SOCIOECONOMIC ACTIVITIES IN KADIBO DIVISION OF NYANDO WETLANDS AND THEIR IMPLICATION FOR WETLAND CONSERVATION

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Abstract

The need to use wetlands sustainably is of great importance as biodiversity is higher in these regions and basic human needs are most acute. The threat from overuse and over-exploitation; lack of application of new management technologies and weak institutional policies have resulted in reduction of the biodiversity within wetlands. The main aim of this study was to investigate and propose ways to enhance wetland resource utilization for sustainable livelihoods and ecosystem services in Kadibo division of Kisumu district, Kenya. A questionnaire survey was administered face to face to the respondents. This questionnaire survey was subjected to sample population of households in three agro-ecological zones of the division. Some questionnaire responses were ranked and this ranking involved farmer's subjective evaluation based on an ordinal scale. The questionnaire responses were standardized by using a standard scale of 1 to 5. Personal in depth key informant interviews were conducted randomly with farmers, research personnel and government officers in the study area. The questionnaire data was then subjected to nonparametric analysis of variance (ANOVA) using Kruskal-Wallis Test and Wilcoxon Scores implemented in SAS Version 9.1 at 5% probability level. Descriptive statistics such as means and frequencies was conducted. In addition, a Principle Component Analysis (PCA) was conducted on some response parameters of the questionnaire. 18.4% of the sampled respondents were found not to practice any soil conservation measures while those who applied soil conservation measures, majority (23.2%) were found to use storm drain construction. The PCA results for the mode of wetland resource exploitation by the respondents had bee keeping, water for domestic use, and eco-tourism loading significantly in component 1 with a variance of 25%. On community perception about the factors threatening wetland existence, fishing, farming, harvesting of handcraft and thatching grass loaded significantly in component 1 with a variance of 37.9 %. Practices such as eco-tourism and recreation, educational sites and agro forestry were significant among sustainable development options proposed by respondents. Consumptive wetland resource utilization practices had resulted in decrease in the wetland areas and their poor ecological performance.

Keywords: Livelihoods, community perception, sustainability, management options, biodiversity conservation

Introduction

Wetlands are important ecosystems that were internationally recognized through the Ramsar Convention on wetlands, 1971 (www.ramsar.org). The Ramsar convention on wetlands is primarily concerned with the conservation and management of wetlands. Parties to the convention are also required to promote wise use of wetlands in their territories and to take measures for the

conservation by establishing nature reserves in wetlands, whether they are included in the Ramsar list or not (www.ramsar.org). The goal of the Ramsar Convention, as adopted by the Parties in 1999 and refined in 2002, is "the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world" (Ramsar, 2007).Wetlands are diverse in terms of habitats, biota, distribution, functions and uses. Many of the wetlands have lost their pristine ecosystem quality and been transformed to modified ecosystems, but their salient role in the ecosystem function cannot be replaced. Over exploitation and developmental activities are threatening their existence. The key to their protection lies in appreciating their values and functions, considering the differences within and between different wetlands. With fluctuating water levels, varying sources of water, changing biota, seasonal, annual, and migratory, these wetlands have vital physical, chemical, biological and socio-economic functions.

Most developing countries depend heavily on the exploitation of natural resources from wetland natural, especially biological resources. Most of these wetland resources are found among very poor rural communities whose livelihood depends solely on their exploitation. Kadibo wetlands of Lake Victoria region in Kenya have been degraded in the recent past. The community has continually been exploiting the wetland resources unsustainably. This has been driven mostly by socio-economic needs of the local community. Some of the activities which have led to increased degradation include wetland draining for agricultural production and settlement, pollution from pesticides and excessive fertilizers eroded from the farmlands, papyrus harvesting and burning of wood fuels. The degradation and exploitation of the wetlands' natural resources has significantly reduced their important role in reduction of nutrient and sediment loading. Excessive nutrient and biocide loading to Lake Victoria greatly affects the water quality and functioning of the lake and its wetland's ecosystem. In addition, the threat posed by overuse and over exploitation, lack of application of new management technologies and weak institutional policies have resulted in reduction of the biodiversity within the wetlands (Abila, 2005).

Sustainable conservation and development depend heavily on strengthening the capacity of local individuals and communities to implement conservation initiatives (IUCN, 1996).The objectives of the research were to: (i) assess the impacts of the various land use activities on the state of the wetland ecosystems (ii) to identify the current wetland management practices, and (iii) evaluate sustainable alternative wetland resource utilization practices for the conservation of these wetlands. It was hypothesized that the various land uses have resulted in negative performance of the wetland ecosystems within the study site.

Materials and Methods

Description of the study site

The research study was carried out in the wetlands of Kadibo division of Kisumu East district within Nyanza province in Kenya. Kadibo wetland lies within the larger wetlands of Nyando. Kadibo division occupies an area of 164.8 km^2 (KNBS, 2010) and lies along latitude 0^0 15′ 30″ South and longitude 34^0 46′ 30″ East. In 2009, Kadibo population was estimated at about 57,859 people and about 11,048 households. The population as of 2010 according to 2009 population census was 61,326 people with 12,994 households (KNBS, 2010). The wetlands in the study site include lake shores, river banks and swamps with nearly all of the current agricultural land formerly being wetlands. The area comprises mainly of Lower Midland Agro-ecological zones. The mean annual temperature ranges between 20-30^{o}C while the mean annual

rainfall range between 1,000 and 1,800mm (Government of Kenya 2006, 2005). The rainfall is bi-modal with long rains (March to June) and short rains (October to November) (Government of Kenya 2006, 2005).

