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Utilization and Management of Wetland Resources of Kingwal Wetland by the Riparian Community.

Sub-thematic area: Utilization and Conservation of Natural Resources.

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Abstract
The uncontrolled utilization of wetland resources continues to impact negatively on wetland natural resource including plant and animal resources species composition, abundance, diversity and consequently on the ecological functioning of wetlands. This study was conducted to determine resource utilization and management by the local community in Kingwal Wetland located in Nandi County. Data were collected through descriptive research design. Systematic randomized sampling and use of structured questionnaire, personal interviews, focused group discussions, key informant discussion and field observations were used to characterize utilization and management of resources by the local community.126 questionnaires were administered to households identified by systematic random sampling method within the study area. Data were analysed through frequency distributions, and chi-square. Results indicated significant differences in the age distribution patterns of the respondents among the sampling sites (χ^2 = 2.334, df = 3, p = 0.531) and that the levels of education attainment among respondents were significantly different among the sampling sites (χ^2 = 36.926, df = 16, p = 0.002). The six most important wetland resources in order of decreasing importance were found to be grains (98.4%), vegetables (88.9%), papyrus (85.7%), grass (82.7%), water (77.8%) and fodder (77.8%). Results further indicated significant differences among economic activities practiced by the local community members (χ^2 = 9.122, df = 7, p = 0.0004), wetland services offered to the local community members (χ^2 = 25.143, df = 11, p = 0.0000) and knowledge of anthropogenic activities impacting the wetland (χ^2 = 21.776, df = 3, p = 0.0000). 50% of respondents did not know the anthropogenic activities impacting the wetland hence were not conserving the wetland, this study therefore recommended that sessions of training and education be provided to the riparian community on the need for sustainable utilization of the resources identified for better economic benefits as well as provide the community with alternative livelihoods that will minimize the identified anthropogenic activities that degrade the wetland.

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I. Introduction

Although there is no universally accepted single definition for wetlands, *(Finlayson et al 2011; Flournoy 1997; Copeland 2010)*, the Ramsar treaty defines wetlands as areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres. Kenya acceded to the Ramsar Convention and it came into force in the country on October 5, 1990 with the Kenya Wildlife Service (KWS) designated as the convention's implementing authority and national focal point (Ramsar Convention Secretariat 2012a). The national wetland policy of Kenya on the other hand defines wetlands according to Lathrop, as those ecosystems that integrate the characteristics of terrestrial and aquatic environments namely, water, soil and vegetation (Lathrop 2011). This definition provides an important base for the Ramsar treaty definition emphasizing the use of wetlands as habitats for water fowls and therefore discourage progressive encroachment and loss of wetlands. A summary of these definitions indicate that wetlands comprise both land ecosystems that are strongly influenced by water, and aquatic ecosystems with special characteristics due to shallowness and proximity to land (Roggeri, 2016). The Environmental Management and Coordination (Wetlands, Riverbanks, Lakeshores and Sea Shores Management) Regulations 2009 define wetlands as 'areas permanently or seasonally flooded by water where plants and animals have become adapted; and include swamps, areas of marsh, peat land, mountain bogs, banks of rivers, vegetation, areas of impeded drainage or brackish, salt or alkaline; including areas of marine water the depth of which at low tide does not exceed six meters. Riparian and coastal zones adjacent to the wetlands are also included in this definition. Both the definitions of the Ramsar Convention and EMCA Wetland Regulations include shallow lakes and rivers, floodplains as well as coastal belts and marine areas in their ambit.

Wetlands occupy an estimated 6 per cent of the Earth's surface area (Ramsar Convention Secretariat 2006). The exact extent of Kenya's wetlands is still unknown owing to the lack of a wetlands inventory but they are estimated to occupy around 3-4 per cent of Kenya's land mass although this can increase to 6 per cent during the rainy seasons (Kenya Wetlands Forum 2012).

Wetlands goods and services contribute greatly to the livelihoods of riparian communities and to the total environmental stability within the wetland. Some important ecological functions including groundwater re-charge and discharge (Burt *et al*., 2002), nutrient retention (Kansiime and Nalubega, 1999), sediment/toxicant retention (Cole and Brooks, 2000), micro-climate stabilization (Bullock and Acreman, 2003), flood control (Burt, 1997; Bergstrom *et al*., 1990; Adamus, 1996; Costanza *et al*., 2007; Costanza *et al*., 2005; Acreman, 2011), nutrient cycling and carbon sequestration (Zedler and Kercher, 2005, Daniels and Cumming 2008). Wetland goods are also a source of food, and provide materials for construction and tourism (Kairu, 2001; Blumenfeld, 2009). However, the integrity of many wetlands continues to be decimated by multiple anthropogenic activities making them unable to perform their ecological functions (Eliśka *et al*., 2008). Some of these activities include the changes in water quality due to inputs of nutrients such as nitrogen and phosphorus from the catchment (Cole *et al*., 2010). Other anthropogenic activities impacting wetlands include agricultural activities, urbanization and pollution, (Mulei et al, 2014) There is also massive utilization and harvesting of vegetation from the wetland which has led to changes in plant and animal species occurrence, diversity and richness. (Mironga, 2005b; Abila et al., 2005; Mwakubo et al., 2007).

Kingw'al wetland is found on the catchments of Yala River. It is popular as a habitat for the endangered Sitatunga antelope (*Tragelaphus spekei,)*, the rare African python *Python sebae* and papyrus specialist birds including the globally threatened papyrus yellow warbler *Chloropeta gracilirostris* and papyrus gonolek *Laniarius mufumbiri* (Nasirwa and Njoroge 1997; Bennun and Njoroge 1999; Byaruhanga et al. 2001; Birdlife International 2004). Further, the wetland supplies large amounts of organic nutrients to fringing waters, thus allowing an increase in animal and plant production at the wetland edge (Gaudet 1980; Moore 1994). Kingwal wetland is a very important resource for communities living in the catchment area and downstream (Odongo, 1996). Cultivation in Kingw'al wetland in time of dry season is on increase and poses the biggest threat to the system resulting into degradation of vulnerable soil organic matter which is stored under waterlogged conditions; reduction in the water holding and filtration functions of the wetland as well as reduction in availability of drinking water among others This agrees with findings from studies in other wetlands. (Ashley *et al*., 2004; Kirui, 2010).

