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Effects of Land-Use Changes on Vegetation Structure and Composition Along the Rongai River in Nakuru County, Kenya

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ABSTRACT

Land-use practices have a significant impact on the environment, sustainability, and human well-being. The main objective of this research was to characterize and describe the effects of land-use change on vegetation structure and composition along the Rongai River. To identify the numerous plant types at diverse land uses along the Rongai River, a reconnaissance study was initially conducted. The descriptive survey design was also used for the study, respondents were administered with structured questionnaires (closed-ended) to assess the land-use system with the major threat to the sustainability of River Rongai. The Shannon Diversity Index and species dominance in the vegetative communities were all calculated. Based on nearby land uses, three riverside sampling sites were selected for this study. Three transects, each 100 meters long and running parallel to the river, were set up at each point. Randomly, all trees with a Diameter at Breast Height (DBH≥2 cm) about 1.4 m above the ground were identified. Three major land-use types identified in the study areas were forests, agricultural and grazing areas. Tree species that were most dominant includes: *Vachellia xanthophlea*, *Syzygium cordatum*, *Vachellia abyssinica*, *Erythrina abyssinica*, *Eucalyptus salgina* and *Ficus natalensis*. ANOVA showed that land uses, plant vegetations and the interaction effect of site and plant vegetation have no significant ($P \geq 0.05$) effect on length.

1. INTRODUCTION

Changes in land-use practices have affected the integrity and quality of water resources worldwide [1]. Changes in land and water use have also resulted from the human population increase, posing a growing threat to biodiversity and ecosystem services [2]. Physico-chemical and biological diversity are very important to the health of an aquatic ecosystem like rivers and other freshwater systems [3]. Despite the importance of riparian vegetation in the provision of ecosystem services and maintenance of regional biodiversity, the impact of anthropogenic activities on vegetation diversity is still poorly understood [4]. Riparian vegetation exhibits unique characteristics such as hydric soils, floral and faunal composition, and community structural relationships and provides an ideal habitat for floral and faunal communities. A healthy riparian ecosystem is essential to the maintenance of water quality and biological integrity in surface water systems, and their destruction often leads to the degradation of adjoining aquatic ecosystems [5]. Despite their importance, the anthropogenic impact on this vegetation type is still poorly understood more so in developing countries [6].

Although the effects of land-use changes are well documented for aquatic ecosystems, few studies have specifically assessed riparian vegetation [7]. Changes in riparian vegetation can affect water quality and aquatic communities. Indeed, agriculture, pasture, and urban land-use changes often result in decreased diversity and shifts in relative abundance among the functional feeding groups (FFGs) of aquatic macroinvertebrate assemblages [8]. In contrast, sites of good riparian quality present higher densities of scrapers, predators, and collector-gatherers. The natural factors that determine the structure of riparian vegetation include natural disturbances for example periodic flooding or tree fall, altitudinal climate shift and geographically unique channel processes [9]. Riparian vegetation is especially vulnerable to environmental changes and might be the first component of the landscape to show a decline in these crucial services brought on by processes related to land use change [10]. Particularly in Neotropical societies, little is known about how urbanization and agricultural practices affect riparian vegetation assemblages and the environmental benefits they provide. Keeping these places in a relatively well-conserved state, like those found close to the sites, is crucial for this reason. This type of vegetation is widely acknowledged to be one of the most ecologically diverse, dynamic, and complex ecosystems, and as such, it serves as an essential refuge for biodiversity [11].

Through its beneficial effects on soil microorganisms, higher plant variety modifies the breakdown dynamics of fresh residue inputs, which may have positive effects on soil nutrient cycling and SOM dynamics. For instance, in grassland that has been converted to eutrophic soil, plant diversity increases the carbon use efficiency of soil microbes without affecting the exudation efficiency of phosphorous-acquiring enzymes (phosphatase). This suggests that efficient C, rather than P, cycling is necessary to support plant species richness and phosphatase activity [12].

