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Original Article

Wetland Conservation and Management Practices in Rubanda District, South-Western Uganda

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Worldwide, wetlands cover about 9% of the land surface and are recognized as bio-networks that offer living prospects when managed properly. Despite the present resource management regime, many wetlands in Uganda are being degraded due to mining, construction, agricultural and industrial activity, and little attention has been paid to the effectiveness of wetland conservation. The goal of this research was to evaluate Nyamuriro wetland conservation and management practices in Muko Sub-County, Rubanda District, in south-western Uganda. The study was guided by specific objectives, which included investigating the management approaches used in Nyamuriro wetland conservation, identifying the management challenges preventing Nyamuriro wetland conservation, and evaluating sustainable solutions to the challenges preventing Nyamuriro wetland conservation. The study employed a descriptive cross-sectional research design that included qualitative and quantitative data gathering and analysis techniques. A total of 109 people participated in the study using simple random and purposive sampling approaches. In this study, data was collected using questionnaires, key informant interviews, and observational approaches. Most respondents strongly agree that wetland restoration is the best management approach for Nyamuriro wetland conservation (Mean = 4.87, SD = 0.547). Corruption was the most significant hindrance to the conservation of Nyamuriro wetland among the management problems (Mean = 3.41, SD = 0.467). Overall, the data showed that there was a significant positive association between conservation management techniques but not between viable Nyamuriro wetland conservation measures. The study recommended that strict laws and procedures should be put in place to ease restrictions on wetland conservation.

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INTRODUCTION

Wetlands are crucial for delivering diverse ecological services around the world due to their regulating activities in the aquatic sequence, high efficiency, and biodiversity (Chatanga et al., 2020), and their projected value is substantially larger than their current modest 5–6% share of worldwide land-use. Wetlands improve climate change resilience by protecting against droughts and floods, storing carbon, and, if left alone, decreasing the climate over time (Kadykalo & Findlay, 2016; Moomaw et al., 2018). According to (Li et al. (2021, p. 1) about 87% of the world's wetlands have been lost in the past 300 years, and 54% lost since 1900. This loss is still happening, owing to agricultural and urban development (Asselen et al., 2013; Dixon et al., 2016).

Globally, the convention on wetland management recognizes the importance of policies (Amezaga et al., 2002; Moomaw et al., 2018), and legislation dealing with or containing a component of wetland management in order to build long-term wetland management synergies and coordination with other conventions (Njagi, 2016). Such synergies could be codified in institutions such as multinational

environmental agreements. Rouquette et al. (2011) mentioned that several synergies strive to combine international procedures so that wetlands and other habitats can be protected.

The community's usage and supervision of wetlands in East African countries is influenced by social and societal developments, as well as variances in policies, legal, and institutional frameworks. Wetland sectoral management and use provide all stakeholders unfettered access, resulting in degradation (Njagi, 2016). Even though people living near wetlands use them for residential and agricultural purposes (Hill et al., 2018), there is still much to be desired, resulting in a gap that this study will solve.

Uganda has a large natural resource potential which over 90% of the country's population directly relies on for survival (Shackleton et al., 2017). Natural resource exploitation will continue to be the basis for the majority's lifestyles in the foreseeable future, with a domestic product growth rate of around 6% and a population growth rate of 62.7% (Businge, 2017) because people are out of harmony with their environment (Olalekan et al., 2019). Currently,

wetlands in Uganda cover about 13–14% of the total land area, and this needs to be conserved.

There is a public outcry in Rubanda District that Nyamuriro wetland is being exploited for domestic and agricultural purposes, and much work remains to be done to investigate the management challenges preventing its conservation to meet various domestic, agricultural, and industrial needs and develop possible wetland conservation strategies (Ndyasiima, 2018). This study provided useful and dependable information about the water quality status of Nyamuriro wetland to the communities around the wetland. Although the communities surrounding Nyamuriro wetland use its water for a variety of purposes. There is no information available about the management challenges faced in its conservation, which pose a significant threat to the users, given the possibility that it has been polluted by inorganic fertilizers, pesticides, and herbicides used by farmers in the surrounding hills.