This study was carried out in King'wal wetland situated in Nandi County (Latitude: 34°48'31.2"E to 35°26'88.1"E, Longitude: 0°32'41.7"N to 0°06'31.8"S), bordered to the North and West by Kakamega County, to the South West by Vihiga County, to the South by Kisumu County, South East by Kericho County and East by Uasin Gishu County. The swamp is located between latitude: 35°08'34.1"E to 35°11'22.0"E and longitude: 0°15'11.3"N to 0°16'13.6"S (Figure 3.1). The total surface area of the wetland is about 1218 km^2. The Wetland has its main catchment arising from Uasin Gishu County, around Kesses. It comprises of a system of River Kesses, streams and springs interconnected to numerous swamps within the region stretching from Lolminingai to Kombe locations. (Kingwal Intergrated Wetland Management Plan, 2014-2018, Nandi County)

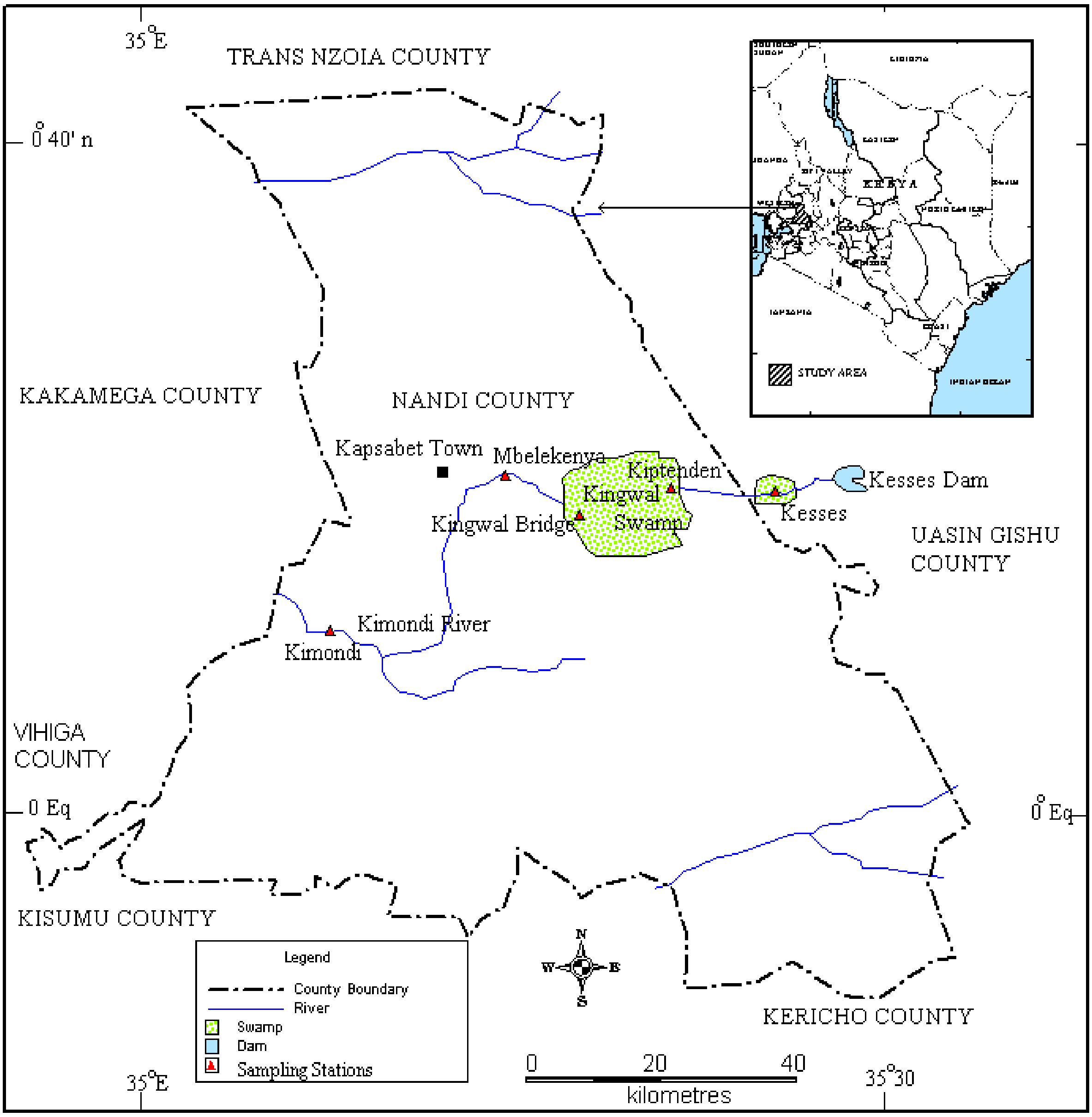

Figure 1: Map of King'wal Wetland showing its location. Inset; Map of Kenya.

There is inadequate data on the utilization and management of many wetlands in Kenya including Kingw'al wetland except for indigenous knowledge, and this has continued to hamper the formulation of policies on sustainable utilization and management of these wetlands. Continuous occurrence of unregulated human activities in wetland ecotones continue to pose threat of habitat degradation, which may potentially affect the biotic assemblage and the overall ecological integrity of the wetlands. This study therefore sought to determine the socioeconomic benefits the wetland provided to the riparian community, establish trends in utilization and management of wetland resources by the local community, determine the anthropogenic activities impacting the wetland and recommend the introduction and adoption of environmentally friendly alternative livelihoods to the riparian community to minimize wetland degradation.