Study approach

Structured questionnaires were conducted face to face with the farmers with a view to establish the sustainability of the practiced agricultural activities. A stratified random sampling approach was employed based on the Agro-ecological Zones (rainfall distribution, soil types/crop suitability, slope, temperature regime). It was assumed that Agro-ecological Zones would broadly classify the land cover and use in more or less similar units for local extrapolation. The three Agro-ecological Zones (Lower midland zone 3, 4, and 5) formed the strata. Within each stratum, sampling areas (households) were chosen randomly. A total of three hundred and eighty four questionnaires were targeted from the total population of 11,048 households (Bartlett *et al.,* 2001). This number was based on Cochran's sample size formula for categorical data collection as shown below:

$$n_0 = \frac{(t)^2(p).(q)}{(d)^2}$$

$$n_0 = \frac{(1.96)^2(0.5).(0.5)}{(0.05)^2}$$

$n_0 =$ 384 questionnaires

Where t = value for selected alpha level of 0.025 in each tail = 1.96.
(p) (q) = estimate of variance = 0.25.
(maximum possible proportion (0.5)*1-maximum possible proportion (0.5) produces maximum possible sample size).
d = acceptable margin of error for proportion being estimated = 0.05

Research assistants were employed and trained to administer the questionnaires in the local language (Dholuo). They were briefed extensively on the intended use of the work and also provided invaluable input into the survey design. The questionnaire was first pilot tested and adjustments made accordingly. The questionnaire had seven sections. These were namely: Bio-data, the social economic activities and crop production data. The third section was on wetland management, ownership and utilization while the forth and fifth sections were on community knowledge on the wetlands and biodiversity richness and changes respectively. The sixth section was on the emerging issues from Kadibo wetlands i.e. the factors threatening the existence of Kadibo wetlands and the problems experienced by the people who live and work around the wetlands. The last section was on conservation and sustainable ways of the wetlands' utilization.

A scoring system of 1-5 was used to rate responses to the questions. Score 5 was the most important factor while score 1 was the least important factor. This ranking involved farmers subjective evaluation based on an ordinal scale. However, due to financial constraints and the fact that some respondents were not patient enough to complete all the sections of the questionnaire, the above target of three hundred and eighty four questionnaires could not be realized. A total of two hundred and forty nine questionnaires, representing a response rate of 64.8% were fully filled and used for the data analysis.

Visual observations of human activities carried out within the study site were made. The assessment of disturbance levels was done focusing on burning, wetland vegetation cutting, livestock grazing, and farming. Personal in depth key informant interviews were conducted randomly with farmers, research personnel and government officers in the study area. The interview technique enabled probing the perceptions, attitudes, beliefs and feelings of farmers about sustainable wetland resource utilization.

Data analysis

The collected data was first standardized. Responses were standardized by using a standard scale of 1 to 5, where variables numbered 1 = 5 scores, 2 = 4 scores, 3 = 3 scores, 4 = 2 scores, and 5 = 1 score. A square root transformation was performed on the data before the analysis since it was not normally distributed. The data was then subjected to nonparametric analysis of variance (ANOVA) using Kruskal-Wallis Test and Wilcoxon Scores using SAS Version 9.1. This was conducted at 5% probability level. Descriptive statistics analysis of means and frequencies was conducted (SAS, 2002). Some questionnaire data responses were subjected to Principle Component Analysis (PCA). The number of indicators on some responses was large and therefore higher chances of redundancy. Because of this possible redundancy (Hatcher and Stepanski, 1994), it was important to reduce the observed indicators into a smaller number of principal components (artificial variables) that could account for most of the variance in the responses, thus making the results useful in proposing policy formulation efforts to address the problem. PCA was conducted with a Varimax orthogonal rotation and new factors were selected that had an Eigen value greater than unity and values greater than 0.3 flagged by an '*' (SAS, 2002). Eigen values were multiplied by 100 and rounded to the nearest integer. A correlation matrix was also generated that formed an important input in the Principle Component Analysis. A Kendal Tau correlation analysis was also conducted to establish which bio-physical and social factor/livelihood variables were significantly related.

Results and Discussion

Education, Occupation and Period of Stay among the Respondents

Out of the 249 respondents interviewed, 50.2% were females while 49.8% were males. The research findings in this study revealed that 68.5% of the respondents had primary level education, 15.9% had none, while those with secondary and college level education were 15.2% and 5% respectively. Education level is key to shaping and influencing community production and soil conservation strategies. Highly educated communities have always demonstrated better means of crop production and soil conservation as opposed to poorly educated communities. On the other hand, this study revealed that farming was the mainstay economic activity (78.4%) of the respondents selected for this assessment (**Fig. 1**). However, to supplement income from farming, most of the respondents were also engaged in other economic activities such as papyrus weaving, small scale business, and casual labor. These secondary income sources were important to the farmers' household. They acted as farmers safety nets incase of horticulture crop failure; they could also help to avoid over dependence and over exploitation of wetland resources.

Majority of the sampled respondents were above 50 years of age (34.7%); 33.9% were between 36-50 years while those between 18-35 and 10-17 years of age were 31% and 0.4% respectively (**Table 1**). In addition, majority of those sampled had stayed in the area for over fifty years (**Fig. 2**). This long duration of stay was important for the study as the respondents were able to state some changes on selected parameters which had happened within the area for the last twenty years.