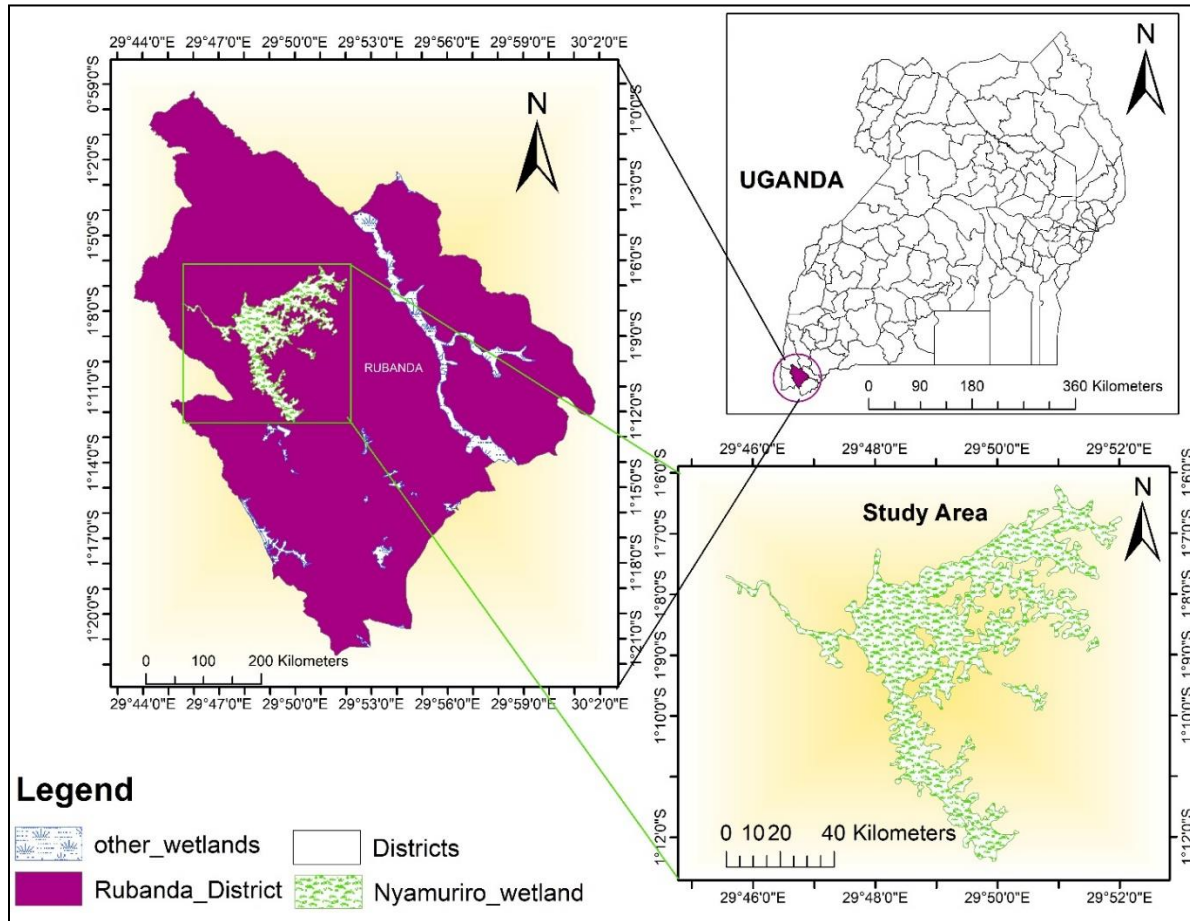
This paper provides an in-depth understanding of Nyamuriro wetland conservation and management practices in Muko Sub-County, Rubanda District, south-western Uganda, the management approaches used in wetland conservation, and the management challenges preventing wetland conservation, and the sustainable solutions to the challenges preventing

wetland conservation (Benson & Ayiga, 2022). Pyke et al. (2018) described various management strategies for wetland conservation. However, management approaches and their effects on wetlands were not fully addressed.

MATERIALS AND METHODS

The research was conducted in Nyamuriro Wetland, which is located in Muko Sub-County, Rubanda District (*Figure 1*). Rubanda District is bordered by Kabale District on the east and north, Kanungu District on the north-west, Kisoro District on the west, and Rwanda on the south. By road, Rubanda District is 35 kilometres west of Kabale, in the Kigezi region. The district features volcanic mountains and hills separated by V-shaped valleys at an elevation of 2,017 meters above sea level. To make data collection easier, the study focused on three parishes: Butare, Kaara, and Nyarurambi, which are all surrounded by the Nyamuriro wetland. Local people engage in farming with crops such as Irish potatoes, bananas, and beans being farmed. However, fishing is done on a small scale due to the lack of fish in the wetland compared to other wetlands in Uganda. This study was conducted over a period of two years (2018–2020) to ease data collection and monitoring of Nyamuriro wetland conservation and management.

Figure 1: Location Map of Nyamuriro wetland, Rubanda District, Southwestern Uganda



Source: Elaborated by the Authors.