II. Materials And Methods

To determine the wetland resource use and management, a descriptive research design was used through household surveys of the population within the sampling sites. The study population comprised of households along the King'wal Wetland where the sampling sites were located. The population was approximately 5,772 with about 1325 households based on the KNBS (2010). From this population about 119 households (9%) reported that they used resources of King'wal Wetlands (Uplublished previsous survey). Therefore, the formula by Mugenda and Mugenda (2003) was used to determine the sample size (n):

$n = z^2(\frac{pq}{d^2})$ Where: n = the desired minimum sample size, z = the standard normal deviation at set confidence interval, d = the acceptable range of error (0.05), p = the proportion of individuals using the swamp (9%), and q = the proportion of individuals not accessing the swamp = 1–p (0.91).

Hence; d = 0.05, p = 0.09, z = 1.96 at 95% confidence level, q = 0.91. Thus $n = 1.96^2(\frac{0.09*0.91}{0.05^2}) = 125.85$

Therefore, the desired sample size was 126 households.

Data was collected through stratified random sampling using questionnaires, focus group discussions, key informant surveys and field observation. The questionnaire used was both open and closed-ended and it captured information such as the socio-economic status of the sampled population, wetland use and economic activities by the local community members and the effect of population increase on the resources. The questionnaire schedule also comprised information on the personal data (age, gender, level of education, and their occupations). Members of the local community who could not understand the questionnaires were interviewed based on the content of the questionnaires. Key informant analysis was done based on response from the Officers of Ministries of Agriculture, Water, Livestock and Officials from KWS, NGOs and CBOs. The focus group discussions explored in more detail; issues captured in the questionnaires. The participants of FGD were persons involved in Community Forestry management, social workers, heads of institutions such as schools, herbalists etc. Statistical analyses were performed with Statistical Package for Social Sciences (SPSS 13.1). Normality and homoscedasticity of data distribution was checked by means of the skewness and kurtosis (Zar, 2001). In cases where data was found not to follow normal distribution (heteroscedastic), log (x+1) transformation was used to normalize all the biological data (Michael and Douglas, 2004).

III. Results and Discussions

Socio-economic status of the sampled population

A total of 126 respondents from the five sampling sites participated in the study. Age distribution indicated that more than two thirds (77%) of the respondents were aged between 31 to 60 years, there were up to 57.2% of the respondents aged 31 to 50 years while respondents aged below 30 years were only 15.8%. These findings are significant as they indicated the responses collected during the survey were given by elderly males who could have been the household leaders and whose decisions were reliable and respected,

There were significant differences in the age distribution patterns of the respondents among the sampling sites (χ^2 = 2.334, df = 3, p = 0.531). Except in King'wal area, none of the sampling location had respondents aged below 20 years. Most of the respondents aged 21-30 years were sampled at Kiptenden and Mbelekenya while most of those aged 31-40 were from Kesses, King'wal and Kimondo. On the other hand, majority of the respondents aged 41 to 60 years category were sampled at Kiptenden and King'wal as higher proportion of respondents aged over 60 years were sampled at King'wal. At Kingwal bridge where most respondents were aged above 60 years, it was difficult to convince the community to accept and embrace conservation as a form of land use and this was shown in the high levels of wetland degradation at this site compared to the other four sites namely Kesses, Kiptenden. Mbelekenya and Kimondi. The level of education for most respondents in Kingwal Bridge sampling site was noted to be at Primary school and below. This implies urgent need for sensitization and training on the use of environmentally friendly livelihoods by the community to minimize wetland degradation.

The distribution of the respondents by gender indicates that among the respondents, close to four fifth of the respondents (77.8%) were males while a fifth (22.2%) were females. There were no significant gender differences in the proportion of respondents (about 4:1; Male: Female) among the sampling sites (χ^2 = 0.727, df = 4, p = 0.948), indicating that males were dominant in each sampling location. The riparian community to the wetland has a known low recognition of feminine opinion in land issues. The findings here in are valid and dependable because four fifths of the responses were given by men, who are normally the family heads in the community.

Table 1. Distribution of the respondents in terms of gender at the five locations along King'wal Swamp, Kenya.

		Sampling sites					
		Kesses	Kiptenden	King'wal	Mbelekenya	Kimondo	Total
Male	Frequency	20	16	20	21	21	98
	% frequency	80.0%	72.7%	80.0%	80.8%	75.0%	77.8%

Female	Frequency	5	6	5	5	7	28
	% frequency	20.0%	27.3%	20.0%	19.2%	25.0%	22.2%
Total	Frequency	25	22	25	26	28	126
	% frequency	100%	100%	100%	100%	100%	100%

Marital status of the respondents among the sampling sites was determined. More than 90% of the respondents were married with few cases of single and widows in the sample. There were no significant differences in the marital status of the respondents among the sampling locations (χ^2 = 1.745, df = 8, p = 0.748) suggesting that in all sampling locations married population were the dominant respondents. The responses from married people in the riparian community to this wetland are most acceptable indicating the findings of this study are authentic.

Although there were different varieties of occupation among the local community members, most of the respondents were dominated by farmers who constitute close to three quarters of the population. Farmers are responsible for most anthropogenic activities in the wetland and are therefore the best entry point and target group in wetland conservation Decision makers in wetland conservation can use these data to make management and conservation decisions in the wetland,

Other respondents were civil servants, casual labourers, traders and housewives, but these were few among the respondents and there were no significant differences in the occupation of the respondents in the five locations (χ^2 = 16.727, df = 16, p = 0.1982) The levels of education of the respondents were sought from the sampling locations. The respondents were dominated by those who had attained upper primary levels of education followed by secondary school levels of education and least those with middle level colleges. The proportion of those without any formal education was equally low. However, the levels of education attainment were significantly different among the sampling sites (χ^2 = 36.926, df = 16, p = 0.002). Only in King'wal were respondents sampled without any formal education. Majority of respondents with lower primary levels of education were sampled from Kimondi and Mbelekenya and non from King'wal. On the contrary, most of the respondents with upper primary levels of education were sampled from Mbelekenya and Kimondi than in other sampling locations. Secondary levels of education dominated among respondents in Kesses and King'wal than other locations while respondents with middle levels college levels of education were sampled at King'wal only.

Approximately 90% of the households were headed by males while the rest were headed by females. The differences in the household heads were not significant among the sampling locations (χ^2 = 6.666, df = 4, p = 0.155).

