

Watershed Stakeholders' Awareness and Perceptions About the Land Use Practices on Sustainable Management of Nyando Wetland, Kenya

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Abstract

Nyando Wetland has numerous resources that support important economic and ecological activities. Lack of awareness and negative perceptions among watershed stakeholders result in negative occurrences such as burning, drainage, and clearing of land for grazing and agriculture; over-exploitation of wetland resources and dumping of wastes. These activities interfere with the well-being of the wetland, putting it at risk of degradation or depletion of resources amid an urgent need for protection. As such, Nyando Wetland sustainable management is in limbo, questioning the viability of watershed stakeholders' awareness and perceptions about the land use practices on sustainable management in the planning process. This paper employs a mixed research design to assess watershed stakeholders' awareness and perceptions about the land use practices for sustainable management. This will foster shared responsibility and leverage local ecological knowledge to balance biodiversity protection with human resource use. The target population of the study consisted of 384 household heads, 45 heads of institutions, and 5 experts in wetland conservation and management. A simple random sampling technique was used to select 384 household heads at the household level. Purposive sampling was also used to select 45 heads of institutions and 5 experts for key informant interviews. Questionnaires, key informant interviews, focus group discussions, and direct observation were used to collect primary data. The literature review was used to collect secondary data. Cross-tabulation and chi-square were used to analyze data. Results show that stakeholders have divergent perceptions with varied levels of awareness about land use practices for sustainable management. Thus, watershed stakeholder education should be prioritized for effective management planning and decision-making. This will build local ownership, integrate diverse knowledge, and foster long-term ecological resilience. The paper recommends targeted communication, proactive engagement, and educational initiatives to raise stakeholder awareness for the development of positive perceptions in the execution of sustainable land use practices.

Keywords: Watershed, Stakeholders, Awareness, Perceptions, Land Use Practices, and Sustainable Management

Introduction

Research on natural resource management suggests that local perceptions form the basis upon which many small-scale societies monitor availability and change in the stock of common-pool natural resources (Reyes-García *et al.*, 2022; & Alvaro *et al.*, 2016). Currently, wetland management places high emphasis on the need to integrate the views and needs of local communities in the management process. That being the case, understanding the relationship between communities and wetland ecosystems is imperative to facilitate the development of wetland management and conservation strategies that can effectively safeguard wetland health and sustain the flow of ecosystem services (Saluja *et al.*, 2023). Nonga *et al.* (2020) found that the local community around Lake Manyara in Tanzania is informed of the ecosystem services accrued from the wetlands, yet the wetlands are unsustainably used. This clearly showed that the stakeholders are not aware of the benefits of sustainable utilization. Sustainable utilization adopts practices which include, but are not limited to, sustainable agriculture, maintaining livestock carrying capacity and improving livestock breed; integrated fishery management (Integrated fish farming), sustainable land practices, and sustainable management of water resources (WLE-LiFELand Project, 2016). Unfortunately, Turyahabwe *et al.* (2017) found that only a small proportion (6%) of the households in a community in Uganda exhibited awareness of the informal or traditional rules and regulations for the use of wetlands for improving food security and maintaining wetland integrity. In Northwestern Myanmar, a total of 97% of the participants in a study by Saluja *et al.* (2023) lacked knowledge of any existing law or regulation that ensures wetland protection.

Lack of awareness among community members always results in negative occurrences that interfere with the well-being of wetlands, putting them at risk (Nyangweso, 2023). For example, over-exploitation of wetland resources, dumping of waste, burning, draining, and clearing of land for grazing and agriculture (Nyangweso, 2023). This puts wetland sustainable management in limbo due to unsustainable use that either degrades or depletes the wetland resources. Amidst this backdrop, the Ramsar Convention's Programme on Communication, Capacity Building, Education, Participation, and Awareness (CEPA) was adopted in 1999 (Resolution VII.9) and renewed in 2002, 2008, and 2015 (Ramsar Convention, 2015 & Karanja *et al.*, 2018). The CEPA was a 9-year strategy (2016–2024) that promoted wetland conservation by raising awareness and changing stakeholders' perceptions of wetlands declared as Ramsar sites (Ramsar Convention, 2015; Karanja *et al.*, 2018; & Shah, 2021). Generally, positive perceptions influence sustainable management outcomes (Basu *et al.*, 2024). In addition, awareness is also a fundamental pillar in the effective management of wetlands. Therefore, watershed community stakeholder awareness and perceptions must be brought on board to achieve social, economic, and environmental sustainability. Turyahabwe *et al.* (2017) stated that a greater percentage of the Kampala-Wakiso urban and peri-urban community in Uganda was aware of the wetland policies and legal provisions under the policy. Also, residents of the Kenya Lake Victoria Basin (KLVB) possess a profound understanding of the various ecosystems and recommend a participatory multi-sectoral community-based watershed management approach as perceived by the local riparian communities (Onyango & Opiyo, 2021). Empowered stakeholders actively plan, implement, and monitor land and water resource use while coordinating across agriculture, forestry, and government sectors to balance environmental sustainability with livelihood security.

Within the Lake Victoria Basin of Kenya is Nyando Wetland, which has numerous resources that support important economic and ecological activities (Maithya *et al.*, 2022). The wetland provides many functions

and services to the environment and the local community. The Luo community living around the wetland practices various socio-economic activities, which include fishing, animal husbandry, mat-making, and cultivation of crops, among others (Rongoei & Kariuki, 2019). The main crops under cultivation include sugarcane, rice, maize, and vegetables (Adunde *et al.*, 2023). Even though crops are a source of food and livelihood sustenance, the unsustainable conversion of the wetland to agriculture may result in degradation during the dry season when large areas of emergent macrophytes are converted to sugar cane, maize, rice, and vegetable farms. Therefore, the wetland is exposed to a myriad of conservation and management challenges and threats due to uncertainty about the future performance of the wetland and livelihood variability. Baseline information on existing wetland resources, including the bio-physical characteristics as well as the socioeconomic and cultural values of the resources, together with the threats that affect the wetland, is available (Letema *et al.*, 2020; & Opaa *et al.*, 2017). Therefore, the local community is in a better position to give the baseline information to promote sustainable management of the wetland.

