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Land Use and Environmental Gradients Influence on Riparian Woody Plant Diversity and Structure in Lake Manyara Watershed Ecosystem, Tanzania

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Abstract

Riparian vegetations are important in supporting ecological connectivity between aquatic and terrestrial ecosystems. The structure and species composition of riparian woody plants have been subjected to multiple forces with varying degree of influences. This study examined the influence of land use and environmental gradient to the structure and composition of the riparian woody plants in northern Tanzania. A total of 270 plots were surveyed for woody plant species in the riparian ecosystems and later analysed to determine the influence of land use categories (homegarden, crop field, woodlot, open canopy forest, and closed canopy forest) and environmental variables (temperature, precipitation, elevation and slope) to the species richness, abundance, and stand parameters. Basal area was higher in woodlots, homegardens and crop fields than in the open and closed canopy forests; and as expected the reverse was true for the number of stocking density. Correlation among stand parameters with environmental variables varied significantly. Species richness and species abundance were negatively correlated to precipitation, temperature and elevation, while stocking density and basal area were positively correlated to precipitation. The study recommends continual retentions of trees on farm, further promoting of agroforestry interventions and sustainable utilization of woody plants in open and close canopy forests.

Keywords

Water Basin, Forest Disturbance, Riparian Forests, Rift Valley, Savannah

1. Introduction

The riparian forests and woodlands occur at the transition between a water body (e.g., river, stream, pond, marshland, lake) and the land. They normally exhibit a special biome characterised by a high biodiversity of flora and fauna, and are considered to be very dynamic ecosystems [1]. They help in control of surface runoff, reduce flooding effect and serve as a natural filter that improves water quality [2]. Riparian forests further serve as a buffer zone that safeguards both the terrestrial and aquatic ecosystems from anthropogenic pressure and climate change [2], and thus improve ecological stability. However, there has been growing pressure for utilisation of the riparian forests and surrounding ecosystems owing to rapid population growth.

Excessive pressure from anthropogenic activities especially through land use change has become the key factor that destabilizes ecosystem integrity of many riparian forests [3]. These land use changes are predominantly through agricultural expansion, infrastructure development and human settlement. Land use has profound influences not only on riparian vegetation, but also to the streamflow and hydrological processes. Land conversion from vegetated to other land uses creates impervious surfaces that impede infiltration capacity and that tend to limit the capacity of riparian areas to furnish water [4]. Additionally, there is a further interlink where demand for riverine freshwater resources exacerbate the degradation of riparian forest vegetation. A sharp decline of the size and condition of the riparian forests has been noticed in several parts of the globe as a result of land use conversion at the vicinity of water bodies [5].

Environmental gradients can influence the structure and dynamics of the riparian forests depending on the site and ecological conditions [6]. The trend on how environmental factors affect riparian forest structure is diverse and tends to differ with localities. For instance, intensive flooding disturbances have been noted to favour the expansion of upland tree species in the riparian zone [7]. Riparian vegetation structure is principally influenced by elevation and distance from water front. Riparian forests were mainly found to be influenced by forest soil type and steep slopes (>30˚) [8]. Furthermore, topography and soil substrate types can explain the variation of vegetation patterns in relation to the influence of environmental and anthropogenic patterns [9] whereas slope, precipitation, humidity, and soil type gradients exhibit influence on riparian vegetation dynamic [10].

Understanding of the cumulative effect of environmental gradients and land use change on the dynamics of the riparian forests has remained a subject of ecological interest. [11] discussed the cumulative effect of various environmental and human-induced factors as to how they affect riparian vegetation communities. However, the knowledge about the influence of environmental gradients to riparian vegetation is limited despite their role on determining the dynamics of the riparian forest ecosystems. Human-induced alteration on riparian forests can introduce variation on the ecosystem that influences the structure and diversity of vegetation [10]. Moreover, forest structure and diversity are dependent on the magnitude of anthropogenic activities and tend to exhibit responses that are opposite depending on their location along the environmental gradients [12].

So far, comprehensive studies in the Lake Manyara Watershed Ecosystem (LMWE) have been limited to hydrology, climate change, and socio-economic aspect of protected areas. For instance, [13] modelled water balance, [14] analysed the socio-economic values of wetland resources, [15] studied the pressure exerted by population to protected areas as a result land uses and more recently [16] analysed the impact of climate change on ground water recharge on Lake Manyara. Thus, the linkage between riparian woody plant diversity patterns, stand parameters and land use while accounting for environmental conditions remain unknown in the LMWE. To address this knowledge gap, the study aimed at 1) analysing woody plant diversity and stand parameters along a land use gradient, 2) examining woody plant structure along a land use gradient, and 3) analysing the response of woody plant diversity and stand parameters to a land use while accounting for environmental conditions. The findings of this study could contribute to informing a better land use that maintains the integrity of the riparian forests in LMWE.