Wetland use and Economic Activities

The wetland goods provided to the local community members in King'wal wetland were determined. Six most important resources in order of decreasing importance available to majority of the respondents living in King'wal Wetland were grains (98.4%), vegetables (88.9%), papyrus (85.7%), grass (82.7%), water (77.8%) and fodder (77.8%). The other resources used by fewer respondents were saltlick (26.2%), timber (11.8%) and ornamental plants (0.8%). The availability trend of these wetland resources has changed over the last 20 years. Grains, water, timber, papyrus and vegetables were more plenty 20 years ago as compared to the current quantities. The relative ranks score reflecting the importance of the plant species now and 20 years ago were determined and the most important resources from the wetland currently are grains, water, fodder, papyrus and vegetables while 20 years ago, other resources like fish, wild games, water, fuelwood, fodder, grass, and ornamental plants were available and important components to the livelihoods of the local community members. These results indicated that high human population growth over the last 20 years have led to increased pressure on wetland resources to address food insecurity hence high rates of wetland encroachment, conversion and agricultural use. The community needs to be educated on the socioeconomic benefits of the wetland and alongside that, the need for sustainable use and management of the wetland.

Challenges facing Lake Victoria wetlands

For a long time, wetlands have been converted into agricultural land in many parts of the world (Verhoeven and Setter, 2009), leading to lose of functional integrity (Hassan et al., 2005). A remarkable percentage of fresh water wetland areas have been lost because of drainage and development.

A number of studies in the Lake Victoria Basin have shown an increasing trend in threats to wetlands (Kairu, 2001; Balirwa, 1998). In the last fifty years, many of these wetlands have been under threat of being drained and reclaimed (Verhoeven and Setter, 2009) while others have been facing serious problems of degradation and their ability to continue providing valuable ecological services is threatened (Kairu, 2001, Kansiime et al., 2007). Increase in human population pressure is a key driver in wetland degradation. About

80% of the human population living in the LVB derives its livelihoods from subsistence agriculture (GIWA, 2006). Thus, agriculture, which is intensifying on most catchments, will continue to have significant impacts on the environment.

Other threats to wetlands are overgrazing, human settlement and encroachment, siltation, pollution (mainly from agriculture and industrial sources), introduction of exotic species such as blue gum trees (Eucalyptus spp.) and overharvesting of water dependent plants. Socio-cultural factors, such as traditions, lifestyles and informal natural resource abstraction by local communities have also influenced perception of wetlands, their use and management. Lack of adequate and appropriate knowledge about the functions and values of wetlands have hindered active management, including rehabilitation of degraded areas by local communities. Lack of national wetland policy and weak legal and institutional frameworks have also contributed towards unfavorable environment for wetland conservation and sustainable use in Kenya. Unsustainable development and urbanization have equally played a role in wetland conversion and degradation. Papyrus wetlands are threatened by drainage, clearing, filling and reclamation for subsistence crop production, overgrazing, road building, construction of dams or barrages for water storage, flood protection, irrigation and hydroelectric schemes, construction of waterways and irrigation. Unsustainable utilization of papyrus has been found to cause complete loss of the wetlands through biodiversity loss. (Morrison et al., 2012) Other past studies have shown by aerial surveys that papyrus cover around the lake have undergone a remarkable loss. A comparative aerial survey between 1969 and 2000 showed 50% loss in Dunga and 47% and 34% loss in Koguta and Kusa respectively (Mafabi 2000). This study like other earlier studies has shown that papyrus height and density are inversely related to human disturbance including footpaths, cutting, burning, grazing and farming (Owino 2005). Further within the wetlands, there exists human-wildlife conflicts in addition to conflicts over papyrus and agricultural space which to the local communities is a common resource (Hardin, 1968). According to Mafabi (2000) land use activities around papyrus swamps of Lake Victoria are dominated by cultivation, livestock grazing and settlements that offer major threats.

In this study King'wal wetland supplied the local community with grains, vegetables, papyrus, grass, water and fodder. Also, some degree of other items like salt lick to the livestock, timber and ornamental plants. These functions concord well with other uses of wetlands worldwide (Zedler and Kercher, 2005) and in Kenya (Crafter *et al*., 1992; Terer *et al*., 2004). For instance, previous studies in in Uasin Gishu indicated that some wetlands have been reclaimed for crop production and most of the remaining ones are under varying degrees of threat (Njuguna, 1996; Jones and Muthuri, 1997). The exploitation of wetlands in Kenya has been on a small scale and at subsistence level mainly for mats, baskets, ropes, roofing material, and firewood (Gichuki *et al*., 2001). However, this has changed with the exploitation of many wetland plants for commercial purposes (Abila, 1998; Otieno *et al*., 1998). The findings that currently, the most important resources from the wetland are grains, water, fodder, papyrus and vegetables while over the last 20 years, fish, wild games, water, fuelwood, fodder, grass, and ornamental plants were more important to the local community members indicate the extent of overexploitation of the current wetlands for agricultural activities that enhance food production while diminishing other natural resources like fish, wild game, fuelwood and various plant species. This was confirmed by the degree of commercialization of agriculture in the area through selling of the crops and timber. The recognition that flora and fauna can be used by the local community members is well documented in Kenya (Feder and Umali, 1993; Gichuki *et al*., 2001; Gichuki, 2003; Osuji, 2007).

This study investigated the status of aquaculture in the wetlands by the local community members. There were four main species of fish that occurred naturally at the wetlands mainly Nile tilapia (*Oreochromis niloticus*), catfish (*Clarias gariepinus*), mudfish (*Protopterus aethipicus*) and *Barbus* spp. There were significant differences between fish species cultured and those in the wild ($\chi^2 = 13.126$, df = 3, p = 0.0001). Tilapia and catfish were the more dominant species in the natural environment and were also the only species cultured while mud fish that was identified in the natural environment by 20% of the respondents and *Barbus spp* that were identified by 10% of the population were not cultured. These findings indicate that the riparian community can culture mudfish and *Barbus spp* in addition to Nile tilapia and Catfish. This indicates that aquaculture is a feasible alternative livelihood the community can adopt to reduce wetland degradation through overutilization of wetland resources.

