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ENVIRONMENTAL IMPACT OF WETLANDS UTILIZATION IN OKANA IN THE LOWER NYANDO RIVER BASIN, KISUMU COUNTY, KENYA

Daniel O.Odaro*, Fatuma Daudi and Elias K.Ucakuwun
Department of Environmental Planning, Sustainability and Geoinformatics
University of Eldoret, Kenya
*Corresponding Author: danielodaro79@gmail.com

Abstract

Wetlands, like any other natural resource, have been exploited by the adjacent communities so as to sustain their livelihoods. The ecosystems have thus supported millions of livelihoods since time immemorial through their socio-cultural and economic values. However, due to the ever increasing human population and economic demand over the years, there has been a corresponding exponential increase both in the frequency and the number of people involved in the harvesting of wetland products. The phenomenon has impacted negatively on the wetland ecosystems thereby compromising their quality and quantity hence sustainability. The study aimed at assessing the impacts of wetlands use that degrade the environmental quality with specific reference to Okana in the lower Nyando River Basin. It also sought to come up with appropriate environmental planning and management strategies which will help to ameliorate the deplorable status of wetlands. The study adopted mixed approach design where both qualitative and quantitative techniques were used. The study used direct observation, photography, surveys and Participatory Rural Appraisal (PRA) tool in collecting data. Field data was analyzed using SPSS. The findings revealed that utilization of wetland resources results into numerous environmental consequences such as biodiversity degradation and loss, waste generation, pollution among other impacts, which need to be addressed for environmental sustainability as well as sustained livelihoods. This can be achieved through selective harvesting of wetland resources, rehabilitation of degraded sites and establishment of a buffer zone based on the NEMA regulations. The study recommends an integrated planning and management of wetland ecosystems that incorporates all stakeholders in the planning and implementation of management strategies for sustainable utilization hence sustainable development.

Key Words: Wetland, Environment, Degradation, Planning and Management, and Sustainability.

Introduction

Wetland ecosystems are diverse habitats, which are permanently or temporarily waterlogged by either saline, brackish or freshwater. They include mangroves, marshes, swamps, lake and riverine edge swamps, ponds, dams, coral reefs, flood plains, swamp forests, peat land, sea grasses, sandy beaches, deltas and estuaries. These wetlands have been classified differently under different classification systems. Mwanuzi (2003) outlines two systems of wetland classification namely the US Fish and Wildlife Services Systems (USFWS) and the Cowardin Wetland and Deepwater Systems (CWDS). Under these classifications there are coastal, inland, marine, estuarine, riverine,

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ISSN:2789-3995
(Online)

lacustrine and palustrine wetlands. In East Africa, wetlands have been classified on the basis of whether fresh or saline. Harper & Mavuti (1996) and Ruwa (1996) have identified several categories of freshwater and intertidal wetlands.

Wetland loss and/or degradation, which may emanate from anthropogenic activities such as infrastructure development, channelization, canalization and draining for agriculture and mosquito control, pollution (Mitsch & Gosselink, 2007), and natural factors such as invasion by both alien and native species (Howard & Matindi, undated), may result in adverse environmental impacts. Besides, the livelihoods of the riparian communities that directly rely on the wetland resources will be in jeopardy. In the long run, the benefits so derived may decline drastically or become exhausted altogether.While wetlands utilization by the riparian communities have to continue throughout the ages, it is imperative that sustainable use be adopted. Such an adoption is only possible if the cause and effect factors are isolated and determined. This is the gist of the study. It discusses the resultant environmental impacts which emanate from various uses of wetland ecosystems as well as planning and management strategies which need to be undertaken in order to enhance environmental quality.

Objective

The purpose of the study was to assess the environmental impact of wetland resource use in Okana area in the lower Nyando River Basin. The study considered the period between 1960s and 2020. The findings will help come up with appropriate strategies for planning and management based on the actual and potential impact whether positive or negative to the community and beyond. Besides, they will also inform the policy makers on the relevant actors or players to be involved in the planning and management processes or activities depending on the wetland user groups.

