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Human Activities and Sustainable Management of Sio-River Wetland in Nambale Sub-County, Busia County, Kenya

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Abstract: *Wetlands are important natural resources and their functions within an environment cannot be over emphasized. Wetlands normally vary in size, distribution, type and functions. They areunique; however, changes have affected their roles, functions, quality and quantity. This study aimed at examining the impact of human activities on the sustainable management of Sio-River wetland in Nambale Sub-County. To effectively achieve these objectives, mixed approach involving cross-sectional research design was used. Data was collected between the month of March and May, 2023. Cluster sampling, simple random sampling and purposive sampling methods were used to select the 400 inhabitants from a target population of 80,830.Specifically, cluster and simple random sampling was used to select householders while purposive sampling on the local chiefs and the environmentalists. Primary data was collected through questionnaires, observation, interview guides and Geographical Information Systems and Remote Sensing, maps and photographs while journals, print materials, internet, theses and dissertations collected secondary data. Quantitative data was analysed using Statistical Package for Social Sciences (SPSS Ver. 21) and presented in various graphs, charts and tables. Qualitative data was thematically analysed. Results showed that human activities, more so, agriculture degraded the wetlands by 80%. It therefore concluded that there was no balance between human activities and sustainable management of Sio-River Wetland due to irresponsibility of local community, inadequate policies and laws and lack of integrated approach in management. In this aspect, this study recommends rehabilitation and restoration of fragile ecosystems, allocation of funds for research and development and adoption of integrated approach in wetland management to enhance sustainability of wetlands in Nambale Sub-County and other parts of the world. Areas of further research entail replication of this study in other areas for effective generalisation and participatory* management of wetland resources to add more knowledge on to what is in existence.

Keywords: River *Sio Ecosystems, Wetlands ecosystem, Human activities impact, Sustainable management, Sio-River Sustainability, Rehabilitation, Resources*

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INTRODUCTION

Globally, wetlands are estimated to occupy 1.21 billion hectares of the earth surface as indicated in the world wetlands (Xu et al., 2019; Nayak & Bhushan, 2022 pp. 1-6). Wetlands are important and valuable resources throughout the world due to the varied goods and services (Ahmad et al., 2019). For instance, wetland goods are categorized as; provisioning, regulating, cultural and supportingwhile key services include; climate change mitigation, shoreline mitigation, flood control, ground water recharge, water purification, carbon sequestration and biodiversity protection (Millennium Ecosystem Assessment,2005). The researcher opines that the situation is not different in Nambale, because wetlands had been the main source of livelihood to most of the residents, this was evident by the sugarcane and rice farming practice in the area which was facilitated by the presence of wetlands, of which the absence of the same could alter the residents' livelihood situation.

Despite wetland benefits to the ecosystem, they are increasingly facing threats of degradation and continue to reduce in quality and quantity (Global Outlook Report, 2018). Worldwide, sometimes wetland loss and degradation are experienced at extremely high rates. Empirically, 35% of wetlands have been lost between 1975 to date (Global Wetland Outlook, 2018). In addition, developed countries such as North America, South America and Asia have experienced about 53% wetland loss due to human activities, high population and high poverty levels (Global Wetland Outlook, 2018). It has been culminated with effort to search for agricultural land, grazing land infrastructural development, settlement and construction materials.

Likewise, Europe's wetlands vary ranging from bogs, fens and riverine that occurs on the streams and rivers. They are valued for their biodiversity and ecosystem services (Bhowmik 2020). Despite of the benefits, at least 80% of wetlands have disappeared amidst protection measures put by the Ramsar Convention, European Union and National legislation thus the need for sustainability. Tomscha et al. (2021) suggested that multiple wetland restoration be enhanced for wetland sustainability. However, in regard to Sio River wetland, the sustainable management practices so far put in place seem scarce and inadequate. Moreover, Africa as a continent is endowed with wetlands ranging from riverine, saline, brackish coastal and marine areas along the coastline and occupies 4.7% of African's continental area (Rebelo & McCartney 2019). Riverine wetlands are found in the riverine systems of Nile, Zaire, Zambezi and Nile providing a lot of benefits. Despite their benefits, about 35% of African countries wetlands are exposed to human encroachment (Kabii, 2022). This is attributed to high population growth and economic development (Rebelo and McCartney, 2019). On that basis, population within the world is gradually growing resulting to over-use of the available Sio River wetland resources.