In addition, a comprehensive wetland management plan should be developed to ensure sustainable exploitation of the wetland resources; the Nyando Wetland community should be empowered to embrace wise use principles through education and awareness creation; and policies should be put in place at the Kisumu County level to conserve Nyando Wetland biodiversity (Raburu & Okeyo-Owuor, 2018). The policy was formulated in 2019, and its implementation is in progress (County Government of Kisumu (CGoK), 2019). Further, there is a need to create a buffer zone, control wetland harvesting, involve the community in the conservation process, implement national wetlands conservation and monitoring, and enforce a comprehensive wetland management policy at national levels (Government of Kenya, 2017 & Otieno & Siakilo, 2015). Several conservation initiatives, including tree planting activities, flood control, education, and capacity building, are taking place in the area being championed by either the County government or NGOs (Maithya, 2021). The implementation of land use practices for the sustainable management of the Nyando Wetland is not clear. Therefore, an inquiry into watershed stakeholders' awareness and perceptions about land use practices on the sustainable management of Nyando Wetland is a vital step. Proper integration of land use practices with other practices will help in achieving social, economic, and environmental sustainability.

Therefore, using a mixed-methods approach, the study evaluates watershed stakeholders' awareness and perceptions about land use practices on the sustainable management of Nyando Wetland. The paper aims to foster shared responsibility and leverage local ecological knowledge to balance biodiversity protection with human resource use. This will build local ownership, integrate diverse knowledge, and foster long-term ecological resilience.

Study Area

The study was carried out in Nyando Wetland (Figure 1). It is located between 0°11' to 0°19'S and 34°47' to 34°57'E (Nile Basin Initiative, 2022) at the mouth of the Nyando River on the north-eastern shores of Lake Victoria. It is the second-largest lacustrine wetland ecosystem on the Kenyan shores of Lake Victoria after Yala Swamp, with a population of around 947,250 people (Kenya National Bureau of Statistics (KNBS), 2019). It covers an area of 42.79 km² within the Winam Gulf of Lake Victoria in East Africa (Ministry of Environment and Mineral Resources (MEMR), 2012 & Ongoro, 2017). It lies between 1300 and 1000 meters above sea level, with an average elevation of 1134m (Rongoei & Tole, 2019). The annual rainfall received is between 1000 and 1600 mm with a mean of 1184 mm and an estimated mean

temperature of 23°C (Rongoei & Kariuki, 2019). The long rains are received between March and May, while the short rains occur in October and December (van Dam *et al.*, 2019). The soils of Nyando Wetland are mainly alluvium formed by large quantities of silt and sand (van Dam *et al.*, 2019). The wetland is dominated by papyrus vegetation with patches of other emergent macrophytes such as *Vossia cuspidata*, *Typha sp.*, *Ipomoea aquatica*, and *Phragmites sp* (Rongoei & Outa, 2016). Ecologically, the wetland does not have strong floodwater detention because it is located at the river mouth, resulting in displacement of communities, loss of life, and property annually (Letema & Omondi, 2020).

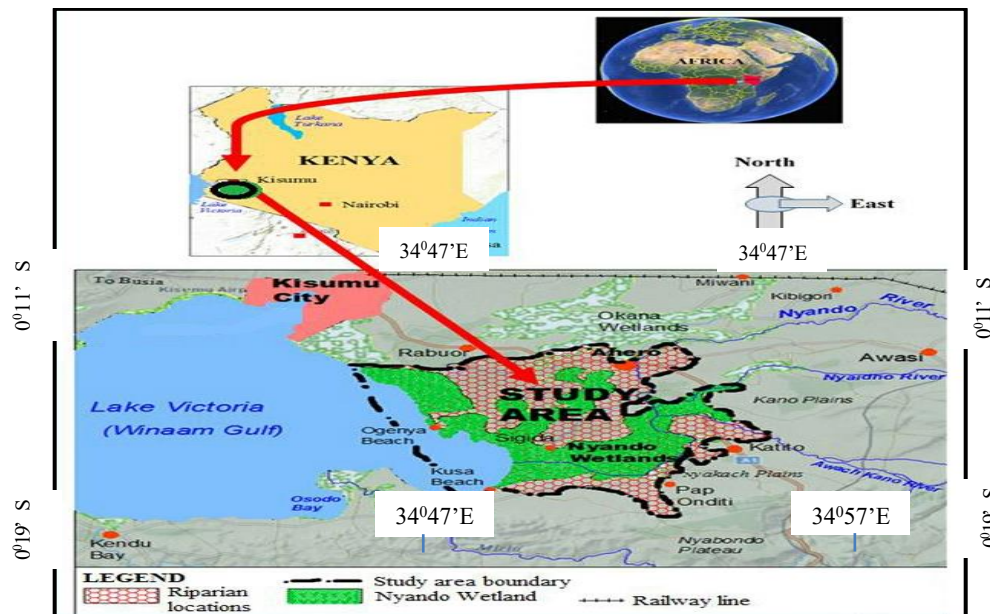


Figure 1: Map of the Study Area

Source: Modified from VIRED International (2019)

Administratively, the wetland is part of Nyando, Nyakach, and Kisumu East Sub-counties in Kisumu County. It borders Lower Nyakach, Nyando, Kadibo, and Winam Divisions. High youth population (KNBS, 2019) exposes the wetland resources to high and increasing pressure because each one of them is striving to earn a living either from farming, fishing, grazing, or harvesting of the available wetland resources like papyrus. The watershed community living around the wetland pursues a diverse range of socio-economic activities, which include fishing, animal husbandry, mat-making, and cultivation of crops, among others. The activities help the community to generate income and build resilient livelihoods.