Methodology

The study adopted mixed approach design where both qualitative and quantitative techniques were used. Several techniques were used to collect and analyze data on the impact of wetland resources utilization in the study area. These include purposive and systematic random sampling techniques, photography, surveys, Statistical Package for Social Sciences (SPSS) and Participatory Rural Appraisal (PRA). Purposive sampling was used in the determination of the wetlands for study as well as in the administration of forty (40) key informant questionnaires. Systematic random sampling technique was used in the selection of respondents for the administration of three hundred and eight (308) questionnaires in the study area. Photograph of clay excavation site was taken during field survey exercise. PRA was used to validate responses obtained during field survey. A total of thirty six (36) participants were also used during the PRA exercise. In summary, the total sample size for the study was three hundred and eighty four (384) and derived by the following the formula: (Mugenda and Mugenda, 2003)

$$n = \frac{Z^2 pq}{d^2}$$

Where: n= the desired sample size

Baraton Interdisciplinary Research Journal (2025), 11(Issue 1), pp. 35-51
www.birj.ueab.ac.ke
ISSN:2789-3995
(Online)

Z= the standard normal deviate at the required confidence level (marginal error); at 95%, z=1.96

p= the proportion of target population

q= 1-*p*

d= level of statistical significance

Thus: at 0.05 confidence level, *Z* =1.96,

p= (50% =0.5);

$$n = \frac{(1.96)^2 \times (0.5 \times 0.5)}{(0.05)^2} = 384.$$

SPSS was used to analyze field data so as to obtain percentages in the incidences such as accidents, injuries, social conflicts and fatalities if any during wetland use.

Study Area

Okana wetland is located in the lower Nyando River basin. It has an estimated area of about 40 km^2 (GOK, 2009). The Okana wetland system lies in West Kano in Nyando Sub-County in Kisumu County. The wetland system is in the western part of Kano Plains where the soils are gleysols type, commonly associated with swamps (LVEMP, 2000a & b). It is located at the confluence of rivers Ombeyi-Oroba, Luanda, Nyangeta, Lielango and Miriu (Fig. 1).

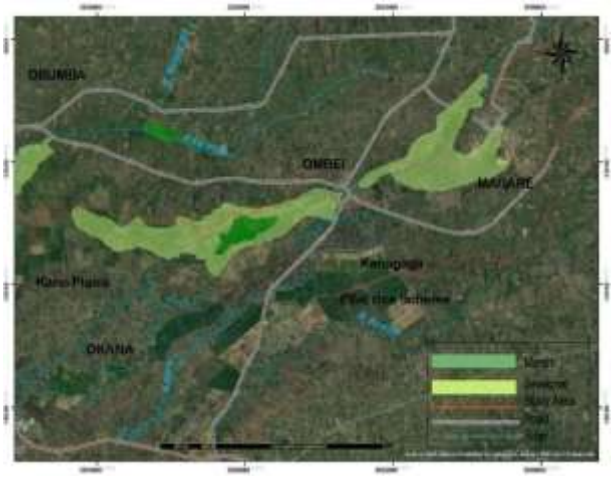

Fig: 1 Study Area.

Okana area comprises several villages with a total population of about thirteen thousand, four hundred and sixty seven (13,467) with a total number of households of nine hundred and thirty eight (938) (GOK, 2019). The major villages in the area include Kowuor, Kabina-Kodeyo, Kagaya, Kaluga, Kosimbo, Kawuor, Kodhiambo, Kokal, Kanyang'anyi, Kanyaoma, Kadeya and Kathina (Fig. 2). In terms of economic activities, the residents basically engage in subsistence agriculture, with rice being the staple crop.

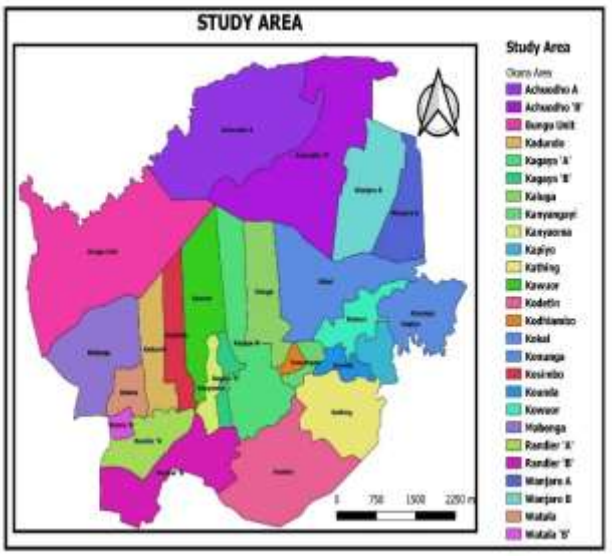

Fig: 2 Okana Area (Villages).