2. Materials and Methods

2.1. Study Area

The Lake Manyara Watershed sub-basin (**Figure 1**) is located in the north-central part of Tanzania at 3˚25'S - 3˚48'S, 35˚44'E - 35˚53'E and has a catchment area of 7667.1 km^2. The landscape of this sub-basin is characterised by water divides and several perennial and seasonal rivers from complex of highlands in Karatu, Ngorongoro, Mbulu and Nou Forest that are drained by Lake Manyara. The most prominent tributaries are the Makuyuni, Simba, Kirurumu and Mto wa Mbu rivers. The watershed further extends to Mbulu plateau which elevates at 2135 m forming the western boundary and the southern boundary is featured by the Kwahara Mountain rising to over 2400 m. The eastern boundary lies on Lolkisale hill and the north-eastern boundary extends to the Lossimingori, Burko and Monduli.

The watershed's average precipitation varies between 700 mm to 1200 mm the east of the plain and top of the plateau respectively. The temperature ranges between 16˚C and 23˚C, and the vegetation pattern is dictated by rainfall and temperature gradients, *i.e.*, the highlands are covered with montane forests whereas the lowland/plains are dominated with sparsely distributed vegetation mostly

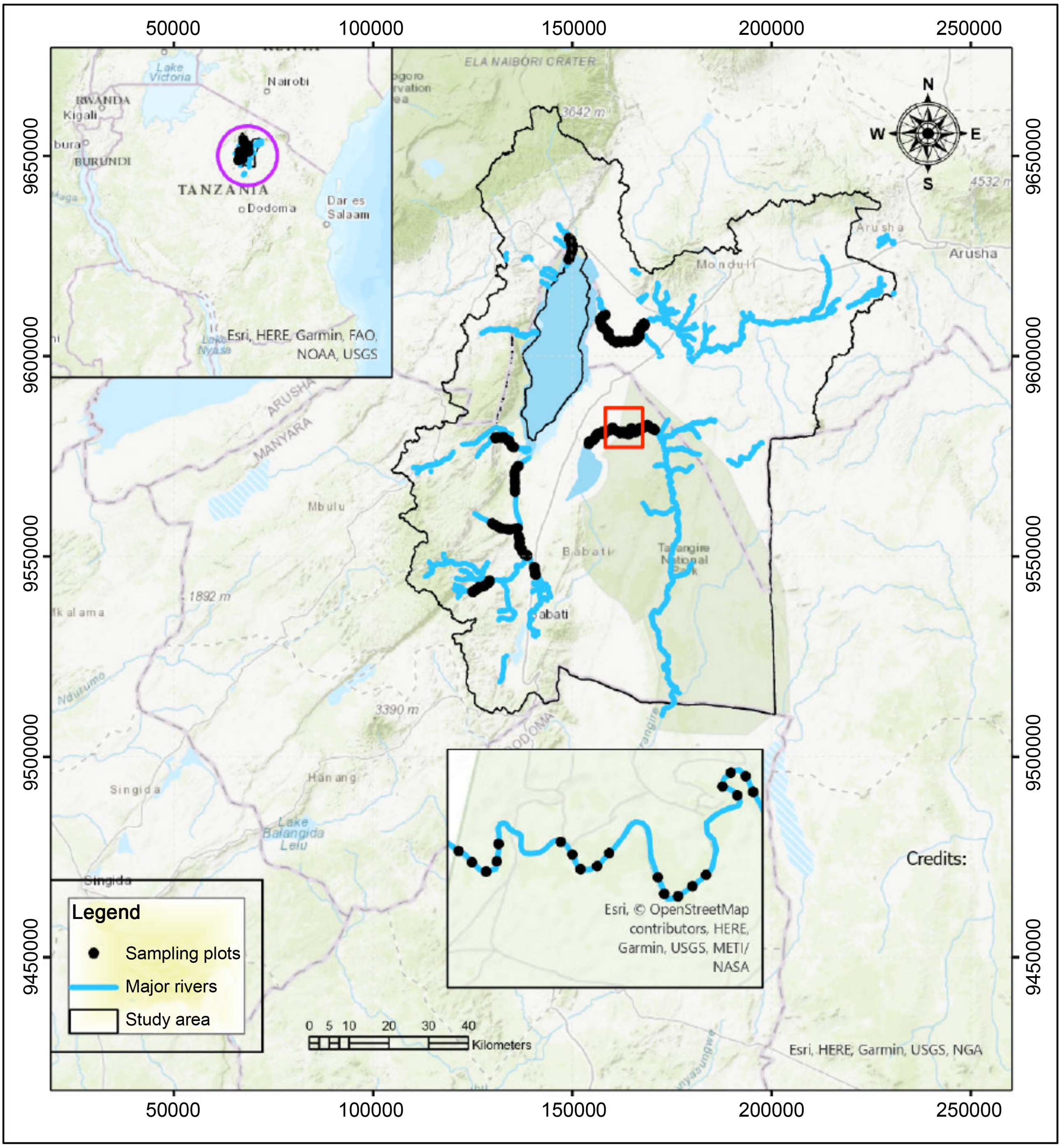

Figure 1. Map of the study area, indicating the spatial distribution of woody plants sampling sites in the LMWE. The inset in the upper left shows the location of the study area within Tanzania.

savanna type bushes and shrubs.

The boundaries of the study area were delineated using the Lake Manyara Watershed (LMW) polygon supplemented with Digital Elevation Model (DEM) acquired from ALOS PALSAR with spatial resolution of 12.5 m in the QGIS 3.10 used to estimate elevation, slope and delineate the location of rivers streams network within a 30 m buffer.

The recent trends of immigration from other parts of the country in search for opportunities like crop farming and grazing land have continued to increase the population growth in the LMWE. The land use pattern in the LMWE is dominated mainly by rural agricultural landscapes used mainly for crop farming (sugar cane, onion, sunflower, maize, sesame and peas) mixed with livestock keeping, scattered settlement and riparian forest patches. It is a landscape mosaic exploited by crop farmers and livestock keepers, thanks to conducive environment owing to fertile soils and water resources availability. Flat terrains adjacent to the rivers has remained suitable for crop farming due to deposition of alluvial soil, making