feed the Ewaso Narok swamp. High temperatures and unreliable rainfall describe the semi-arid climate of the area. This kind of climate leaves the swamp as a primary source of water in the dry season for the livestock and cultivation. The extreme reliance on the wetland possess a risk of extinction if not properly managed or protected.

1.6 Problem statement

Human impacts have a strong and interdependent effect on species diversity and ecosystem functioning, which must be managed together (Worm *et al.*, 2002; Brose & Hillebrand 2016). 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 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; Verhoeven &Setter, 2010). Persistent drought has also made pastoral farmers open up many swamp areas for dry season grazing (Handa, 2011).

Ewaso Narok swamp faces many pressures from both subsistence farmers and pastoralists, as it is a haven within a semi-arid zone. Traditionally the communities adjacent to any resources had set out ways on how to utilize sustainably. One person does not own indigenous knowledge; it is mostly fragmented. Within the society, different age set or gender have their unique information. The communities, which have migrated to Ewaso Narok wetland, also have the

indigenous knowledge of where they come from and it will have an influence on the use and utilization of Ewaso Narok wetland.

1.7 Justification of the study

Indigenous Knowledge is both cumulative and dynamic (Agrawal 1995; Berkes 2012; Gomez-Baggethun & Reyes-Garcia.2013) building on people's experience and adaptation to changes. The IK of communities has allowed them to live in harmony with their environment for a long time. However, the oral and rural nature of this knowledge has made it invisible and hence is often ignored or dismissed during development of communities and by modern science (Boven & Morohashi, 2002) This has left indigenous communities who depend on the local biological diversity for the livelihood, vulnerable to the rigors of climate change and environmental disruptions (World Bank 1997).

Most Indigenous Knowledge studies focus on the documentation of the various practices without validating the impact these practices have on the ecosystem using scientific methods, this study combines both the IK and ecological data to evaluate if there is a significant correlation. Inclusion of indigenous knowledge in community development has the capacity to provide community-based adaptation and mitigation actions. Which can help sustain the resilience of ecological systems at the local, regional and global levels (Mawere *et al*., 2013) .This project, therefore, aims at capturing the indigenous knowledge of the local communities in Ewaso Narok wetland before it becomes extinct and store it in a systematic way for incorporation into the wetland management plans.

1.8 Hypothesis

Agro-pastoral indigenous Knowledge system does not exist in Ewaso Narok swamp and it has not made a substantial contribution to the species distribution patterns, sustainable use and conservation of the wetland.

1.9 Objective and scope.

The aim of the study is to document and investigate the role of indigenous knowledge in agro-pastoral systems in relation to species diversity and conservation of Ewaso Narok wetland, Laikipia Kenya. Concurrently establish if the existing indigenous knowledge has any impact on agro-pastoral use.

1.9.1 Specific Objectives

i. Determine the floristic diversity and abundance in relation to Indigenous Knowledge in Ewaso Narok wetland
ii. Document the Ethnobotanical use of resources and Indigenous Knowledge Systems of the communities adjacent to the Ewaso Narok wetland
iii. Characterize the mechanism of acquiring and disseminating indigenous knowledge for sustainable use and management of Ewaso Narok wetland
iv. Compare the changes in size and establish the conservation concerns of Ewaso Narok wetland

CHAPTER TWO: LITERATURE REVIEW

2.1 Indigenous knowledge and conservation of Natural Resources

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

Wetlands are species-rich highly productive ecosystems, which 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, through unsustainable activities and due to a lack of effective management mechanisms and proper appreciation of their value they have been degraded.

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 can be used as indicators of wetland health. Through activities such as cultivation flora composition is increasingly threatened by human modification of the landscape (Newbold *et al.*, 2016). The effects of the exploitation of the wetland resources by the adjacent communities can be in-directly quantified by assessing the status of the plant communities. According to Isbel *et al.*, (2015), in diverse grassland communities when there is severe drought, the recovery is much faster than that of depauperate communities. The changes in vegetation by the people interacting with where the majority of the useful plants are will assist in knowing if the uses vis a vis the availability of the named species is sustainable.

Human impacts have a strong and interdependent effect on species diversity and ecosystem functioning, which must be managed together (Worm *et al.*, 2002). 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 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). According to Hardin, 1968, “Freedom in a common brings ruin to all”. Shared resources are greatly affected by the Tragedy of commons, as they cannot be fenced off. Indigenous knowledge is the main asset of a community that may be used to invest in the struggle for survival, to produce food, to provide for shelter, environment conservation and to achieve control of their own lives. IK is passed from generation to generation, usually by word of mouth and cultural rituals and has been the basis for agriculture, food preparation, and environmental conservation. The everyday life events have improved the knowledge through trial and error. This experience is normally the result of a clever interpretation of events over a long period and age groups over time.

This 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 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 indigenous knowledge systems 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. Traditionally the communities adjacent to any resources had set out ways on how to utilize sustainably.

One person does not own indigenous Knowledge; 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 Indigenous knowledge shared between the farming and pastoralist communities over time. The indigenous knowledge systems 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 (Agrawal, 1995). The communities, which have migrated to Ewaso Narok wetland, also have the indigenous knowledge of where they come from and it will have an influence on 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. Indigenous knowledge has often been rejected as disorganized and hence it has not been documented and stored in a systematic way 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)

The development process plus the fact that the oral paths through which it is shared are blocked by both urbanization, people staying in non-homogenous community blocks as well as lack of a forum for this function i.e. the youth have less time with elders, threaten the existence of IK. Knowledge is vital as it could determine the survival or not of the communities practicing it. The invasion of new methods and skills from other people that assure instant gains and are not sustainable leads to the erosion of valuable IK of a community replacing the intricate traditional knowledge (Senanayake, 2006). The rate of acquisition and dissemination of the Indigenous knowledge determines the effectiveness in conservation (Wood *et al.,* 2013). The documentation of Indigenous knowledge ensures permanency of the information though passing it down through word of mouth or by simulation and demonstration, writing it down only captures the essential attributes. According to Mundy & Compton (1995), Communication channels for knowledge acquisition can be either Exogenous or Indigenous as shown on (table1)

Table 1: Knowledge acquisition and communication channels

Communication Channels		**Type of Knowledge**	
		Exogenous	Indigenous
	Exogenous	Technology Transfer	Indigenous knowledge-based development
	Indigenous	Diffusion	Cultural continuity and change

Source: Mundy & Compton 1995

Resilience is usually entrenched within Indigenous knowledge systems, which ensures diversified livelihoods and resources (Raygorodetsky, 2011). Lack of resources biodiversity

loss and traditional knowledge systems, it intensifies the exploitation of natural capital and distracts people from intricate indigenous knowledge systems to simple farming methods such as inorganic farming and mono cropping. Participation of local communities with their traditional knowledge, skills, and practices can help in resource conservation while meeting their daily necessities (Barbier, 1993).

The small wetlands of East Africa have recently been transformed from natural ecosystems and biodiversity hotspots into highly productive sites for agriculture and a refuge grazing ground for the herds of pastoralist people during the dry season (Becker *et al.,* 2014). The gradual rise in settlement from the initial settlement in the 1950s in Ewaso Narok over the decades might explain to some extent the changes in land cover within the Ewaso Narok wetland (Thenya *et al.,* 2011). The majority of the small wetland areas are characterized by the presence of non-native weeds such as sedges and graminoids altering the plant communities especially in abandoned or cultivated areas (Handa, 2011). The increase in population will exuberate the conversion of wetlands to agriculture for food and economic output. hence a conservationist approach is needed whereby scientific research and indigenous knowledge are integrated to ensure the sustainable use of the wetland.

Historically the pastoralist has used the basin but currently, due to the adjacent areas being too dry, it is being used to support agricultural farming. The upper part of the swamp is dominated by subsistence farming, while in the lower part of the swamp and the pastoralist community uses the fringe areas. (Thenya *et al.*, 2011). Some of the adjacent villages to the wetland are Mathira, Maundu Meri, Container, Thome and Location. These are cosmopolitan villages, though Maundu meri and Container villages have the Samburu and Turkana pastoralist as the main inhabitants.

2.2 Documentation of IK and its significance

Wetland utilization is often based on community management strategies that have evolved over time through the development of indigenous knowledge. This knowledge may be adaptive and holistic in nature; it is accumulated over generations and passed down to the younger generations. Indigenous communities will always have alternative perspectives and knowledge based on their locally improved practices of resource use. Not all-indigenous knowledge is

ecologically for instance, some indigenous system of wetland management remains sustainable while others are characterized by mismanagement and degradation (Dixon 2005). This leads to the importance of documentation and later assessing the impact of the knowledge on wetland management and promote the good knowledge that promotes sustainable use of the resource. Hardin (1968) emphasizes that degradation is inevitable once the level of exploitation exceeds the carrying capacity of site-specific wetlands. It is often difficult to identify, and generalize the indigenous practices that function in resource and ecosystem management (Berkes *et al.,* 2000).

A given practice may be documented from one social group but not the next, or from a one-time period but not another, varying environmental and socioeconomic characteristics have given rise to the various management scenarios. A people's culture helps in building resiliency by ensuring that they are creative and innovative during conflicts and disasters (UNESCO 2010).

Indigenous knowledge is linked to beliefs and practices which when analyzed are geared towards the use and resilience of the ecosystem. The use of modern science to deduce the role of IK in conservation is problematic, though it is easier to conceptualize the knowledge through relating directly to the utilization of the resources. Indigenous knowledge of enhancing biodiversity and conservation can be applied as an integrated system of knowledge practice and beliefs by empowering the communities to take charge of the destiny of the future of the shared resources, which in this case is the wetland. IK systems are sustained by adopting hybrid types which sometimes is the modern knowledge to already existing traditional ecological knowledge (Gomez-Baggethun *et al.,* 2013)

2.3 Conservation concerns

Plant communities play a major role in the important ecosystem functions and values that wetland provides such as water filtration, wildlife habitat, flood protection among others and can be used as indicators of wetland health. Floristic composition is increasingly threatened by human modification of the landscape 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. The changes in vegetation by the people interacting with where the majority of the useful plants are will assist in knowing if the uses verses the availability of the named species are sustainable.

The land-use changes have a major impact on biodiversity as compared to climate change; this is because the actions are rapid and immediate as opposed to climate change, which is a much slower process. (Verburg *et al.*, 2011) Land use decisions may also be affected by climate change making some areas more or less suitable for some practices. This study seeks to ascertain whether the indigenous knowledge possessed by the locals has any impact on the land use, by observing the land-use change verses the uses and sustainability of the practices in the wetland

The encroachment by the local communities into the swamp in search of pastures and farming land has put a lot of pressure on the wetland. There is a need to ascertain whether the exploitation of the resources in this ecosystem is sustainable. Therefore, this research would not be complete without addressing the several conservation concerns such as the sustainability of the Ewaso Narok swamp by looking at the changes that have taken place over time. Quantification of the wetland in relation to its size over time is an efficient method to understand the changes that are happening over time. Remote sensing is the science of obtaining information without physically being in contact with it. This process involves detection and measurement of radiation at different wavelengths reflected or emitted from distant objects or materials, by which they may be identified and categorized by class/type, substance and spatial distribution (Kansakar &Hossain, 2016).

CHAPTER THREE: MATERIALS & METHODS

3.1. Study area

Ewaso Narok swamp is located in Rumuruti- Laikipia plateau at longitude 36º12'17"E to 36º45'16"E and latitude 0º28'51"N and 0º7'28"S with height of 1,811 m a.s.l. It is characterized by a semi-arid climate (Alvarez *et al.,* 2011).

The wetland extends over a length of 19 km long and average width of 2km on the leeward side of the Aberdare range. (Figure 2) The Eng'are Narok, Pesi Rivers, mainly serves it. Several other seasonal streams drain into the swamp making it permanently flooded except for the portions drained for agriculture (Handa, 2011).

The Ewaso Narok swamp drainage system comes from the Nyandarua ranges and Lake Ol'Bolosat catchment, with a minor contribution from Oraimutia River draining the Sabugo highlands in Nyahururu, which is currently heavily deforested. The swamp is a relic of a series of once-numerous wetlands that have been drained for food production. The Ewaso Ngiro is the major permanent river, receiving all the tributaries in the drainage basin. Important tributaries from Mt. Kenya include the Nanyuki, Burguret, Likii, Ontulili, Sirimon and Timau rivers, while those from the Nyandarua Ranges include Eng'are Ngobit, Moyok, Pesi and Mutara rivers.

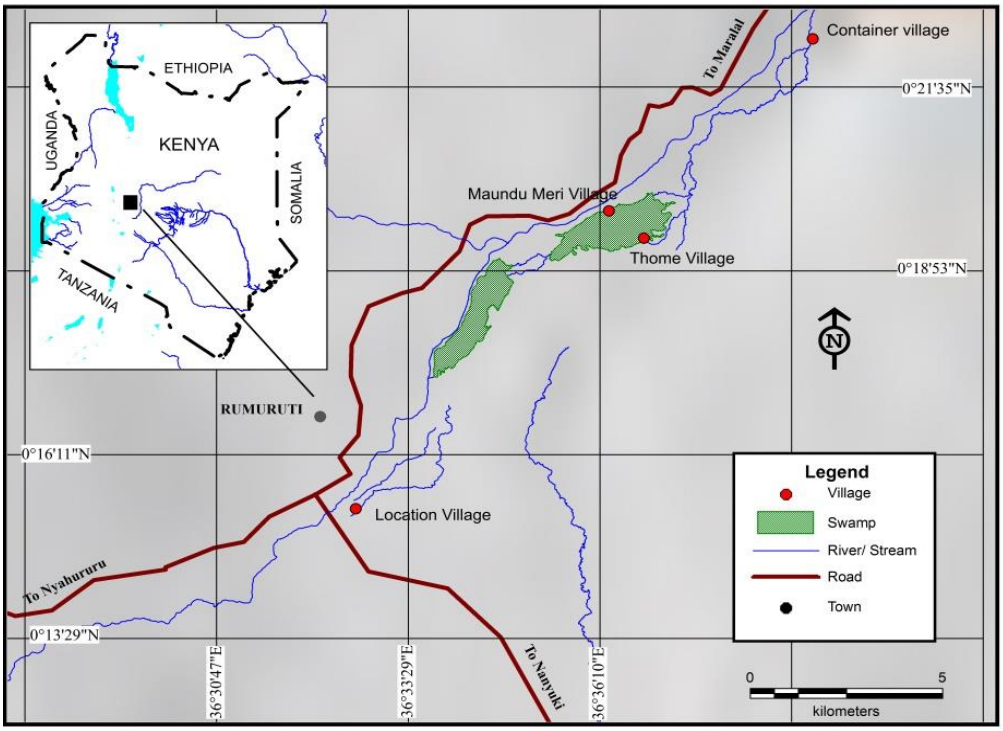


Figure 2: The Study Area in Ewaso Narok Swamp

Source: Nyaboke B.

3.1.2 Climate

Laikipia County has a warm and temperate climate, with high rainfall occurring in the Nyahururu area to the Western part. The average annual average temperature is 16.2ºC with precipitation of about 819mm annually. Rumuruti is on the drier side of Laikipia and the climate is generally temperate, the average annual temperature is 17.2ºC with a precipitation of 714mm annually. The rainfall is lowest in January with an average of 26mm and the highest in April with an average of 112mm. Though April receives the highest rainfall, on the other hand, it is the hottest month of the year with an average temperature of 18.3ºC. The lowest temperatures are experienced during the month of August with average temperatures of 16.4 ^{0}C

3.1.3 Population and land use

Rumuruti as a township within Laikipia West sub-county with a population of 9,900 and the adjacent villages of interest to this study were Maundu meri with 3600, Container village 2300 and Thome with 5,600 (E. Tum, *Pers comms* October 22 ,2016). Rumuruti Provincial administration. Ewaso Narok wetland is attractive for two main reasons: a source of food and income for the farming community and refuge for the pastoral community during the dry season as a source of fodder and water. There is varied land use of the wetland, but horticultural farming of tomatoes and French beans is the annual mainstay of most agricultural farmers. The

reliability of income from agricultural farming has led to the previously solely pastoralist communities embracing agriculture which has further reduced the grazing area. This in effect affects the pastoralists that have historically used the wetland as a dry season grazing area. GoK (2009) policy document on the use of the wetlands; the government allows sustainable utilization of the wetlands provided one acquires a permit, but in actual sense, there is no adequate mechanism to ensure the use of the wetland is sustainable in most places.