The area was purposively selected as the study location since the wetland faces policy and conservation challenges, a high rate of land use conversion, and resource use conflicts. It is also of ecological significance, yet riparian communities rely heavily on the wetlands' ecosystem goods, including papyrus harvesting, brick making, livestock grazing, and subsistence farming. In connection with this, Nyando Wetland has experienced a drastic loss of wetland cover over the past decades. Averting the social, economic, and ecological degradation calls for stakeholder involvement in the management process to balance biodiversity protection with human resource use (Boeve *et al.*, 2017; & Reed *et al.*, 2018).

Methodology

The study employed a mixed research design to address the study problem. Both qualitative and quantitative data were used. Questionnaires, Key Informant Interviews (KIIs), direct observation, and Focus Group Discussions (FGDs) were used to collect data. A mixed research design was used because it offers advantages that include increased rigor, broader perspectives, and the ability to explore complex issues more deeply. A simple random sampling technique was used to select 384 household heads at the household level. Fifty (50) Key Informants were also purposively selected. Their selection was based on proximity to the wetland, activities they carry out in the wetland, and their knowledge of environmental conservation and management. Therefore, the respondents included 384 household heads for questionnaire administration, 45 institutional heads and 5 experts for KII, and 20 participants for FGD.

Data was collected from both primary and secondary sources. Primary data was collected from the field using questionnaires, KII schedule, FDG guide questions, and observation schedule. Secondary data were collected by reviewing literature from journal articles, reports, and relevant published books on studies already done about stakeholders' awareness and perceptions of land use practices on sustainable management.

The data gathered was analyzed quantitatively using both descriptive and inferential statistics. Frequencies, percentages, and chi-square were used, respectively. Chi-square test of independence was carried out to investigate the relationship between the level of awareness of land use practices and perception of the execution of land use practices.

Results

Land Use Practices on Sustainable Management of Nyando Wetland

Land Use Practices

Households own land in the wetland (Figure 2), while others own land away from the wetland (Table 1). Fifteen (15) heads of institutions also own land in the wetland. Households that own land in the wetland have inherited (67.7%), bought (20.6), or inherited and bought (11.7%) the land (Figure 3). The land tenure gives the stakeholders the opportunity to use the land as they wish, which can either be sustainable or extractive. Sustainable land use activities meet human needs while preserving the environment and ensuring the land's long-term productivity. While extractive land use activities like sand harvesting and digging of canals remove the natural resources from the wetland. Plate 1 shows sand harvesting in Nyamware Beach, an activity that provides materials for construction but can lead to riverbed degradation, water pollution, and habitat destruction. These effects can further lead to biodiversity loss, increased erosion, and disruptions to ecosystems. Therefore, land use practices for sustainable management should be embraced to solve degradation problems emanating from extractive land use practices.

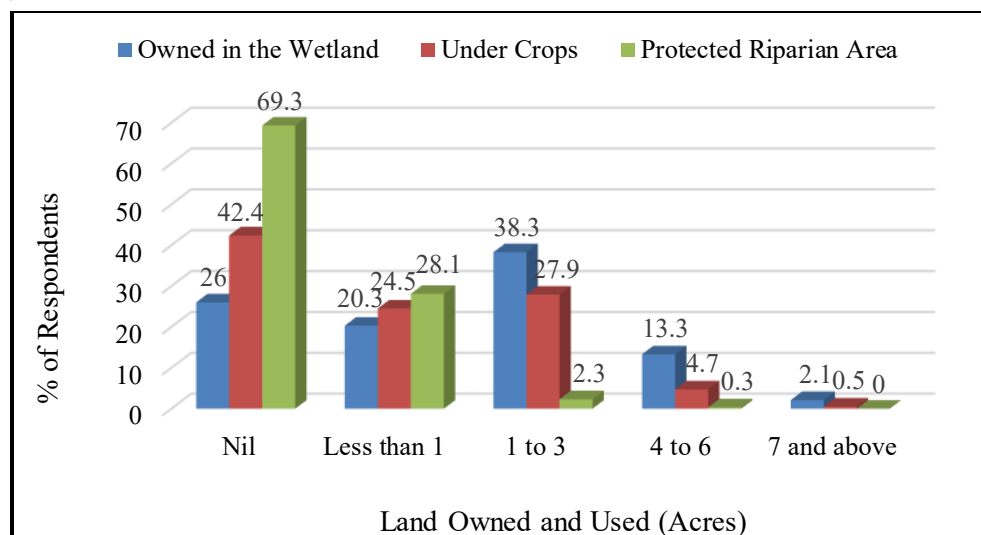


Figure 2: Comparison of Acreage Owned in the Wetland, Under Crops, and Protected
Source: Field Survey (2024)

Table 1: Acreage Owned by Stakeholders Away from the Wetland

Acreage	Frequency	Percent
Less than 1	104	27.1
1-3	227	59.1
4-6	41	10.7
7 and above	12	3.1

Source: Field Survey (2024)