the land fertile compared to the surrounding areas. The level of agricultural mechanisation is relatively low, hence putting the entire agricultural systems at subsistence level. Pastoralism is also an economic mainstay among community members in the watershed. A previous study by [15] noted a significant change in land use change relating to agriculture whereby farmland had increased by 118% between 1958-1987 and further increased by 44% in 2001 against baseline of 1987.

2.2. Riparian Woody Plant Survey

A buffer of 60 m was established along from downstream to upstream to include areas with different land use categories (*i.e.*, homegardens, crop fields, woodlots, open canopy forest and closed canopy forest) within LMWE. The land use categories have the following descriptions: 1) Homegardens—mainly dominated by agroforestry practices. Tree layers, arable and commercial crop such as banana, yams and maize; 2) Crop fields—these are characterised by both arable and commercial crops such as maize, bean, sugar cane; 3) Woodlots—these are found close to households, growing in small mosaics. Either naturally regenerated or planted; 4) Open Canopy Forest—these are found in areas where there is some decrease of human encroachment, trees are relatively sparsely stocked; and 5) Closed canopy forest—these are found in areas where there is little or no human encroachment, trees are densely stocked.

Sampling clusters were systematically established at an interval of 2 km. Within each cluster, five plots were laid out measuring 20 m × 10 m. Each plot was separated from the other by an interval of 100 m. In each plot, all woody plant equal and greater than 5 cm diameter were identified, their diameters measured at breast height (1.3 m) using a calliper and recorded. Overall, 270 plots were surveyed in the five land use types within the riparian ecosystems of LMWE, composed of closed canopy forest (n = 47 plots), Open canopy forest (n = 56 plots), homegardens (n = 17 plots), woodlots (n = 20 plots), and crop fields (n = 130 plots).

2.3. Environmental Variables

In order to understand the influence of environmental variables on species richness and abundance, and stand parameters (basal area and stock density), the centroid for each of the 270 plots was used; to quantify 1) annual temperature, annual precipitation, *WorldClim* database (https://www.worldclim.org), 2) elevation from SRTM digital elevation model from the US Geological Survey (https://earthexplorer.usgs.gov), and 3) slope, from DEM using QGIS.