Furthermore, research exhibits that the total numbers of Ramsar sites have reduced tremendously despite the benefits provided to people and the environment. About 17% of river wetlands have been changed into non wetlands due to human activities (Xu et al., 2019). This is linked to high population and illegal human activities. For example, the Democratic Republic of Congo (DRC) which is known of having large area of Ramsar sites is threatened by civil wars and political unrest (Ramsar, 2018). Similarly, the Okavango Delta System (Botswana), a Ramsar wetland in

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the world faces threats from fires and overuse. Likewise, Lake Chuta wetland in Zimbabwe is threatened despite its invaluable values (Musasa & Murambanyika, 2020). Though Sio River wetland supplies a lot of resources to the inhabitants, human activities practised are degrading them.

Additionally, East Africa, wetlands are widely distributed all over the land covering about 18 million hectares which is approximately 7% of the region (Muhimbo, 2022). They provide a lot of benefits to the ecosystem not only fish but also herbal medicine, fuel wood and papyrus wood among others. However, anthropogenic activities such as pollution, deforestation, industrialization, urbanization agricultural activities, mining, overgrazing, and irrigation have exerted pressure on East African wetlands (Mkonda, 2022). Despite the contributions of the Ethiopian wetlands to people's livelihood, cultivation has degraded them (Tecklie and Yosef, 2022, pp. 6-7). According to Omolo, etal., (2018), in Tanzania, besides the values of Lake Manyara, Mara Bay and Masirori wetlands anthropogenic activities are threats. Additionally, Uganda well surrounded with wetlands such as Katehe, Nakivumbo, Kagera and Nakivale with multitude of benefits but lot of threats (Omagor, et al., 2018). According to Mugumya (2018), wetland destructions have been accentuated by poverty, high population growth and weak legal frameworks. To ensure that these resources remain beneficial, sustainable wetland management need to be put in place (Nile Basin Initiative, 2019 & Mugumya, 2018). Looking at Nambale, poverty, high population and weak governance are among the challenges facing the wetlands.

Precisely, Kenya's wetlands occupy about 3 to 4 per cent of the land's surface which is equivalent to 14000km^2 (Kareri, 2018). Kenya's wetlands provide ecological and socio-economic goods to the ecosystem (Ministry of Environment and Natural resource (MEMRI), 2012; Chepchumba, 2018). Initially, these wetlands were sources of food, clean water, and fish, building materials, fuel wood, handicraft material, recreational sites and flood control sites (Ministry of Environment and Natural Resources, 2012). Cultural ceremonies such as circumcision still take place in special places in wetlands where the initiates are smeared with mud and Kenya continues to recognize the values of its wetlands (Kenya Constitution, 2010, Kenya Vision 2030 & Kenya County Development plans). The Sio-River wetland has been valuable in its provision of water, medicine and building materials.

Essentially, Kenya is a signatory to United Nations agencies (Convention on Biodiversity Ramsar Convention and United Nations Framework Convention on Climate Change) all geared towards wetland protection. This is because of their immense contribution to the ecosystem. Initially, wetlands were the only available resources that people derived their livelihood by getting water pasture and fodder for animals during drought and dry spells (Kareri, 2018). Kenya's wetlands such as Tana River Delta, Ondiri, Nyando, Kingwal, Marura, Saiwa, Great Rift Valley and Lake Victoria have been threatened by anthropogenic activities. This has in turn resulted into loss of riverine wetlands, loss of biodiversity and water quality changes among others (Chepkwony et al, 2018;Kareri, 2018). The rich biodiversity (papyrus reeds, grass and trees) have disappeared due to encroachment.

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Specifically, Busia County is also endowed with resources: forests, valleys, lakes, rivers streams and wetlands (Busia County Biodiversity Policy, 2016 & Busia County CIDP, 2018-2022). Notable wetlands in the county are Yala, and Sio plus other small wetlands on tributaries of the above rivers such as Malakisi, M'nambale, Walatsi, Musokoto (Naburi, 2018). These are rich sources for fisheries, recreation, water, food, medicine, wildlife habitats, firewood and grazing sites (Dindi, 2018) though this is not the case as at now. The land has gradually changed in the entire Busia County where Nambale Sub-County is included (Okusimba et al., 2019). The rich wetland resources have diminished due to degradation (Naburi, 2018; National Spatial Plan, 2015-2045).