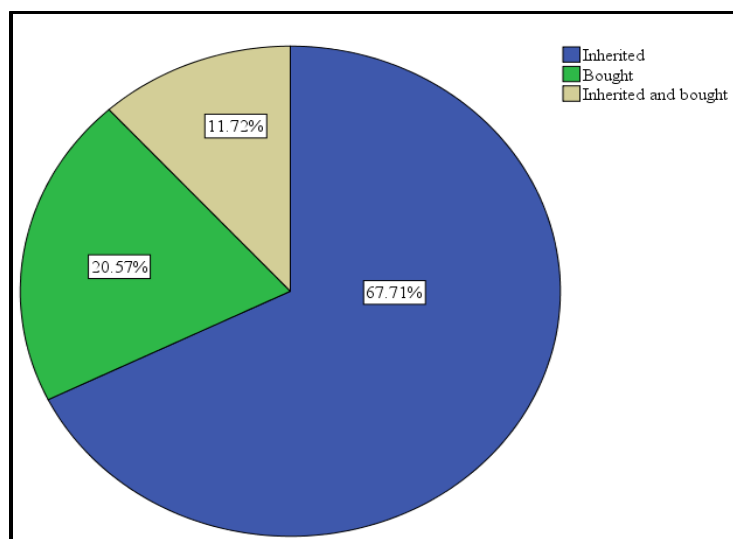


Figure 3: Nature of Land Ownership in Nyando Wetland
Source: Field Survey (2024)



Plate 1: Left and Right Panels: Sand Harvesting at Nyamware Beach

Source: Field Survey (2024)

Figure 2 also shows that the majority of the households (38.3%) own 1 to 3 acres of land in the wetland. Twenty-seven point nine percent (27.9%) practice crop farming as compared to those owning the largest parcels of land (More than 7 acres – 2.1%), with 0.5% practicing crop farming. This may be as a result of the effect of flooding, backflow of Lake Victoria water into the farm lands, financial inability to manage large parcels of land, involvement in alternative livelihood activities, land disputes, and lack of commitment to carrying out farming activities. Figure 2 shows that 26% of the households do not own land in the wetland. Therefore, it follows that 42.4% and 69.3% of the households do not practice crop farming and protection of riparian areas, respectively (The trend is shown in Figure 4). This may be attributed to the involvement of some households in alternative livelihood activities like formal employment, ownership of enough acreage away from the wetland (Table 1), a dire need to preserve the wetland in its natural state without interference, and the inability to acquire land in the wetland. Heads of institutions that own land in the wetland also practice crop farming.

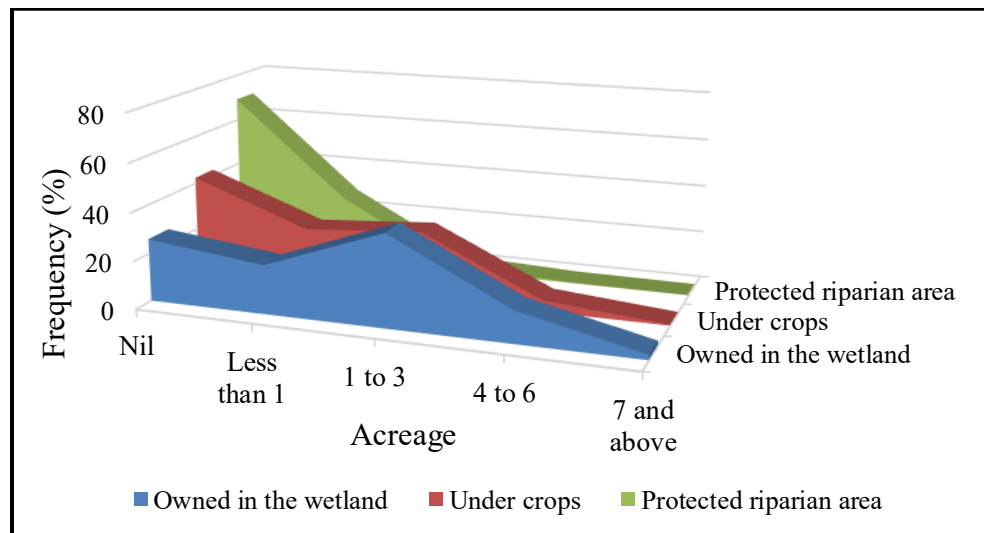


Figure 4: Trend in Acreage Owned in the Wetland and Usage

Source: Field Survey (2024)

Survey results show that involvement in sustainable management activities is not directly proportional to the size of the land one owns in the wetland. Figure 2 shows that a majority (28.1%) who own less than one acre of land have protected the riparian area adjacent to their farms, as opposed to 10% of the households who own larger parcels of land (7 acres and above). Protection of riparian areas may increase crop yield because of preserved soil and water, and protection of crops from destruction by animals. The households (30.7%) who protect the riparian area adjacent to their farms may be among the 10% and 33% who get large and medium volumes of produce, respectively, from their farms (Figure 5). High production may also result from sustainable farming practices and ownership of large parcels of land. Conversely, low crop production from the wetland may result from inadequate climatic conditions, ownership of larger parcels of land away from the wetland, involvement of stakeholders in alternative livelihood activities, use of unsustainable methods, lack of funds, and ownership of small parcels of land in the wetland. This may explain the nil production from 41% and small production from 16% of the households (Figure 5).