3.1.4 Communities adjacent to Ewaso Narok Swamp

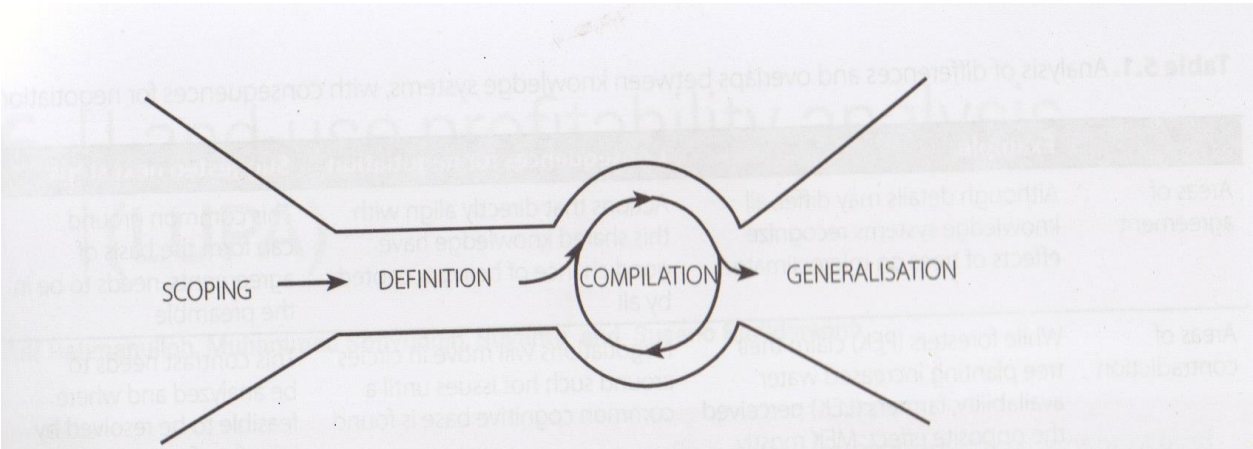
Baringo borders Laikipia County to the west, Meru and Nyeri to the South, Nyandarua to the Southwest, Samburu to the North and Isiolo to the Northeast. These six Counties have both pastoral and agricultural communities. This diversity is evident along Ewaso Narok Swamp as multi-ethnic communities who are either pastoralists or agricultural farmers surround it. The pastoralists are mainly the Maasai, Samburu, Turkana and the Kalenjins (Nandi, Pokot, Tugen) who were the earliest occupants of this area, Other communities acquired land through the various land buying companies, and the new immigrants who include the Agikuyu, Abaluhya, Ameru, Abagusii among others (Kariuki, 2015)

3.2 Ethnobotanical survey

Participatory rural appraisal, semi-structured interviews, focus group discussions and observation of people's activities were used to collect primary data on the agro-pastoral communities of the four selected villages. The multi-stage sampling design was used where both purposive and random samples were drawn from people residing in the villages surrounding the wetland.

The swamp was stratified into zones of 0-3 km and all the households in that radius were sampled, 3-6km households were randomly selected by giving them a number and writing on a paper, shuffle and randomly pick the household to be interviewed.

The four stages of elicitation of local knowledge as described by Dixon *et al*., (2001) was used to ensure the data captured can be evaluated in terms of (i) repetition (ii) contradiction (iii) completeness and (iv) consistency in use of terms was applied in this study.



Objective	To refine knowledge acquisition objectives	To generate a broad understanding of domain and define boundaries and terms	To create coherent and comprehensive knowledge base	To test how representive the knowledge base is of farmers generally
Informants and activities	A broad range of activities a cross the community	One or two intensive interactions with a small number of purposively selected informants	Iterative cycle: repeated interaction with statified sample of key informants, knowledge representation and evaluation of emerging knowledge base	A variety of questionnaire-based survey approaches on a sufficiently large and randomly selected sample of informants from the community

Figure 3: Stages of elicitation of local Knowledge *Source: Dixon et al., 2001*

3.3 Sample size determination

Fisher *et al.,* formula was used 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

$$N = \frac{1.96^2\ (0.5x0.5)}{0.05x0.05} = 384.16$$

Adjustment was done using finite population correction formula for a population of less than ten thousand people.

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

Where n is the sample size

N is the population size.

n_o is calculated sample size for infinite population

Therefore;

n = 384

1 + (384 – 1)/557

= 1.688

Then

n/1.688

= 384/1.688

=227.

Therefore, a minimum of 227 respondents was sampled, and one person per each household.

3.4 Participatory Rural Appraisal

Participatory Rural appraisal tool (Chambers 1994) was used as it supports the direct participation of the community in analyzing investigation and presenting their experiences to both the pastoralists and the cultivating farmers. PRA comprises a set of methodologies that are used by a researcher to stimulate communities to reflect upon their situation, to openly discuss interactions between them and their environment and it raises concerns and expectation on the conservation and management of the resource. This approach allows the local people to fully participate in the study than merely being the objects of investigation. (Martin, 1995).

3.5 Semi-structured interviews and discussions

Six Focus group discussions were carried out in each, village where semi-structured questions were asked under an informal setting. Initially, general questions were asked to be able to understand how the community works as a whole and subsequently discuss the different indigenous knowledge systems in the area. The key informant interviews were conducted by using purposive sampling, targeting the village leaders and the WRUA chairperson. A questionnaire was the appropriate instrument (see Appendix III) in this research to collect data as the information comes from a greater number of sources and this will assess the effects of the changes in the indigenous knowledge systems and the use of Ewaso Narok wetland.

3.6 Household survey

The stratified random sampling procedure was used to get the appropriate sample. Data was collected from a sample of 229 households through interviews. The questions were asked using the local dialect understood by the people interviewed. Individual household heads either the husband, wife or in some instance an employee responsible for making the decision on the resource utilization.

3.7 Data analysis

Household survey data was tabulated in SPSS and Pearson's chi-squared test was used to analyze the data.

3.8 Vegetation sampling

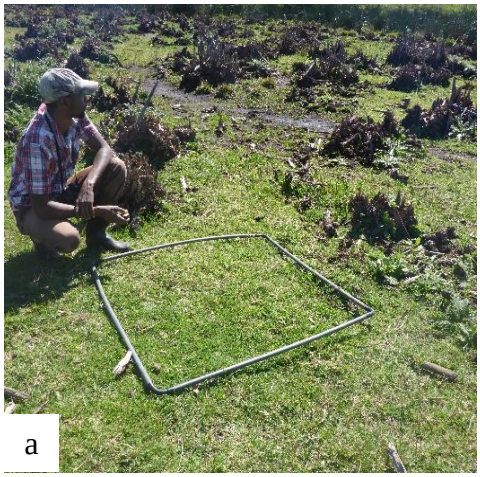
This study was conducted from the beginning of November –to mid-December 2016 at the peak of the short rains. In such a season, the herbaceous plants are in flower or seed and therefore accuracy of species identification is enhanced. A stratified sampling method was used to

identify two blocks (Pristine and Grazing sites). A preliminary survey of the area clearly showed grazing as major land use of the vegetation adjacent to the swamp and this is why the study focused on the two blocks. Adjacent to the grazing sites were farmlands and fallow areas, which were not considered in this study as the farmlands would majorly have the crop in season and mostly the fallow areas would majorly have weeds. This was done to establish the species composition effect vis a vis the use in the vegetation on the swamp adjacent to the four villages namely; Thome, Maundu Meri, Container, and Location.

3.8.1 Sampling design

A total of 32 plots of both vegetation types of 10m x 10m were established in the two habitat types (i) Pristine and (ii) grazing land (Figure 4). 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, as it is almost impossible to count herbaceous individuals in a 10m x 10m plot. All the individuals in the 1m x 1m quadrat were enumerated; the general 10m x 10 m plot was used to capture the species that were not encountered in the 1m x 1m quadrat (Appendix II). This approach ensured that all the species were included.

The Standard herbarium procedure (Foreman & Bridson, 1992) was used to collect plants for identification and voucher plant specimen with associated label data was deposited at the East African Herbarium. There are no considerable differences in Pielou's Evenness index when sampling freshwater macrophytes in different seasons (Sarma &Sigh 2017), hence data was collected in one optimum season.



a

b

Figure 4: a) A field assistance helping set up the quadrant used in data collection at the grazing field, and b) A scientist recording data at the pristine papyrus plots

3.8.2 Floristic composition

Species diversity of encountered plants was analyzed using the Shannon-Wiener diversity index (H'), as shown in the equation below: -

$$H' = \sum_{i=1}^{s} (Pi.\ln pi)$$

Where; H' = Shannon-Wiener diversity index

Pi = n/N = the proportion of the species individuals found in the i^{th} species

Ln = the natural logarithm

Species distribution was determined using the Pielou's **species evenness** equation;

$$J' = \frac{H'}{Log\ S}$$

Where J' = evenness index

H'= diversity

S = number of observed species

Species Abundance *(S)* is the total number of individuals of a species. It can also be expressed as an index by using the Margalef richness equation;

$$d = \frac{S - 1}{Log\ S}$$

Where d = margalef richness index

3.8.3 Plant assemblages and species similarity

Variability of species composition was observed through the ordination of samples on a non-metric Multi-Dimensional Scaling (NMDS) plot. The ordination is based on the square root transformation matrix of the Bray-Curtis Euclidean similarity distances. In the NMDS plot, the closer the sample points to each other on the plot area, the closer their similarities in terms of species composition. An NMDS plot was generated using PRIMER 5, an ecological statistics software (Clarke & Gorley, 2006). Principal Component Analysis was prepared using R

3.9 Trends in Conservation status

The fourth specific objective in this study was to compare the changes in size and establish the conservation concerns of Ewaso Narok wetland. Three Landsat images were used over a period of 15 years. It was not possible to sequentially get images due to the availability and quality of the images, hence downloads of 2002,2010 and 2017.were used. The supervised (iso cluster) method using Erdas 8.4 was used to determine the classification of image data into various thematic classes. Changes in the various habitats were established by the use of remote sensing techniques and ground-truthing was done by getting the specific GPS point in the field.

The three satellite images of the swamp were analyzed to show the percentage 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. .Remote-sensing data gives us a clear picture of what is happening to the wetland resource over time, this data was complemented with the data collected in the household survey and the focus group discussions. The respondents were asked to elaborate on the changes they have observed over time in the wetland, their response was to include both the positive and the negative changes. This data will give a projection of the sustainability and the resilience of the wetland to the dynamic changes over time.

CHAPTER FOUR: RESULTS

4.1 Indigenous knowledge on the use of resources in Ewaso Narok swamp

The relationship between plants and people over time was determined by documenting the specific uses and beliefs of the plants in the wetland in the focus group discussion and household survey. A total of 37 species from 22 plant families were recorded as useful species around Ewaso Narok wetland with the Cyperaceae and Fabaceae families having the highest number of species (Figure 5).

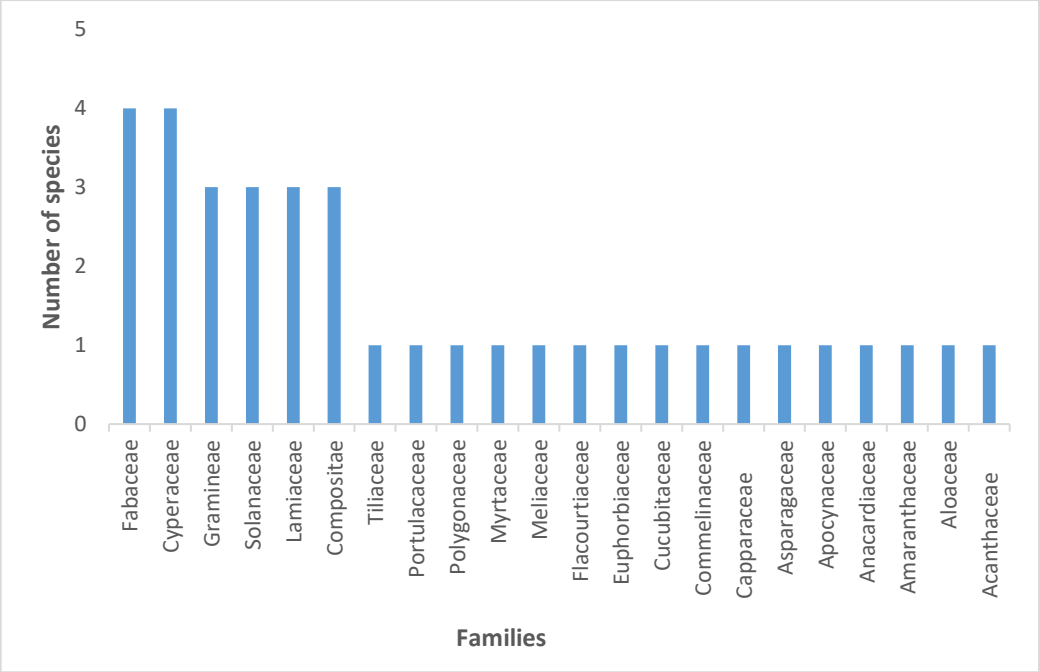


Figure 5: Useful plant families found around Ewaso Narok Swamp

4.1.1 The use categories of Species

Several uses were enumerated and classified into five categories, a summary of the uses is given in figure 6 showing medicinal and food plant species ranked the highest.

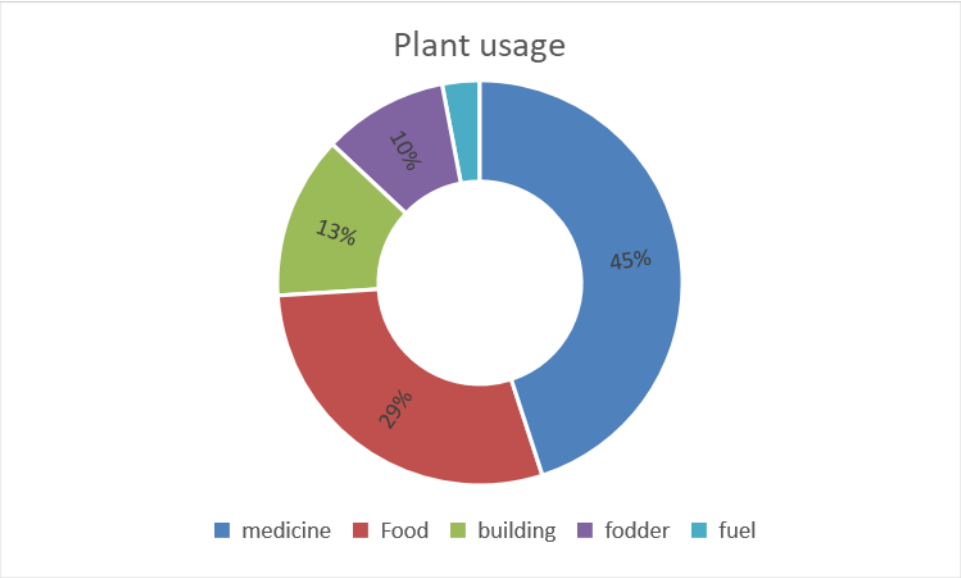


Figure 6: Plant usage data

a) Food plants

Twelve 12 species were mentioned as food with more than half being vegetables such as *Asystasia mysorensis, Portulaca oleracea, Cleome gynandra, Solanum incanum* and *Amaranthus sp*. and the rest as fruit species such as *Rhus natalensis, Carissa spinarum, Grewia tephrodermis.*

b) Building and craft production

Through the use of local resources to make crafts such as roofing and house partitioning material and other uses, income is not only generated from these commodities but also it acts as an incentive to ensure the people do not transform the wetland area by clearing for agriculture. In Ewaso Narok wetland, the use of *Cyperus papyrus* and *Cyperus rigidifolius* was sighted in Maundu Meri village (Figure 7) which had the Turkana community as the majority. This is a practice they came with though now it is not so common as they have changed to the modern iron sheets for the roofing.