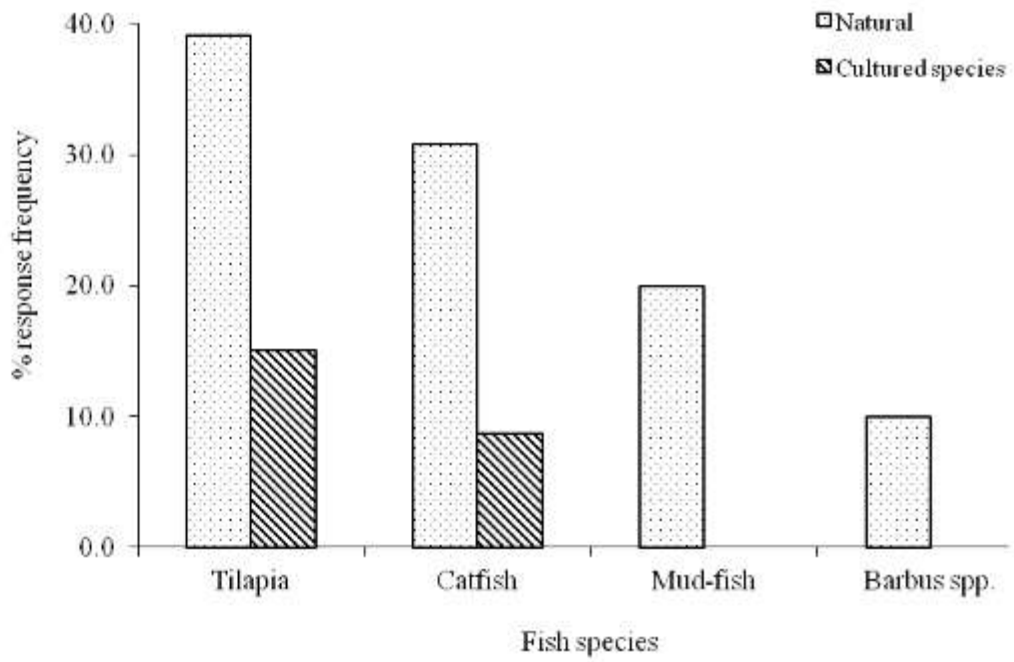

Figure 3: Frequency of occurrence of the species in the natural environment and under culture in King'wal Swamp

The riparian community can successfully embrace participatory wetland management if alternative livelihoods are provided to community to enable it meet their daily family needs. Kenyans have used the plants and animal resources for food, medicines, cosmetics, building, tools, clothing and rituals. Perhaps lack of enough water currently as compared to the last 20 years is limiting the full potential of aquaculture. This is because, few respondents reported aquaculture of two common fish species Nile tilapia (*Oreochromis niloticus*), catfish (*Clarias gariepinus*) despite the dominance of these 2 species of fish in the natural waters of the wetlands. As in many other parts of Kenya, increasing populations near the wetlands, impose pressures leading to overexploitation of fisheries resources without elaborate efforts to start aquaculture projects. The wetland ecosystem has favourable conditions for aquaculture as it provides water, planktons, water plants and clay soils befitting for brooding and fingerlings growth. From these findings, aquaculture is an alternative livelihood that can be adopted by the community if proper education and training is provided to the members, Aquaculture will provide the most needed proteins to eliminate malnutrition. Food security is a thorny issue to most communities and training community in aquaculture would go a long way in solving this problem that has been worsened by climate change impacts emanating from environmental degradation. It is however worth noting that the riparian community to King'wal wetland have cultural believes that hinder production and use of fish as food. This therefore demands that the government, NGOs, institutions of learning and other stakeholders put in place programmes for educating and sensitizing community on the nutritional and economic value of fish. If achieved this will minimize overexploitation of wetland resources and hence wetland degradation.

The King'wal Wetland community uses the wetland for various economic activities. There were significant differences in the types of economic activities practiced by the local community members (χ^2 = 9.122, df = 7, p = 0.0004). Figure 4 shows the key economic activities practiced by the local community members include: poultry keeping as noted by 81% of respondents, tree nurseries (48%), and bee keeping as observed by 36% of respondents, while the least were flower nurseries and zero grazing.

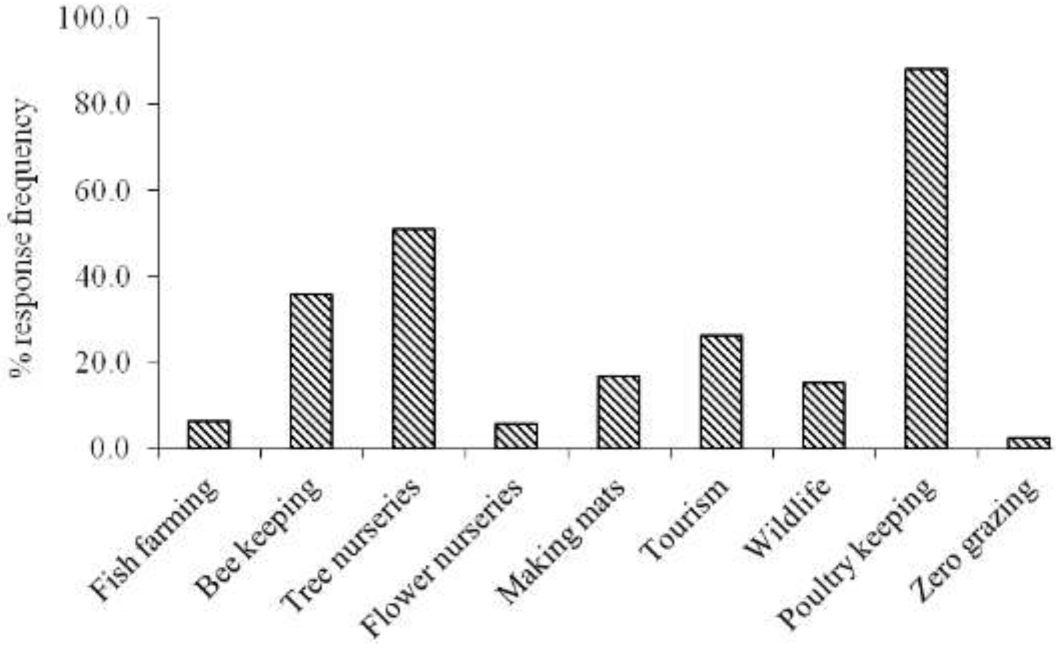

Figure.4: Economic activities practiced within the wetlands by the local community members in King'wal Swamp

Despite the occurrence of several resources in the study areas, the key economic activities practiced by the local community members of King'wal were: poultry keeping, tree nurseries, apiary among others practiced by few respondents including floriculture and dairy farming.