Table 1: Age distribution of the respondents

Age (years)	(%) Frequency
10-17	0.40
18-35	31.05
36-50	33.87
Above 50	34.68

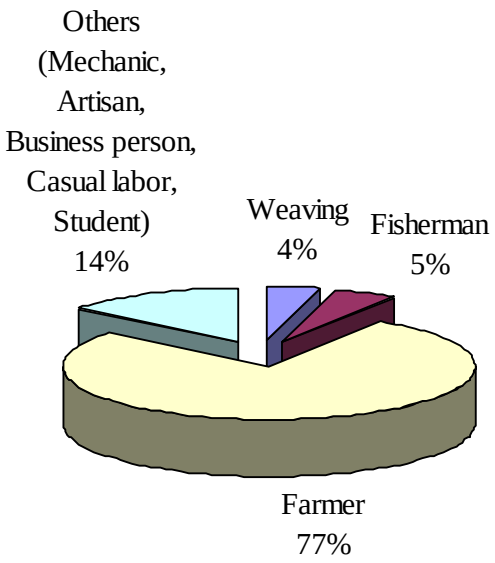


Fig. 1: Occupation distribution of the respondents sampled

Main Agro-Economic Activities in the Study Site and Sustainability

Within Kadibo Division, both crop production and livestock farming was practiced. Majority of the farmers in the study area practiced both subsistence and commercial farming with about half of the respondents being peasant farmers. Both commercial and subsistence crops were cultivated and the major economic crops bringing high returns included sugarcane, rice and green grams (**Table 2**). Majority of the farmers practiced mixed cropping (67.6 %) while 37.4 % practiced mono cropping. In mixed cropping system, different crops were usually intercropped for instance maize and beans were typically intercropped. Mixed cropping was important for soil erosion control especially when ground cover crops were included in the intercropping system.

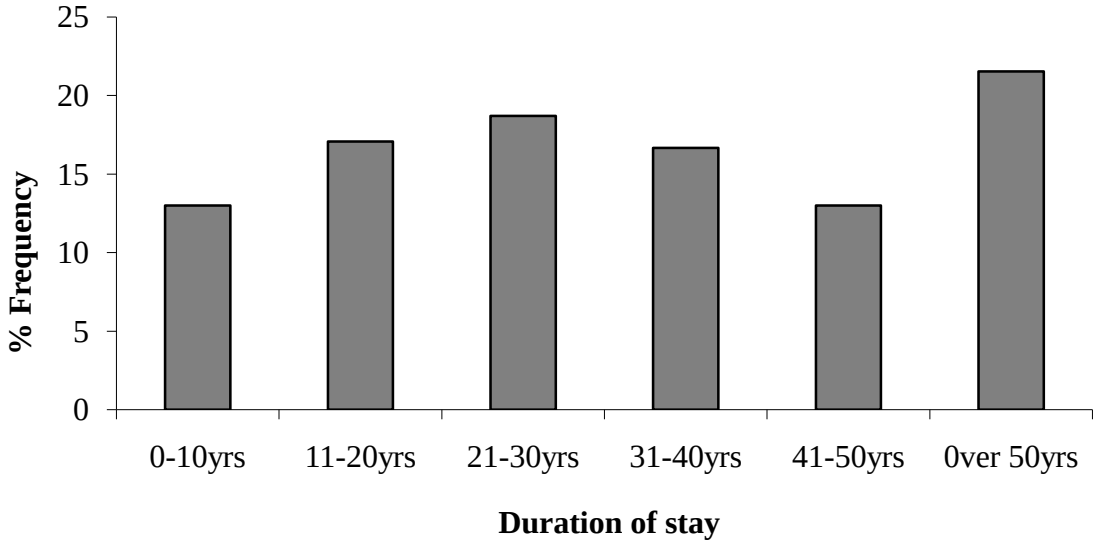


Fig. 2: Period of stay among the respondents within the study area

One of the major problems in communal agriculture at present is the lack of diversity or agro diversity. In the traditional systems of farming local farmers produced a variety of small grain crops that included millet, sorghum, finger millet as well as cowpeas, groundnuts, cucumbers, pumpkins, okra and others (Svotwa *et al.*, 2008). As was also found in this study, the agro scenario in these areas was characterized by the dominance of the maize crop (**Table 2**). This had to do with the high levels of production that could be realized on small pieces of land as well as the little labor that was required in

the form of post harvest technologies for storage and processing. The variety of crops grown by farmers (leaf, root, fruit and leguminous crops) formed the base for effective soil nutrient exchange. A well-planned rotation involving those crops could be useful in the prevention of soil erosion and maintenance of soil fertility. Crop rotation improves the nitrogen status of the soil by leguminous plants (Mukwada, 2000). It enhances the nutrient status of the soil when deep rooted crops draw nutrients to top levels of the soil. There was a variation in the sizes of land under different crops cultivated by the farmers (**Table 2**). The small portions of land sizes were indicative of the high rate of land fragmentation that was associated with the general increase in the population size and the number of households that needed to survive on the wetlands. The increase in the population density within the perimeter of the wetland can also be attributed to the fact that these wetland areas had fertile soils and had lots of moisture especially during the dry season.

Table 2: Different types of crops cultivated and their average plot sizes, average returns in Kenya Shillings (KShs.), and the number of respondents who were involved in their cultivation.