2.4. Statistical Analyses

2.4.1. Woody Plant Species Diversity and Structure

To understand woody plant species diversity patterns and stand parameters within LMWE, first, the study aggregated total woody plant species richness and abundance across the land use categories. Second, the number of trees per hectare (stock density) was computed to determine how dense are the woody plants among the land use categories. Third, basal area per hectare was computed to understand the stand condition across the land use categories (Equation (1)). Afterwards, the differences in total woody plant species richness and abundance among land use categories was tested by using Analysis of Variance (ANOVA), followed by multiple comparisons Tukey's HSD test (at the $\alpha = 0.05$ level) to determine whether differences occurred between the land use categories. Finally, to understand the structure of woody vegetation across, the distribution of stand parameters (*i.e.*, stocking and basal area) was summarised among different diameter classes across the five land use categories using bar graph. All data were analysed in R 4.0.4

$$G = \pi * DBH^2 / 40000 \quad (1)$$

where: G = the basal area per hectare, DBH = the diameter at breast height (1.3 m) from the base of the tree.

2.4.2. Effects of Land Use and Environmental Variables to Woody Plant Diversity Patterns and Stand Parameters

To understand the responses of total species richness and abundance, stocking (stock density) and basal area to land use and environmental variables, a generalised linear mixed effect model (GLMM) was used. Species richness was modelled using a GLMM with Poisson error distribution in the *lme*4 R package [17]. Given that the species abundance, stocking and basal area were over-dispersed, a negative binominal generalised linear model was fitted using the MASS R package [17]. "Sites" was included as a random effect because transects were nested within sites. Before modelling, collinearity was tested and retained only variables with r < 0.7 [18] in the model.

3. Results

3.1. Woody Plant Diversity and Stand Parameters across Land Use

A total of 1954 individuals was recorded comprised of 139 woody plant species out of which only 16 species were exotics. Major vegetation types unveiled were those comprised of Vachellia/Acacia-Combretum-Commiphora in the non-riverine areas and Rauvolfia-Ficus-Albizia in the riverine areas, despite presence of exotic species. The study observations noted low level of exotic species integration especially in the homegardens, crop fields and woodlots, where farmers manage tree planting and retention. The dominant exotic species in the landscape were comprised of *Senna spectabilis, Psidium guava* and *Acrocarpus flaxinifolius*.

Species richness (ANOVA, $df = 4$, $F = 4.85$, $P \leq 0.004$), Species abundance (ANOVA, $df = 4$, $F = 3.74$, $P = 0.005$), stocking density (ANOVA, $df = 2$, $F = 4.62$, $P = 0.005$), and basal area (ANOVA, $df = 4$, $F = 4.59$, $P < 0.007$) varied significantly between all five land use categories (Table 1, Figure 2). Unexpectedly, the mean basal area was found to be higher in the woodlots, homegardens and crop fields compared to the closed and open forest canopy areas. The stocking density and species abundance was higher in the open and closed forest canopy compared to the rest.

