The impact of agricultural activities on the livelihood of riparian communities of Nalwekomba wetland ecosystem along River Nile, Namasagali, Kamuli District Uganda

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Abstract

Land degradation in Uganda is becoming a major constraint to growth and development of rural livelihoods. The socioeconomic impacts of agricultural land use to the degraded Nalwekomba wetland ecosystem were investigated in three riparian parishes that highly depended on the wetland for a livelihood. These parishes were purposely selected and a sample of 130 households were randomly selected. Results showed wetlands are under threat of over-exploitation due to agriculture land uses. Majority of the respondents were willing to leave the wetland. There is a need to design strategies for alternative livelihood options for wetland dependent communities to achieve Sustainable Development Goals.
Keywords: Land Degradation; Livelihood; Wetland system

General introduction

Wetlands resource degradation continues to be one of the most pressing issues globally. Wetlands are among the most important ecosystems on the earth‘s surface (Muhimbo, 2022; Fois, *et al*, 2022; Mugumya, 2018), though have witnessed a drastic loss in their acreage. The drastic loss of wetlands is due to anthropogenic activities in many parts of the world (Adeeyo, *et al.*, 2022).
However, in East Africa, wetlands are steadily converted to agriculture for food security reasons (Ondiek, *et al*., 2020). Major weaknesses identified for wetland degradation are the ignorance of people about the benefits of wetlands and the weak implementation of frameworks and policies that currently exist (Adeeyo, *et al.*,

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2022). Wetlands are very important to the livelihoods of people in rural areas (Sinthumule & Netshisaulu, 2022). Thus, as a wetland ecosystem degrades, the livelihoods of most rural poor people deteriorate (Hardlife *et al.*, 2014). This is because communities living around the riparian areas continue highly to depend on wetlands for a livelihood.

Uganda is endowed with numerous natural resources, with the most renowned productive wetland ecosystems (Mugumya, 2018). However, Businge (2017) singles out wetland degradation as a severe environmental problem. Farming and use of wetland products including molluscs, fuelwood, fodder, fibre and fish are found to subsidise living costs and provide diverse livelihood options to local residents (Adhya & Banerjee, 2022).

Introduction to Nalwekomba wetland ecosystem

Nalwekomba wetland has long been one of the most valued ecosystems providing a livelihood for the riparian communities of Namasagali Sub County, Kamuli district along river Nile with a range of direct and indirect benefits for decades. These included but not limited to fish, water purification and storage (UN-Water, 2018), flood control, biodiversity conservation, recreational purposes, and food (FAO, 2019b) for both humans and livestock. However, the increasing population around the wetland since 2000, coupled with land shortage and climate variability, have left households with limited options, and have continued to rely heavily on wetlands for food security and income to sustain their livelihoods (Turyahabwe *et al.*, 2013). Expansion of agricultural fields has caused an alarming rate of wetland degradation (NEMA, 2018/19).

83% of the households are experiencing food insecurity (Turyahabwe *et al*., 2013) and will increase as farmers are chased out of the wetlands to enhance restoration. This hampers development especially if such farmers have no guaranteed alternative livelihoods.

Activities like expansion of agricultural farmlands (NEMA, 2016; Tumuheire, 2017), overgrazing and unsustainable harvesting of papyrus and other vegetation (NEMA, 2016/17), over fishing among other practices have been accountable for the increasing degradation of the wetland. This has resulted in flooding (Gumm, Emily, 2011), biodiversity loss, variation in water quality and quantity, creation of artificial boundaries within the wetland ecosystems, among other problems. This has been due to wetland services and goods regarded as public goods (Businge, 2017) and this has contributed to 64–71 % of wetland loss since the beginning of the twentieth century (FAO, 2019a). This calls for a thorough understanding of human-ecosystem interactions and the design of appropriate sustainable agricultural production systems/ technologies for a sustainable livelihood especially for the rural poor.

The objective was to investigate the impact of agricultural activities on the livelihood of riparian communities of the Nalwekomba wetland ecosystem.