Results and Discussion

Anthropogenic activities in Okana area such as clearance of vegetation, clay excavation, harvesting of medicinal herbs and wetland macrophytes from the wetland have accelerated the vulnerability of the area to numerous environmental problems, some of which are hazardous. This section outlines the consequential environmental issues.

Baraton Interdisciplinary Research Journal (2025), 11(Issue 1), pp. 35-51
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Biodiversity decline and loss

Human activities such as clearing of wetlands, burning of wetland vegetation, deforestation and hunting often lead to negative impact on the abundance of flora and fauna. It has been examined that wetlands provide habitat for numerous species of fauna. The ecological function therefore ceases if the wetland ecosystems are cleared for different purposes. Whereas some may relocate or migrate to other habitats (especially mobile biota), some species would perish since typical wetland biomes such as shorebirds may not easily adapt to new ecosystems. Immobile biota (flora) and other species, which might not be tolerant to fire, would succumb thereby becoming extinct.

In summary, human interference has had an overall impact of reduced and/or loss of biodiversity in Okana wetland ecosystem. During a PRA exercise, it was observed that some species of flora and fauna have declined in number while others have disappeared altogether in the recent past (Tables 1a & b). The decline and/or loss of the species is attributed to clearance of wetland vegetation. The result agrees with the findings of Masese et al. (2012) that human activities such as burning of wetlands and wetland conversion into farmlands always scare away animals and birds thereby seeking other areas for habitation. This affects both the richness and abundance of the biodiversity in the wetland ecosystems.

Table 1a. Species of plants that have declined/disappeared in Okana wetlands

Local Name	Botanical Name
Adugo	*Acacia drepanolobium*
Okaka lang'o	*Aloe secundiflora*
Keyo	*Combretum* spp.
Ochol	*Diospyros abbysinica*
Powo	*Grewia bicolor*
Pedo	*Caesalpinia sepiana*
Atego	*Keetia gueinzii*
Sangla	*Rhus natalensis*
Saa	*Oncoba spp.*
Achak	*Pittoasporum spp.*
Nyayado	*Cassia floribunda*

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Table 1b. Species of animals that have declined/disappeared in Okana wetlands

Local Name	Scientific Name	English/Common Name
Ondiek	*Crocuta Crocuta*	Hyena
Bim	*Papio Anubis*	Olive baboon
Ong'er	*Ceropithecus mitis*	Monkey
Dwe	*Tragelapus spekei*	Sitatunga
Nyang'	*Crocodilus niloticus*	Crocodile
Tula	*Asio abyssinicus graueri*	Owl
Ng'ielo	*Python sebae*	Python
Muok	*Orycteropus afer*	Antbear
Awendo	*Acryllium vulturinum*	Guinea fowl
Ndemu	*Mehelya spp.*	Brown mamba
Tel-tel	*Capethera spp.*	Wood pecker
Aywer	*Francolinus spp.*	Spurfowl
Chiewo	*Hystix galeata*	Porcupine
Aluru	*Coturnix delegorguei*	Harlequin quail
Magungu	*Anastomus lamelligerus*	Open billed stock

Creation of micro-habitats

Pottery is a well-known wetland activity in Okana area. The famous centre for the craft is at Bungu Koraga where women engage in pottery either as individuals or groups. Clay excavation for pottery in the area devastates the environment and the resultant pits left after excavation often become health hazards to the surrounding population. The micro-habitats created normally form breeding grounds for disease vectors such as mosquitoes and snails. The open pits may also be filled with surface run off during rainy seasons leading to drowning incidences (Plate 1). Besides, excavation often leaves behind hanging walls or debris, which are

Baraton Interdisciplinary Research Journal (2025), 11(Issue 1), pp. 35-51
www.birj.ueab.ac.ke
ISSN:2789-3995
(Online)

quite vulnerable to land subsidence or collapse thereby causing loss of lives particularly to women who may be in the pits harvesting clay at the time. Furthermore, clay excavation leaves a barren land, which is completely uninhabitable unless reclaimed. The scenario eventually leads to land dereliction if no immediate remedial measures are undertaken.