Increased population growth along the Sio River wetland is exerting a lot of pressure on it with about 2.8% population rise and poverty index at 39% per year (Nile Basin Initiative, 2019). This is due to high demand of food and other wetland resources. Alongside, increased human activities along the Sio River wetlands aim at food security for the growing population. The execution of various developmental activities, intensive agriculture and pressures from other human activities lead to degradation of Sio River wetland (Nile Basin Initiative, 2019). This has resulted to wetland shrinking in size to the extent of getting extinct as well as undermining quality, quantity, roles and functions of Sio River wetland.

Despite development of a Community Management Plan, it has not been effective and essentially calls for sustainable management practices to avert further destruction (Nile Basin Initiative, 2019). The local community sustains livelihood through utilization of wetland resources. This is due to goods and services provided by the wetlands. However, the Sio River wetland has been adversely affected by degradation through overuse of its resources. This is due to high population resulting from high birth rates, poverty and migration of people (immigration). According to NBI (2019), the wetland's population is growing at 2.8%. This has negatively influenced water quality, biodiversity composition and sustainable utilization of the Sio River wetland. Execution of human activities such as agriculture, settlement, industrial activities and pollution has resulted to loss of Sio-river wetland.

Additionally, policy gaps as a result of growing poverty (2.9%) and unsustainable use of Sio River wetland have caused encroachment. This current trend therefore call for the need for an interrogation into the economic viability of Sio River wetland resource use and the sustainability of the livelihoods by the respective riparian communities living adjacent to the wetland. It was against this backdrop that this research was carried out to ascertain the impact of human activities on sustainable wetland management on Sio River wetland in Nambale Sub-county, Busia County.

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METHODOLOGY

This study used a mixed approach involving a cross-sectional research design. This is design was relevant for identifying the households and the human activities involved (Kombo and Tromp, 2018). Specifically, a sample of 400 respondents involving 392 households, five local authority and three environmentalists from a target population of 80,830 were used in the study. The sample size for this study was calculated using Yamane, (1967).

Clustered sampling was used to group households into wards, simple random sampling was used to select the households who live within the wetland under study (Lohr, 2019). Finally, the members of the local authority, representative from the County Government were purposively sampled to give information on the status of Sio River Wetland. The sample size for this study was calculated using Yamane, (1967).

Primary and secondary methods were used to collect data (Mugenda&Mugenda, 199). Observation, key pictorials, interviews and questionnaires, maps and photographs were used as primary data collection. Questionnaires were administered on the 392 householders, Interview guides were administered on the five local authority and three environmentalists', observations, maps and remotely sensed maps were taken to ascertain the human activities carried out on the wetland. This enhanced collection of first-hand information.Secondary sources involved gathering data that had already been collected, majorly using secondary sources such as journals (both published and unpublished), magazines, newspapers, books, theses, dissertations, maps, conference papers, internet, media sources, government reports with useful information on wetlands and reviewed literature from the library (Mugenda&Mugenda, 2018).

Qualitative and quantitative responses were summarized, categorized and coded into numerical values. The coded information was analysed using Statistical Package for Social Sciences (SPSS) version.The qualitative data involved description of the human activities and the changes on the wetland Quantitative data was presented using bar charts, pie charts and tables (Kombo & Tromp, 2018).

RESULTS

Demographic Characteristics of the Respondents

The study sought to examine the demographic characteristics of the respondents who took part in the study. the characteristics examined included the following: gender distribution and the educational level of the respondents.

Slightly more than a half (53%) of the respondents who took part in the study were males. Only (47%) were female.

Education level of the householders on wetland use was also examined.The results revealed that 17.2% of the respondents were not having any formal education qualification, 35.0% were

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having primary education level, 23.9% were having secondary education, and 18.8% were having tertiary education while 5.1% were having university education

Human Activities and Sustainable Management of Sio-River Wetland

The study sought to examine some of the human activities practised and sustainable management on the Sio – River Wetland in Nambale Sub-County. The respondents were asked to give their views on the human activities and management of the river Sio Wetland. Table 1 shows their distribution.