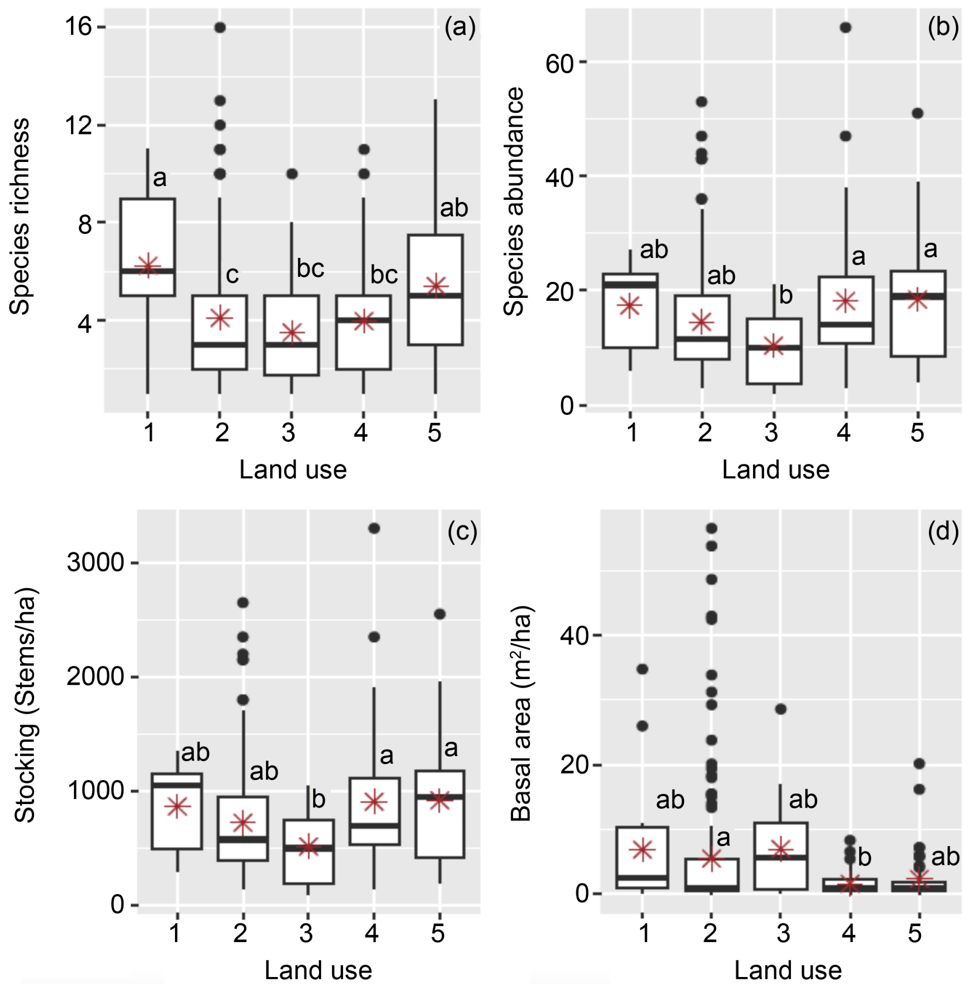

Figure 2. Box plot of (a) Species richness, (b) Species abundance, (c) Stocking density (Stem ha^{-1}) and (d) Basal area across the land use gradient (1 = Home Garden, 2 = Crop field, 3 = Woodlot, 4 = Open canopy forest, 5 = Closed canopy forest) in the LMWE. Different letters above the boxplots indicate significant differences between land use at P < 0.05 (Post-Hoc Tukey test).

Table 1. Woody plant stocking parameter (Mean Stocking Density and Mean Basal Area) across the land use gradients in the Lake Manyara Watershed.

Land use category	Species Richness (Per plot)	Species Abundance (Per plot)	Mean Stocking Density (Stems Ha^{-1})	Mean Basal Area (m^2 Ha^{-1})
Homegarden (n = 17)	6.23 ± 0.73	17.35 ± 1.82	867.64 ± 914	6.88 ± 2.36
Crop field (n = 130)	4.10 ± 0.243	14.50 ± 0.86	725.38 ± 43.00	5.50 ± 0.95
Woodlot (n = 20)	3.50 ± 0.55	10.35 ± 1.40	517.50 ± 70.17	6.98 ± 1.69
Open canopy forest (56)	3.96 ± 0.32	18.17 ± 1.53	908.928 ± 76.87	1.62 ± 0.23
Closed canopy forest (47)	5.40 ± 0.40	18.42 ± 1.53	921.27 ± 76.54	2.36 ± 0.56

3.2. Woody Plant Structure across Land Use

Across all land use categories, the tree structure shows an inverted-J shape curve (**Figure 3**). The curve slopes are steep to all land use categories except for the woodlot. Two patterns of unusual distributions were noted: 1) diameter class 2 (15 - 24.9 cm) in crop field, woodlot and open forest canopy was found to have higher number of stems exceeding class 1 (5 - 14.9 cm), and 2) higher number of stems for diameter class 10 (>95 cm) for crop field and woodlot exceeded their immediate lower classes.

3.3. Correlations among Woody Plant Diversity Patterns and Stand Parameters to Land Use and Environmental Variables

Correlation among stand parameters and environmental variables varied at significant levels. Species richness and species abundance were negatively correlated to annual precipitation but not stocking density and basal area (**Table 2**). Species richness, species abundance and stocking were negatively correlated to elevation and temperature, except for basal area. On the other hand, species richness, species abundance, stocking and basal area was found to be positively correlated to slope.

Using closed canopy as baseline land use, comparisons were made against other land uses for species richness, species abundance, stocking and basal area. Results indicated that species richness and species abundance in the crop field, home garden, open canopy forest and woodlot were lower compared to baseline land use as expected. However, basal area in the crop field, homegarden, open canopy forest and woodlot were unusually higher compared to baseline land use. Except for open canopy forest, stocking was lower in the crop field, homegarden and woodlot compared to baseline land use.