Field operations however recorded farming activities as well as brick making as additional economic activities practiced in the wetland. Most respondents however denied practicing them probably for fear that the government could penalize them as this contravenes the wetland policy regulations.

The biological diversity of wetlands is unevenly distributed, with some habitats being characterized by a richer range of species than others (Schuijt, 2012).

Similar results have been reported in other wetlands in the East African region indicating that wetlands provide important natural resources, upon which the rural economy depends, *(S. M. Mwakubo et al, 2009.)* They provide many substantial benefits not only to local society, but also to the people who live far away from them. They are recognized globally for their vital role in sustaining a wide array of biodiversity and providing goods and services *(T. V. Ramachandra, et al, 2011.)* and also as important sources of natural resources, upon which the rural economies depends, *(B. R. Malabika et al, 2012.)* Wetlands provide a wide range of tangible and non-tangible benefits to various communities (F. Karanja, et al, 2001, Wetlands Management Department, Uganda, 2009) The tangible benefits include water for domestic use and watering of livestock, support to dry season agriculture, provision of handicrafts, building materials, and food resources such as fish, yams, vegetables, wild game, and medicine. The nontangible benefits include flood control, purification of water, maintenance of the water table, microclimate moderation, and storm protection. Wetlands also serve as habitats for important flora and fauna, have aesthetic and heritage values, and contain stocks of biodiversity of potentially high pharmaceutical value *(F. Karanja, et al, 2001, Wetlands Management Department, Uganda, 2009)*]. All these benefits have a bearing on food security. Over 80% of the people living adjacent to wetland areas in directly use wetland resources for their household food security needs *(Turyahabwe, et al, 2013).* Besides, they also indirectly contribute to food security by providing services that foster food production such as weather modifications and nutrient retention. Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (. TFAO (Food and Agricultural Organization et al, 2001). A better understanding of the benefits and costs of utilizing wetland resources will provide important information for understanding and addressing the economic causes of wetland degradation and loss. This study was undertaken to determine Kingwal wetland resources, their economic value and benefits and to demonstrate to wetland users, managers, and policy makers how valuable wetland resources are, as a basis for guiding decision making on wetland conservation.

Services that the local community members derive from Kingwal wetlands were determined. There were significant differences in the services offered through wetlands by the local community members (χ^2 =

25.143, df = 11, p = 0.0000). The social services derived from the wetlands by all the respondents were climatic regulations, air quality regulation while majority of the local community members also derived social benefits such as water recharge (75.3%), cultural practices (54.6%), flood control (53.5%) and erosion protection (43.4%).

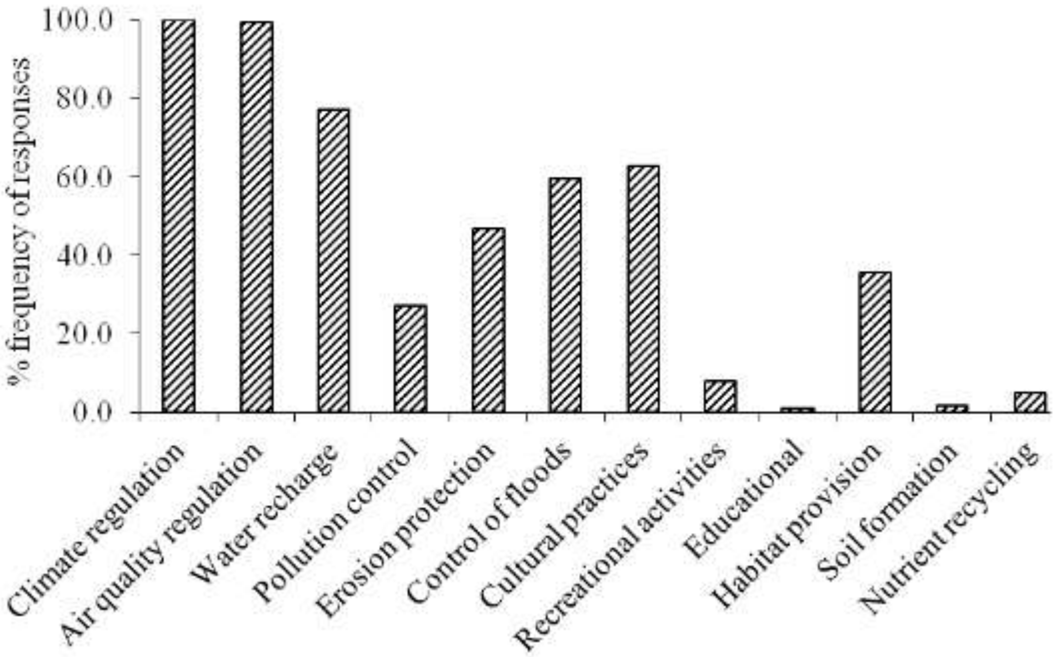

Figure 5: Services that the local community members derive from the wetlands

Globally, wetlands provide a wide range of economic, social, environmental and cultural benefits. in recent times classified as ecosystem services (Costanza et al. 1997). These services include maintaining water quality and supply, regulating atmospheric gases, sequestering carbon, protecting shorelines, sustaining unique indigenous biota, and providing cultural, recreational and

educational resources (Dise 2009). Despite covering only 1.5% of the Earth's surface, wetlands provide a disproportionately high 40% of global ecosystem services (Zedler and Kercher 2005).