Riparian degradation occurs because of disturbances from anthropogenic activities that occur at different levels, frequencies, and intensities exerting pressure on the riparian vegetation and biodiversity. Livestock grazing, agriculture, and hydrological modification are a few of the disturbances brought on by land-use change that have an impact on riparian populations along River Rongai. Increased erosion, decreased plant vigour, altered plant age structure, and reduced species diversity are all effects of unrestricted cattle grazing. However, animals can also contribute to a rise in the variety of plant species by spreading seeds from far-off places and/or from nearby riparian vegetation [13].

Agricultural expansion has shifted between regions over time; this followed the general development of civilizations, economies, and increasing populations [14]. The communities located around the Rongai River rely on it for domestic usage, irrigation, and other human activities. All of these activities reduce the amount of water in the river, resulting in a loss of biodiversity, including floral species along the river [15]. However, there is a lack of evidence on the extent/amount of the effects of land use change along the river on riparian vegetation. Rapid development in the Rongai area has resulted in changes in land use, which has resulted in the establishment of impermeable surfaces. Riparian vegetation is essential for preserving regional biodiversity and delivering environmental services. As a result, knowing the impact of human activities on stream flow was critical. Therefore, the study aims to contribute to the characterization and documentation of the effects of land-use change through the assessment of the changes on vegetation structure and composition along Rongai River. This will increase more information about Rongai River.

2. MATERIAL AND METHODS

2.1 Location of the study area

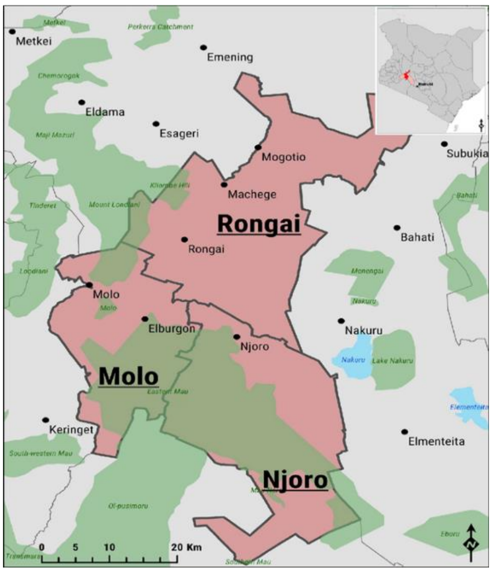

Figure 1. Study area map

Rongai sub-county where the study was done is shown in Figure 1. The study was done along the Rongai River, which is located in Nakuru County (Nakuru-Eldoret Highway, Rongai, Rift Valley). In Rongai Sub-County, government records show that 7,000 people were resettled in the area. It is located 30 kilometres (km) west of Nakuru, on the Nakuru-Uganda Railway and the A104 Road. The GPS (Global Positioning System) coordinates of the area are 0°10'24" South, 35°51'49.8" East and the GPS of the sample sites were as follows; upstream which is Salga was 1919.900 altitude, -0.216 latitude and 35.864 longitude. Kirangari, the middle stream was 1844.200 altitude, -0.146 latitude and 35.897 longitude. El-Ravine the downstream was 1713.900 altitude, -0.101 Latitude and 35.933 longitude.

2.2 Data collection

To initially identify the diverse plant groups at various land uses in River Rongai, a reconnaissance study was carried out. The Shannon Diversity Index, relative values for density, frequency, and abundance, and species dominance in the vegetative communities were analyzed. Three sampling sites were selected for this study in the forested, agricultural, and grazing zones along the river based on the local land uses. The choice of sampling sites was based on denser of population and their water consumption. The smaller plots were built inside the larger plots to facilitate the sampling of grasses and plants. Using the metal Diameter at Breast Height (DBH) tape, the DBH of every tree was calculated. The Geographic coordinates of each site were recorded with the help of the Global Positioning System. Given that the riparian vegetation occurs as a thin plant community margin along with a river system that can occasionally grow through floodplains, the size of these plots was the specified maximum for data collection in riparian vegetation communities. Then, a list of the plants present in these locations was created, along with an estimate of their quantities (abundance).