Plate: 1 Clay excavation site at Okana wetland.

Water Pollution

The residents in Okana area abstract water from both surface and groundwater sources. The sources of water include rivers, ponds, water pans, wells and boreholes. On the average, abstraction from the wells outstrips the other sources and account for up to 91.7%. Thanks to SANA International and GWAKO – Non-Governmental Organizations – that facilitated construction of the wells. It is however important to note that any single household may abstract water from two or three sources depending on the purpose for the water – whether for drinking, general domestic cleaning, bucket irrigation or watering of livestock. The choice is dictated by the apparent varying water quality from the sources.

Surface water sources like rivers, ponds and water pans are subjected to both point and non-point sources of pollution such as run-offs of urban and domestic wastes and from large scale farms in the upstream such as Chemelil, Miwani and Muhoroni sugar cane plantations as well as from nearby small scale farms. Massive soil erosion due to clearance of vegetation over the years also contributes to poor quality especially turbidity of surface water sources. Besides, industrial discharges in the upstream catchment further contribute to pollution in the area. The findings are in agreement with the results of analyses of the parameters of water quality for River Nyando wetlands, Okana area included, are shown in Tables 2a-c (LVEMP, 2000 a & b). Groundwater sources namely wells and boreholes are equally polluted. Water tapped from the two sources is saline due to high concentrations of fluoride. The presence of fluoride in the water is explained partly by leaching of soda from subterranean sources when groundwater circulates along fissures and partly associated with the late –stage silification.

The evidence of water pollution adduced from the findings of LVEMP clearly confirms the fact that the wetlands in the study area have been degraded. The phenomenon has consequently impaired the role of the wetland ecosystems in water purification and prevention of salt intrusion. The ecosystems therefore fail to purify water through removal of nitrogen, phosphorus, heavy metals and other chemicals and pollutants from water and this leads to lowering of water quality as depicted in the

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ISSN:2789-3995
(Online)

findings. Masese et al. (2012) further confirms the pollution phenomenon of the wetlands due to the agro-based factories in the upstream of the catchment which discharge their effluents into the wetland ecosystems.

Table 2a.Water quality status for River Nyando wetlands (Extracted from LVEMP, 2000 a & b)

Site Code	Nutrients	Faecal Coliform Contamination	Remarks
01	Nearly eutrophic	Contaminated	Continued nutrient loading will lead to eutrophication
02	Uncontaminated freshwater	Not contaminated	Has non faecal coliforms
03	Uncontaminated	Uncontaminated	Has non faecal coliforms
04	Uncontaminated	Uncontaminated	Has non faecal coliforms
05	Uncontaminated	Uncontaminated	Has non faecal coliforms
06	Uncontaminated	Contaminated	Has non faecal coliforms
07	Uncontaminated	Contaminated	Has non faecal coliforms
08	Uncontaminated	Contaminated	Has TNTC
09	Uncontaminated	Contaminated	Small quantities of non faecal coliforms
10	Uncontaminated	Contaminated	Small quantities of non faecal coliforms
11	Nearly eutrophic	Contaminated	TNTC and non faecal coliforms
12	Uncontaminated	Contaminated	TNTC and non faecal coliforms
13	Nearly eutrophic	Contaminated	TNTC and non faecal coliforms
14	Eutrophic	Contaminated	High chloride value indicates domestic sewage High BOD implies large quantities of organic matter
15	High quantities of Nitrate-Nitrogen	Contaminated	TNTC and non faecal coliforms
16	High quantities of Nitrate-Nitrogen	Contaminated	Small quantities of non faecal coliforms
17	Uncontaminated	Contaminated	TNTC and non faecal colifroms

KEY: **BOD** Biological Oxygen Demand
TNTC Too Numerous To Count

Baraton Interdisciplinary Research Journal (2025), 11(Issue 1), pp. 35-51
www.birj.ueab.ac.ke
ISSN:2789-3995
(Online)