Materials and methods

Description of the study site

To assess the impact agricultural activities on Nalwekomba wetland ecosystem to the livelihood of the riparian communities of Namasagali sub-county, we selected three riparian parishes of the catchment (Figure 1). The parishes were representative of the wetland catchment in terms of geology, soils, climate, vegetation and land use. The study areas are characterised by a bi-modal rainfall, one in the months of March through to May, and the other from September to December with a mean precipitation of 109 mm and 124mm respectively. The area is dominated by intensive mixed agriculture consisting of maize, beans and sweet potatoes and cassava as annual crops. There appeared a new trend of farmers moving away from growing traditional crops to rice and sugarcane growing. Livestock keeping was a limited extent in the wetland ecosystem. Fishing is an off-farm activity and the main species are Tilapia, Catfish and Nile Perch. Nalwekomba wetland is located in Namasagali Sub-county, Kamuli district along the eastern part of River Nile. It is one of the largest drainage ecosystems of Kamuli districts that drain water directly into River Nile, a transboundary river serving 10 countries in Africa. The wetland receives water from Kiko, Kiwungu, Nabirama, Kananage, Balawooli and Nankulyaku water streams. A number of human activities are carried out in its tributaries and the catchment. Cultivation of the wetland has caused water diversions, increased inorganic content in River Nile with its consequences. Unregulated fishing in the wetlands (for food and for live bait) has caused a blockage to the flow of water and thus increasing floods in Namasagali Sub County (Figure 2).

Methods

The study applied a mixed method approach including both qualitative and quantitative techniques to generate more knowledge on the impacts of agricultural activities on the livelihood of three riparian communities of Nalwekomba wetland ecosystem (Namasagali, Bwiza and Kasozi) that highly depended on the wetland for a livelihood. Mixed methods are very useful when examining complex systems such as social-ecological systems. These parishes were purposively selected and a sample of 130 households were randomly selected using systematic random sampling technique from a list of all residents in the selected parishes of farmers using Nalwekomba wetland ecosystem. Namasagali Sub County has a population

of 37,524 people (NPHC, 2014). We used a semi-structured questionnaire to collect data on the socio-economic characteristics of households, agricultural activities, drivers of wetland degradation, willingness to leave and pay for ecosystem services and implications of wetland degradation to the River Nile waters.

In addition, qualitative interviews were conducted, targeting leadership at the local level, to collect in-depth information on the impact of agricultural activities on the livelihoods of the three riparian communities. We selected 10 key informants, including local council leaders at sub-county level, extension officer, environment officer, agricultural officer, politicians, and local environment committees for individual interviews. In addition, we organised 3 focus group discussions in each of the 3 selected parishes, including 8 farmers per group with homogenous characteristics.