2.2.1 Sample size

Since the data collection was to provide a general idea of the effects of land-use change on vegetation structure and composition, a purposive sampling technique was used only where land-use changes were identified.

2.2.2 Data analysis

Data obtained along River Rongai riparian areas were analyzed using SPSS Software Version 25. The plant species diversity was determined according to Shannon Diversity Index. This index considers both the numbers of species and their relative abundances (Frequency). It Shannon Diversity Index was calculated as follows:

$$Shannon\ Diversity\ Index\ (H') = -\sum P_i\ log\ (P_i) \qquad (1)$$

where, P_i is the fraction of the entire population made up of species i and Σ = the summation of all the values from species i to species S, where S is the number of species encountered. As the value index increases, there is more order in the community; a small value would indicate a lack of order in the community. Alternatively, said another way: Shannon Diversity Index, taking into account the number of individuals as well as a number of species. It varies from zero (0) for communities with only a single species to one (1) for communities with many species, each with few individuals.

The richness of species was evaluated by counting the number of species present. The plant species abundance and diversity between the rivers of Rongai riparian areas were compared by using a two-sample t-test at a 5% significant level based on the SPSS software version 25. Furthermore, the general linear model (GLM) was carried out in order to find out the effect of land use, site and plant vegetation on the length and Diameter at Breast Height (DBH) of identified tree species using SAS software 9.4.

Table 1. DBH and length for vegetation structure in Salga/Kampi ya moto

Land-Use	Plant Vegetation	Scientific Names	Length (m)	DBH (cm)
Forest	Tree	*Ficus natalensis*	9.6	21
Forest	Tree	*Ficus natalensis*	12.8	80
Agriculture	Shrub	*Polygonum cuspidatum*	0.4	1
Forest	Tree	*Grevillea rubusta*	16	34
Forest	Tree	*Grevillea rubusta*	11.2	24
Forest	Tree	*Vachellia xanthophlea*	19.2	63
Forest	Tree	*V. xanthophlea*	9.6	36
Forest	Tree	*V. xanthophlea*	11.2	33
Forest	Tree	*V.xanthophlea*	14.4	35
Grazing	Shrub	*Leucaena leucocephala*	3.2	5
Grazing	Tree	*Leucaena leucocephala*	8	9
Forest	Tree	*Vachellia abyssinica*	14.4	60
Forest	Tree	*Vachellia abyssinica*	9.6	74
Grazing	Shrub	*Solobium Spp*	6.4	5
Forest	Tree	*Syzygium cordatum*	16	38
Forest	Tree	*Syzygium cordatum*	14.4	48
Forest	Tree	*Syzygium cordatum*	17.6	90
Grazing	shurb	*Solasenensis spp*	17.6	9
Grazing	Shrub	*Solasenensis spp*	16	9
Grazing	Shrub	*Solasenensis spp*	18.4	8
Grazing	Shrub	*Solasenensis spp*	16	7
Grazing	Shrub	*Solasenensis spp*	19.2	15
Forest	Tree	*Ficus benjamina*	19.2	55
Forest	Tree	*Erythrine abyssinica*	3.2	14
Agriculture	Tree	*Erythrine abyssinica*	8	24
Agriculture	Tree	*Erythrine abyssinica*	4.8	17
Forest	Herb	*Lantana camara*	7.2	15
Forest	Herb	*Lantana camara*	6.4	25
Forest	Herb	*Lantana camara*	8	18
Forest	Herb	*Lantana camara*	7.2	21
Forest	Tree	*Ficus sycomorus*	16	38
Forest	Tree	*Ficus sycomorus*	16	40
Forest	Tree	*Rhus longiflora*	17.6	21
Forest	Tree	*Rhus longiflora*	16	25
Agriculture	Tree	*Rhus longiflora*	11.2	22
Agriculture	Tree	*Rhus longiflora*	9.6	15
Forest	Shrub	*Dombeya torida*	3.2	14
Forest	Shrub	*Dombeya torida*	3.2	13
Grazing	Shrub	*Dombeya torida*	4	15
Forest	Tree	*Dombeya goetzenii*	4.8	10
Forest	Shrub	*Dombeya goetzenii*	4	17
Grazing	Shrub	*Dombeya goetzenii*	4	15
Forest	Tree	*Dombeya goetzenii*	5.6	21
Forest	Shrub	*Dombeya goetzenii*	4	18