Study Population and Sample Size Determination

A study population of 10,046 people was selected in the study area. To get the sample size, the formula developed by (Israel, 1992) was used. Due to the enormously large population size, this formula was used to get the sample size of the population.

$$n = \frac{N}{1 + N(e)^2}$$

Where n = Sample size; N = Population size; 1 = constant; e = Level of precession 10 %

Therefore: $N = 10046$; 1 = constant; $e = 10 \%$

$$n = \frac{10046}{1 + 10046(0.1)^2} = 99 \quad n = 99$$

However, because the minimal sample size was 99 households, ten key informants from the same group were picked to obtain more specific information on the study, resulting in 109 respondents, hence reducing bias about the study.

Through observation, printed guided survey questionnaires were handed out face-to-face to respondents, and key informant interviews were conducted with those who had prior knowledge of Nyamuriro wetland in Rubanda District. The Natural Resource Officer, the Environment Officer, Wetland officer, and local communities of Rubanda District were key informants who supplied more

detailed information. Community key informants (n = 10) who were engaged in wetland conversational included leaders in Rubanda District. These included natural resource officer (1), environmental officer (1), wetland officer (1), and local communities (7). This was done to obtain specific data and information from respondents who were thought to be more knowledgeable and skilled about the study's content. Given the small numbers, perspectives are not distinguished by respondent position or community in wetland management. Data from both qualitative and quantitative sources was evaluated (SPSS version 26.0).

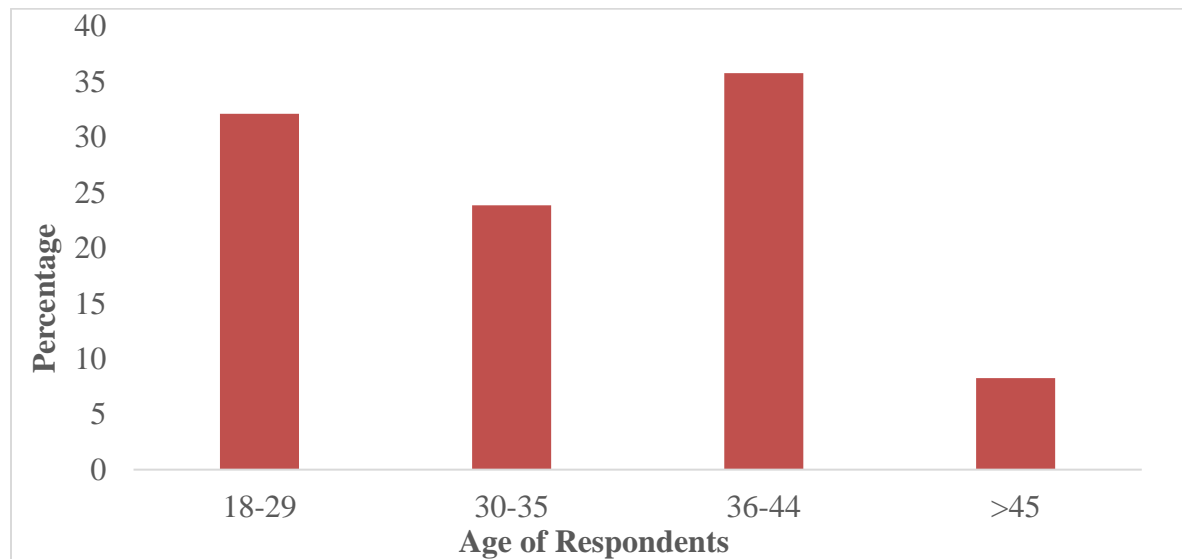
RESULTS

Demographics

Male respondents accounted for 67% (67) of the 109 participants in the survey, while female respondents accounted for 33%. Males have more energy and are more involved in the management and preservation of Nyamuriro wetland in Rubanda District than their female counterparts.

Figure 2 shows that the majority of respondents (36%) were between the ages of 36 and 44, with only 8% being 45 or older. The age of the interviewees was considered in order to get knowledge based on their life experience with the Nyamuriro wetland management.