4. Discussion

4.1. Patterns of Woody Plant Species Distribution in the Study Site

The riparian landscape in the LMWE contains higher number of woody plants species, that signifies its ecological relevance. The number of woody plant species

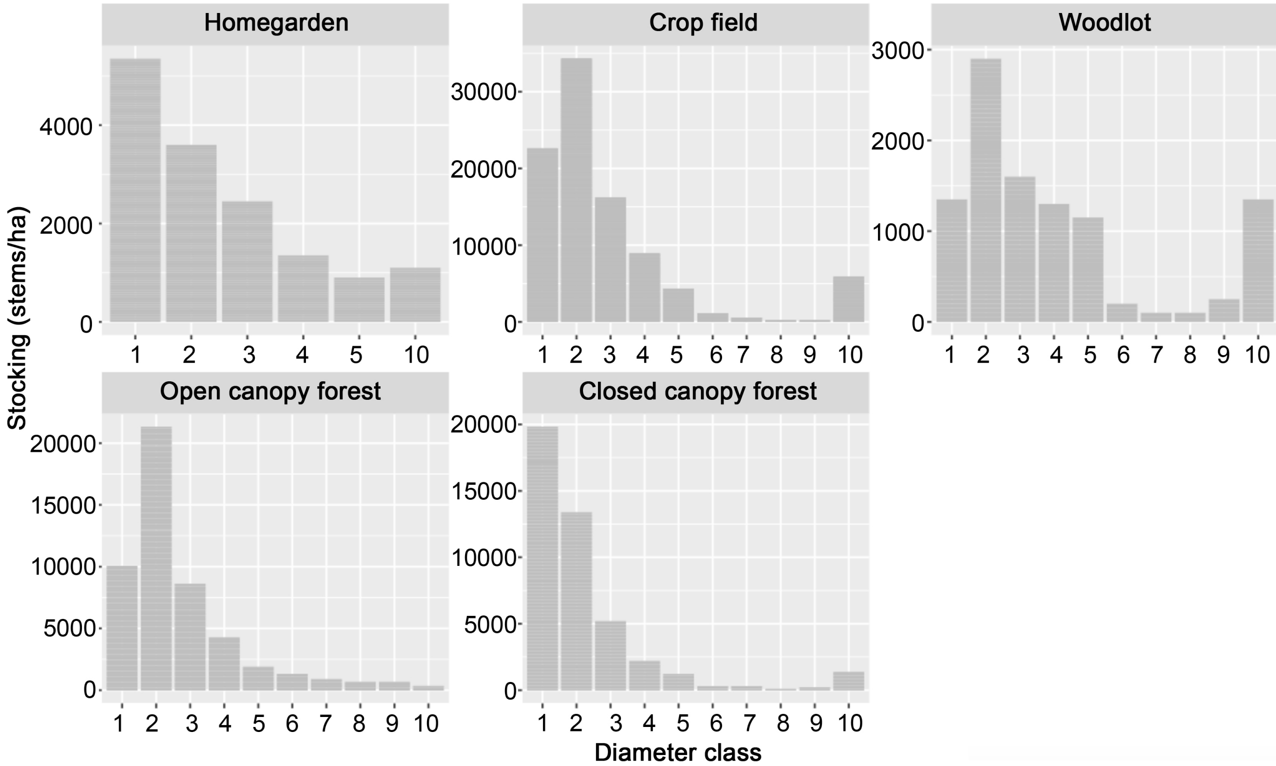

Figure 3. Distribution of number of stems by diameter class (1 = 5 - 14.9, 2 = 15 - 24.9, 3 = 25 - 34.9, 4 = 35 - 44.9, 5 = 45 - 54.9, 6 = 55 - 64.9, 7 = 65 - 74.9, 8 = 75 - 84.9, 9 = 85 - 94.9, 10 = ≥95,) across the land use gradients in the LMWE.

Table 2. Summary Statistics of GLMMs describing association between independent and dependent variables with significance levels indicated by: ***P < 0.001; **P < 0.01; *P < 0.05; ns = not significant. Land use was defined as factors (categorical variable) whereas the baseline variable is closed canopy forest.