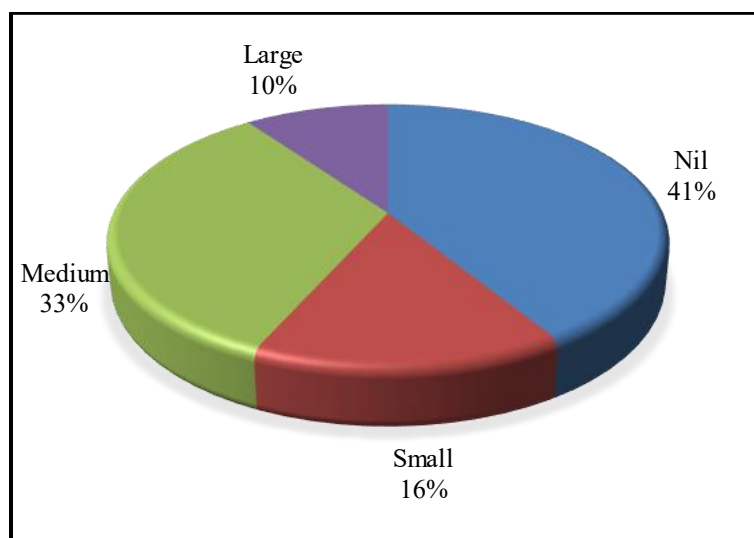


Figure 5: Volume of Produce from the Wetland

Source: Field Survey (2024)

Ownership of land in the wetland has prompted the stakeholders to carry out a lot of activities in the wetland, such as pumping of water from the wetland, sand harvesting, fish farming, settlement, grazing, and construction of schools, churches, garbage disposal sites, and companies. Other extractive land use activities carried out in the wetland are papyrus harvesting, fishing, hunting, fetching firewood (Papyrus roots), and fetching water. Apart from the extractive land use practices (activities), stakeholders also carry out management activities. Figure 4 shows that most households practice sustainable farming (85.4%), prevent soil erosion (85.2%), and plant trees (83.1%). Based on FGD results, inorganic fertilizer is not used for farming due to high soil productivity in the wetland. They added that stakeholders also practice crop rotation, strip cropping, multiple cropping, mixed cropping, and cover cropping to preserve the soil and improve soil productivity, as was witnessed through observation. Some households, especially those that own parcels of land in the wetland, graze their animals in isolated grazing areas to conserve the wetland and protect their crops. This is a challenge because households from far locations like Upper Nyakach, Ahero, Rabuor, and Chiga, among others, graze without restrictions, as was stated by FGD participants and observed. Overgrazing results in soil erosion and destruction of plant biomass. Results from observation

show that trees are planted in the wetland in the form of woodlots (Plate 2a) and agroforestry (Plate 2b) to conserve the soil and water. Unfortunately, eucalyptus trees (Plate 2a) that drain water from the wetland dominate the tree population. It is not a good species for the wetland ecosystem and its riparian area. Other species, like grevillea trees (Plate 2b), should be planted in abundance to replace eucalyptus.



Plate 2a: Left panel: Woodlots at Harambee in Lower Nyakach

Source: Field Survey (2024)



Plate 2b: Right panel: Agroforestry in a Farm at Ogenya in Kano

Source: Field Survey (2024)

Key Informant Interview (KII) and FGD results identified tree planting, awareness on good agricultural farm practices, measurement of silts, and protection of the riparian area; wastewater treatment, mixed cropping, and strip cropping as land use practices on sustainable management in Nyando Wetland. Focus Group Discussion (FGD) participants and KIs requested for identification of the best tree species that can help preserve and conserve the wetland. This was further supported by survey results, where 30% of the households requested soil testing to come up with a suitable tree species for the wetland because eucalyptus drains water from the wetland and cannot thrive in some areas, like Ombaka and Ogenya in Kano. Dried tree stumps and trees were seen in Ombaka, Ogenya, Nduru, and Odega villages. Focus Group Discussion participants and KI's explained that some trees dried due to flooding and unfavorable soil conditions, while some were cut or uprooted to create room for farming and settlement. Most of the trees in Kano and Odega were planted by LVEMP II Kenya, while most of the woodlots in Nyakach are privately owned. Key Informant Interview (KII) by an LVEMP II official in their office in Kisumu showed the need for follow-up activities through evaluation, but their efforts are derailed due to a lack of funding. Evaluation is a step forward that can help in the identification of the best tree species for the wetland ecosystem and its riparian areas.

Level of Awareness of the Land Use Practices on Sustainable Management

Figure 6 shows that the majority of the households (44%) have a high level of awareness of land use practices on sustainable management of Nyando Wetland. Twenty-nine point seven percent (29.7%) have a very high level of awareness, while 14.1% and 12.2% have average and low levels of awareness, respectively. All FGD participants were aware of land use practices on sustainable management, except the market/urban centers and youth groups. Key Informants (KI's) have a high level of awareness of the land

use practices. The level of awareness can help stakeholders to identify the best sustainable practices for the management of Nyando Wetland.

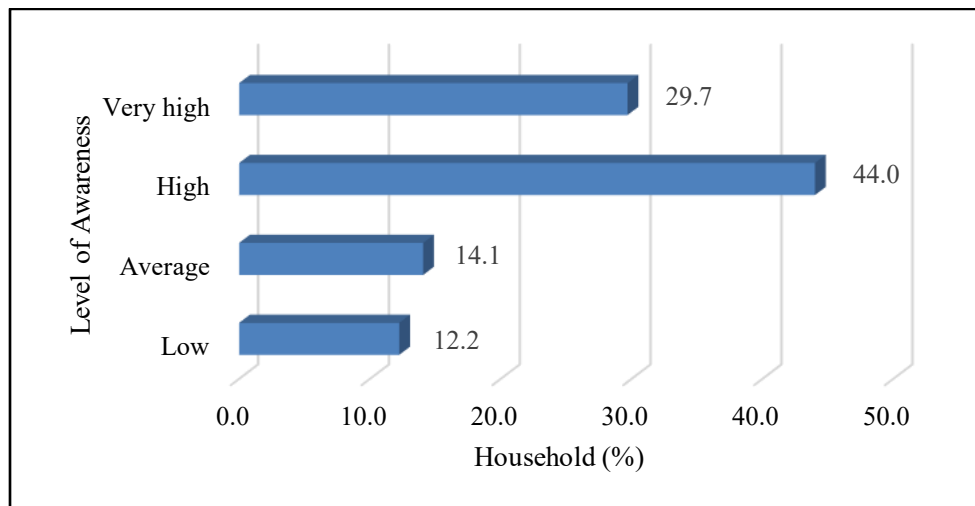


Figure 6: Level of Awareness on Land Use Practices
Source: Field Survey (2024)