After the Papyrus is harvested, if it will be used for roofing it is bent into two when it is still fresh and allowed to dry then arranged on the rafters of the roof. For partitioning, it is arranged on a line and sewn together. The leaves of *Cyperus rigidifolius* are more flexible,

and they are just stacked together to form a thatch.

Figure 7: Cyperus thatch used for roofing and partitioning - a) and b) *Cyperus papyrus* c) *Cyperus rigidifolius*

c) Fodder

Some of the introduced fodder trees such as *Calliandra* sp. and *Sesbania* sp. were largely mentioned. *Cyperus rigidifolius* was harvested and used for feeding the cows, and for the herders who bring their cows to the swamp they would also feed on the *Cyperus papyrus*, and the few Graminoid species such as *Echinocloa pyramidalis, Leersia hexandra*, and *Digitaria* sp.

d) Medicinal plants

There were 16 species mentioned to be of medicinal value in the wetland with *Ajuga remota* and *Carissa spinarum* ranking the highest. During the discussions, the list of medicinal plants was very long but this study had a limitation to the wetland species only.

Table 2: List of the plant species with their usage

Family	Scientific name	Common name (Language)	Medicine	Food	Building	fodder	fuel
Acanthaceae	*Asystasia mysorensis* T. Anderson	Muhikanaihuu (kik)		X			
Aloaceae	*Aloe* sp.	Thukurui (kik)	X				
Amaranthaceae	*Amaranthus hybridus* L.	Terere (swa)		X			
Anacardiaceae	*Rhus natalensis* Bernh.	Msingiyoi(sam)/muthigiu (kik)		X			
Apocynaceae	*Carissa spinarum* L.	Lamurei (sam)/Mukawa (kik)	X	X			
Asparagaceae	*Asparagus africanus* Lam.	Ekebekebeke (Tur)/morura (kik)	X				
Capparaceae	*Cleome gynandra L.*	Thageti (kik)		X			
Commelinaceae	*Commelina benghalensis L.*	Nakiteteyo/Mukengeria (kik)	X			X	
Compositae	*Psiadia punctulata* (DC.) Vatke	lobai (Tur)	X				
Compositae	*Bidens pilosa* L.	Nakoi(Tur)	X				
Compositae	*Galinsoga parvifolia* Cav.	Kang'ei (Kik)		X			
Cucubitaceae	*Cucumis dipsaceus* Ehrenb. ex Spach	Ekaleruk (Tur)	X	X			
Cyperaceae	*Cyperus papyrus* L.	Marura (kik)			X	X	X
Cyperaceae	*Cyperus exaltatus* Retz.	Mirera			X		
Cyperaceae	*Cyperus rigidifolius* Steud.	Marura(kik)			X	X	
Cyperaceae	*Cyperus blysmoides.* Hochst.	Marura(kik)		X			
Euphorbiaceae	*Croton dichogamus* Pax	Kererwa	X				
Fabaceae	*Sesbania sesban* (L.) Merr.	Sesbania (Eng)				X	
Fabaceae	*Acacia xanthophloea* Benth.	Acacia (Eng) / olerai (sam)	X				X
Fabaceae	*Senna occidentalis* (L.) Link	Lomany/osenetoi (sam)	X				

Family	Scientific name	Common name (Language)	Medicine	Food	Building	fodder	fuel
Fabaceae	*Caliandra calothyrsus* Meisn.	Caliandra (Eng)				X	
Flacourtiaceae	*Dovyalis caffra* Warb.	Kaiyaba (Kik)		X			
Gramineae	*Digitaria* sp.					X	
Gramineae	*Echinocloa Pyramidalis* (Lam.) Hitchc. & Chase					X	
Gramineae	*Leersia hexandra* Sw.					X	
Lamiaceae	*Leonotis nepetifolia* (L.) *R.Br.*	Ol bibi(Sam)	X				
Lamiaceae	*Vitex keniensis* Turrill	Meru oak (Eng)			X		
Lamiaceae	*Ajuga remota* Benth.	Losururu /Wanjiru Warurii(Kik)	X				
Meliaceae	*Azadirachta indica* A. Juss	Neem tree (Eng)	X				
Myrtaceae	*Eucalyptus saligna* Sm.	Mubau (Kik)			X		
Polygonaceae	*Oxygonum sinuatum* (Hochst. & Steud. ex Meisn.) Dammer	Esuguru (Tur)/Conge (Kik)	X				
Portulacaceae	*Portulaca oleracea* L.	Gatumia(Kik)		X			
Solanaceae	*Solanum nigrum* L.	Manage (Kik)		X			
Solanaceae	*Solanum incanum* L.	Mutongu(Kik)	X				
Solanaceae	*Ipomoea* sp.	Ekwaki (Tur)	X				
Tiliaceae	*Grewia tephrodermis* K. Schum	Engomo(Tur)/Theregendi(Kik)		X			

KEY: Eng-English, Kik-Kikuyu, Sam-Samburu, Swa-Swahili, Tur-Turkana,

4.1.2 Documentation of the existing Indigenous knowledge in Ewaso Narok

Based on 229 households interviewed on questions in Appendix I, on their awareness of indigenous knowledge practices, it was noted that the respondents comprised of 60% male and 40% female with their ages ranging from 23 to 71years. About 72% were between 30 and 50 years, whereas those above 50 years were 22% while those below 30years at 6%. The study targeted the key decision-makers in the households thus the reason why the majority of respondents were above 30 years. It was also observed that 84.7% of the respondents were aware of the existing indigenous knowledge as shown in Figure 8.

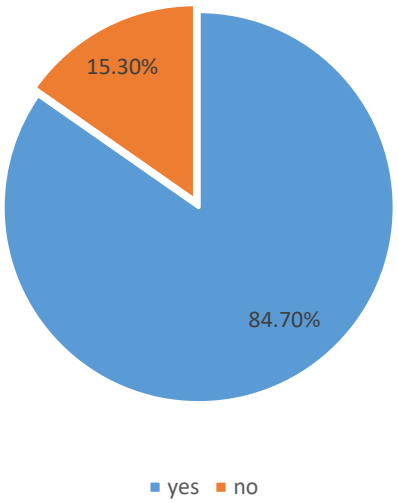


Figure 8: Level of awareness on the existing indigenous knowledge

The IK of the communities adjacent to the swamp was broadly categorized into five major classes, which are; Usage of wetland species for making crafts, in livestock management, in crop farming, in irrigation practices and other uses such as herbal medicine, bee and fish farming

a) Wetland species for crafts

It was observed that locally available reeds of *Cyperus papyrus* were used for roofing, making mats, which are sometimes used to partition houses. Additional uses included

the making of baskets and brooms while roots were sometimes used as firewood. Another species *Cyperus rigidifolius* was used specifically for thatching. Immediately the Papyrus is harvested, for roofing, it is bent into two when it is still fresh and allowed to dry then arranged on the rafters of the roof. If it is for partitioning, it is arranged on a line and sewn together. The leaves of *Cyperus rigidifolius* are more flexible, and they are just stacked together to form a thatch.

With modernization, however, most of the houses now have iron sheet roofs as opposed to the Cyperus thatch. The exception is the tourist hotels and ranches that continue to utilize the plant to do their roofing. The women groups in the villages adjacent thus earn a living by harvesting the papyrus and supplying it to these hotels and ranches. When the respondents were asked if they harvest the papyrus sustainably, they said;"papyrus grows very fast and it quickly recovers from the harvesting. When there are large orders of papyrus for the "makuti" roofing, we harvest as much as we can for in the dry season the pastoralists will burn the "marura" this sets out less papyrus left for burning.by the herders."

Through the use of local resources to make crafts such as roofing and house partitioning material and other uses, income is not only generated from these commodities but also it acts as an incentive to ensure that people do not transform the wetland area by clearing it for agriculture. This practice was sighted in Maundu Meri village where the majority are from the Turkana community.

b) Provision of Livestock grazing

The swamp provides pasture in the dry season; the community has the IK for the management of both the livestock and the swamp. Based on their local knowledge the community determines the time of the year to move their livestock into the swamp and outline which areas of the swamp can comfortably provide sufficient feeds for their animals. They also determine when the area is not safe for grazing especially when very wet or just after the rains when they believe the animals have a higher chance of

getting liver flukes *Fasciola hepatica*.. This practice enabled the grass near the swamp to regenerate when the rainy season starts, though in some areas the grass and papyrus is burned in the dry season to enable the growth of new more palatable shoots for their animals.

c) Crop and soil management

This study established different farming systems put into practice to not only ensure a constant supply of food but also improve the soil quality. These included intercropping, crop rotation, shift cultivation, and use of manure. In tomato farming, the use of sticks and strings to support the tomatoes was practiced all over the area as shown in Figure 9. Other vegetables such as kales were planted to ensure the workers in the farm had a constant food supply in addition to the tomatoes and maize, the latter which was used as a hedge plant. The sticks used for stalking the tomatoes were from

Figure 9: Farming IK practices on intercropping to provide diversified food supply, and pest management

Euclea divinorum Carissa spinarum and Psiadia punctulata which are termite resistant hence could be reused during the next planting season.

Mulching and Furrow farming Figure 10 is practiced to ensure that as farmers irrigate the plants, water is not quickly lost through evaporation. Rotational farming, shift cultivation, intercropping, use of manure, and mulching was a common practice. Intercropping was not only to improve the soil quality but to also ensure a constant supply of food. Additionally, Seed selection was also an important practice as farmers use nurseries to propagate the vegetables to a usable size then transplant them to the field. Horticultural farming is a recently acquired practice in the region as its returns are much higher than the subsistence farming.

Figure 10: Furrow farming for water conservation: through reduced evapotranspiration

d) Irrigation practices

The open canal system was dug during the colonial period to deter farmers from moving into the swamp. However, due to lack of maintenance the water does not flow

to some far villages such as Maundu meri and this resulted in the farmers moving into the swamp to access water. The various irrigation methods used depend on the financial ability of the farmer. The canals alongside the swamp provide the farmers with water which they pump to the crops. The watering of crops in the evening was a common practice to prevent the loss of water through high evaporation rates during the day.

e) Other practices

Fish farming, beekeeping, use of medicinal herbs and agroforestry were some of the Indigenous knowledge learned and practiced by some farmers.

4.1.2.1 Household data on the IK practices known in Ewaso Narok

One of the objectives of this study was to document all the IK practices that the locals were aware of and to achieve this, the question posed was open-ended to allow the respondents who knew more than one knowledge to enumerate all. There was a total of 7 practices which were mentioned (Figure 11), knowledge related to crop farming, livestock management, and irrigation took prominence. These practices all directly impact on the sustainable use of the Ewaso Narok wetland resources.

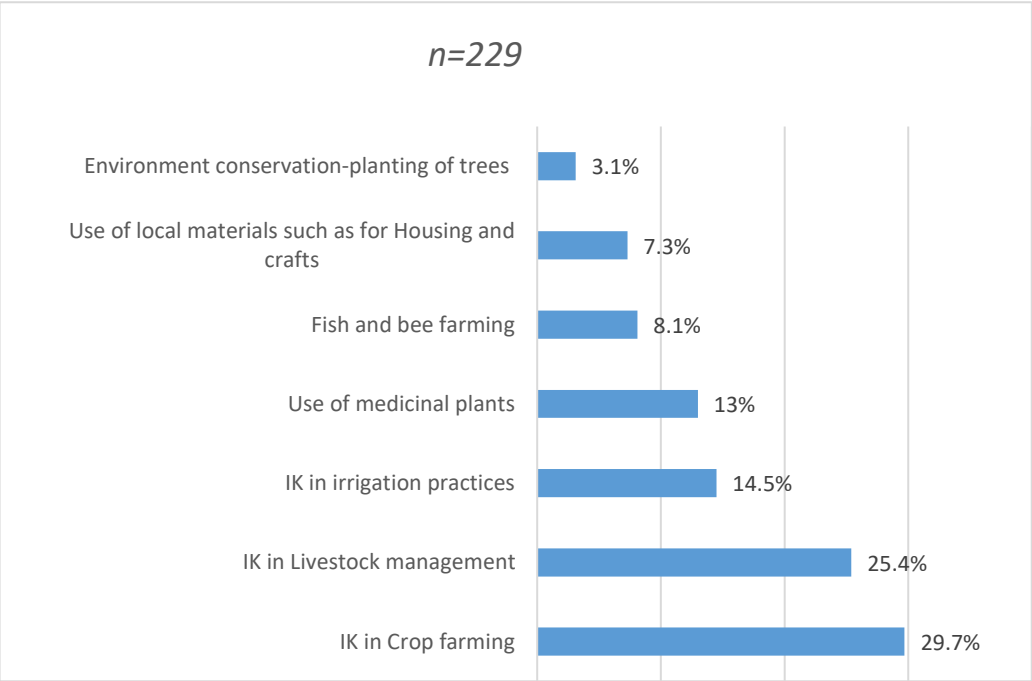


Figure 11: List of mentioned indigenous knowledge practices (N=229)

Information on whether the list of the IK practices that were mentioned to be known is currently in use was recorded to ascertain the level of knowledge erosion in the area. The data in (Figure 12) shows that the frequency of the practices still in use is less as compared to the list of the mentioned practices.

Modernization has greatly reduced the use of herbal medicine from 13% to 6.7%, and an increase of IK in crop farming from 29% to 31%.

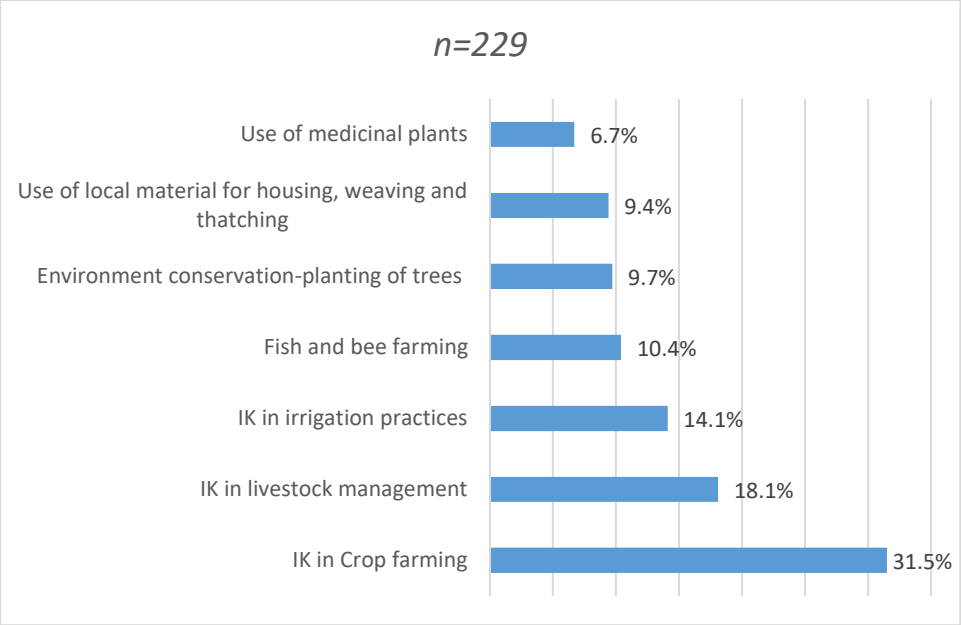


Figure 12: List of indigenous Knowledge practices currently in use

4.1.3 Mechanisms of acquiring and disseminating 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 Indigenous knowledge is mainly through observation and active participation from people who are more knowledgeable. In most cases, the parents are the ones who teach their children (Figure 13).