Table1
Beneficial and Destructive of Human Activities along Sio River Wetland

Positive	Frequency	Percentage	Negative	Frequency	Percentage
Agriculture	4	80.0	Agriculture	1	20.0
Livestock keeping	1	20.0	Digging along the river	1	20.0
Sand harvesting	2	40.0	Deforestation	1	20.0
			Sand harvesting	1	20.0

Based on the interview schedules with the local chiefs, the local community depended on the wetland for food and income from agriculture (80%), grazing (20%), and sand harvesting (40%).According to the findings, agriculture, deforestation and sand harvesting caused 20% destruction on the wetland.

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Plate 1: Livestock grazing on Sio River wetland during the Study Period

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DISCUSSION

The researchers observed that these human activities have led to a noticeable decline in wetland vegetation and alteration of hydrological patterns. The expansion of agricultural plots has encroached upon the wetland's natural buffer zones, while deforestation in the surrounding areas has disrupted the delicate balance between water retention and drainage. The extraction of sand, although contributing to the community's income, has left scars on the wetland landscape and impacted its overall ecological functionality.

Wetlands are vital ecosystems that provide a wide range of ecosystem services, including water purification, flood control, habitat provision, and carbon sequestration (Mitsch and Gosselink, 2015). These ecosystems have been recognized for their importance in supporting both local communities and global biodiversity. However, the sustainability of wetlands is increasingly threatened by human activities, leading to ecological degradation and loss of benefits. The dependency of local communities on wetlands for food and income has been documented in various studies. According to Schuyt and Brander (2004), wetlands have been traditionally utilized for subsistence agriculture, fisheries, and collection of non-timber forest products. In many developing regions, wetlands contribute significantly to livelihoods, acting as safety nets during periods of food scarcity (Nel et al., 2007). The present study's finding of 80% dependence on wetland-based agriculture aligns with these observations.

Agricultural expansion and intensification have been identified as leading causes of wetland degradation (Davidson, 2014). Unsustainable farming practices, such as excessive use of agrochemicals and poor irrigation management, can lead to soil erosion and pollution of wetland waters (Zhang et al., 2020). Deforestation, often driven by agricultural expansion, can exacerbate these impacts by altering hydrological regimes and reducing habitat connectivity (Turner et al., 2015). These findings corroborate the present study's revelation of agriculture and deforestation causing 20% destruction of the wetland. Sand harvesting, while a source of income, has been shown to have negative ecological consequences. A study by Erftemeijer and Lewis (2006) highlighted that excessive sand extraction disrupts sediment dynamics, affecting water quality and habitat suitability for aquatic species. Sustainable sand harvesting practices, guided by regulations and monitoring, are crucial to prevent irreversible ecological damage (Pranzini et al., 2017).

These findings underscore the urgent need for a comprehensive and collaborative approach to wetland management. Preserving the delicate equilibrium between human utilization and ecological health is paramount. Implementing sustainable agricultural practices, reforestation efforts, and responsible sand harvesting guidelines are crucial steps toward ensuring the long-term viability of the wetland ecosystem. To address wetland degradation and promote sustainable management, a participatory and integrated approach is recommended. Engaging local communities in conservation efforts has been proven effective in enhancing stewardship and reducing destructive practices (Agrawal and Gibson, 1999). Integrated land-use planning, as

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demonstrated by Lechner et al. (2018), facilitates the coexistence of agriculture and conservation by delineating zones for various activities based on ecological considerations.

CONCLUSION

The importance of the Sio River Wetland to the local community's socioeconomic well-being has been amply proven by the study and therefore, it cannot be overlooked. Just like other wetlands, local community have benefitted from wetland economically and socially. Moreover, human activities are being undertaken in Sio River wetland which underlies its socio-economic importance to the local community. Anthropogenic activities such as sand harvesting has reduced water level and pollution, farming coupled with excessive use of fertilizer has interfered with wetland biodiversity and soil fertility. Even though human activities have negative effect on Sio-River Wetland, sustainable wetland management plan has been inadequately implemented. There are minimal measures from the local community, government, private sector and NGOs in place to curb human activities that have negative effect on the Sio-River Wetlands including awareness and education, bamboo promotion and policy and regulatory framework. Therefore, the future of wetland is bleak and uncertain if the current trend of resource exploitation is not checked and arrested promptly.

Based on the study findings, the following recommendations were made in regards to policy and practice. Human activities undertaken at Sio-River wetland are important to sustainability of the local livelihood and therefore, the study recommends that local community have the responsibility to ensure its sustainability by engaging in activities which are not harmful to the wetlands but beneficial to them in the short run.

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