Based on level of awareness on land use practices on sustainable management, households identified other sustainable management activities practiced in Nyando Wetland (Figure 7) namely; creation of buffer zone (CBZ) (1%), protection of riparian area (PRA) (28.6%), waste management (WM) (44%), controlled grazing (CG) (38%), practicing agroforestry (PA) (32%) and controlled harvesting of plant biomass (CHPB) (27.9%). Focus Group Discussion (FGD) and KII results show that there is no buffer zone along the Nyando Wetland. This means that 1% of the households that stated that they are practicing the creation of buffer zones are merely referring to eucalyptus woodlots in their private farms within the wetland, as was observed in Lower Nyakach. Based on the level of awareness, households were able to state the evidence of implementation of the sustainable land use practices in the wetland (Table 2).

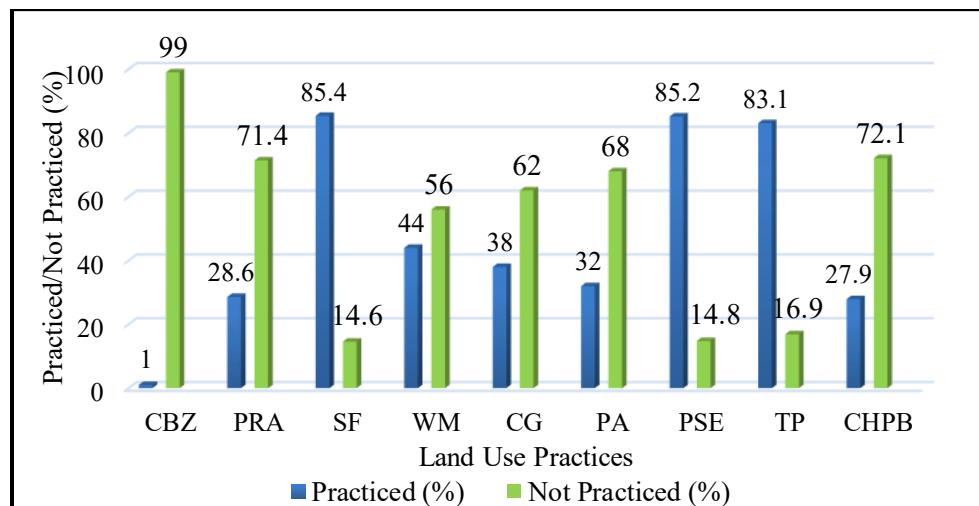


Figure 7: Land Use Practices on Sustainable Management of Nyando Wetland
Source: Field Survey (2024)

KEY: CBZ: Creation of Buffer Zone

PRA: Protection of Riparian Area

SF: Sustainable Farming

WM: Waste Management

CG: Controlled Grazing

PA: Practicing Agroforestry

PSE: Prevention of Soil Erosion

TP: Tree Planting

CHPB: Controlled Harvesting of Plant Biomass

Table 2: Evidence of Implementation of Sustainable Land Use Practices in Nyando Wetland

Land use practices	Evidences
Sustainable crop farming	Strip cropping, organic farming, crop rotation, agroforestry, grass around the farm, fallowing, mixed cropping, trenches, mulching, no-till farming, controlled use of irrigation water, multiple farming, high yields from the wetland, cover crops, napier grass around the farm, no use of inorganic fertilizers, and boosted welfare.
Sustainable rice farming	Ridges, grass around the farm, trenches, controlled use of irrigation water, scaring birds from rice fields (No poisoning through spraying as was done before), high yields from the wetland and lagoons
Waste management	Collection and burning of wastes, rubbish pits, lagoons, and the presence of dustbins.
Controlled papyrus harvesting	Regeneration of papyrus and protected fish breeding areas.
Fish farming/fishing management	Protected areas around fish ponds and protected fish breeding areas.
Controlled grazing	Isolated grazing areas during the planting season and existing rules by the wetland committee on grazing
Wildlife Management	Protection of wild animals and scavenging birds from rice fields
Agroforestry and afforestation	Trees around homesteads, woodlots, and trees in crop fields.

*Source: Field Survey (2024)****Stakeholders' Perceptions on Execution of Land Use Practices***

Generally, FGD participants and KIs have positive perceptions of the execution of the sustainable land use practices. The CEO of the West Kano Irrigation Scheme categorically stated that Nyando Wetland should be sustainably managed by executing sustainable land use practices for the future generation to benefit. The same was reiterated by the head of Nduru and Kusa BMU; the Chairperson of No Sex for Fish (Nduru Beach); the Chairperson of Ahero, Katito, and Pap Onditi Market; and the CEO of Ahero and Nyakach County Hospital. The majority of the households have positive perceptions of the execution of sustainable farming (75.8%), prevention of soil erosion (80.5%), and tree planting (72.4%) (Figure 8). This may be because sustainable farming, prevention of soil erosion, and tree planting increase crop production and earnings from the wetland, enhancing social and economic gain. Creation of buffer zone, protection of riparian area, waste management, controlled grazing, practicing agroforestry, and controlled harvesting of plant biomass registered high negative perceptions of 85.9%, 64.6%, 53.9%, 59.4%, 62.2%, and 70.9%, respectively. This may be because the creation of a buffer zone and protection of riparian areas are taken as practices that deny households the opportunity to expand farming activities and deny them the

opportunity to graze in the protected areas. Waste management is not undertaken by many households because it is not an income-generating activity, and it may be viewed as a time-wasting activity by households. Households might have perceived controlled grazing and controlled harvesting of plant biomass as practices that deny them the opportunity to utilize the wetland maximally. Households might have also preferred planting trees as woodlots rather than in crop fields (agroforestry), hence the high negative perceptions. Generally, all land use practices have registered positive perceptions greater than 20% on execution, except the creation of a buffer zone and protection of a riparian area, with 6.8% (Figure 8). This means that the households are willingly executing the land use practices for sustainable management. This can be improved with working institutional arrangements in place where stakeholder education, awareness creation, and support by the government are embraced.