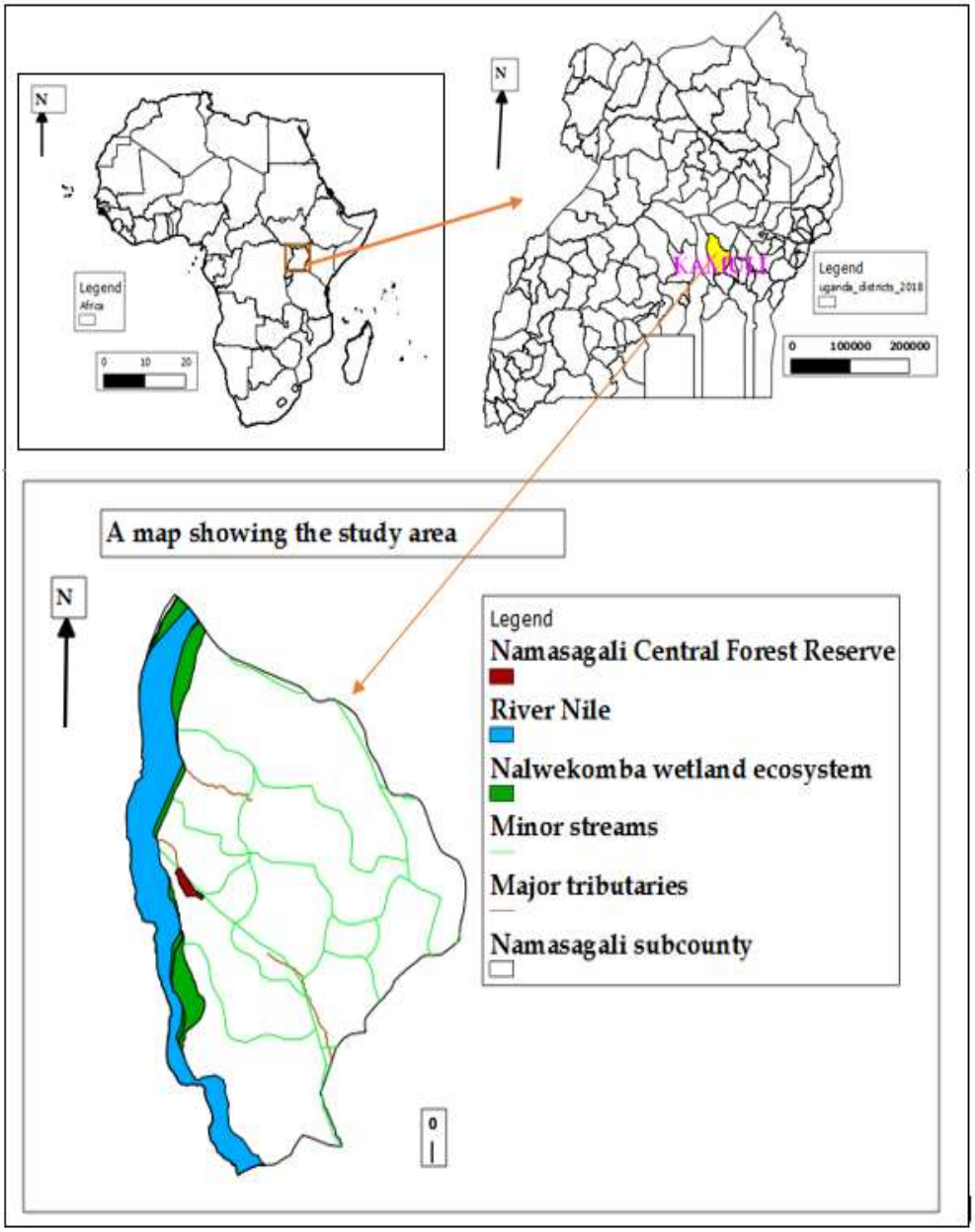

Fig.1. *Map showing Nalwekomba wetland Ecosystem*

The collected primary data were analysed using Microsoft excel, Stata version 17, R 4.0.10 and SPSS version 20 to produce descriptive statistics and establish relationships between variables using the Pearson Chi-square; significance was estimated at $p \leq 0.05$. Frequencies and percentages were calculated to facilitate the

drawing up of inferences related to wetland governance. Secondary data were obtained from online resources like FAO reports on wetlands, UN-water, NEMA reports, and other relevant research resources. Qualitative data analysis involved the categorization of data for purposes of classification into descriptive and interpretive.

Results

Demographic characteristics of households

Survey data were collected from 130 households. These were from three parishes; Namasagali (6.1%), Bwiza (33.1%) and Kasozi (60.8%).

Gender of respondents

There were more male than female respondents (Table 1). Although gender is an important factor in the quantification of the direct and indirect benefits from natural resources, it was not significant in explaining the high levels of degradation in the wetland and its catchment with a P-value of (0.494).

Marital status

Married respondents devoted much more time in the wetland gardens compared to single respondents and thus many of them were interviewed during data collection. Marital status did not significantly contribute to the high levels of wetland degradation with a p-value of (0.868).

Age of respondents

The most respondents (about 60%) were within the most active working age (< 42 years) and only (5.4%) were >66 years (Table 1). It was due to the fact that most of the activities in the wetland require using physical energy that could only be provided for by youth. There was no significant relationship between age and wetland degradation with a P-value of (0.818).