Crop	Average returns per growing season (Ksh.)	No. of the respondents who cultivated the crop	Percent (%)	Mean acreage
Arrow roots	6000.0	3	0.4	0.2
Bananas	440.0	3	0.4	0.4
Beans	24755.6	50	7.2	0.8
Butter nuts	57321.4	8	1.2	0.9
Capsicum	17920.0	3	0.4	0.4
Cassava	2985.7	24	3.5	0.5
Coriander	180.0	1	0.1	0.3
Cotton	4500.0	1	0.1	1.0
Cow peas	2359.1	29	4.2	0.8
Green grams	90312.5	13	1.9	0.8
Maize	25042.8	237	34.2	1.1
Mangoes	1200.0	1	0.1	0.1
Millet	8100.0	44	6.3	0.8
Pawpaw	890.0	2	0.3	0.3
Pepper	14666.7	3	0.4	0.5
Green pepper	2100.0	2	0.3	0.2
Potatoes	2600.0	9	1.3	0.3
Rice	114529.0	33	4.8	2.3
Sorghum	12000.0	94	13.6	0.9
Sugarcane	205166.7	4	0.6	1.1
Sweet potatoes	1433.3	13	1.9	0.4
Tomatoes	27828.6	33	4.8	0.6
Vegetables	3726.0	68	9.8	0.4
Water melons	48333.3	7	1.0	0.7
Yams	3200.0	3	0.4	0.6
Onions	1600.0	3	0.4	0.3
Spider plant	350.0	1	0.1	0.3
Crotalaria sp.	184.2	1	0.1	0.1
TOTAL			**100.0**	

Rapid population expansion causes further subdivision of small plots and this poses a threat to sustainable utilization of the wetland and is at risk of degenerating into 'the tragedy of commons' (Hardin, 1968). The land size becomes too small for mechanization and its output is limited. The variation of sizes of farmers' garden portions could have resulted from unsystematic and uncontrolled fragmentation of fields as farmers traditionally shared their land portions with their next of kin. Farmers tend to densely populate areas whose physical environment support agricultural production (Whynne-Hammond, 1990). The physical conditions could include fertile soils for crop production, low slope angle, reliable rainfall and moderate temperatures. Such a scenario of increased land fragmentation and farmers densely populating in fertile areas was associated with reduced farm yields and financial income per individual farmer (Svotwa *et al.*, 2008).

Soil Conservation Methods

The study area (Kadibo) lying on a relatively flat zone of the Kano plains, the challenge facing farmers was mostly flooding. With many farmers involved in storm drain construction (23.2 %) and terracing (22.4 %) as shown in **Table 3**, awareness on need for soil and hence wetland conservation was high among farmers. Environmental awareness enables community members to develop the commitment to constructively participate in transformation of the environment (Baez *et al.*, 1987). The development of such an appreciation of environmental quality among wetland farmers promotes in them an attitude of care for their plots and a sense of responsibility for the well being of the wetland system as a whole. Mulching cushions the ground from raindrop impact and conserves soil moisture (Muler - Saman and Kotschi, 1994). Terracing reduces runoff down slope. Some of the farmers did not use any soil conservation method. This phenomena is however, not unusual in any situation of technology transfer. The rate of adoption of new technology and ideas by a community is influenced by a variety of factors, which include socio-cultural influence and social marketing strategies (Kolter and Zaltman, 1971). The number of adopters increases as awareness of the technology increases and the benefits become apparent. There are however, late adopters and laggards. The latter group of farmers is conservative and resists change (Rodgers, 1971). Such farmers who do not apply soil conservation measures are the most vulnerable to losses resulting from disasters such as floods and soil erosion. Considering the physical environment of the Nyando wetlands, these strategies are not in anyway inappropriate conservation techniques if applied on the site.

Patterns of Wetland Resource Utilization/ Benefits by the Local Community

A scoring system of 1-5 was used to rank the main wetland resource utilization. Score 5= highly important beneficial activity from the wetlands while score 1= was the least important beneficial activity. Due to the large number of the wetland resource utilization activities, it was important to conduct Principal Component Analysis (PCA) to reduce chances of redundancy. Because of this possible redundancy, it was important to reduce the observed indicators into a smaller number of principal components (artificial variables) that could account for most of the variance in the responses. There were statistically significant differences on the wetland resource utilization activities at $P < 0.05$ (**Table 4**).

PCA results determined that there were only four meaningful components which were worth retaining. These components were namely; a combination of consumptive and sustainable resource uses, social economic activities, while both component three and four had consumptive resource utilization activities loading significantly into them. This was based on the Eigen value-one criterion and the

interpretability criteria. The values were multiplied by 100 and rounded to the nearest integer. Values greater than 0.3 were flagged by an '*' (**Table 5**). The wetland resource utilization activities loading significantly in component 1 (consumptive and sustainable resource uses) were; bee keeping, brick making, harvesting of wood fuel, water for domestic use and ecotourism benefits.