They play a fundamental part in local and global water cycles and are at the heart of the connection between water, food, and energy; a challenge for our society in the context of sustainable management. In King'wal wetland, the local community members were also aware of similar ecosystem and social functions of the wetlands such as water recharge, cultural practices, flood control and erosion protection. Few studies however, have reported the use of wetlands by the local community members in ecosystem and social functions. It is therefore necessary to design programmes to train and educate the community on the important role played by wetlands in enhancing provisioning of such unique services.

Wetland biodiversity and use values

Data from wetland flora indicated that there were significant differences in the biodiversity of wetland flora in the sampling sites. (χ^2 = 65.121, df = 8, p = 0.0000). Most of the respondents reported that the most dominant biodiversity in King'wal wetland were: acacia plants (48.8%), sedge grasses (45.8%), papyrus reeds (44.5%) and duckweeds (32.3%). Yet lower proportion of the respondents reported the availability of floating ferns (12.3%), water lily (13.2%) and wondering Jew (5.4%). There were significant differences in the fauna in the study five sites (χ^2 = 35.121, df = 16, p = 0.0012). The main species of animal reported by majority of the respondents were: Sitatunga (80.2%), duck (70%), fish (60%), hare (66.5%) and cranes (65.3%). Other animals such as shy otters, porcupines, owl and egrets were present but were identified by low number of respondents.

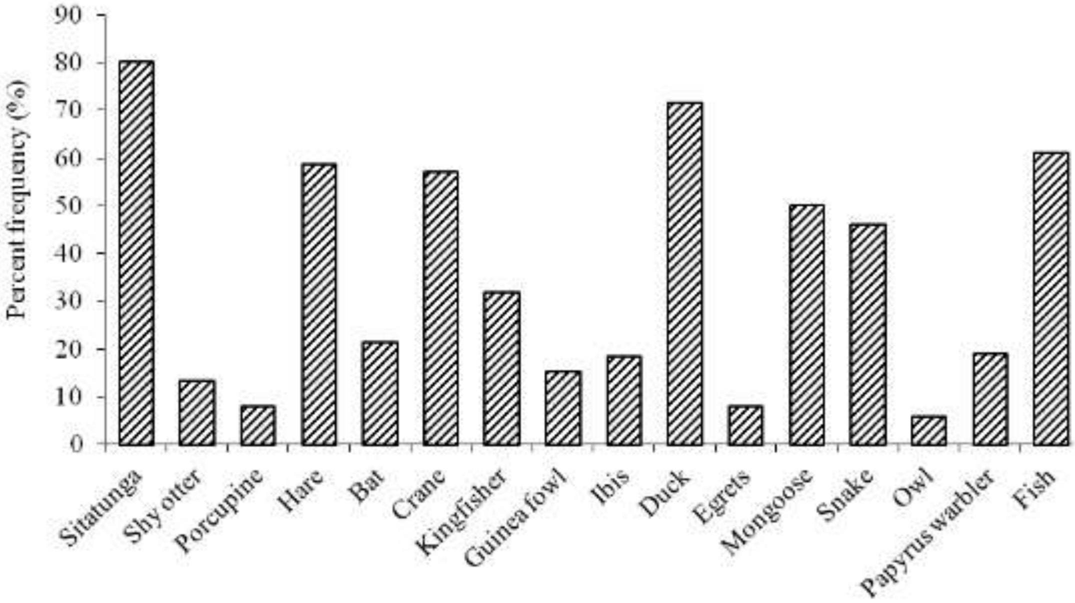

Figure 6: Fauna of the King'wal Swamp during the study period

There were significant association between animal species and their uses (χ^2 = 49.127, df = 24, p = 0.0000). The main use of Sitatunga and ducks was for food and tourism, porcupine, hare, guinea fowl and mongoose were used as food. On the other hand, bats, cranes, kingfishers, and papyrus were mainly useful for tourist's attraction in the study area. Ibis was used for tick control while mongoose was medicinal for few respondents.

Wetlands provide fully 60 percent of all threatened species and 40 percent of all endangered species listed in 1991 with essential habitat (Wetland Atlas). Information on wetland dependent species of fauna and flora is relatively limited. Many wetlands are highly productive and rich in animal species. Animals are attracted to wetlands because they provide food, water, cover, and nesting sites. Wetlands provide many animals with homes. Wetlands provide critical habitat for wildlife. It has been estimated that in the United States roughly 150 species of birds and more than 200 species of fish depend on wetlands for their survival. Many birds such as the great blue heron, great egret, bald eagle, osprey, red-shouldered hawk, owls, wild turkey, belted kingfisher, red-bellied woodpecker, pileated woodpecker, and several species of swallows, sparrows, and warblers use wetlands. Ducks occupy wetlands in great numbers. Duck species include the wood duck, mallards, black ducks, blue-winged teal, gadwall, widgeon, and the northern pintail, (*Wetland atlas, Kenya*). Mammals such as the muskrat, beaver, raccoon, and white-tailed deer also use wetlands. In addition, a wide variety of reptiles, turtles, and freshwater fish depend on wetlands for survival (*Neiring,1988*). One group of animals often overlooked when the inhabitants of wetlands are considered is the invertebrate species. These small animals, which include flatworms, aquatic earthworms, leeches, crawfish, and fairy shrimp, are vital links between plants and the animal food chains. Many invertebrates graze on living plants while others consume dead organic material. The invertebrates are in turn eaten by fish, birds, frogs, toads, and turtles. Invertebrates make energy available to animals which may consume little or no plant material. What happens to these vital links when wetlands are altered or destroyed? What happens to the animals that depend on these species for some or all of their nutritional requirements? Wetland habitat loss, fragmentation and degradation leads to loss of biodiversity and the flow of energy in the form of food, from one species to another is interrupted resulting into a negative impact on both species diversity and on population size. A general criterion of wetlands in the Lake Victoria basin is the presence of indicator organisms, the most perceptible of which is vegetation. Vegetation is in addition, a gauge of environmental integrity and an important determinant of an ecosystem's biotic composition (Hejny and others 1998). Wetland vegetation in the lake Victoria basin is generally typified by hydrophytes which are plants that have adapted morphologically (by for instance, possessing aerial root tips), physiologically (through for example, anaerobic respiration that enables these plants to withstand the absence of atmospheric oxygen), and reproductively (by, for instance, producing viviparous seeds which germinate within the fruit) to specifically tolerate partial or complete inundations for short or prolonged periods of time (Tiner2012). Examples of hydrophytes that are common in Kenya include mangroves (particularly *Rhizophora mucronata* and *Ceriops tagal*), *Arundo donax* (giant reed), *Phragmites* (reed), *Typha* (cattail, bulrush, kachalla and reedmace) and *Cyperus* papyrus (papyrus). Most of these important vegetations are found in Kingwal wetland, making it paramount to conserve and sustainably manage King'wal wetland. Both freshwater and marine wetlands are species-rich and contain an array of invertebrates, birds, amphibians, reptiles and mammals (Dvorak and others 1998). King'wal wetland unlike most of the other wetlands in Kenya is a habitat for the endangered Sitatunga antelope. This makes it a special wetland that needs sustainable utilization and management of the ecosystem. King'wal wetland therefore like most other wetlands in Kenya exhibits exhibit high levels of endemism because the water component acts as a physical barrier to the dispersion of some taxonomic groups. An example is the 300 cichlid species that are endemic to wetlands in the Lake Victoria basin (Millennium Ecosystem Assessment 2005). Besides feeding on the ecosystem's vegetation, many of the animals within wetlands prey on each other, consequently forming an elaborate food chain that comprises plants at the base, herbivores in the middle and carnivores at the apex (*Ulgiati and Brown 2009*). Most of the locals reported that the most dominant biodiversity in King'wal Swamp were: acacia plants (48.8%), sedge grasses (45.8%), papyrus reeds (44.5%) and duckweeds (32.3%). Yet lower proportion of the respondents reported the availability of floating ferns (12.3%), water lily (13.2%) and wondering Jew (5.4%).