Education of respondents

Levels of education showed a significant relationship with wetland degradation with a p-values of 0.035, 0.004 and 0.000). Respondents reported that education opportunities were highly skewed towards boys than girl children. Results further revealed that there were a lot of more female respondents with no education compared to males. Results further revealed a high number of respondents between 18-29 years dropping out of school, especially at lower secondary level, and this was partly attributed to poverty. Despite respondents having basic education, the majority had not completed secondary education.

Size of land farmed

The size of land cultivated was significant (p=0.003<0.05) in explaining the type of crop farmed. The size of land cultivated under food crops is important in ensuring high yields and food secure households. However, survey data revealed that large pieces of land formally under food crop cultivation had been converted to sugar cane plantations. This land-use change has contributed to food insecurity among the riparian communities and many other forms of dependence.

Tab. 1 *Demographic characteristics of small scale farmers of Namasagali in percentages by parish*

Characteristic	**Category**	**Bwiza**	**Kasozi**	**Namasagali**	**General**	**p-value**
Gender	Female	27.9	54.4	12.5	**43.1**	**0.494[b]**
	Male	72.1	45.6	87.5	**56.9**	
Age (Years)	18-29	25.5	32.9	50.0	**31.5**	
	30-41	44.2	26.6	37.5	**33.1**	**0.818[a]**
	42-53	18.6	26.6	12.5	**23.1**	**0.884[c]**
	54-65	4.7	8.9		**6.9**	
	> 65	7.0	5.1		**5.4**	
Marital Status	Single	11.6	11.4	25.0	**12.3**	**0.868[b]**
	Married	83.7	75.9	75.0	**78.5**	
	Divorced	2.3	6.3		**4.6**	
	Widow	2.3	6.4		**4.6**	
	Widower					
Education Level	No education	34.9	26.6		**27.7**	
	Primary	44.2	53.2	100.0	**53.1**	
	Secondary	16.3	17.7		**16.2**	**0.035[b]** **0.004[a]**
	Tertiary	4.7	2.5		**3.0**	**0.000[d]**
Average acreage farmed		3.2	2.4	2.1	**2.6**	**0.003[f]**

[a] Reduction in Water level, quality and quantity, [b] Deforestation, [c] Reduction in the size of the wetland, [d] Land size cultivated, f Type of crop grown. The level of significance was measured at ≤5 **

***Major Agricultural activities conducted in the Nalwekomba wetland ecosystem that contribute* to the livelihood of the riparian parishes.**

Majority of respondents in the catchment derive their livelihood from crop and livestock farming and only a few practice fishing farming of Clarias, undersized tilapia and earthworms. Other sources of livelihood include harvesting of papyrus, medicinal plants, and fetching of water for domestic purposes. Medicinal plants are highly harvested by women and herbalists.

The major crops grown in Nalwekomba wetland are rice, maize, and ground nuts. potatoes, beans, millet, sorghum, leaf vegetables. According to (figure 2), rice generates the highest mean revenue per acre and covers the largest part of the wetland across all the three sampled parishes. Bwiza parish generates the highest mean revenue from rice (USD 600), Kasozi (USD 500) and Namasagali (USD 500) respectively. Rice is followed by maize and groundnuts. Rice dominated due to the higher prices offered per Kilogram. The respondents revealed that the price per Kiloramg of rice does not fluctuate so much even during the harvesting period when the supply is high on the market.

Due to land use changes some farmers are diversifying to sugarcane growing. The yield of the local varieties was reported to be reducing due to climate variability and change. This has prompted farmers to open up virgin plots in the wetland in order to expand their agricultural fields through clearing of vegetation and massively cutting down trees.

Nalwekomba wetland drains its waters into River Nile, and these inorganic chemicals used in agricultural production cause eutrophication of the river with its related consequences. Sugar cane growing was reported as one of the emerging threats to the conservation of Nalwekomba wetland. Charcoal burning was reported to be highly practised and contributed to deforestation since trees are cut without replanting in order to avail agricultural fields.