Table 3: Erosion control measures on the farms by farmers

Method	No. of farmers	Percentage (%)
Others (dyking, furrowing, canalization)	2	0.5
Contour ridge use	10	2.7
Inter cropping	13	3.5
Fallowing	17	4.6
Crop rotation	18	4.9
Agro forestry	25	6.8
Mulching	48	13.0
None	68	18.4
Terraces	83	22.4
Storm drain construction	86	23.2

Table 4: ANOVA table for wetland resource utilization practices by the local community at $P < 0.05$

(Source of variance)	Kruskal-Wallis test		
	Chi-Square	df	*p-value*
Wetland resource utilization activities	4654.1678	10	<.0001
Occupation	95.8404	16	<.0001
Education level	2.6929	3	0.4414

Table 5: Eigen scores and the variance of first four components of PCA of wetland resource utilization/benefit by the local community

	Component 1	Component 2	Component 3	Component 4
Eigen values	2.5	1.7	1.5	1.1
% Variance	25.0	16.5	10.8	9.2
% Cumulative variance	25.0	41.5	52.3	61.5
Mode of exploitation				
Grazing	10	72*	8	4
Harvesting of handcraft materials	-12	52	55*	-9
Fishing	-2	66*	-10	-4
Hunting	-7	-5	88*	2
Harvesting of thatching grass	-5	37*	21	71*
Bee keeping	75*	-32	6	2
Brick making	66*	14	-31	-8
Harvesting of wood fuel	61*	2	-45	-9
Water for domestic use	76*	29	3	-16
Ecotourism benefit	70*	-5	-3	25
Others (crop cultivation)	4	-33	-16	72*

The wetlands were very resourceful and majority of the community members were finding their livelihoods through diverse consumptive uses (brick making, harvesting of wood fuel and domestic water). Most of these consumptive wetland resource utilization practices resulted in a negative performance of the wetlands ecosystem due to clearance of the plants resulting to decline in faunal composition especially birds. Some of the wetlands (Nduru, Nyamware and Ogenya singida) were however being utilized as fish landing beaches which had a potential of being converted to eco-tourist sites. Bee keeping, a non-consumptive wetland resource utilization was an alternative sustainable wetland resource utilization. Some community members were engaging themselves in bee keeping after being trained by the Victoria Institute for Research and Development (VIRED) personnel. This was however being done at a small scale and there was need to train more people, facilitate them with the necessary equipment and also facilitate on the marketing of the honey and its products.

The wetland resource utilization activities which loaded significantly in component 2 (social economic activities) included grazing and fishing. The wetlands were particularly important for grazing during droughts and the dry seasons when the water levels receded. An interesting observation made during this study was the free range grazing of animals on the wetlands (**Plate 1**). Large herds of cattle were always allowed to range freely in the wetland areas. Free ranging and over-grazing of livestock on such areas of land can have a negative impact on the environment. Overgrazing by livestock on any piece of land leads to compaction of the soils and this negatively affects the soil structure and its biological activity. Fishing was a major livelihood of the local community. Nduru, Nyamware and Ogenya singida were some of the main fish landing points in the study site. There was some evidence that the wetlands suffered some cutting and burning of papyrus to allow access for fishing of swamp fish species. If not controlled, fishing can lead to over exploitation and loss of biodiversity. Finally those wetland resource utilization activities loading significantly in component 3 and 4 (consumptive resource uses) were harvesting of handcraft materials, hunting of wild animals, harvesting of thatching grass and others (crop cultivation and water for irrigation).

Plate 1: Grazing within the wetlands

Agriculture, which was one of the most important agro economic activities within the area had been intensified in the last decade and most people were draining the wetlands for crop production. This was mostly attributed to rapid increase in human population, high levels of poverty and unemployment. The increasing numbers of marginalized people were moving and settling in fragile wetland areas in search of new means of livelihood. This led to decrease in the wetland sizes as people cleared them for crop cultivation and settlement leading to decrease in biodiversity within these wetlands. The local communities were also turning to alternative sources of income such as papyrus-based products such as mats, chairs and baskets.

Given the existing pressure on papyrus, this resource could soon be harvested beyond its regenerative capacity. Wood fuel from papyrus, which was one of the main reasons for papyrus harvesting was not sustainable. Fuel from papyrus cannot burn for longer time and hence one may need to harvest a lot for

just simple cooking. There was therefore need to find alternative means of fuel for cooking such as firewood or biogas. These wetland resource utilization activities had intensified in recent years and were of particular concern as they had led to other forms of disturbance to papyrus such as pollution and burning. They were threatened by unsustainable cutting of papyrus and overgrazing by cattle during the dry season when the water level receded.

Major Threats to the Wetlands Existence as Perceived by the Respondents

A Principal Component Analysis (PCA) was conducted to determine the main factors threatening the wetland existence as perceived by the respondents. PCA results determined that there were only two meaningful components which were worth retaining. These components were namely; human induced threats and a combination of natural threats and sustainable resource uses. This was based on the Eigen value-one criterion and the interpretability criteria. **Table 6** shows Eigen scores of the first two components of PCA. There was statistically significant difference between the factors threatening wetland existence as perceived by the local community at $P < 0.05$ (**Table 7**). The factors threatening wetland existence which significantly loaded in component 1 (human induced threats) were fishing, farming, harvesting of thatching grass and handcraft materials. These were generally human induced exploitive activities which had resulted to decrease in wetland sizes as well as habitat losses. Meanwhile, the second group of factors threatening wetland existence which significantly loaded in component 2 (natural threats and sustainable resource uses) were eco-tourism benefit, droughts and others (floods, climate change). Natural threats to wetlands, such as climate change, drought and floods may be unavoidable, but human-induced threats such as the wetland consumptive activities discussed above could be prevented through sustainable and non consumptive ways of wetland resource extraction such as eco-tourism activities.