Table 2. DBH and length for vegetation structure in Kirangari

Land-Use	Plant Vegetation	Plant Species	Length (m)	DBH (cm)
Forest	Tree	*Vachellia abyssinica*	4	21
Forest	Tree	*Vachellia abyssinica*	4	15
Forest	Tree	*Vachellia abyssinica*	4	35
Forest	Tree	*Vachellia abyssinica*	8.8	60
Forest	Tree	*Vachellia sieberiana*	7.2	24
Forest	Tree	*Vachellia sieberiana*	8	24
Forest	Tree	*Vachellia sieberiana*	6.4	25
Agriculture	Tree	*Vachellia sieberiana*	4	35
Forest	Tree	*Vachellia xanthophlea*	11.2	35
Forest	Tree	*Vachellia xanthophlea*	7.2	13
Forest	Tree	*Vachellia xanthophlea*	1.3	2
Forest	Tree	*Vachellia xanthophlea*	7.2	11
Forest	Tree	*Vachellia xanthophlea*	9.6	16
Agriculture	Tree	*Vachellia xanthophlea*	8.8	16
Agriculture	Tree	*Vachellia xanthophlea*	9.6	16

Forest	Tree	*Vachellia xanthophlea*	8.8	24
Grazing	Tree	*Ficus sycomorus*	5.6	38
Grazing	Tree	*Ficus sycomorus*	6.4	28
Grazing	Tree	*Ficus sycomorus*	1.5	5
Grazing	Tree	*Ficus sycomorus*	2.4	7
Forest	Shrub	*Ziziphus mauritania*	4.8	15
Grazing	Herb	*Lantana camara*	6.4	18
Forest	Herb	*Lantana camara*	7.2	24
Forest	Herb	*Lanatana camara*	6.4	17
Forest	Tree	*Syzygium cordatum*	14.4	35
Forest	Tree	*Syzygium cordatum*	16	36
Forest	Tree	*Syzygium cordatum*	14.4	36
Grazing	Tree	*Erythrina abyssinica*	3.2	10
Forest	Tree	*Vachellia nilotica*	6.4	16
Forest	Tree	*Vachellia nilotica*	7.2	21
Forest	Tree	*Vachellia gerardii*	4.8	8
Forest	Tree	*Rhus natalensesis*	7.2	28

Table 3. DBH and length for vegetation structure in EL-Ravine

Land-Use	Plant Vegetation	Plant Species	Length (m)	DBH (cm)
Forest	Tree	*Ficus sycomorus*	16	41
Forest	Tree	*Ficus sycomorus*	19.2	90
Forest	Tree	*Ficus sycomorus*	14.4	45
Forest	Shrub	*Maytenus senegolensesis*	7.2	33
Forest	Tree	*Vachellia sieberiana*	7.2	23
Forest	Tree	*Eucalyptus salgina*	19.2	78
Forest	Tree	*Eucalyptus salgina*	20.8	85
Agriculture	Tree	*Eucalyptus salgina*	19.2	81
Agriculture	Tree	*Eucalyptus salgina*	17.6	87
Forest	Tree	*Jakaranda mimosiforia*	8	15
Forest	Tree	*Jakaranda mimosiforia*	11.2	17
Grazing	Tree	*Juniperus procera*	8	16
Grazing	Tree	*Vachellia xanthophlea*	6.4	15
Grazing	Tree	*Vachellia xanthophlea*	8	21
Grazing	Tree	*Vachellia abyssinica*	3.2	6
Forest	Tree	*Vachellia abyssinica*	2.4	8
Forest	Tree	*Rhus natalensis*	6.4	21