Table 2b. Physio-chemical analysis (Extracted from LVEMP, 2000 a & b)

Site Code	Temp ^{0}C	Ph	TDS	Cond us/cm	Cl mg/l	NO_3-N mg/l	PO_4-P mg/l	F. Colf.	T. Colf	BOD_5
01	19.7	6.0	57	117.2	3.5	0.76	0.06	4	10	-
02	21.4	6.5	48.2	98	2.0	0.4	0.023	NIL	46	-
03	22.5	6.5	14	30.1	4.1	0.4	0.01	NIL	18	-
04	19.5	6.0	17	35.0	4.3	0.47	0.015	NIL	10	-
05	19.0	6.5	15	39.9	2.6	0.54	0.025	NIL	12	6.0
06	19.5	6.5	23	49.3	4.8	0.44	0.034	10	34	-
07	20.5	6.5	25	52.4	5.5	0.53	0.025	TNTC	120	-
08	21.5	6.5	16	35.5	5.7	0.47	0.016	4	TNTC	-
09	18.8	6.5	17	33.1	4.2	0.59	0.12	28	30	-
10	18.7	6.5	15	31.3	4.7	0.44	0.006	NIL	16	-
11	19.6	6.5	17	30.4	5.9	0.38	0.08	TNTC	TNTC	-
12	21.5	6.5	16	33.4	4.5	0.48	0.016	56	TNTC	8.0
13	21.0	7.0	17	34.9	4.8	0.47	0.079	30	TNTC	-
14	25.1	6.0	367	765	10.5	1.78	0.178	TNTC	TNTC	-
15	20.5	6.5	54	171.1	5.4	1.11	0.11	32	TNTC	10
16	20.5	6.5	54	112.5	3.8	1.33	0.038	48	12	6.5
17	24.2	6.5	25	52.5	2.5	0.83	0.016	TNTC	TNTC	4.0

KEY:

BOD	Biological Oxygen Demand
NIL	Absence of faecal coliforms
TDS	Total Dissolved Solids
TNTC	Too Numerous To Count

Baraton Interdisciplinary Research Journal (2025), 11(Issue 1), pp. 35-51
www.birj.ueab.ac.ke
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(Online)

Table 2c. Heavy metals analysis (Extracted from LVEMP, 2000 a & b)

Site Code	Cd	Mn	Cu	Pb	Ni	Zn	Fe	Al
01	0.0000	1.38	0.00	0.018	0.008	0.005	18.38	0.00
02	0.0000	0.205	0.005	0.00	0.003	0.05	1.45	-
03	0.0000	0.015	0.003	0.008	0.01	0.018	0.35	0/00
05	0.0000	0.093	0.003	0.008	0.005	0.095	1.20	0.375
06	0.0050	0.083	0.005	0.003	0.013	0.023	0.775	0.05
07	0.0025	0.25	0.00	0.00	0.013	0.00	3.80	0.475
08	0.0000	0.153	0.00	0.00	0.008	0.018	2.55	0.40
09	0.0000	0.66	0.003	0.00	0.008	0.038	2.53	1.025
10	0.125	0.043	0.00	0.01	0.01	0.00	0.40	0.00
11	0.0050	0.083	0.00	0.00	0.013	0.00	0.00	0.00
12	0.0025	0.158	0.01	0.005	0.015	0.028	1.75	1.05
15	0.0025	0.61	0.003	0.003	0.023	0.025	5.60	2.025
16	0.0050	0.10	0.00	0.00	0.018	0.010	5.50	4.175
17	0.0025	0.17	0.00	0.00	0.015	0.010	2.78	1.60

KEY: **Al** Aluminium **Fe** Iron **Pb** Lead
Cd Cadnium **Mn** Manganese **Zn** Zinc
Cu Copper **Ni** Nickel

Baraton Interdisciplinary Research Journal (2025), 11(Issue 1), pp. 35-51
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Waste Generation

The utilization of wetland resources plays a significant role in waste generation in Okana area. For example, activities such as harvesting of wetland macrophytes (reeds, papyruses, grass, etc), crafts making (mats, baskets, sisal fibres, ceramics, furniture and fishing gears), agriculture, water abstraction and use among others often lead to waste generation. Crop residues, husks from craft making processes, waste water and agricultural chemical used in crop and livestock husbandry as well as human faecal matter normally constitute liquid and solid wastes, which are pollutants. Other wastes include spoilt products like vegetables in the nearby market/trading centres, packaging materials like papers and plastic bags and other assorted urban wastes.