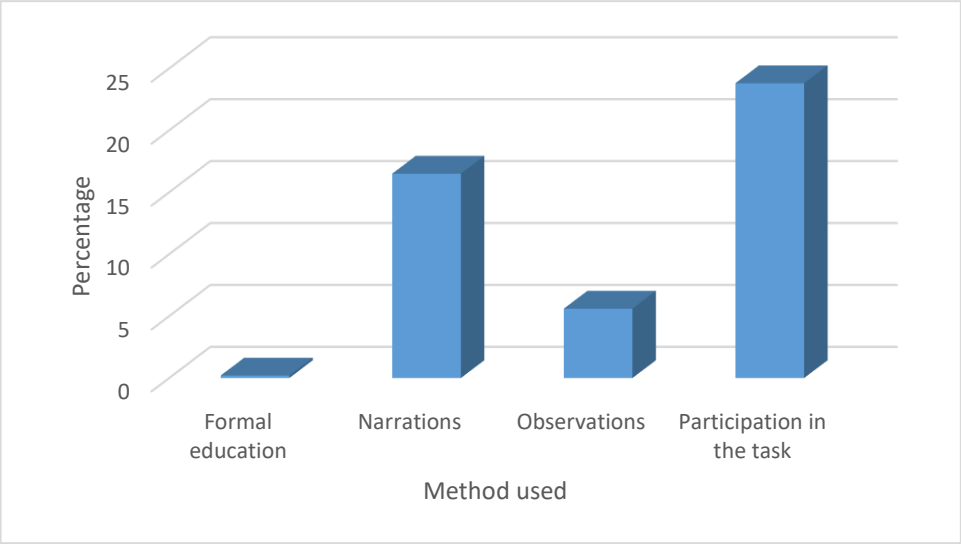


Figure 13: Method of Indigenous Knowledge acquisition

The young generation acquires knowledge at an early stage through practice. In the case of farmers and pastoralist, they engage their children in assisting at an early stage (Figure 14)

Figure 14: A child helping the father in irrigating the land

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 and when they are old enough to take care of the cattle alone, they already have acquired all the knowledge. Children are engaged in farming and herding activities from between 8-10 years (Table 2).

Table 3: Age from which children start involvement in farming activities

Age	**Frequency**	**Percentage**
10 years	34	29.1
8 years	30	25.6
6 years	21	18
7 years	15	12.9
5 years	5	4.3
9 years	4	3.5
18 years	2	1.8
15 years	2	1.7
12 years	2	1.7
4 years	1	0.9
13 years	1	0.9
Total	**117**	**100**

Over 50 percent of the children are involved in herding, fetching water and collecting firewood, both had slightly over 20 percent of the children involved (Table 3).

Table 4: How children are engaged

Activity	Frequency	Percentage
Herding	69	59
Farming	24	20.6
Fetching water	18	15.4
Collecting firewood	6	5.1
Total	**117**	**100.0**

The Ewaso Narok villages are multiethnic as data from the household survey recorded 13 ethnic groups namely: - Borana, Luo, Kisii, Kamba, Kikuyu, Kipsigis, Luhya, Maasai, Nandi, Njemps, Samburu, Somali, and Turkana. With this blend of cultures, there is the IK that they came with as shown in (Table 4). Knowledge on crop farming and livestock management were the highest as these two practices are the mainstay of the people living around the wetland.

Table 5: Indigenous Knowledge practices that you came with

Practice (n=229)	**Frequency***	**Percent**
Crop farming practice such shifting, intercropping, rotational, mulching, and staking	101	36.1
Livestock management practice such as control of where and when to graze	59	21.1
Use of medicinal plants	35	12.5
Fish and bee farming	30	10.7
Use of local material such as *Cyperus* for housing, weaving, and thatching	25	8.9
Environment conservation-planting of trees around the riverbank, cleaning	19	6.8
Use of furrows and canals for irrigation	10	3.6
Use of local material such as Papyrus for housing, weaving, and thatching	1	.4
Total	**280**	**100.0**

*Table represents the open-ended question from the quantitative survey on IK practices one came with.

This research needed to ascertain if there was a significant difference in the IK possessed in relation to the village they came from and using the household survey data. Container village had the highest number of people with IK practices (93.5%) and Thome village had highest number of people without any IK practices (25.8%) (Table 5)

Table 6: The differences of Indigenous Knowledge possessed across the 4 villages

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

There were significant differences in the level of Indigenous knowledge depending on the village where one comes from (Table 6). The Chi-square test figures were 0.016 that is below 0.05.

Table 7: Chi-Square tests showing possession of indigenous knowledge practices

	value	**Df**	**Asymp. Sig. (2-sided)**	**Exact Sig. (2-sided)**
Pearson Chi-Square	10.340[a]	3	.016*	.014
Likelihood Ratio	10.068	3	.018	.021
Fisher's Exact Test	9.595			.020
N of Valid Cases	229			

*significant p-value at 0.05

This research sought to ascertain if there were any differences in the IK possessed visa Vis the number of years one has lived in the village (Table 7). The people who had lived less than ten years relatively had similar knowledge to the people who had lived 40 years and above.

Table 8: 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+
<10years	33(82.5%)	7(17.5%)	40 (17.5%)
11-20years	50(84.7%)	9(15.3%)	59(25.7%)
21-30years	63(86.3%)	10(13.7%)	73(31.9%)
31-40years	32(88.9%)	4(11.1%)	36(15.8%)
41-50years	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

The number of years one has lived in the village as shown in (Table 7) had no significant difference in relation to the Indigenous knowledge they possessed P=0.838. This could be because regardless of the difference in IK possessed from the area they came from, they tend to copy what they see the farmers adjacent to them are doing.

Table 9: Chi-square test Length of time lived in the village

Test	**Value**	**Degree of Freedom (df)**	**Assumption to Significant figure 2-sided**
Pearson Chi-Square	2.082[a]	5	.838*
Likelihood Ratio	2.911	5	.714
Fisher's Exact Test	1.730	-	-

4.1.4 Contribution of IK in Ewaso Narok wetland utilization

The household survey data showed that IK on the utilization of the wetland had a positive impact by increasing the conservation efforts (Table 10). 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.

Table 10: Impact of Indigenous Knowledge Practices to the wetland

Contribution of IK to the wetland utilization (n=229)	**Frequency***	**Percent**
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 fertilizer 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 represents open-ended questions from the quantitative survey on the impact of IK to the wetland.

4.2. Floristic composition

A trend of increasing species richness with the increase of the plot sampled was observed. Species totaling to 117 from 35 families were encountered in the sample area, which comprised of 32 plots. (Appendix iv).

The species accumulation curve did not flatten (Figure 15), meaning that the area has a high potential of species. The inability of the 32 plots to capture a higher diversity was attributed to many factors including the intense grazing, which could not allow all the species of similar morphology e.g. the grasses to be identified to species level. This phenomenon is also attributed to the fact that Ewaso Narok swamp has various unique microhabitats at frequent intervals such as banks, farmlands, fallow and grasslands. Species tend to have similar requirements e.g. macrophytes, will require similar environmental conditions therefore similar patterns in abundance.

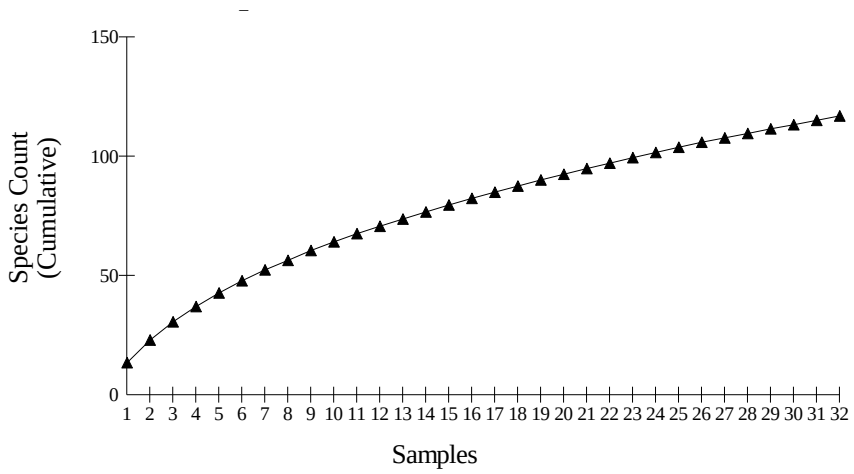


Figure 15: Species accumulation curve

4.2.1 New distribution range for *Rorippa palustris* in Kenya

There was a new plant record for Kenya in the family Brassicaceae known as *Rorippa. palustris* (L.) Besser (Figure 16), collector number Nyaboke B.827 which was collected in Maundu meri N 00º 19.556, E 36º 35.886, 1800 m.a.sl on a graze land with dead stumps of *Cyperus papyrus* L on black cotton soil on the margins of the

swamp. This is an erect or decumbent herb up to 40 cm high, simple alternate usually pinnate lobed leaves, which clasp at the base, the inflorescence is a terminal raceme, flowers yellow about 2mm

4.2.2 Species distribution patterns

Figure 16: *Rorippa palustris* (L.) Besser
Source; B.Nyaboke.

The standard deviations for component 1 and component 2 are displayed in (figure 17). Each site was unique in their own way but Thome was visually unique compared to the others, which by length and direction of arrows are a bit similar. There were 117 species in all the four sites that were similar, hence the crowding at the center. *Cynodon nlemfuensis* and *Cyperus rotundus* are strongly present in Container village whereas *Cyperus exaltatus* and *Leersia hexandra* are more common in Thome village

4.2.3 Multi-Dimensional Scale ordination

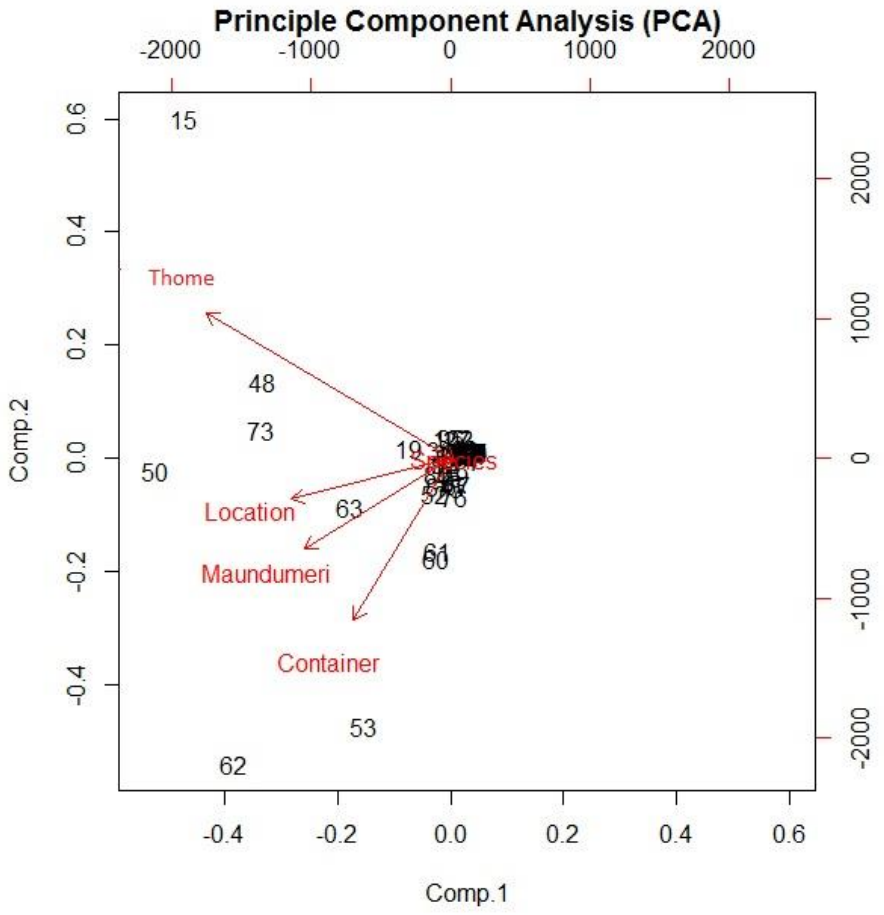


Figure 17: Principle Component Analysis of Species Distribution in Ewaso Narok

The similarity is seen by the distance of the plots from each other (Figure 18). The wider the gap, the higher the dissimilarity. A decrease in similarity means an increase in B-beta diversity.

Whereas there is an unclear visual separation of plots according to sample zones, two distinct clusters defined by habitat type form. (as indicated by a red circle- pristine and the green circle- grazing). Another major observation is that samples from Thome (red labels enclosed by the rectangle) are more similar to each other irrespective of the habitat type.

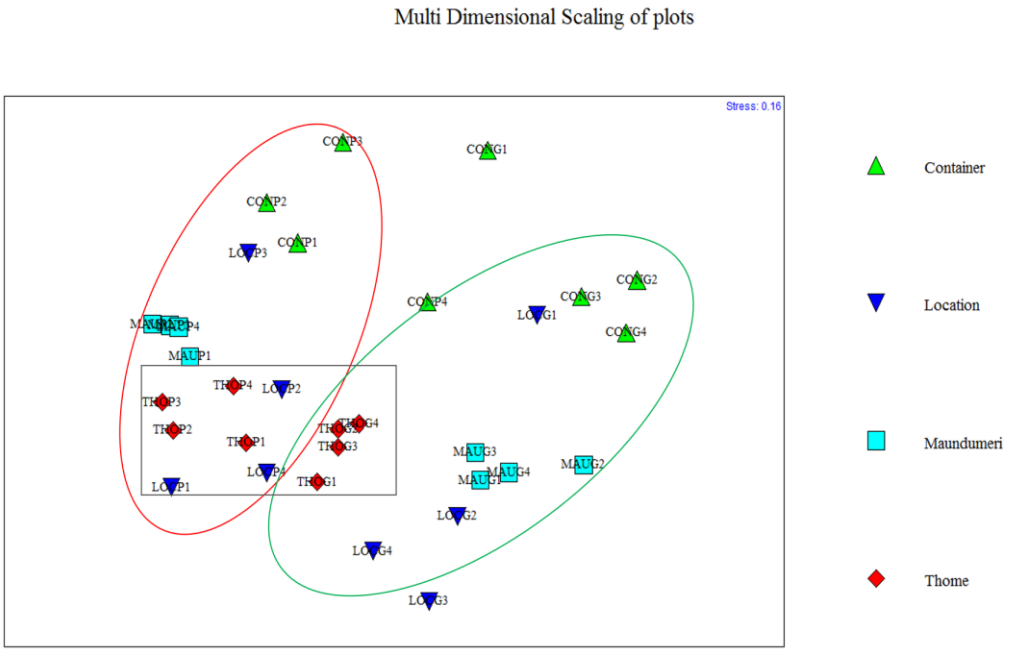


Figure 18: Multi-Dimensional Scaling of plots

Over 22000 individual plants of varying lifeforms but mainly herbaceous were counted. The computation of the Shannon Weiner diversity index was 2.71 ±1.95 and the species evenness index was 0.64±0.58, Species richness of 7.69±3.23. as shown in Table 10. Location village had the highest species diversity whereas Thome village had the lowest species diversity.

Table 11: Plant diversity indices

	Container	**Location**	**Maundu Meri**	**Thome**
No. of species (S)	54	68	34	29
No. of individuals (N)	5656	6070	4493	5896
Species richness (d)	6.13	7.69	3.92	3.23
Species evenness (J')	0.60	0.64	0.58	0.58
Diversity index (H')	2.40	2.71	2.03	1.95

The number of species within the two vegetation types in the four villages were compared and Maundu meri pristine had the lowest number of species and location grassland had the highest number of species as shown in table 11 below. In heavily silted wetland areas species such as *Typha latifolia* thrive, in the four areas sampled, the presence of *T. latifolia* was recorded in Location village, which is near the Rumuruti Township, and farming was very extensive in this area.