Table 4. Descriptive statistics on plant vegetation DBH and length

Site		Length (m)	DBH (cm)
Salga/Kampi ya moto	Mean	9.97	33.41
	Minimum	0.40	1.00
	Maximum	19.20	90.00
Kirangari	Mean	9.32	26.91
	Minimum	1.30	2.00
	Maximum	20.80	90.00
El-Ravine	Mean	8.61	14.24
	Minimum	1.50	5.00
	Maximum	19.20	38.00
Total	Mean	9.50	27.67
	Minimum	0.40	1.00
	Maximum	20.80	90.00

3. RESULTS

3.1 Riparian vegetation structure and composition along River Rongai

Three major land-use types identified in the study area were forests, agricultural and grazing areas. The study area was divided into 3 sites such as Salga/Kampi ya moto, Kirangari and EL-Ravine. Tree species dominated the landscape includes; *Acacia Xanthophlea, Syzygium cordatum, Vachellia abyssinica, Erythrina abyssinica, Eucalyptus salgina* and *Ficus natalensis*. The DBH and length of tree species in three sites are shown in Tables 1-3. In addition, descriptive statistics are presented in Table 4.

3.2 Riparian plant species distribution

Different tree species from various families were distributed along Rongai River. Mrytacea family was found to be more distributed in Salga/Kampi ya moto, Fabacea family in Kirangari and Moracea family in El-Ravine (Table 5). There was also a belt of grass species from the Poaceae family, including *Pennisetum clandestinum* and *Cynodon dactylon*, as well as bushes including *Lantana trifolia* and *Hypericum revolutum*. Tree species such as *Syzigium cordatum*, *Syzigium guineense*, *Grevillea robusta* and *Dombeya torrida* were among those recognized. However grazing area were dominated by tree species such as *Leucaena leucocephala*, *Ficus sycomorus* and *Acacia xanthophlea*.

Table 5. Mostly plant species distribution along River Rongai in three different sampling locations

Number	Family	Species	Salga/Kampi ya moto	Kirangari	El-Ravine
1.	Fabaceae	*Albizia gummifera*	10	0	0
2.	Salicaceae	*Dovyalis abyssinica*	15	0	0
3.	Fabaceae	*Vachellia xanthophlea*	150	50	9
4.	Anacardiaceae	*Rhus longiflora*	120	0	3
5.	Moraceae	*Ficus sycomorus*	20	1	10
6.	Myrtaceae	*Zyzygium cordatum*	210	0	0
7.	Malvaceae	*Dombeya torrida*	40	6	2
8.	Malvaceae	*Dombeya goetzenii*	70	4	4
9.	Rubiaceae	*Vangueria madagascariensis*	13	3	5
10.	Rosaceae	*Prunus Africana*	5	0	0
11.	Anacardiaceae	*Rhus natalensis*	10	3	6
12.	Fabaceae	*Vachellia sieberiana*	80	12	7
13.	Amarathaceae	*Amaranthus hybridus*	30	18	5
14.	Malvaceae	*Sida cordifolia*	10	0	2
15.	Euphorbiaceae	*Ricinus communis*	12	0	0
16.	Lamiaceae	*Leonotis mollissima*	20	0	4
17.	Rosaceae	*Rubus steudneri*	15	0	0
18.	Fabaceae	*Sesbania sesban*	35	7	0
19.	Fabaceae	*Pterolobium stellatum*	10	5	5
20.	Asteraceae	*Bidens pilosa*	5	0	0
21.	Asteraceae	*Aspilia mossambicensis*	8	0	0
22.	Polygonaceae	*Polygonum setosulum*	4	5	0
23.	Polygonacea	*Polygonium amphibium*	15	9	0
24.	Polygonaceae	*Oxygonum sinuatum*	4	2	0
25.	Verbenaceae	*Lantana camara*	80	25	12
26.	Fabaceae	*Vachellia abyssinica*	30	10	5
27.	Euphorbiaceae	*Croton megalocarpus*	0	2	3
28.	Myrtaceae	*Eucalyptus salgina*	5	2	60
29.	Malvaceae	*Hibiscus ficus*	2	0	3
30.	Malvaceae	*Grewia similis*	0	0	3
31.	Commelinaceae	*Commelina benghalensis*	0	0	4
32.	ASteracea	*Ageratum conyzoides*	15	8	10