Description	Species richness	Species abundance	Stocking	Basal Area
Intercept	11.2048***	11.5919**	15.7906***	−19.7310*
Annual Precipitation	−0.0013*	−0.1487^{ns}	0.0001^{ns}	0.0061***
Average Annual Temperature	−0.3588**	−0.3475**	−0.3574**	0.5133^{ns}
Elevation	−0.0007^{ns}	−0.0014^{ns}	−0.0014^{ns}	0.0033^{ns}
Slope	0.0006^{ns}	0.0007^{ns}	0.0008^{ns}	0.0109***
Land use: Crop field	−0.2250*	−0.1487^{ns}	−0.1492^{ns}	0.9451***
Land use: Homegarden	−0.1121^{ns}	−0.1432^{ns}	−0.1364^{ns}	1.0115**
Land use: Open canopy forest	−0.4135**	−0.0739^{ns}	0.0672^{ns}	0.5430^{ns}
Land use: Woodlot	−0.4722**	−0.4991**	−0.4985**	1.0300**

recorded was higher, nearly twice as much compared to similar multiple land use sites in other parts of Tanzania, for instance farmlands on the slopes of Mt. Kilimanjaro [19] [20]. This suggests that the riparian forests in the study site remain an important refuge for woody plant species, that merit adequate conservation attention, but also the higher number can be a result of expansive study area. Within the study site itself, the species richness as indicated by

Tukey's HSD test did not significantly differ across land use types ($P < 0.05$), though in absolute value it was higher in the homegardens compared to all other land uses (**Table 1**, **Figure 2**). Species abundance was high in the forests (closed and open canopy forests) compared to farmlands (homegarden, crop field and woodlot) though with no statistically significant differences. Patterns of species richness were not expected to these types of land uses, as forests are likely to be more stocked compared to other land uses in their proximities [5]. Overall, woody plant species density (**Table 1**, **Figure 2**) was within the range observed in other parts of Tanzania, where forest protection status is high and where homegardens has high tree stocks. A mean stocking density range observed of 600 to 900 stem ha^{-1} has been found in protected areas around the country [21].

The study speculates that the reason for near equal species richness, abundance and tree density value across the land use types in the study site is due to unbiased disturbances: mainly the extractive use (timber, woodfuel and construction material) and non-extractive use disturbances such as grazing, cultivation and settlement expansion. Homegardens and crop fields were found to have a clear pattern of marked boundaries with trees; a design which ensures planting and retention of large number of trees. The riparian forests seem to have higher recruitment potential of woody plant species owing to the more conducive environment for protection than homegardens, crop fields and woodlots. Riparian forests (closed canopy forests and open canopy forests) cover areas that are flood prone and unsuitable terrain for extensive human activities, hence providing good environment for recruitment of woody plant species. However, being outside of individual ownerships, the riparian forests are susceptible to unregulated extraction of the woody plants compared to farmlands (homegardens, crop fields and woodlots). Collective actions for protection of riparian forest are of utmost importance in the entire LMWE. An integrated land management scheme supported by bylaws and other measures could improve the protection of the riparian forests for sustainable utilization.

4.2. Patterns of Woody Plant Structure across the Land Uses

The diameter class distribution patterns of woody plant species structure in the study area expressed an inverted J-shaped curve (**Figure 3**). The riparian forests (closed and open canopy forests) in the study site are semi-natural environment, with less disturbances, hence the stand structure exhibited was expected, as also noted by other studies [22]. Our observation implies that the stand structure in the riparian forests of the current study area is characterised by large number of small-sized trees, with more than 30% of trees with dbh measured below 15 cm. Under natural condition, diameter class exhibit inverted J-shape due to natural tree recruitment, survival and growth [6]. The inverted J-shaped curve explains tree succession path, whereby as trees grows in a natural stand they succumb to selective elimination as a result of competition for resources (*i.e.*, light, water, nutrients) and diseases. High mortality rate is experienced for young trees (seedlings and saplings) and the rate diminish as trees grow in size. Therefore, our observation indicate that the structure of the woody plant species exhibited implies a healthy ecosystem as establishment, recruitment and growth are depicted by higher number of juvenile trees across the five land uses.

Exceptional case was found in the homegarden, crop field and woodlot land use types due to sharp rise of the graph at the diameter class 10 (dbh ≥ 95). This unusual sharp rise is due to high concentration of trees with large diameters. Consistently, the large-sized trees with exceptionally huge diameters have been retained to these land use types owing to their limited use in terms of extractable woody material. The ecological advantage of the large-sized trees in highly disturbed landscapes due to human modifications is to act as a reliable seed source for forest species and connecting forest patches [23]. Farmlands are normally are a result of clearance of forested land to pave way for expansion of agricultural activities and/or infrastructure development leading to dwindling of forest cover [24]. These anthropogenic pressures are considered to be the main driver of biodiversity loss and/or modification of habitats as well as influence the hydrology of landscapes [25].