Table 6: Eigen scores and variance of first two components of PCA of the factors threatening wetland existence as perceived by the community

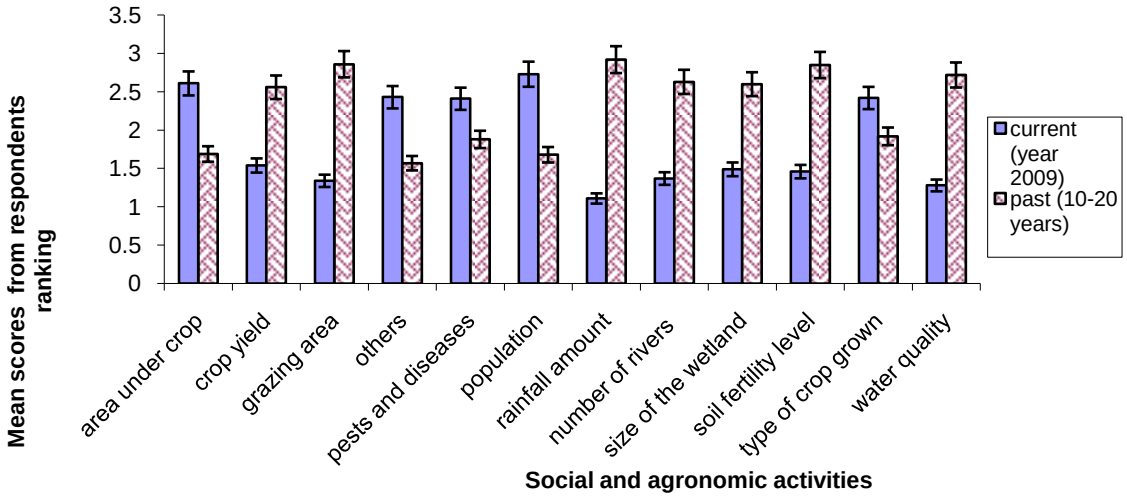
	Component1 (Human induced threats)	**Component 2 (Natural threats and sustainable resource uses)**
Eigen values	2.6	1.1
% Variance	37.9	15.5
% Cumulative variance	37.9	53.4
Factors threatening wetland existence		
Fishing	74*****	-7
Farming	81*****	10
Eco-tourism	8	61*****
Harvesting of thatching grass	84*****	11
Harvesting of handcraft materials	84*****	-2
Droughts	-8	66*****
Others (floods, climate change)	-8	51*****

Table 7: ANOVA table for factors threatening wetland existence as perceived by the respondents at $P < 0.05$

Source of variance	Kruskal-Wallis test		
	Chi-Square	df	*p-value*
Factors threatening wetland existence	2485.0538	6	0.0001
Location	304.9418	3	0.0001
Education	18.2071	3	0.0004

Changes in Social and Agro-Economic Activities

The area under crop production had increased (**Fig. 3**) and this implied that more people were opening up new areas for cultivation. This increase in the area under crop production had occurred at the expense of grazing area and the size of the wetlands which had reduced over the years (**Fig. 3**). The clearance of the wetland vegetation for crop cultivation resulted to decline in the floral and faunal composition of these wetland ecosystems. The respondents, many of who depended on rain fed agriculture for crop production said that the amount of the rainfall had drastically reduced over the years and that contributed to poor crop yields due to droughts. Most of the farmers said that their crops were experiencing poor growth rate and low yields especially when they did not use any fertilizers. This supported the fact that majority of the respondents had acknowledged that the soil fertility levels in their farms had reduced probably due to over cultivation of the farms which contributed to poor crop yields (**Fig. 3**). However, the decline in crop yields could also have been brought about by the increased incidences of pests and diseases (**Fig. 3**) which had occurred in the last twenty years.



KEY: 3= high/big 2=medium 1= low/small

Fig. 3: Comparison of the changes in social and agro-economic activities both at the current (2009) and past (10-20 years).

Conservation Efforts, Sustainable Utilization, and Management of the Kadibo wetlands

Majority of those interviewed 98.8% believed that there was a need to conserve the wetlands. A larger percentage, 38.2% said that the local community should be responsible for the wetland conservation while 36.6% believed that both the local community and the government should jointly be responsible for the conservation of wetlands. This was a clear indication that the local community should not at all be left out in any conservation efforts. Infact, they should be empowered and be involved in every stage of conservation. Despite some environmental based organizations (NGO's and government organizations) being operational in the area, a considerable number 61.7% said that they did not get any training on wetland conservation from the government or NGO's. However, there were those who said they got trainings on wetland conservation 38.3%. This signified that either there was not enough workforce to offer these trainings or the community might have been reluctant to be trained.

There were some environmental based Non-Governmental Organizations (NGO's) operating in the area. Victoria Institute for Research on Environment and Development (VIRED) was one of the significant organizations operational in the area involved in wetland conservation. VIRED acted as a catalyst to bridge gaps between technical environment concerns and basic community needs. VIRED in collaboration with the Kenya Wildlife Service were conducting research, mobilizing communities, creating awareness, and empowering the local communities to sustainably manage wetland resources within the Lake Victoria Basin. It offered various training programmes to the local community on sustainable utilization of the wetland resources which covered horticultural production, fish farming, bee keeping and the production of quality wetland products. Their focus was placed on prudent utilization of wetland products for improving the livelihoods of the communities. Through collaboration with CARE Kenya, they also undertook flood water mitigation management projects (http://viredinternational.org/).