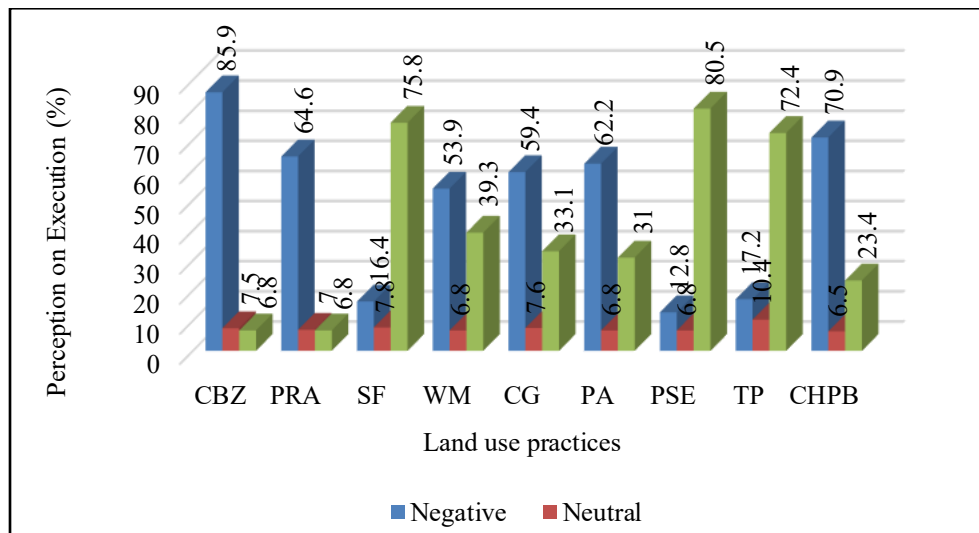


Figure 8: Perception on the Execution of Land Use Practices on the Sustainable Management of Nyando Wetland

Source: Field Survey (2024)

KEY: CBZ: Creation of Buffer Zone
 PRA: Protection of Riparian Area
 SF: Sustainable Farming
 WM: Waste Management
 CG: Controlled Grazing
 PA: Practicing Agroforestry
 PSE: Prevention of Soil Erosion
 TP: Tree Planting
 CHPB: Controlled Harvesting of Plant Biomass

The chi-square test of independence revealed a significant association between level of awareness on land use practices and perception on execution of land use practices [$\chi^2(6, N = 384) = 9.082, p = .169$, $\chi^2(6, N = 384) = 23.31, p = .001$, $\chi^2(6, N = 384) = 54.45, p < .001$, $\chi^2(6, N = 384) = 32.59, p < .001$ and $\chi^2(6, N = 384) = 31.18, p < .001$, $\chi^2(6, N = 384) = 35.54, p < .001$, $\chi^2(6, N = 384) = 28.61, p < .001$ and $\chi^2(6, N = 384) = 40.12, p < .001$ and $\chi^2(6, N = 384) = 16.02, p = .013$ respectively]. Perception of the execution of the creation of the buffer zone gave a result of $p > .05$, meaning that it has no significant relationship with

the level of awareness of land use practices. This can be attributed to the fact that the execution of protection of riparian areas, sustainable farming, waste management, controlled grazing, practicing agroforestry, tree planting, and controlled harvesting of plant biomass benefits the stakeholders more than the creation of a buffer zone. Therefore, the level of awareness of land use practices does not influence the perception of the execution of the creation of the buffer zone.

Discussion

The findings indicate that both extractive and sustainable land use practices are carried out in the Nyando Wetland. Households practice crop farming, papyrus harvesting, fishing, fish farming, tree planting, agroforestry, grazing, pumping of water, settlement, hunting, fetching firewood, digging of canals, and sand harvesting. Companies dig canals, harvest sand, pump water, and carry out rice farming. Resource user groups harvest papyrus, reeds, and fish. Government agencies construct dykes, social amenities, garbage disposal sites, and cemeteries. Non-Governmental Organizations (NGOs) plant trees and provide alternative settlement targets (Tents). Most of these activities are extractive, which leads to wetland loss. Abdullahi (2016) explains that extractive land use practices in the Tana Delta wetland have resulted in many environmental impacts, endangering the flora and fauna, besides adversely affecting the locals' livelihoods. This is similar to the Nyando Wetland case.

Therefore, immediate intervention is required, for instance, awareness creation on sustainable management and education of farmers to adopt sustainable farming for sustainable livelihoods. Sustainable farming practices include, but are not limited to, the use of conservation tillage, the implementation of crop rotation and intercropping strategies, and the creation of buffer zones around the wetland. These methods help in reducing soil erosion and improving water quality, promoting biodiversity, and protecting the wetland from agricultural runoff, respectively. Musasa & Marambanyika (2022) also reiterated that identification of suitable crop farming and livestock grazing methods that maintain balanced wetland hydrology, vegetation, soil organic matter, erosion, and nutrient retention is necessary. Evacuation of the wetland area to seek alternative settlement should be an immediate action aimed at Nyando Wetland restoration. Stakeholders should also be discouraged from overharvesting wetland resources like sand, papyrus, fish, and water. The government, through its agencies, should desist from constructing social amenities in the wetland to avoid wasting resources, as wetland settlements and amenities are always abandoned when water levels rise.