Higher basal area in the farmlands (homegardens, crop fields and woodlots) (**Table 1**, **Figure 2**) in LMWE depict a common phenomenon noted by other studies in Tanzania [21], where, farmlands tend to retain large trees for multiple uses. In the LMWE, the higher basal area in the farmlands (homegardens, crop fields and woodlots) was contributed by the presence of large-sized trees mostly being *Ficus sycomorus*, *Ficus sur* and *Adansonia digitata* whose diameters were formidably large, measuring 100 - 600 cm. While exploitation of these tree species is limited due to unsuitability as a woody material, they rather play important ethnobotanical and provision of the non-wood forest products e.g., baobab seed oil and pulp. Additionally, tree of less significance in terms of timber extraction were also dominating the landscape which includes *Rauvolfia caffra*, *Albizia gummifera*, *Senna spectabilis*, *Vachellia tortilis* and *Vachellia nilotica.* On the other hand, the lower basal area in the riparian forest (closed canopy forests and open canopy forests) can be explained by growth competition among woody plant species, which restrict adequate diameter increment. Furthermore, close proximity to the rivers makes the riparian forests vulnerable from sand mining and brick making activities: causing both vegetation clearance and firewood extraction for baking; hence removal of trees of certain sizes and general deprival for adequate tree growth in size.

4.3. Correlation of the Woody Plants and Environmental Gradients

Environmental gradients (slope, elevation, precipitation and climate) tend to influence forest stand properties and results in stand dynamics, composition, recovery and structure [26]. However, the influence of elevation, slope and temperature on stand structure tend to vary in different way on the direction and magnitude of its effects [27]. In the LMWE, there are multiple and compounding environmental and anthropogenic factors that influence land use change like limited land use planning, rapid urbanisation and mushrooming of peri-urban areas/centers. Commercial farming has increased with intensive use of pesticide and industrial fertilizer application that cause pollution and lead to habitat degradation and hydrologic alteration. This observation coincides well with findings from [25] study which examined the effects of land use and environmental gradients on the diversity assemblage in lakes in China.

Species richness, species abundance and stocking density indicated negative correlation with temperature and elevation in the study site (**Table 2**). Temperature has been reported to have negative relationship with species and abundance, especially by causing water scarcity [28]. The implication of negative relationships caused by temperature is the decline of forest health as only few trees will be able to withstand the higher temperature levels. The LMWE being within the East African Rift Valley, has some areas under semi-arid (dryland) condition, which experience excessive temperature and heat waves, especially during dry season. This dry condition has direct consequence on germination, recruitment and growth of tree species. [29] attributed that high temperature tend to depress tree species as it triggers negative growth responses. Similarly, other studies have further documented that temperature (and other climate change parameters) has affected trees species range [30]. Despite warm temperature to be indispensable for higher species richness and abundance, yet excessive warm conditions become unsuitable altogether as it exceeds tolerable local minimum milder climates [31].

Basal area increased with slope, precipitation, and land use (**Table 2**), which reflect the intensity of competition among individual trees whereby large sized ones has potential contribution as result of reduced removal and/or mortality at higher versus lower slopes. This finding is in line with the observation from other studies such as [32] which investigated the influence of temperature and stand basal area interaction on the growth of tree species. The role of basal area in forest management and ecology is closely related to forest stand and volume competition that dictates the health of the tree vegetation [33]. There have been observations across Tanzania, where a general pattern of basal area increases with increasing elevations due to increase of precipitation especially in mountainous areas [34] [35].

These observations translate that high temperatures lead to sparse distribution of vegetation, while basal area in large sized trees are positively associated with homegardens, crop fields and woodlots. Rainfall variability and slope are primary factors limiting basal area patterns, while temperature, elevation and land use tend to influence the stocking density, species richness and abundance in decreasing ways.

5. Conclusion

This study revealed that species richness, abundance, basal area and stocking density were influenced by both land uses and environmental gradients. Land use influenced riparian woody plants composition and stand parameters as they are contributed by human selective use and retention. A clear pattern was observed of large basal area in the farmlands (homegardens, crop field and woodlots) while higher level of stocking density and species abundance for the forests (open and closed forest canopy). Environmental variables influenced the structure and distribution of the woody plants where temperature, precipitation and elevation but not slope had negative correlation with species diversity (richness and abundance). Stand parameters (stocking density and basal area) were positively correlated to precipitation and slope, while temperature and elevation had negative correlation with stocking density but positive correlation with basal area. In order to protect riparian woody vegetation in LMWE in the future, it is necessary to undertake strategic land use planning and moderate land use dynamics through sustainable land management practices.

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Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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