Table 12: Plant diversity on the pristine and grassland plots

	CONG	**CONP**	**LOCG**	**LOCP**	**MAUG**	**MAUP**	**THOG**	**THOP**
No. of species (S)	30	41	48	37	30	11	25	14
No. of individuals (N)	3895	1761	3269	2801	3170	1323	2040	3856
Species richness (d)	3.51	5.35	5.81	4.54	3.60	1.39	3.15	1.57
Species evenness (J')	0.60	0.69	0.64	0.60	0.55	0.19	0.64	0.54
Diversity index (H')	2.03	2.55	2.49	2.15	1.89	0.45	2.04	1.42

Key

CONG-Container village grazeland

CONP-Container village pristine

LOCG-Location village graze land

LOCP- Location village pristine

MAUG Maundu meri village grazeland

MAUP -Maundu meri Pristine

THOG-Thome village graze land

THOP- Thome village pristine

4.3 Land use

There were seven land-use classes in Ewaso Narok wetland namely; Cyperus papyrus zone, *Cyperus exaltatus/rigidifolia* zone, *Cynodon/Digitaria* zone, Fallow/bareland zone. Cropland, water, and built-up zones as shown in Figure 19

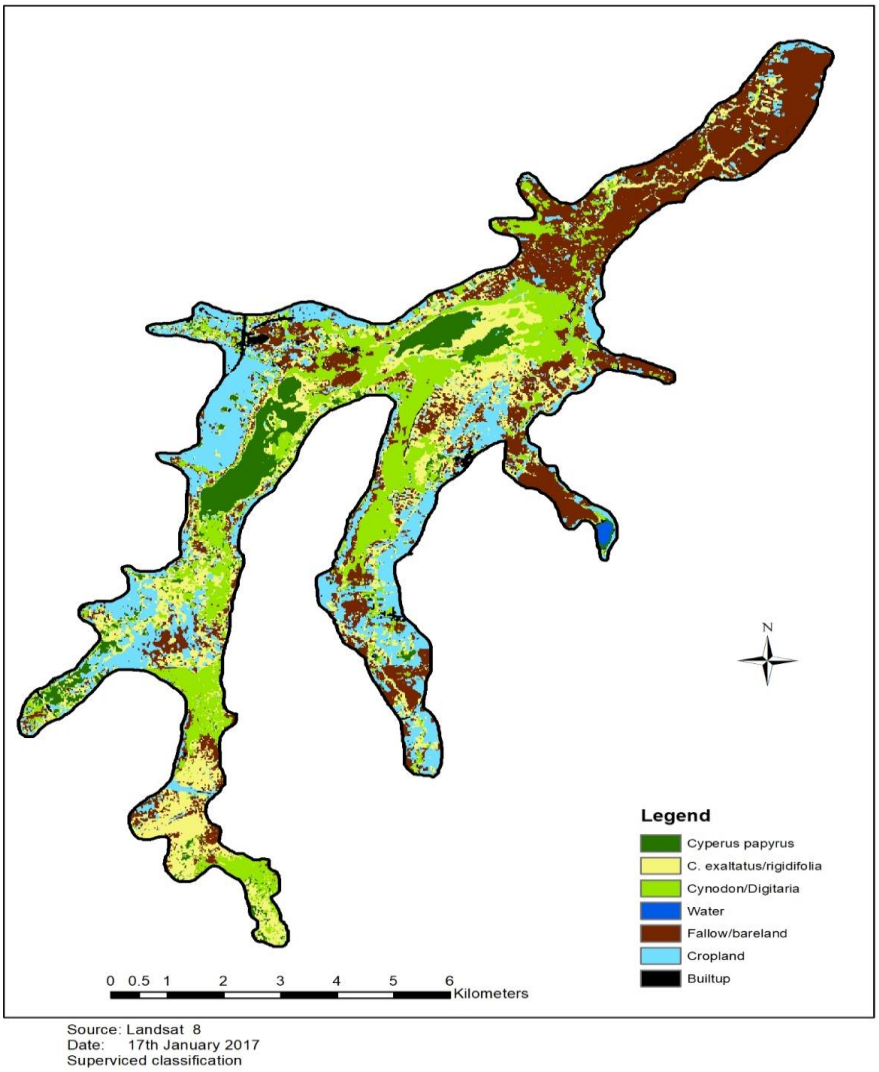


Figure 19: Land use map for Ewaso Narok Swamp

Source: Field Data 2017

The graphical representation of the landuse shows fallow/bareland and cropland had the highest area coverage as shown in Figure 20

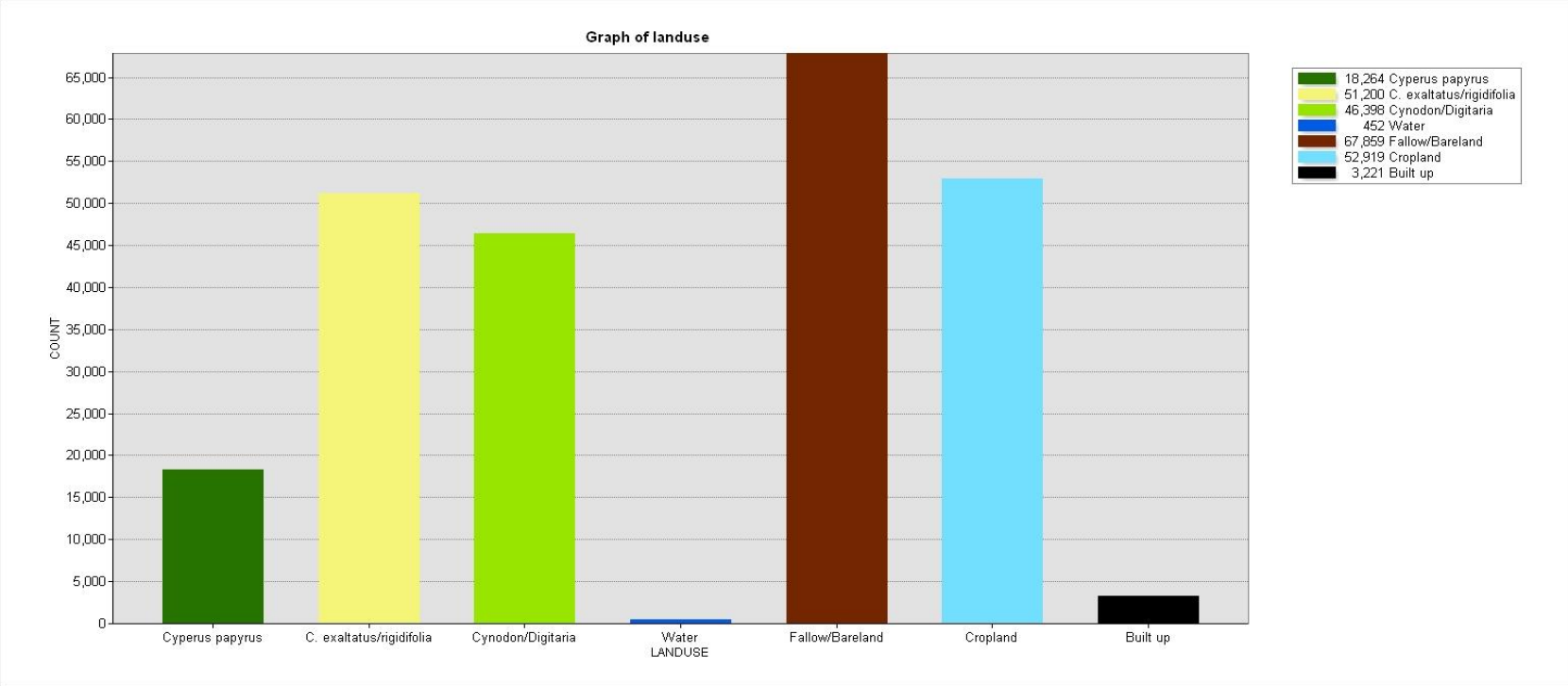


Figure 20: Graphical representation for the land use

4.3.1 Conflict OverResource Use

Livestock from one county where grazing is paramount can cross into another county and interfere with farming on which the economy in that region significantly depend. The fact that some farmers are temporarily in the swamp, they do not care about destroying other farmer's crops or even graze the crops. Figure 21 is showing livestock grazing while unattended near cultivated land. Such incidences have resulted in farmers keeping watch of their farms to keep away the livestock from destroying their crops.

There are two to three conflict cases per week between farmers and pastoralists (*pers. Comms* Johnson Eynae, Chief, Thome). Emphasis to be placed not only on conflicts occurring within the wetland but also between wetlands and adjacent areas. Due to the reduction of pastures in the swamp, the herders moved to the nearby ranches hence exuberating the conflict which was reported in the local newspaper (Daily Nation 18/9/2016)

Figure 21 Livestock grazing near a farmland

4.3.2. Land Use and Land Cover Change

This study recorded extensive conversion of natural vegetation to agriculture, the most notable change that have occurred is the reduction in the size of the swamp and the satellite images confirm this fact. Land-use changes by conversion of natural vegetation to farms and fallow land have been on the increase. This eventually leads to biodiversity loss (Verhoeven & Setter 2010) and the reduction of ecosystem services. The high food production intensity in the wetland is attributed to the horticultural farming of crops like tomatoes and French beans

The land use classes were easily identified as the study involved ecological assessment of the pristine *Cyperus papyrus* habitat and the adjacent grazing land, which was dominated by *Cyperus exaltatus* and *Cyperus rigidifolius* and immediate after *Cynodon nlemfuensis* and *Digitaria sp*. Further away there is farmland and fallow/ barren land. The Landsat images of 2002, 2010 and 2017 showing the type of human activities involved in land use over a period of 15 years by providing land cover (Figure 22).

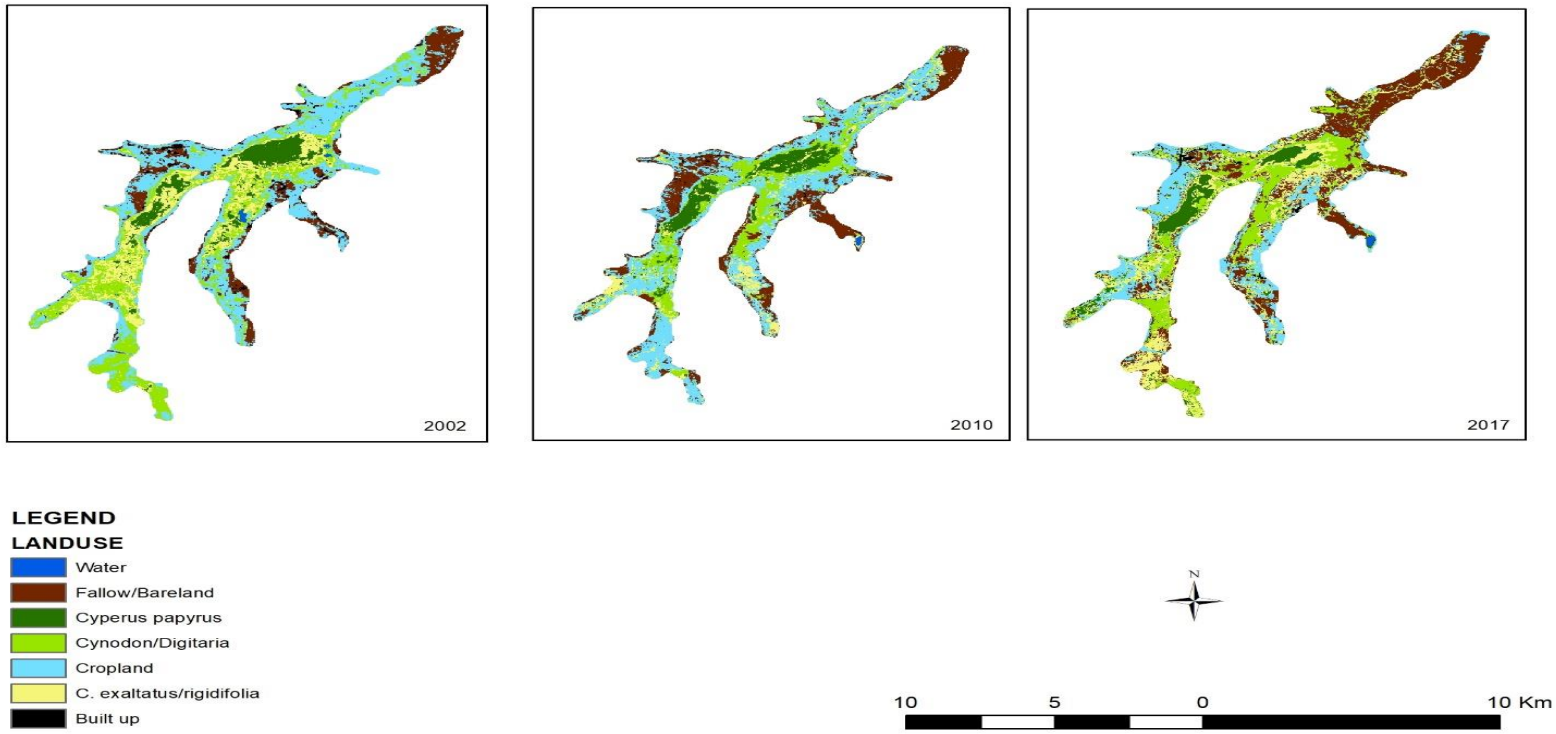


Figure 22: Wetland use between 2002 and 2017

Source: Field Data 2017

As seen in Figure 23, the study established that in the year 2010 *Cyperus papyrus* had slightly increased though in the same year the other *Cyperus* species had declined. This data shows that *Cyperus papyrus* is inversely proportional to *C. exaltatus* / *C. rigidifolius* community. Cropland hit the highest mark in 2010 though there was a decrease in the built-up area. This disparity could be because most of the farmers around the swamp do not necessarily live around the wetland, they would commute to their farmland when necessary.

The land is communal hence the residents do not have title deeds to the land thus the

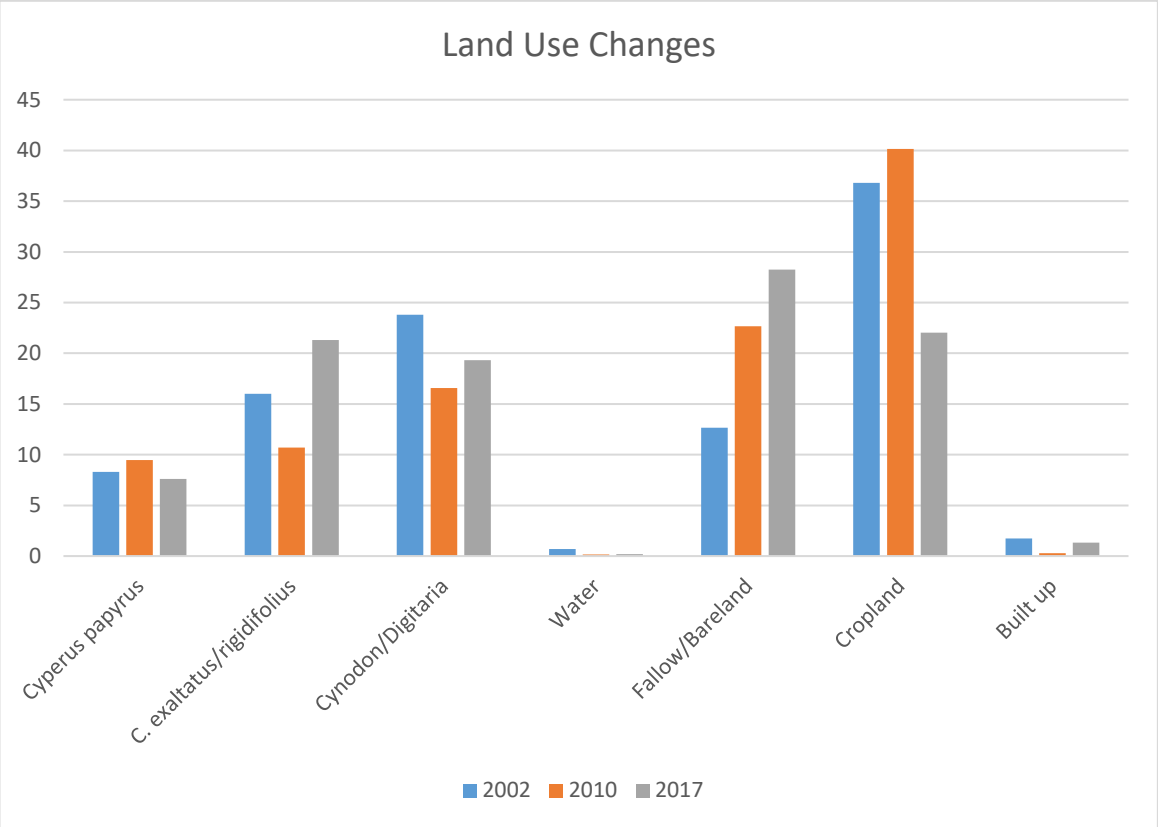


Figure 23: Comparison of wetland cover between the 2002 and 2017

built-up area will be very minimal. The increase in built-up houses in 2017 was necessitated by the conflicts between the herders and the farmers and this led to some of the farmers living close to their farms, though there have been efforts by the WRMA to push for gazettement of the swamp.