In the entire Okana area there are no licensed dumping sites, which meet Waste Management regulations developed by the National Environment and Management Authority (NEMA) and gazetted in 2007. Besides, there are no waste collection and disposal facilities. Furthermore, awareness on waste management is quite minimal. Consequently, the residents either burn the wastes or dump them in the water ways, particularly rivers.

Human – Wildlife Conflict

Okana wetlands are quite productive and support substantial agriculture. However, the crop farms are often destroyed by wild game, which find habitat in the wetlands. A wide range of wild game considered as pests and predators in the adjacent farms are listed in Table 3. In response to scare the pests (wild game) away from the crop farms, humans often keep vigil at the farms during the day and night to drive them away. At times, traps are used to bait the animals thereby killing the latter. Sometimes scaring methods such as use of fire and scarecrow are deployed. Statistics on the number of wild game killed was quite scanty. This is probably due to the sensitivity of the matter on the threats concerning wildlife given that hunting is illegal. The respondents were perhaps reluctant to divulge the information in fear of dire consequences should the data reach the Kenya Wildlife Service (KWS). Conflict therefore arises as humans strive to protect their farms from destruction while the animals roam about to fend for their survival. The findings also agree with those of Okeyo-Owuor et al. (2012) [12] that wetland resource use usually results into human-wildlife conflicts over papyrus as habitats for the wild game and agricultural space that the local communities consider to be a common resource.

Baraton Interdisciplinary Research Journal (2025), 11(Issue 1), pp. 35-51
www.birj.ueab.ac.ke
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(Online)

Table 3. Troublesome wild game in Okana wetlands

Class	Local Name	Scientific Name	English/Common Name
Mammals	Mwanda	*Tragelapus* spp.	Antelope
	Ong'er	*Ceropithecus mitis*	Monkey
	Aidha	*Paraxerus ochracerus*	Bush squirrel
	Oyieyo	*Rattus* rattus	Rat
	Ogwang'	*Civettictus civetta*	African civete cat
	Nyamanduklu	*Lutra maculicoli*	River Otter
	Chiewo	*Hystix galeata*	Porcupine
	Ondiek	*Crocuta Crocuta*	Hyena
Birds	Osogo	*Ploceus* spp.	Weaverbird
	Awendo	*Acryllium vulturinum*	Guinea fowl
	Akuru	*Streptopelia perspicillata*	Pigeon
	Dharna	*Buphagus erythrorynchus*	Tick bird
	Ongo	*Haliaeetus vocifer*	African fish eagle
	Olit	*Accipter brevipes*	Sparrow hawk
	Oluru	*Colius* spp.	Mousebird
	Aywer	*Francolinus* spp.	Spurfowl
	Ongowang'	*Belearica rogulorum*	Crowned crane bird
	Mire	*Quelea quelea*	Sudan Dioch
	Otenga	*Hieraaetus spilogaster*	African hawk eagle
Reptiles	Ng'ech	*Veranus* spp.	Monitor lizard
	Ng'ielo	*Python sebae*	Python
	Olueru	*Mehelya* spp.	Brown mamba
	Fuu	*Bitis* spp.	Puff udder
	Rachier	*Dendroapspis* spp.	Black mamba
	Alum	*Philothamnus* spp.	Green mamba
	Ndemu	*Mehelya* spp.	Brown mamba

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The wild game, which are considered trouble some by the local residents are serious pests to cultivated crops especially during planting and just before harvesting seasons. For instance, animals such as monkeys, porcupines, bush squirrel and antelopes often destroy crops. Bush squirrels are notorious during planting seasons while monkeys cause havoc just before harvesting periods. Bird species such as guinea fowls and weaverbirds are equally destructive to crop farms during planting and just before harvesting seasons, respectively.