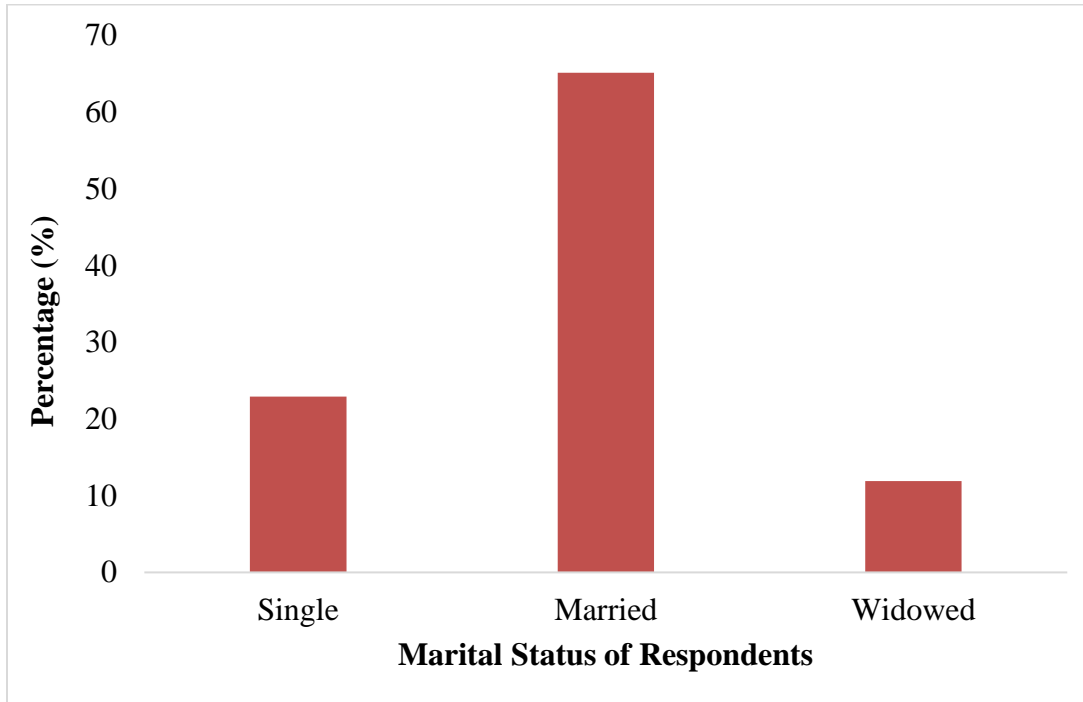
Figure 2: Age distribution



According to Figure 3, 65% of respondents were married, whereas 12% were widowed. The researcher considered the respondents' marital status in order to document justified information from categories of variable comprehension in keeping with their day-to-day family tasks and

responsibilities in the study area's wetland ecosystem protection. Because of the majority of respondents were energetic and were involved in clearing ridges and wetland monitoring, the study took their marital status into account.

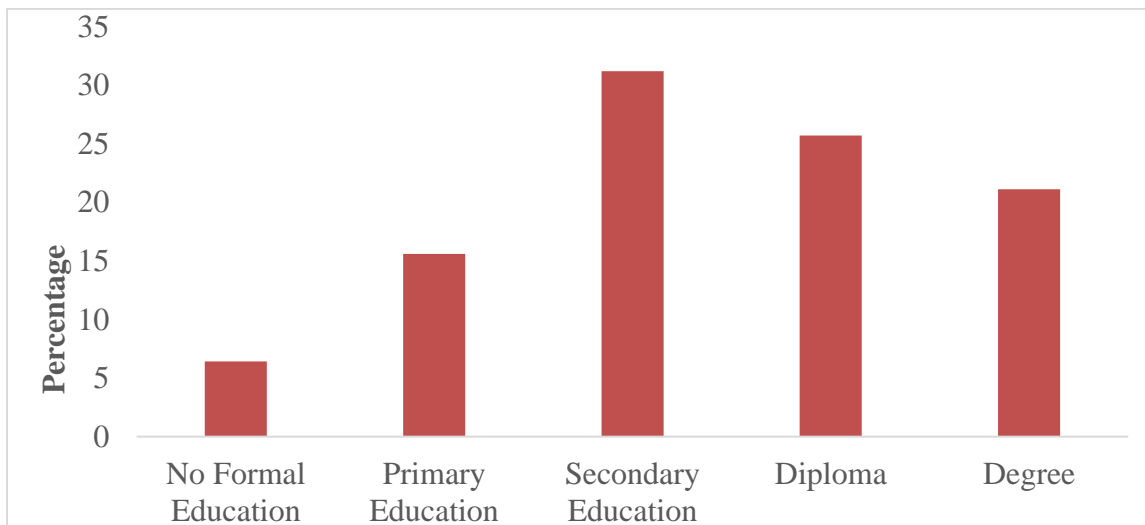
Figure 3: Marital status



According to a field study done in Rubanda District, 31% of respondents had completed their ordinary level of education, with 26% having a diploma level of education. Only 6% of those polled did not have any formal schooling (*Figure 4*).