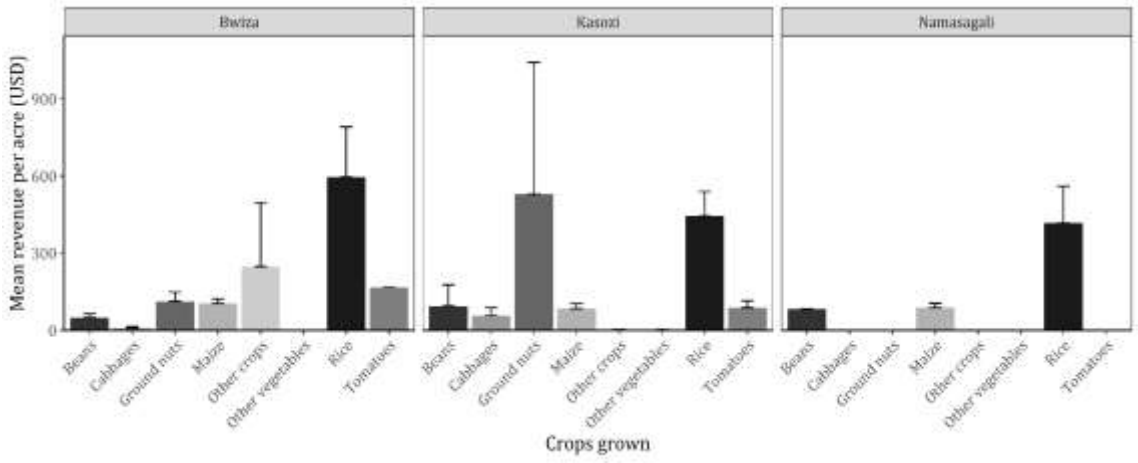

Fig.2. *Major agricultural activities conducted in Nalwekomba wetland ecosystem*

Driving forces leading to degradation of Nalwekomba wetland ecosystem

Most farmers in the study parishes live under the poverty circle of rural population. The desire to improve on their incomes and food security through agricultural production amidst low levels of soil fertility in the upland agricultural fields are the main driving force for the degradation of the Nalwekomba wetland ecosystem (table 2). Income was significant with p-values of (0.006 and 0.013) respectively. According to Omolo, *et al.*, (2018) factors having detrimental impacts on the wetlands' ecosystem services, and included conversion of sections of the wetlands into farmlands, grazing, charcoal burning, unsustainable fishing, overharvesting of papyrus and brick-making.

Firewood collection is practised on a small scale mainly by women for cooking and this had no significant impact on wetland degradation at a P-value of (0.577) as opposed to men who collected firewood for commercial purposes and could cut live trees to meet the required tonnage.

Tab. 2 Driving forces leading to degradation of Nalwekomba wetland ecosystem in percentages

Driving forces for cultivating the wetland	**Bwiza**		**Kasozi**		**Namasagali**		**p-value(**)**
	Yes	**No**	**Yes**	**No**	**Yes**	**No**	
Food	44.2	55.8	59.1	48.9	12.5	87.5	0.061[a]
Income	60.5	39.5	63.3	36.7	25	75	0.006[a], 0.013[c]
Fuel	7.0	93.0	3.8	96.2	-	100	0.577[a]

Availability of land and good quality (fertility and water)	16.3	83.7	21.5	78.5	75	25	0.026[b]
Availability of water for irrigation and & need for pasture	11.6	88.4	17.7	82.3	25.0	75.0	0.037[c]
Lack of arable land suitable for upland rice, and payment of loans	11.6	88.4	17.7	82.3	25.0	75.0	0.265[a]

The total N is greater than 130 since these are multiple responses.
The level of significance was measured at 5 **
[a] deforestation, [b] reduction in water quality and quantity and level, [c] reduction in soil fertility

The impacts of agricultural activities on Nalwekomba wetland ecosystem that affect the livelihoods of the riparian communities

Flooding of the wetland was reported to promote delayed planting of rice and other crops and imposing a threat to the transport and education sectors (figures 3 and 4). The floods were also reported to cause low harvest of many crops due to rotting, swept away rice and other crops, and affected transportation of food due to poor roads. Many school going children fail to attend school due to flooded roads especially in the months of April, May, October, November and December.