From the results, sustainable land use activities carried out in Nyando Wetland are protection of riparian area (28.6%), sustainable farming (85.4%), waste management (44%), controlled grazing (38%), agroforestry (32%), prevention of soil erosion (85.2%), tree planting (83.1%) and controlled harvesting of plant biomass (27.9%). From the results, some stakeholders are not practicing these activities. This explains why some stakeholders are not well informed about the activities taking place in Nyando Wetland. Households, heads of BMUs, NGO representatives, heads of resource user groups, women groups, fishermen, and fishmongers are more informed about activities taking place in the wetland than the other stakeholders. While schools, NEMA representatives, county officials, health facilities, urban/market centres, companies, and youth groups are less informed. The former exploit the wetland resources to sustain their livelihoods and/or are involved in conservation activities, unlike the latter. Even though this is the case, results show that households (73.7%), institutions, county officials, NGO, and NEMA representatives have a high level of awareness on land use practices for sustainable management. In addition, women's

groups, youth groups, fishermen, and fishmongers, except the market/urban centers and youth groups, are aware of the land use practices for sustainable management.

The high level of awareness should propel them to participate fully in the implementation of the land use practices because stakeholders have positive perceptions of the execution of sustainable land use practices. Achieving social, economic, and environmental sustainability requires that stakeholders embrace sustainable utilization. This calls for the identification of suitable crop farming and livestock grazing methods, for instance, rotational grazing that maintains balanced wetland hydrology, soil organic matter, vegetation, nutrient retention, and erosion. The process necessitates an appropriate selection of crops where drought- and waterlogging-tolerant crops with less irrigation technology are planted in the wetland. This will reduce demand for agricultural wetland water, hence improving water efficiency. In addition, riparian buffers and wetland habitat management should be adopted where riparian trees and native riparian grasses are planted for wetland hydrology. Use of artificial canals and pumps for watering crops should be discouraged. Instead, advanced irrigation technologies like drip irrigation and sprinkler irrigation should be adopted to achieve the goal of water conservation.

Chi-square results show a significant association between the level of awareness of land use practices and perception of execution of land use practices (creation of buffer zone, protection of riparian area, sustainable farming, waste management, controlled grazing, practicing agroforestry, prevention of soil erosion, tree planting, and controlled harvesting of plant biomass). Cramer's V values were significant (Cramer's V = .17, $p = .001$; .27, $p < .001$; .21, $p < .001$; .20, $p < .001$; 0.22, $p < .001$; .19, $p < .001$; .23, $p < .001$ and .15, $p = .013$ respectively) indicating a high strength of association. Therefore, the level of awareness of land use practices on sustainable management defines stakeholder perceptions of the execution of the land use practices on sustainable management. With the high level of awareness and positive perceptions, stakeholders should fully participate in the execution of the sustainable land use practices and implement the wetland policies on sustainable management to the letter.

Conclusion

The study assessed watershed stakeholders' awareness and perceptions about the land use practices on the sustainable management of Nyando Wetland. The analysis showed a statistically significant relationship ($p < 0.05$), suggesting that stakeholders with a high level of awareness of land use practices have positive perceptions of the execution of land use practices, while those with a low level of awareness have negative perceptions. Positive perceptions of the execution of sustainable land use practices are a scorecard in achieving social, economic, and environmental sustainability.

Recommendations

Informed by the findings, the study recommends the following to promote stakeholder involvement in Nyando wetland management to balance resource use and human activities for the achievement of social, economic, and environmental sustainability;

- Targeted communication, proactive engagement, and educational initiatives to raise stakeholder awareness. Through this, all stakeholders will develop positive perceptions of the execution of land use practices for the sustainable management of Nyando Wetland. Wetland management committee, local leaders, National Environmental Management Authority, as a national government entity, and Non-Governmental Organizations should promote such initiatives. In addition, stakeholders who have a high

level of awareness and perceptions on sustainable management, like women, those in informal employment, and single stakeholders, should also be facilitated by the county or national government to educate their counterparts. This should be done through social media platforms, organized seminars and workshops, or door-to-door campaigns.

- Adoption of sustainable practices. For instance, the adoption of sustainable farming methods that promote wetland farming because wetlands have become part of agricultural systems. Farming in wetlands promotes social and economic sustainability. Fortunately, wetland regulations (2025) permit subsistence harvesting of resources like papyrus and reeds; fishing, aquaculture, and limited cultivation. Therefore, stakeholders should take the initiative to achieve social, economic, and environmental sustainability by promoting integrated farming systems. The government should also engage the Ministry of Agriculture and Livestock Development to involve extension officers in the campaign during Nyando Watershed visits. Agricultural NGOs like TechnoServe, One Acre Fund, Farm Africa, and Nuru Kenya should also do the same.
- The government should involve the Nyando Wetland community in management planning and decision-making because they are aware of and willing to sustainably manage the wetland. This will surely succeed when their awareness level is raised through organized seminars and workshops. The stakeholders will therefore have the opportunity to explore and promote multiple-use systems where wetland agriculture coexists with other uses to enhance social, economic, and environmental sustainability.
- Government agencies like NEMA should educate schools, health facilities, Beach Management Units, urban/market centers, companies, resource user groups, women groups, youth groups, fishermen, and fish mongers on sustainable management. This will enhance their participation in the execution of sustainable practices. The local leaders and NGOs should also organize seminars to create awareness on the same and extend this to households
- Further research on strengthening local governance, public awareness, and designing incentives for smallholder farmers to adopt sustainable practices in Nyando Wetland.

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