The respondents also reported how they use the plants in King'wal Swamp. Duckweeds were used mainly as fodder, papyrus was mainly used to make mats, acacia was used as firewood, sedges grass had different uses such as brick making and fodder. Water lily and wondering jew had few users among the local community members. Among the various plant parts, only the leaves of the duckweed, acacia and water lily were used by the local community respondents. On the contrary the stems of papyrus reeds were used by many respondents while majority of the local community members used whole sedge plant part of the sedge grass. The main use of Sitatunga and ducks was for food and tourism, porcupine, hare, guinea fowl and mongoose were used as food. On the other hand, bats, cranes, and kingfishers were mainly useful for tourists' attraction in the study area. Ibis was useful for tick control while mongoose was medicinal for few respondents.

Wetland resources and resource use management

Figure 7 shows the anthropogenic activities that are likely to affect the functional integrity of the wetlands was reported by the local community members. There were significant differences in the knowledge of activities affecting wetlands (χ^2 = 21.776, df = 3, p = 0.0000). Only 23.3% attested that the wetland water resource was useful for consumption while 76.7% did not agree with the notion. Negative effects of these activities in the wetlands for majority of the respondents included: use of fertilizers for agricultural activities, release of sewage, runoffs and erosion while up to 40% of the respondents were not sure of these detrimental activities.

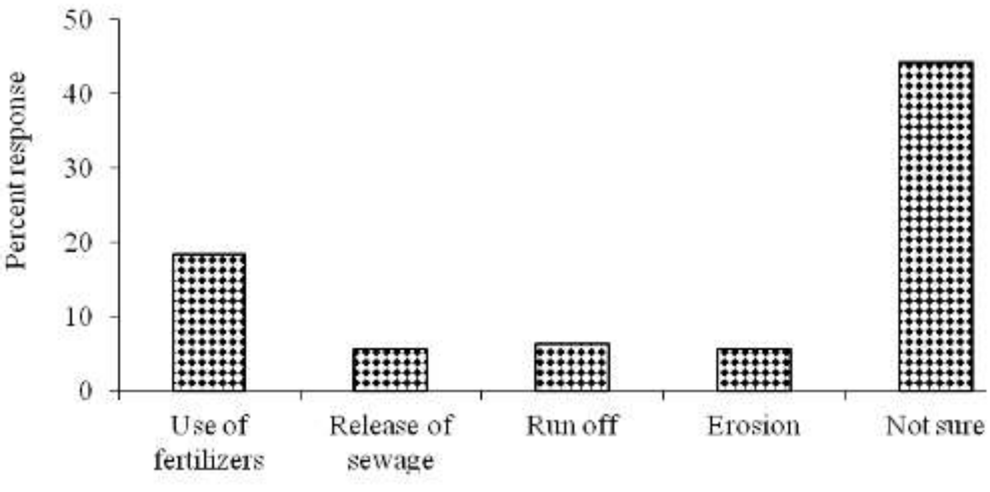

Figure 7: Activities affecting wetland integrity in Kingwal Swamp during the study period

Results from this study indicated that over 50% of the respondents were not aware of the anthropogenic activities impacting the wetland. This implies that the level of awareness on participatory conservation which holds the community at the centre and as primary stakeholders needs to be enhanced. Conservation education Programmes and trainings need to be designed for the riparian communities for sensitization. National and County governments, funded projects such as Lake Victoria Environmental Management Programme, Kenya Wildlife Services, Community Based Organizations and Non-governmental organizations working in the area of conservation could be used to run the conservation trainings and education sessions.

This study recommended and participated in the drafting of a management plan to enhance resource identification, sustainble utilization and management to rescue Kingwal wetland from the ultimate destruction.

IV. Conclusions

- The level of conservation education and training among the riparian community members was low with over 50% of the community not aware of the anthropogenic activities impacting the wetland.
- The riparian community needs sensitization on the available wetland resources and their benefits and hence the need for sustainable utilization and management.

V. Recommendations

- There is need to train the community to adopt alternative livelihoods to wetland resources utilization in order to attain sustainable utilization and management of the wetland
- Draft and use a management plan to ensure sustainable resource utilization and management of the wetland.
- provide the community with alternative livelihoods that will minimize the identified anthropogenic activities that degrade the wetland.

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