There has been a lot of deforestation of the wetland in the process of converting the land to agriculture fields. Trees are cut to expand agricultural fields leading to deforestation of the wetland. Nalwekomba wetland ecosystem is now seasonal and yet it was a permanent wetland before degradation. This has resulted into loss/migration of many birds, extinction of species such as fish which could supplement on nutritional needs of the study communities. Livestock keepers move long distances up to river Nile, especially during the dry periods of the year to look for water for their livestock. In doing this, a lot of time is lost which would otherwise be used for doing a diversity of income sources. Income that people used to get out of extraction of fish for baits from Nalwekomba wetland has declined with a threat of such people losing out on their livelihood source. Nalwekomba has witnessed invasion of new weeds and high levels of soil erosion.

Fig.3. *Flooding of Nalwekomba affecting transport on the road*

Fig.4. *Farmers scared of crossing the flooded road of Nalwekomba wetland and for some farmers their rice had been covered by water for weeks*

Willingness to leave the wetland ecosystem for conservation

The Nalwekomba wetland ecosystem has long been a home to a diversity of flora and fauna hence the need to restore its ecological integrity. The results in (figure 5) reveals that the respondents were willing to leave the wetland ecosystem and among these, belong to the most active working group (below 50 years) across the three parishes. Kasozi parish had more respondents willing to leave across all age categories including respondents above 50 years compared to the other two

parishes. The age group 50 years and above in Namasagali parish were not at all willing to leave the ecosystem.

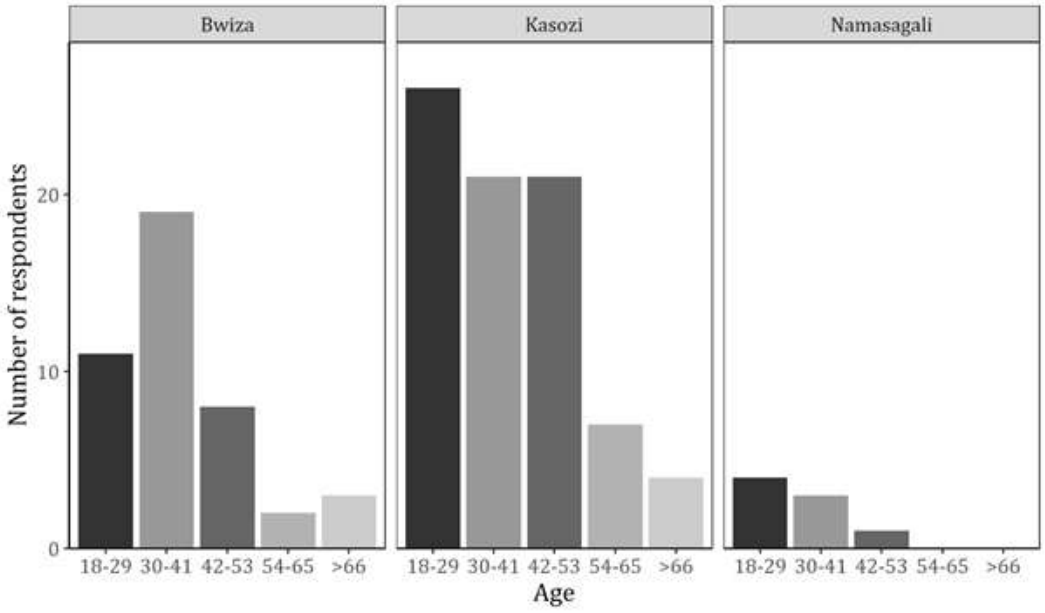

Fig.5. *Respondents willingness to leave Nalwekomba wetland ecosystem for restoration by age group across the three sampled parishes*

Willingness to pay for restoration of the wetland ecosystem

Respondents interviewed were willing to contribute towards conservation across all the three parishes (figure 6). On average, the respondents from Kasozi parish were willing to pay a lot more money in terms of mean (USD 70) for the restoration of the ecosystem compared to the rest of the parishes. These respondents revealed that they had lost access to most of the ecosystem goods and services, for example, fish and water for irrigation since the wetland had turned into seasonal in nature.