In River Rongai riparian zone, overall species diversity values (H') based on the Shannon Diversity Index were high in the grazing areas, followed by the forest areas and lowest in the agricultural areas recording diversity values of 0.85, 0.61, and 0.32 respectively (Figure 2). These diversity index differences mean that grazing areas has more diverse species, followed by forest areas, then agricultural areas with least diverse of species. The study revealed that it is because the land is more degraded in agricultural areas. ANOVA showed that there was no significant difference in the plant abundance and diversity among the different land uses in the Rongai River (p=0.39).

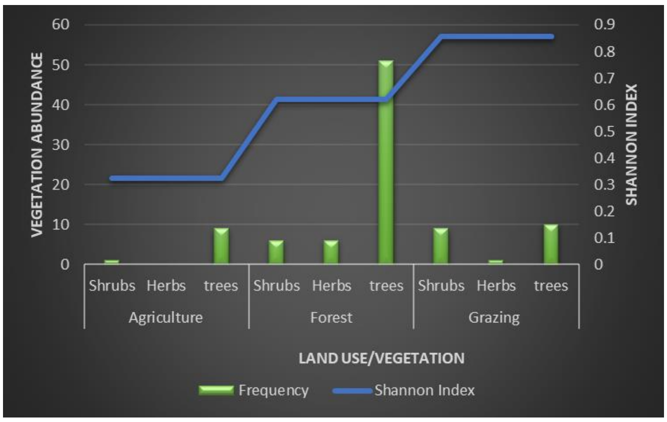

Figure 2. Riparian vegetation structure and Shannon Diversity Index across different land uses along River Rongai

3.3 Land use system with a major threat to the sustainability of Rongai River

The majority of respondents (63.3%), cited open-field agriculture farming as the biggest threat to the sustainability of the River Rongai, while 36.7% answered that greenhouse flower cultivation near the river poses the greatest harm (Table 6).

Table 6. Land use system with a major threat to the sustainability of River Rongai

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Green house flower farming	11	36.7	36.7	36.7
	Open field agricultural farming	19	63.3	63.3	100.0
	Total	30	100.0	100.0	

3.4 Effects of selected land use system on the sustainability of River Rongai

The majority of respondents (63.3%), indicated that they contribute to water reduction when asked how their chosen land use system affects the sustainability of the Rongai River, Meanwhile, 23.3% of respondents indicated that they use water abstraction for irrigation, and 13.3% of respondents indicated that they pollute the water (Table 7).