The primary rationale for considering respondents' greatest levels of education was to guarantee that data gathering techniques were created and deployed effectively in relation to respondents' literacy levels. As a result, they may be able to embrace better farming methods and new technological strategies for wetland protection.

Figure 4: Level of education



Approaches Employed in the Conservation of Nyamuriro Wetland

The majority of respondents strongly agree with wetland restoration (Mean = 4.87, SD = 0.547) as one of the management options used in the conservation of wetlands in the study area, the study findings aligned with community engagement (Mean = 3.96, SD = 0.500). It was also shown that

some respondents agreed with wetland monitoring (Mean = 3.78, SD = 0.804) (Table 1). According to respondents, community members were involved in monitoring the wetland to reduce encroachment. It was also discovered that some individuals disagreed with strict laws (Mean = 2.75, SD = 0.785) while others were unsure about trench clearing (Mean = 3.13, SD = 0.492).

Table 1: Community response to conservation

Indicators of conservation	N	Min.	Max.	Mean	Std. Dev.
Wetland restoration	109	2	4	4.87	0.547
Community participation	109	2	4	3.96	0.5
Monitoring of wetland	109	0	4	3.78	0.804
Clearing of trenches	109	3	4	3.13	0.492
Strict laws	109	2	4	2.75	0.785
Valid N (listwise)	109				

Note that a score of 5 indicates strong agreement, a score of 4 indicates agreement, a score of 3 indicates uncertainty, a score of 2 indicates disagreement, and a score of 1 indicates significant disagreement. The mean was used to make conclusions of the findings and was interpreted as follows: 1 to 1.8 = strongly disagree; 1.81 to 2.60 = disagree; 2.61 to 3.40 = not sure; 3.41 to 4.20 = agree; 4.21 to 5 strongly agree.

The Management Challenges

The majority of the respondents strongly agree that corruption is the most significant obstacle to wetlands conservation (Mean = 3.41, SD = 0.467). Corruption, as observed in Muko sub-county, is a global phenomenon that may be broadly defined as the exploitation of public power for the advantage of the private interest. The study findings agreed with the introduction of invasive plants such as eucalyptus, which affected the protection of wetlands (Mean = 3.77, SD = 0.509). According to the findings of the study, several respondents felt

that flooding of the river Ruhura was a problem (Mean = 3.19, SD = 1.357) (Table 2). According to respondents, the flooding of the river Ruhura is hindering the conservation of Nyamuriro wetland. It was also discovered that some respondents agreed that financing for wetland restoration was insufficient (Mean = 3.16, SD = 0.757). During the field survey, respondents disagreed with local people's ignorance of wetlands conservation (Mean = 2.49, SD = 0.944). Local residents in areas bordering wetlands face a challenge of lack of information and awareness about conservation, according to respondents, but not ignorance.

Table 2: Management Challenges

Management challenges	N	Min.	Max.	Mean	Std. Dev
Corruption	109	3	4	3.41	.467
Introduction of invasive species	109	0	4	3.77	.509
Flooding of River Ruhura	109	0	4	3.19	1.357
Inadequate funding	109	0	4	3.16	.757
Ignorance of local people	109	1	4	2.49	0.944
Valid N (listwise)	109				

Note that a score of 5 indicates strong agreement, a score of 4 indicates agreement, a score of 3 indicates uncertainty, a score of 2 indicates disagreement, and a score of 1 indicates significant disagreement. The mean was used to make conclusions of the findings and was interpreted as follows: 1 to 1.8 = strongly disagree; 1.81 to 2.60 = disagree; 2.61 to 3.40 = not sure; 3.41 to 4.20 = agree; 4.21 to 5 strongly agree.

Adoptable Strategies to Address the Challenges

Figure 5: Potential Strategies for adoption to address the challenges that hindered the conservation of Nyamuriro wetland