Apart from crop farms, wild games are also injurious to people and domestic animals such as cattle, goats, sheep and poultry. Animals like antelopes, monitor lizards, African civete cats as well as bird species such as African fish eagle, African hawk eagle and sparrow hawk normally prey on domestic chicken. Hyenas, African python, tick birds on the other hand are predators of livestock while snake species are poisonous and often lethal to humankind.

Resource Use Conflict

Whereas wetland resources are common property to all local people, uses to which the resources are put vary considerably. In Okana, there are several users of wetlands namely farmers, pastoralists, craft makers, herbalists among others. Each of these groups seeks to derive maximum gains regardless of their counterparts. For example, whereas farmers would wish to put larger portions of the wetlands under cultivation, both the pastoralists and craft makers would prefer the wetland ecosystems to remain intact (fallow) for grazing pasture and macrophyte (especially papyruses, reeds and grasses) harvesting, respectively. Though the conflict has not been on the fore or so grave like in other areas in the country such as Samburu and West Pokot over grazing pasture and water resources, there is a potential of the phenomenon in the near future given the ever increasing human populations and economic demands over the years against steadily declining resources in the community. Research by Masese et al. (2012) [11]confirms that wetland resource use has associated conflicts, which they describe as human-human conflicts. These include use of water for either livestock, domestic or irrigation purposes, harvesting papyrus for either mat making or other crafts, hunting wild game for either food or sale, and harvesting immature fish either for food or as bait for Nile Perch fishery.

Accidents and Injuries

Anthropogenic activities such as clay excavation, harvesting of wetland plants for craft making and building and construction often endanger the resource users. The dangers of clay excavation have been discussed in the previous paragraphs above. Apart from vulnerability to land subsidence or collapses hence leading to deaths, the open pits are potential sites for accidents especially to the unsuspecting herdsmen, young girls during fire wood collection or anyone at dusk. The women who undertake excavation confess several incidences of bodily injuries like bruises and joint dislocations when they slip in the pits accidentally. In fact, 35% of the women have become casualties in one incident or another. The respondents were, however, hesitant or denied categorically any fatal incident related to activity. The denial is perhaps due to fear that the activity would be outlawed if information reached authorities.

Baraton Interdisciplinary Research Journal (2025), 11(Issue 1), pp. 35-51
www.birj.ueab.ac.ke
ISSN:2789-3995
(Online)

Incidences of accidents and injuries, which arise from macrophyte harvesting, were also reported. Forty percent (40%) of the respondents have had bodily injuries such as cuts, joint dislocations and bruises from tools used and twigs while harvesting. The harvesters have high risk of such injuries since most of the time they have unprotected wears particularly footwear and arm gloves when getting into the wetland to harvest. Besides, the wetland harbours pest and disease vectors like leeches and tse tse flies, which often expose the harvesters to high risk of infection. The residents who make mats usually have an occupation risk of being pierced by the needles. They often apply jelly or soap to improve slipperiness thereby reducing the risk of getting hurt.

However, only 5% have had incidences of snake bites and ambush, with the latter case leading to the above mentioned injuries. Like in the case of clay excavation activity, no death incident had been encountered. All casualties including victims of snake bites were duly treated especially using medicinal herbs. The findings agree with those of Katondo (2005) who established that harvesting of Simiyu fringing wetland of Lake Victoria, Mwanza region in Tanzania resulted in several accidents and injuries including drowning and attacks by snakes, hippopotamuses, crocodiles, mosquitoes and leeches as well as stakeholders conflicts.

Loss of Ecological Functions

The values of wetland ecosystems are seldom limited to the social and economic benefits only. The ecosystems also have numerous ecological functions which are worth mentioning, even though they were not within the scope of the study. Wetlands contribute towards balancing of the hydrologic cycle thereby maintaining both surface and underground water supply through water recharge and discharge; act as Carbon dioxide (CO_2) sinks which reduce the greenhouse effect; provide habitat for wildlife, such as the waterfowl, shore birds and other birds and animals which depend on wetlands for their survival; purify water through removal of nitrogen, phosphorus, heavy metals and other chemicals and pollutants from water and this leads to improved water quality through filtration process; control flood, erosion and sedimentation by reducing the flood and erosion velocities as well as trapping water-borne sediments; and protect shorelines by breaking the speed of winds and strength of waves.