Table 7. Effects of selected land use system on the sustainability of River Rongai

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Water pollution	4	13.3	13.3	13.3
	Water abstraction for irrigation	7	23.3	23.3	36.7
	Water reduction	19	63.3	63.3	100.0
	Total	30	100.0	100.0	

4. DISCUSSIONS

4.1 Riparian vegetation structure and composition across land uses

A total of 252 plant vegetation species were identified along both the riparian zone of Rongai River along the river from 25 Families. This plant vegetation abundance and diversity are low compared to Njoro River which accounts for 145 plant species from 40 families and 110 species from 45 families in Kamweti River riparian area [13]. The lower vegetation abundance and diversity along Rongai River is due to over domestic use of water. The volume of water in Rongai River is very low compared to Njoro and Kamweti rivers. Along Rongai River, the common types of land use activities noted were forests, grazing and agriculture. Méndez-Toribio et al. [11] observed that the common types of land use are Agriculture, Urban and Forested area in Duero River. The forested landscape along river Rongai majorly consisted of tree species as shown in Tables 1, 2, 3 and in Figure 2. Tree species dominated the landscape includes; *Vachellia Xanthophlea*, *Syzygium cordatum*, *Vachellia abyssinica*, *Erythrina abyssinica*, *Eucalyptus salgina* and *Ficus natalensis*. The riparian vegetation disturbances brought on by land use were assessed in this study based on actual observations. Trees and plants predominated in the River Rongai's woodland region. These observations are the same as in Mountain River's woodland region [16]. EL-Ravine was the site with a few anthropogenic disturbances, such as the gathering of wood for fuel and the grazing of cattle.

The Shannon Diversity Index values for the forest areas of the Rongai River riparian zone, agricultural areas and grazing areas were 0.61, 0.32 and 0.85 respectively. The results are above to the values (0.27−0.34) reported by Becker et al. [17] for Watershed in the Central Appalachians but below to the values (2.17−2.62) recorded by Compaoré et al. [18] for the Riparian Forest in the southern Burkina Faso. The results confirm well to the range (0.377−2.243) reported by Sarmiento et al. [19] for Cabadbaran River.

The higher diversity index in grazing areas could be attributed to the dropping of animals, which provides nutrients to plant species, hence more diverse of species in grazing areas. Due to the favourable weather conditions observed throughout the sample times, the great species diversity in these sites suggests that the forest provides an optimum environment for floral development and reproduction [16]. In both land uses, trees were the dominant plant species. Analysis of Variance (ANOVA) showed that the main factors (site, land use and plant vegetation) and the interaction effect of land use and site significantly ($p \leq 0.05$) affected the Diameter at Breast Height. However, the interaction effect of land use and plant vegetation, and site and plant vegetation have no significant ($P \geq 0.05$) effect on Diameter Breast Height. However, ANOVA for length showed that only site, and the interaction effect of land use and site, and land use and plant vegetation significantly ($p \leq 0.05$) affected the length. However, land use, plant vegetations and the interaction effect of site and plant vegetation have no significant ($P \geq 0.05$) effect on length.

It was discovered that the riparian vegetation in the sites had changed, with some sections having only small patches of tree cover or none at all. This has resulted in a significant loss of the natural environment. Since the procedure involves clearing the native vegetation and siltation, intense farming on the riverbanks gave the sites a more disordered appearance. These have a detrimental effect on the ecosystem and eventually reduce the variety of plant species [20]. Along with agriculture, unchecked cow grazing and water extraction for domestic use severely disrupted the agricultural fields, leaving the left side of the bank barren. Because of siltation and sedimentation brought on by cattle trampling the soils on the banks of these locations, riparian plants and aquatic macrophytes cannot grow there because of habitat loss.

4.2 Riparian vegetation distribution

In the study area, *Bidens pilosa*, a fast-growing plant from the Asteraceae family, was widely distributed throughout all types of land use. It behaves like a typical weed in pastures and cultivated fields, as well as in natural and semi-natural settings [16]. *B. pilosa* is a prolific seed producer, and its seeds are easily disseminated by wind, water, clothing, animals, birds, and human activity. Additionally, it has been noted as a pollutant in agricultural goods and crop seeds. At elevations between sea level and 3600 m, it is recognized as a significant weed in cultivated fields, forest edges, and secondary forests. Asteraceae family member *Ageratum conyzoides,* which was once widespread, is recognized to be invasive in some areas of Kenya, Tanzania, and Uganda. Agricultural soils are known to support A. conyzoides, and it is also widely distributed in disturbed sites and degraded places. This shows similarities between River Rongai and River Njoro [13].