The need to provide basic needs such as food and shelter have influenced how we use the land as a resource. The increase in demand due to the ever-increasing population has to be balanced to ensure that there is no biodiversity loss and the ecosystems are able to perform their ecological function.

The highest land cover activities are cropland and fallow/bare land, this shows that the natural vegetation has been cleared to pave way for farming (Figure 24) which reduces the size of the wetland significantly and raises concern of the sustainability of the wetland in the future.

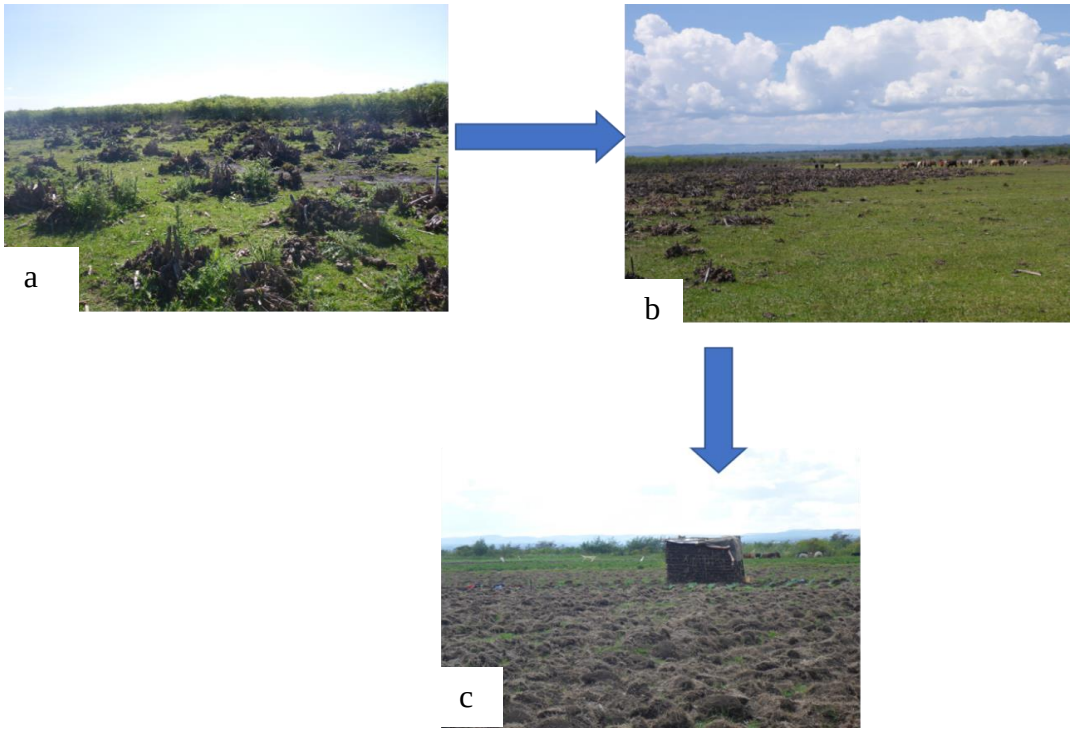


Figure 24: Sequence of wetland conversion a) Papyrus is burnt (b)The area with the burnt papyrus is left to dry (c)The area is then ploughed

Tillage necessitates reclamation, which affects biodiversity and drainage; it leaves the area to no longer be considered as a wetland. The pristine species are replaced by secondary vegetation which is much more diverse though most being weedy species and sometimes invasive.

4.4 Household survey on change over time

In the household survey, the 79% of the respondents agreed that they have seen changes in the wetland over time and 21% have not seen any changes (Table 13). The recent immigrants, who have been in the area for less than five years and would not see any major changes, could bring up this disparity. However, the people who have lived around the swamp long enough were definite about the major changes that have taken place over the time.

Table 13: Positive and negative changes on the wetland as observed by residents

Positive differences observed over time	**Frequency**	**%**	**Negative differences observed over time**	**Frequency***	**%**
Increased crop production	66	36.3	Increased number of wetland users	86	25
Increased irrigation practices	26	14.3	Reduced water levels	85	24.7
Increased livestock rearing	18	9.9	Vegetation loss	85	24.7
Reduced flooding	15	8.2	Prolonged droughts	45	13.1
Mechanized farming	9	4.9	Increased livestock and crop diseases	29	8.4
Increased income through farm produce	8	4.4	Disappearance of wild animals	9	2.6
Increased utilization of the wetland	8	4.4	Increased water pollution	3	0.9
Reduced human-wildlife conflicts	8	4.4	The disappearance of some crops such as sugarcane	2	0.6
Improved soil fertility	7	3.8		-	-
Increased agroforestry	7	3.8		-	-
Reduced pest attacks	3	1.6		-	-
Increased utilization of the swamp	2	1.1		-	-
Introduction of new species	2	1.1		-	-
Decreased pesticide use	2	1		-	-
Adequate drainage	1	0.5		-	-
Total	**182**	**100**	**Total**	**344**	**100.0**

Source: Field Data 2016

*Table represents open-ended question from the quantitative survey on positive and negative changes that have been observed over time.

Increased wetland uses due to increased population had the highest mention on the changes of the swamp at 35.1% (Table 23). The introduction of new crops and mechanized farming contributed to 12% of the perceived changes in the area. This is mainly through diversification and intensification, which was driven by the market opportunities, and household demands. Though it was not so clear the difference between climate change and drought, they would use them interchangeably as the farmers would associate the lack of rain to climate change. When the respondents were further questioned on how the government policy had contributed in the changes observed, it could be summarized to having a functional land tenure policy.

Table 14: Causes of the wetland changes

Causes of observed wetland changes	**Frequency**	**Percent**
Increased wetland uses due to increased population	88	35.1
Climatic change	53	21.1
Drought	51	20.3
Mechanized farming	19	7.6
Government policy	10	4.0
Introduction of new crops	10	4.0
Poor farming methods	8	3.2
Deforestation	6	2.4
Floods	3	1.2
Increased irrigation	1	0.4
Insecurity	1	0.4
New ideas from immigrants	1	0.4
Total	**251**	**100.0**

*Table represents the open-ended question from the quantitative survey on causes of wetland changes.

CHAPTER FIVE: DISCUSSION

5.1 Indigenous knowledge on the use of resources in Ewaso Narok

This study on Ethno ecological approach was used as it is not only list-making of the useful plants but the systematic research into the local ecological knowledge which addresses the theoretical questions about the relationships between humans and their environment. The communities around the wetland have rich knowledge on useful plants, the pastoralists had a long list of the medicinal species they use but the limitation for this study was to record the species found in the wetland. Most leafy vegetables are herbaceous annuals, which grow very well around the wetland, 32 % of the useful plants in the wetland were vegetables. African Leafy vegetables are rich in minerals and they play a significant role in the day-to-day food and nutritional requirement in the rural areas. Opportunities, challenges, and risks are some of the factors that influence the decisions in agro-pastoral systems

5.1.1 The use categories

The fodder species were mainly the sedges, which were cut and transported to the livestock or the livestock were brought to the wetland to feed. The *Cyperus papyrus* grows very tall and the animals are not able to eat the stalks; during the study, it was observed that the herder would cut; the papyrus to enable the cattle feed on the leaves and the flower, which are usually at the uppermost.

The root decoction of *Carissa spinarum* has been reported to treat malaria, polio symptoms, chest pain, arthritis, rheumatism, gonorrhoea, constipation, yellow fever and epilepsy (Kokwaro, 2009)

Ajuga remota was a highly ranked medicinal plant; a decoction is made from these plants and used to treat malaria. The lifecycle of a mosquito depends on stagnant water, which makes wetlands an ideal place for their multiplication. According to Cocquyt *et al.,* (2011), 66% of the herbalist in Kenya recommends the use of *Ajuga remota* for the treatment of malaria, fever, and infections. The burden of drug-resistant parasite has led many people into herbal remedies; the ajugarin-1 and other phytoecdysteroids

present in *A. remota* have shown to be effective in inhibition of both the chloroquine-sensitive and resistance *Plasmodium falciparum* (Kuria *et al.,* 2002; Cocquyt *et al*., 2011).

5.1.2 Documentation of the existing Indigenous knowledge in Ewaso Narok

There was a high level of awareness of the existing 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.

a) Roofing and mat making

Roofing and mat making was a practice that was once very common but with modernization, most of the houses now have iron sheet roofs as opposed to the *Cyperus* thatch. The exceptions are tourist hotels and the ranches who are the main consumers of the *Cyperus papyrus* from the swamp. The women groups in the villages adjacent thus earn a living by harvesting the papyrus and supplying to the ranches. The practice of controlling where to burn is done when there are large orders by the adjacent ranches for the "makuti" as this will leave less papyrus for burning

b) Provision of Livestock grazing

The Indigenous knowledge that determines the time of the year to move their livestock into the swamp and outline which areas of the swamp that can comfortably provide sufficient feeds for their animals. The amalgamation of these practices enabled the grass near the swamp to regenerate when the rainy season starts. The areas where the burning took place in the dry season, palatable young shoots would emerge just after the rains. According to pastoralists, the burning was beneficial to them, but from a conservation point of view, the burning reduces the biodiversity in the area.

c) Crop and soil management

This study established different farming systems put into practice to not only ensure a constant supply of food but also improve soil quality. Crop diversification is an important strategy to agroecology (Alteri 2002; Lin,2011) as it promotes beneficial

biological interactions such as regeneration of soil fertility, high productivity, crop protection, and increased yield.

This study established mixed farming was done for the following reasons; to ensure constant food supply, ensure there is enough cover on the soil which reduces soil erosion and improves soil fertility through increased soil organic matter. Maize is used as a hedge plant to assist in pest and disease management through the 'push and pull' phenomena. The choice of the trailing sticks for the tomatoes was particular on the species that were termite resistant and could be used in the subsequent planting seasons. Parrotta *et al.*, (2015), complex forest and associated ecosystems based on traditional knowledge including shifting cultivation and agroforestry systems ensures the societal needs are met without jeopardizing the biodiversity and functionality of the associated ecosystems

d) Other practices

i) Use of medicinal plants; the knowledge on which species treats was for few knowledgeable people, who knew which herbs to use especially for the prevalent diseases. There were plants used in Ethnovertinery such as aloe sap, which was mainly being used by the poultry farmers, and *Ajuga remota* for ectoparasites (Njoroge & Bussman 2006). The availability of healthcare facilities has reduced the dependency of medicinal plants over time.

ii) Fish farming was not a very common practice, the young boys would fish as a pass time (iii) Beekeeping; there were few farmers with beehives, (iv) The introduced fodder trees and shrubs such as *Calliandr*a and *Leucaena* were some of the species being used for agroforestry.

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

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).

This study shows information is mainly acquired informally through participation in the task, narrations, and observations. Inherited knowledge played a minimal role on the drainage and cultivation, since cultivation in the study area was initiated within the participant's lifetime, however direct observation and personal communication was a key source of knowledge in wetland use. 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.

5.1.4 Contribution of IK in Ewaso Narok wetland utilization

The communities surrounding the Ewaso Narok swamp are diverse and this has been demonstrated by the blending in of the extant knowledge with the knowledge of the emigrants to the area. The trial and error practice have been seen as most users of the wetland would pick up a practice that was successfully applied by their neighbors.
This research has established there is a direct correlation between the possession of IK and 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).

The knowledge on the conservation of important indicator species such as *Cyperus papyrus* ensures the integrity of the wetland is maintained. 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.

The rotation for grazing land within the swamp will not be highly affected as the grazing communities only use the wetland as a dry season grazing land. During the wet season, they do not graze their cattle in very wet areas; this could probably change with time if the free grazing land becomes inaccessible especially given that the private ranches own a majority of grassland in the area. Since it is not possible to keep off the farmers and pastoralists from the wetland, sustainable agriculture can be promoted as

it allows for food production to go on without causing severe or irreversible damage to the wetland ecosystem character (Verhoeven & Setter 2010)

5.2. Floristic composition

Cyperus papyrus had the highest overall relative density (14.5%) and a potential of over a million individuals in the entire sampled area. *Cynodon nlemfuensis* was second in density followed by *Azolla filiculoides*, which did not occur in all the areas but was in high density as it was in bloom. Others with high occurrences are graminoids such as *Leersia hexandra* and *Digitaria abyssinica*, sedges such as *Cyperus exaltatus* and *Cyperus rotundus* second after *C. papyrus*

The survey showed clear zonation of the plant community as is commonly observed in wetlands. *Cyperus papyrus* was the dominant species in the pristine plot; it forms a monoculture with a light green canopy that looks like a fluffy blanket from above. Papyrus has one of the highest growth rates from young shoot to senescence stage optimally in 12 months (Terer *et al.,* 2012) and it is a unique indicator species .wherever *papyrus* grows there are permanent swamps and standing water in the vicinity. They form a habitat for birds, animals, and insects. From the four villages sampled, low diversity prevailed in all zones (< 3). Location was the most diverse while Thome was least diverse; a scenario that was reflective on the number of species occurring at sites.

5.2.1 New distribution range for *Rorippa palustris* (L.) Besser in Kenya.

R. palustris is a cosmopolitan plant, native to parts of Africa, North America, Europe, and Asia. The IUCN conservation status for this species is Least Concern (LC) as it is a widely spread species, though according to the East African Herbarium records this species has only been collected in Ethiopia. The Flora of East Africa, (1952-2012) records 6 species of *Rorippa* namely *R. cryptantha, R madagascariensis, R micrantha,*

R nudiuscula, R. nasturtium-aquaricum and *R. microphylla*. Five of the above-mentioned species occur in Kenya with exception of *R. madascariensis*, which only occurs in Uganda and Tanzania. The extended distribution of this species could have been because of the cattle trade from Ethiopia to Isiolo and then to Rumuruti (Gituku *et al.*, 2015) The Palaearctic-African bird migration systems could be a probable mode of dispersion (Moreau 1972; Hahn 2009). The Marsh warblers have been traced to migrate from Europe, make a stopover in Ethiopia and move further south into Kenya in Tsavo west National park (Pearson 2014)

5.2.2 Species distribution patterns

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. The two habitats sampled (pristine and grassland) in the four villages were expected to form two distinct clusters in the Multi-dimensional scaling of the plot. This was not observed because of excessive land conversion leaving a very thin strip of intact *Cyperus papyrus* and *Cyperus exaltatus*, and a large area covered by *Cynodon nlemfuensis* and *Digitaria abyssinica*. Thome village had the highest number of similar species regardless of the habitat. The data on the awareness of available on IK practices showed Thome had the highest number of people who did not have any Indigenous knowledge (25%).

5.3 Land use

The increasing population puts a clear demand on the land, which is constant. Rapid land-use conversion is inevitable and this directly influences the land adjacent to the swamp as it is viewed as communal land, which can be exploited to generate extra food or income. The conversion is usually done in stages where the pristine papyrus blocks are burned first to kill the rhizomatous roots, this is followed by letting the area be grazed for a while before finally cultivating it. There has been a shift from purely pastoral to agro-pastoral system due to the quick returns made from the farming of

crops such as tomatoes. Access to extensive communally owned public land for grazing is key for the pastoralists, but due to the land pressure, the pastoralists are forced to diversify their livelihoods to agro-pastoralism.