Besides, the ecosystems also provide important sites for cultural or religious rituals and/or ceremonies like baptism, prayers, circumcision and ash drive (*tero buru* conducted on the flood plains) among others. For instance, in the study area, baptism is usually conducted in the wetland by the Seventh Day Adventist (SDA) and *Roho* sect faithfuls who baptize by water immersion. Ash drive was conducted in the past but has since been discarded following the influence of Christianity. All these functions are likely to be lost due to wetland degradation. The study result agrees with the findings of Maskini & Hongo (2005) who observed that overgrazing results into decreased plant species composition, loss of forage yield, and soil moisture content, increased runoff and erosion hazard, poor range condition, encroachment of undesirable (poisonous plant) species, siltation and eutrophication. Swallow (2004) also established that conversion of wetland into agricultural farmland reduces its filtering ability

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thereby contributing to sediment plume and eutrophication. All these result due to the impairment or loss of the wetland ecological functions.

Conclusion

The study findings have revealed that environmental problems or issues that arise from wetland resources utilization are numerous and interactive. They can hardly be examined comprehensively in isolation since some of them emerge as cause and effects. Their current status, coping mechanisms and planning and management strategies have been summarized in Table 4 below. The study however has not considered the statistical trend in the decline or loss of the biodiversity over the years. The trend lines can be dealt with at another level for continuity of knowledge.

Table 4. Environmental Issues in Okana

Issue	Current Status	Coping Mechanisms	Planning Aspect
Clearance of vegetation	• Vast areas have become bare or with scanty vegetation	• Planting of wetland macrophytes and exotic trees • Buying timber for building and construction • Buying of fuel wood to supplement available ones	• Afforestation • Reafforestation • Agro forestry • Reservation of 10% of land under forest cover
Flooding	• Not controlled	• River dredging • Desilting canals	• Afforestation • Reafforestation • Construction of huge dams and dykes • Training on disaster preparedness and early warning systems
Biodiversity loss	• No control of hunting and gathering	• Wild game hunted for meat • Wild greens gathered • Medicinal herbs extracted	• Declaration of wildlife sanctuary protected area by KWS • Development of eco-tourism • Establishment of private sanctuaries • Planting of identified medicinal plants
Water pollution	• Point and non-point not controlled	• Boiling drinking water • Rainwater harvesting • Treating water using chlorine and PUR chemicals	• Training on rainwater harvesting • Construction of pit latrines in homesteads • Develop alternative uses of wastes

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Land degradation	• Excavated areas not filled up	• Open pits neglected	• Re-filling up of open pits • Fencing off of open pits as buffer zones • Putting up posters indicating danger zones
Waste Management	• No dumping sites in all market/trading centres • Few homesteads have pit latrines	• Burning of solid wastes • Disposing wastes in nearby bushes and water sources	• Construction of pit latrines in homesteads, market/trading centres, churches and schools • Recycling and reuse of wastes • Designation of licensed dumping sites in the villages, social and educational institutions • Installation of waste bins in schools, churches and market/trading centres
Resource Use Conflicts	• No harmonization frameworks by different sector groups • No control of human-wildlife conflict	• Different sector groups train and undertake own initiative of resource management independent of any other • Activities are never complementary • Wild game killed when stray in crop farms	• Harmonization of activities by different sector groups • Development of eco-tourism • Fencing off of wildlife sanctuary and crop farms • Declaration of wildlife sanctuary as protected area
Drought	• Not controlled	• Grazing livestock in the wetland • Abstraction of water from wells	• Afforestation • Reafforestation • Rainwater harvesting • Construction of silage • Construction of water pans • Sinking of wells

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Recommendations

The study therefore recommends an integrated planning and management of the wetland ecosystems where all sectors, groups or stakeholders including the wetland resource users, government, Non-Governmental Organizations (NGOs), researchers, environmental activists, scientists and Community Based Organizations (CBOs) among others are involved both in the planning and implementation of the management strategies. This will ensure that the economic, cultural/social and environmental pillars are put into considerations thereby resulting into sustainable utilization and sustained livelihoods.

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