One of the most prominent factors underlying wetland management problems in Kenya as expected elsewhere has been said to be lack of or insufficient awareness of the functions and benefits of wetlands leading to inappropriate use of swamp resources (Mafabi, 2000). Innovative co-operative ways need to be devised to sustain the conservation of biodiversity while addressing their needs and development issues. The study demonstrates that like most tropical wetlands, Kadibo wetlands were of great socioeconomic value to the local community. Long lasting sustainable utilization, conservation and management of this resource therefore hinges on addressing the seemingly conflicting demands of biodiversity conservation, community utilization and agro-industrial development. The high economic potential of the Nyando wetlands, the wetlands being non-protected areas and the lack of proper enforcement of wetland policy makes them vulnerable ecosystems. A Principal Component Analysis (PCA) was conducted to determine the main sustainable conservation strategies as proposed by the respondents. PCA results determined that there were only three meaningful components (consumptive resource uses, sustainable resource uses, and non-consumptive resource uses) which were worth retaining. **Table 8** shows Eigen scores of the first three components of PCA.

There was statistically significant difference between the conservation strategies proposed by the respondents at $P < 0.05$ (**Table 9**).Significant loadings in component 1 (consumptive resource uses) consisted of wetland conservation for hand craft materials and grazing. These were generally consumptive wetland resource utilization methods which may not be sustainable hence loadings into component 2 and 3 were recommended. Component 2 (sustainable

resource uses) loadings were eco-tourism center and others (educational/research sites). These loadings into component 2 were the alternative and sustainable methods of non consumptive wetland resource utilization. Eco-tourism was the least developed activity despite being a sustainable and a viable economic activity. Finally, a significant loading into component 3 (non-consumptive uses) was conservation through the practice of agro-forestry and bee keeping. Bee keeping was a non consumptive wetland resource utilization which was also sustainable.

Table 8: Eigen scores of first three components of PCA for sustainable conservation strategies proposed by the respondents

	Component 1 (consumptive uses)	**Component 2 (sustainable uses)**	**Component 3 (non-consumptive uses)**
Eigen values	1.7	1.3	1.1
% Variance	30.3	21.2	18.2
% Cumulative variance	30.3	51.5	69.7
Conservation strategies			
Eco-tourism center	-6	80*	-24
Bee keeping	37*	46*	62*
Conservation for handcraft materials	78*	-20	-5
Grazing	84*	10	-23
Practicing agro-forestry	-14	-3	93*
Others (educational/research site)	3	65*	14

Table 9: ANOVA table for the proposed sustainable conservation strategies by the respondents at $P < 0.05$

(Source of variation)	**Kruskal-Wallis test**		
	Chi-Square	df	*p-value*
Conservation strategies	2772.8137	5	0.0001
Education level	9.6236	3	0.0221
Location	302.1410	3	0.0001

The practice of agro-forestry is a combination of consumptive and non consumptive wetland resource utilization (i.e. through cultivation of crops and planting of trees). The locals were involved in agro-forestry practices in the last decade. This was a significant boost not only to conservation of soil but also to wise use of wetland resources. Through some organizations operating in the area, the community was educated on the importance of agro-forestry. Vi Agro-forestry organization and VIRED were amongst the NGO's operational within the area which sometimes gave tree seedlings to the local community to plant on their farms. Trees could help as alternative sources of wood fuel and reduce on dependence on wetland resources particularly papyrus whose fuel wood was not sustainable. Trees could also sequester carbon from agricultural activities thus reducing carbon dioxide emissions into the atmosphere.

Sustainable Wetland Utilization through Eco-Tourism

Eco-tourism which was least developed within Kadibo and the entire of Nyando wetlands is an alternative sustainable method of wetland utilization. Income could be

generated through collection of entry fees from the tourists visiting the wetland. The wetland could be promoted as a locally controlled, people-centered tourist destination.Eco-tourism is a sustainable form of tourism, which is nature based and incorporates a desire to minimize negative social and environmental impacts (Swarbrooke, 1999) and embrace economic, environmental, social, community and visitor benefits (Herath, 2002). Wetland resources within the Kadibo division were currently undergoing rapid transformation through diverse consumptive practices by the local community for their daily livelihood. Despite increased consumptive utilization of wetlands in Kadibo division, the people's income, majority of who were farmers still remained low. Consumptive utilization of wetland resources degrades them and therefore not sustainable. However, the diverse resources could be used for eco-tourism development which not only helps in conserving them but also provides sustainable income for the community.

Tourism creates employment, demand for transport, telecommunication, financial services, handicrafts, consumption of local products (foods), accommodation, linkages to agriculture, fisheries, food processing, light manufacturing and the informal sector (Nyakaana, 2008).The development and promotion of ecotourism was crucial for sustainable management and utilization of wetland resources in Kadibo division for poverty alleviation and sustainable socio-economic development. This non-consumptive utilization of wetland resources has more advantages over most forms of consumptive uses such as agriculture, sand and clay harvesting as ecotourism initiatives endeavor to respect and maintain environmental integrity while at the same time improving existing social and cultural manifestations for community livelihoods (Nyakaana, 2008). Furthermore, ecotourism initiatives are centred on attracting small numbers of high-spending tourists willing to stay longer in a destination, thus maximising the economic benefits to the stakeholders while minimizing the negative impacts on the environment and society as a whole (Jones, 2007; Hwey-Lian *et al.,* 2004; Pemberton and Mader, 2004; Shores, 2003).