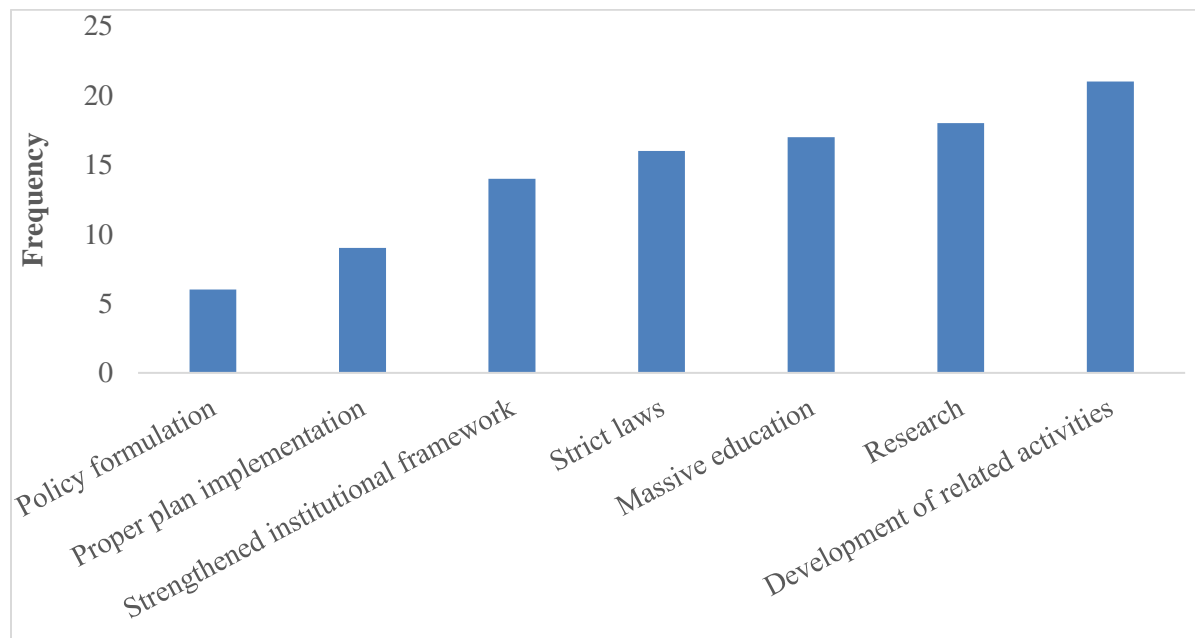


Table 3: Ordinal Regression Analysis

Parameter Estimates		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower	Upper
Threshold	[WLC = 1]	5.175	3.197	2.620	1	.106	-1.092	11.441
	[WLC = 2]	13.777	3.818	13.019	1	.000	6.293	21.260
	[WLC = 3]	22.331	4.554	24.041	1	.000	13.404	31.257
	[WLC = 4]	30.911	5.536	31.173	1	.000	20.060	41.762
	[WLC = 5]	39.656	6.722	34.805	1	.000	26.482	52.831
	[WLC = 6]	48.352	8.008	36.454	1	.000	32.656	64.049
Location	Challenges	-.113	2.370	.002	1	.962	-4.757	4.532
	Strategies	.356	2.096	.029	1	.865	-3.751	4.464
	Approaches	8.601	2.157	15.893	1	.000	4.373	12.830

Link function: Logit.

Wetland Conservation (WLC):

According to the study's findings (Figure 5), 21% of respondents thought that the development of related activities near marshes should be encouraged. It was also found that 6% of respondents recognized the necessity for policy formation to aid in wetlands conservation. According to the study's findings, 18% of respondents believe that additional research should be done to determine potential mitigation techniques for wetlands conservation, 17% of the respondents believed that mass education was required, 16% of respondents believe that stricter rules are required. Respondents expressed their dissatisfaction with community members' lack of compliance with current weak regulations, which are rarely enforced in the research area, and 14% of respondents mentioned strengthening the institutional framework. Lastly, 9% mentioned proper plan execution for wetlands conservation was necessary.

Ordinal Regression Analysis

Potential strategies employed in the conservation of Nyamuriro wetland were not significant positive predictors of wetland conservation (WLC) with a predicted increase of 0.356 and management approaches were significant positive with 8.601 respectively. Sustainable strategies ($p = 0.865$, CI

$= -3.751 - 4.464$) and management approaches ($p = 0.000$, $CI = 4.373 - 12.830$). This indicates that sustainable wetland management techniques had little effect on the Nyamuriro wetland.

DISCUSSIONS

Management Approaches in the Conservation of Nyamuriro Wetland

Many respondents strongly agreed with wetland restoration. According to respondents, the restoration of degraded wetland ecosystems was done at the locations where respondents used to produce Irish potatoes. This was due to floods that had been occurring in the study area regularly. As a result, residents of the community, as well as other stakeholders such as NEMA and Nature Uganda, agreed to take steps to combat the vice. Donaldson et al. (2021) stated that while wetlands are extremely different, they all have a common structural aspect, whether they are ponds, marshes, coral reefs, lakes, or mangroves.

Community engagement was also one of the management options used in the conservation of Nyamuriro wetlands. This implies that community members also take part in the monitoring and evaluation of various land use activities that take place in and around wetlands in order to avoid

deterioration. As a result, they took part in monitoring and reporting illegal activities through their various community forums.