While for the rest of the respondents whose parishes stretch up to river Nile had access to fish and water.

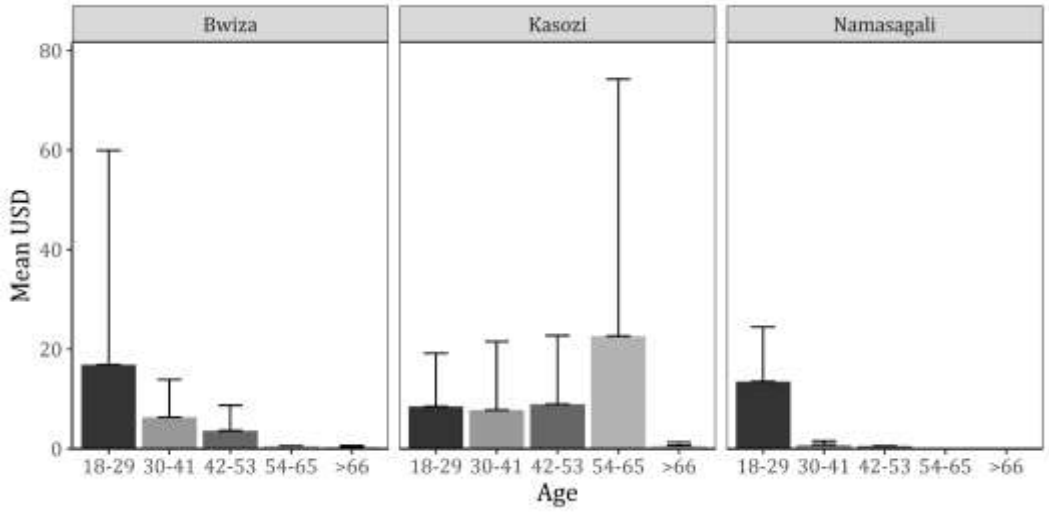

Fig.6. *Respondents' average willingness to pay by age groups across the three sampled parishes*

Respondents were asked for the possible ways through which the wetland could be restored. Tree planting ranked highest with (55.5%), reserve land of 30 meters from the main water source, massive sensitization of riparian communities about the importance of leaving a wetland intact and provision of alternative sources of livelihood. However, this was reported to highly depend on arable land available; acreage was significant in revealing the people who carried out tree planting in the wetland ($p=0.004<0.05$). Only respondents who own large pieces of land plant trees mainly for income generation. The results further show that tree planting could improve the state of Nalwekomba as farmers were willing to leave the wetland and this was significant with a p-value (0.009). This calls for high level natural resource stakeholders to maximise the willingness of the people to leave in order to restore Nalwekomba wetland. Education level was not an important variable in explaining the reasons for planting trees (*P-value =0.223*).

Discussion

Wetlands in most parts of the world are under threat of over-exploitation, loss and/or degradation partly due to agriculture land uses (Kinaro, 2008). Though we thought that married respondents had more responsibilities and needed more income and resources, the study revealed that all households irrespective of marital

status were heavily engaged in the wetland for crop farming as their primary source of livelihood. The results conform to those reported by Violet (2010) on wetland degradation who found out that 53% of the respondents were married.

A large proportion of the productive age group (youths) cultivated the wetland for crop farming, this differs from the findings of Marambanyika (2015). Population increase and land fragmentation have led to opening up marginal land for agriculture. These findings concur with Tumuheire (2017) who found out that the majority of the respondents interviewed 93.8% were growing their crops in the wetland which supplies enough water to the growing crops. Similar results were reported by Namaalwa *et al.* (2020), who cited that Namatala Wetland in Uganda faces severe degradation from agricultural development, Marambanyika (2015) who reported that in southern Zimbabwe agricultural expansion is the major economic activity taking place in the wetland as well as Turyahabwe *et al.* (2013), who indicated that locally perceived threats to wetlands were mainly from crop farming.