The results in Figure 23 concur with 1985-2015 Landsat images form Muriuki *et al.,* (2016) giving 7% reduction in papyrus vegetation,14% reduction of grazing land,4% increase of fallow land and 16% increase in cropland.

Increase in human population is automatically a cause of resource use conflicts in wetlands, some statutes are biased towards a certain type of resource use at the expense of others. Excessive grazing by livestock causes soil compaction with resultant increased run-off and siltation, which reduces water quality. The breakdown of the Indigenous Knowledge system and traditional resource management methods is also contributing to wildlife-human conflict. Conflict resolution skills are not well developed at the regional, national and local levels nor are there adequate opportunities for the acquisition of the skills. As resource use conflict escalates, the integrity of the wetland ecosystem and the biodiversity are threatened to increasing degrees.

5.4 Household survey on change over time

Some of the positive changes given by the farmers were in reference to their livelihood and not necessarily about the conservation of the wetland. For example, the intensification of crop and livestock production has occurred in terms of quantity and quality, which has been driven by the fulfillment of local priorities and preferences.

According to the area chief and the locals, the decrease of the swamp could be due to

a) The influx of new people after 2010 from the other areas. However, from the satellite imagery, there was no significant increase in the built-up area, as most farmers would commute to their farms.
b) Pesi river was a reliable source of water for the farmers upstream, but for the last three years since 2014, the river has been seasonal hence the farmers upstream have moved to cultivate on the swamp and increased the pressure on swamp.

c) Once the employees from the adjacent are laid off, they go and settle around the swamp
d) Settlement of some Internally displaced persons after the Post-Election Violence in 2007/2008

The Ramsar Convention has helped in the protection of wetlands, which supports biodiversity, improves water quality. Carbon sequestration and flood abatement are some of the functions impaired when wetlands are degraded (Zedler &Kercher 2005). The poor communities in developing countries are enticed to the wetlands due to the fertile soils, availability of pasture, and all year supply of water for both the crops and the animals and the potential to develop a livelihood beyond the subsistence level. Human activities need to be understood and integrated into conservation strategies for sustainable resource management (Junker *et al.*, 2015) Ramsar (2018b) highlights drainage, water pollution, disrupted flow regimes, introduction of invasive species and unsustainable use has compromised the quality of remaining wetlands

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Ewaso Narok wetland is characterized by high α-diversity in the grasslands and the *Papyrus* zones. The distinctive wet habitats offer an ideal opportunity to preserve diverse communities within a small area of land, hence the clamor to protect these habitats regardless of the size. The discovery of a new range of distribution of *R. palustris* in this study is very important to science as it gives insight on the occurrence of species, which are weedy in nature and might turn out to be invasive in the future. Continuing globalization with the increase in trade across borders has its negative effect of spreading Invasive Alien Species which is one of the threats for ecological and well-being of the planet

The small-scale farmers in Ewaso Narok wetland possess an extensive base of IK and this has been demonstrated on how they utilize the resources and the adaptation strategies they possess especially in forage resource management. The Knowledge and communication channels in this study were both intergeneration (parents to children) and lateral (among peers and from place to place). The self-regulatory indigenous practices are acquired and practiced to reduce conflicts when the resources are limited, in this context the limiting factors in the swamp is farming land and grazing land.

The Ewaso Narok wetland is surrounded by a rather densely populated landscape with people who are highly dependent on the different resources it has; this scenario heightens the tension between conservation aims and livelihoods. Integrated Natural Resource Management (INRM) will ensure improved livelihoods through agricultural productivity and at the same time warrants agro-ecosystem resilience and the ecosystem services available. When planning for sustainable development, the conservation of wetlands through wise use should be taken into consideration by the decision of the policymakers

Sustainable intensification of agriculture around the wetland can be anchored on agricultural policy, which will ensure functional land tenure policy, improved access to the quantity and quality seeds and good strategies of restoring soil fertility.

This study nullifies the hypothesis that Agro -pastoral Indigenous knowledge does not exist in Ewaso Narok swamp and it has not made any substantial contribution to the sustainable use and conservation of the wetland.

6.2 Recommendations

- The keystone species such as the *Cyperus papyrus* need to be protected as they maintain the wetland integrity. The elimination of *C. Papyrus* in the wetland ecosystem,opens up to emergence of other species such as *Cyperus exaltatus* and *Cyperus rigidifolius*
- Incorporation of human activities into an integrated conservation strategy so that the ecosystem services are available without the degradation of the environment. The use knowledge possessed by the farmers on the processes of wetland degradation and regeneration, hydrological variation and vegetation develop a range of adaptive wetland practices, which can support environmentally sustainable use of the wetland.
- Ewaso Narok wetland is communal land thus property rights need to be defined, open access makes it difficult for conservation efforts to be effective as commons will be degraded sooner than later. Provision for economic incentives for conservation can be introduced by controlling the use and access to the wetland, this can be effectively achieved by coordination of the national laws with the local rules e.g. by selecting the village elders to be in charge of enforcing traditional rules.

- Ewaso Narok Wetland, being a small wetland needs to be gazetted as a protected area.as the development of management plans takes so long and it will be too late to save the wetland.

6.3 Suggestions for Further Research

- It would be interesting to know whether some knowledge systems are more important or valuable than others.
- Find out the application of IK in answering other societal challenges and predicaments threatening food, nutrition, and human security.
- Conduct the spatial analysis on the main drivers of land-use change with the current demographic data to be collected in the census 2019 combined with thorough ecological and socio-economic data.

REFERENCES

Agrawal, A. (1995). Dismantling the divide between indigenous and western knowledge. Development and Change 26:413-439.

Ajibade, L.T. (2003). In search for methodology for the collection and evaluation of farmers' indigenous environmental knowledge, INDILINGA: African Journal of Indigenous Knowledge System, No 2. 99-113. www.ajol.info/index.php/indilinga/article/view/47002 Accessed on April 2016

Altieri, M.A. (1995). Agroecology: the science of sustainable agriculture, Westview Press, Boulder, CO, USA.

Altieri, M. A. (2002). Agroecology: the science of natural resource management for poor farmers in marginal environments. *Agriculture, Ecosystems and Environment*, 93: 1–24.

Alvarez, M.**,** Becker, M., Böhme, B., Handa, C., Josko, M., Kamiri, H.W., Langensiepen, M., Menz, G., Misana, S., Mogha, N.G, Möseler, B.M, Mwita, E.J., Oyieke, H.A. & Sakané, N. (2012). Floristic classification of the vegetation in small wetlands of Kenya and Tanzania. *Biodiversity and Ecology* 4: 63–76.

Barbier, E.B. (1993) Sustainable use of wetlands. Valuing tropical wetland benefits: Economic methodologies and applications.*The Geographical Journal 159(1)* (3): 22-32.

Berkes, F. (2012) sacred ecology 3rd Ed. New York, Routledge.

Berkes, F., Colding, J., Folke, C. (2000) Rediscovery of Traditional Ecological Knowledge as Adaptive Management. *Ecological Applications*, 10(5), 1251–1262

Boven, K. & Morohashi, J. (2002) Best practices using Indigenous Knowledge. UNESCO/MOST Paris France

Brose, U., Hillebrand, H. (2016) Biodiversity and ecosystem functioning in dynamic landscapes. *Phil. Trans. R. Soc. B* 371: 20150267. http://dx.doi.org/10.1098/rstb.2015.0267 Accessed on July 2018

Chambers, R. (1994). The origins and practice of participatory rural appraisal, *World Development*, 22 (8):953–969.

Clarke, K.R., Gorley, R.N., (2006). PRIMER v6: User Manual/Tutorial. PRIMER-E, Plymouth, 192pp.

Cocquyt, K., Cos, P., Herdewijn, P., Maes ,L., Van den Steen, P. E., Laekeman, G. (2011). *Ajuga remota* Benth.: From ethnopharmacology to phytomedical perspective in the treatment of malaria, *Phytomedicine*, Vol 18 (14) 1229-1237

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin ,R.G., Sutton ,P., van den Belt M (1997) The value of the world's ecosystem services and natural capital. *Nature* 387: 253–260.

Daily Nation 18/9/2016 Samburu herders clash with Laikipia ranchers over pasture https://www.nation.co.ke/counties/laikipia/Herders-ranchers-clash-Laikipia/1183290-3385758-format-xhtml-gsij6az/index.html

Dixon, A. (2005). Wetland Sustainability and the Evolution of Indigenous Knowledge in Ethiopia. *The Geographical Journal*, *171*(4), 306-323.

Dixon, H.J., Doores, J.W., Joshi, L., Sinclair,F.L.(2001) Agroecological knowledge toolkit for Windows :methodological guidelines, computer software and manual for AKT5. Bangor, UK: School of Agricultural and Forest Sciences, University of Wales. http://akt.bangor.ac.uk/documents/AKT5manual.pdf.

Delang, C.O. (2006). Not just minor products: The economic rationale for the consumption of wild food plants by subsistence farmers. *Ecological Economics* 59:64-73

Forman, L. & Bridson, D. (1992). The herbarium handbook. Royal Botanic Gardens, Kew.

Flora of Tropical .East .Africa, (1952-2012). Flora of Tropical East Africa. Royal Botanic Gardens, Kew, London.

Gituku, C., Wasonga, V.,Ngugi, K. (2015). Economic contribution of the pastoral meat trade in Isiolo Town, Kenya IIED Country Report IIED, London. http://pubs.iied.org/10124IIED Accessed on April 2018

Gomez-Baggethun, E., Corbera, E., Reyes-Garcia, V. (2013) Traditional ecological knowledge and the global environmental change: research findings and policy implications. *Ecology and Society* 18(4):72.

Gomez-Baggethun, E., Reyes-Garcia, V. (2013) reinterpreting change in Traditional ecological Knowledge *Human Ecology*.41 (4).643-647.

GISP, (2004) Africa Invaded, The growing danger of invasive alien species. (http://www.issg.org/pdf/publications/GISP/Resources/AfricaInvaded.pdf). Accessed June 2016

Glowka, L. (1994) A guide to Convention on Biological Diversity, IUCN Gland, and Cambridge. pp 161

Government of Kenya, (GoK) (1999) Environmental Management and Coordination Act No 8.

Government of Kenya, (GoK). (2009) The Environmental Management and Co-ordination (Wetlands, River Banks, Lake Shores and Sea Management) Regulations Government of the Republic of Kenya Legal Notice No. 19

Grenier, L. (1998). Working with indigenous knowledge: a guide for researchers, IDRC, Ottawa.

Hahn, S., Bauer, S., Liechti, F. (2009). The natural link between Europe and Africa – 2.1 billion birds on migration. *Oikos*. Vol.118. pp 624 - 626.

Handa, C. (2011) Vegetation based indicators of used wetlands in East Africa. Bonn: Rheinischen Friedrich-Wilhelms-Universität, Bonn. pp 106.

Hardin, G. (1968) The Tragedy of the Commons *Science*, Vol. 162, No. 3859 (Dec. 13, 1968), pp. 1243-1248 http://www.jstor.org/stable/1724745 Accessed on April 2016

IUCN/UNEP/WWF, (1991) Caring for the Earth. A Strategy for Sustainable Living. Gland, Switzerland. (https://portals.iucn.org/library/efiles/edocs/CFE-003.pdf). Accessed on August 2017

Junker, J., Boesch, C., Mundry, R., Stephens, C., Lormie, M., Tweh, C., Kühl, H.S. (2015). Education and access to fish but not economic development predict chimpanzee and mammal occurrence in West Africa. *Biological Conservation*, 182: 27-35.

Kariuki, F.W. (2015) Inter-Ethnic Conflicts: Trends, Causes, Effects and Interventions in Rumuruti Division of Laikipia County, Kenya (1963-2010). A thesis submitted to Kenyatta University.

Kansakar, P., Hossain, F. (2016) A review of applications of satellite earth observations data for global societal benefit and stewardship of planet earth. *Space policy* 36, 46-54.

Kokwaro, J.O (2009) Medicinal Plants of East Africa. Third Edition, Nairobi. University of Nairobi Press.

Kuria, A.M.K, Chepkwony, H., Govaerts, C., Roets, E., Busson, R. de Witte, P. ,Zupko, I.,Hoornaert, G.,Quirynen, L, Maes, L., Janssens, L.,Hoogmartens, J. (2002). The Antiplasmodial Activity of Isolates from *Ajuga remota*. *Journal of Natural Products*, 65: 789-793.

Lin, B.; (2011) Resilience in Agriculture through Crop Diversification: Adaptive Management for Environmental Change, *BioScience*, 61(3): 83–193.

Martin, G.J. (1995) *Ethnobotany*: A Methods Manual. Chapman & Hall, London.

Mawere. M., Madziwa, B.F, Mabeza, C.M. (2013) Climate change and adaptation in third world Africa: A quest for increased food security in semi-arid Zimbabwe. *The International Journal Of Humanities & Social Studies* 1(2):14-22.

Moreau, R. E. 1972. The Palaearctic African bird migration systems. Academic Press

Mugenda, O. M., Mugenda, A. G. (2003). Research methods. Quantitative and qualitative approaches. ACT, Nairobi.

Mundy, P., Compton, J. L. (1995) Indigenous communication and indigenous knowledge. In D.M. Warren, L.J. Slikkerveer, D. & Brokensha (Eds.*), The cultural dimension of development: Indigenous knowledge systems* (pp. 112-123). London: Intermediate Technology Publications.

O'Connell, M. J. (2003). Detecting, measuring and reversing changes to wetlands. *Wetlands Ecology and Management*, 11(6):397-401.

Parrotta, J.A., Dey De Pryck ,J., Darko, O. B., Padoch ,C., Powell, B., Sandbrook, C. (2015). The Historical, Environmental and Socio-Economic Context of Forests And Tree-Based Systems For Food Security And Nutrition. In: Vira, B, Wildburger, C& Mansourian, S, (Eds). *Forests and Food: Addressing hunger and nutrition across sustainable landscapes.* Open Book Publishers. (http://books.openedition.org/obp/2778). Accessed on March 2017

Pearson, D., Brackhurst, G. and Jacson, C (2014) The study and ringing of Palaearctic birds at Ngulia Lodge, Tsavo West National Park, Kenya 1969-2012 an overview and update. *Scopu*s Special supplement No. 4

R Core Team, (2017). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. Version 3.4.2. https://www.r-project.org Accessed on June 2017)

Ramsar Convention on wetlands, (2010). The wise use of wetlands: Concepts and approaches for the wise use of wetlands. Ramsar handbooks for the wise use of wetlands, 4th Edition, vol. 1. Ramsar Convention Secretariat, Gland, Switzerland.

Ramsar Convention on Wetlands, (2018a). Global Wetland Outlook: State of the World's Wetlands and their Services to People. Gland, Switzerland: Ramsar Convention Secretariat.

Ramsar Convention on Wetlands, (2018b). Scaling up wetland conservation, wise use, and restoration to achieve the Sustainable Development Goals. Ramsar Convention Secretariat, Gland, Switzerland.

(https://www.ramsar.org/sites/default/files/documents/library/wetlands_sdgs_e.pdf) .Accessed February 2018

Raygorodetsky, G. (2011) Why Traditional Knowledge Holds the Key to Climate Change. United Nations University. https://unu.edu/publications/articles/why-traditional-knowledge-holds-the-key-to-climate-change.html Accessed on 18 September 2018.

Rÿser, R.C. (2011). Indigenous people and traditional Knowledge. Berkshire Encyclopedia of sustainability. (http://www.academia.edu/841635/Indigenous_and_Traditional_Knowledge). Accessed on October 2016

Russi D., ten Brink P., Farmer A., Badura T., Coates D., Förster J., Kumar R. and Davidson N. (2013) The Economics of Ecosystems and Biodiversity for Water and Wetlands. IEEP, London and Brussels; Ramsar Secretariat, Gland.