According to respondents, community members were involved in monitoring the wetland to reduce encroachment. This was done to dissuade any individual, group, or organization from intruding on or abusing the wetland ecology in the study region. This agrees with Ragavan et al. (2021), who stated that assessment wetland inventory is the collection of data that provides managers and/or policymakers with the information they need not only to manage individual wetlands but also to carry out conservation actions.

It was also discovered that some individuals disagreed with strict laws. This contradicts Tehreem et al. (2020), who claims that wetlands have been damaged throughout the years due to agricultural demands, urban development, industrialization, population growth, and pollution. Respondents maintained that a lot had been accomplished since Rubanda became an independent district local government, including the enactment of strong ordinances that deterred improper behaviour and intentions regarding the usage of the Nyamuriro wetland ecosystem.

Key informants 1, 2, and 3 mentioned that; "corruption as seen in Muko sub-county is a phenomenon which is locally widespread and public servants in Rubanda district use public power to benefit from mining activities in this area." This has led to wetland degradation and in ten years from now, if there is no action taken, Nyamuriro wetland will be no more. Therefore, there is a need for strict laws to manage the wetland'

Key informant 4 mentioned that " restoration of degraded wetland ecosystems should be done in the areas where they used to grow Irish potatoes. This was as a result of flooding that had persistently occurred in the study area. As a result, the community members, in addition to other

stakeholders such as the National Environmental Authority (NEMA), and Nature Uganda are working together to restore Nyamuriro wetland"

This study identified management approaches in the conservation of Nyamuriro wetland. According to the findings, wetland restoration, community participation, wetland monitoring, clearing of trenches, and strict laws. However, sustainable strategies employed in the conservation of Nyamuriro wetland were not significant positive predictors of wetland conservation (WLC) with a predicted increase of 0.356. This study's findings show that the management approaches were significantly positive with 8.601 respectively. Sustainable strategies ($p = 0.865$, $CI = -3.751 - 4.464$) and management approaches ($p = 0.000$, $CI = 4.373 - 12.830$). This indicates that sustainable wetland management techniques had little effect on the Nyamuriro wetland hence, this model is capable of predicting management approaches for wetland conservation.

Management Challenges

The majority of the respondents strongly agree that corruption is the most significant obstacle to wetlands conservation. For example, some political commentators encourage residents living near Nyamuriro Wetland to recreate the swamp, while NEMA is obstructing wetland protection. The study findings agreed that the introduction of invasive plants such as eucalyptus affected the protection of wetlands. According to the interviews, it was narrated that, "Nyamuriro wetland is covered with a countless number of different living species, animals, plants, and microorganisms. Surprisingly, when these species arrive at a new site, they may be able to blend in with the local flora and fauna and live in peaceful coexistence. Some invasive species, on the other hand, are so taken with their new surroundings that they take over and push out the native species."

According to respondents, the flooding of the river Ruhura is hindering the conservation of Nyamuriro wetland. This was particularly so since if it flooded, it would jeopardize conservation techniques such as wetland edge gardening and timely harvesting of art and craft materials. Respondents highlighted that the Rubanda district received peanuts in the areas of natural resource management yearly, which impacted conservation efforts, including those at Nyamuriro Wetland. Inadequate funding made it impossible to carry out comprehensive monitoring, community engagement, and sensitization processes, posing a significant obstacle to wetlands conservation. Respondents also stated that limited and inadequate funding for their work would compel them to accept bribes in order to keep a blind eye on wetlands degraders. Respondents disagreed with local people's ignorance of wetlands conservation. To justify this, local residents in areas bordering wetlands face a challenge of lack of information and awareness about conservation, according to respondents, but not ignorance. This prompted people to undertake a variety of operations, including land reclamation for agriculture, tree planting in the form of draining marshes to make way for other activities such as settlement, dairy farming, and tea production.

Key informant 1 mentioned that “the challenge affecting Nyamuriro wetland restoration is the sustainable supply of water resources since it is facing the problem of water shortage due to mining activities and agricultural practices. He added that Nyamuriro wetland and its catchments in Rubanda district are gradually vanishing due to the lack of ecological flow. The second challenge is the lack of indigenous knowledge like digging using simple tools like hoes, which helps to utilize regional water resources for wetland restoration”

Key informant 2 mentioned that “Ignorance has led to the poor implementation of wetland management strategies like clearing of trenches and wetland monitoring in Rubanda district because local communities lack mass education on proper farming

methods and mining has greatly affected Nyamuriro wetland water and little effort has been made”