In the three types of land use in the research locations, the Poacea family was also present as evidenced by species like *Cynodon dactylon*, a stoloniferous grass that has become widely naturalized in tropical and subtropical portions of the world. The plant is regarded as one of the "severe" weeds in agriculture and the environment worldwide [20]. The capacity of the grass species to grow quickly, disseminate via seeds and stolons, quickly colonize new regions, and grow into dense mats was linked to its presence in the study sites [21]. According to studies, *C. dactylon* can change the hydrological cycles, fire regimes, biophysical dynamics, nutrient cycles, and community structure of an ecosystem [22]. It may easily re-sprout from stolons and rooted runners after dormancy. Plants are also quick to recover from fires and can withstand significant floods for at least a few weeks, according to studies. It was also noted that the roots of the *C. dactylon* community efficiently increased the stability of riparian shallow soil and riverbank.

In the study area, *Pennisetum clandestinum* was a frequent species of grass. The highlands of Eastern Africa are where it is thought to have originated, although it has been widely introduced elsewhere for fodder and to conserve soil [16]. It does not typically spread very far in well-managed conditions, but it is particularly tolerant of grazing and moving and can gradually enter poorly-managed plantations, causing a loss of biodiversity [21]. *L. hexandra*, a semi-aquatic species, was widespread in the river's riparian zone and may be found in a range of wet, mostly freshwater settings. Along with *Juniperus*, *Arundinaria, Celtis, Podocarpus*, and *Olea capensis, Dombeya torrida*, an under-storey wood tree of wetter highland forests of East Africa and Ethiopia from the Malvacea family, was prevalent in the studied region. A fast-growing shrub or small tree from the Euphobiacea family called *Ricinus communis* was present in River's upper reaches [23]. It is incredibly prolific, produces poisonous seeds, is exceedingly tolerant of many environmental conditions, and has been widely dispersed by humans. It is said to be invasive in a lot of places, especially in the tropics, and because dense thickets shade out native plants, it can have a bad effect on biodiversity. Riparian zones near forest areas were found to be in better condition and exhibit a greater variety of indices in the study area [24]. Additionally, it was seen that areas close to agricultural areas suffered a lot of damage. According to this study, soil compaction was the primary effect of the agricultural regions in both study sites [20]. Changing their capacity for flooding and the availability of habitat has been documented to impact the water quality of streams and the biological functionality of riparian zones.

5. CONCLUSIONS AND RECOMMENDATIONS

The study revealed that the river's poor riparian biological conditions in agricultural regions were the case, supporting the theory that intensive land uses have a detrimental impact on riparian habitat conditions. Furthermore, it was evident that a larger diversity of species and structural complexity in the community were observed as the quality of the riparian environment increased. The possibility for conserving plant species, the complexity of structure, and function in riparian ecosystems were greatest in the wooded areas. A good stream's water quality is significantly influenced by riparian vegetation. The study revealed that the loss of riparian vegetation along the river Rongai downstream is due to anthropogenic activities like clearing, livestock grazing, agricultural practices, and settlements, which result in a reduction in the overall health of the stream as well as a loss of the advantages provided by riparian ecosystems.

Since the overhead irrigation system that open-field farmers currently use is not sustainable in terms of water conservation but also causes soil leaching and surface run-off, it is necessary to encourage them to organize into community-based organizations and associations to provide capacity building on sustainable irrigation practices that promote water use efficiency. Environmental conservation officers in conjunction with administrative organs from both the national and county government need to create awareness of the importance of conserving riparian land. This sensitization exercise will reduce riparian land encroachment and destruction by farmers who clear the vegetation intending to expand arable land.

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