Schuyt, K.D, (2005) Economic consequences of wetland degradation for local populations in Africa, *Ecological Economics,* Volume 53, Issue 2, Pages 177-190,

Secretariat of the Convention on Biological Diversity, (2005). Handbook of the Convention on Biological Diversity Including its Cartagena Protocol on Biosafety, 3rd edition, Montreal, Canada.

Senanayake, S.G.J.N., (2006). Indigenous knowledge as a key to sustainable development. *Journal of Agricultural Sciences – Sri Lanka*, 2(1), pp.87–94. DOI:http://doi.org/10.4038/jas.v2i1.8117 Accessed on April 2016

Sillitoe, P. (2017). Indigenous Knowledge: enhancing its contribution to Natural Resource Management. CAB International

Sharma, R.C., Singh S. Macrophytes of sacred Himalayan lake Dodi Tal, India: quantitative and diversity analysis. Biodiversity Int J. 2017; 1(4):137–144. DOI: 10.15406/bij.2017.01.00020

Terer, T., Triest, L. & Muthama Muasya, A. (2012) Effects of harvesting *Cyperus papyrus* in undisturbed wetland, Lake Naivasha, Kenya *Hydrobiologia* 680:

135. (https://doi.org/10.1007/s10750-011-0910-2). Accessed on November 2018

Thenya, T., (2001) 'Challenges of conservation of dryland shallow waters, Ewaso Narok swamp, Laikipia District, Kenya', *Hydrobiologia* 458: 107.doi:10.1023/A:1013196500456

Thenya, T., Kiteme, B.P., Ouko, C.A., Kahiu, N., Njuguna, E. C., Karanja, F., Ojwang', D., Wambugu, G., (2011). Assessment of Ecological Status and Socio-economic Dynamic of Upper Ewaso Ng'iro Basin Wetlands. CETRAD.

UNESCO, (2010).The Power of Culture for Development, http://unesdoc.unesco.org/images/0018/001893/189382e.pdf Accessed on August 2018

UNSDG, (2015) Sustainable Development Knowledge Platform https://sustainabledevelopment.un.org/sdg15 accessed 10 November 2017

Verhoeven, J., Setter, T. (2010). Agricultural use of wetlands: Opportunities and limitations. *Annals of Botany*, 105(1), 155-163. Retrieved from http://www.jstor.org/stable/43576455

Verburg, P. H., Neumann,K., Nol, L.,(2011). Challenges in using land use and land cover data for global change studies. Global Change Biology, 17(2): 974–989.

Wiesmann, U., Gichuki, F.N., Kiteme, B.P, Liniger, H. (2000) 'Mitigating Conflicts Over Scarce Water Resources in the Highland-Lowland System of Mount Kenya', *Mountain Research and Development* 20: 10-15. DOI: http://dx.doi.org/10.1659/0276-474 (2000)020 [0010: MCOSWR]2.0.CO;2

Wood, A., Dixon A., McCartney, M. (2013). Wetland management and sustainable livelihoods in Africa. Abingdon: Routledge/Earthscan from Routledge; New York.

World Bank, (1997) "Knowledge and Skills for the Information Age, The First Meeting of the Mediterranean Development Forum"; Mediterranean Development Forum, URL: http://www.worldbank.org/html/fpd/technet/mdf/objectiv.html

Accessed on June 2018

Worm, B., Lotze, H.K., Hillebrand, H., Sommer, U (2002) Consumer versus Resource Control of Species Diversity and Ecosystem Functioning. *Nature* **417**, 848-851 DOI: 10.1038/nature0083

Warren, D.M., (1996) Indigenous Knowledge, Conservation and Development. Sustainable Development in the Third World Countries: applied and Theoretical perspectives ed. Valentine U.J 1996. Praeger Publishers, 88 Post Road West. USA

Zedler, J.B., Kercher, S. (2005) Wetland Resources: Status, Trends, Ecosystem Services, and Restorability. *Annu.Rev. Environ Resour*.30, 39-74

APPENDICES

Appendix I: Household survey datasheet

Prior informed consent was done verbally before any interview was taken and it was clear to the community that the information was purely for academic purposes and by no means for bioprospecting.

Household survey datasheet used at Ewaso Narok Swamp Laikipia

Date: _____

Qnaire No. _____

A. Background information

Respondent's name: _____ Location: _____

Village: _____ Division: _____

Community: _____ District: _____

How long have you lived in this village? _____

Where did you originally come from? _____

B: Household characteristics:

Respondent	Gender	Age	Marital Status	Education Level	Main Occupation	Relationship to household head
Person 1						

Size of family Children Adults Total

Children	
Adults	
Total	

Code	Character states
Gender	1=Male, 2=Female

Age	1=Adult, 2=Youth, 3=Children
Marital Status	1=Married, 2=Single, 3=Widowed, 4=divorced
Education Level	1=no formal, 2=Primary, 3=Secondary, 4=College, 5=Adult education, 6=Other (specify)
Main occupation	1=No occupation, 2=Farmer, 3=Others (specify)
Relationship to household head	1=Husband, 2=wife, 3=daughter, 4=son, 5=Relative, 6=Non-relative
Size of family	1=Adults, 2=Children

C: Overview of Household Resources:

Resource type	No/size
Land (acres)	
Crops cultivated	
Livestock-Cattle	
Sheep	
Goats	
Donkeys	
Chicken	
Others (specify)	

D: Sources of Income

Source	Unit Price (e.g., tins, kg, bundle etc.)	Quantity sold	Amount (KSh)
Crop sale (Name the crop)			
Livestock sales (name the livestock/ product sold			
Formal employment			

Other sources of income			

E: Wetland utilization

a) What resources do you get from wetland?

Water	
Fodder	
Medicinal species	
Others (specify	

Rank 1=very important;2=important; 3=intermediate(alternative);4=Least (last option)

b) How regularly do you get these resources from the wetland?

Water	
Fodder	
Medicinal species	
Others (specify	

c) Name the species harvested from the wetland used for food fodder, medicinal, Building, others(Specify)

Species Name	Use

d) Who collects the materials (Gender /Age)?

_____

e) Who are the main consumers of products from the wetland (Men /Women /Youth)?

_____

f) Do they collect for household use or for monetary value?

_____-

F) Indigenous knowledge systems

a) Do you know any indigenous knowledge practices on the utilization of the wetland?

Yes No

b) Elaborate the various indigenous knowledge practices you are aware of

_____

_____

_____

c) Of the above-mentioned indigenous Knowledge practices, which one is still in use

_____

_____

_____

d) Are there any indigenous knowledge practices that you came with before settling in Ewaso Narok and you are applying?

Yes No

e) If yes state which ones

_____

_____

_____

f) How did you acquire the knowledge?

_____

_____

_____

g) Are the children ever involved in collection from the wetlands?

Yes No

h) If yes, how and at what age are they involved?

_____

_____

_____

i) How is the Indigenous knowledge passed to the younger generation?

_____

_____

j) What is the contribution of Indigenous Knowledge on Ewaso Narok wetland conservation?

_____

_____

k) Have you noticed any difference on the wetland over the last years?

Yes No

l) What are the differences both positive and negative?

_____

_____

m) What could have brought the changes in the wetland?

_____

_____

Appendix II: Vegetation Survey Datasheet

Recorder:	Slope gradient:	Date:
Transect no:	Latitude:	Alt:
Sample plot No:	Longitude:	Photo No:

Habitat description:

Soil, ground description

Vegetation Cover (%)		Dominant Species
Trees		
Shrubs		
Herbs		

Disturbance	Paths/track	stumps	Charcoal kilns	Fire/Burning	Clearing	Grazing

General Vegetation (10X10m)	
1	
2	
3	
4	
5	
6	
7	

(1X1) Quadrat

Species name	Q1	Q2	Q3	Q4

Appendix III: Semi Structured Questionnaire

Issues for semi structured interview

Village———————————

Division———————————

Location ———————————

District———————————

1. Who owns Ewaso Narok wetland and how is it managed?

2. Is the community involved in its management?

3. How important is Ewaso Narok Swamp?

4. What are the resources you get from the Swamp?

5. Is there any IK practices in relation to cultivation or livestock rearing?

6. Do you think the swamp is under any threat and if yes what are the threats?

7. Have you noticed any changes in the Swamp?

8. What has caused the changes?

9. What are the conflicts in the uses of resources in the wetland?

10. What do you think can be done to better manage the wetland and what will be your involvement?

Appendix IV: Plant checklist

No	Family	Scientific name	Lifeform
1	Acanthaceae	*Dyschoriste nagchana* (Nees) Benn.	H
2	Acanthaceae	*Justicia anselliana* (Nees) T.Anders	H
3	Molluginaceae	*Glinus lotoides* L.	H
4	Amaranthaceae	*Alternanthera sessilis* (L.) DC.	H
5	Amaranthaceae	*Amaranthus hybridus* L.	H
6	Amaryllidaceae	*Allium sativum* L.	H
7	Anacardiaceae	*Searsia natalensis* (Bernh. ex C.Krauss) F.A.Barkley	S
8	Apocynaceae	*Carissa spinarum* L.	S
9	Apocynaceae	*Gomphocarpus semilunatus* A.Rich	S
10	Apocynaceae	Marsdenia sp	C
11	Asparagaceae	*Asparagus africanus* Lam.	C
12	Salviniaceae	*Azolla filiculoides* Lam.	H
13	Salviniaceae	*Azolla nilotica* Mett.	H
14	Cactaceae	*Opuntia ficus-indica* (L.) Mill.	S
15	Celastraceae	*Maytenus arbutifolia* (A.Rich.) Wilczek	S
16	Commelinaceae	*Commelina* sp	H
17	Commelinaceae	*Commelina diffusa* Burm.f.	H
18	Commelinaceae	*Commelina subulata* Roth	H
19	Compositae	*Acmella caulirhiza* Delile	H
20	Compositae	*Ageratum conyzoides* (L.) L	H
21	Compositae	*Bidens pilosa* L.	H
22	Compositae	*Cirsium vulgare* (Savi) Ten.	H
23	Compositae	*Erigeron bonariensis* L.	H
24	Compositae	*Cotula sp*	H
25	Compositae	*Crassocephalum vitellinum* (Benth.) S.Moore	H

26	Compositae	*Galinsoga parviflora* Cav.	H
27	Compositae	*Galinsoga quadriradiata* Ruiz & Pav.	H
28	Compositae	*Melanthera scandens* (Schumach. & Thonn.) Roberty	H
29	Compositae	*Tripteris vaillantii* Decne	H
30	Compositae	*Laphangium luteoalbum* (L.) Tzvelev	H
31	Compositae	*Sonchus asper* (L.) Hill	H
32	Compositae	*Sphaeranthus* sp	H
33	Compositae	*Sphaeranthus steetzii* Oliv. & Hiern.	H
34	Compositae	*Sphaeranthus suaveolens* (Forssk.) DC.	H
35	Compositae	*Xanthium strumarium* L.	H
36	Solanaceae	*Ipomoea cairica* (L.) Sweet	C
37	Brassicaceae	*Crassula granvikii* Mildbr.	H
38	Brassicaceae	*Lepidium bonariense* L.	H
39	Brassicaceae	*Rorippa palustris* (L) Besser	H
40	Brassicaceae	*Nasturtium officinale* R.Br.	H
41	Cucurbitaceae	*Zehneria scabra* Sond.	C
42	Cyperaceae	*Courtoisina assimilis* (Steud.) Maquet	H
43	Cyperaceae	*Cyperus sp*	H
44	Cyperaceae	*Cyperus dichrostachyus* Hochst. ex A.Rich.	H
45	Cyperaceae	*Cyperus exaltatus* Retz.	H
46	Cyperaceae	*Cyperus latifolius* Poir	H
47	Cyperaceae	*Cyperus papyrus* L.	H
48	Cyperaceae	*Cyperus rigidifolius* Steud.	H
49	Cyperaceae	*Cyperus rotundus* L.	H
51	Cyperaceae	*Eleocharis marginulata* Hochst. ex Steud.	H
52	Cyperaceae	*Pycreus sp*	H
53	Cyperaceae	*Pycreus elegantulus* (Steud.) C.B.Clarke	H

54	Cyperaceae	*Schoenoplectus corymbosus* (Roth ex Roem. & Schult.) J.Raynal	H
55	Euphorbiaceae	*Euphorbia inaequilatera* Sond.	
56	Poaceae	*Brachiaria sp*	H
57	Poaceae	*Cynodon dactylon* (L.) Pers.	H
58	Poaceae	*Cynodon nlemfuensis* Vanderyst	H
59	Poaceae	*Digitaria abyssinica* (A.Rich.) Stapf	H
60	Poaceae	*Echinochloa colona* (L.) Link	H
61	Poaceae	*Echinochloa haploclada* (Stapf) Stapf	H
62	Poaceae	*Echinochloa pyramidalis* (Lam.) Hitchc. & Chase	H
63	Poaceae	*Eragrostis sp*	H
64	Poaceae	*Eragrostis exasperata* Peter	H
65	Poaceae	*Eragrostis patula* (Kunth) Steud	H
66	Poaceae	*Eriochloa fatmensis* (Hochst. & Steud.) Clayton	H
67	Poaceae	Grass (unidentified) Nyaboke B. 894	H
68	Poaceae	*Leersia hexandra* Sw.	H
69	Poaceae	*Paspalum sp* 1	H
70	Poaceae	*Paspalum scrobiculatum* L.	H
71	Poaceae	*Paspalum sp* Nyaboke B. 907	H
72	Poaceae	*Sporobolus pyramidalis* Beauv.	H
73	Mimosaceae	*Acacia xanthophloea* Benth.	T
74	Mimosaceae	*Aeschynomene sp*	S
75	Mimosaceae	*Aeschynomene schimperi* A.Rich.	S
76	Papilionaceae	*Alysicarpus glumaceus* (Vahl) DC.	
77	Papilionaceae	*Senna didymobotrya* (Fresen.) H S Irwin & Barneby	S
78	Papilionaceae	*Sesbania sesban* (L.) Merr.	S
79	Papilionaceae	*Trifolium sp*	H
80	Papilionaceae	*Trifolium rueppellianum* Fresen.	H

81	Papilionaceae	*Trifolium semipilosum* Fresen.	H
82	Papilionaceae	*Vigna luteola* (Jacq.) Benth.	C
83	Lythraceae	*Ammannia auriculata* Willd.	H
84	Lythraceae	*Lythrum rotundifolium* A.Rich.	H
85	Malvaceae	*Sida schimperiana* Hochst. ex A.Rich.	H
86	Marsileaceae	*Marsilea sp*	H
87	Onagraceae	*Ludwigia abysinica* A.Rich.	S
88	Onagraceae	*Ludwigia stolonifera* (Guill. and Perr) Raven	H
89	Oxalidaceae	*Oxalis comiculata* L.	H
90	Polygonaceae	*Oxygonum sinuatum* (Meisn.) Dammer	H
91	Polygonaceae	*Polygonum sp*	H
92	Polygonaceae	*Polygonum salicifolium* Willd.	H
93	Polygonaceae	*Polygonum senegalense* Meisn.	H
94	Polygonaceae	*Polygonum setosulum* A. Rich	H
95	Polygonaceae	*Rumex steudelii* Hochst. ex A.Rich.	H
96	Portulacaceae	*Portulaca oleracea* L.	H
97	Ranunculaceae	*Ranunculus multifidus* Forssk.	H
98	Rhamnaceae	*Scutia myrtina* (Burm.f.) Kurz	H
99	Scrophulariaceae	*Veronica anagallis-aquatica* L.	H
100	Solanaceae	*Solanum anguivi* Lam.	H
101	Solanaceae	*Solanum villosum* Miller	H
102	Tiliaceae	*Grewia similis* K.Schum.	S
103	Typhaceae	*Typha domingensis* Pers.	H
104	Verbenaceae	*Verbena sp*	H
105	Verbenaceae	*Verbena bonariensis* L.	H

Key

C-Climber, **H**-Herb, **S**-Shrub, **T**-Tree