Findings from this study revealed that men had resources to cultivate in the wetland and the catchment while women mostly cultivated the catchment. However, both men and women cleared trees when opening up new areas and during expansion of the agricultural fields. These findings concur with the results from a study conducted by (Safari, 2016) who found out that farmers in many wetlands clear land for agricultural practices, and as a result of land reclamation, there is rapid soil erosion and loss of land cover. Women cultivated a small total piece of land (169 acres) compared to men who cultivated 593 acres.

Respondents with basic education had knowledge on the effects of the different activities on the wetland but they had no option since they could not take on professional jobs due to unemployment levels in the country. Respondents with high levels of education owned large pieces of land, were very busy with off-farm activities and professional employment. Similar results were confirmed by Nakiyemba *et al.* (2020), who observed a higher percentage of non-degraders (mean = 7.21) in the group with the highest education compared to the degraders with a mean (5.33) level of education.

Results further showed that income was the leading factor to deforestation of the wetland. Farmers revealed that with improved incomes, they could acquire all the basic necessities in life. Stability of income for women is necessary in strengthening the operation of small scale village saving groups and thus improving access to loans for initial capital and fighting poverty. men prioritised school fees/ income, loan settlement, and food while women prioritised food, income and medicinal plants and fruits as the major benefits from the wetland. These findings are similar to Nabahungu (2012) who found out that in Rwanda, wetlands support

the livelihoods of many poor people through agriculture providing both food and income.

Respondents from the three riparian communities revealed were willing to leave the wetland if the government avails them with alternative livelihood options. Respondents from Kasozi parish (Figure 5) were more willing to leave in order to conserve the wetland because the parish mainly depends on this ecosystem for most of its goods and services such as water for domestic and agricultural production. This is because it does not stretch up to River Nile. Respondents who are 50 years and above from Kasozi parish were more willing to leave the ecosystem for restoration compared to those from Namasagali and Bwiza in the same age bracket. This is because they do not have alternative off-farm activities unlike their counterparts in Namasagali and Bwiza parishes who can switch to fishing since they stretch up to River Nile. The most productive age groups below 50 years were willing to leave the ecosystem across all parishes because they can easily get involved in other off-farms activities such as fishing, motorcycle riding as a means of local transport known as (boda boda), baking local snacks and other related businesses.

Figure 6 reveals that respondents across all parishes were willing to pay/contribute towards conservation to restore the wetland ecosystem. Respondents willing to pay in parishes of Bwiza and Namasagali are mainly in the age group of 18 to 29 compared to Kasozi where most age groups were willing to pay for restoration of wetland ecosystem. This is because in Kasozi parish respondents mainly depend on agricultural production, unlike Namasagali and Bwiza who have access to river Nile and fishing is a lucrative activity for a livelihood. Age group 54 to 65 are more willing to pay in Kasozi compared to the other two parishes. This is due to the fact that these are settled members of the community who may not want to move away from their communities looking for off-farm activities hence value restoration of the ecosystem.

Findings from other studies suggest that people were willing to sacrifice part of their income to preserve wetlands for future generations (Truong, 2021; Asmare, *et al.,* 2022). Perception and attitude toward wetland values and conservation are essential to the sustainable management and wise use of the resource (Truong, 2021; Sinthumule & Netshisaulu, 2022). Factors such as land size around the wetland, distance to the wetland have a negative influence on households' willingness to pay (Asmare, *et al.,* 2022). Age and wetland income, agricultural income and prior participation in conservation are significant in determining the willingness to pay for the various households (Pramod, *et al.,* 2015). Contrary to these findings, (Tebeje, 2017; Asmare, *et al.*, 2022; Getachew, 2018) found out that age is not statistically significant in explaining the willingness to pay.

It is concluded that the benefits accrued to cultivation of Nalwekomba wetland ecosystem and its catchment has left it vulnerable to agents of soil erosion and flooding (figures 3 & 4) due to low levels of water infiltration which has made it become seasonal in nature. This has greatly impacted on River Nile, a trans-boundary river and source of livelihood to ten countries in the Nile Basin in Africa.

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