Key informants 3 and 4 mentioned that “there was a challenge of inadequate knowledge and awareness among the local people in the communities surrounding wetlands. This led them to do all things, including reclamation for agriculture, tree planting in the form of draining wetlands for other activities including settlement, dairy farming, and wolfram mining”

We acknowledge that this study has numerous limitations. First, the study sample was small due to the pandemic of COVID-19. Secondly, since this research is limited to Nyamuriro wetland, it cannot describe the acceptance of wetland policy by the entire Ugandan population. In this study, we did not consider the wetland policy instruments of other nations. Comparing wetland management strategies from various countries will enhance biodiversity conservation. Thirdly, research does not adhere to a particular theory. Despite some limitations, the management challenges proposed in this study can serve as a useful reference for predicting and conserving wetlands in Kigezi region, Uganda.

The purpose of this study was to understand the management challenges of Nyamuriro Wetland conservation in Rubanda District, Uganda. Our findings added to the understanding of people's attitudes toward new management approaches in the conservation of Nyamuriro wetland to reduce the challenges hindering its conservation in Rubanda district. We used a questionnaire to gather supporting data for the current wetland conservation in the Rubanda district. Our research may still be limited so that we cannot reach a thorough conclusion about the sustainable strategies for the challenges hindering the conservation of wetlands. This paper argues that there should be unambiguously required focused governance improvements to minimize inefficiencies from wetland conservation control procedures to assure

Nyamuro wetland protection, and public participation in wetland conservation.

Adoptable Strategies to Address the Challenges

At least, 21% of respondents thought that development of related activities near marshes should be encouraged. Similarly, Roy-Basu et al. (2020) showed that there is a need to examine wetlands' long-term management like co-management models. It was also found that some respondents recognized the necessity for policy formation to aid in wetlands conservation; this is in line with Khumalo, 2019) who stated that a multimeric index was initially used to measure the biotic integrity of fish communities in Illinois streams.

Some of respondents believe that additional research should be done to determine potential mitigation techniques for wetlands conservation. Community residents in the Nyamuro wetland area saw the environment as an avenue for food production, tree planting that drained the ecology, and a water source for their animals and water supplies, but they thought that keeping it intact or partially exploited deprived them of the basic benefits. As a result, it was indicated future research should focus on the utilization techniques for long-term conservation. Community members in the study area had previously mismanaged wetland ecosystem resources due to a lack of awareness about wetland ecosystem goods and services, according to respondents, until folding became widespread and persistent in the study area. As a result, respondents stated that broad community sensitization would be the best method to guarantee the long-term protection of wetland ecosystems in the research area.

Respondents expressed their dissatisfaction with community members' lack of compliance with current weak regulations. It was also suggested that the government and other stakeholders come up with tight legislation, even if it meant starting with

strict bye-laws. It was also reported that strengthening the institutional framework and proper plan execution for wetlands conservation was necessary.

Key informants 1 and 2 mentioned that “there was need for all the stakeholders to always reserve ample time and commit themselves in the proper plan implementation of the various issues such as monitoring and evaluating the activities by the community members and other wetland users such as those engaged in hand craft for survival”

Key informants 3 mentioned that "there is a need for research, especially on the effect of wolfram mining, which pollutes the river Ruhura that passes through Nyamuro wetland, affecting aquatic life and the wetland ecosystem. She went on to say that local communities grow Irish potatoes in Nyamuro Wetland, and polluted water from mining areas enters their crops, contaminating crops with heavy metals and affecting human life after consumption; no effort is made to address this issue, resulting in the need for heavy metal assessment in crops grown in Nyamuro Wetland”

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The study's goal was to evaluate wetland conservation and management practices in Rubanda District, South-Western Uganda. Overall, the findings indicate that there is a substantial positive correlation between management approaches used in conservation but not in the sustainable strategies used in study area. This shows that in the public processes for dealing with wetland resource sustainability challenges, there was a disconnect between managers and users. This is linked to the fact that rising poverty and the present state of wetland degradation threaten the potential bas of different livelihood choices. Over all, the unfavourable consequences of how the designed management plans were implemented and execution process was managed.

Recommendations

To combat corruption and the introduction of invasive species into wetland ecosystems, strict laws and policies should be implemented. Environmental managers and policymakers are primarily responsible for preventing corruption and the entrance of invasive wetland species.

The management control role, which is critical to good wetland resource governance, should be reformed and repositioned to ensure that monitoring, assessment, and reporting activities are logically linked to promote long-term conservation. This should unambiguously require focused governance improvements to minimize inefficiencies from wetland conservation control procedures to assure Nyamuriro wetland protection.

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Conflict of Interest

There are no competing interests in the publication of this research.

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