Existing and Potential Eco-Tourism Resources and Development within Kadibo Division

Wetlands in Kadibo division were endowed with diverse and unique natural and cultural resources that were suitable for ecotourism development and promotion. Floral diversity in anyone eco-system as evident in Kadibo wetlands (**Table 10**) was important for supporting diverse fauna especially herbivores and birds and this was important for ecotourism development, which could be used to positively change the livelihoods of the local community. The wetland resources of the wetlands within Kadibo division should be used to develop different eco-tourism activities. As nature and cultural tourism in developing countries are among the fastest growing sub-sectors of the tourism industry (Ceballos-Lascurai, 2003) and tourism is itself the world's largest and fastest growing industry. Worldwide tourism generates 11% of world income, employs 200 million people, transports 700 million international travelers per year and is expected to double in size by the year 2020 with an anticipated one billion tourists per year (Roe and Khanya, 2001). The development of eco-tourism could be more beneficial to the community as a whole than the present consumptive use of resources that led to resource degradation and continued high levels of poverty. When developing eco-tourism, the main guiding principle is to compliment rather than undermine livelihood and social security of the community.

Table 10: Some floral and faunal composition within the wetlands of Kadibo division

Plants	**Use/importance/harm**	**Current status (2009)**
Papyrus (*Cyperus papyrus*)	Weaving, thatching, fuel wood	Rare
Reeds *(Phragmites australis)*	Thatching, weaving, fuel wood	Rare
Sesbania (*Sesbania sesban*)	Fuel wood	Rare
Bottlebrush Sedge *(Carex comosa)*	Thatching, animal feed	Rare
Lantana (*Lantana camara*)	Weed, fuel wood	Rare
Scented-pod Acacia (*Acacia nilotica*)	Fuel wood	Rare
Bananas (*Musa spp.)*	Human food, animal food	Rare
Animals		
Tilapia (*Oreochromis mossambicus*)	Human food	Rare
Nile Perch (*Lates niloticus*)	Human food	Rare
Mud Fish (*Neochanna spp.)*	Human food	Rare
Channel Cat Fish (*Ictalurus punctatus*)	Human food	Rare
Common Frog *(Rana temporaria)*	Prediction of rainy seasons	Rare
African Rock Python *(Python sebae)*	Harmful to people and domestic animals	Rare
Nile Monitor Lizard *(Varanus niloticus)*	Eats chicken, destroys crops	Rare
Common Crocodile *(Crocodylus niloticus)*	Harmful to people	Rare
Hippopotamus *(Hippopotamus amphibius)*	Destroys crops	Rare
Thomson's Gazelle *(Gazella thomsoni)*	Human food, crop destruction	Rare
Sitatunga (*Tragelaphus spekii*)	Human food	Rare
Vervet Monkey *(Cercopithecus aethiops)*	Destroys crops	Rare
Brown Hare (*Lepus capensis)*	Destroys crops, human food	Rare
African Spurred Tortoise *(Geochelone sulcata)*	Eat insects and crops	Extinct
Hyena *(Crocuta spp.)*	Eat domestic animals	Extinct
Social Weavers *(Philetairus socius)*	Destroys crops	Rare
Greyish Eagle-owl *(Bubo cinerascens)*	Eats chicken	Rare
Papyrus Yellow Warbler *(Chloropeta gracilirostris)*		Rare
Papyrus Gonolek *(Laniarius mufumbiri)*		Rare
Papyrus Canary (*Serinus koliensis*)		Rare
White-winged Warbler *(Xenoligea montana)*		Rare

Conclusion and Recommendations

The study demonstrated that like most tropical wetlands, Kadibo wetlands were important for their biodiversity and was of great socioeconomic value to the local community. Consumptive wetland resource utilization practices (crop cultivation, harvesting of wood fuel, harvesting of handcraft materials, grazing, brick making, and hunting of wild animals among others resulted in decrease in the wetland areas and their poor ecological performance. The success of an integrated natural resource management depends on developing and implementing a comprehensive management plan drawn up by all the stakeholders. Although there has been polices in place for conservation of wetlands in Kenya, a major challenge to proper wetland

conservation has been on the enforcement of such policies. It is therefore important that the various stakeholders to the Nyando wetlands be identified and their needs assessed. Such a management plan would identify the various interest group needs and will spell out how the resources will be utilized to ensure sustainability and minimize resource access and use conflict. Sustainable development options as proposed by respondents such as eco-tourism and recreation, practicing of bee keeping, educational sites and agro forestry should be adopted. Eco-tourism which denotes a sustainable form of tourism that is small in scale and in which local control and benefits are of primary importance to the communities can be introduced to conserve the resources and provide an alternative sustainable livelihood strategy to reduce poverty in the community.

There is need to establish proper and clear wetland area demarcation boundaries to aid in their conservation. The government should ensure that the policies in place for the conservation of wetlands are enforced strictly. Declaring Nyando wetlands as protected wetland areas will also go in line with their conservation. Successful eco-tourism development within the area will require government participation through financial empowerment of the local community, training the local community on environmental conservation and development of eco-tourism enterprises and involving them in planning and implementation of eco-tourism related activities. There is need for more research to be carried out in all communities living within the Nyando wetlands in order to come up with a recommended carrying capacity that is in line with proper conservation measures for purposes of safeguarding the wetlands. More research is also needed to establish the viability of establishing eco-tourism within the Nyando wetlands to assess its strengths, opportunities, weaknesses and threats.

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